Appendix G

Pit Void Water Quality Report

R E P O R T

McArthur River Mine Expansion, Evaluation of Pit Void Water Quality

Prepared for

Xstrata

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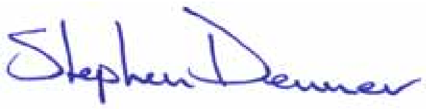

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The proposed open pit will intersect the McArthur River and Barney Creek, which will require diversion using bunds during mining. It is known that the main channel of the McArthur River contains up to 30 m of saturated alluvial sediments, which will be exposed in the uppermost pit wall. Similarly, shallow saturated alluvial sediments may also exist where the pit intersects Barney Creek. These alluvial sediments may locally have high permeability due to the presence of sand and gravel deposits. Underlying the alluvial sediments is weathered and fresh bedrock, which contain local aquifer zones in sub-vertical structures.

Xstrata requested URS undertake modelling of the final void water quality in the proposed open pit to predict the water volume and water quality for the four proposed closure scenarios for the pit.

Water balance and geochemical modelling were undertaken for the following McArthur River Mine pit closure scenarios:

1. **Do nothing** – Let the pit fill naturally from groundwater inflows and direct rainfall, together with tailings dam seepage pumped to the pit. No surface water inflows to the pit from the McArthur River will occur.

2. **Breach the diversion bunds to facilitate filling the pit quickly from surface water inflows, then re-establish the bund permanently** – Stream flow from the McArthur River is allowed to enter the pit for the first 15 months of the simulation (i.e. until the pit is full) only. For simplicity, stream flow from other streams in the area, which is small in relation to McArthur River, is ignored.

3. **Breach the bund permanently and allow surface water to flow through the pit area** – All stream flow in the McArthur River is allowed to enter the pit and overflow downstream.

4. **Do nothing but allow the overtopping of diversion channel to enter the pit** – Stream flow overtopping the McArthur River diversion channel is allowed to enter the pit and overflow downstream. This is likely to occur in floods with a peak discharge greater than about 400 m3/s, which has an ARI (Average Recurrence Interval) of about 2 years.

Water Balance Modelling

Water balance modelling was undertaken to estimate the steady-state water levels in the pit for the various closure scenarios.

In Scenario 1, groundwater slowly fills the pit to stabilise at about 74 GL, about 196 m deep, and well below the capacity of the pit. Results indicate that it is likely to take some 69 years for water levels to stabilise. An advantage of this scenario is that the pit will never overflow as a result of seepage inflow and rainfall alone. A disadvantage is that water quality in the pit will continuously decline as a result of concentration by evaporation. Should the flood protection bunds around the pit fail, the pit could be filled with river water and consequently the concentrated-quality pit water, mixed with the stream flow, could be released to the environment.

In Scenarios 2 and 3, the pit fills rapidly with river water, probably within 1-2 years. The volume of the pit (83 GL) is less than the average annual stream flows in the McArthur River (595 GL) and the median flows (379 GL), so rapid filling of the pit is likely. Once stream flow is excluded from the pit in Scenario 2, the water level falls slowly to stabilise at around 74 GL, approximating the regional groundwater table (20 m below the pit rim). The quality of water in the pit will subsequently concentrate as a consequence of evaporation, and the pit is at risk of overtopping from a bund failure, as with Scenario 1.

In Scenario 3, once the pit is full it will remain close to full and regular flushing will ensure that the quality of water in the pit is similar to the quality of the river water. Stream flow into the pit will always be substantially greater than evaporation over the dry winter season, so the pit water level will only drop a short distance over winter and the pit will be quickly refilled during the first flows of the wet season. Seepage inflows will be negligible with this scenario because the water level is typically above the regional water table level. Seepage outflows are predicted to be small relative to stream flows. Any concentration by evaporation of salts and metals in the pit over the winter dry season is likely to be relatively small due to high volumes of stream inflows, and will be flushed the following summer.

A potential disadvantage with Scenario 3 is that coarse sediment is likely to settle in the pit and the pit may absorb low flows; potentially affecting the downstream environment. Downstream ecology may rely on nutrients or habitat that is influenced by the movement of coarse sediment (i.e. bed load) during floods. Water exiting the pit may have a higher capacity to entrain sediment, possibly causing erosion of the channel downstream of the pit. Extraction of low flows, e.g. during the tail of the wet season or as a result of winter rainfall events, may impact on any downstream ecosystems that rely on these flows. Assuming bed load settles in the pit and average annual flows, the pit will fill at about 2.85 m per year. Accordingly, to completely fill the pit will take approximately 77 years.

In Scenario 4, where only floods greater than a 2 year ARI enter the pit, there is more variation in pit water levels than with Scenario 3, but the pit still remains close to full. Even the reduced inflows from the McArthur River are still considerably larger than evaporation or seepage outflows from the pit. The main advantage of this scenario over Scenario 3 is that most low flows, including bed load, can continue to move through the diversion channel, thus bypassing the pit. While some sediment will be collected in the pit during floods, it is not likely to be as much as with Scenario 3, so impacts on the downstream environment are likely to be less.

The contribution of smaller streams near the pit has not been considered in this analysis, but it may be important to allow bed load sediment and small flows from these streams to bypass the pit in a similar manner as for the McArthur River.

Mass Balance Modelling

Mass balance modelling was undertaken to investigate the water quality in the final void. Sulfate was selected as the key indicator parameter as it is relatively non-reactive and is generally stable when water of variable pH levels are mixed.

Results of mass balance modelling of sulfate concentrations generally indicate that the sulfate concentrations will increase steadily under Scenario 1, as a consequence of groundwater inflow and evaporation. Model results (average case) indicate that from 33 years to 99 years after closure the sulfate concentrations (selected key indicator parameter) are likely to almost double from 3,700 mg/L to 6,500 mg/L. This is considerably higher than typical McArthur River concentrations which are about 10 mg/L (maximum of 100 mg/L). Should the flood protection bunds around the pit fail, the pit could be filled with river water and consequently the concentrated-quality pit water, mixed with the stream flow, could be released to the environment. Although it will take approximately 69 years before the open pit is completely full, Scenario 1 is not considered to be an acceptable option, as there is always a danger for flooding of the pit, which would result in the release of low quality pit water to the environment. Although dilution of this pit water with the flood water will reduce the concentration of sulfate (and other chemical compounds), there is still the risk that the surrounding environment may be adversely impacted.

In Scenario 2, the water quality in the open pit will concentrate gradually with time, once the pit has been filled with river water during the first one to two years following mining. However, the buffering capacity of the river water used to fill the open pit results in a reduced sulfate concentration (selected key indicator parameter) in the final void water, when compared to Scenario 1. Based on application of a best-fit regression to the modelled data (average case), it is likely that the sulfate concentration in the open pit from 33 years to 99 years after closure will increase from 1,400 mg/L to 4,600 mg/L, which is considerably higher than that of existing McArthur River concentrations (in the order of 10 mg/L, maximum of 100 mg/L). As for Scenario 1, should the flood protection bunds around the pit fail, the pit could be filled with river water and consequently the concentrated-quality pit water, mixed with the stream flow, could be released to the environment.

Under Scenarios 3 and 4, sulfate concentrations in the open pit are buffered by the regular (Scenario 3) or occasional (Scenario 4) inflow of river water. In general, the sulfate concentrations remain close to the sulfate concentrations in the river water. The buffering effect of the river water becomes apparent after several months (Scenario 3) or years (Scenario 4), as the water quality in the final void is the same for the best, average and worst cases modelled.

In Scenario 3, the water quality in the pit will be regularly flushed with river water which has a buffering effect on the water quality in the pit, whereby the concentrations of parameters in the pit will remain low and close to levels in the river water. However, throughflow of the river water may result in coarse sediment settling in the pit and the pit may absorb low flows; potentially affecting the downstream environment.

Geochemical Modelling

Geochemical modelling was undertaken to investigate the water quality and speciation that is likely to occur from the mixing of different water types. Based on the modelled saturation indices, the following minerals could precipitate under Scenario 1 and Scenario 2 in both the best case and worse case models:

- $Fe(OH)3$
- Goethite
- Jarosite-K
- Hematite

In addition, the SI for gypsum is close to zero under Scenario 1, and there is a possibility that gypsum may precipitate due to evaporation. Of the above minerals, $Fe(OH)_3$, goethite and hematite could precipitate under Scenarios 3 and 4.

Recommended Pit Closure Scenario

Based on the results of all of the modelling outcomes, the pit closure scenario with the lowest potential to impact the environment, is Scenario 4:

> **Do nothing but allow flow overtopping the diversion channel to enter the pit** – Stream flow overtopping the McArthur River diversion channel is allowed to enter the pit and overflow downstream. This is likely to occur in floods with a peak discharge greater than about 400 m^3/s, which is an ARI (Average Recurrence Interval) of about 2 years.

Upon pit closure water quality and levels should be monitored and periodically assessed to determine actual water balance and geochemical mixing outcomes.

1.1 Background

McArthur River Mining (MRM) is planning to convert its existing underground mine to an open cut mine. The proposed open pit will intersect the McArthur River and Barney Creek, which will require diversion during mining using bunds. It is known that the main channel of the McArthur River contains up to 30 m of saturated alluvial sediments, which will be exposed in the uppermost pit wall. Similarly, shallow saturated alluvial sediments may also exist where the pit intersects Barney Creek. These alluvial sediments may locally have high permeability due to the presence of sand and gravel deposits. Underlying the alluvial sediments is weathered and fresh bedrock, which contain local aquifer zones in sub-vertical and sub-horizontal structures.

Consideration has been given to the following potential pit void water management and closure scenarios at the end of mine life:

1. Do nothing **-** let the pit fill naturally from groundwater inflows and direct rainfall, together with tailings dam seepage pumped to the pit.

2. Breach the diversion bund temporarily to facilitate filling the pit quickly from Macarthur River inflows, then re-establish the bund permanently.

3. Breach the diversion bund permanently and allow the McArthur River to fill and flow through the pit area.

4. Breach the flood protection bund to allow flood flows which overtop the diversion channel to enter the pit (ARI about 2 years).

1.2 Scope of Work

The aim of the study was to evaluate the likely levels and quality of water in the pit and exiting the pit for the various closure scenarios. The study involved the following tasks:

- **Task 1 – Data Review** – sourcing and reviewing the information to characterise the hydrogeology and hydrology of the pit.

- **Task 2 – Water Balance Modelling** – simulation of water levels in the pit and the contribution of the various inflows and outflows to the pit water balance for the various scenarios.

- **Task 3 - Geochemical Modelling** – simulation of the final water quality for the scenarios based on results of the water balance modelling.

- **Task 4 – Reporting** – preparation of a report summarising the methods used in the study; input parameters; assumptions; results of the water balance and water quality simulations; predicted chemical composition of the final void water; and recommendations for further work.

2.1 Scenarios Modelled

The pit closure scenarios modelled for the end of mine life were:

5. **Do nothing** – Let the pit fill naturally from groundwater inflows and direct rainfall, together with tailings dam seepage pumped to the pit. No surface water inflows to the pit from the McArthur River will occur.

6. **Breach the diversion bunds temporarily to facilitate filling the pit quickly from McArthur River inflows, then re-establish the bund permanently** – Stream flow from the McArthur River is allowed to enter the pit for the first 15 months of the simulation (i.e. until the pit was full). For simplicity, flow into the pit from other streams in the area (which is small in relation to McArthur River) is ignored.

7. **Breach the bund permanently and allow the McArthur River to flow through the pit area and isolate the diversion channel from river flows** – All stream flow in the McArthur River is allowed to enter the pit and overflow downstream, eventually re-joining the river downstream of the diversion.

8. **Breach the flood protection bund to allow flood flows which overtop the diversion channel to enter the pit** – Flood flows overtopping the McArthur River diversion channel are allowed to enter the pit and overflow downstream. This is likely to occur in floods with a peak discharge greater than about 400 m^3/s, which has an ARI (Average Recurrence Interval) of about 2 years.

2.2 Water Balance and Geochemical Models

The study was undertaken using a combination of water balance and water quality modelling.

Initially, a water balance model (programmed in STELLA) was used to estimate:

- The steady-state water levels in the pit for the various closure scenarios;
- The contribution of the various inflows and outflows to the pit water balance; and
- The time for pit water levels to stabilise after mining concludes and the closure strategy is implemented.

Subsequently, water quality modelling was used to estimate the quality of the pit water for the various closure scenarios. The first step in the water quality modelling involved the development of a mass balance water quality model, based on the components and values of the STELLA water balance model. This water quality model can be used to assess the temporal changes in the concentration of specific compounds, taking into account mixing water from different sources (e.g. rainfall, groundwater inflow, etc.). The model is a mass balance model and, as such, only takes into account the processes of mixing, dilution and concentration. It does not simulate any chemical reactions (e.g. redox reactions, precipitation, solution, etc.) that may occur due to the mixing of these different waters. The second step in the water quality modelling involved geochemical equilibrium modelling using PHREEQC, (USGS, 1999) to estimate average water quality in the final void and to assess the likelihood of precipitation of minerals.

2.3 Data Inputs

A summary of the data requirements for the water balance modelling, and its availability and/or source, is provided in **Table 1**.

Table 1
Data Requirements/Availability – Water Balance Modelling

Data Requirement	Availability/Source
Rainfall	Monthly rainfall and evaporation at MRM, station number GS907132, measured by the Bureau of Meteorology and supplied by Kellogg Brown and Root Pty Ltd covering the period 1/1/1970 to 31/12/2002.
Evaporation	
Surface Water Flow	Daily streamflow in the McArthur River at the MRM pump, gauging station number GS907132 014074, measured by the Department of Infrastructure, Planning and the Environment and supplied by Kellogg Brown and Root Pty Ltd covering the period 1/1/1970 to 31/12/2002.
Pit Geometry (incl. depth-volume-surface area relationships)	Data supplied by MRM.
Pit Geology	Sourced from current URS dewatering study.
Groundwater Pit Seepage	Sourced from current URS dewatering study.
Tailings Dam Seepage Inflow	Sourced from current URS tailings dam study.

A summary of the data requirements for the water quality modelling, and its availability and/or source, is provided in **Table 2**.

Table 2
Data Requirements/Availability – Water Quality Modelling

Data Requirement	Availability/Source
Water Balance Components, Rates and Volumes	Derived from the STELLA water balance model, developed by URS for the current EIS study.
Water Quality Data	
• Groundwater Quality including Tailings Dam Seepage	Available groundwater quality data and information, from existing monitoring program. Some additional groundwater sampling and analysis specific to the modelling was undertaken in April 2003.
• Surface Water Quality	Available surface water quality data and information, from existing monitoring program. Some additional groundwater sampling and analysis specific to the modelling was undertaken in April 2003.
• Rainfall Water Quality	Sourced from previous study (CSIRO, 1999).
• Host-Rock Leachability	Sourced from kinetic leaching study undertaken by URS as part of the previous EIS study.

It should be noted that the results of the void water quality modelling are dependent on the quality and availability of the input data and as such comments relevant to the quality of the data have been made in later sections of the report.

3.1 Data Inputs

The pit water balance was simulated using the STELLA programming language (High Performance Systems Inc., 2003). STELLA is a programming language suited to the simulation of time-based cause-effect systems. A dynamic simulation with a monthly time step was used.

The water balance model was used to simulate water quality in the final void under the four closure scenarios described in **Section 2.1**.

The following inflows and outflows were considered in the water balance model:

- Inflows to the pit from rainfall, stream flow from the McArthur River and Barney Creek, groundwater seepage, and diverted tailings dam seepage; and
- Outflows to seepage, stream flow to the McArthur River and Barney Creek, and evaporation.

The pit geometry data are given in **Table 3**.

Estimated pit seepage inflow/outflow rates are given in **Figure 2-1**.

Table 3
Pit Geometry

Elevation (m AHD*100)	Water depth (m)	Surface area (ha)	Cumulative volume (GL)
9820	0	0	0.00
9840	20	8	1.43
9860	40	15	4.33
9880	60	22	8.72
9900	80	29	14.34
9920	100	35	21.25
9940	120	41	29.50
9960	140	47	39.04
9980	160	55	49.93
10000	180	62	62.31
10020	200	69	76.10
10030	210	73	79.53
10040	220	77	82.95

Source: MRM.

3.2 Results of Water Balance Modelling

This section presents the results of the modelling and based on these results an interpretation of the likely impacts of the closure scenarios.

Table 4 summaries the stream flow and weather input to the water balance model. Most stream flows in the McArthur River at the mine site occur between December and March. Stream flows are large and variable. **Figure 3-1** shows that flows in very wet and very dry years can vary substantially from the median. Up to 640 GL has can been received in very wet years, more than the annual average flow. The coefficient of variation in annual flows is 89%.

Figure 3-2 shows the quality of stream flow for the McArthur River, derived from observed data supplied by MRM. The data indicate significant seasonal fluctuations in water quality. Sediment load is highest during wet periods and is highly influenced by large events. Note there were few observations of sediment load, so the data in **Figure 3-2** are estimated and may be an underestimate. Bed load was estimated to be high during high-flow events and floods.

Salt loads (TDS and SO_4) tend to increase over the dry winter as evaporation concentrates salts in pools. Flushing by fresh stream flows tends to lower average salt loads during the summer wet season.

Concentrations of copper, lead and zinc tend to increase during winter as a result of entrainment by stream flows from bed sediments and mineralised zones close to the surface. These metals tend to precipitate out of the water column during the dry season as a result of the increasing alkalinity, collecting in the bed sediments.

Table 4
Average Stream Flow in the McArthur River and Weather at MRM

Month	Streamflow (GL/mth)	Rainfall (mm/mth)	Pan Evaporation (mm/mth)	Daily Maximum Temperature (°C)	Daily Minimum Temperature (°C)	Daily Relative Humidity (%)
Jan	111.05	176.6	229.4	35.8	24.8	60.5
Feb	225.84	181.4	193.2	35.2	24.7	63.5
Mar	163.90	146.1	207.7	35.0	23.1	57.5
Apr	11.06	31.3	216.0	34.5	20.2	43.5
May	4.18	9.1	195.3	32.4	16.5	39.5
Jun	2.76	1.7	174.0	29.8	12.6	37.0
Jul	1.35	3.5	186.0	29.7	12.2	36.5
Aug	0.80	0.1	223.2	32.0	13.5	35.0
Sep	0.69	6.7	261.0	34.7	16.6	34.5
Oct	3.25	15.6	306.9	37.6	20.7	35.0
Nov	7.47	55.4	309.0	38.6	24.1	43.0
Dec	62.72	120.8	282.1	37.6	24.8	50.5
Sum	595.1	748.3	2,783.8			
Average				34.4	19.5	44.7

19-29 years of record.

Figure 3-3 plots the predicted volume of water in the pit for the simulation period (based on 1970-2002 rainfall records), starting from an empty pit. **Figure 3-3** plots predicted volumes and **Table 5** summarises the water balance for the steady state condition. The steady-state condition occurs once pit water levels have stabilised, which takes different periods of time for the different scenarios.

In Scenario 1, groundwater slowly fills the pit to stabilise at about 74GL, approximately 196 m deep, below the capacity of the pit. The rate of groundwater seepage into the pit slows as the water level rises, and the water level stabilises at the point that net evaporation matches seepage inflow. Results indicate it is likely to take some 69 years for water levels to stabilise. An advantage of this scenario is that the pit will never overflow as a result of seepage inflow and rainfall alone. This scenario does not involve extraction of any stream flows. A disadvantage is that water quality in the pit will continuously decline as a result of concentration by evaporation. Should the flood protection bunds around the pit fail, the pit could be filled with river water and consequently the poor-quality pit water, mixed with the stream flow, could be released to the environment.

In Scenarios 2 and 3, the pit fills rapidly with river water, probably within 1-2 years. The volume of the pit (83 GL) is less than the average annual stream flows (595 GL) and the median flows (379 GL) in the McArthur River, so rapid filling of the pit is likely.

Once stream flow is excluded from the pit in Scenario 2, the water level falls slowly to stabilise at around 74 GL. The water level falls because of seepage out of the pit when the water level is above the regional groundwater table (20 m below the pit rim) and the excess of evaporation over inflows when the pit water level is at or just below the regional groundwater table. The quality of water in the pit will concentrate as a consequence of evaporation, and the pit is at risk of overtopping from a bund failure, as with Scenario 1.

In Scenario 3, once the pit is full it will remain close to full and regular flushing will ensure the quality of water in the pit is similar to the quality of the river water. Stream flow into the pit will always be substantially greater than evaporation over the dry winter season, so the pit water level will only drop a short distance over winter and the pit will be quickly refilled during the first flows of the wet season. Seepage inflows will be negligible with this scenario because the water level is typically above the regional water table level. Seepage outflows are predicted to be small relative to stream flows. Any concentration by evaporation of salts and metals in the pit over the winter dry season is likely to be relatively small due to high volumes of stream inflows, and will be flushed the following summer.

A potential disadvantage with Scenario 3 is that coarse sediment is likely to settle in the pit and the pit may absorb low flows, potentially affecting the downstream environment. Downstream ecology may rely on nutrients or habitat that is influenced by the movement of coarse sediment (i.e. bed load) during floods. Water exiting the pit may have a higher capacity to entrain sediment, possibly causing erosion of the channel downstream of the pit. Retention of low flows in the pit, e.g. during the tail of the wet season or as a result of winter rainfall events, may impact on any downstream ecosystems that rely on these flows. Furthermore, the diversion channel which by then will have developed a functional riverine ecosystem will be isolated from river flows, while a new riverine ecosystem will need to be established along the river channels flowing into and out of the pit.

The pit is not likely to fill quickly with sediment with Scenario 3. Assuming bed load settles in the pit and average annual flows, the pit will fill at about 2.85 m per year. Accordingly, to completely fill the pit will take approximately 77 years.

With Scenario 4, where only floods greater than a 2 year ARI enter the pit, there is more variation in pit water levels than with Scenario 3, but the pit still remains close to full. Even the reduced inflows from the McArthur River are still considerably larger than evaporation or seepage outflows from the pit. The main advantage of this scenario over Scenario 3 is that most low flows, including bed load, can continue to move through the diversion channel, thus bypassing the pit. While some sediment will be collected in the pit during floods, it is not likely to be as much as with Scenario 3, so impacts on the downstream environment are likely to be less.

The contribution of smaller streams near the pit has not been considered in this analysis, but it may be important to allow bed load sediment and small flows from these streams to bypass the pit in a similar manner as with the McArthur River.

Table 5
Predicted Pit Water Balance, Steady State

Scenario	McArthur R Stream Flow In	Rainfall In	Seepage In	Tailings Seepage In	Seepage Out	Evaporation Out	Overflow Out	Volume Of Water In Pit
1. No inflow from McArthur River								
Average (GL/year)	0.00	0.55	1.18	0.07	0.00	1.73	0.00	74.41
Inflows - proportion of total (%)	0	30.5	65.4	4.0				
Outflows - proportion of total (%)					0	100	0	
2 Initial inflow only from McArthur River								
Average (GL/year)	22.17	0.55	0.92	0.07	0.05	1.76	21.83	75.87
Inflows - proportion of total (%)	93.5	2.3	3.9	0.3				
Outflows - proportion of total (%)					0.2	7.5	92.3	
3 Permanent inflow from McArthur River								
Average (GL/year)	595.07	0.55	0.00	0.07	0.92	1.92	592.78	82.63
Inflows - proportion of total (%)	99.9	0.1	0	0				
Outflows - proportion of total (%)					0.2	0.3	99.5	
4 Overbank inflow from McArthur River								
Average (GL/year)	111.64	0.55	0.04	0.07	0.51	1.89	109.89	81.35
Inflows - proportion of total (%)	99.4	0.5	0	0.1				
Outflows - proportion of total (%)					0.5	1.7	97.9	

4.1 Mass Balance Modelling

4.1.1 Introduction

The mass balance modelling was undertaken to assess the temporal changes in final void water quality, based on the flows in and out of the pit (as determined through the water balance modelling). The model simulates end-point concentrations of specified compounds from the mixing of water from different sources and with different water quality. The mass balance model was used to simulate water quality in the final void under the four closure scenarios described in **Section 2.1**.

The mass balance model was used to model the concentration of a specific compound with time for each scenario. Monthly time steps were adopted in the model. Scenario 1 was modelled for a total period of 1188 months or 99 years. Scenarios 2 to 4 were modelled for a total period of 396 months or 33 years. Scenario 1 was modelled for longer than Scenarios 2 to 4 due to the greater time required for steady state water level conditions to be achieved, however the results of the mass balance modelling of Scenario 1 at 33 years are also provided for comparison with the other scenarios.

It should be noted that the mass balance model does not incorporate chemical reactions that may occur due to the mixing of different types of water. Geochemical equilibrium modelling was undertaken as a separate exercise and is described in **Section 4.2**.

4.1.2 Data Inputs

The data inputs for the mass balance modelling include the water balance components and flows, and water quality data.

Water Balance Components and Flows

Water balance components and flows were obtained from the STELLA water balance model. The water balance components incorporate the following :

- Stream inflow from the McArthur River.
- Rainfall into the open pit.
- Groundwater seepage into the open pit.
- Tailings dam seepage pumped to the open pit.
- Groundwater seepage out of the open pit.
- Evaporation from the open pit.
- Overflow from the open pit.

Water Quality Data and Information

The water quality information has been sourced from a variety of sources, and includes the following :

- Groundwater quality data.
- Surface water quality data.
- Rainfall water quality data.
- Host-rock leachability and leachate water quality data.

Groundwater Quality Data

A network (including both regional and local locations) of groundwater monitoring bores has been established by MRM to monitor the impacts of the current mining operations on the groundwater resources of the area. Groundwater monitoring has been on-going at and in the vicinity of the site since 1995.

Additional groundwater monitoring was undertaken in selected monitoring bores by URS in April 2003, as part of this study. The purpose of this monitoring was to investigate groundwater and surface water physical and chemical field-measured parameters, major ions, heavy metals and nitrate-nitrite concentrations. The results of this groundwater monitoring are presented in **Table 6**.

Table 6
Groundwater Quality – 17 April 2003

Parameter	Units	GW1A	GW2	GW3	GW5	GW15
Depth	mbgl	20.19	7.75	9.83	5.20	8.00
Physico-chemical Parameters (field measurements)						
pH	-	6.84	7.00	6.82	7.30	7.88
Dissolved Oxygen	ppm	1.42	1.96	1.38	1.7	2.69
Redox Potential	mV	170	-165	-210	109	117
Temperature	ºC	31.9	30.6	31.8	33.7	32.2
Electrical Conductivity	µS/cm	2558	2600	2600	1473	1670
Major Ions						
Bicarbonate	mg/L	418	462	389	434	512
Calcium	mg/L	195	216	371	276	93.4
Carbonate	mg/L	<1	<1	<1	<1	<1
Chloride	mg/L	175	73.8	137	124	78.3
Magnesium	mg/L	156	178	211	439	142
Potassium	mg/L	7.3	9.5	57	36.4	9.8
Sodium	mg/L	153	158	137	435	124
Sulfate	mg/L	622	888	1370	1600	215
Fluoride	mg/L	0.7	0.5	0.4	1.6	0.9
Metals						
Arsenic	µg/L	4.7	6.25	2.4	5.45	9.3
Barium	µg/L	58	104	100	95	144
Cadmium	µg/L	0.08	<0.04	0.66	0.12	0.46
Copper	µg/L	3.08	2.78	2.57	7.72	2.99
Iron	µg/L	100	1000	<100	<100	60
Lead	µg/L	0.47	0.34	1.71	3.44	34.3
Silver	µg/L	<0.1	<0.1	<0.25	<0.25	<0.1
Tellurium	µg/L	0.22	0.02	1	13.7	3.84
Zinc	µg/L	30.9	3.1	208	103	272
Nutrients						
Nitrate as N	mg/L	1.15	0.03	3.11	49.1	35.5
Nitrite as N	mg/L	<0.005	0.01	0.01	0.235	0.09

Surface Water Quality Data

Surface water quality monitoring has been undertaken in the vicinity of the mine site since 1975, with regular monitoring of the water quality in the McArthur River upstream from the mine site (at location SW7).

Rainwater Quality Data

The quality of rainfall water is not routinely monitored by the Bureau of Meteorology. Some rainfall water quality data are available from a study undertaken by CSIRO in 1999. This study included the sampling and analysis of rainfall water at several location within the vicinity of Mt Isa and in Darwin.

The rainwater analysis results are presented in **Table 7**.

Table 7
Mean Rainwater Analysis Results (after CSIRO, 1999)

	Units	C1 19.7 km to NW	C11 52.7 km to NW	C38 52.2 km to E	Darwin 1,300 km to NW
Rainfall	mm	555	395	603	2043
pH		4.59	4.71	4.77	4.95
Hydrogen	µg/L	25.80	19.86	17.24	11.39
Sodium	µg/L	158.63	154.03	101.15	356.34
Potassium	µg/L	58.65	62.56	35.19	43.01
Magnesium	µg/L	31.60	46.18	26.74	43.75
Calcium	µg/L	100.20	116.23	60.12	32.06
Ammonia	µg/L	57.72	63.13	50.51	122.66
Chloride	µg/L	237.54	202.08	155.99	652.34
Nitrate	µg/L	378.23	285.22	328.63	229.42
Sulfate	µg/L	778.11	643.62	403.46	230.55
Non sea salt Sulfate	µg/L	739.68	605.19	374.64	144.09

Note: Means derived from all available data (i.e. 12 month means, 9th September 1997 – 8th September 1998).

Host-rock Leachability and Leachate Water Quality Data

An assessment of the host-rock leachability and the water quality of leachate water was undertaken as part of the geochemical assessment study of overburden and tailing materials, as reported in "*Geochemical Assessment of Overburden and Tailing Materials Including Conceptual Design of Overburden Emplacement Area. Appendix to EIS for Proposed Expansion of McArthur River Mine*" (URS, 2005).

The study included kinetic leach column tests undertaken on different types of material and overburden and analysis of leachate water to determine the geochemical characteristics of these materials. Reference is made to the above-mentioned report for detailed information on this study.

The information relevant to the mass balance modelling includes the following :

- Based on an assessment of available drill cores and of the geochemical characteristics of samples of the overburden material, it appears that approximately 10% of the material in the walls of the final void will be Potentially Acid Forming (PAF) material, whilst 90% will be Non-Acid Forming (NAF) material.

- Analysis results of leachate water from column leach tests undertaken on two samples from the PAF material are presented in **Table 8** and **Table 9**. With respect to sulfate (which can be used as an indicator analyte), the leachate analysis results from sample MRM1 indicate that sulfate concentrations increase with time in the leachate water, with concentrations up to about 12,600 mg/L after 74 weeks.
- Analysis results of leachate water from column leach tests undertaken on two samples from the NAF material are presented in **Table 10** and **Table 11**.

Table 8
Column Leach Test Results for Sample MRM1 (PAF Lower Pyritic/Dolomitic Shale)

	16/01/03	6/02/03	6/03/03	3/04/03	24/04/03	19/06/03	15/10/03	17/12/03	4/03/04	16/06/04	10/11/04	9/02/05
Volume Leached (L)	0.38	0.42	0.38	0.34	0.4	0.42	0.4	0.39	0.38	0.382	0.372	0.4
Cum. Volume (L)	0.38	1.38	2.22	2.56	2.96	3.78	4.18	4.57	4.95	5.332	5.704	6.104
Pore Volumes	0.3	1	1.6	1.9	2.2	2.8	3.1	3.4	3.7	3.9	4.2	4.5
pH	7.11	6.81	6.49	6.29	5.17	5.51	5.73	6.12	4.38	3.98	4.09	4.04
EC (μS/cm)	2,177	3,740	5,560	5,500	5,770	4,610	4,340	2,350	10,200	10,300	9,180	8,550
Acidity (mg/L)	17	7	29	50	46	53	304	500	613	559	961	1550
Alkalinity (mg/L)										0	0	0
Dissolved Elements (mg/L)												
Aluminium	<0.1	0.1	<0.1	<0.1	<0.1	<0.1			1.63	3.86		
Arsenic	<0.01	<0.1	<0.01	<0.01	0.01	<0.01	0.005	0.007	0.004	0.006		
Calcium	207	226	352	219	205	185	251	256	279	358	389	360
Cadmium	<0.005	<0.005	<0.005	<0.005	<0.005	0.006	0.014	0.0193	0.0358	0.0631	0.0933	0.112
Chloride	49	90	29	7	34	25			8	1		
Cobalt	0.2	0.04	0.48	0.43	0.24	0.26	0.457	0.546	0.69	0.871	1.03	0.937
Chromium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01			<0.001	0.001		
Copper	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.012	0.029	0.037	0.058		
Iron	17	2.9	0.12	17	10	12.4	91.8	190	275	307	416	883
Mercury	<0.0001	0.0002	<0.0001	<0.0001	<0.0001	<0.0001			<0.0001	<0.0001		
Potassium	22	19	17	12	5	7			3.1	4		
Magnesium	221	692	956	859	1120	856	876	1560	1980	2560	2730	2570
Manganese	10.8	5.8	44	27	23	22.2	35.2	56.7	73.8	111	130	126
Sodium	22	17	9	6	5	63			3.7	6		
Nickel	0.66	0.11	0.59	0.45	0.28	0.23	0.491	0.525	0.567	0.63		0.68
Lead	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.038	0.043	0.287	0.286	0.215	0.152
Sulfate	1,400	3,800	4,870	3,990	5,100	3,970	4,030	7,430	11,000	12,600	12,500	12,300
Tin	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01			<0.001	<0.001		
Selenium	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.03	<0.01	0.02	< 0.050	< 0.050
Tellurium	0.03	0.04	0.086	0.109	0.095	0.154			0.198	0.337		
Zinc	4.9	0.5	9.2	15.3	9.9	11.1	40.5	48.4	90.4	134	157	230

Table 9
Column Leach Test Results for Sample MRM2 (PAF Upper Pyritic/Dolomitic Shale)

	16/01/03	6/02/03	6/03/03	3/04/03	24/04/03	19/06/03	15/10/03	17/12/03	4/03/04	16/06/04
Volume Leached (L)	0.4	0.42	0.4	0.4	0.44	0.38	0.43	0.43	0.42	0.41
Cum. Volume (L)	0.4	1.4	2.36	2.76	3.2	4	4.43	4.86	5.28	5.69
Pore Volumes	0.3	1	1.7	2	2.4	3	3.3	3.6	3.9	4.2
pH	7.35	6.91	6.19	6.59	5.6	5.49	6.57	5.98	4.93	4.73
EC (μS/cm)	984	1,672	3,510	2,636	2,770	2,803	2,229	2,831	3,890	4,420
Acidity (mg/L)					19	25	41	60	13	123
Alkalinity (mg/L)	33	18	50	7						0
Dissolved Elements (mg/L)										
Aluminium	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1			0.51	1.02
Arsenic	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.001	0.003	0.002	0.002
Calcium	87	101	275	108	103	88	100	99	112	97
Cadmium	<0.005	<0.005	0.006	<0.005	0.009	0.008	0.0191	0.0274	0.0509	0.0503
Chloride	25	61	78	11	44	5			4	3
Cobalt	0.21	0.04	1.07	0.24	0.22	0.2	0.224	0.24	0.221	0.273
Chromium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01			<0.001	<0.001
Copper	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.001	0.016	0.021	0.032
Iron	<0.01	<0.01	<0.01	0.13	0.02	<0.01	0.91	5.7	7.09	9.45
Mercury	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001			<0.0001	<0.0001
Potassium	19	14	28	13	13	10			5.6	6
Magnesium	56	223	462	329	427	465	336	695	644	747
Manganese	0.89	0.65	7.5	2.1	2.5	2.91	3.14	5.37	4.66	8.51
Sodium	41	39	63	19	18	15			9.5	8
Nickel	0.42	0.05	0.9	0.19	0.15	0.12	0.218	0.197	0.165	0.178
Lead	<0.01	<0.01	<0.01	0.01	0.02	<0.01	0.009	0.025	0.062	0.028
Sulfate	467	1,190	2,540	1,580	1,950	1,990	1,460	2,920	2,810	3,260
Tin	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01			<0.001	<0.001
Selenium	<0.01	0.01	0.01	<0.01	0.02	0.02	0.02	0.04	0.03	0.03
Tellurium	0.012	0.013	0.047	0.028	0.029	0.033			0.021	0.02
Zinc	0.8	0.4	25	8.8	9.4	10.3	20	31.8	60.5	66.5

Table 10
Column Leach Test Results for Sample MRM 3 (NAF Upper Pyritic/Dolomitic Shale)

	16/01/03	6/02/03	6/03/03	3/04/03	24/04/03	19/06/03	15/10/03	17/12/03	4/03/04	16/06/04
Volume Leached (L)	0.22	0.32	0.32	0.32	0.34	0.26	0.34	0.34	0.34	0.335
Cum. Volume (L)	0.22	0.92	1.7	2.02	2.36	1.96	2.3	2.64	2.98	3.315
Pore Volumes	0.2	0.7	1.3	1.5	1.7	1.5	1.7	2	2.2	2.5
pH	7.63	7.07	6.5	6.98	5.94	5.66	7.2	6.63	6.77	6.63
EC (μS/cm)	518	977	2,321	1,316	1,147	1,272	1,050	1,034	1,590	1,790
Acidity (mg/L)			14	5				7	16	13
Alkalinity (mg/L)	45	25			15	16	13			5
Dissolved Elements (mg/L)										
Aluminium	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1			<0.01	<0.01
Arsenic	0.02	0.01	0.02	<0.01	<0.01	<0.01	0.003	0.003	0.003	<0.001
Calcium	36	68	193	88	84	76	76	85	103	103
Cadmium	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.0014	0.0018	0.0018	0.0024
Chloride	28	13	64	15	39	2			<1	<1
Cobalt	<0.01	<0.01	0.08	0.02	0.01	0.01	0.02	0.018	0.017	0.02
Chromium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01			<0.001	<0.001
Copper	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.002	0.003	<0.001	0.002
Iron	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Mercury	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001			<0.0001	<0.0001
Potassium	17	18	38	20	17	16			18.7	15
Magnesium	25	90	226	108	110	124	100	141	182	199
Manganese	0.09	0.16	0.8	0.3	0.3	0.4	0.426	0.556	0.584	0.874
Sodium	26	30	61	16	16	12			125	10
Nickel	0.01	0.01	0.08	0.02	0.01	<0.01	0.021	0.014	0.012	0.015
Lead	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.001	<0.001
Sulfate	202	580	1,450	576	632	708	551	751	956	1,020
Tin	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01			0.004	0.004
Selenium	<0.01	<0.01	0.02	<0.01	0.01	0.02	0.02	0.02	0.02	0.02
Tellurium	0.002	0.004	0.01	0.006	0.005	0.007			0.01	0.011
Zinc	0.04	0.11	1.53	0.61	0.38	0.5	1.29	1.37	1.96	2.36

Table 11
Column Leach Test Results for Sample MRM 4 (NAF Upper Pyritic/Dolomitic Shale)

	16/01/03	13/02/03	6/03/03	3/04/03	24/04/03	19/06/03	15/10/03	17/12/03	4/03/04	16/06/04	10/11/04	8/02/05
Volume Leached (L)	0.24	0.5	0.32	0.3	0.38	0.34	0.4	0.38	0.38	0.374	0.38	0.375
Cum. Volume (L)	0.24	1.555	1.875	2.175	2.555	3.295	3.695	4.075	4.455	4.829	5.209	5.584
Pore Volumes	0.2	1.2	1.4	1.6	1.9	2.4	2.7	3.0	3.3	3.6	3.9	4.1
pH	8.34	6.45	6.91	7.56	6.21	5.87	7.42	7.55	7.17	7.17	7.2	7.07
EC (μS/cm)	282	1,540	2,480	1,504	1,350	1,419	1,361	1,279	1,600	1,840	1,940	2,450
Acidity (mg/L)									16	6	<1	<1
Alkalinity (mg/L)	168	63	40	25	22	24	26	34	8	23	27	34
Dissolved Elements (mg/L)												
Aluminium	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1			0.01	<0.01		
Arsenic	0.1	0.02	0.02	<0.01	<0.01	<0.01	0.006	0.005	0.004	0.003		
Calcium	7	97	237	136	125	130	161	178	186	185	211	364
Cadmium	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.0018	0.0015	0.0023	0.0025	0.0045	0.0069
Chloride	25	18	64	11	29	5			2	2		
Cobalt	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	0.009	0.009	0.008	0.01	0.013	0.025
Chromium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01			<0.001	<0.001		
Copper	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.003	0.003	0.001	0.003		
Iron	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.05	<0.01	<0.01	<0.01	<0.01	<0.01
Mercury	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001			<0.0001	<0.0001		
Potassium	11	31	55	35	32	30			32.3	39		
Magnesium	3	49	118	56	69	80	79	113	94.4	121	142	192
Manganese	<0.01	0.06	0.16	0.09	0.09	0.13	0.151	0.184	0.156	0.211	0.266	0.442
Sodium	46	157	203	78	76	57			73.1	43		
Nickel	0.01	<0.01	0.02	<0.01	<0.01	<0.01	0.008	0.007	0.005	0.005	0.011	0.018
Lead	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	0.002	<0.01	0.001	<0.001	<0.001	<0.001
Sulfate	73	771	1,420	701	719	753	744	952	900	998	1,140	1,640
Tin	0.02	<0.01	<0.01	0.01	0.01	<0.01			0.008	0.009		
Selenium	0.01	0.04	0.06	0.01	0.03	0.02	0.02	0.03	0.02	0.02	0.024	0.03
Tellurium	<0.001	0.005	0.009	0.006	0.006	0.007			0.011	0.013		
Zinc	<0.01	0.07	0.55	0.34	0.25	0.29	0.681	0.593	0.992	1.26	1.66	3.44

4.1.3 Assessment Cases and Model Parameters

For the purpose of the mass balance modelling, sulfate has been selected as the indicator compound to assess the water quality in the final void, because sulfate is relatively non-reactive and stable when waters with different pH levels are mixed. Given this fact, a mass balance approach to model sulfate concentrations in the open pit is realistic.

As explained above, interpretation of drill cores has indicated that 10% of the pit wall material is PAF material, with 90% being NAF material. Therefore, it has been assumed in the mass balance model that 10% of the groundwater seepage into the open pit will have sulfate concentrations as determined from the leachate column tests undertaken on PAF material (samples MRM1 and MRM2) and 90% will have sulfate concentrations as determined from the tests on NAF material (samples MRM3 and MRM4).

The analysis results of leachate water from material identified as PAF material (sample MRM1) indicates that sulfate concentrations can increase to 12,600 mg/L after 74 weeks. However, the residual Acid Neutralising Capacity (ANC) of this material was still 98.3% after 74 weeks, indicating that more sulfate can be leached from the material. At this stage, it is not possible to predict how much sulfate can leach from the pit wall material over the proposed lifetime of the development. Therefore, three cases have been modelled for each scenario, as follows :

- Case 1 : Sulfate concentration leaching from PAF material at 5,000 mg/L (best case)
- Case 2: Sulfate concentration leaching from PAF material at 12,000 mg/L (average case)
- Case 3 : Sulfate concentration leaching from PAF material at 20,000 mg/L (worst case)

It must be noted that the selection of sulfate concentrations for the best and worst case was arbitrary, and based on general knowledge of and experience with acid mine drainage issues.

Sulfate concentrations in rainwater and streamwater were derived from the monitoring data. The highest sulfate concentration monitored was adopted in the model.

A summary of the sulfate concentrations for the modelled cases is provided in **Table 12**.

Table 12
Modelled Sulfate Concentrations (mg/L)

	Case 1 (best case)	Case 2 (average case)	Case 3 (worst case)
Groundwater Inflow			
• from PAF material (10%)	5,000	12,000	20,000
• from NAF material (90%)	1,600	1,600	1,600
Surface Water	100	100	100
Rainfall	1	1	1

Mass balance modelling was undertaken to asses the temporal variations of sulfate concentrations in the open pit for each case under each of the four identified scenarios. The results of the mass balance modelling are described below.

In the assessment of the modelling results, the sulfate concentrations modelled during the first two to three timesteps were ignored, as the model is stabilising during these timesteps.

4.1.4 Results of Mass Balance Modelling

Case 1 (Best Case)

The modelled temporal sulfate concentrations for each scenario are presented in **Figures 4-1 to 4-4**. A statistical analysis of the modelled concentrations is presented in **Table 13**.

Table 13
Statistics of Modelled Sulfate Concentrations – Case 1

	Scenario 1		Scenario 2	Scenario 3	Scenario 4
Number of modelled months	**1,188**	**396**	**396**	**396**	**396**
Number of blank values	0	0	2	2	2
Number of non-blank values	1,188	396	394	394	394
Mean	3,258	2,322	511	104	115
Standard Deviation	862.3	306.8	314.1	2.3	9.8
Range	3,296	1,177	994	11	58
Minimum	1,612	1,612	101	100	101
Lower Quartile	2,620	2,011	210	102	108
Median	3,130	2,340	472	103	113
Upper Quartile	3,906	2,619	789	105	120
Maximum	4,909	2,789	1,094	111	159
Skewness	0.19993	-0.09268	0.27118	0.62218	1.56817
Kurtosis	-1.022	-1.41	-1.283	0.102	3.585
Coefficient of Variation	26%	13%	61%	2%	9%
10% Percentile	2,077	1,916	119	101	105
25% Percentile	2,620	2,011	210	102	108
50% Percentile	3,130	2,340	472	103	113
75% Percentile	3,906	2,619	789	105	120
90% Percentile	4,549	2,720	972	107	127
95% Percentile	4,740	2,749	1,030	108	131

A summary of the modelling results is as follows.

Scenario 1

Under Scenario 1, groundwater seepage into the open pit slowly fills the pit (to about 74GL) after about 69 years. As there is no stream inflow, the resulting water quality in the pit is the result of the mixing of groundwater inflow, collected tailings dam seepage, and rainfall water, and the concentration of compounds in the pit water through evaporation. Sulfate concentrations in the open pit increase to approximately 2,800 mg/L after 33 years.

As described above, the advantage of this scenario is that the pit is unlikely to overflow as a result of the balance between groundwater inflow, collected tailings dam seepage inflow, rainfall, and evaporation. However, the disadvantage is that the sulfate concentrations (and concentrations of other ions and metals) will gradually increase with time. The sulfate concentration in the pit after 99 years is in the order of 4,900 mg/L.

Scenario 2

Under Scenario 2, the open pit is rapidly filled with river water from the McArthur River. The inflow of river water, with a relatively low sulfate concentration when compared to the concentration in the groundwater, buffers the effects of groundwater seepage and of evaporation.

The sulfate concentration in the open pit after 33 years is approximately 1,100 mg/L. Following the filling of the pit during the first two years, changes in the volume of water in the pit are the result of the net balance between groundwater inflow, collected tailings dam seepage, rainfall and evaporation. Similarly, the sulfate concentrations increase with time due to groundwater inflow, collected tailings dam seepage and evaporation.

The long-term sulfate concentration has been estimated by applying a best-fit regression to the latter modelled data when the water level in the pit has stabilised (after approximately 20 years). The best-fit regression is as follows :

$$[SO_4^{2-}] = 3.0755 \times \text{months} - 125.21$$

Using this regression, the sulfate concentration after 99 years (i.e. 1188 months) is approximately 3,500 mg/L, which is approximately 70% of the concentrations reached under Scenario 1.

Scenario 3

Under Scenario 3, the pit will be filled with river water, and will remain full and be regularly flushed with river water. The regular filling of the pit with river water has a buffering effect on the water quality in the pit, whereby sulfate concentrations remain very low and close to the sulfate levels in the river water.

The modelled sulfate concentration in the open pit varies between 100 and 111 mg/L.

Scenario 4

Under Scenario 4, only floods greater than a 2 year ARI enter the pit. Consequently, there is more variation in pit water levels than with Scenario 3, but the pit still remains close to full. Similar to Scenario 3, the occasional filling of the pit with river water has a buffering effect on the water quality in the pit. Modelled sulfate concentrations in the open pit vary between 101 and 159 mg/L.

Case 2 (Average Case)

The modelled temporal sulfate concentrations for each scenario are presented in **Figures 4-5 to 4-8**. A statistical analysis of the modelled concentrations is presented in **Table 14**.

Table 14
Statistics of Modelled Sulfate Concentrations – Case 2

	Scenario 1		Scenario 2	Scenario 3	Scenario 4
Number of Modelled Months	**1,188**	**396**	**396**	**396**	**396**
Number of blank values	0	0	2	2	2
Number of non-blank values	1,188	396	394	394	394
Mean	4,306	3,079	623	104	115
Standard Deviation	1,129.2	406.1	405.7	2.3	10.6
Range	4,322	1,556	1,278	11	67
Minimum	2,140	2,140	101	100	101
Lower Quartile	3,473	2,666	232	102	108
Median	4,144	3,102	569	103	113
Upper Quartile	5,155	3,472	981	105	120
Maximum	6,462	3,696	1,379	111	168
Skewness	0.18924	-0.09301	0.28606	0.6262	1.90258
Kurtosis	-1.022	-1.411	-1.281	0.046	5.411
Coefficient of Variation	26%	13%	65%	2%	9%
10% Percentile	2,754	2,540	120	101	105
25% Percentile	3,473	2,666	232	102	108
50% Percentile	4,144	3,102	569	103	113
75% Percentile	5,155	3,472	981	105	120
90% Percentile	5,993	3,605	1,220	107	127
95% Percentile	6,243	3,643	1,296	108	131

A summary of the modelling results is as follows.

Scenario 1

Sulfate concentrations in the open pit increase to approximately 3,700 mg/L after 33 years and to approximately 6,500 mg/L after 99 years.

Scenario 2

Due to the initial buffering effect of the filling of the pit with river water, sulfate concentrations remain low, and increase to approximately 1,400 mg/L after 33 years. However, concentrations will keep increasing with time, and may reach 4,600 mg/L after 99 years.

Scenario 3

Due to the buffering effect of the regular inflow of river water, sulfate concentrations in the open pit vary between 100 and 111 mg/L, which shows no change compared to Case 1.

Scenario 4

Due to the buffering effect of the occasional inflow of river water, sulfate concentrations in the open pit vary between 101 and 168 mg/L, which is only a minor increase compared to Case 1.

Case 3 (Worst Case)

The modelled temporal sulfate concentrations for each scenario are presented in **Figures 4-9 to 4-12**. A statistical analysis of the modelled concentrations is presented in **Table 15**.

Table 15
Statistics of Modelled Sulfate Concentrations – Case 3

	Scenario 1		Scenario 2	Scenario 3	Scenario 4
Number of Modelled Months	**1188**	**396**	**396**	**396**	**396**
Number of blank values	0	0	2	2	2
Number of non-blank values	1,188	396	394	394	394
Mean	5,504	3,944	750	104	116
Standard Deviation	1,434.2	519.5	510.3	2.4	11.6
Range	5,493	1,990	1,604	11	76
Minimum	2,743	2,743	101	100	101
Lower Quartile	4,447	3,415	257	102	108
Median	5,302	3,973	680	103	114
Upper Quartile	6,582	4,446	1,201	105	120
Maximum	8,237	4,733	1,704	111	177
Skewness	0.18187	-0.09324	0.29638	0.67832	2.24379
Kurtosis	-1.022	-1.412	-1.279	0.113	7.399
Coefficient of Variation	26%	13%	68%	2%	10%
10% Percentile	3,527	3,254	121	101	105
25% Percentile	4,447	3,415	257	102	108
50% Percentile	5,302	3,973	680	103	114
75% Percentile	6,582	4,446	1,201	105	120
90% Percentile	7,644	4,616	1,503	107	127
95% Percentile	7,960	4,665	1,599	109	132

A summary of the modelling results is as follows.

Scenario 1

Sulfate concentrations in the open pit increase to approximately 4,700 mg/L after 33 years and to approximately 8,200 mg/L after 99 years.

Scenario 2

Due to the initial buffering effect of the filling of the pit with river water, sulfate concentrations remain low, and increase to approximately 1,700 mg/L after 33 years. However, concentrations will keep increasing with time, and may reach 5,800 mg/L after 99 years.

Scenario 3

Due to the buffering effect of the regular inflow of river water, sulfate concentrations in the open pit vary between 100 and 111 mg/L, which shows no change compared to Case 1.

Scenario 4

Due to the buffering effect of the occasional inflow of river water, sulfate concentrations in the open pit vary between 101 and 177 mg/L, which is only a minor increase compared to Case 1.

4.1.5 Discussion of Results

The modelled sulfate concentrations for each scenario and for each case are presented on **Figures 4-13 to 4-16**.

The modelling results indicate that the sulfate concentrations will increase steadily under Scenario 1, due to groundwater inflow, collected tailings dam seepage, and evaporation. Although it will take approximately 69 years before the open pit is completely full, Scenario 1 is not considered to be an acceptable option, as there is always a danger for flooding of the pit, which would results in the release of low quality pit water to the environment. Although dilution of this pit water with the flood water will reduce the concentration of sulfate (and other chemical compounds), there is still the risk that the surrounding environment may be adversely impacted.

Under Scenario 2, the water quality in the open pit will deteriorate gradually with time, once the pit has been filled with river water during the first one to two years following mining. However, the buffering capacity of the river water used to fill the open pit results in a reduced sulfate concentration in the final void water, when compared to Scenario 1.

Under Scenarios 3 and 4, sulfate concentrations in the open pit are buffered by the regular (Scenario 3) or occasional (Scenario 4) inflow of river water. In general, the sulfate concentrations remain close to the sulfate concentrations in the river water. The buffering effect of the river water becomes apparent after several months (Scenario 3) or years (Scenario 4), as the water quality in the final void is approximately the same for the best, average and worst cases modelled.

4.2 Geochemical Equilibrium Modelling

4.2.1 Introduction

Geochemical equilibrium modelling was undertaken to assess the chemical reactions (in terms of precipitation and dissolution) that may take place when water from different sources (i.e. river water, rainwater, pitwall leachate, groundwater) is mixed in the final void.

The geochemical modelling was undertaken using the PHREEQC model (USGS, 1999).

PHREEQC version 2 is a computer program written in the C programming language that is designed to perform a wide variety of low-temperature aqueous geochemical calculations. PHREEQC is based on an ion-association aqueous model and has capabilities for:

1. speciation and saturation-index calculations;
2. batch-reaction and one-dimensional (1D) transport calculations involving reversible reactions, which include aqueous, mineral, gas, solid-solution, surface-complexation, and ion-exchange equilibria, and irreversible reactions, which include specified mole transfers of reactants, kinetically controlled reactions, mixing of solutions, and temperature changes; and
3. inverse modelling, which finds sets of mineral and gas mole transfers that account for differences in composition between waters, within specified compositional uncertainty limits.

Speciation modelling is useful in situations where the possibility of mineral dissolution or precipitation needs to be known. It uses a chemical analysis of a water to calculate the distribution of aqueous species by using an ion-association aqueous model. The most important results of speciation calculations are saturation indices for minerals, which indicate whether a mineral should dissolve or precipitate.

Batch-reaction modelling can be applied to problems in laboratory, natural, or contaminated systems. Batch reactions can be divided into equilibrium and non-equilibrium reactions. Equilibrium reactions include equilibration of a solution with an assemblage of minerals and specified-pressure gases, ion-exchange sites, surface-complexation sites, a finite gas phase, and (or) solid solutions. Non-equilibrium reactions include kinetic reactions, addition or removal of elements from solution, mixing, and changing temperature.

Inverse modelling can be used to deduce geochemical reactions and mixing in local and regional aquifer systems. It calculates geochemical reactions that account for the change in chemical composition of water along a flow path. For inverse modelling, at least two chemical analyses of water are needed at different points along the flow path, as well as a set of minerals and gases that are potentially reactive. Mole transfers of phases are calculated that account for the change in water composition along the flow path. The numerical method accounts for uncertainties in analytical data.

For the purpose of this study, the speciation and saturation-index calculations within the PHREEQC model were used to assess the final void water quality resulting from the mixing of different water types. The kinetic leaching study was undertaken to assess the water quality of the leachate from PAF and NAF material in the pit wall.

The required input parameters for the geochemical equilibrium model include the following :

- pH for each water type.
- Electron activity (pe) of each water type. The electron activity can be calculated as follows :

$$pe = \frac{Eh * F}{2.3 * R * T}$$

with : Eh = Redox Potential [V]

F = Faraday constant = 96,485 C/mol

R = gas constant = 8,314 J/mol/K

T = temperature [K]

- Redox Potential (Eh) of each water type.
- Concentrations of ions, metals and other analytes in each water type.
- Mixing ratios.

The values of the input parameters are determined through monitoring and sampling of the different types of water.

The geochemical equilibrium model was used to simulate water quality in the final void under the four closure scenarios described in **Section 2.1**.

4.2.2 Data Inputs

The geochemical equilibrium model is adopted to determine the water quality and speciation resulting from mixing the following water types in the final void :

- River water from the McArthur River.
- Rainfall water.
- Groundwater seepage into the pit (10% through PAF material and 90% through NAF material).
- Collected tailings dam seepage.

Where no information is available for a given parameter, a value has been estimated from text book values and experience. This is especially the case with redox potential, which is not always measured on site.

Redox potential is an essential parameter for the geochemical equilibrium model, as redox reactions directly or indirectly control speciation and mobility of many elements/compounds in water. However, redox potential values are not available for rainfall and leachate seepage water. Redox potential for these water types has been estimated from standard Eh-pH diagrams for natural environments (after Garrels & Christ, 1965), as presented in **Figure 4-17**.

The values of the input parameters adopted in the geochemical equilibrium modelling are presented in **Table 16**.

Table 16
Input Parameters for Geochemical Equilibrium Model

	River Water -SW7	PAF Leachate - MRM1	NAF Leachate - MRM3	Rainfall	Tailings Dam Seepage
Source of Data	April 2003 monitoring at location SW7	Kinetic leachate study – sample MRM1	Kinetic leachate study – sample MRM3	CSIRO, 1999, location C1	September 2002 monitoring at location GW17
pH	8.20	3.98	6.50	4.59	6.56
Dissolved Oxygen (ppm)	6.91				
Eh (Redox)	157				
Eh (Upper Limit - Calculated)	736	994	836	949	833
Eh (Lower Limit - Calculated)	-484	-236	-383	-271	-386
Eh (Extrapolated from Graph)		700		600	100
Redox Potential (mV)	157	700(1)	109(2)	600(1)	100(1)
Temperature (ºC)	28.4	25.0(3)	25.0(3)	25.0(3)	25.0(3)
Temperature (ºK)	301.5	298.1	298.1	298.1	298.1
pe	2.63	11.85	1.84	10.15	1.69
Dissolved Elements (mg/L)					
Calcium	48.7	358	193	0.1002	405
Cadmium	0.00006	0.0631	<0.005	0(3)	0.00008
Chloride	15.3	1	64	0.2375	2610
Copper	0.001	0.058	<0.01	0(3)	0.0174
Iron	<20	307	0.01	0(3)	0.00315
Potassium	4.2	4	38	0.0586	297
Magnesium	47	2560	226	0.0316	1070
Sodium	10.6	6	61	0.1586	3030
Lead	0.00055	0.286	<0.01	0(3)	0.00029
Sulfate	6.4	5,000 (best case) 20,000 (worst case)	1,450	0.7781	6190
Zinc	0.0104	134	1.53	0(3)	0.327

(1) Extrapolated from textbook figures
(2) Value observed in monitoring well GW5 in April 2003
(3) Assumed values

The geochemical equilibrium model was applied for the four scenarios described above. As the PHREEQC model does not currently allow for time-dependent speciation modelling, the mixing ratios for the different water types have been determined from a statistical analysis of the in/outflow components of the water balance model, presented in **Table 17**.

Table 17
Statistical Analysis of Flows (m^3/month) of Water Balance Model

	River inflow	Rainfall	Seepage in	Collected Tailings Seepage in	Seepage out	Evaporation	Overflow from pit	Volume in Pit
Scenario 1								
Minimum	0.00	0.00	0.08	0.01	0.00	0.01	0.00	0.00
Average	0.00	0.05	0.14	0.01	0.00	0.12	0.00	57.73
Median	0.00	0.01	0.14	0.01	0.00	0.12	0.00	70.04
Maximum	0.00	0.34	0.19	0.01	0.00	0.23	0.00	75.79
Scenario 2								
Minimum	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00
Average	1.85	0.05	0.08	0.01	0.00	0.15	1.63	75.37
Median	0.00	0.01	0.09	0.01	0.00	0.14	0.00	74.74
Maximum	275.04	0.34	0.19	0.01	0.10	0.23	223.40	83.22
Scenario 3								
Minimum	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00
Average	49.59	0.05	0.00	0.01	0.08	0.16	49.19	82.08
Median	3.07	0.01	0.00	0.01	0.08	0.15	2.67	82.73
Maximum	1,267.21	0.34	0.19	0.01	0.10	0.26	1,267.11	83.22
Scenario 4								
Minimum	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00
Average	9.30	0.05	0.00	0.01	0.04	0.16	8.95	80.74
Median	0.00	0.01	0.00	0.01	0.04	0.15	0.00	81.47
Maximum	543.43	0.34	0.19	0.01	0.10	0.24	541.65	83.30

Based on the average flows, the mixing ratios of the different water types for each scenario have been calculated, as presented in **Table 18**.

Table 18 Adopted Water Mixing Ratios for Geochemical Equilibrium Modelling				
	Scenario 1	Scenario 2	Scenario 3	Scenario 4
River water	0.0000	0.9344	0.9989	0.9940
Rainfall	0.2410	0.0232	0.0009	0.0049
Groundwater Inflow – PAF Material	0.0727	0.0039	0.0000	0.0000
Groundwater Inflow – NAF Material	0.6544	0.0353	0.0000	0.0004
Collected Tailings Seepage	0.0319	0.0031	0.0001	0.0006

4.2.3 Results of the Geochemical Equilibrium Modelling

The input file for the PHREEQC model and the output generated by the model are presented in **Appendix A**. The modelled composition of the final void water quality for the best case (i.e. sulfate concentrations from PAF material leachate at 5,000 mg/L) is presented in **Table 19**. The composition for the worst case scenario (i.e. sulfate concentrations from PAF material leachate at 20,000 mg/L) is presented in **Table 20**.

The calculated concentrations of the dissolve elements clearly demonstrate the buffering and dilution effects of filling of the pit (either initially, regularly or occasionally) on the quality of the water in the final void.

The geochemical equilibrium model also calculates the saturation index (SI) for several potential minerals that could precipitate from the mixed water. If the SI is greater than zero, the mineral could precipitate but not dissolve; if the SI is less than zero, the mineral remains dissolved and will not precipitate; if the SI is equal to 0, the mineral could dissolve or precipitate.

Based on the modelled saturation indices, the following minerals could precipitate under Scenario 1 and Scenario 2 in both the best case and worse case models:

- $Fe(OH)_3$
- Goethite
- Jarosite-K
- Hematite

In addition, the SI for gypsum is close to zero under Scenario 1, and there is a possibility that gypsum may precipitate due to evaporation. Of the above minerals, $Fe(OH)_3$, goethite and hematite could precipitate under Scenarios 3 and 4.

The results of the geochemical equilibrium modelling are only indicative, and further monitoring and sampling of the different types of water will need to be undertaken to gain a more accurate understanding of their water quality, and of their interaction when mixed in the final void.

Table 19
Modelled Final Void Water Composition – Best Case

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
pH	4.13	7.66	8.20	8.19
pe	11.87	4.18	2.63	2.64
Concentration (mg/L)				
Calcium	165.931	55.035	48.702	48.742
Cadmium	0.006	0.000	0.000	0.000
Chloride	126.486	24.775	15.550	16.826
Copper	0.008	0.001	0.001	0.001
Iron	22.513	10.557	9.993	9.942
Potassium	34.830	6.221	4.227	4.372
Magnesium	370.484	65.352	47.069	47.458
Sodium	138.469	21.615	10.898	12.407
Lead	0.024	0.002	0.001	0.001
Sulfate	1517.748	96.454	7.023	10.712
Zinc	10.838	0.592	0.010	0.011
Saturation Index				
Anglesite	-2.19	-4.06	-5.93	-5.75
Anhydrite	-0.86	-2.01	-3.11	-2.93
$Cd(OH)_2$	-13.23	-7.02	-6.70	-6.70
$CdSO_4$	-10.11	-11.80	-13.65	-13.47
$Fe(OH)_3$ (a)	1.21	3.66	3.62	3.62
FeS (ppt)	-97.98	-66.64	-59.78	-59.65
Goethite	7.10	9.66	9.63	9.63
Gypsum	-0.64	-1.80	-2.91	-2.73
H_2 (g)	-32.01	-23.69	-21.66	-21.68
H_2O (g)	-1.51	-1.43	-1.42	-1.42
H_2S (g)	-97.08	-72.27	-66.39	-66.25
Halite	-6.43	-7.86	-8.35	-8.26
Hematite	16.22	21.35	21.29	21.29
Jarosite-K	7.24	1.63	-2.44	-2.06
Mackinawite	-97.25	-65.90	-59.05	-58.92
Melanterite	-5.30	-6.82	-8.03	-7.85
O_2 (g)	-19.10	-34.69	-38.67	-38.65
$Pb(OH)_2$	-7.51	-1.23	-0.91	-0.92
Pyrite	-156.43	-108.68	-97.97	-97.69
Sphalerite	-89.43	-58.61	-53.47	-53.30
Sulfur	-70.95	-54.43	-50.56	-50.41
$Zn(OH)_2$ (e)	-7.53	-1.45	-2.19	-2.17

Table 20
Modelled Final Void Water Composition – Worst Case

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
pH	3.98	7.51	8.20	8.20
pe	11.97	4.57	2.63	2.64
Concentration (mg/L)				
Calcium	166.332	55.035	48.702	48.742
Cadmium	0.006	0.000	0.000	0.000
Chloride	126.486	24.775	15.550	16.826
Copper	0.008	0.001	0.001	0.001
Iron	22.859	10.573	9.993	9.942
Potassium	34.834	6.221	4.227	4.372
Magnesium	373.402	65.498	47.069	47.458
Sodium	138.469	21.617	10.898	12.407
Lead	0.025	0.002	0.001	0.001
Sulfur	2639.729	156.593	7.023	10.712
Zinc	10.989	0.600	0.010	0.011
Saturation Index				
Anglesite	-2.10	-3.82	-5.93	-5.75
Anhydrite	-0.71	-1.82	-3.11	-2.93
$Cd(OH)_2$	-13.67	-7.34	-6.70	-6.70
$CdSO_4$	-9.99	-11.61	-13.65	-13.47
$Fe(OH)_3$ (a)	0.91	3.64	3.62	3.62
FeS (ppt)	-97.20	-68.29	-59.78	-59.65
Goethite	6.80	9.65	9.63	9.63
Gypsum	-0.49	-1.61	-2.91	-2.73
H_2 (g)	-31.89	-24.16	-21.66	-21.68
H_2O (g)	-1.51	-1.43	-1.42	-1.42
H_2S (g)	-96.06	-73.67	-66.39	-66.25
Halite	-6.46	-7.87	-8.35	-8.26
Hematite	15.61	21.31	21.29	21.29
Jarosite-K	7.29	2.45	-2.44	-2.06
Mackinawite	-96.47	-67.56	-59.05	-58.92
Melanterite	-4.98	-6.57	-8.03	-7.85
O_2 (g)	-19.33	-33.74	-38.67	-38.65
$Pb(OH)_2$	-7.98	-1.50	-0.91	-0.92
Pyrite	-154.74	-111.26	-97.97	-97.69
Sphalerite	-88.83	-60.31	-53.47	-53.30
Sulfur	-70.04	-55.35	-50.56	-50.41
$Zn(OH)_2$ (e)	-7.96	-1.76	-2.19	-2.17

Water balance and geochemical modelling were undertaken for the following McArthur Rive Mine pit closure scenarios:

1. **Do nothing** – Let the pit fill naturally from groundwater inflows and direct rainfall, together with tailings dam seepage pumped to the pit. No surface water inflows to the pit from the McArthur River will occur.
2. **Breach the diversion bunds temporarily to facilitate filling the pit quickly from McArthur River inflows, then re-establish the bund permanently** – Stream flow from the McArthur River is allowed to enter the pit for the first 15 months of the simulation (i.e. until the pit was full). For simplicity, flow into the pit from other streams in the area (which is small in relation to McArthur River) is ignored.
3. **Breach the bund permanently and allow the McArthur River to flow through the pit area and isolate the diversion channel from river flows** – All stream flow in the McArthur River is allowed to enter the pit and overflow downstream, eventually re-joining the river downstream of the diversion.
4. **Breach the flood protection bund to allow flood flows which overtop the diversion channel to enter the pit** – Flood flows overtopping the McArthur River diversion channel are allowed to enter the pit and overflow downstream. This is likely to occur in floods with a peak discharge greater than about 400 m^3/s, which has an ARI (Average Recurrence Interval) of about 2 years.

5.1 Conclusions

5.1.1 Water Balance Modelling

In Scenario 1, groundwater slowly fills the pit to stabilise at about 74 GL, about 169 m deep, and well below the capacity of the pit. Results indicate that it is likely to take some 69 years for water levels to stabilise. An advantage of this scenario is that the pit will never overflow as a result of seepage inflow and rainfall alone. A disadvantage is that water quality in the pit will continuously decline as a result of concentration by evaporation.

In Scenarios 2 and 3, the pit fills rapidly with river water, probably within 1-2 years. The volume of the pit (83 GL) is less than the average annual stream flows in the McArthur River (595 GL) and the median flows (379 GL), so rapid filling of the pit is likely. Once stream flow is excluded from the pit in Scenario 2, the water level falls slowly to stabilise at around 74 GL, approximating the regional groundwater table (20 m below the pit rim). The quality of water in the pit will subsequently concentrate as a consequence of evaporation, and the pit is at risk of overtopping from a bund failure, as with Scenario 1.

In Scenario 3, once the pit is full it will remain close to full and regular flushing will ensure that the quality of water in the pit is similar to the quality of the river water. Stream flow into the pit will always be substantially greater than evaporation over the dry winter season, so the pit water level will only drop a short distance over winter and the pit will be quickly refilled during the first flows of the wet season. Seepage inflows will be negligible with this scenario because the water level is typically above the regional water table level. Seepage outflows are predicted to be small relative to stream flows. Any concentration by evaporation of salts and metals in the pit over the winter dry season is likely to be relatively small due to high volumes of stream inflows, and will be flushed the following summer.

A potential disadvantage with Scenario 3 is that coarse sediment is likely to settle in the pit and the pit may absorb low flows; potentially affecting the downstream environment. Downstream ecology may rely on nutrients or habitat that is influenced by the movement of coarse sediment (i.e. bed load) during floods. Water exiting the pit may have a higher capacity to entrain sediment, possibly causing erosion of the channel downstream of the pit. Extraction of low flows, e.g. during the tail of the wet season or as a result of winter rainfall events, may impact on any downstream ecosystems that rely on these flows. Assuming bed load settles in the pit and average annual flows, the pit will fill at about 2.85 m per year. Accordingly, to completely fill the pit will take approximately 77 years.

In Scenario 4, where only floods greater than a 2 year ARI enter the pit, there is more variation in pit water levels than with Scenario 3, but the pit still remains close to full. Even the reduced inflows from the McArthur River are still considerably larger than evaporation or seepage outflows from the pit. The main advantage of this scenario over Scenario 3 is that most low flows, including bed load, can continue to move through the diversion channel, thus bypassing the pit. While some sediment will be collected in the pit during floods, it is not likely to be as much as with Scenario 3, so impacts on the downstream environment are likely to be less.

The contribution of smaller streams near the pit has not been considered in this analysis, but it may be important to allow bed load sediment and small flows from these streams to bypass the pit in a similar manner as for the McArthur River.

5.1.2 Mass Balance Modelling

Mass balance modelling was undertaken to investigate the water quality in the final void. Sulfate was selected as the key indicator parameter as it is relatively non-reactive and is generally stable when waters of variable pH levels are mixed.

Results of mass balance modelling of sulfate concentrations generally indicate that the sulfate concentrations will increase steadily under Scenario 1, as a consequence of groundwater inflow, collected tailings dam seepage inflow, and evaporation. Model results (average case) indicate that from 33 years to 99 years after closure the sulfate concentrations (selected key indicator parameter) are likely to almost double from 3,700 mg/L to 6,500 mg/L. This is considerably higher than existing McArthur River concentrations (in the order of 10 mg/L, maximum of 100 mg/L). Should the flood protection bunds around the pit fail, the pit could be filled with river water and consequently the poor quality pit water, mixed with the stream flow, could be released to the environment. Although it will take approximately 69 years before the open pit is completely full, Scenario 1 is not considered to be an acceptable option, as there is always a danger for flooding of the pit, which would result in the release of low quality pit water to the environment. Although dilution of this pit water with the flood water will reduce the concentration of sulfate (and other chemical compounds), there is still the risk that the surrounding environment may be adversely impacted.

In Scenario 2, the water quality in the open pit will concentrate gradually with time, once the pit has been filled with river water during the first one to two years following mining. However, the buffering capacity of the river water used to fill the open pit results in a reduced sulfate concentration (selected key indicator parameter) in the final void water, when compared to Scenario 1. However, based on application of a best-fit regression to the modelled data (average case), it is likely that the sulfate concentration in the open pit from 33 years to 99 years after closure will increase from 1,400 mg/L to 4,600 mg/L, which is considerably higher than that of existing McArthur River concentrations (in the order of 10 mg/L, maximum of 100 mg/L). Similarly to Scenario 1, should the flood protection bunds around the pit fail, the pit could be filled with river water and consequently the poor quality pit water, mixed with the stream flow, could be released to the environment.

Under Scenarios 3 and 4, sulfate concentrations in the open pit are buffered by the regular (Scenario 3) or occasional (Scenario 4) inflow of river water. In general, the sulfate concentrations remain close to those in the river water. The buffering effect of the river water becomes apparent after several months (Scenario 3) or years (Scenario 4), as the water quality in the final void is the same for the best, average and worst cases modelled.

In Scenario 3, the water quality in the pit will be regularly flushed with river water which has a buffering effect on the water quality in the pit, whereby the concentrations of parameters in the pit will remain low and close to levels in the river water. However, throughflow of the river water may result in coarse sediment settling in the pit and the pit may absorb low flows; potentially affecting the downstream environment.

5.1.3 Geochemical Modelling

Geochemical modelling was undertaken to investigate the water quality and speciation that is likely to occur from the mixing of different water types.

Based on the modelled saturation indices, the following minerals could precipitate under Scenario 1 and Scenario 2 in both the best case and worse case models:

- $Fe(OH)_3$
- Goethite
- Jarosite-K
- Hematite

In addition, the SI for gypsum is close to zero under Scenario 1, and there is a possibility that gypsum may precipitate due to evaporation. Of the above minerals, $Fe(OH)_3$, goethite and hematite could precipitate under Scenarios 3 and 4.

5.2 Recommendations

Based on the results of all of the modelling outcomes, the recommended pit closure scenario, likely to have the lowest potential to impact the environment, is Scenario 4:

> **Breach the flood protection bund to allow flood flows which overtop the diversion channel to enter the pit -** Flood flows overtopping the McArthur River diversion channel are allowed to enter the pit and overflow downstream. This is likely to occur in floods with a peak discharge greater than about 400 m^3/s, which is an ARI (Average Recurrence Interval) of about 2 years.

Upon pit closure water quality and levels should be monitored and periodically assessed to determine actual water balance and geochemical mixing outcomes.

High Performance Systems, Inc.(2003) ithink/STELLA. http://www.hps-inc.com.

CSIRO (August 1999) *MIM – Emissions and the Environment. Final Report to Mount Isa Mines Limited*. Supporting document for "Final Report of Mount Isa Mines Limited Panel Assessment Study (February 2001).

USGS (1999) *User's Guide to PHREEQC (Version 2) – A Computer Program for Speciation, Batch-Reaction, One-Dimensional Transport, and Inverse Geochemical Calculations*. Water-Resources Investigations Report 99-4259, United States Geological Survey.

URS Australia Pty Ltd (URS) has prepared this report in accordance with the usual care and thoroughness of the consulting profession for the use of Xstrata and only those third parties who have been authorised in writing by URS to rely on the report. It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report. It is prepared in accordance with the scope of work and for the purpose outlined in the Proposal dated 9 August 2004.

The methodology adopted and sources of information used by URS are outlined in this report. URS has made no independent verification of this information beyond the agreed scope of works and URS assumes no responsibility for any inaccuracies or omissions. No indications were found during our investigations that information contained in this report as provided to URS was false.

This report was prepared between May and June 2005 and is based on the conditions encountered and information reviewed at the time of preparation. URS disclaims responsibility for any changes that may have occurred after this time.

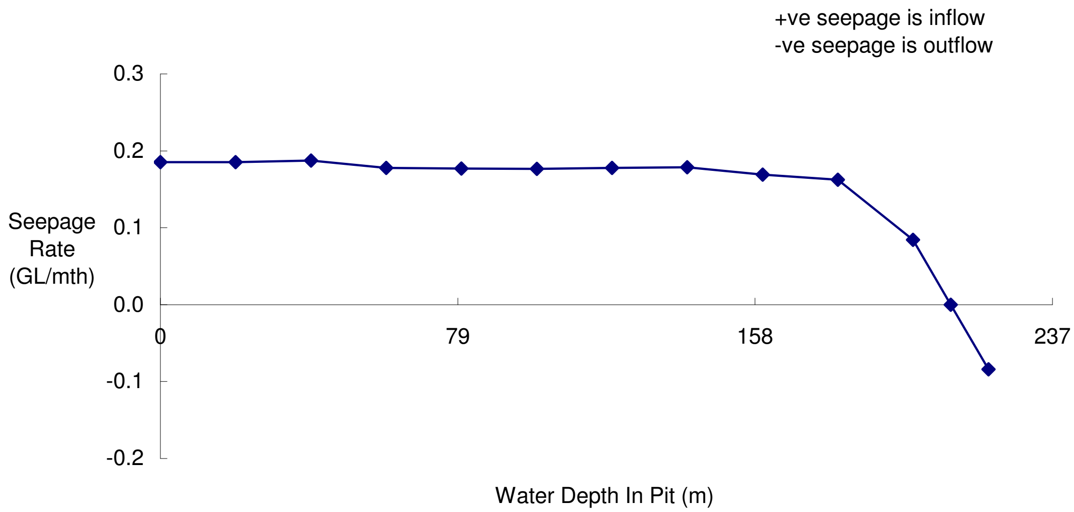
This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

This report contains information obtained by inspection, sampling, testing or other means of investigation. This information is directly relevant only to the points in the ground where they were obtained at the time of the assessment. The borehole logs indicate the inferred ground conditions only at the specific locations tested. The precision with which conditions are indicated depends largely on the frequency and method of sampling, and the uniformity of conditions as constrained by the project budget limitations. The behaviour of groundwater and some aspects of contaminants in soil and groundwater are complex. Our conclusions are based upon the analytical data presented in this report and our experience. Future advances in regard to the understanding of chemicals and their behaviour, and changes in regulations affecting their management, could impact on our conclusions and recommendations regarding their potential presence on this site.

Where conditions encountered at the site are subsequently found to differ significantly from those anticipated in this report, URS must be notified of any such findings and be provided with an opportunity to review the recommendations of this report.

Whilst to the best of our knowledge information contained in this report is accurate at the date of issue, subsurface conditions, including groundwater levels can change in a limited time. Therefore this document and the information contained herein should only be regarded as valid at the time of the investigation unless otherwise explicitly stated in this report.

Figures



Job No.	42625552		XSTRATA McARTHUR RIVER MINE EXPANSION EVALUATION OF PIT WATER QUALITY **ESTIMATED SEEPAGE INFLOW/OUTFLOWS FOR THE PIT**	**Figure 2-1**
Prep. By	RC	17 May 05		URS
Chk'd By	JB	17 May 05		
Revision No.		0		

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McArthur River Pit Water Quality Model - Surface Water Figs.xls

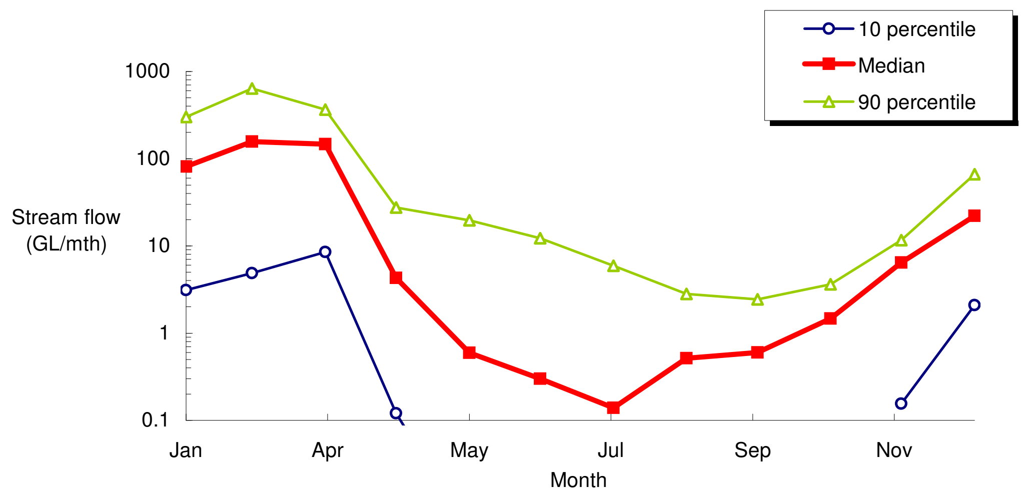

Figure 3-1: Observed Seasonal Variation In Stream Flow

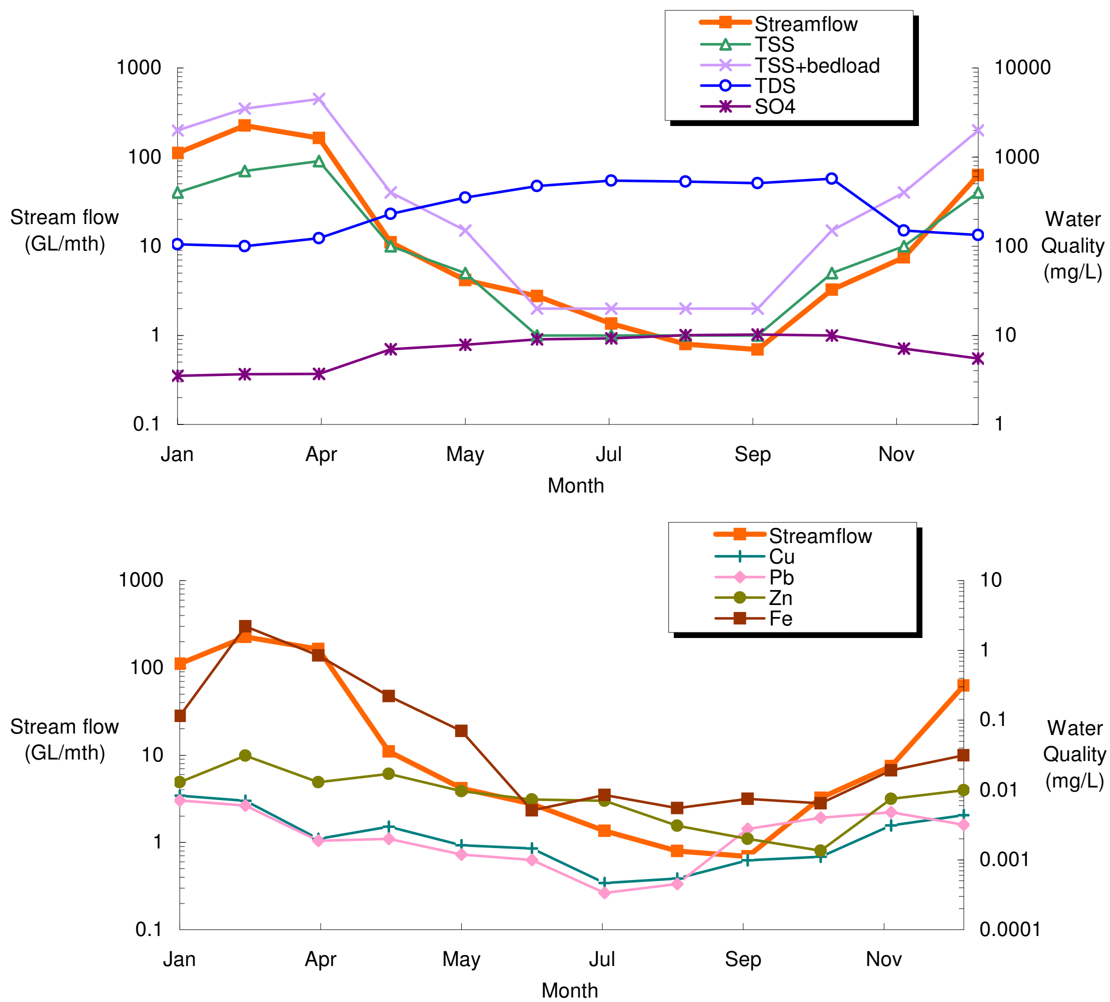

Figure 3-2: Estimated Average Seasonal Variation In Water Quality

Job No.	42625552		XSTRATA McARTHUR RIVER MINE EXPANSION EVALUATION OF PIT WATER QUALITY **McARTHUR RIVER STREAMFLOW**	**Figure 3-1, 3-2**
Prep. By	RC	17 May 05		URS
Chk'd By	JB	17 May 05		
Revision No.		0		

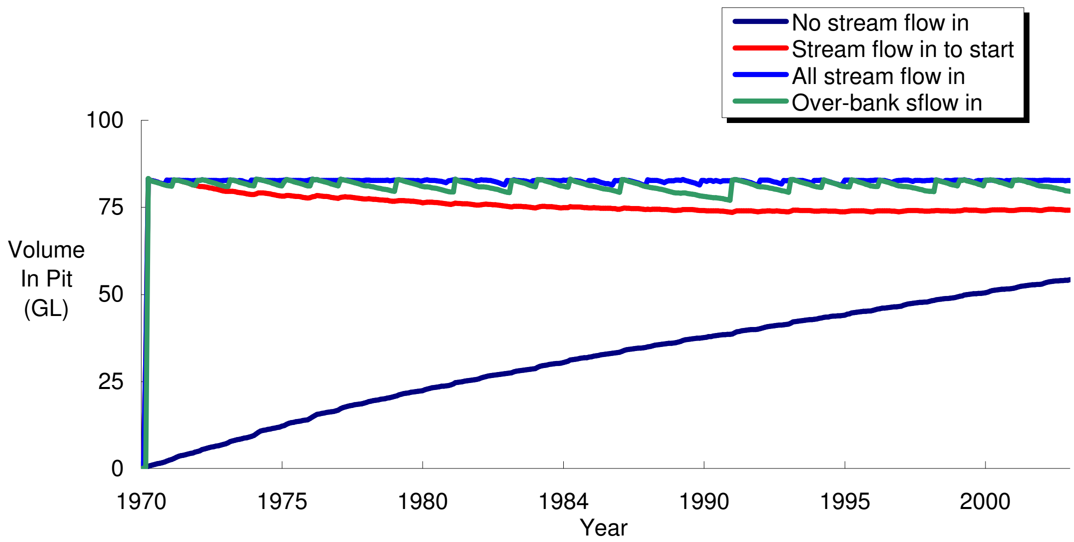

Figure 3-3: Predicted Volumes of Water In The Pit - Starting From Empty

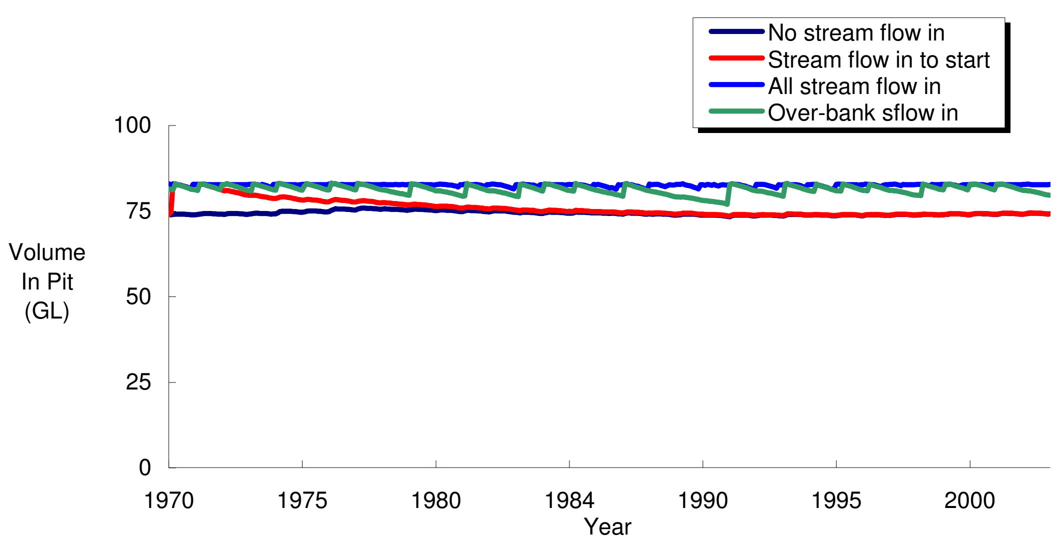

Figure 3-4: Predicted Volumes of Water In The Pit - Steady State

Job No.	42625552		XSTRATA McARTHUR RIVER MINE EXPANSION EVALUATION OF PIT WATER QUALITY **PREDICTED VOLUMES OF WATER IN THE PIT**	**Figure 3-3, 3-4**
Prep. By	RC	17 May 05		URS
Chk'd By	JB	17 May 05		
Revision No.	1			

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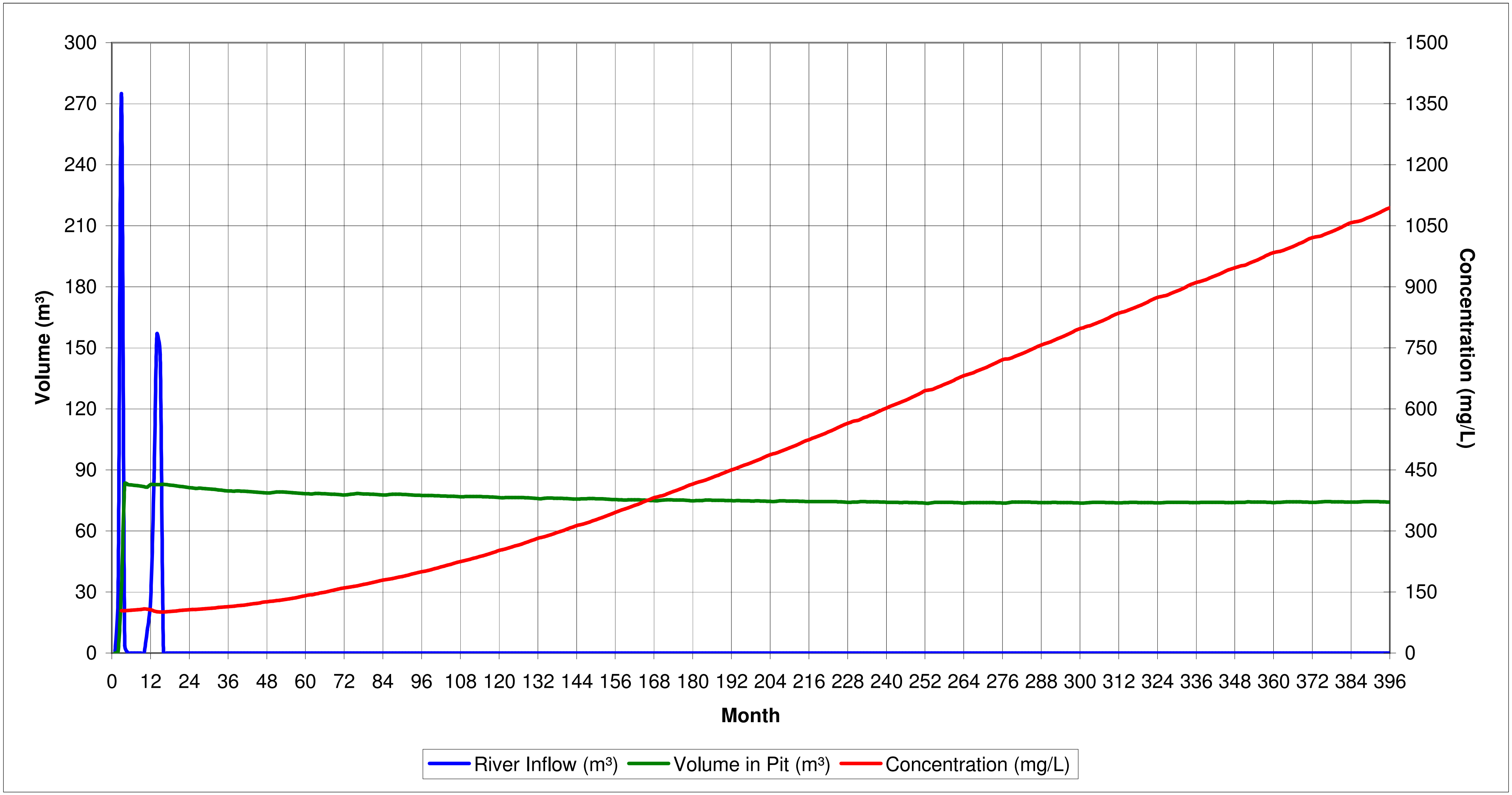
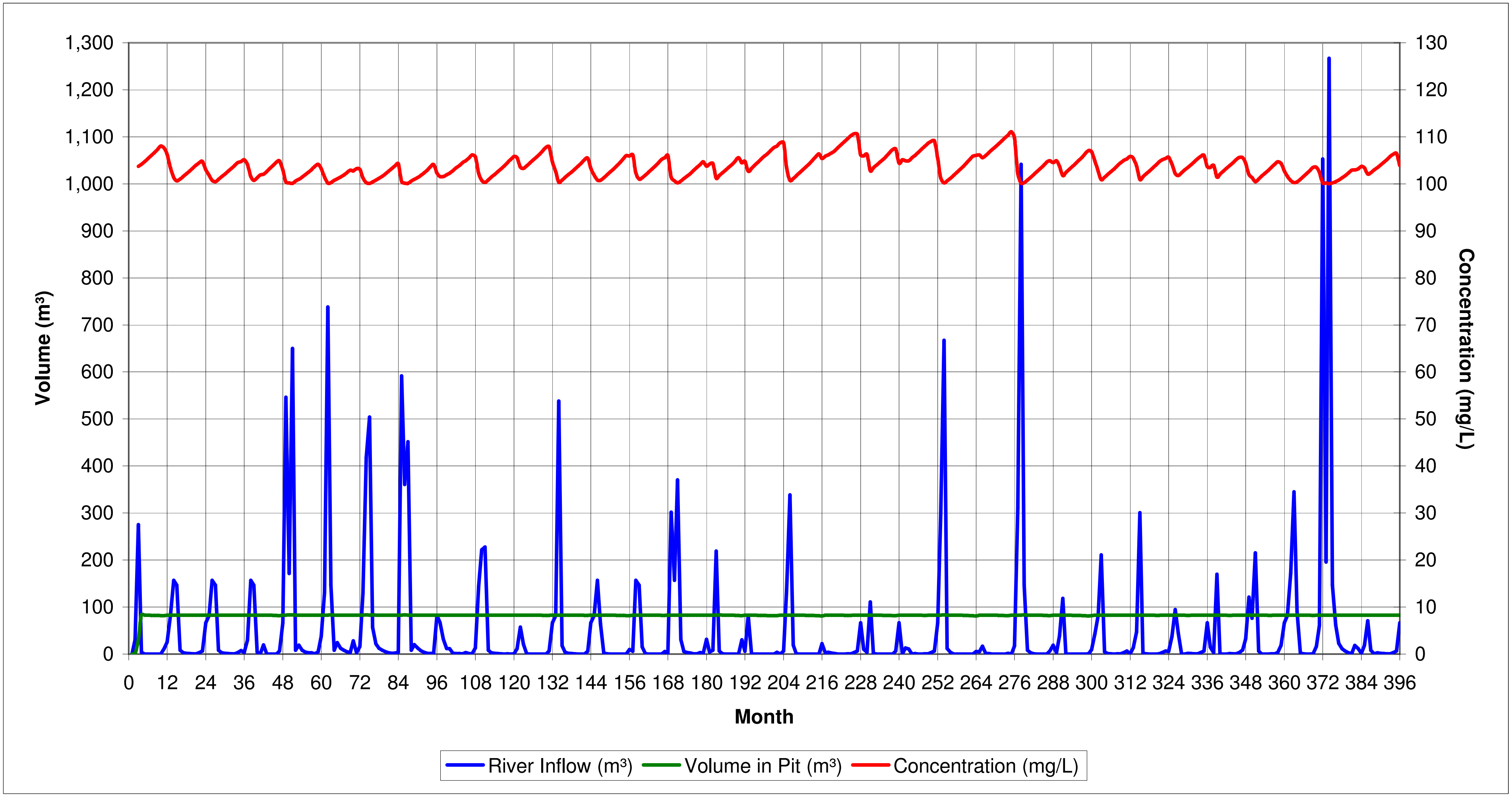
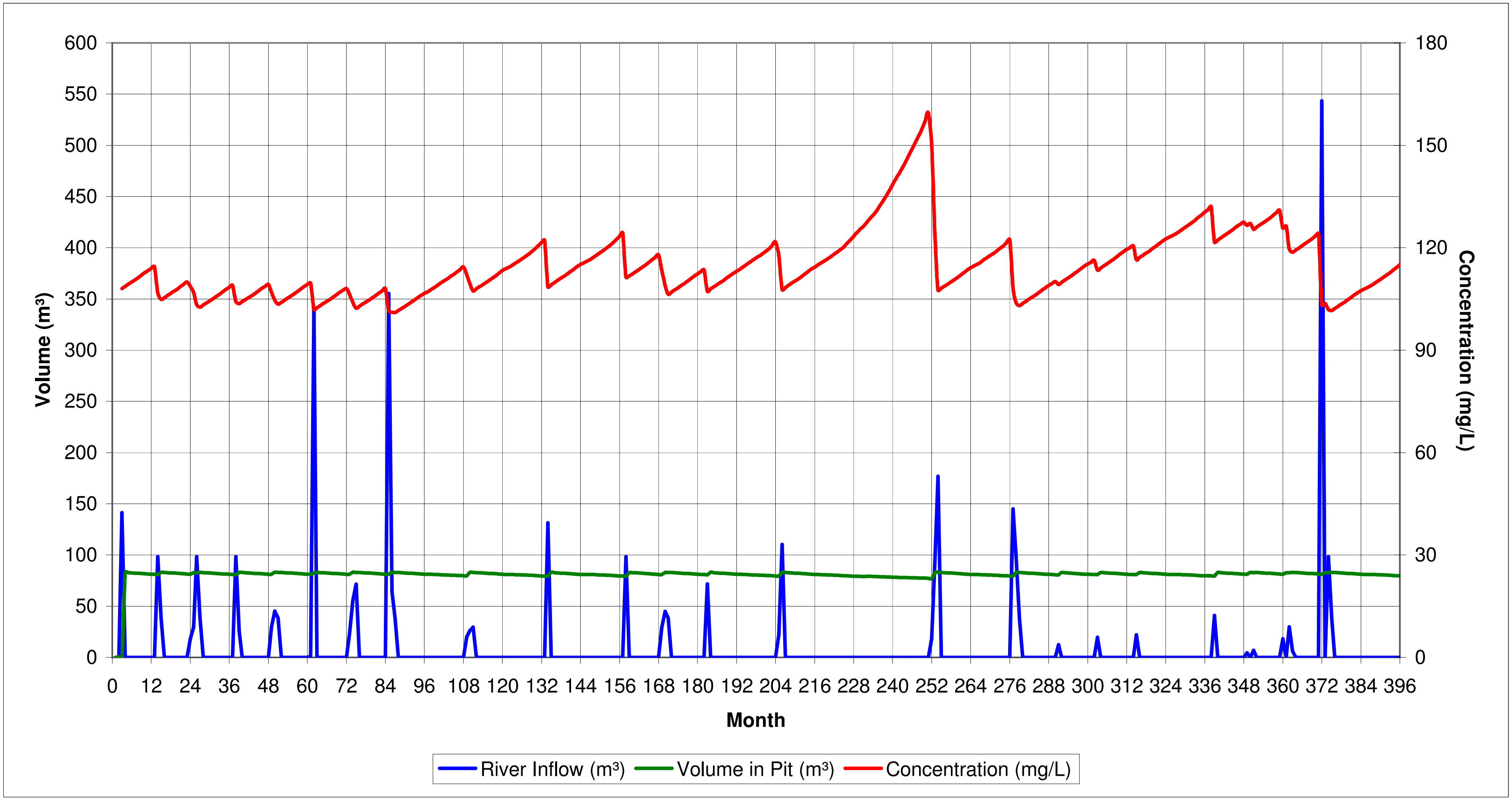
XSTRATA	McARTHUR RIVER MINE EXPANSION, EVALUATION OF PIT WATER QUALITY	MODELLED OPEN PIT SULFATE CONCENTRATIONS BEST CASE - SCENARIO 1
URS Dames & Moore Woodward Clyde	FILE: DATE: REVISION: CHECKED: APPROVED: 42625552	FIGURE 4-1



XSTRATA	McARTHUR RIVER MINE EXPANSION, EVALUATION OF PIT WATER QUALITY	MODELLED OPEN PIT SULFATE CONCENTRATIONS BEST CASE - SCENARIO 2
URS Dames & Moore Woodward Clyde / FILE: DATE: REVISION: / CHECKED: APPROVED:	42625552	FIGURE 4-2

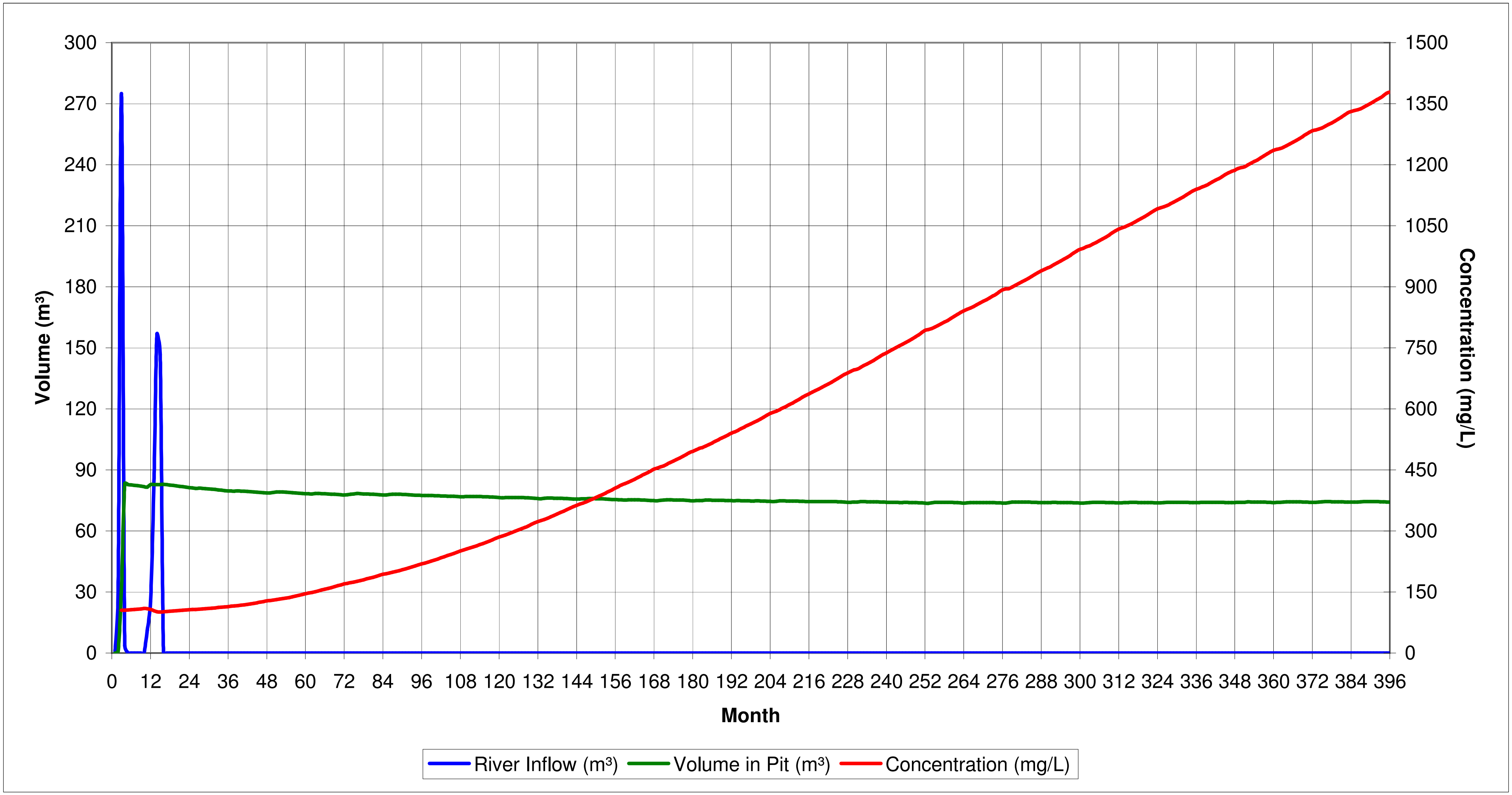


XSTRATA	McARTHUR RIVER MINE EXPANSION, EVALUATION OF PIT WATER QUALITY		MODELLED OPEN PIT SULFATE CONCENTRATIONS BEST CASE - SCENARIO 3
URS Dames & Moore Woodward Clyde	FILE: DATE: REVISION:	CHECKED: APPROVED:	42625552	FIGURE 4-3

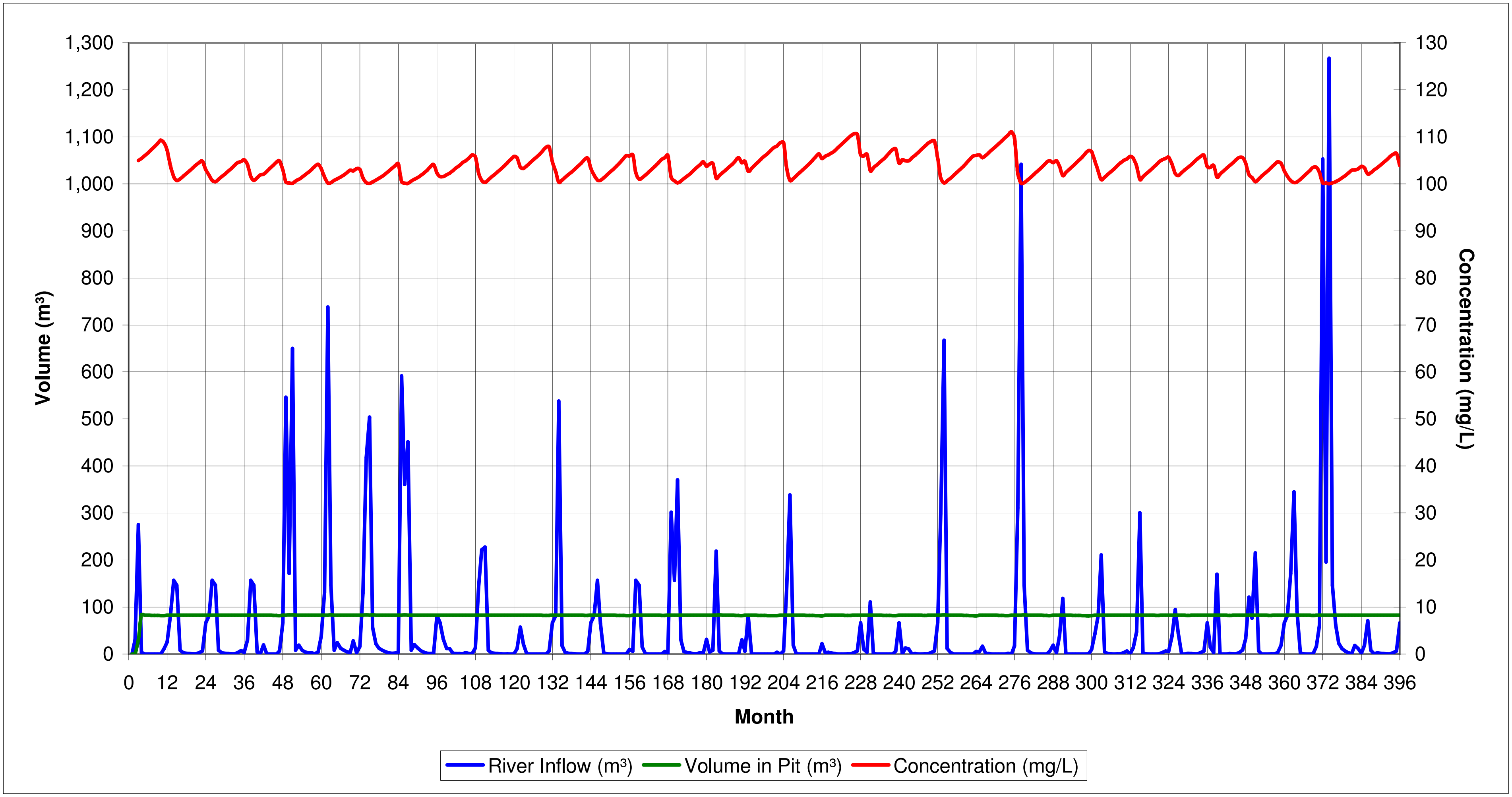


XSTRATA	McARTHUR RIVER MINE EXPANSION, EVALUATION OF PIT WATER QUALITY	MODELLED OPEN PIT SULFATE CONCENTRATIONS BEST CASE - SCENARIO 4
URS Dames & Moore Woodward Clyde	FILE: DATE: REVISION: / CHECKED: APPROVED: / 42625552	FIGURE 4-4

XSTRATA	McARTHUR RIVER MINE EXPANSION, EVALUATION OF PIT WATER QUALITY	MODELLED OPEN PIT SULFATE CONCENTRATIONS AVERAGE CASE - SCENARIO 1
URS Dames & Moore Woodward Clyde	FILE: DATE: REVISION: CHECKED: APPROVED: 42625552	FIGURE 4-5



XSTRATA	McARTHUR RIVER MINE EXPANSION, EVALUATION OF PIT WATER QUALITY	MODELLED OPEN PIT SULFATE CONCENTRATIONS AVERAGE CASE - SCENARIO 2
URS Dames & Moore Woodward Clyde	FILE: DATE: REVISION: CHECKED: APPROVED: 42625552	FIGURE 4-6



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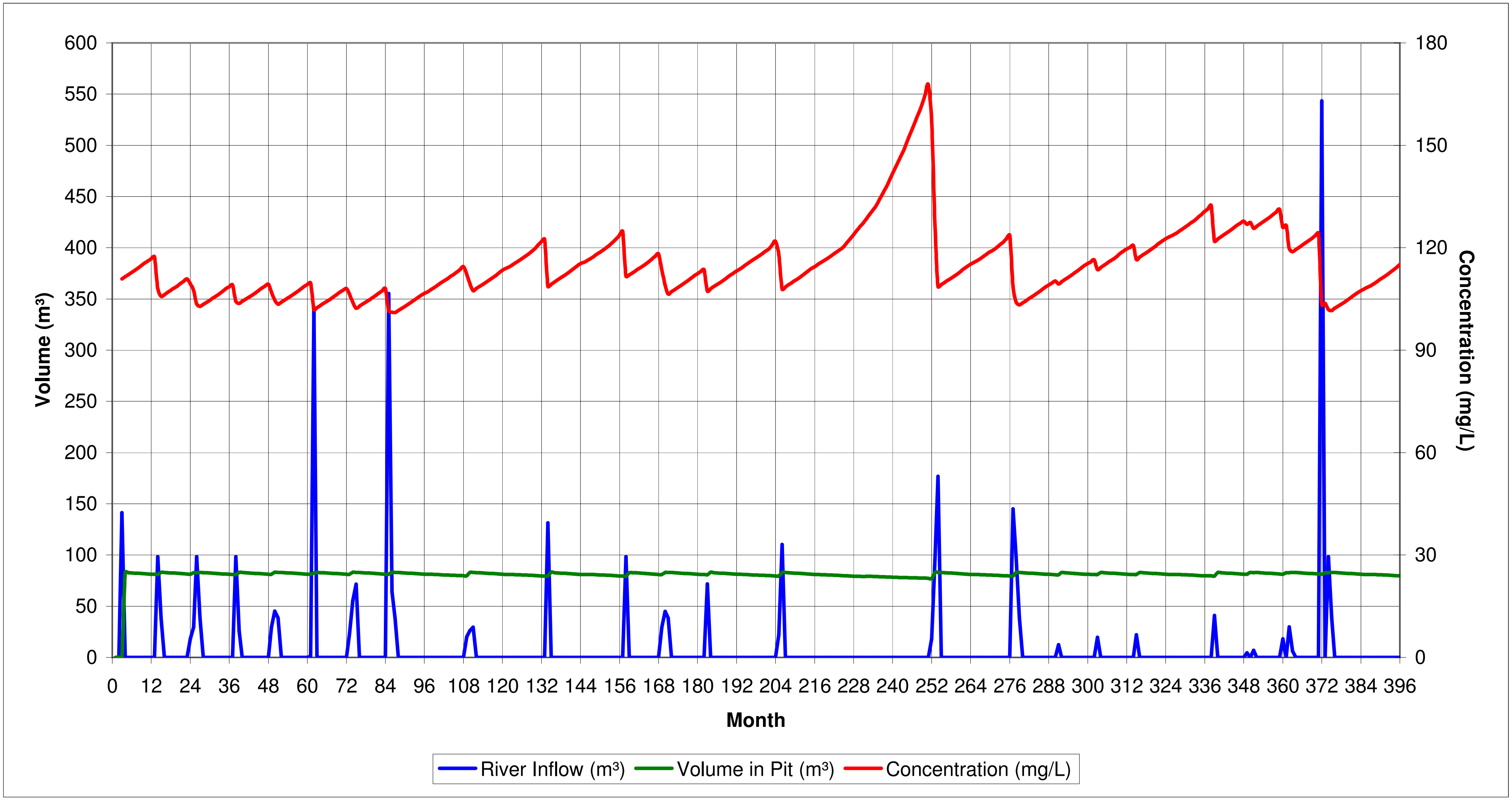
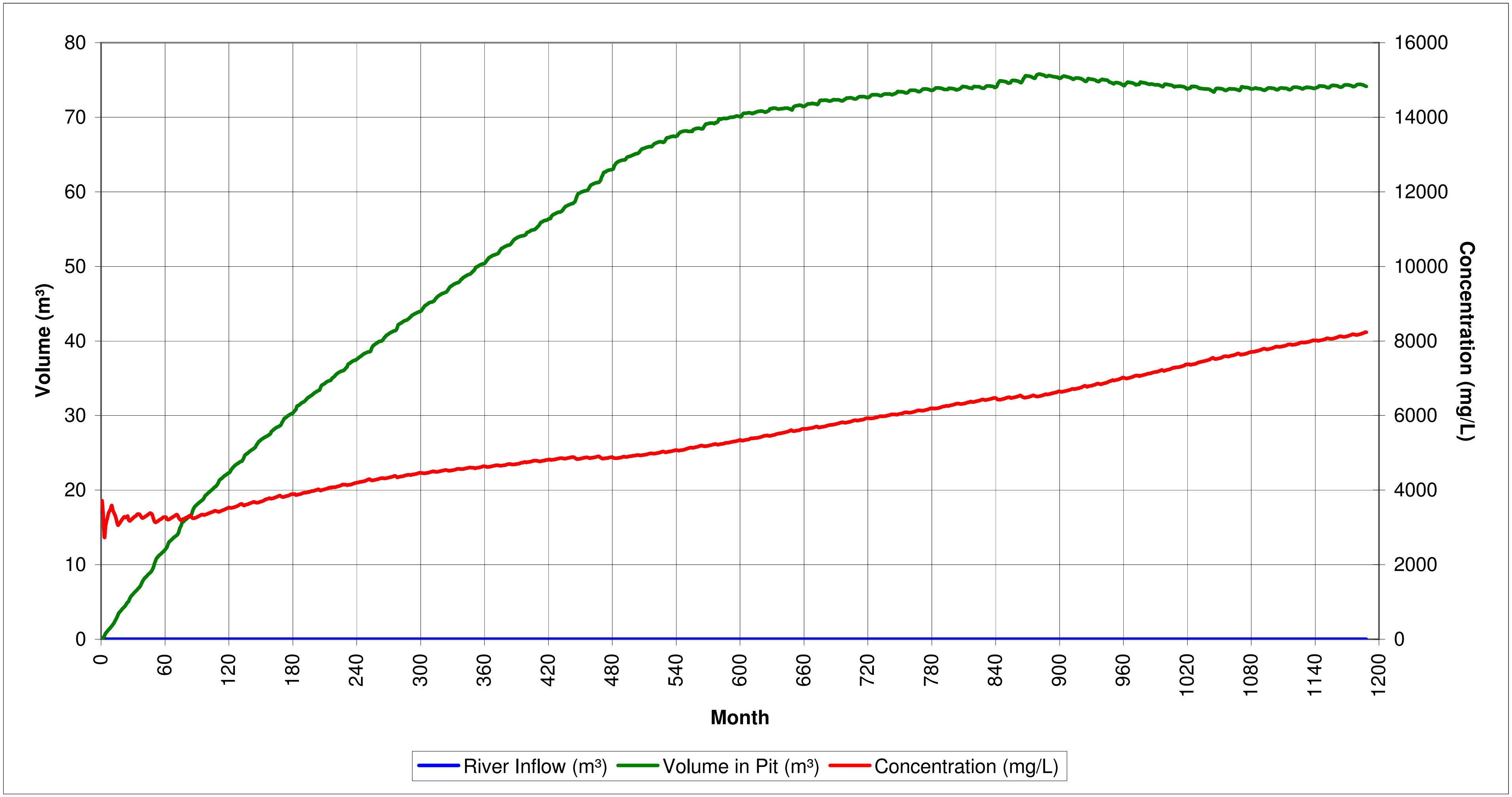
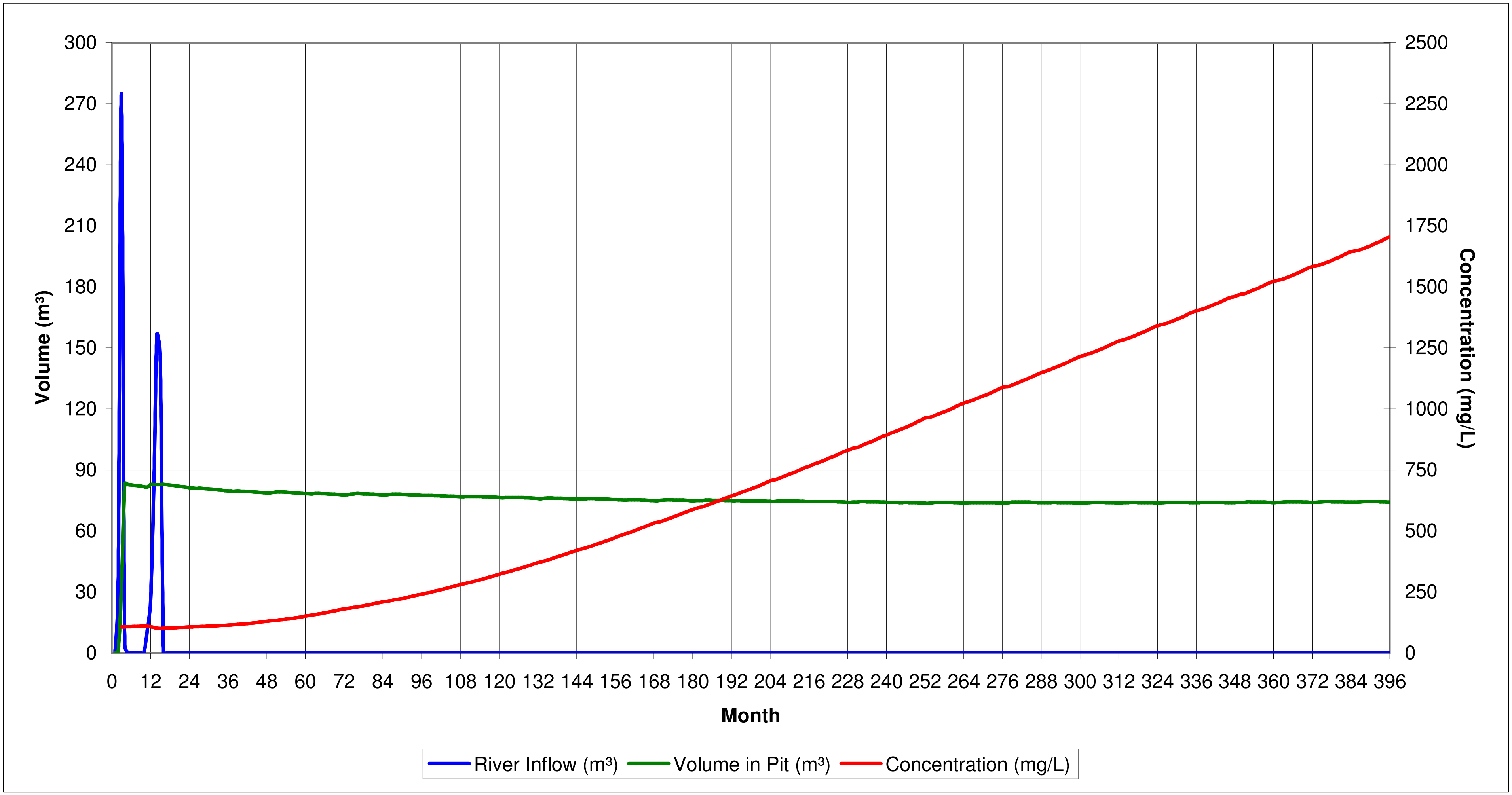
URS Dames & Moore Woodward Clyde	FILE: DATE: REVISION:	CHECKED: APPROVED:	42625552	FIGURE 4-7



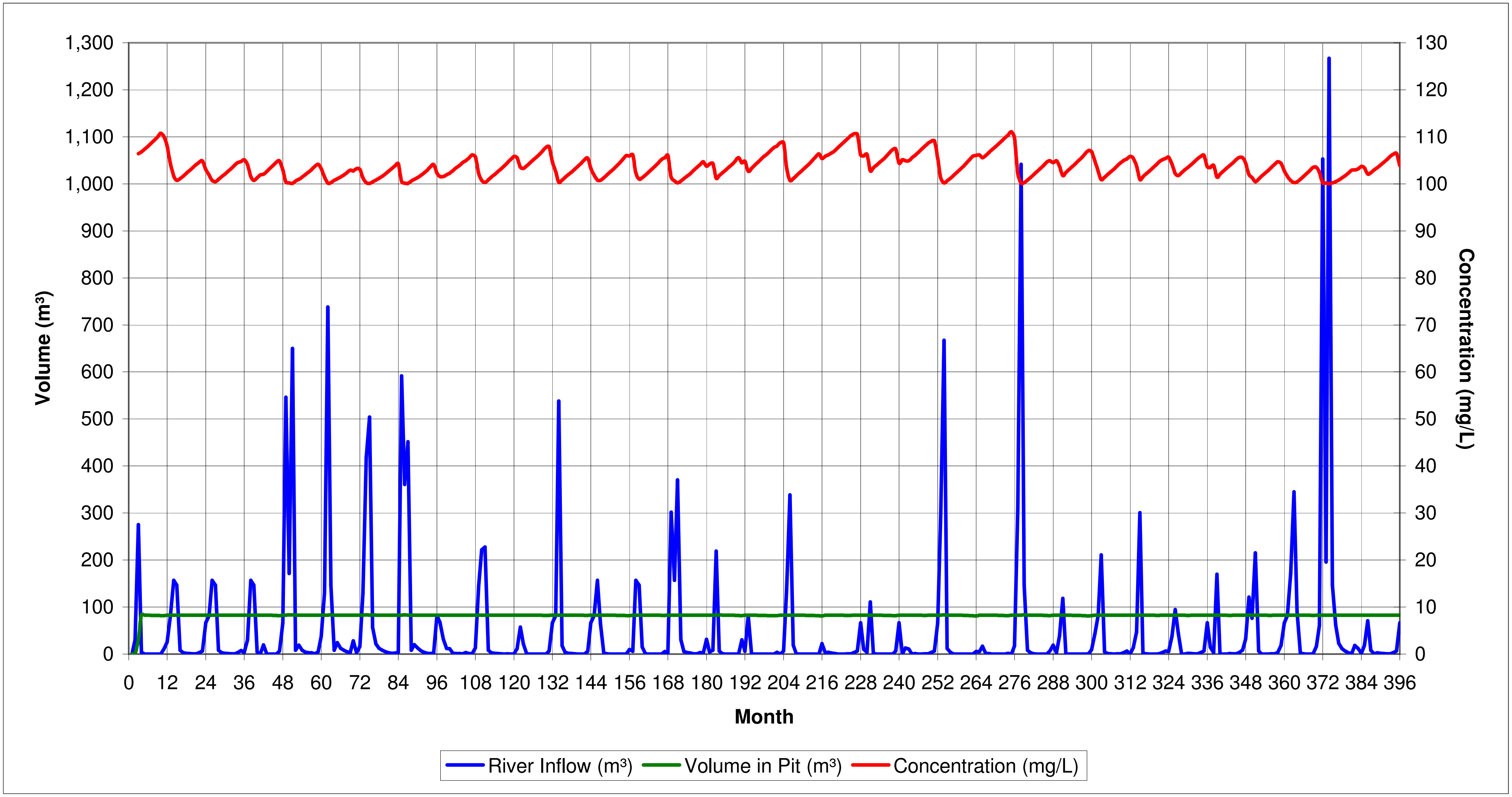
XSTRATA	McARTHUR RIVER MINE EXPANSION, EVALUATION OF PIT WATER QUALITY	MODELLED OPEN PIT SULFATE CONCENTRATIONS AVERAGE CASE - SCENARIO 4
URS Dames & Moore Woodward Clyde	FILE: DATE: REVISION: CHECKED: APPROVED: 42625552	FIGURE 4-8



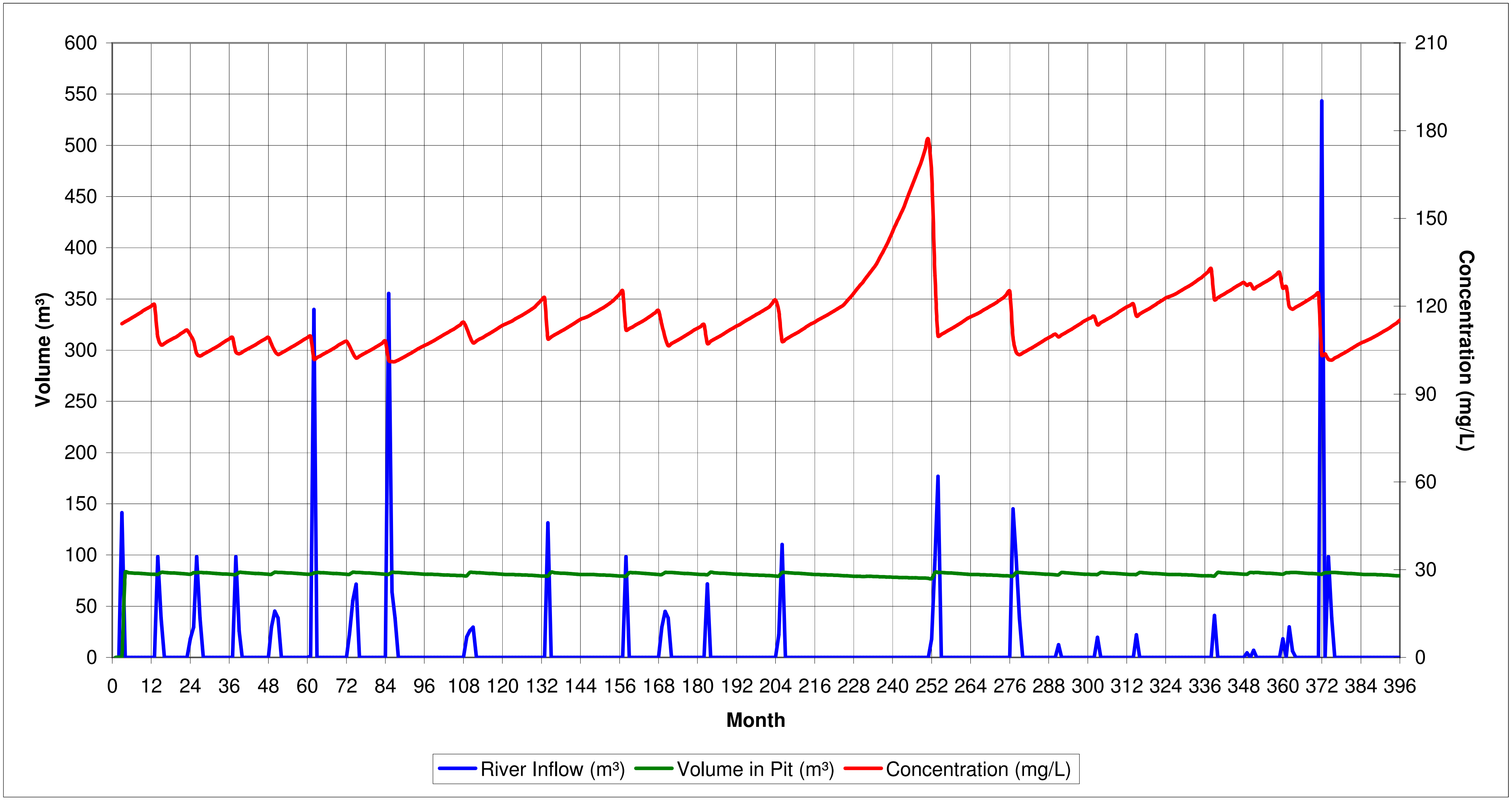
XSTRATA	McARTHUR RIVER MINE EXPANSION, EVALUATION OF PIT WATER QUALITY	MODELLED OPEN PIT SULFATE CONCENTRATIONS WORST CASE - SCENARIO 1
URS Dames & Moore Woodward Clyde	FILE: CHECKED: DATE: APPROVED: REVISION:	42625552	FIGURE 4-9



XSTRATA	McARTHUR RIVER MINE EXPANSION, EVALUATION OF PIT WATER QUALITY	MODELLED OPEN PIT SULFATE CONCENTRATIONS WORST CASE - SCENARIO 2
URS Dames & Moore Woodward Clyde	FILE: DATE: REVISION: CHECKED: APPROVED: 42625552	FIGURE 4-10



XSTRATA	McARTHUR RIVER MINE EXPANSION, EVALUATION OF PIT WATER QUALITY	MODELLED OPEN PIT SULFATE CONCENTRATIONS WORST CASE - SCENARIO 3
URS Dames & Moore Woodward Clyde	FILE: DATE: REVISION: CHECKED: APPROVED: 42625552	FIGURE 4-11



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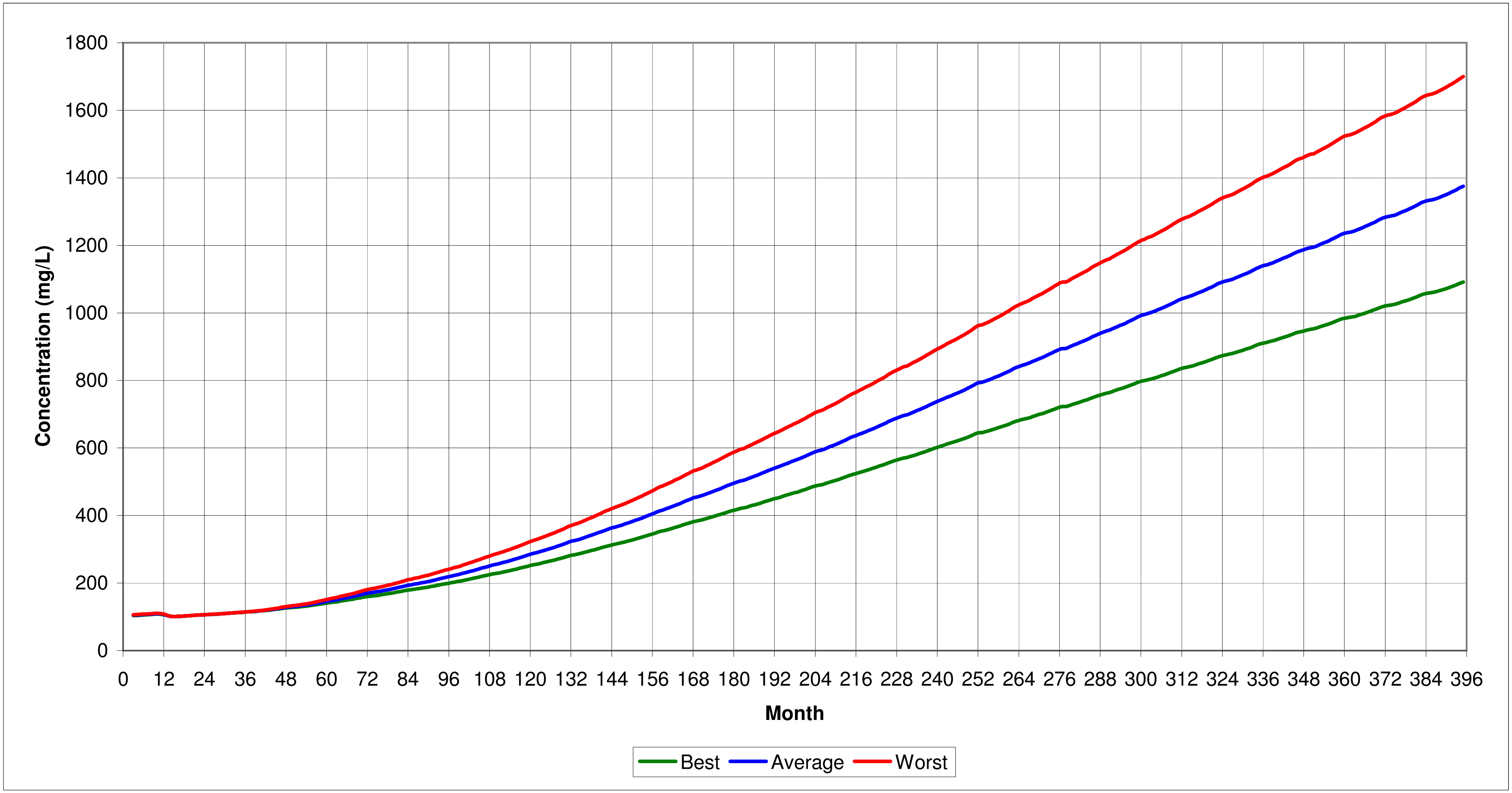
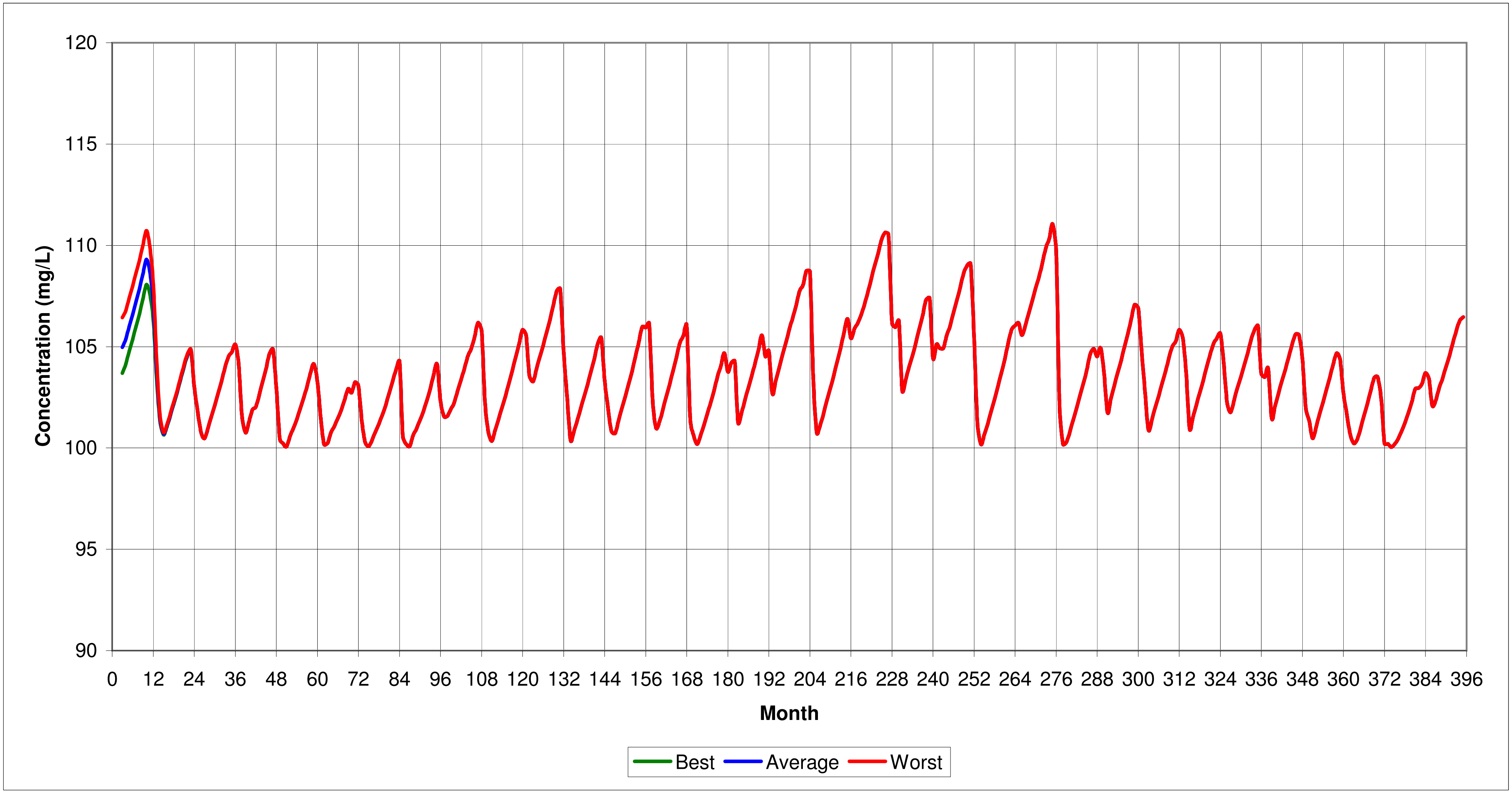
URS Dames & Moore Woodward Clyde	FILE: DATE: REVISION:	CHECKED: APPROVED:	42625552	FIGURE 4-12

XSTRATA	McARTHUR RIVER MINE EXPANSION, EVALUATION OF PIT WATER QUALITY	MODELLED OPEN PIT SULFATE CONCENTRATIONS SCENARIO 1 - ALL CASES
URS Dames & Moore Woodward Clyde	FILE: DATE: REVISION: CHECKED: APPROVED:	42625552
		FIGURE 4-13

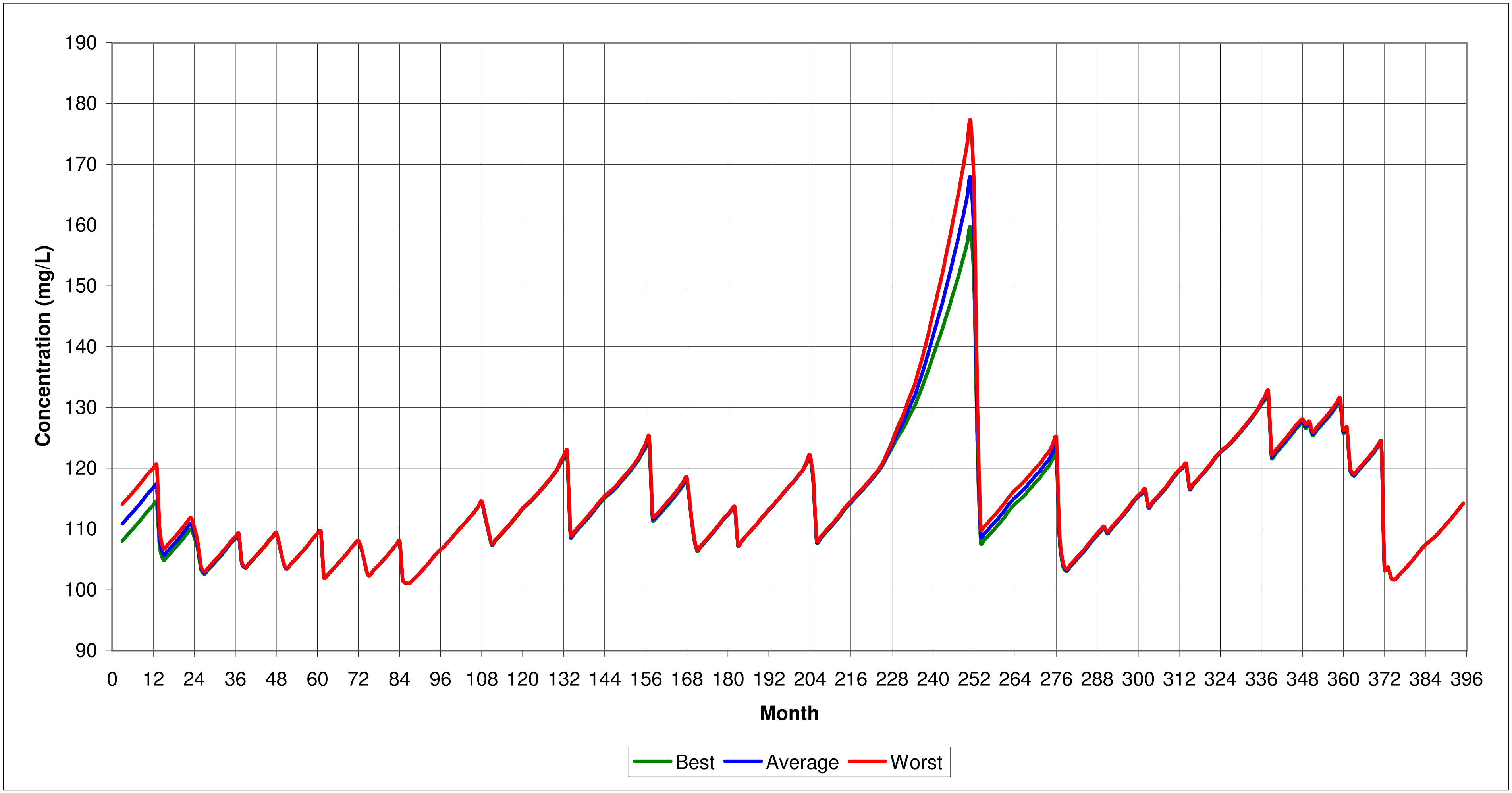


XSTRATA	McARTHUR RIVER MINE EXPANSION, EVALUATION OF PIT WATER QUALITY	MODELLED OPEN PIT SULFATE CONCENTRATIONS SCENARIO 2 - ALL CASES
URS Dames & Moore Woodward Clyde	FILE: DATE: REVISION: / CHECKED: APPROVED: / 42625552	FIGURE 4-14



XSTRATA	McARTHUR RIVER MINE EXPANSION, EVALUATION OF PIT WATER QUALITY	MODELLED OPEN PIT SULFATE CONCENTRATIONS SCENARIO 3 - ALL CASES

URS Dames & Moore Woodward Clyde	FILE: DATE: REVISION:	CHECKED: APPROVED:	42625552	FIGURE 4-15



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URS Dames & Moore Woodward Clyde / FILE: / DATE: / REVISION: / CHECKED: / APPROVED:	42625552	FIGURE 4-16

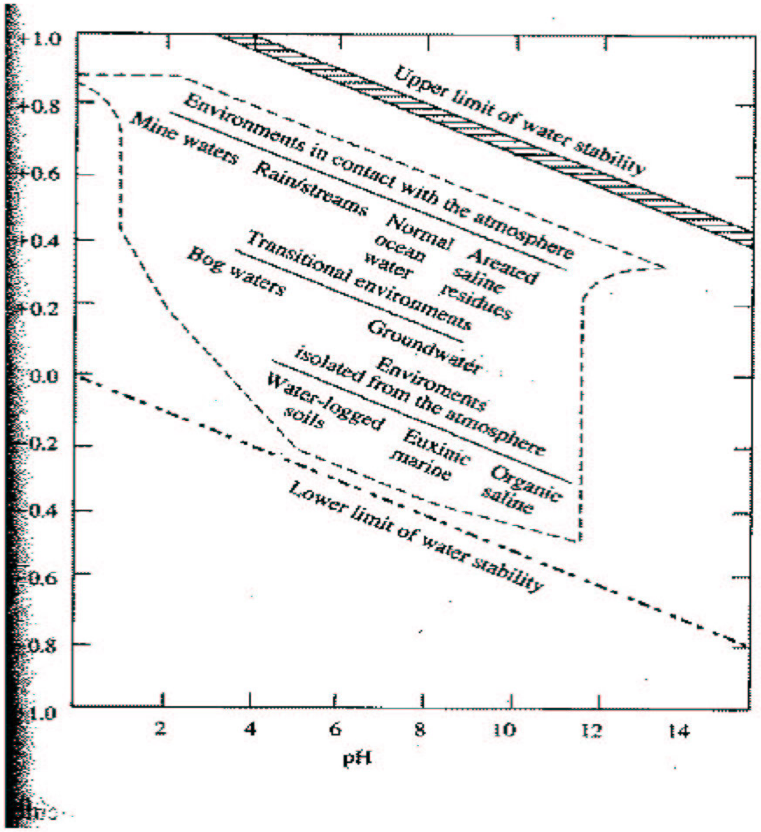

Figure 11.4 Approximate position of some natural environments in terms of Eh and pH. The dashed line represents the limits of measurements in natural environments, as reported by Baas-Becking et al. (1960) and shown in Fig. 11.3. The crosshatched area defines theoretical conditions under which waters are calculated to contain dissolved oxygen at or above a detection limit of 5 μg/L. Modified after R. M. Garrels and C. L. Christ (1965). Solutions, minerals and equilibria. Copyright © 1965 by Freeman, Cooper and Company. Used by permission.

XSTRATA		McARTHUR RIVER MINE EXPANSION, EVALUATION OF PIT WATER QUALITY	Eh-pH Diagram
URS Dames & Moore Woodward Clyde	FILE: DATE: REVISION:	CHECKED: APPROVED:	42625552	FIGURE 4-17

Appendix A
Geochemical Equilibrium Model Input and Output

Appendix A
Geochemical Equilibrium Model Input and Output

```
   Input file: C:\Documents and Settings\SXDENNE0\My Documents\MRM1.pqi
  Output file: C:\Documents and Settings\SXDENNE0\My Documents\MRM1.pqo
Database file: C:\Program Files\USGS\Phreeqc Interactive 2.11\phreeqc.dat
------------------
Reading data base.
------------------
    SOLUTION_MASTER_SPECIES
    SOLUTION_SPECIES
    PHASES
    EXCHANGE_MASTER_SPECIES
    EXCHANGE_SPECIES
    SURFACE_MASTER_SPECIES
    SURFACE_SPECIES
    RATES
    END
------------------------------------
Reading input data for simulation 1.
------------------------------------
    DATABASE C:\Program Files\USGS\Phreeqc Interactive 2.11\phreeqc.dat
    SOLUTION 1 River water
        temp      28.4
        pH        8.2
        pe        2.63
        redox     pe
        units     mg/l
        density   1
        S(6)      6.4
        Ca        48.7
        Cd        6e-005
        Cl        15.3
        Cu        0.001
        Fe        10
        K         4.2
        Mg        47
        Na        10.6
        Pb        0.00055
        Zn        0.0104
        water    1 # kg
    SOLUTION 2 PAF Leachate
        temp      25
        pH        3.98
        pe        11.85
        redox     pe
        units     mg/l
        density   1
        Ca        358
        Cd        0.0631
        Cl        1
        Cu        0.058
        Fe        307
        K         4
        Mg        2560
        Na        6
        Pb        0.286
        S(6)      5000
        Zn        134
        water    1 # kg
    SOLUTION 3 NAF Leachate
        temp      25
        pH        6.5
        pe        1.84
        redox     pe
        units     mg/l
        density   1
        Ca        193
        Cd        0.0025
        Cl        64
        Cu        0.005
        Fe        0.01
        K         38
        Mg        226
```

```
        Na        61
        Pb        0.005
        S(6)      1450
        Zn        1.53
        water    1 # kg
    SOLUTION 4 Rainwater
        temp      25
        pH        4.59
        pe        10.15
        redox     pe
        units     mg/l
        density   1
        Ca        0.1002
        Cd        0
        Cl        0.2375
        Cu        0
        Fe        0
        K         0.0586
        Mg        0.0316
        Na        0.15869
        Pb        0
        S(6)      0.7781
        Zn        0.01
        water    1 # kg
    SOLUTION 5 Tailings Seepage
        temp      25
        pH        6.56
        pe        1.69
        redox     pe
        units     mg/l
        density   1
        Ca        405
        Cd        0.00008
        Cl        2610
        Cu        0.0174
        Fe        0.00315
        K         297
        Mg        1070
        Na        3030
        Pb        0.00029
        S(6)      6190
        Zn        0.327
        water    1 # kg
    MIX 1 Mixing of water in open pit - best case Scenario 1
        1    0
        2    0.0727
        3    0.6544
        4    0.2410
        5    0.0319
    END
-------------------------------------------
Beginning of initial solution calculations.
-------------------------------------------
Initial solution 1.   River water
-----------------------------Solution composition------------------------------
    Elements           Molality       Moles
    Ca               1.215e-003  1.215e-003
    Cd               5.339e-010  5.339e-010
    Cl               4.316e-004  4.316e-004
    Cu               1.574e-008  1.574e-008
    Fe               1.791e-004  1.791e-004
    K                1.074e-004  1.074e-004
    Mg               1.933e-003  1.933e-003
    Na               4.611e-004  4.611e-004
    Pb               2.655e-009  2.655e-009
    S(6)             6.663e-005  6.663e-005
    Zn               1.591e-007  1.591e-007
----------------------------Description of solution----------------------------
                                       pH  =   8.200
                                       pe  =   2.630
                        Activity of water  =   1.000
                           Ionic strength  =  6.879e-003
```

```
                   Mass of water (kg)  =  1.000e+000
             Total alkalinity (eq/kg)  =  1.996e-004
                Total carbon (mol/kg)  =  0.000e+000
                   Total CO2 (mol/kg)  =  0.000e+000
                  Temperature (deg C)  =  28.400
              Electrical balance (eq)  =  6.283e-003
 Percent error, 100*(Cat-|An|)/(Cat+|An|)  =  84.94
                           Iterations  =   4
                              Total H  = 1.110130e+002
                              Total O  = 5.550704e+001
----------------------------Distribution of species----------------------------
```

Species	Molality	Activity	Log Molality	Log Activity	Log Gamma
OH-	2.233e-006	2.043e-006	-5.651	-5.690	-0.039
H+	6.825e-009	6.310e-009	-8.166	-8.200	-0.034
H2O	5.551e+001	9.999e-001	1.744	-0.000	0.000
Ca	1.215e-003				
Ca+2	1.209e-003	8.591e-004	-2.918	-3.066	-0.148
CaSO4	6.060e-006	6.069e-006	-5.218	-5.217	0.001
CaOH+	2.467e-008	2.260e-008	-7.608	-7.646	-0.038
CaHSO4+	2.559e-013	2.344e-013	-12.592	-12.630	-0.038
Cd	5.339e-010				
Cd+2	5.087e-010	3.579e-010	-9.294	-9.446	-0.153
CdCl+	1.490e-011	1.365e-011	-10.827	-10.865	-0.038
CdOH+	6.609e-012	6.053e-012	-11.180	-11.218	-0.038
CdSO4	3.609e-012	3.615e-012	-11.443	-11.442	0.001
Cd(OH)2	4.009e-014	4.015e-014	-13.397	-13.396	0.001
CdCl2	2.271e-014	2.274e-014	-13.644	-13.643	0.001
Cd(SO4)2-2	1.894e-015	1.332e-015	-14.723	-14.875	-0.153
CdCl3-	6.507e-018	5.960e-018	-17.187	-17.225	-0.038
Cd(OH)3-	7.795e-019	7.139e-019	-18.108	-18.146	-0.038
Cd(OH)4-2	1.433e-024	1.008e-024	-23.844	-23.996	-0.153
Cl	4.316e-004				
Cl-	4.316e-004	3.948e-004	-3.365	-3.404	-0.039
FeCl+	9.966e-010	9.127e-010	-9.001	-9.040	-0.038
ZnCl+	1.081e-010	9.898e-011	-9.966	-10.004	-0.038
CdCl+	1.490e-011	1.365e-011	-10.827	-10.865	-0.038
PbCl+	9.858e-012	9.029e-012	-11.006	-11.044	-0.038
ZnCl2	4.141e-014	4.148e-014	-13.383	-13.382	0.001
CdCl2	2.271e-014	2.274e-014	-13.644	-13.643	0.001
PbCl2	5.298e-015	5.306e-015	-14.276	-14.275	0.001
ZnCl3-	2.047e-017	1.875e-017	-16.689	-16.727	-0.038
CdCl3-	6.507e-018	5.960e-018	-17.187	-17.225	-0.038
PbCl3-	1.855e-018	1.699e-018	-17.732	-17.770	-0.038
FeCl+2	1.546e-018	1.088e-018	-17.811	-17.963	-0.153
ZnCl4-2	5.416e-021	3.810e-021	-20.266	-20.419	-0.153
FeCl2+	1.883e-021	1.725e-021	-20.725	-20.763	-0.038
PbCl4-2	4.683e-022	3.295e-022	-21.329	-21.482	-0.153
FeCl3	6.800e-026	6.810e-026	-25.168	-25.167	0.001
Cu(1)	4.144e-011				
Cu+	4.144e-011	3.781e-011	-10.383	-10.422	-0.040
Cu(2)	1.570e-008				
Cu(OH)2	1.560e-008	1.563e-008	-7.807	-7.806	0.001
CuOH+	5.155e-011	4.720e-011	-10.288	-10.326	-0.038
Cu+2	4.169e-011	2.978e-011	-10.380	-10.526	-0.146
CuSO4	2.132e-013	2.136e-013	-12.671	-12.670	0.001
Cu(OH)3-	1.630e-013	1.492e-013	-12.788	-12.826	-0.038
Cu(OH)4-2	6.708e-018	4.719e-018	-17.173	-17.326	-0.153
Fe(2)	2.474e-006				
Fe+2	2.344e-006	1.675e-006	-5.630	-5.776	-0.146
FeOH+	1.178e-007	1.079e-007	-6.929	-6.967	-0.038
FeSO4	1.085e-008	1.087e-008	-7.965	-7.964	0.001
FeCl+	9.966e-010	9.127e-010	-9.001	-9.040	-0.038
FeHSO4+	4.989e-016	4.569e-016	-15.302	-15.340	-0.038
Fe(3)	1.766e-004				
Fe(OH)3	1.439e-004	1.441e-004	-3.842	-3.841	0.001
Fe(OH)4-	2.604e-005	2.385e-005	-4.584	-4.623	-0.038
Fe(OH)2+	6.658e-006	6.098e-006	-5.177	-5.215	-0.038
FeOH+2	1.454e-010	1.023e-010	-9.837	-9.990	-0.153
Fe+3	1.663e-016	8.202e-017	-15.779	-16.086	-0.307
FeSO4+	3.630e-017	3.324e-017	-16.440	-16.478	-0.038
FeCl+2	1.546e-018	1.088e-018	-17.811	-17.963	-0.153

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     Fe2(OH)2+4        1.001e-018  2.451e-019   -18.000   -18.611    -0.611
     Fe(SO4)2-         2.761e-020  2.528e-020   -19.559   -19.597    -0.038
     Fe3(OH)4+5        2.062e-021  2.290e-022   -20.686   -21.640    -0.954
     FeCl2+            1.883e-021  1.725e-021   -20.725   -20.763    -0.038
     FeHSO4+2          7.990e-025  5.621e-025   -24.097   -24.250    -0.153
     FeCl3             6.800e-026  6.810e-026   -25.168   -25.167     0.001
H(0)              2.991e-025
     H2                1.495e-025  1.498e-025   -24.825   -24.825     0.001
K                 1.074e-004
     K+                1.074e-004  9.825e-005    -3.969    -4.008    -0.039
     KSO4-             2.742e-008  2.512e-008    -7.562    -7.600    -0.038
     KOH               5.390e-011  5.399e-011   -10.268   -10.268     0.001
Mg                1.933e-003
     Mg+2              1.920e-003  1.371e-003    -2.717    -2.863    -0.146
     MgSO4             1.200e-005  1.202e-005    -4.921    -4.920     0.001
     MgOH+             1.167e-006  1.068e-006    -5.933    -5.971    -0.038
Na                4.611e-004
     Na+               4.611e-004  4.226e-004    -3.336    -3.374    -0.038
     NaSO4-            8.107e-008  7.424e-008    -7.091    -7.129    -0.038
     NaOH              4.418e-010  4.425e-010    -9.355    -9.354     0.001
O(0)              0.000e+000
     O2                0.000e+000  0.000e+000   -41.647   -41.646     0.001
Pb                2.655e-009
     PbOH+             1.783e-009  1.633e-009    -8.749    -8.787    -0.038
     Pb+2              7.512e-010  5.285e-010    -9.124    -9.277    -0.153
     Pb(OH)2           1.005e-010  1.007e-010    -9.998    -9.997     0.001
     PbSO4             1.018e-011  1.020e-011   -10.992   -10.992     0.001
     PbCl+             9.858e-012  9.029e-012   -11.006   -11.044    -0.038
     Pb(OH)3-          2.000e-013  1.832e-013   -12.699   -12.737    -0.038
     PbCl2             5.298e-015  5.306e-015   -14.276   -14.275     0.001
     Pb(SO4)2-2        2.610e-015  1.836e-015   -14.583   -14.736    -0.153
     Pb(OH)4-2         9.454e-017  6.651e-017   -16.024   -16.177    -0.153
     Pb2OH+3           4.262e-017  1.932e-017   -16.370   -16.714    -0.344
     PbCl3-            1.855e-018  1.699e-018   -17.732   -17.770    -0.038
     PbCl4-2           4.683e-022  3.295e-022   -21.329   -21.482    -0.153
S(6)              6.663e-005
     SO4-2             4.845e-005  3.431e-005    -4.315    -4.465    -0.150
     MgSO4             1.200e-005  1.202e-005    -4.921    -4.920     0.001
     CaSO4             6.060e-006  6.069e-006    -5.218    -5.217     0.001
     NaSO4-            8.107e-008  7.424e-008    -7.091    -7.129    -0.038
     KSO4-             2.742e-008  2.512e-008    -7.562    -7.600    -0.038
     FeSO4             1.085e-008  1.087e-008    -7.965    -7.964     0.001
     ZnSO4             6.618e-010  6.629e-010    -9.179    -9.179     0.001
     HSO4-             2.478e-011  2.269e-011   -10.606   -10.644    -0.038
     PbSO4             1.018e-011  1.020e-011   -10.992   -10.992     0.001
     CdSO4             3.609e-012  3.615e-012   -11.443   -11.442     0.001
     Zn(SO4)2-2        2.561e-013  1.801e-013   -12.592   -12.744    -0.153
     CaHSO4+           2.559e-013  2.344e-013   -12.592   -12.630    -0.038
     CuSO4             2.132e-013  2.136e-013   -12.671   -12.670     0.001
     Pb(SO4)2-2        2.610e-015  1.836e-015   -14.583   -14.736    -0.153
     Cd(SO4)2-2        1.894e-015  1.332e-015   -14.723   -14.875    -0.153
     FeHSO4+           4.989e-016  4.569e-016   -15.302   -15.340    -0.038
     FeSO4+            3.630e-017  3.324e-017   -16.440   -16.478    -0.038
     Fe(SO4)2-         2.761e-020  2.528e-020   -19.559   -19.597    -0.038
     FeHSO4+2          7.990e-025  5.621e-025   -24.097   -24.250    -0.153
Zn                1.591e-007
     Zn+2              1.133e-007  8.030e-008    -6.946    -7.095    -0.150
     Zn(OH)2           2.535e-008  2.539e-008    -7.596    -7.595     0.001
     ZnOH+             1.966e-008  1.801e-008    -7.706    -7.745    -0.038
     ZnSO4             6.618e-010  6.629e-010    -9.179    -9.179     0.001
     ZnCl+             1.081e-010  9.898e-011    -9.966   -10.004    -0.038
     Zn(OH)3-          1.389e-011  1.272e-011   -10.857   -10.895    -0.038
     Zn(SO4)2-2        2.561e-013  1.801e-013   -12.592   -12.744    -0.153
     ZnCl2             4.141e-014  4.148e-014   -13.383   -13.382     0.001
     Zn(OH)4-2         4.543e-016  3.196e-016   -15.343   -15.495    -0.153
     ZnCl3-            2.047e-017  1.875e-017   -16.689   -16.727    -0.038
     ZnCl4-2           5.416e-021  3.810e-021   -20.266   -20.419    -0.153
------------------------------Saturation indices-------------------------------
     Phase               SI log IAP  log KT

     Anglesite        -5.97  -13.74   -7.77  PbSO4
     Anhydrite        -3.15   -7.53   -4.38  CaSO4
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    Cd(OH)2          -6.70    6.95   13.65  Cd(OH)2
    CdSO4           -13.69  -13.91   -0.22  CdSO4
    Fe(OH)3(a)        3.62    8.51    4.89  Fe(OH)3
    Goethite          9.63    8.51   -1.12  FeOOH
    Gypsum           -2.95   -7.53   -4.58  CaSO4:2H2O
    H2(g)           -21.66  -24.82   -3.16  H2
    H2O(g)           -1.42   -0.00    1.42  H2O
    Halite           -8.37   -6.78    1.59  NaCl
    Hematite         21.29   17.03   -4.26  Fe2O3
    Jarosite-K       -2.53  -12.00   -9.47  KFe3(SO4)2(OH)6
    Melanterite      -8.07  -10.24   -2.17  FeSO4:7H2O
    O2(g)           -38.67  -41.65   -2.98  O2
    Pb(OH)2          -0.91    7.12    8.03  Pb(OH)2
    Zn(OH)2(e)       -2.20    9.30   11.50  Zn(OH)2
Initial solution 2.   PAF Leachate
-----------------------------Solution composition------------------------------
    Elements           Molality       Moles
    Ca                9.008e-003  9.008e-003
    Cd                5.661e-007  5.661e-007
    Cl                2.844e-005  2.844e-005
    Cu                9.204e-007  9.204e-007
    Fe                5.544e-003  5.544e-003
    K                 1.032e-004  1.032e-004
    Mg                1.062e-001  1.062e-001
    Na                2.632e-004  2.632e-004
    Pb                1.392e-006  1.392e-006
    S(6)              5.249e-002  5.249e-002
    Zn                2.067e-003  2.067e-003
----------------------------Description of solution----------------------------
                                       pH  =   3.980
                                       pe  =  11.850
                        Activity of water  =   0.998
                           Ionic strength  =  2.210e-001
                       Mass of water (kg)  =  1.000e+000
                 Total alkalinity (eq/kg)  = -3.984e-003
                    Total carbon (mol/kg)  =  0.000e+000
                       Total CO2 (mol/kg)  =  0.000e+000
                      Temperature (deg C)  =  25.000
                  Electrical balance (eq)  =  1.397e-001
 Percent error, 100*(Cat-|An|)/(Cat+|An|)  =  64.77
                               Iterations  =  13
                                  Total H  = 1.110194e+002
                                  Total O  = 5.572292e+001
---------------------------Distribution of species---------------------------
                                                    Log       Log        Log
    Species            Molality    Activity  Molality  Activity      Gamma

    H+                1.319e-004  1.047e-004    -3.880    -3.980     -0.100
    OH-               1.364e-010  9.537e-011    -9.865   -10.021     -0.155
    H2O               5.551e+001  9.976e-001     1.744    -0.001      0.000
Ca              9.008e-003
    Ca+2              6.844e-003  2.144e-003    -2.165    -2.669     -0.504
    CaSO4             2.162e-003  2.275e-003    -2.665    -2.643      0.022
    CaHSO4+           1.878e-006  1.395e-006    -5.726    -5.855     -0.129
    CaOH+             4.563e-012  3.390e-012   -11.341   -11.470     -0.129
Cd              5.661e-007
    Cd+2              3.690e-007  1.124e-007    -6.433    -6.949     -0.516
    CdSO4             1.638e-007  1.723e-007    -6.786    -6.764      0.022
    Cd(SO4)2-2        3.300e-008  1.005e-008    -7.482    -7.998     -0.516
    CdCl+             2.891e-010  2.147e-010    -9.539    -9.668     -0.129
    CdOH+             1.199e-013  8.906e-014   -12.921   -13.050     -0.129
    CdCl2             1.702e-014  1.791e-014   -13.769   -13.747      0.022
    CdCl3-            3.044e-019  2.261e-019   -18.517   -18.646     -0.129
    Cd(OH)2           4.330e-020  4.556e-020   -19.363   -19.341      0.022
    Cd(OH)3-          6.557e-029  4.871e-029   -28.183   -28.312     -0.129
    Cd(OH)4-2         1.358e-038  4.136e-039   -37.867   -38.383     -0.516
Cl              2.844e-005
    Cl-               2.840e-005  2.001e-005    -4.547    -4.699     -0.152
    ZnCl+             3.100e-008  2.303e-008    -7.509    -7.638     -0.129
    FeCl+2            9.273e-009  2.824e-009    -8.033    -8.549     -0.516
    FeCl+             2.570e-009  1.909e-009    -8.590    -8.719     -0.129
    CdCl+             2.891e-010  2.147e-010    -9.539    -9.668     -0.129
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     PbCl+              2.332e-010  1.732e-010    -9.632    -9.761    -0.129
     ZnCl2              4.586e-013  4.825e-013   -12.339   -12.316     0.022
     FeCl2+             3.397e-013  2.524e-013   -12.469   -12.598    -0.129
     CdCl2              1.702e-014  1.791e-014   -13.769   -13.747     0.022
     PbCl2              5.220e-015  5.493e-015   -14.282   -14.260     0.022
     ZnCl3-             1.458e-017  1.083e-017   -16.836   -16.965    -0.129
     FeCl3              4.799e-019  5.049e-019   -18.319   -18.297     0.022
     CdCl3-             3.044e-019  2.261e-019   -18.517   -18.646    -0.129
     PbCl3-             1.175e-019  8.730e-020   -18.930   -19.059    -0.129
     ZnCl4-2            3.567e-022  1.086e-022   -21.448   -21.964    -0.516
     PbCl4-2            2.745e-024  8.360e-025   -23.561   -24.078    -0.516
Cu(1)              2.433e-016
     Cu+                2.433e-016  1.635e-016   -15.614   -15.787    -0.173
Cu(2)              9.204e-007
     Cu+2               6.929e-007  2.205e-007    -6.159    -6.657    -0.497
     CuSO4              2.275e-007  2.394e-007    -6.643    -6.621     0.022
     CuOH+              2.954e-011  2.101e-011   -10.530   -10.678    -0.148
     Cu(OH)2            3.974e-013  4.182e-013   -12.401   -12.379     0.022
     Cu(OH)3-           3.231e-022  2.401e-022   -21.491   -21.620    -0.129
     Cu(OH)4-2          1.498e-030  4.563e-031   -29.824   -30.341    -0.516
Fe(2)              2.794e-004
     Fe+2               2.172e-004  6.912e-005    -3.663    -4.160    -0.497
     FeSO4              6.212e-005  6.536e-005    -4.207    -4.185     0.022
     FeHSO4+            6.056e-008  4.499e-008    -7.218    -7.347    -0.129
     FeCl+              2.570e-009  1.909e-009    -8.590    -8.719    -0.129
     FeOH+              2.803e-010  2.083e-010    -9.552    -9.681    -0.129
Fe(3)              5.264e-003
     Fe(OH)2+           1.221e-003  9.069e-004    -2.913    -3.042    -0.129
     FeOH+2             9.440e-004  2.875e-004    -3.025    -3.541    -0.516
     Fe3(OH)4+5         7.114e-004  4.214e-007    -3.148    -6.375    -3.227
     FeSO4+             3.668e-004  2.725e-004    -3.436    -3.565    -0.129
     Fe2(OH)2+4         2.586e-004  2.224e-006    -3.587    -5.653    -2.066
     Fe(SO4)2-          4.267e-005  3.170e-005    -4.370    -4.499    -0.129
     Fe+3               3.729e-005  4.673e-006    -4.428    -5.330    -0.902
     Fe(OH)3            1.058e-006  1.113e-006    -5.976    -5.953     0.022
     FeHSO4+2           2.509e-007  7.640e-008    -6.601    -7.117    -0.516
     FeCl+2             9.273e-009  2.824e-009    -8.033    -8.549    -0.516
     Fe(OH)4-           1.302e-011  9.671e-012   -10.885   -11.015    -0.129
     FeCl2+             3.397e-013  2.524e-013   -12.469   -12.598    -0.129
     FeCl3              4.799e-019  5.049e-019   -18.319   -18.297     0.022
H(0)               2.944e-035
     H2                 1.472e-035  1.549e-035   -34.832   -34.810     0.022
K                  1.032e-004
     K+                 9.963e-005  7.019e-005    -4.002    -4.154    -0.152
     KSO4-              3.530e-006  2.622e-006    -5.452    -5.581    -0.129
     KOH                2.204e-015  2.319e-015   -14.657   -14.635     0.022
Mg                 1.062e-001
     Mg+2               7.596e-002  2.551e-002    -1.119    -1.593    -0.474
     MgSO4              3.023e-002  3.180e-002    -1.520    -1.498     0.022
     MgOH+              1.188e-009  8.826e-010    -8.925    -9.054    -0.129
Na                 2.632e-004
     Na+                2.564e-004  1.894e-004    -3.591    -3.723    -0.131
     NaSO4-             6.796e-006  5.048e-006    -5.168    -5.297    -0.129
     NaOH               1.133e-014  1.192e-014   -13.946   -13.924     0.022
O(0)               3.287e-023
     O2                 1.644e-023  1.730e-023   -22.784   -22.762     0.022
Pb                 1.392e-006
     Pb+2               7.141e-007  2.175e-007    -6.146    -6.663    -0.516
     PbSO4              6.180e-007  6.503e-007    -6.209    -6.187     0.022
     Pb(SO4)2-2         5.959e-008  1.815e-008    -7.225    -7.741    -0.516
     PbCl+              2.332e-010  1.732e-010    -9.632    -9.761    -0.129
     PbOH+              5.438e-011  4.040e-011   -10.265   -10.394    -0.129
     PbCl2              5.220e-015  5.493e-015   -14.282   -14.260     0.022
     Pb2OH+3            2.855e-015  1.967e-016   -14.544   -15.706    -1.162
     Pb(OH)2            1.423e-016  1.497e-016   -15.847   -15.825     0.022
     PbCl3-             1.175e-019  8.730e-020   -18.930   -19.059    -0.129
     Pb(OH)3-           2.205e-023  1.638e-023   -22.657   -22.786    -0.129
     PbCl4-2            2.745e-024  8.360e-025   -23.561   -24.078    -0.516
     Pb(OH)4-2          1.174e-030  3.575e-031   -29.930   -30.447    -0.516
S(6)               5.249e-002
     MgSO4              3.023e-002  3.180e-002    -1.520    -1.498     0.022
     SO4-2              1.884e-002  5.317e-003    -1.725    -2.274    -0.549
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         CaSO4            2.162e-003  2.275e-003    -2.665     -2.643     0.022
         ZnSO4            5.067e-004  5.331e-004    -3.295     -3.273     0.022
         FeSO4+           3.668e-004  2.725e-004    -3.436     -3.565    -0.129
         Zn(SO4)2-2       7.567e-005  2.304e-005    -4.121     -4.637    -0.516
         HSO4-            7.287e-005  5.413e-005    -4.137     -4.267    -0.129
         FeSO4            6.212e-005  6.536e-005    -4.207     -4.185     0.022
         Fe(SO4)2-        4.267e-005  3.170e-005    -4.370     -4.499    -0.129
         NaSO4-           6.796e-006  5.048e-006    -5.168     -5.297    -0.129
         KSO4-            3.530e-006  2.622e-006    -5.452     -5.581    -0.129
         CaHSO4+          1.878e-006  1.395e-006    -5.726     -5.855    -0.129
         PbSO4            6.180e-007  6.503e-007    -6.209     -6.187     0.022
         FeHSO4+2         2.509e-007  7.640e-008    -6.601     -7.117    -0.516
         CuSO4            2.275e-007  2.394e-007    -6.643     -6.621     0.022
         CdSO4            1.638e-007  1.723e-007    -6.786     -6.764     0.022
         FeHSO4+          6.056e-008  4.499e-008    -7.218     -7.347    -0.129
         Pb(SO4)2-2       5.959e-008  1.815e-008    -7.225     -7.741    -0.516
         Cd(SO4)2-2       3.300e-008  1.005e-008    -7.482     -7.998    -0.516
Zn              2.067e-003
         Zn+2             1.485e-003  4.277e-004    -2.828     -3.369    -0.541
         ZnSO4            5.067e-004  5.331e-004    -3.295     -3.273     0.022
         Zn(SO4)2-2       7.567e-005  2.304e-005    -4.121     -4.637    -0.516
         ZnCl+            3.100e-008  2.303e-008    -7.509     -7.638    -0.129
         ZnOH+            6.014e-009  4.468e-009    -8.221     -8.350    -0.129
         Zn(OH)2          4.645e-013  4.887e-013   -12.333    -12.311     0.022
         ZnCl2            4.586e-013  4.825e-013   -12.339    -12.316     0.022
         ZnCl3-           1.458e-017  1.083e-017   -16.836    -16.965    -0.129
         Zn(OH)3-         1.982e-020  1.472e-020   -19.703    -19.832    -0.129
         ZnCl4-2          3.567e-022  1.086e-022   -21.448    -21.964    -0.516
         Zn(OH)4-2        7.300e-029  2.223e-029   -28.137    -28.653    -0.516
------------------------------Saturation indices-------------------------------
         Phase               SI log IAP  log KT
         Anglesite        -1.15   -8.94   -7.79  PbSO4
         Anhydrite        -0.58   -4.94   -4.36  CaSO4
         Cd(OH)2         -12.64    1.01   13.65  Cd(OH)2
         CdSO4            -9.12   -9.22   -0.10  CdSO4
         Fe(OH)3(a)        1.72    6.61    4.89  Fe(OH)3
         Goethite          7.61    6.61   -1.00  FeOOH
         Gypsum           -0.36   -4.95   -4.58  CaSO4:2H2O
         H2(g)           -31.66  -34.81   -3.15  H2
         H2O(g)           -1.51   -0.00    1.51  H2O
         Halite          -10.00   -8.42    1.58  NaCl
         Hematite         17.22   13.22   -4.01  Fe2O3
         Jarosite-K        8.39   -0.82   -9.21  KFe3(SO4)2(OH)6
         Melanterite      -4.23   -6.44   -2.21  FeSO4:7H2O
         O2(g)           -19.80  -22.76   -2.96  O2
         Pb(OH)2          -6.85    1.30    8.15  Pb(OH)2
         Zn(OH)2(e)       -6.91    4.59   11.50  Zn(OH)2
Initial solution 3.   NAF Leachate
----------------------------Solution composition-------------------------------
         Elements           Molality       Moles
         Ca               4.825e-003  4.825e-003
         Cd               2.229e-008  2.229e-008
         Cl               1.809e-003  1.809e-003
         Cu               7.884e-008  7.884e-008
         Fe               1.794e-007  1.794e-007
         K                9.738e-004  9.738e-004
         Mg               9.315e-003  9.315e-003
         Na               2.659e-003  2.659e-003
         Pb               2.418e-008  2.418e-008
         S(6)             1.512e-002  1.512e-002
         Zn               2.345e-005  2.345e-005
---------------------------Description of solution-----------------------------
                                        pH  =   6.500
                                        pe  =   1.840
                         Activity of water  =   0.999
                            Ionic strength  =  4.115e-002
                        Mass of water (kg)  =  1.000e+000
                  Total alkalinity (eq/kg)  = -4.358e-007
                     Total carbon (mol/kg)  =  0.000e+000
                        Total CO2 (mol/kg)  =  0.000e+000
                       Temperature (deg C)  =  25.000
                    Electrical balance (eq)  = -9.827e-005
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 Percent error, 100*(Cat-|An|)/(Cat+|An|)  =  -0.22
                              Iterations  =   6
                                 Total H  = 1.110124e+002
                                 Total O  = 5.556672e+001
----------------------------Distribution of species----------------------------
                                                    Log       Log          Log
    Species             Molality    Activity  Molality  Activity      Gamma
    H+                 3.669e-007  3.162e-007    -6.435    -6.500     -0.065
    OH-                3.837e-008  3.164e-008    -7.416    -7.500     -0.084
    H2O                5.551e+001  9.995e-001     1.744    -0.000      0.000
Ca                4.825e-003
    Ca+2               3.257e-003  1.620e-003    -2.487    -2.790     -0.303
    CaSO4              1.568e-003  1.583e-003    -2.805    -2.800      0.004
    CaHSO4+            3.523e-009  2.933e-009    -8.453    -8.533     -0.080
    CaOH+              1.021e-009  8.498e-010    -8.991    -9.071     -0.080
Cd                2.229e-008
    Cd+2               1.217e-008  5.847e-009    -7.915    -8.233     -0.318
    CdSO4              8.183e-009  8.260e-009    -8.087    -8.083      0.004
    CdCl+              1.002e-009  8.340e-010    -8.999    -9.079     -0.080
    Cd(SO4)2-2         9.236e-010  4.437e-010    -9.035    -9.353     -0.318
    CdCl2              5.144e-012  5.193e-012   -11.289   -11.285      0.004
    CdOH+              1.846e-012  1.537e-012   -11.734   -11.813     -0.080
    CdCl3-             5.878e-015  4.894e-015   -14.231   -14.310     -0.080
    Cd(OH)2            2.585e-016  2.609e-016   -15.588   -15.583      0.004
    Cd(OH)3-           1.111e-022  9.253e-023   -21.954   -22.034     -0.080
    Cd(OH)4-2          5.426e-030  2.607e-030   -29.266   -29.584     -0.318
Cl                1.809e-003
    Cl-                1.809e-003  1.494e-003    -2.743    -2.826     -0.083
    ZnCl+              3.449e-008  2.871e-008    -7.462    -7.542     -0.080
    CdCl+              1.002e-009  8.340e-010    -8.999    -9.079     -0.080
    PbCl+              3.384e-010  2.817e-010    -9.471    -9.550     -0.080
    FeCl+              1.564e-010  1.302e-010    -9.806    -9.885     -0.080
    ZnCl2              4.448e-011  4.491e-011   -10.352   -10.348      0.004
    CdCl2              5.144e-012  5.193e-012   -11.289   -11.285      0.004
    PbCl2              6.607e-013  6.669e-013   -12.180   -12.176      0.004
    ZnCl3-             9.039e-014  7.526e-014   -13.044   -13.123     -0.080
    CdCl3-             5.878e-015  4.894e-015   -14.231   -14.310     -0.080
    PbCl3-             9.504e-016  7.913e-016   -15.022   -15.102     -0.080
    ZnCl4-2            1.173e-016  5.633e-017   -15.931   -16.249     -0.318
    PbCl4-2            1.178e-018  5.657e-019   -17.929   -18.247     -0.318
    FeCl+2             3.919e-020  1.882e-020   -19.407   -19.725     -0.318
    FeCl2+             1.509e-022  1.256e-022   -21.821   -21.901     -0.080
    FeCl3              1.858e-026  1.876e-026   -25.731   -25.727      0.004
Cu(1)             5.862e-008
    Cu+                5.862e-008  4.780e-008    -7.232    -7.321     -0.089
Cu(2)             2.022e-008
    Cu+2               1.244e-008  6.302e-009    -7.905    -8.201     -0.295
    CuSO4              6.243e-009  6.303e-009    -8.205    -8.200      0.004
    Cu(OH)2            1.303e-009  1.315e-009    -8.885    -8.881      0.004
    CuOH+              2.403e-010  1.992e-010    -9.619    -9.701     -0.082
    Cu(OH)3-           3.009e-016  2.505e-016   -15.522   -15.601     -0.080
    Cu(OH)4-2          3.289e-022  1.580e-022   -21.483   -21.801     -0.318
Fe(2)             1.794e-007
    Fe+2               1.247e-007  6.317e-008    -6.904    -7.200     -0.295
    FeSO4              5.450e-008  5.502e-008    -7.264    -7.259      0.004
    FeCl+              1.564e-010  1.302e-010    -9.806    -9.885     -0.080
    FeOH+              7.584e-011  6.314e-011   -10.120   -10.200     -0.080
    FeHSO4+            1.374e-013  1.144e-013   -12.862   -12.942     -0.080
Fe(3)             1.433e-011
    Fe(OH)2+           1.071e-011  8.914e-012   -10.970   -11.050     -0.080
    Fe(OH)3            3.595e-012  3.629e-012   -11.444   -11.440      0.004
    FeOH+2             1.773e-014  8.517e-015   -13.751   -14.070     -0.318
    Fe(OH)4-           1.257e-014  1.046e-014   -13.901   -13.980     -0.080
    FeSO4+             2.693e-017  2.242e-017   -16.570   -16.649     -0.080
    Fe(SO4)2-          2.885e-018  2.402e-018   -17.540   -17.619     -0.080
    Fe+3               1.592e-018  4.173e-019   -17.798   -18.380     -0.581
    FeCl+2             3.919e-020  1.882e-020   -19.407   -19.725     -0.318
    FeCl2+             1.509e-022  1.256e-022   -21.821   -21.901     -0.080
    FeHSO4+2           3.951e-023  1.898e-023   -22.403   -22.722     -0.318
    Fe2(OH)2+4         3.667e-026  1.952e-027   -25.436   -26.709     -1.274
    FeCl3              1.858e-026  1.876e-026   -25.731   -25.727      0.004
    Fe3(OH)4+5         3.554e-034  3.636e-036   -33.449   -35.439     -1.990
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H(0)            2.930e-020
     H2               1.465e-020  1.479e-020   -19.834   -19.830     0.004
K               9.738e-004
     K+               9.417e-004  7.775e-004    -3.026    -3.109    -0.083
     KSO4-            3.215e-005  2.676e-005    -4.493    -4.572    -0.080
     KOH              8.441e-012  8.521e-012   -11.074   -11.069     0.004
Mg              9.315e-003
     Mg+2             5.904e-003  2.998e-003    -2.229    -2.523    -0.294
     MgSO4            3.411e-003  3.443e-003    -2.467    -2.463     0.004
     MgOH+            4.133e-008  3.441e-008    -7.384    -7.463    -0.080
Na              2.659e-003
     Na+              2.595e-003  2.166e-003    -2.586    -2.664    -0.078
     NaSO4-           6.387e-005  5.317e-005    -4.195    -4.274    -0.080
     NaOH             4.480e-011  4.523e-011   -10.349   -10.345     0.004
O(0)            0.000e+000
     O2               0.000e+000  0.000e+000   -52.725   -52.720     0.004
Pb              2.418e-008
     PbSO4            1.293e-008  1.305e-008    -7.888    -7.884     0.004
     Pb+2             9.864e-009  4.738e-009    -8.006    -8.324    -0.318
     Pb(SO4)2-2       6.985e-010  3.355e-010    -9.156    -9.474    -0.318
     PbOH+            3.508e-010  2.920e-010    -9.455    -9.535    -0.080
     PbCl+            3.384e-010  2.817e-010    -9.471    -9.550    -0.080
     PbCl2            6.607e-013  6.669e-013   -12.180   -12.176     0.004
     Pb(OH)2          3.557e-013  3.591e-013   -12.449   -12.445     0.004
     PbCl3-           9.504e-016  7.913e-016   -15.022   -15.102    -0.080
     Pb2OH+3          1.612e-016  3.098e-017   -15.793   -16.509    -0.716
     Pb(OH)3-         1.565e-017  1.303e-017   -16.805   -16.885    -0.080
     PbCl4-2          1.178e-018  5.657e-019   -17.929   -18.247    -0.318
     Pb(OH)4-2        1.964e-022  9.435e-023   -21.707   -22.025    -0.318
S(6)            1.512e-002
     SO4-2            1.004e-002  4.898e-003    -1.998    -2.310    -0.312
     MgSO4            3.411e-003  3.443e-003    -2.467    -2.463     0.004
     CaSO4            1.568e-003  1.583e-003    -2.805    -2.800     0.004
     NaSO4-           6.387e-005  5.317e-005    -4.195    -4.274    -0.080
     KSO4-            3.215e-005  2.676e-005    -4.493    -4.572    -0.080
     ZnSO4            8.124e-006  8.201e-006    -5.090    -5.086     0.004
     Zn(SO4)2-2       6.798e-007  3.265e-007    -6.168    -6.486    -0.318
     HSO4-            1.809e-007  1.506e-007    -6.743    -6.822    -0.080
     FeSO4            5.450e-008  5.502e-008    -7.264    -7.259     0.004
     PbSO4            1.293e-008  1.305e-008    -7.888    -7.884     0.004
     CdSO4            8.183e-009  8.260e-009    -8.087    -8.083     0.004
     CuSO4            6.243e-009  6.303e-009    -8.205    -8.200     0.004
     CaHSO4+          3.523e-009  2.933e-009    -8.453    -8.533    -0.080
     Cd(SO4)2-2       9.236e-010  4.437e-010    -9.035    -9.353    -0.318
     Pb(SO4)2-2       6.985e-010  3.355e-010    -9.156    -9.474    -0.318
     FeHSO4+          1.374e-013  1.144e-013   -12.862   -12.942    -0.080
     FeSO4+           2.693e-017  2.242e-017   -16.570   -16.649    -0.080
     Fe(SO4)2-        2.885e-018  2.402e-018   -17.540   -17.619    -0.080
     FeHSO4+2         3.951e-023  1.898e-023   -22.403   -22.722    -0.318
Zn              2.345e-005
     Zn+2             1.458e-005  7.142e-006    -4.836    -5.146    -0.310
     ZnSO4            8.124e-006  8.201e-006    -5.090    -5.086     0.004
     Zn(SO4)2-2       6.798e-007  3.265e-007    -6.168    -6.486    -0.318
     ZnCl+            3.449e-008  2.871e-008    -7.462    -7.542    -0.080
     ZnOH+            2.973e-008  2.475e-008    -7.527    -7.606    -0.080
     Zn(OH)2          8.898e-010  8.983e-010    -9.051    -9.047     0.004
     ZnCl2            4.448e-011  4.491e-011   -10.352   -10.348     0.004
     ZnCl3-           9.039e-014  7.526e-014   -13.044   -13.123    -0.080
     Zn(OH)3-         1.078e-014  8.978e-015   -13.967   -14.047    -0.080
     ZnCl4-2          1.173e-016  5.633e-017   -15.931   -16.249    -0.318
     Zn(OH)4-2        9.362e-021  4.497e-021   -20.029   -20.347    -0.318
------------------------------Saturation indices------------------------------
     Phase               SI log IAP  log KT
     Anglesite        -2.84  -10.63   -7.79  PbSO4
     Anhydrite        -0.74   -5.10   -4.36  CaSO4
     Cd(OH)2          -8.88    4.77   13.65  Cd(OH)2
     CdSO4           -10.44  -10.54   -0.10  CdSO4
     Fe(OH)3(a)       -3.77    1.12    4.89  Fe(OH)3
     Goethite          2.12    1.12   -1.00  FeOOH
     Gypsum           -0.52   -5.10   -4.58  CaSO4:2H2O
     H2(g)           -16.68  -19.83   -3.15  H2
     H2O(g)           -1.51   -0.00    1.51  H2O
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    Halite            -7.07   -5.49    1.58  NaCl
    Hematite           6.25    2.24   -4.01  Fe2O3
    Jarosite-K       -14.66  -23.87   -9.21  KFe3(SO4)2(OH)6
    Melanterite       -7.30   -9.51   -2.21  FeSO4:7H2O
    O2(g)            -49.76  -52.72   -2.96  O2
    Pb(OH)2           -3.47    4.68    8.15  Pb(OH)2
    Zn(OH)2(e)        -3.65    7.85   11.50  Zn(OH)2
Initial solution 4.   Rainwater
-----------------------------Solution composition------------------------------
    Elements           Molality       Moles
    Ca                2.500e-006  2.500e-006
    Cl                6.699e-006  6.699e-006
    K                 1.499e-006  1.499e-006
    Mg                1.300e-006  1.300e-006
    Na                6.903e-006  6.903e-006
    S(6)              8.100e-006  8.100e-006
    Zn                1.530e-007  1.530e-007
----------------------------Description of solution----------------------------
                                       pH  =   4.590
                                       pe  =  10.150
                        Activity of water  =   1.000
                           Ionic strength  =  4.455e-005
                       Mass of water (kg)  =  1.000e+000
                 Total alkalinity (eq/kg)  = -2.592e-005
                    Total carbon (mol/kg)  =  0.000e+000
                       Total CO2 (mol/kg)  =  0.000e+000
                      Temperature (deg C)  =  25.000
                  Electrical balance (eq)  =  1.933e-005
 Percent error, 100*(Cat-|An|)/(Cat+|An|)  =  29.71
                               Iterations  =   3
                                  Total H  = 1.110125e+002
                                  Total O  = 5.550625e+001
----------------------------Distribution of species----------------------------
                                                Log       Log         Log
    Species            Molality    Activity  Molality  Activity     Gamma
    H+                2.590e-005  2.570e-005   -4.587    -4.590    -0.003
    OH-               3.925e-010  3.895e-010   -9.406    -9.410    -0.003
    H2O               5.551e+001  1.000e+000    1.744    -0.000     0.000
Ca               2.500e-006
    Ca+2              2.496e-006  2.420e-006   -5.603    -5.616    -0.013
    CaSO4             3.780e-009  3.780e-009   -8.423    -8.423     0.000
    CaHSO4+           5.736e-013  5.691e-013  -12.241   -12.245    -0.003
    CaOH+             1.575e-014  1.563e-014  -13.803   -13.806    -0.003
Cl               6.699e-006
    Cl-               6.699e-006  6.647e-006   -5.174    -5.177    -0.003
    ZnCl+             2.669e-012  2.649e-012  -11.574   -11.577    -0.003
    ZnCl2             1.844e-017  1.844e-017  -16.734   -16.734     0.000
    ZnCl3-            1.386e-022  1.375e-022  -21.858   -21.862    -0.003
    ZnCl4-2           4.725e-028  4.581e-028  -27.326   -27.339    -0.013
H(0)             4.688e-033
    H2                2.344e-033  2.344e-033  -32.630   -32.630     0.000
K                1.499e-006
    K+                1.499e-006  1.487e-006   -5.824    -5.828    -0.003
    KSO4-             8.242e-011  8.178e-011  -10.084   -10.087    -0.003
    KOH               2.006e-016  2.006e-016  -15.698   -15.698     0.000
Mg               1.300e-006
    Mg+2              1.297e-006  1.258e-006   -5.887    -5.900    -0.013
    MgSO4             2.308e-009  2.308e-009   -8.637    -8.637     0.000
    MgOH+             1.791e-013  1.777e-013  -12.747   -12.750    -0.003
Na               6.903e-006
    Na+               6.902e-006  6.849e-006   -5.161    -5.164    -0.003
    NaSO4-            2.708e-010  2.687e-010   -9.567    -9.571    -0.003
    NaOH              1.760e-015  1.760e-015  -14.754   -14.754     0.000
O(0)             1.517e-027
    O2                7.586e-028  7.586e-028  -27.120   -27.120     0.000
S(6)             8.100e-006
    SO4-2             8.073e-006  7.827e-006   -5.093    -5.106    -0.013
    HSO4-             1.971e-008  1.956e-008   -7.705    -7.709    -0.003
    CaSO4             3.780e-009  3.780e-009   -8.423    -8.423     0.000
    MgSO4             2.308e-009  2.308e-009   -8.637    -8.637     0.000
    ZnSO4             2.716e-010  2.716e-010   -9.566    -9.566     0.000
    NaSO4-            2.708e-010  2.687e-010   -9.567    -9.571    -0.003
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     KSO4-            8.242e-011  8.178e-011   -10.084   -10.087    -0.003
     CaHSO4+          5.736e-013  5.691e-013   -12.241   -12.245    -0.003
     Zn(SO4)2-2       1.783e-014  1.728e-014   -13.749   -13.762    -0.013
Zn              1.530e-007
     Zn+2             1.527e-007  1.480e-007    -6.816    -6.830    -0.013
     ZnSO4            2.716e-010  2.716e-010    -9.566    -9.566     0.000
     ZnOH+            6.364e-012  6.315e-012   -11.196   -11.200    -0.003
     ZnCl+            2.669e-012  2.649e-012   -11.574   -11.577    -0.003
     Zn(SO4)2-2       1.783e-014  1.728e-014   -13.749   -13.762    -0.013
     Zn(OH)2          2.821e-015  2.821e-015   -14.550   -14.550     0.000
     ZnCl2            1.844e-017  1.844e-017   -16.734   -16.734     0.000
     Zn(OH)3-         3.497e-022  3.470e-022   -21.456   -21.460    -0.003
     ZnCl3-           1.386e-022  1.375e-022   -21.858   -21.862    -0.003
     ZnCl4-2          4.725e-028  4.581e-028   -27.326   -27.339    -0.013
     Zn(OH)4-2        2.207e-030  2.140e-030   -29.656   -29.670    -0.013
------------------------------Saturation indices------------------------------
     Phase               SI log IAP  log KT
     Anhydrite        -6.36  -10.72   -4.36  CaSO4
     Gypsum           -6.14  -10.72   -4.58  CaSO4:2H2O
     H2(g)           -29.48  -32.63   -3.15  H2
     H2O(g)           -1.51   -0.00    1.51  H2O
     Halite          -11.92  -10.34    1.58  NaCl
     O2(g)           -24.16  -27.12   -2.96  O2
     Zn(OH)2(e)       -9.15    2.35   11.50  Zn(OH)2
Initial solution 5.   Tailings Seepage
-----------------------------Solution composition-----------------------------
     Elements           Molality       Moles
     Ca               1.024e-002  1.024e-002
     Cd               7.216e-010  7.216e-010
     Cl               7.463e-002  7.463e-002
     Cu               2.776e-007  2.776e-007
     Fe               5.718e-008  5.718e-008
     K                7.700e-003  7.700e-003
     Mg               4.462e-002  4.462e-002
     Na               1.336e-001  1.336e-001
     Pb               1.419e-009  1.419e-009
     S(6)             6.532e-002  6.532e-002
     Zn               5.071e-006  5.071e-006
----------------------------Description of solution----------------------------
                                             pH  =   6.560
                                             pe  =   1.690
                              Activity of water  =   0.995
                                 Ionic strength  =  2.457e-001
                             Mass of water (kg)  =  1.000e+000
                       Total alkalinity (eq/kg)  = -4.947e-007
                          Total carbon (mol/kg)  =  0.000e+000
                             Total CO2 (mol/kg)  =  0.000e+000
                            Temperature (deg C)  =  25.000
                        Electrical balance (eq)  =  4.577e-002
 Percent error, 100*(Cat-|An|)/(Cat+|An|)  =  12.94
                                     Iterations  =   8
                                        Total H  = 1.110124e+002
                                        Total O  = 5.576752e+001
----------------------------Distribution of species----------------------------
                                                    Log       Log         Log
     Species            Molality    Activity  Molality  Activity       Gamma
     H+               3.487e-007  2.754e-007    -6.458    -6.560    -0.102
     OH-              5.236e-008  3.616e-008    -7.281    -7.442    -0.161
     H2O              5.551e+001  9.948e-001     1.744    -0.002     0.000
Ca              1.024e-002
     Ca+2             6.543e-003  1.993e-003    -2.184    -2.700    -0.516
     CaSO4            3.701e-003  3.916e-003    -2.432    -2.407     0.025
     CaHSO4+          8.548e-009  6.319e-009    -8.068    -8.199    -0.131
     CaOH+            1.616e-009  1.195e-009    -8.791    -8.923    -0.131
Cd              7.216e-010
     CdCl+            3.265e-010  2.414e-010    -9.486    -9.617    -0.131
     Cd+2             1.629e-010  4.863e-011    -9.788   -10.313    -0.525
     CdSO4            1.305e-010  1.381e-010    -9.884    -9.860     0.025
     Cd(SO4)2-2       4.993e-011  1.491e-011   -10.302   -10.827    -0.525
     CdCl2            4.942e-011  5.229e-011   -10.306   -10.282     0.025
     CdCl3-           2.320e-012  1.715e-012   -11.635   -11.766    -0.131
     CdOH+            1.976e-014  1.461e-014   -13.704   -13.835    -0.131
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     Cd(OH)2           2.678e-018  2.834e-018   -17.572   -17.548     0.025
     Cd(OH)3-          1.553e-024  1.148e-024   -23.809   -23.940    -0.131
     Cd(OH)4-2         1.238e-031  3.696e-032   -30.907   -31.432    -0.525
Cl                7.463e-002
     Cl-               7.463e-002  5.197e-002    -1.127    -1.284    -0.157
     ZnCl+             1.453e-007  1.074e-007    -6.838    -6.969    -0.131
     ZnCl2             5.523e-009  5.845e-009    -8.258    -8.233     0.025
     FeCl+             1.111e-009  8.211e-010    -8.954    -9.086    -0.131
     ZnCl3-            4.611e-010  3.408e-010    -9.336    -9.467    -0.131
     CdCl+             3.265e-010  2.414e-010    -9.486    -9.617    -0.131
     PbCl+             3.151e-010  2.329e-010    -9.502    -9.633    -0.131
     CdCl2             4.942e-011  5.229e-011   -10.306   -10.282     0.025
     ZnCl4-2           2.974e-011  8.878e-012   -10.527   -11.052    -0.525
     PbCl2             1.813e-011  1.919e-011   -10.742   -10.717     0.025
     CdCl3-            2.320e-012  1.715e-012   -11.635   -11.766    -0.131
     PbCl3-            1.072e-012  7.921e-013   -11.970   -12.101    -0.131
     PbCl4-2           6.600e-014  1.970e-014   -13.180   -13.705    -0.525
     FeCl+2            2.814e-019  8.403e-020   -18.551   -19.076    -0.525
     FeCl2+            2.639e-020  1.951e-020   -19.579   -19.710    -0.131
     FeCl3             9.581e-023  1.014e-022   -22.019   -21.994     0.025
Cu(1)             2.077e-007
     Cu+               2.077e-007  1.374e-007    -6.683    -6.862    -0.179
Cu(2)             6.990e-008
     Cu+2              4.158e-008  1.282e-008    -7.381    -7.892    -0.511
     CuSO4             2.436e-008  2.578e-008    -7.613    -7.589     0.025
     Cu(OH)2           3.303e-009  3.495e-009    -8.481    -8.457     0.025
     CuOH+             6.586e-010  4.631e-010    -9.181    -9.334    -0.153
     Cu(OH)3-          1.029e-015  7.606e-016   -14.988   -15.119    -0.131
     Cu(OH)4-2         1.836e-021  5.481e-022   -20.736   -21.261    -0.525
Fe(2)             5.718e-008
     Fe+2              3.711e-008  1.145e-008    -7.430    -7.941    -0.511
     FeSO4             1.894e-008  2.004e-008    -7.723    -7.698     0.025
     FeCl+             1.111e-009  8.211e-010    -8.954    -9.086    -0.131
     FeOH+             1.768e-011  1.307e-011   -10.752   -10.884    -0.131
     FeHSO4+           4.908e-014  3.628e-014   -13.309   -13.440    -0.131
Fe(3)             2.684e-012
     Fe(OH)2+          2.020e-012  1.493e-012   -11.695   -11.826    -0.131
     Fe(OH)3           6.565e-013  6.947e-013   -12.183   -12.158     0.025
     FeOH+2            4.181e-015  1.248e-015   -14.379   -14.904    -0.525
     Fe(OH)4-          3.096e-015  2.288e-015   -14.509   -14.640    -0.131
     FeSO4+            7.818e-018  5.779e-018   -17.107   -17.238    -0.131
     Fe(SO4)2-         1.684e-018  1.245e-018   -17.774   -17.905    -0.131
     Fe+3              4.472e-019  5.353e-020   -18.350   -19.271    -0.922
     FeCl+2            2.814e-019  8.403e-020   -18.551   -19.076    -0.525
     FeCl2+            2.639e-020  1.951e-020   -19.579   -19.710    -0.131
     FeCl3             9.581e-023  1.014e-022   -22.019   -21.994     0.025
     FeHSO4+2          1.428e-023  4.262e-024   -22.845   -23.370    -0.525
     Fe2(OH)2+4        5.280e-027  4.195e-029   -26.277   -28.377    -2.100
     Fe3(OH)4+5        2.500e-035  1.309e-038   -34.602   -37.883    -3.281
H(0)              4.231e-020
     H2                2.116e-020  2.239e-020   -19.675   -19.650     0.025
K                 7.700e-003
     K+                7.229e-003  5.034e-003    -2.141    -2.298    -0.157
     KSO4-             4.712e-004  3.483e-004    -3.327    -3.458    -0.131
     KOH               5.958e-011  6.305e-011   -10.225   -10.200     0.025
Mg                4.462e-002
     Mg+2              2.600e-002  8.536e-003    -1.585    -2.069    -0.484
     MgSO4             1.862e-002  1.970e-002    -1.730    -1.705     0.025
     MgOH+             1.514e-007  1.119e-007    -6.820    -6.951    -0.131
Na                1.336e-001
     Na+               1.274e-001  9.346e-002    -0.895    -1.029    -0.134
     NaSO4-            6.239e-003  4.612e-003    -2.205    -2.336    -0.131
     NaOH              2.108e-009  2.230e-009    -8.676    -8.652     0.025
O(0)              0.000e+000
     O2                0.000e+000  0.000e+000   -53.109   -53.085     0.025
Pb                1.419e-009
     PbSO4             5.890e-010  6.233e-010    -9.230    -9.205     0.025
     Pb+2              3.770e-010  1.126e-010    -9.424    -9.949    -0.525
     PbCl+             3.151e-010  2.329e-010    -9.502    -9.633    -0.131
     Pb(SO4)2-2        1.079e-010  3.220e-011    -9.967   -10.492    -0.525
     PbCl2             1.813e-011  1.919e-011   -10.742   -10.717     0.025
     PbOH+             1.072e-011  7.928e-012   -10.970   -11.101    -0.131
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    PbCl3-           1.072e-012  7.921e-013   -11.970   -12.101    -0.131
    PbCl4-2          6.600e-014  1.970e-014   -13.180   -13.705    -0.525
    Pb(OH)2          1.053e-014  1.114e-014   -13.978   -13.953     0.025
    Pb(OH)3-         6.249e-019  4.619e-019   -18.204   -18.335    -0.131
    Pb2OH+3          3.032e-019  1.998e-020   -18.518   -19.699    -1.181
    Pb(OH)4-2        1.280e-023  3.822e-024   -22.893   -23.418    -0.525
S(6)            6.532e-002
    SO4-2            3.629e-002  9.846e-003    -1.440    -2.007    -0.567
    MgSO4            1.862e-002  1.970e-002    -1.730    -1.705     0.025
    NaSO4-           6.239e-003  4.612e-003    -2.205    -2.336    -0.131
    CaSO4            3.701e-003  3.916e-003    -2.432    -2.407     0.025
    KSO4-            4.712e-004  3.483e-004    -3.327    -3.458    -0.131
    ZnSO4            1.674e-006  1.772e-006    -5.776    -5.752     0.025
    Zn(SO4)2-2       4.749e-007  1.418e-007    -6.323    -6.848    -0.525
    HSO4-            3.567e-007  2.636e-007    -6.448    -6.579    -0.131
    CuSO4            2.436e-008  2.578e-008    -7.613    -7.589     0.025
    FeSO4            1.894e-008  2.004e-008    -7.723    -7.698     0.025
    CaHSO4+          8.548e-009  6.319e-009    -8.068    -8.199    -0.131
    PbSO4            5.890e-010  6.233e-010    -9.230    -9.205     0.025
    CdSO4            1.305e-010  1.381e-010    -9.884    -9.860     0.025
    Pb(SO4)2-2       1.079e-010  3.220e-011    -9.967   -10.492    -0.525
    Cd(SO4)2-2       4.993e-011  1.491e-011   -10.302   -10.827    -0.525
    FeHSO4+          4.908e-014  3.628e-014   -13.309   -13.440    -0.131
    FeSO4+           7.818e-018  5.779e-018   -17.107   -17.238    -0.131
    Fe(SO4)2-        1.684e-018  1.245e-018   -17.774   -17.905    -0.131
    FeHSO4+2         1.428e-023  4.262e-024   -22.845   -23.370    -0.525
Zn              5.071e-006
    Zn+2             2.766e-006  7.677e-007    -5.558    -6.115    -0.557
    ZnSO4            1.674e-006  1.772e-006    -5.776    -5.752     0.025
    Zn(SO4)2-2       4.749e-007  1.418e-007    -6.323    -6.848    -0.525
    ZnCl+            1.453e-007  1.074e-007    -6.838    -6.969    -0.131
    ZnCl2            5.523e-009  5.845e-009    -8.258    -8.233     0.025
    ZnOH+            4.113e-009  3.040e-009    -8.386    -8.517    -0.131
    ZnCl3-           4.611e-010  3.408e-010    -9.336    -9.467    -0.131
    Zn(OH)2          1.191e-010  1.261e-010    -9.924    -9.899     0.025
    ZnCl4-2          2.974e-011  8.878e-012   -10.527   -11.052    -0.525
    Zn(OH)3-         1.948e-015  1.440e-015   -14.710   -14.842    -0.131
    Zn(OH)4-2        2.761e-021  8.243e-022   -20.559   -21.084    -0.525
------------------------------Saturation indices-------------------------------
    Phase               SI log IAP  log KT
    Anglesite        -4.17  -11.96   -7.79  PbSO4
    Anhydrite        -0.35   -4.71   -4.36  CaSO4
    Cd(OH)2         -10.85    2.80   13.65  Cd(OH)2
    CdSO4           -12.22  -12.32   -0.10  CdSO4
    Fe(OH)3(a)       -4.49    0.40    4.89  Fe(OH)3
    Goethite          1.40    0.40   -1.00  FeOOH
    Gypsum           -0.13   -4.71   -4.58  CaSO4:2H2O
    H2(g)           -16.50  -19.65   -3.15  H2
    H2O(g)           -1.51   -0.00    1.51  H2O
    Halite           -3.90   -2.31    1.58  NaCl
    Hematite          4.82    0.81   -4.01  Fe2O3
    Jarosite-K      -15.57  -24.78   -9.21  KFe3(SO4)2(OH)6
    Melanterite      -7.75   -9.96   -2.21  FeSO4:7H2O
    O2(g)           -50.12  -53.08   -2.96  O2
    Pb(OH)2          -4.98    3.17    8.15  Pb(OH)2
    Zn(OH)2(e)       -4.50    7.00   11.50  Zn(OH)2
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Beginning of batch-reaction calculations.
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Reaction step 1.
Using mix 1. Mixing of water in open pit - best case Scenario 1
Mixture 1.   Mixing of water in open pit - best case Scenario 1
     0.000e+000 Solution 1River water
     7.270e-002 Solution 2PAF Leachate
     6.544e-001 Solution 3NAF Leachate
     2.410e-001 Solution 4Rainwater
     3.190e-002 Solution 5Tailings Seepage
-----------------------------Solution composition------------------------------
    Elements           Molality       Moles
    Ca               4.140e-003  4.140e-003
    Cd               5.577e-008  5.577e-008
    Cl               3.568e-003  3.568e-003
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    Cu               1.274e-007  1.274e-007
    Fe               4.031e-004  4.031e-004
    K                8.908e-004  8.908e-004
    Mg               1.524e-002  1.524e-002
    Na               6.023e-003  6.023e-003
    Pb               1.171e-007  1.171e-007
    S                1.580e-002  1.580e-002
    Zn               1.658e-004  1.658e-004
----------------------------Description of solution----------------------------
                                       pH  =   4.132      Charge balance
                                       pe  =  11.873      Adjusted to redox equilibrium
                        Activity of water  =   0.999
                           Ionic strength  =  5.118e-002
                       Mass of water (kg)  =  1.000e+000
                 Total alkalinity (eq/kg)  = -2.961e-004
                    Total carbon (mol/kg)  =  0.000e+000
                       Total CO2 (mol/kg)  =  0.000e+000
                      Temperature (deg C)  =  25.000
                  Electrical balance (eq)  =  1.156e-002
 Percent error, 100*(Cat-|An|)/(Cat+|An|)  =  20.41
                               Iterations  =  11
                                  Total H  = 1.110129e+002
                                  Total O  = 5.556991e+001
----------------------------Distribution of species----------------------------
                                                 Log       Log        Log
    Species          Molality    Activity  Molality  Activity      Gamma
    H+               8.656e-005  7.384e-005    -4.063    -4.132     -0.069
    OH-              1.672e-010  1.355e-010    -9.777    -9.868     -0.091
    H2O              5.551e+001  9.993e-001     1.744    -0.000      0.000
Ca              4.140e-003
    Ca+2             2.958e-003  1.391e-003    -2.529    -2.857     -0.328
    CaSO4            1.181e-003  1.195e-003    -2.928    -2.923      0.005
    CaHSO4+          6.304e-007  5.170e-007    -6.200    -6.287     -0.086
    CaOH+            3.810e-012  3.125e-012   -11.419   -11.505     -0.086
Cd              5.577e-008
    Cd+2             3.155e-008  1.427e-008    -7.501    -7.846     -0.345
    CdSO4            1.751e-008  1.772e-008    -7.757    -7.752      0.005
    CdCl+            4.811e-009  3.945e-009    -8.318    -8.404     -0.086
    Cd(SO4)2-2       1.849e-009  8.365e-010    -8.733    -9.078     -0.345
    CdCl2            4.706e-011  4.762e-011   -10.327   -10.322      0.005
    CdCl3-           1.061e-013  8.699e-014   -12.974   -13.061     -0.086
    CdOH+            1.959e-014  1.606e-014   -13.708   -13.794     -0.086
    Cd(OH)2          1.154e-020  1.167e-020   -19.938   -19.933      0.005
    Cd(OH)3-         2.162e-029  1.773e-029   -28.665   -28.751     -0.086
    Cd(OH)4-2        4.728e-039  2.138e-039   -38.325   -38.670     -0.345
Cl              3.568e-003
    Cl-              3.568e-003  2.895e-003    -2.448    -2.538     -0.091
    ZnCl+            4.844e-007  3.972e-007    -6.315    -6.401     -0.086
    FeCl+2           9.920e-008  4.487e-008    -7.003    -7.348     -0.345
    FeCl+            3.507e-008  2.876e-008    -7.455    -7.541     -0.086
    CdCl+            4.811e-009  3.945e-009    -8.318    -8.404     -0.086
    PbCl+            3.381e-009  2.773e-009    -8.471    -8.557     -0.086
    ZnCl2            1.190e-009  1.204e-009    -8.924    -8.919      0.005
    FeCl2+           7.076e-010  5.803e-010    -9.150    -9.236     -0.086
    CdCl2            4.706e-011  4.762e-011   -10.327   -10.322      0.005
    PbCl2            1.258e-011  1.272e-011   -10.900   -10.895      0.005
    ZnCl3-           4.771e-012  3.912e-012   -11.321   -11.408     -0.086
    FeCl3            1.660e-013  1.680e-013   -12.780   -12.775      0.005
    CdCl3-           1.061e-013  8.699e-014   -12.974   -13.061     -0.086
    PbCl3-           3.569e-014  2.927e-014   -13.448   -13.534     -0.086
    ZnCl4-2          1.255e-014  5.677e-015   -13.901   -14.246     -0.345
    PbCl4-2          8.966e-017  4.056e-017   -16.047   -16.392     -0.345
Cu(1)           3.792e-017
    Cu+              3.792e-017  3.032e-017   -16.421   -16.518     -0.097
Cu(2)           1.274e-007
    Cu+2             8.988e-008  4.314e-008    -7.046    -7.365     -0.319
    CuSO4            3.748e-008  3.792e-008    -7.426    -7.421      0.005
    CuOH+            7.163e-012  5.838e-012   -11.145   -11.234     -0.089
    Cu(OH)2          1.631e-013  1.651e-013   -12.787   -12.782      0.005
    Cu(OH)3-         1.642e-022  1.346e-022   -21.785   -21.871     -0.086
    Cu(OH)4-2        8.038e-031  3.635e-031   -30.095   -30.439     -0.345
Fe(2)           2.048e-005
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Fe+2	1.499e-005	7.195e-006	-4.824	-5.143	-0.319
FeSO4	5.445e-006	5.509e-006	-5.264	-5.259	0.005
FeCl+	3.507e-008	2.876e-008	-7.455	-7.541	-0.086
FeHSO4+	3.261e-009	2.674e-009	-8.487	-8.573	-0.086
FeOH+	3.755e-011	3.079e-011	-10.425	-10.512	-0.086
Fe(HS)2	0.000e+000	0.000e+000	-197.970	-197.964	0.005
Fe(HS)3-	0.000e+000	0.000e+000	-296.727	-296.813	-0.086
Fe(3)	3.827e-004				
Fe(OH)2+	2.450e-004	2.010e-004	-3.611	-3.697	-0.086
FeOH+2	9.914e-005	4.484e-005	-4.004	-4.348	-0.345
FeSO4+	2.954e-005	2.423e-005	-4.530	-4.616	-0.086
Fe(SO4)2-	2.783e-006	2.282e-006	-5.556	-5.642	-0.086
Fe+3	2.147e-006	5.131e-007	-5.668	-6.290	-0.622
Fe2(OH)2+4	1.293e-006	5.412e-008	-5.888	-7.267	-1.378
Fe(OH)3	3.463e-007	3.504e-007	-6.461	-6.455	0.005
Fe3(OH)4+5	3.236e-007	2.272e-009	-6.490	-8.644	-2.154
FeCl+2	9.920e-008	4.487e-008	-7.003	-7.348	-0.345
FeHSO4+2	1.059e-008	4.790e-009	-7.975	-8.320	-0.345
FeCl2+	7.076e-010	5.803e-010	-9.150	-9.236	-0.086
Fe(OH)4-	5.273e-012	4.325e-012	-11.278	-11.364	-0.086
FeCl3	1.660e-013	1.680e-013	-12.780	-12.775	0.005
H(0)	1.368e-035				
H2	6.840e-036	6.921e-036	-35.165	-35.160	0.005
K	8.908e-004				
K+	8.649e-004	7.019e-004	-3.063	-3.154	-0.091
KSO4-	2.589e-005	2.123e-005	-4.587	-4.673	-0.086
KOH	3.255e-014	3.294e-014	-13.487	-13.482	0.005
Mg	1.524e-002				
Mg+2	1.029e-002	4.960e-003	-1.988	-2.305	-0.317
MgSO4	4.948e-003	5.006e-003	-2.306	-2.300	0.005
MgOH+	2.972e-010	2.437e-010	-9.527	-9.613	-0.086
Na	6.023e-003				
Na+	5.895e-003	4.848e-003	-2.229	-2.314	-0.085
NaSO4-	1.276e-004	1.046e-004	-3.894	-3.980	-0.086
NaOH	4.284e-013	4.335e-013	-12.368	-12.363	0.005
O(0)	1.718e-022				
O2	8.589e-023	8.690e-023	-22.066	-22.061	0.005
Pb	1.171e-007				
PbSO4	5.757e-008	5.825e-008	-7.240	-7.235	0.005
Pb+2	5.319e-008	2.406e-008	-7.274	-7.619	-0.345
PbCl+	3.381e-009	2.773e-009	-8.471	-8.557	-0.086
Pb(SO4)2-2	2.910e-009	1.316e-009	-8.536	-8.881	-0.345
PbCl2	1.258e-011	1.272e-011	-10.900	-10.895	0.005
PbOH+	7.742e-012	6.349e-012	-11.111	-11.197	-0.086
PbCl3-	3.569e-014	2.927e-014	-13.448	-13.534	-0.086
PbCl4-2	8.966e-017	4.056e-017	-16.047	-16.392	-0.345
Pb(OH)2	3.304e-017	3.343e-017	-16.481	-16.476	0.005
Pb2OH+3	2.038e-017	3.419e-018	-16.691	-17.466	-0.775
Pb(OH)3-	6.334e-024	5.194e-024	-23.198	-23.284	-0.086
Pb(OH)4-2	3.561e-031	1.610e-031	-30.448	-30.793	-0.345
S(-2)	0.000e+000				
H2S	0.000e+000	0.000e+000	-98.081	-98.076	0.005
HS-	0.000e+000	0.000e+000	-100.794	-100.886	-0.091
S-2	0.000e+000	0.000e+000	-109.336	-109.672	-0.336
Fe(HS)2	0.000e+000	0.000e+000	-197.970	-197.964	0.005
Fe(HS)3-	0.000e+000	0.000e+000	-296.727	-296.813	-0.086
S(6)	1.580e-002				
SO4-2	9.379e-003	4.306e-003	-2.028	-2.366	-0.338
MgSO4	4.948e-003	5.006e-003	-2.306	-2.300	0.005
CaSO4	1.181e-003	1.195e-003	-2.928	-2.923	0.005
NaSO4-	1.276e-004	1.046e-004	-3.894	-3.980	-0.086
ZnSO4	5.085e-005	5.145e-005	-4.294	-4.289	0.005
HSO4-	3.769e-005	3.091e-005	-4.424	-4.510	-0.086
FeSO4+	2.954e-005	2.423e-005	-4.530	-4.616	-0.086
KSO4-	2.589e-005	2.123e-005	-4.587	-4.673	-0.086
FeSO4	5.445e-006	5.509e-006	-5.264	-5.259	0.005
Zn(SO4)2-2	3.981e-006	1.801e-006	-5.400	-5.745	-0.345
Fe(SO4)2-	2.783e-006	2.282e-006	-5.556	-5.642	-0.086
CaHSO4+	6.304e-007	5.170e-007	-6.200	-6.287	-0.086
PbSO4	5.757e-008	5.825e-008	-7.240	-7.235	0.005
CuSO4	3.748e-008	3.792e-008	-7.426	-7.421	0.005
CdSO4	1.751e-008	1.772e-008	-7.757	-7.752	0.005

```
     FeHSO4+2          1.059e-008  4.790e-009    -7.975     -8.320    -0.345
     FeHSO4+           3.261e-009  2.674e-009    -8.487     -8.573    -0.086
     Pb(SO4)2-2        2.910e-009  1.316e-009    -8.536     -8.881    -0.345
     Cd(SO4)2-2        1.849e-009  8.365e-010    -8.733     -9.078    -0.345
Zn              1.658e-004
     Zn+2              1.105e-004  5.097e-005    -3.957     -4.293    -0.336
     ZnSO4             5.085e-005  5.145e-005    -4.294     -4.289     0.005
     Zn(SO4)2-2        3.981e-006  1.801e-006    -5.400     -5.745    -0.345
     ZnCl+             4.844e-007  3.972e-007    -6.315     -6.401    -0.086
     ZnCl2             1.190e-009  1.204e-009    -8.924     -8.919     0.005
     ZnOH+             9.224e-010  7.564e-010    -9.035     -9.121    -0.086
     ZnCl3-            4.771e-012  3.912e-012   -11.321    -11.408    -0.086
     Zn(OH)2           1.162e-013  1.175e-013   -12.935    -12.930     0.005
     ZnCl4-2           1.255e-014  5.677e-015   -13.901    -14.246    -0.345
     Zn(OH)3-          6.134e-021  5.031e-021   -20.212    -20.298    -0.086
     Zn(OH)4-2         2.386e-029  1.079e-029   -28.622    -28.967    -0.345
------------------------------Saturation indices------------------------------
     Phase               SI log IAP  log KT
     Anglesite        -2.19   -9.98   -7.79  PbSO4
     Anhydrite        -0.86   -5.22   -4.36  CaSO4
     Cd(OH)2         -13.23    0.42   13.65  Cd(OH)2
     CdSO4           -10.11  -10.21   -0.10  CdSO4
     Fe(OH)3(a)        1.21    6.10    4.89  Fe(OH)3
     FeS(ppt)        -97.98 -101.90   -3.92  FeS
     Goethite          7.10    6.10   -1.00  FeOOH
     Gypsum           -0.64   -5.22   -4.58  CaSO4:2H2O
     H2(g)           -32.01  -35.16   -3.15  H2
     H2O(g)           -1.51   -0.00    1.51  H2O
     H2S(g)          -97.08  -98.08   -1.00  H2S
     Halite           -6.43   -4.85    1.58  NaCl
     Hematite         16.22   12.21   -4.01  Fe2O3
     Jarosite-K        7.24   -1.97   -9.21  KFe3(SO4)2(OH)6
     Mackinawite     -97.25 -101.90   -4.65  FeS
     Melanterite      -5.30   -7.51   -2.21  FeSO4:7H2O
     O2(g)           -19.10  -22.06   -2.96  O2
     Pb(OH)2          -7.51    0.64    8.15  Pb(OH)2
     Pyrite         -156.43 -174.90  -18.48  FeS2
     Sphalerite      -89.43 -101.05  -11.62  ZnS
     Sulfur          -70.95  -66.07    4.88  S
     Zn(OH)2(e)       -7.53    3.97   11.50  Zn(OH)2
------------------
End of simulation.
------------------
------------------------------------
Reading input data for simulation 2.
------------------------------------
     SOLUTION 1 River water
         temp      28.4
         pH        8.2
         pe        2.63
         redox     pe
         units     mg/l
         density   1
         S(6)      6.4
         Ca        48.7
         Cd        6e-005
         Cl        15.3
         Cu        0.001
         Fe        10
         K         4.2
         Mg        47
         Na        10.6
         Pb        0.00055
         Zn        0.0104
         water    1 # kg
     SOLUTION 2 PAF Leachate
         temp      25
         pH        3.98
         pe        11.85
         redox     pe
         units     mg/l
         density   1
```

```
    Ca        358
    Cd        0.0631
    Cl        1
    Cu        0.058
    Fe        307
    K         4
    Mg        2560
    Na        6
    Pb        0.286
    S(6)      5000
    Zn        134
    water    1 # kg
SOLUTION 3 NAF Leachate
    temp      25
    pH        6.5
    pe        1.84
    redox     pe
    units     mg/l
    density   1
    Ca        193
    Cd        0.0025
    Cl        64
    Cu        0.005
    Fe        0.01
    K         38
    Mg        226
    Na        61
    Pb        0.005
    S(6)      1450
    Zn        1.53
    water    1 # kg
SOLUTION 4 Rainwater
    temp      25
    pH        4.59
    pe        10.15
    redox     pe
    units     mg/l
    density   1
    Ca        0.1002
    Cd        0
    Cl        0.2375
    Cu        0
    Fe        0
    K         0.0586
    Mg        0.0316
    Na        0.15869
    Pb        0
    S(6)      0.7781
    Zn        0.01
    water    1 # kg
SOLUTION 5 Tailings Seepage
    temp      25
    pH        6.56
    pe        1.69
    redox     pe
    units     mg/l
    density   1
    Ca        405
    Cd        0.00008
    Cl        2610
    Cu        0.0174
    Fe        0.00315
    K         297
    Mg        1070
    Na        3030
    Pb        0.00029
    S(6)      6190
    Zn        0.327
    water    1 # kg
MIX 1 Mixing of water in open pit - best case Scenario 2
    1    0.9344
    2    0.0039
```

```
    3    0.0353
    4    0.0232
    5    0.0031
PRINT
    warnings              -1
SELECTED_OUTPUT
    file                 MRM1_Scenario2.txt
    totals               Ca  Cd  Cl  Cu  K  Mg  Mn
                          Na  Pb  S(-2)  Zn  S(6)  Al  Alkalinity
                          B  Ba  Br  C  C(4)  C(-4)  Cu(1)
                          Cu(2)  N  Mn(3)  Mn(2)  Li  Hfo_w  Hfo_s
                          H(0)  Fe(3)  Fe(2)  F  Fe  N(0)  N(3)
                          N(-3)  N(5)  O(0)  P  S  Si  Sr
                          X
    molalities           Ca+2  CaCO3  CaF+  CaH2PO4+
                          CaHCO3+  CaHPO4  CaHSO4+  CaOH+
                          CaPO4-  CaSO4  CaX2  Cd(CO3)2-2
                          Cd(OH)2  Cd(OH)3-  Cd(OH)4-2  Cd(SO4)2-2
                          Cd+2  CdCl+  CdCl2  CdCl3-
                          CdCO3  CdHCO3+  CdOH+  CdSO4
                          CdX2  Cl-  CO2  CO3-2
                          Cu(OH)2  Cu(OH)3-  Cu(OH)4-2  Cu+
                          Cu+2  CuOH+  CuSO4  CuX2
                          Fe(HS)2  Fe(HS)3-  Fe(OH)2+  FeH2PO4+
                          FeF3  FeF2+  FeF+2  FeF+
                          FeCO3  FeCl3  FeCl2+  FeCl+2
                          FeCl+  Fe3(OH)4+5  Fe2(OH)2+4  Fe+3
                          Fe+2  Fe(SO4)2-  Fe(OH)4-  Fe(OH)3
                          FeX2  FeSO4+  FeSO4  FeOH+2
                          FeOH+  FeHSO4+2  FeHSO4+  FeHPO4+
                          FeHPO4  FeHCO3+  FeH2PO4+2  H2S
                          HSO4-  HS-  K+  KHPO4-
                          KOH  KSO4-  KX  Mg+2
                          MgCO3  MgF+  MgH2PO4+  MgHCO3+
                          MgHPO4  MgOH+  MgPO4-  MgSO4
                          MgX2  Mn(NO3)2  Mn+2  Mn+3
                          MnCl+  MnCl2  MnCl3-  MnCO3
                          MnF+  MnHCO3+  MnOH+  MnSO4
                          MnX2  Na+  NaCO3-  NaF
                          NaHCO3  NaHPO4-  NaOH  NaSO4-
                          NaX  NH3  NH4+  NH4SO4-
                          NH4X  Pb(CO3)2-2  Pb(OH)2  Pb(OH)3-
                          Pb(OH)4-2  Pb(SO4)2-2  Pb+2  Pb2OH+3
                          PbCl+  PbCl2  PbCl3-  PbCl4-2
                          PbCO3  PbHCO3+  PbNO3+  PbOH+
                          PbSO4  PbX2  PO4-3  SO4-2
                          Zn(CO3)2-2  Zn(OH)2  Zn(OH)3-  Zn(OH)4-2
                          Zn(SO4)2-2  Zn+2  ZnCl+  ZnCl2
                          ZnCl3-  ZnCl4-2  ZnCO3  ZnHCO3+
                          ZnOH+  ZnSO4  ZnX2  Al(OH)2+
                          Al(OH)3  Al(OH)4-  Al(SO4)2-  Al+3
                          AlF+2  AlF2+  AlF3  AlF4-
                          AlF5-2  AlF6-3  AlHSO4+2  AlOH+2
                          AlOHX2  AlSO4+  AlX3  Ba+2
                          BaCO3  BaHCO3+  BaOH+  BaSO4
                          BaX2  BF(OH)3-  BF2(OH)2-  BF3OH-
                          BF4-  Br-  CH4  F-
                          H+  H2  H2BO3-  H2O
                          H2PO4-  H2SiO4-2  H3BO3  H3SiO4-
                          H4SiO4  HCO3-  HF  HF2-
                          Hfo_psi  Hfo_sO-  Hfo_sOCd+  Hfo_sOCu+
                          Hfo_sOFe+  Hfo_sOH  Hfo_sOH2+  Hfo_sOHBa+2
                          Hfo_sOHCa+2  Hfo_sOHSr+2  Hfo_sOMn+  Hfo_sOPb+
                          Hfo_sOZn+  Hfo_wF  Hfo_wH2BO3  Hfo_wH2PO4
                          Hfo_wHPO4-  Hfo_wO-  Hfo_wOBa+  Hfo_wOCa+
                          Hfo_wOCd+  Hfo_wOCu+  Hfo_wOFe+  Hfo_wOFeOH
                          Hfo_wOH  Hfo_wOH2+  Hfo_wOHF-  Hfo_wOHSO4-2
                          Hfo_wOMg+  Hfo_wOMn+  Hfo_wOPb+  Hfo_wOSr+
                          Hfo_wOSrOH  Hfo_wOZn+  Hfo_wPO4-2  Hfo_wSO4-
                          HPO4-2  Li+  LiOH  LiSO4-
                          LiX  N2  NO2-  NO3-
                          O2  OH-  S-2  SiF6-2
```

```
                         Sr+2  SrCO3  SrHCO3+  SrOH+
                         SrSO4  SrX2  X-
activities              Al(OH)2+  Al(OH)3  Al(OH)4-  Al(SO4)2-
                         Al+3  AlF+2  AlF2+  AlF3
                         AlF4-  AlF5-2  AlF6-3  AlHSO4+2
                         AlOH+2  AlOHX2  AlSO4+  AlX3
                         Ba+2  BaCO3  BaHCO3+  BaOH+
                         BaSO4  BaX2  BF(OH)3-  BF2(OH)2-
                         BF3OH-  BF4-  Br-  Ca+2
                         CaCO3  CaF+  CaH2PO4+  CaHCO3+
                         CaHPO4  CaHSO4+  CaOH+  CaPO4-
                         CaSO4  CaX2  Cd(CO3)2-2  Cd(OH)2
                         Cd(OH)3-  Cd(OH)4-2  Cd(SO4)2-2  Cd+2
                         CdCl+  CdCl2  CdCl3-  CdCO3
                         CdHCO3+  CdOH+  CdSO4  CdX2
                         CH4  Cl-  CO2  CO3-2
                         Cu(OH)2  Cu(OH)3-  Cu(OH)4-2  Cu+
                         Cu+2  CuOH+  CuSO4  CuX2
                         Fe(HS)2  Fe(HS)3-  Fe(OH)2+  F-
                         Fe(OH)3  Fe(OH)4-  Fe(SO4)2-  Fe+2
                         Fe+3  Fe2(OH)2+4  Fe3(OH)4+5  FeCl+
                         FeCl+2  FeCl2+  FeCl3  FeCO3
                         FeF+  FeF+2  FeF2+  FeF3
                         FeH2PO4+  FeH2PO4+2  FeHCO3+  FeHPO4
                         FeHPO4+  FeHSO4+  FeHSO4+2  FeOH+
                         FeOH+2  FeSO4  FeSO4+  FeX2
                         H+  H2  H2BO3-  H2O
                         H2PO4-  H2S  H2SiO4-2  H3BO3
                         H3SiO4-  H4SiO4  HCO3-  HF
                         HF2-  Hfo_psi  Hfo_sO-  Hfo_sOCd+
                         Hfo_sOCu+  Hfo_sOFe+  Hfo_sOH  Hfo_sOH2+
                         Hfo_sOHBa+2  Hfo_sOHCa+2  Hfo_sOHSr+2  Hfo_sOMn+
                         Hfo_sOPb+  Hfo_sOZn+  Hfo_wF  Hfo_wH2BO3
                         Hfo_wH2PO4  Hfo_wHPO4-  Hfo_wO-  Hfo_wOBa+
                         Hfo_wOCa+  Hfo_wOCd+  Hfo_wOCu+  Hfo_wOFe+
                         Hfo_wOFeOH  Hfo_wOH  Hfo_wOH2+  Hfo_wOHF-
                         Hfo_wOHSO4-2  Hfo_wOMg+  Hfo_wOMn+  Hfo_wOPb+
                         Hfo_wOSr+  Hfo_wOSrOH  Hfo_wOZn+  Hfo_wPO4-2
                         Hfo_wSO4-  HPO4-2  HS-  HSO4-
                         K+  KHPO4-  KOH  KSO4-
                         KX  Li+  LiOH  LiSO4-
                         LiX  Mg+2  MgCO3  MgF+
                         MgH2PO4+  MgHCO3+  MgHPO4  MgOH+
                         MgPO4-  MgSO4  MgX2  Mn(NO3)2
                         Mn+2  Mn+3  MnCl+  MnCl2
                         MnCl3-  MnCO3  MnF+  MnHCO3+
                         MnOH+  MnSO4  MnX2  N2
                         Na+  NaCO3-  NaF  NaHCO3
                         NaHPO4-  NaOH  NaSO4-  NaX
                         NH3  NH4+  NH4SO4-  NH4X
                         NO2-  NO3-  O2  OH-
                         Pb(CO3)2-2  Pb(OH)2  Pb(OH)3-  Pb(OH)4-2
                         Pb(SO4)2-2  Pb+2  Pb2OH+3  PbCl+
                         PbCl2  PbCl3-  PbCl4-2  PbCO3
                         PbHCO3+  PbNO3+  PbOH+  PbSO4
                         PbX2  PO4-3  S-2  SiF6-2
                         SO4-2  Sr+2  SrCO3  SrHCO3+
                         SrOH+  SrSO4  SrX2  X-
                         Zn(CO3)2-2  Zn(OH)2  Zn(OH)3-  Zn(OH)4-2
                         Zn(SO4)2-2  Zn+2  ZnCl+  ZnCl2
                         ZnCl3-  ZnCl4-2  ZnCO3  ZnHCO3+
                         ZnOH+  ZnSO4  ZnX2
equilibrium_phases      Al(OH)3(a)  Albite  Alunite  Anglesite
                         Anhydrite  Anorthite  Aragonite  Barite
                         Calcite  Ca-Montmorillonite  Cd(OH)2  CdSiO3
                         CdSO4  Celestite  Cerrusite  CH4(g)
                         Chalcedony  Hydroxyapatite  Hematite  Hausmannite
                         Halite  H2S(g)  H2O(g)  H2(g)
                         Gypsum  Goethite  Gibbsite  Fluorite
                         FeS(ppt)  Fe(OH)3(a)  Dolomite  CO2(g)
                         Chrysotile  Chlorite(14A)  Illite  Jarosite-K
                         Kaolinite  K-feldspar  K-mica  Mackinawite
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```
                              Manganite  Melanterite  N2(g)  NH3(g)
                              O2(g)  Otavite  Pb(OH)2  Pyrite
                              Pyrochroite  Pyrolusite  Quartz  Rhodochrosite
                              Sepiolite  Sepiolite(d)  Siderite  SiO2(a)
                              Smithsonite  Sphalerite  Strontianite  Sulfur
                              Talc  Vivianite  Willemite  Witherite
                              Zn(OH)2(e)
        saturation_indices   Al(OH)3(a)  Zn(OH)2(e)  Witherite  Willemite
                              Vivianite  Talc  Sulfur  Strontianite
                              Sphalerite  Smithsonite  SiO2(a)  Siderite
                              Sepiolite(d)  Sepiolite  Rhodochrosite  Quartz
                              Pyrolusite  Pyrochroite  Pyrite  Pb(OH)2
                              Otavite  O2(g)  NH3(g)  N2(g)
                              Melanterite  Manganite  Mackinawite  K-mica
                              K-feldspar  Kaolinite  Jarosite-K  Illite
                              Hydroxyapatite  Hematite  Hausmannite  Halite
                              H2S(g)  H2O(g)  H2(g)  Gypsum
                              Goethite  Gibbsite  Fluorite  FeS(ppt)
                              Fe(OH)3(a)  Dolomite  CO2(g)  Chrysotile
                              Chlorite(14A)  Chalcedony  CH4(g)  Cerrusite
                              Celestite  CdSO4  CdSiO3  Cd(OH)2
                              Ca-Montmorillonite  Calcite  Barite  Aragonite
                              Anorthite  Anhydrite  Anglesite  Alunite
                              Albite
        gases                CH4(g)  CO2(g)  H2(g)  H2O(g)
                              H2S(g)  N2(g)  NH3(g)  O2(g)
        kinetic_reactants    Albite  Calcite  K-feldspar  Organic_C
                              Pyrite  Pyrolusite
    END
-------------------------------------------
Beginning of initial solution calculations.
-------------------------------------------

Initial solution 1.   River water

-----------------------------Solution composition------------------------------

    Elements           Molality       Moles

    Ca               1.215e-003  1.215e-003
    Cd               5.339e-010  5.339e-010
    Cl               4.316e-004  4.316e-004
    Cu               1.574e-008  1.574e-008
    Fe               1.791e-004  1.791e-004
    K                1.074e-004  1.074e-004
    Mg               1.933e-003  1.933e-003
    Na               4.611e-004  4.611e-004
    Pb               2.655e-009  2.655e-009
    S(6)             6.663e-005  6.663e-005
    Zn               1.591e-007  1.591e-007

----------------------------Description of solution----------------------------

                                       pH  =   8.200
                                       pe  =   2.630
                        Activity of water  =   1.000
                           Ionic strength  =  6.879e-003
                       Mass of water (kg)  =  1.000e+000
                 Total alkalinity (eq/kg)  =  1.996e-004
                    Total carbon (mol/kg)  =  0.000e+000
                       Total CO2 (mol/kg)  =  0.000e+000
                      Temperature (deg C)  =  28.400
                  Electrical balance (eq)  =  6.283e-003
 Percent error, 100*(Cat-|An|)/(Cat+|An|)  =  84.94
                               Iterations  =   4
                                  Total H  = 1.110130e+002
                                  Total O  = 5.550704e+001

----------------------------Distribution of species----------------------------

                                                Log       Log         Log
    Species            Molality    Activity  Molality  Activity     Gamma
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	OH-	2.233e-006	2.043e-006	-5.651	-5.690	-0.039
	H+	6.825e-009	6.310e-009	-8.166	-8.200	-0.034
	H2O	5.551e+001	9.999e-001	1.744	-0.000	0.000
Ca		1.215e-003				
	Ca+2	1.209e-003	8.591e-004	-2.918	-3.066	-0.148
	CaSO4	6.060e-006	6.069e-006	-5.218	-5.217	0.001
	CaOH+	2.467e-008	2.260e-008	-7.608	-7.646	-0.038
	CaHSO4+	2.559e-013	2.344e-013	-12.592	-12.630	-0.038
Cd		5.339e-010				
	Cd+2	5.087e-010	3.579e-010	-9.294	-9.446	-0.153
	CdCl+	1.490e-011	1.365e-011	-10.827	-10.865	-0.038
	CdOH+	6.609e-012	6.053e-012	-11.180	-11.218	-0.038
	CdSO4	3.609e-012	3.615e-012	-11.443	-11.442	0.001
	Cd(OH)2	4.009e-014	4.015e-014	-13.397	-13.396	0.001
	CdCl2	2.271e-014	2.274e-014	-13.644	-13.643	0.001
	Cd(SO4)2-2	1.894e-015	1.332e-015	-14.723	-14.875	-0.153
	CdCl3-	6.507e-018	5.960e-018	-17.187	-17.225	-0.038
	Cd(OH)3-	7.795e-019	7.139e-019	-18.108	-18.146	-0.038
	Cd(OH)4-2	1.433e-024	1.008e-024	-23.844	-23.996	-0.153
Cl		4.316e-004				
	Cl-	4.316e-004	3.948e-004	-3.365	-3.404	-0.039
	FeCl+	9.966e-010	9.127e-010	-9.001	-9.040	-0.038
	ZnCl+	1.081e-010	9.898e-011	-9.966	-10.004	-0.038
	CdCl+	1.490e-011	1.365e-011	-10.827	-10.865	-0.038
	PbCl+	9.858e-012	9.029e-012	-11.006	-11.044	-0.038
	ZnCl2	4.141e-014	4.148e-014	-13.383	-13.382	0.001
	CdCl2	2.271e-014	2.274e-014	-13.644	-13.643	0.001
	PbCl2	5.298e-015	5.306e-015	-14.276	-14.275	0.001
	ZnCl3-	2.047e-017	1.875e-017	-16.689	-16.727	-0.038
	CdCl3-	6.507e-018	5.960e-018	-17.187	-17.225	-0.038
	PbCl3-	1.855e-018	1.699e-018	-17.732	-17.770	-0.038
	FeCl+2	1.546e-018	1.088e-018	-17.811	-17.963	-0.153
	ZnCl4-2	5.416e-021	3.810e-021	-20.266	-20.419	-0.153
	FeCl2+	1.883e-021	1.725e-021	-20.725	-20.763	-0.038
	PbCl4-2	4.683e-022	3.295e-022	-21.329	-21.482	-0.153
	FeCl3	6.800e-026	6.810e-026	-25.168	-25.167	0.001
Cu(1)		4.144e-011				
	Cu+	4.144e-011	3.781e-011	-10.383	-10.422	-0.040
Cu(2)		1.570e-008				
	Cu(OH)2	1.560e-008	1.563e-008	-7.807	-7.806	0.001
	CuOH+	5.155e-011	4.720e-011	-10.288	-10.326	-0.038
	Cu+2	4.169e-011	2.978e-011	-10.380	-10.526	-0.146
	CuSO4	2.132e-013	2.136e-013	-12.671	-12.670	0.001
	Cu(OH)3-	1.630e-013	1.492e-013	-12.788	-12.826	-0.038
	Cu(OH)4-2	6.708e-018	4.719e-018	-17.173	-17.326	-0.153
Fe(2)		2.474e-006				
	Fe+2	2.344e-006	1.675e-006	-5.630	-5.776	-0.146
	FeOH+	1.178e-007	1.079e-007	-6.929	-6.967	-0.038
	FeSO4	1.085e-008	1.087e-008	-7.965	-7.964	0.001
	FeCl+	9.966e-010	9.127e-010	-9.001	-9.040	-0.038
	FeHSO4+	4.989e-016	4.569e-016	-15.302	-15.340	-0.038
Fe(3)		1.766e-004				
	Fe(OH)3	1.439e-004	1.441e-004	-3.842	-3.841	0.001
	Fe(OH)4-	2.604e-005	2.385e-005	-4.584	-4.623	-0.038
	Fe(OH)2+	6.658e-006	6.098e-006	-5.177	-5.215	-0.038
	FeOH+2	1.454e-010	1.023e-010	-9.837	-9.990	-0.153
	Fe+3	1.663e-016	8.202e-017	-15.779	-16.086	-0.307
	FeSO4+	3.630e-017	3.324e-017	-16.440	-16.478	-0.038
	FeCl+2	1.546e-018	1.088e-018	-17.811	-17.963	-0.153
	Fe2(OH)2+4	1.001e-018	2.451e-019	-18.000	-18.611	-0.611
	Fe(SO4)2-	2.761e-020	2.528e-020	-19.559	-19.597	-0.038
	Fe3(OH)4+5	2.062e-021	2.290e-022	-20.686	-21.640	-0.954
	FeCl2+	1.883e-021	1.725e-021	-20.725	-20.763	-0.038
	FeHSO4+2	7.990e-025	5.621e-025	-24.097	-24.250	-0.153
	FeCl3	6.800e-026	6.810e-026	-25.168	-25.167	0.001
H(0)		2.991e-025				
	H2	1.495e-025	1.498e-025	-24.825	-24.825	0.001
K		1.074e-004				
	K+	1.074e-004	9.825e-005	-3.969	-4.008	-0.039
	KSO4-	2.742e-008	2.512e-008	-7.562	-7.600	-0.038
	KOH	5.390e-011	5.399e-011	-10.268	-10.268	0.001

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Mg              1.933e-003
    Mg+2             1.920e-003  1.371e-003    -2.717    -2.863    -0.146
    MgSO4            1.200e-005  1.202e-005    -4.921    -4.920     0.001
    MgOH+            1.167e-006  1.068e-006    -5.933    -5.971    -0.038
Na              4.611e-004
    Na+              4.611e-004  4.226e-004    -3.336    -3.374    -0.038
    NaSO4-           8.107e-008  7.424e-008    -7.091    -7.129    -0.038
    NaOH             4.418e-010  4.425e-010    -9.355    -9.354     0.001
O(0)            0.000e+000
    O2               0.000e+000  0.000e+000   -41.647   -41.646     0.001
Pb              2.655e-009
    PbOH+            1.783e-009  1.633e-009    -8.749    -8.787    -0.038
    Pb+2             7.512e-010  5.285e-010    -9.124    -9.277    -0.153
    Pb(OH)2          1.005e-010  1.007e-010    -9.998    -9.997     0.001
    PbSO4            1.018e-011  1.020e-011   -10.992   -10.992     0.001
    PbCl+            9.858e-012  9.029e-012   -11.006   -11.044    -0.038
    Pb(OH)3-         2.000e-013  1.832e-013   -12.699   -12.737    -0.038
    PbCl2            5.298e-015  5.306e-015   -14.276   -14.275     0.001
    Pb(SO4)2-2       2.610e-015  1.836e-015   -14.583   -14.736    -0.153
    Pb(OH)4-2        9.454e-017  6.651e-017   -16.024   -16.177    -0.153
    Pb2OH+3          4.262e-017  1.932e-017   -16.370   -16.714    -0.344
    PbCl3-           1.855e-018  1.699e-018   -17.732   -17.770    -0.038
    PbCl4-2          4.683e-022  3.295e-022   -21.329   -21.482    -0.153
S(6)            6.663e-005
    SO4-2            4.845e-005  3.431e-005    -4.315    -4.465    -0.150
    MgSO4            1.200e-005  1.202e-005    -4.921    -4.920     0.001
    CaSO4            6.060e-006  6.069e-006    -5.218    -5.217     0.001
    NaSO4-           8.107e-008  7.424e-008    -7.091    -7.129    -0.038
    KSO4-            2.742e-008  2.512e-008    -7.562    -7.600    -0.038
    FeSO4            1.085e-008  1.087e-008    -7.965    -7.964     0.001
    ZnSO4            6.618e-010  6.629e-010    -9.179    -9.179     0.001
    HSO4-            2.478e-011  2.269e-011   -10.606   -10.644    -0.038
    PbSO4            1.018e-011  1.020e-011   -10.992   -10.992     0.001
    CdSO4            3.609e-012  3.615e-012   -11.443   -11.442     0.001
    Zn(SO4)2-2       2.561e-013  1.801e-013   -12.592   -12.744    -0.153
    CaHSO4+          2.559e-013  2.344e-013   -12.592   -12.630    -0.038
    CuSO4            2.132e-013  2.136e-013   -12.671   -12.670     0.001
    Pb(SO4)2-2       2.610e-015  1.836e-015   -14.583   -14.736    -0.153
    Cd(SO4)2-2       1.894e-015  1.332e-015   -14.723   -14.875    -0.153
    FeHSO4+          4.989e-016  4.569e-016   -15.302   -15.340    -0.038
    FeSO4+           3.630e-017  3.324e-017   -16.440   -16.478    -0.038
    Fe(SO4)2-        2.761e-020  2.528e-020   -19.559   -19.597    -0.038
    FeHSO4+2         7.990e-025  5.621e-025   -24.097   -24.250    -0.153
Zn              1.591e-007
    Zn+2             1.133e-007  8.030e-008    -6.946    -7.095    -0.150
    Zn(OH)2          2.535e-008  2.539e-008    -7.596    -7.595     0.001
    ZnOH+            1.966e-008  1.801e-008    -7.706    -7.745    -0.038
    ZnSO4            6.618e-010  6.629e-010    -9.179    -9.179     0.001
    ZnCl+            1.081e-010  9.898e-011    -9.966   -10.004    -0.038
    Zn(OH)3-         1.389e-011  1.272e-011   -10.857   -10.895    -0.038
    Zn(SO4)2-2       2.561e-013  1.801e-013   -12.592   -12.744    -0.153
    ZnCl2            4.141e-014  4.148e-014   -13.383   -13.382     0.001
    Zn(OH)4-2        4.543e-016  3.196e-016   -15.343   -15.495    -0.153
    ZnCl3-           2.047e-017  1.875e-017   -16.689   -16.727    -0.038
    ZnCl4-2          5.416e-021  3.810e-021   -20.266   -20.419    -0.153

------------------------------Saturation indices-------------------------------

    Phase               SI log IAP  log KT

    Anglesite        -5.97  -13.74   -7.77  PbSO4
    Anhydrite        -3.15   -7.53   -4.38  CaSO4
    Cd(OH)2          -6.70    6.95   13.65  Cd(OH)2
    CdSO4           -13.69  -13.91   -0.22  CdSO4
    Fe(OH)3(a)        3.62    8.51    4.89  Fe(OH)3
    Goethite          9.63    8.51   -1.12  FeOOH
    Gypsum           -2.95   -7.53   -4.58  CaSO4:2H2O
    H2(g)           -21.66  -24.82   -3.16  H2
    H2O(g)           -1.42   -0.00    1.42  H2O
    Halite           -8.37   -6.78    1.59  NaCl
    Hematite         21.29   17.03   -4.26  Fe2O3
    Jarosite-K       -2.53  -12.00   -9.47  KFe3(SO4)2(OH)6
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    Melanterite      -8.07  -10.24   -2.17  FeSO4:7H2O
    O2(g)           -38.67  -41.65   -2.98  O2
    Pb(OH)2          -0.91    7.12    8.03  Pb(OH)2
    Zn(OH)2(e)       -2.20    9.30   11.50  Zn(OH)2

Initial solution 2.   PAF Leachate

-----------------------------Solution composition------------------------------

    Elements           Molality       Moles

    Ca               9.008e-003  9.008e-003
    Cd               5.661e-007  5.661e-007
    Cl               2.844e-005  2.844e-005
    Cu               9.204e-007  9.204e-007
    Fe               5.544e-003  5.544e-003
    K                1.032e-004  1.032e-004
    Mg               1.062e-001  1.062e-001
    Na               2.632e-004  2.632e-004
    Pb               1.392e-006  1.392e-006
    S(6)             5.249e-002  5.249e-002
    Zn               2.067e-003  2.067e-003

----------------------------Description of solution----------------------------

                                       pH  =   3.980
                                       pe  =  11.850
                        Activity of water  =   0.998
                           Ionic strength  =  2.210e-001
                       Mass of water (kg)  =  1.000e+000
                 Total alkalinity (eq/kg)  = -3.984e-003
                    Total carbon (mol/kg)  =  0.000e+000
                       Total CO2 (mol/kg)  =  0.000e+000
                      Temperature (deg C)  =  25.000
                  Electrical balance (eq)  =  1.397e-001
 Percent error, 100*(Cat-|An|)/(Cat+|An|)  =  64.77
                               Iterations  =  13
                                  Total H  = 1.110194e+002
                                  Total O  = 5.572292e+001

----------------------------Distribution of species----------------------------

                                                Log       Log         Log
    Species            Molality    Activity  Molality  Activity     Gamma

    H+               1.319e-004  1.047e-004    -3.880    -3.980    -0.100
    OH-              1.364e-010  9.537e-011    -9.865   -10.021    -0.155
    H2O              5.551e+001  9.976e-001     1.744    -0.001     0.000
Ca              9.008e-003
    Ca+2             6.844e-003  2.144e-003    -2.165    -2.669    -0.504
    CaSO4            2.162e-003  2.275e-003    -2.665    -2.643     0.022
    CaHSO4+          1.878e-006  1.395e-006    -5.726    -5.855    -0.129
    CaOH+            4.563e-012  3.390e-012   -11.341   -11.470    -0.129
Cd              5.661e-007
    Cd+2             3.690e-007  1.124e-007    -6.433    -6.949    -0.516
    CdSO4            1.638e-007  1.723e-007    -6.786    -6.764     0.022
    Cd(SO4)2-2       3.300e-008  1.005e-008    -7.482    -7.998    -0.516
    CdCl+            2.891e-010  2.147e-010    -9.539    -9.668    -0.129
    CdOH+            1.199e-013  8.906e-014   -12.921   -13.050    -0.129
    CdCl2            1.702e-014  1.791e-014   -13.769   -13.747     0.022
    CdCl3-           3.044e-019  2.261e-019   -18.517   -18.646    -0.129
    Cd(OH)2          4.330e-020  4.556e-020   -19.363   -19.341     0.022
    Cd(OH)3-         6.557e-029  4.871e-029   -28.183   -28.312    -0.129
    Cd(OH)4-2        1.358e-038  4.136e-039   -37.867   -38.383    -0.516
Cl              2.844e-005
    Cl-              2.840e-005  2.001e-005    -4.547    -4.699    -0.152
    ZnCl+            3.100e-008  2.303e-008    -7.509    -7.638    -0.129
    FeCl+2           9.273e-009  2.824e-009    -8.033    -8.549    -0.516
    FeCl+            2.570e-009  1.909e-009    -8.590    -8.719    -0.129
    CdCl+            2.891e-010  2.147e-010    -9.539    -9.668    -0.129
    PbCl+            2.332e-010  1.732e-010    -9.632    -9.761    -0.129
    ZnCl2            4.586e-013  4.825e-013   -12.339   -12.316     0.022
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	FeCl2+	3.397e-013	2.524e-013	-12.469	-12.598	-0.129
	CdCl2	1.702e-014	1.791e-014	-13.769	-13.747	0.022
	PbCl2	5.220e-015	5.493e-015	-14.282	-14.260	0.022
	ZnCl3-	1.458e-017	1.083e-017	-16.836	-16.965	-0.129
	FeCl3	4.799e-019	5.049e-019	-18.319	-18.297	0.022
	CdCl3-	3.044e-019	2.261e-019	-18.517	-18.646	-0.129
	PbCl3-	1.175e-019	8.730e-020	-18.930	-19.059	-0.129
	ZnCl4-2	3.567e-022	1.086e-022	-21.448	-21.964	-0.516
	PbCl4-2	2.745e-024	8.360e-025	-23.561	-24.078	-0.516
Cu(1)	2.433e-016					
	Cu+	2.433e-016	1.635e-016	-15.614	-15.787	-0.173
Cu(2)	9.204e-007					
	Cu+2	6.929e-007	2.205e-007	-6.159	-6.657	-0.497
	CuSO4	2.275e-007	2.394e-007	-6.643	-6.621	0.022
	CuOH+	2.954e-011	2.101e-011	-10.530	-10.678	-0.148
	Cu(OH)2	3.974e-013	4.182e-013	-12.401	-12.379	0.022
	Cu(OH)3-	3.231e-022	2.401e-022	-21.491	-21.620	-0.129
	Cu(OH)4-2	1.498e-030	4.563e-031	-29.824	-30.341	-0.516
Fe(2)	2.794e-004					
	Fe+2	2.172e-004	6.912e-005	-3.663	-4.160	-0.497
	FeSO4	6.212e-005	6.536e-005	-4.207	-4.185	0.022
	FeHSO4+	6.056e-008	4.499e-008	-7.218	-7.347	-0.129
	FeCl+	2.570e-009	1.909e-009	-8.590	-8.719	-0.129
	FeOH+	2.803e-010	2.083e-010	-9.552	-9.681	-0.129
Fe(3)	5.264e-003					
	Fe(OH)2+	1.221e-003	9.069e-004	-2.913	-3.042	-0.129
	FeOH+2	9.440e-004	2.875e-004	-3.025	-3.541	-0.516
	Fe3(OH)4+5	7.114e-004	4.214e-007	-3.148	-6.375	-3.227
	FeSO4+	3.668e-004	2.725e-004	-3.436	-3.565	-0.129
	Fe2(OH)2+4	2.586e-004	2.224e-006	-3.587	-5.653	-2.066
	Fe(SO4)2-	4.267e-005	3.170e-005	-4.370	-4.499	-0.129
	Fe+3	3.729e-005	4.673e-006	-4.428	-5.330	-0.902
	Fe(OH)3	1.058e-006	1.113e-006	-5.976	-5.953	0.022
	FeHSO4+2	2.509e-007	7.640e-008	-6.601	-7.117	-0.516
	FeCl+2	9.273e-009	2.824e-009	-8.033	-8.549	-0.516
	Fe(OH)4-	1.302e-011	9.671e-012	-10.885	-11.015	-0.129
	FeCl2+	3.397e-013	2.524e-013	-12.469	-12.598	-0.129
	FeCl3	4.799e-019	5.049e-019	-18.319	-18.297	0.022
H(0)	2.944e-035					
	H2	1.472e-035	1.549e-035	-34.832	-34.810	0.022
K	1.032e-004					
	K+	9.963e-005	7.019e-005	-4.002	-4.154	-0.152
	KSO4-	3.530e-006	2.622e-006	-5.452	-5.581	-0.129
	KOH	2.204e-015	2.319e-015	-14.657	-14.635	0.022
Mg	1.062e-001					
	Mg+2	7.596e-002	2.551e-002	-1.119	-1.593	-0.474
	MgSO4	3.023e-002	3.180e-002	-1.520	-1.498	0.022
	MgOH+	1.188e-009	8.826e-010	-8.925	-9.054	-0.129
Na	2.632e-004					
	Na+	2.564e-004	1.894e-004	-3.591	-3.723	-0.131
	NaSO4-	6.796e-006	5.048e-006	-5.168	-5.297	-0.129
	NaOH	1.133e-014	1.192e-014	-13.946	-13.924	0.022
O(0)	3.287e-023					
	O2	1.644e-023	1.730e-023	-22.784	-22.762	0.022
Pb	1.392e-006					
	Pb+2	7.141e-007	2.175e-007	-6.146	-6.663	-0.516
	PbSO4	6.180e-007	6.503e-007	-6.209	-6.187	0.022
	Pb(SO4)2-2	5.959e-008	1.815e-008	-7.225	-7.741	-0.516
	PbCl+	2.332e-010	1.732e-010	-9.632	-9.761	-0.129
	PbOH+	5.438e-011	4.040e-011	-10.265	-10.394	-0.129
	PbCl2	5.220e-015	5.493e-015	-14.282	-14.260	0.022
	Pb2OH+3	2.855e-015	1.967e-016	-14.544	-15.706	-1.162
	Pb(OH)2	1.423e-016	1.497e-016	-15.847	-15.825	0.022
	PbCl3-	1.175e-019	8.730e-020	-18.930	-19.059	-0.129
	Pb(OH)3-	2.205e-023	1.638e-023	-22.657	-22.786	-0.129
	PbCl4-2	2.745e-024	8.360e-025	-23.561	-24.078	-0.516
	Pb(OH)4-2	1.174e-030	3.575e-031	-29.930	-30.447	-0.516
S(6)	5.249e-002					
	MgSO4	3.023e-002	3.180e-002	-1.520	-1.498	0.022
	SO4-2	1.884e-002	5.317e-003	-1.725	-2.274	-0.549
	CaSO4	2.162e-003	2.275e-003	-2.665	-2.643	0.022
	ZnSO4	5.067e-004	5.331e-004	-3.295	-3.273	0.022

```
     FeSO4+             3.668e-004  2.725e-004    -3.436     -3.565    -0.129
     Zn(SO4)2-2         7.567e-005  2.304e-005    -4.121     -4.637    -0.516
     HSO4-              7.287e-005  5.413e-005    -4.137     -4.267    -0.129
     FeSO4              6.212e-005  6.536e-005    -4.207     -4.185     0.022
     Fe(SO4)2-          4.267e-005  3.170e-005    -4.370     -4.499    -0.129
     NaSO4-             6.796e-006  5.048e-006    -5.168     -5.297    -0.129
     KSO4-              3.530e-006  2.622e-006    -5.452     -5.581    -0.129
     CaHSO4+            1.878e-006  1.395e-006    -5.726     -5.855    -0.129
     PbSO4              6.180e-007  6.503e-007    -6.209     -6.187     0.022
     FeHSO4+2           2.509e-007  7.640e-008    -6.601     -7.117    -0.516
     CuSO4              2.275e-007  2.394e-007    -6.643     -6.621     0.022
     CdSO4              1.638e-007  1.723e-007    -6.786     -6.764     0.022
     FeHSO4+            6.056e-008  4.499e-008    -7.218     -7.347    -0.129
     Pb(SO4)2-2         5.959e-008  1.815e-008    -7.225     -7.741    -0.516
     Cd(SO4)2-2         3.300e-008  1.005e-008    -7.482     -7.998    -0.516
Zn                 2.067e-003
     Zn+2               1.485e-003  4.277e-004    -2.828     -3.369    -0.541
     ZnSO4              5.067e-004  5.331e-004    -3.295     -3.273     0.022
     Zn(SO4)2-2         7.567e-005  2.304e-005    -4.121     -4.637    -0.516
     ZnCl+              3.100e-008  2.303e-008    -7.509     -7.638    -0.129
     ZnOH+              6.014e-009  4.468e-009    -8.221     -8.350    -0.129
     Zn(OH)2            4.645e-013  4.887e-013   -12.333    -12.311     0.022
     ZnCl2              4.586e-013  4.825e-013   -12.339    -12.316     0.022
     ZnCl3-             1.458e-017  1.083e-017   -16.836    -16.965    -0.129
     Zn(OH)3-           1.982e-020  1.472e-020   -19.703    -19.832    -0.129
     ZnCl4-2            3.567e-022  1.086e-022   -21.448    -21.964    -0.516
     Zn(OH)4-2          7.300e-029  2.223e-029   -28.137    -28.653    -0.516

------------------------------Saturation indices-------------------------------

     Phase               SI log IAP  log KT

     Anglesite        -1.15   -8.94   -7.79  PbSO4
     Anhydrite        -0.58   -4.94   -4.36  CaSO4
     Cd(OH)2         -12.64    1.01   13.65  Cd(OH)2
     CdSO4            -9.12   -9.22   -0.10  CdSO4
     Fe(OH)3(a)        1.72    6.61    4.89  Fe(OH)3
     Goethite          7.61    6.61   -1.00  FeOOH
     Gypsum           -0.36   -4.95   -4.58  CaSO4:2H2O
     H2(g)           -31.66  -34.81   -3.15  H2
     H2O(g)           -1.51   -0.00    1.51  H2O
     Halite          -10.00   -8.42    1.58  NaCl
     Hematite         17.22   13.22   -4.01  Fe2O3
     Jarosite-K        8.39   -0.82   -9.21  KFe3(SO4)2(OH)6
     Melanterite      -4.23   -6.44   -2.21  FeSO4:7H2O
     O2(g)           -19.80  -22.76   -2.96  O2
     Pb(OH)2          -6.85    1.30    8.15  Pb(OH)2
     Zn(OH)2(e)       -6.91    4.59   11.50  Zn(OH)2

Initial solution 3.   NAF Leachate

----------------------------Solution composition-----------------------------

     Elements           Molality       Moles

     Ca                 4.825e-003  4.825e-003
     Cd                 2.229e-008  2.229e-008
     Cl                 1.809e-003  1.809e-003
     Cu                 7.884e-008  7.884e-008
     Fe                 1.794e-007  1.794e-007
     K                  9.738e-004  9.738e-004
     Mg                 9.315e-003  9.315e-003
     Na                 2.659e-003  2.659e-003
     Pb                 2.418e-008  2.418e-008
     S(6)               1.512e-002  1.512e-002
     Zn                 2.345e-005  2.345e-005

----------------------------Description of solution---------------------------

                                       pH  =   6.500
                                       pe  =   1.840
                        Activity of water  =   0.999
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                          Ionic strength  =  4.115e-002
                       Mass of water (kg)  =  1.000e+000
                 Total alkalinity (eq/kg)  = -4.358e-007
                    Total carbon (mol/kg)  =  0.000e+000
                       Total CO2 (mol/kg)  =  0.000e+000
                      Temperature (deg C)  =  25.000
                  Electrical balance (eq)  = -9.827e-005
 Percent error, 100*(Cat-|An|)/(Cat+|An|)  =  -0.22
                               Iterations  =   6
                                  Total H  = 1.110124e+002
                                  Total O  = 5.556672e+001

----------------------------Distribution of species----------------------------

                                                  Log       Log         Log
    Species          Molality    Activity  Molality  Activity       Gamma

    H+              3.669e-007  3.162e-007    -6.435    -6.500      -0.065
    OH-             3.837e-008  3.164e-008    -7.416    -7.500      -0.084
    H2O             5.551e+001  9.995e-001     1.744    -0.000       0.000
Ca             4.825e-003
    Ca+2            3.257e-003  1.620e-003    -2.487    -2.790      -0.303
    CaSO4           1.568e-003  1.583e-003    -2.805    -2.800       0.004
    CaHSO4+         3.523e-009  2.933e-009    -8.453    -8.533      -0.080
    CaOH+           1.021e-009  8.498e-010    -8.991    -9.071      -0.080
Cd             2.229e-008
    Cd+2            1.217e-008  5.847e-009    -7.915    -8.233      -0.318
    CdSO4           8.183e-009  8.260e-009    -8.087    -8.083       0.004
    CdCl+           1.002e-009  8.340e-010    -8.999    -9.079      -0.080
    Cd(SO4)2-2      9.236e-010  4.437e-010    -9.035    -9.353      -0.318
    CdCl2           5.144e-012  5.193e-012   -11.289   -11.285       0.004
    CdOH+           1.846e-012  1.537e-012   -11.734   -11.813      -0.080
    CdCl3-          5.878e-015  4.894e-015   -14.231   -14.310      -0.080
    Cd(OH)2         2.585e-016  2.609e-016   -15.588   -15.583       0.004
    Cd(OH)3-        1.111e-022  9.253e-023   -21.954   -22.034      -0.080
    Cd(OH)4-2       5.426e-030  2.607e-030   -29.266   -29.584      -0.318
Cl             1.809e-003
    Cl-             1.809e-003  1.494e-003    -2.743    -2.826      -0.083
    ZnCl+           3.449e-008  2.871e-008    -7.462    -7.542      -0.080
    CdCl+           1.002e-009  8.340e-010    -8.999    -9.079      -0.080
    PbCl+           3.384e-010  2.817e-010    -9.471    -9.550      -0.080
    FeCl+           1.564e-010  1.302e-010    -9.806    -9.885      -0.080
    ZnCl2           4.448e-011  4.491e-011   -10.352   -10.348       0.004
    CdCl2           5.144e-012  5.193e-012   -11.289   -11.285       0.004
    PbCl2           6.607e-013  6.669e-013   -12.180   -12.176       0.004
    ZnCl3-          9.039e-014  7.526e-014   -13.044   -13.123      -0.080
    CdCl3-          5.878e-015  4.894e-015   -14.231   -14.310      -0.080
    PbCl3-          9.504e-016  7.913e-016   -15.022   -15.102      -0.080
    ZnCl4-2         1.173e-016  5.633e-017   -15.931   -16.249      -0.318
    PbCl4-2         1.178e-018  5.657e-019   -17.929   -18.247      -0.318
    FeCl+2          3.919e-020  1.882e-020   -19.407   -19.725      -0.318
    FeCl2+          1.509e-022  1.256e-022   -21.821   -21.901      -0.080
    FeCl3           1.858e-026  1.876e-026   -25.731   -25.727       0.004
Cu(1)          5.862e-008
    Cu+             5.862e-008  4.780e-008    -7.232    -7.321      -0.089
Cu(2)          2.022e-008
    Cu+2            1.244e-008  6.302e-009    -7.905    -8.201      -0.295
    CuSO4           6.243e-009  6.303e-009    -8.205    -8.200       0.004
    Cu(OH)2         1.303e-009  1.315e-009    -8.885    -8.881       0.004
    CuOH+           2.403e-010  1.992e-010    -9.619    -9.701      -0.082
    Cu(OH)3-        3.009e-016  2.505e-016   -15.522   -15.601      -0.080
    Cu(OH)4-2       3.289e-022  1.580e-022   -21.483   -21.801      -0.318
Fe(2)          1.794e-007
    Fe+2            1.247e-007  6.317e-008    -6.904    -7.200      -0.295
    FeSO4           5.450e-008  5.502e-008    -7.264    -7.259       0.004
    FeCl+           1.564e-010  1.302e-010    -9.806    -9.885      -0.080
    FeOH+           7.584e-011  6.314e-011   -10.120   -10.200      -0.080
    FeHSO4+         1.374e-013  1.144e-013   -12.862   -12.942      -0.080
Fe(3)          1.433e-011
    Fe(OH)2+        1.071e-011  8.914e-012   -10.970   -11.050      -0.080
    Fe(OH)3         3.595e-012  3.629e-012   -11.444   -11.440       0.004
    FeOH+2          1.773e-014  8.517e-015   -13.751   -14.070      -0.318
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	Fe(OH)4-	1.257e-014	1.046e-014	-13.901	-13.980	-0.080
	FeSO4+	2.693e-017	2.242e-017	-16.570	-16.649	-0.080
	Fe(SO4)2-	2.885e-018	2.402e-018	-17.540	-17.619	-0.080
	Fe+3	1.592e-018	4.173e-019	-17.798	-18.380	-0.581
	FeCl+2	3.919e-020	1.882e-020	-19.407	-19.725	-0.318
	FeCl2+	1.509e-022	1.256e-022	-21.821	-21.901	-0.080
	FeHSO4+2	3.951e-023	1.898e-023	-22.403	-22.722	-0.318
	Fe2(OH)2+4	3.667e-026	1.952e-027	-25.436	-26.709	-1.274
	FeCl3	1.858e-026	1.876e-026	-25.731	-25.727	0.004
	Fe3(OH)4+5	3.554e-034	3.636e-036	-33.449	-35.439	-1.990
H(0)		2.930e-020				
	H2	1.465e-020	1.479e-020	-19.834	-19.830	0.004
K		9.738e-004				
	K+	9.417e-004	7.775e-004	-3.026	-3.109	-0.083
	KSO4-	3.215e-005	2.676e-005	-4.493	-4.572	-0.080
	KOH	8.441e-012	8.521e-012	-11.074	-11.069	0.004
Mg		9.315e-003				
	Mg+2	5.904e-003	2.998e-003	-2.229	-2.523	-0.294
	MgSO4	3.411e-003	3.443e-003	-2.467	-2.463	0.004
	MgOH+	4.133e-008	3.441e-008	-7.384	-7.463	-0.080
Na		2.659e-003				
	Na+	2.595e-003	2.166e-003	-2.586	-2.664	-0.078
	NaSO4-	6.387e-005	5.317e-005	-4.195	-4.274	-0.080
	NaOH	4.480e-011	4.523e-011	-10.349	-10.345	0.004
O(0)		0.000e+000				
	O2	0.000e+000	0.000e+000	-52.725	-52.720	0.004
Pb		2.418e-008				
	PbSO4	1.293e-008	1.305e-008	-7.888	-7.884	0.004
	Pb+2	9.864e-009	4.738e-009	-8.006	-8.324	-0.318
	Pb(SO4)2-2	6.985e-010	3.355e-010	-9.156	-9.474	-0.318
	PbOH+	3.508e-010	2.920e-010	-9.455	-9.535	-0.080
	PbCl+	3.384e-010	2.817e-010	-9.471	-9.550	-0.080
	PbCl2	6.607e-013	6.669e-013	-12.180	-12.176	0.004
	Pb(OH)2	3.557e-013	3.591e-013	-12.449	-12.445	0.004
	PbCl3-	9.504e-016	7.913e-016	-15.022	-15.102	-0.080
	Pb2OH+3	1.612e-016	3.098e-017	-15.793	-16.509	-0.716
	Pb(OH)3-	1.565e-017	1.303e-017	-16.805	-16.885	-0.080
	PbCl4-2	1.178e-018	5.657e-019	-17.929	-18.247	-0.318
	Pb(OH)4-2	1.964e-022	9.435e-023	-21.707	-22.025	-0.318
S(6)		1.512e-002				
	SO4-2	1.004e-002	4.898e-003	-1.998	-2.310	-0.312
	MgSO4	3.411e-003	3.443e-003	-2.467	-2.463	0.004
	CaSO4	1.568e-003	1.583e-003	-2.805	-2.800	0.004
	NaSO4-	6.387e-005	5.317e-005	-4.195	-4.274	-0.080
	KSO4-	3.215e-005	2.676e-005	-4.493	-4.572	-0.080
	ZnSO4	8.124e-006	8.201e-006	-5.090	-5.086	0.004
	Zn(SO4)2-2	6.798e-007	3.265e-007	-6.168	-6.486	-0.318
	HSO4-	1.809e-007	1.506e-007	-6.743	-6.822	-0.080
	FeSO4	5.450e-008	5.502e-008	-7.264	-7.259	0.004
	PbSO4	1.293e-008	1.305e-008	-7.888	-7.884	0.004
	CdSO4	8.183e-009	8.260e-009	-8.087	-8.083	0.004
	CuSO4	6.243e-009	6.303e-009	-8.205	-8.200	0.004
	CaHSO4+	3.523e-009	2.933e-009	-8.453	-8.533	-0.080
	Cd(SO4)2-2	9.236e-010	4.437e-010	-9.035	-9.353	-0.318
	Pb(SO4)2-2	6.985e-010	3.355e-010	-9.156	-9.474	-0.318
	FeHSO4+	1.374e-013	1.144e-013	-12.862	-12.942	-0.080
	FeSO4+	2.693e-017	2.242e-017	-16.570	-16.649	-0.080
	Fe(SO4)2-	2.885e-018	2.402e-018	-17.540	-17.619	-0.080
	FeHSO4+2	3.951e-023	1.898e-023	-22.403	-22.722	-0.318
Zn		2.345e-005				
	Zn+2	1.458e-005	7.142e-006	-4.836	-5.146	-0.310
	ZnSO4	8.124e-006	8.201e-006	-5.090	-5.086	0.004
	Zn(SO4)2-2	6.798e-007	3.265e-007	-6.168	-6.486	-0.318
	ZnCl+	3.449e-008	2.871e-008	-7.462	-7.542	-0.080
	ZnOH+	2.973e-008	2.475e-008	-7.527	-7.606	-0.080
	Zn(OH)2	8.898e-010	8.983e-010	-9.051	-9.047	0.004
	ZnCl2	4.448e-011	4.491e-011	-10.352	-10.348	0.004
	ZnCl3-	9.039e-014	7.526e-014	-13.044	-13.123	-0.080
	Zn(OH)3-	1.078e-014	8.978e-015	-13.967	-14.047	-0.080
	ZnCl4-2	1.173e-016	5.633e-017	-15.931	-16.249	-0.318
	Zn(OH)4-2	9.362e-021	4.497e-021	-20.029	-20.347	-0.318

```
------------------------------Saturation indices------------------------------

    Phase               SI  log IAP   log KT

    Anglesite        -2.84  -10.63   -7.79  PbSO4
    Anhydrite        -0.74   -5.10   -4.36  CaSO4
    Cd(OH)2          -8.88    4.77   13.65  Cd(OH)2
    CdSO4           -10.44  -10.54   -0.10  CdSO4
    Fe(OH)3(a)       -3.77    1.12    4.89  Fe(OH)3
    Goethite          2.12    1.12   -1.00  FeOOH
    Gypsum           -0.52   -5.10   -4.58  CaSO4:2H2O
    H2(g)           -16.68  -19.83   -3.15  H2
    H2O(g)           -1.51   -0.00    1.51  H2O
    Halite           -7.07   -5.49    1.58  NaCl
    Hematite          6.25    2.24   -4.01  Fe2O3
    Jarosite-K      -14.66  -23.87   -9.21  KFe3(SO4)2(OH)6
    Melanterite      -7.30   -9.51   -2.21  FeSO4:7H2O
    O2(g)           -49.76  -52.72   -2.96  O2
    Pb(OH)2          -3.47    4.68    8.15  Pb(OH)2
    Zn(OH)2(e)       -3.65    7.85   11.50  Zn(OH)2

Initial solution 4.   Rainwater

-----------------------------Solution composition-----------------------------

    Elements           Molality       Moles

    Ca               2.500e-006  2.500e-006
    Cl               6.699e-006  6.699e-006
    K                1.499e-006  1.499e-006
    Mg               1.300e-006  1.300e-006
    Na               6.903e-006  6.903e-006
    S(6)             8.100e-006  8.100e-006
    Zn               1.530e-007  1.530e-007

----------------------------Description of solution----------------------------

                                       pH  =   4.590
                                       pe  =  10.150
                        Activity of water  =   1.000
                           Ionic strength  =  4.455e-005
                       Mass of water (kg)  =  1.000e+000
                 Total alkalinity (eq/kg)  = -2.592e-005
                    Total carbon (mol/kg)  =  0.000e+000
                       Total CO2 (mol/kg)  =  0.000e+000
                      Temperature (deg C)  =  25.000
                  Electrical balance (eq)  =  1.933e-005
 Percent error, 100*(Cat-|An|)/(Cat+|An|)  =  29.71
                               Iterations  =   3
                                  Total H  = 1.110125e+002
                                  Total O  = 5.550625e+001

----------------------------Distribution of species----------------------------

                                                    Log       Log         Log
    Species            Molality    Activity  Molality  Activity       Gamma

    H+               2.590e-005  2.570e-005    -4.587    -4.590      -0.003
    OH-              3.925e-010  3.895e-010    -9.406    -9.410      -0.003
    H2O              5.551e+001  1.000e+000     1.744    -0.000       0.000
Ca              2.500e-006
    Ca+2             2.496e-006  2.420e-006    -5.603    -5.616      -0.013
    CaSO4            3.780e-009  3.780e-009    -8.423    -8.423       0.000
    CaHSO4+          5.736e-013  5.691e-013   -12.241   -12.245      -0.003
    CaOH+            1.575e-014  1.563e-014   -13.803   -13.806      -0.003
Cl              6.699e-006
    Cl-              6.699e-006  6.647e-006    -5.174    -5.177      -0.003
    ZnCl+            2.669e-012  2.649e-012   -11.574   -11.577      -0.003
    ZnCl2            1.844e-017  1.844e-017   -16.734   -16.734       0.000
    ZnCl3-           1.386e-022  1.375e-022   -21.858   -21.862      -0.003
    ZnCl4-2          4.725e-028  4.581e-028   -27.326   -27.339      -0.013
H(0)            4.688e-033
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     H2                 2.344e-033  2.344e-033   -32.630   -32.630     0.000
K               1.499e-006
     K+                 1.499e-006  1.487e-006    -5.824    -5.828    -0.003
     KSO4-              8.242e-011  8.178e-011   -10.084   -10.087    -0.003
     KOH                2.006e-016  2.006e-016   -15.698   -15.698     0.000
Mg              1.300e-006
     Mg+2               1.297e-006  1.258e-006    -5.887    -5.900    -0.013
     MgSO4              2.308e-009  2.308e-009    -8.637    -8.637     0.000
     MgOH+              1.791e-013  1.777e-013   -12.747   -12.750    -0.003
Na              6.903e-006
     Na+                6.902e-006  6.849e-006    -5.161    -5.164    -0.003
     NaSO4-             2.708e-010  2.687e-010    -9.567    -9.571    -0.003
     NaOH               1.760e-015  1.760e-015   -14.754   -14.754     0.000
O(0)            1.517e-027
     O2                 7.586e-028  7.586e-028   -27.120   -27.120     0.000
S(6)            8.100e-006
     SO4-2              8.073e-006  7.827e-006    -5.093    -5.106    -0.013
     HSO4-              1.971e-008  1.956e-008    -7.705    -7.709    -0.003
     CaSO4              3.780e-009  3.780e-009    -8.423    -8.423     0.000
     MgSO4              2.308e-009  2.308e-009    -8.637    -8.637     0.000
     ZnSO4              2.716e-010  2.716e-010    -9.566    -9.566     0.000
     NaSO4-             2.708e-010  2.687e-010    -9.567    -9.571    -0.003
     KSO4-              8.242e-011  8.178e-011   -10.084   -10.087    -0.003
     CaHSO4+            5.736e-013  5.691e-013   -12.241   -12.245    -0.003
     Zn(SO4)2-2         1.783e-014  1.728e-014   -13.749   -13.762    -0.013
Zn              1.530e-007
     Zn+2               1.527e-007  1.480e-007    -6.816    -6.830    -0.013
     ZnSO4              2.716e-010  2.716e-010    -9.566    -9.566     0.000
     ZnOH+              6.364e-012  6.315e-012   -11.196   -11.200    -0.003
     ZnCl+              2.669e-012  2.649e-012   -11.574   -11.577    -0.003
     Zn(SO4)2-2         1.783e-014  1.728e-014   -13.749   -13.762    -0.013
     Zn(OH)2            2.821e-015  2.821e-015   -14.550   -14.550     0.000
     ZnCl2              1.844e-017  1.844e-017   -16.734   -16.734     0.000
     Zn(OH)3-           3.497e-022  3.470e-022   -21.456   -21.460    -0.003
     ZnCl3-             1.386e-022  1.375e-022   -21.858   -21.862    -0.003
     ZnCl4-2            4.725e-028  4.581e-028   -27.326   -27.339    -0.013
     Zn(OH)4-2          2.207e-030  2.140e-030   -29.656   -29.670    -0.013

------------------------------Saturation indices-------------------------------

     Phase               SI log IAP  log KT

     Anhydrite        -6.36  -10.72   -4.36  CaSO4
     Gypsum           -6.14  -10.72   -4.58  CaSO4:2H2O
     H2(g)           -29.48  -32.63   -3.15  H2
     H2O(g)           -1.51   -0.00    1.51  H2O
     Halite          -11.92  -10.34    1.58  NaCl
     O2(g)           -24.16  -27.12   -2.96  O2
     Zn(OH)2(e)       -9.15    2.35   11.50  Zn(OH)2

Initial solution 5.   Tailings Seepage

-----------------------------Solution composition------------------------------

     Elements           Molality       Moles

     Ca                 1.024e-002  1.024e-002
     Cd                 7.216e-010  7.216e-010
     Cl                 7.463e-002  7.463e-002
     Cu                 2.776e-007  2.776e-007
     Fe                 5.718e-008  5.718e-008
     K                  7.700e-003  7.700e-003
     Mg                 4.462e-002  4.462e-002
     Na                 1.336e-001  1.336e-001
     Pb                 1.419e-009  1.419e-009
     S(6)               6.532e-002  6.532e-002
     Zn                 5.071e-006  5.071e-006

----------------------------Description of solution----------------------------

                                       pH  =   6.560
                                       pe  =   1.690
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```
                          Activity of water  =   0.995
                             Ionic strength  =  2.457e-001
                         Mass of water (kg)  =  1.000e+000
                   Total alkalinity (eq/kg)  = -4.947e-007
                      Total carbon (mol/kg)  =  0.000e+000
                         Total CO2 (mol/kg)  =  0.000e+000
                        Temperature (deg C)  =  25.000
                    Electrical balance (eq)  =  4.577e-002
 Percent error, 100*(Cat-|An|)/(Cat+|An|)  =  12.94
                                 Iterations  =   8
                                    Total H  = 1.110124e+002
                                    Total O  = 5.576752e+001

----------------------------Distribution of species----------------------------
```

Species	Molality	Activity	Log Molality	Log Activity	Log Gamma
H+	3.487e-007	2.754e-007	-6.458	-6.560	-0.102
OH-	5.236e-008	3.616e-008	-7.281	-7.442	-0.161
H2O	5.551e+001	9.948e-001	1.744	-0.002	0.000
Ca	1.024e-002				
Ca+2	6.543e-003	1.993e-003	-2.184	-2.700	-0.516
CaSO4	3.701e-003	3.916e-003	-2.432	-2.407	0.025
CaHSO4+	8.548e-009	6.319e-009	-8.068	-8.199	-0.131
CaOH+	1.616e-009	1.195e-009	-8.791	-8.923	-0.131
Cd	7.216e-010				
CdCl+	3.265e-010	2.414e-010	-9.486	-9.617	-0.131
Cd+2	1.629e-010	4.863e-011	-9.788	-10.313	-0.525
CdSO4	1.305e-010	1.381e-010	-9.884	-9.860	0.025
Cd(SO4)2-2	4.993e-011	1.491e-011	-10.302	-10.827	-0.525
CdCl2	4.942e-011	5.229e-011	-10.306	-10.282	0.025
CdCl3-	2.320e-012	1.715e-012	-11.635	-11.766	-0.131
CdOH+	1.976e-014	1.461e-014	-13.704	-13.835	-0.131
Cd(OH)2	2.678e-018	2.834e-018	-17.572	-17.548	0.025
Cd(OH)3-	1.553e-024	1.148e-024	-23.809	-23.940	-0.131
Cd(OH)4-2	1.238e-031	3.696e-032	-30.907	-31.432	-0.525
Cl	7.463e-002				
Cl-	7.463e-002	5.197e-002	-1.127	-1.284	-0.157
ZnCl+	1.453e-007	1.074e-007	-6.838	-6.969	-0.131
ZnCl2	5.523e-009	5.845e-009	-8.258	-8.233	0.025
FeCl+	1.111e-009	8.211e-010	-8.954	-9.086	-0.131
ZnCl3-	4.611e-010	3.408e-010	-9.336	-9.467	-0.131
CdCl+	3.265e-010	2.414e-010	-9.486	-9.617	-0.131
PbCl+	3.151e-010	2.329e-010	-9.502	-9.633	-0.131
CdCl2	4.942e-011	5.229e-011	-10.306	-10.282	0.025
ZnCl4-2	2.974e-011	8.878e-012	-10.527	-11.052	-0.525
PbCl2	1.813e-011	1.919e-011	-10.742	-10.717	0.025
CdCl3-	2.320e-012	1.715e-012	-11.635	-11.766	-0.131
PbCl3-	1.072e-012	7.921e-013	-11.970	-12.101	-0.131
PbCl4-2	6.600e-014	1.970e-014	-13.180	-13.705	-0.525
FeCl+2	2.814e-019	8.403e-020	-18.551	-19.076	-0.525
FeCl2+	2.639e-020	1.951e-020	-19.579	-19.710	-0.131
FeCl3	9.581e-023	1.014e-022	-22.019	-21.994	0.025
Cu(1)	2.077e-007				
Cu+	2.077e-007	1.374e-007	-6.683	-6.862	-0.179
Cu(2)	6.990e-008				
Cu+2	4.158e-008	1.282e-008	-7.381	-7.892	-0.511
CuSO4	2.436e-008	2.578e-008	-7.613	-7.589	0.025
Cu(OH)2	3.303e-009	3.495e-009	-8.481	-8.457	0.025
CuOH+	6.586e-010	4.631e-010	-9.181	-9.334	-0.153
Cu(OH)3-	1.029e-015	7.606e-016	-14.988	-15.119	-0.131
Cu(OH)4-2	1.836e-021	5.481e-022	-20.736	-21.261	-0.525
Fe(2)	5.718e-008				
Fe+2	3.711e-008	1.145e-008	-7.430	-7.941	-0.511
FeSO4	1.894e-008	2.004e-008	-7.723	-7.698	0.025
FeCl+	1.111e-009	8.211e-010	-8.954	-9.086	-0.131
FeOH+	1.768e-011	1.307e-011	-10.752	-10.884	-0.131
FeHSO4+	4.908e-014	3.628e-014	-13.309	-13.440	-0.131
Fe(3)	2.684e-012				
Fe(OH)2+	2.020e-012	1.493e-012	-11.695	-11.826	-0.131
Fe(OH)3	6.565e-013	6.947e-013	-12.183	-12.158	0.025

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     FeOH+2              4.181e-015  1.248e-015   -14.379    -14.904    -0.525
     Fe(OH)4-            3.096e-015  2.288e-015   -14.509    -14.640    -0.131
     FeSO4+              7.818e-018  5.779e-018   -17.107    -17.238    -0.131
     Fe(SO4)2-           1.684e-018  1.245e-018   -17.774    -17.905    -0.131
     Fe+3                4.472e-019  5.353e-020   -18.350    -19.271    -0.922
     FeCl+2              2.814e-019  8.403e-020   -18.551    -19.076    -0.525
     FeCl2+              2.639e-020  1.951e-020   -19.579    -19.710    -0.131
     FeCl3               9.581e-023  1.014e-022   -22.019    -21.994     0.025
     FeHSO4+2            1.428e-023  4.262e-024   -22.845    -23.370    -0.525
     Fe2(OH)2+4          5.280e-027  4.195e-029   -26.277    -28.377    -2.100
     Fe3(OH)4+5          2.500e-035  1.309e-038   -34.602    -37.883    -3.281
H(0)                4.231e-020
     H2                  2.116e-020  2.239e-020   -19.675    -19.650     0.025
K                   7.700e-003
     K+                  7.229e-003  5.034e-003    -2.141     -2.298    -0.157
     KSO4-               4.712e-004  3.483e-004    -3.327     -3.458    -0.131
     KOH                 5.958e-011  6.305e-011   -10.225    -10.200     0.025
Mg                  4.462e-002
     Mg+2                2.600e-002  8.536e-003    -1.585     -2.069    -0.484
     MgSO4               1.862e-002  1.970e-002    -1.730     -1.705     0.025
     MgOH+               1.514e-007  1.119e-007    -6.820     -6.951    -0.131
Na                  1.336e-001
     Na+                 1.274e-001  9.346e-002    -0.895     -1.029    -0.134
     NaSO4-              6.239e-003  4.612e-003    -2.205     -2.336    -0.131
     NaOH                2.108e-009  2.230e-009    -8.676     -8.652     0.025
O(0)                0.000e+000
     O2                  0.000e+000  0.000e+000   -53.109    -53.085     0.025
Pb                  1.419e-009
     PbSO4               5.890e-010  6.233e-010    -9.230     -9.205     0.025
     Pb+2                3.770e-010  1.126e-010    -9.424     -9.949    -0.525
     PbCl+               3.151e-010  2.329e-010    -9.502     -9.633    -0.131
     Pb(SO4)2-2          1.079e-010  3.220e-011    -9.967    -10.492    -0.525
     PbCl2               1.813e-011  1.919e-011   -10.742    -10.717     0.025
     PbOH+               1.072e-011  7.928e-012   -10.970    -11.101    -0.131
     PbCl3-              1.072e-012  7.921e-013   -11.970    -12.101    -0.131
     PbCl4-2             6.600e-014  1.970e-014   -13.180    -13.705    -0.525
     Pb(OH)2             1.053e-014  1.114e-014   -13.978    -13.953     0.025
     Pb(OH)3-            6.249e-019  4.619e-019   -18.204    -18.335    -0.131
     Pb2OH+3             3.032e-019  1.998e-020   -18.518    -19.699    -1.181
     Pb(OH)4-2           1.280e-023  3.822e-024   -22.893    -23.418    -0.525
S(6)                6.532e-002
     SO4-2               3.629e-002  9.846e-003    -1.440     -2.007    -0.567
     MgSO4               1.862e-002  1.970e-002    -1.730     -1.705     0.025
     NaSO4-              6.239e-003  4.612e-003    -2.205     -2.336    -0.131
     CaSO4               3.701e-003  3.916e-003    -2.432     -2.407     0.025
     KSO4-               4.712e-004  3.483e-004    -3.327     -3.458    -0.131
     ZnSO4               1.674e-006  1.772e-006    -5.776     -5.752     0.025
     Zn(SO4)2-2          4.749e-007  1.418e-007    -6.323     -6.848    -0.525
     HSO4-               3.567e-007  2.636e-007    -6.448     -6.579    -0.131
     CuSO4               2.436e-008  2.578e-008    -7.613     -7.589     0.025
     FeSO4               1.894e-008  2.004e-008    -7.723     -7.698     0.025
     CaHSO4+             8.548e-009  6.319e-009    -8.068     -8.199    -0.131
     PbSO4               5.890e-010  6.233e-010    -9.230     -9.205     0.025
     CdSO4               1.305e-010  1.381e-010    -9.884     -9.860     0.025
     Pb(SO4)2-2          1.079e-010  3.220e-011    -9.967    -10.492    -0.525
     Cd(SO4)2-2          4.993e-011  1.491e-011   -10.302    -10.827    -0.525
     FeHSO4+             4.908e-014  3.628e-014   -13.309    -13.440    -0.131
     FeSO4+              7.818e-018  5.779e-018   -17.107    -17.238    -0.131
     Fe(SO4)2-           1.684e-018  1.245e-018   -17.774    -17.905    -0.131
     FeHSO4+2            1.428e-023  4.262e-024   -22.845    -23.370    -0.525
Zn                  5.071e-006
     Zn+2                2.766e-006  7.677e-007    -5.558     -6.115    -0.557
     ZnSO4               1.674e-006  1.772e-006    -5.776     -5.752     0.025
     Zn(SO4)2-2          4.749e-007  1.418e-007    -6.323     -6.848    -0.525
     ZnCl+               1.453e-007  1.074e-007    -6.838     -6.969    -0.131
     ZnCl2               5.523e-009  5.845e-009    -8.258     -8.233     0.025
     ZnOH+               4.113e-009  3.040e-009    -8.386     -8.517    -0.131
     ZnCl3-              4.611e-010  3.408e-010    -9.336     -9.467    -0.131
     Zn(OH)2             1.191e-010  1.261e-010    -9.924     -9.899     0.025
     ZnCl4-2             2.974e-011  8.878e-012   -10.527    -11.052    -0.525
     Zn(OH)3-            1.948e-015  1.440e-015   -14.710    -14.842    -0.131
     Zn(OH)4-2           2.761e-021  8.243e-022   -20.559    -21.084    -0.525
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------------------------------Saturation indices------------------------------

    Phase               SI log IAP  log KT

    Anglesite        -4.17  -11.96   -7.79  PbSO4
    Anhydrite        -0.35   -4.71   -4.36  CaSO4
    Cd(OH)2         -10.85    2.80   13.65  Cd(OH)2
    CdSO4           -12.22  -12.32   -0.10  CdSO4
    Fe(OH)3(a)       -4.49    0.40    4.89  Fe(OH)3
    Goethite          1.40    0.40   -1.00  FeOOH
    Gypsum           -0.13   -4.71   -4.58  CaSO4:2H2O
    H2(g)           -16.50  -19.65   -3.15  H2
    H2O(g)           -1.51   -0.00    1.51  H2O
    Halite           -3.90   -2.31    1.58  NaCl
    Hematite          4.82    0.81   -4.01  Fe2O3
    Jarosite-K      -15.57  -24.78   -9.21  KFe3(SO4)2(OH)6
    Melanterite      -7.75   -9.96   -2.21  FeSO4:7H2O
    O2(g)           -50.12  -53.08   -2.96  O2
    Pb(OH)2          -4.98    3.17    8.15  Pb(OH)2
    Zn(OH)2(e)       -4.50    7.00   11.50  Zn(OH)2

-----------------------------------------
Beginning of batch-reaction calculations.
-----------------------------------------

Reaction step 1.

Using mix 1.  Mixing of water in open pit - best case Scenario 2

Mixture 1.    Mixing of water in open pit - best case Scenario 2

     9.344e-001 Solution 1River water
     3.900e-003 Solution 2PAF Leachate
     3.530e-002 Solution 3NAF Leachate
     2.320e-002 Solution 4Rainwater
     3.100e-003 Solution 5Tailings Seepage

-----------------------------Solution composition------------------------------

    Elements           Molality       Moles

    Ca               1.373e-003  1.373e-003
    Cd               3.496e-009  3.496e-009
    Cl               6.989e-004  6.988e-004
    Cu               2.194e-008  2.194e-008
    Fe               1.890e-004  1.890e-004
    K                1.591e-004  1.591e-004
    Mg               2.688e-003  2.688e-003
    Na               9.402e-004  9.401e-004
    Pb               8.769e-009  8.768e-009
    S                1.004e-003  1.004e-003
    Zn               9.059e-006  9.058e-006

----------------------------Description of solution----------------------------

                                       pH  =   7.662      Charge balance
                                       pe  =   4.182      Adjusted to redox equilibrium
                        Activity of water  =   1.000
                           Ionic strength  =  9.913e-003
                       Mass of water (kg)  =  9.999e-001
                 Total alkalinity (eq/kg)  =  1.704e-004
                    Total carbon (mol/kg)  =  0.000e+000
                       Total CO2 (mol/kg)  =  0.000e+000
                      Temperature (deg C)  =  28.177
                  Electrical balance (eq)  =  6.555e-003
 Percent error, 100*(Cat-|An|)/(Cat+|An|)  =  60.53
                               Iterations  =   7
                                  Total H  = 1.110019e+002
                                  Total O  = 5.550522e+001

----------------------------Distribution of species----------------------------
```

	Species	Molality	Activity	Log Molality	Log Activity	Log Gamma
	OH-	6.466e-007	5.819e-007	-6.189	-6.235	-0.046
	H+	2.386e-008	2.179e-008	-7.622	-7.662	-0.039
	H2O	5.551e+001	9.999e-001	1.744	-0.000	0.000
Ca		1.373e-003				
	Ca+2	1.289e-003	8.640e-004	-2.890	-3.064	-0.174
	CaSO4	8.430e-005	8.450e-005	-4.074	-4.073	0.001
	CaOH+	7.296e-009	6.580e-009	-8.137	-8.182	-0.045
	CaHSO4+	1.246e-011	1.124e-011	-10.905	-10.949	-0.045
Cd		3.496e-009				
	Cd+2	3.063e-009	2.027e-009	-8.514	-8.693	-0.179
	CdSO4	2.830e-010	2.836e-010	-9.548	-9.547	0.001
	CdCl+	1.365e-010	1.231e-010	-9.865	-9.910	-0.045
	CdOH+	1.083e-011	9.767e-012	-10.965	-11.010	-0.045
	Cd(SO4)2-2	2.195e-012	1.452e-012	-11.659	-11.838	-0.179
	CdCl2	3.258e-013	3.265e-013	-12.487	-12.486	0.001
	Cd(OH)2	1.902e-014	1.907e-014	-13.721	-13.720	0.001
	CdCl3-	1.507e-016	1.359e-016	-15.822	-15.867	-0.045
	Cd(OH)3-	1.088e-019	9.817e-020	-18.963	-19.008	-0.045
	Cd(OH)4-2	6.069e-026	4.015e-026	-25.217	-25.396	-0.179
Cl		6.989e-004				
	Cl-	6.988e-004	6.292e-004	-3.156	-3.201	-0.046
	ZnCl+	1.142e-008	1.030e-008	-7.942	-7.987	-0.045
	FeCl+	2.064e-009	1.861e-009	-8.685	-8.730	-0.045
	CdCl+	1.365e-010	1.231e-010	-9.865	-9.910	-0.045
	PbCl+	9.344e-011	8.427e-011	-10.029	-10.074	-0.045
	ZnCl2	6.855e-012	6.871e-012	-11.164	-11.163	0.001
	CdCl2	3.258e-013	3.265e-013	-12.487	-12.486	0.001
	PbCl2	7.906e-014	7.924e-014	-13.102	-13.101	0.001
	ZnCl3-	5.481e-015	4.943e-015	-14.261	-14.306	-0.045
	CdCl3-	1.507e-016	1.359e-016	-15.822	-15.867	-0.045
	FeCl+2	1.172e-016	7.754e-017	-15.931	-16.110	-0.179
	PbCl3-	4.477e-017	4.038e-017	-16.349	-16.394	-0.045
	ZnCl4-2	2.415e-018	1.598e-018	-17.617	-17.796	-0.179
	FeCl2+	2.187e-019	1.973e-019	-18.660	-18.705	-0.045
	PbCl4-2	1.883e-020	1.246e-020	-19.725	-19.905	-0.179
	FeCl3	1.238e-023	1.241e-023	-22.907	-22.906	0.001
Cu(1)		1.890e-011				
	Cu+	1.890e-011	1.696e-011	-10.723	-10.771	-0.047
Cu(2)		2.192e-008				
	Cu(OH)2	2.093e-008	2.098e-008	-7.679	-7.678	0.001
	Cu+2	7.059e-010	4.767e-010	-9.151	-9.322	-0.170
	CuOH+	2.427e-010	2.188e-010	-9.615	-9.660	-0.045
	CuSO4	4.724e-011	4.734e-011	-10.326	-10.325	0.001
	Cu(OH)3-	6.431e-014	5.800e-014	-13.192	-13.237	-0.045
	Cu(OH)4-2	8.027e-019	5.311e-019	-18.095	-18.275	-0.179
Fe(2)		3.411e-006				
	Fe+2	3.173e-006	2.143e-006	-5.498	-5.669	-0.170
	FeSO4	1.917e-007	1.921e-007	-6.717	-6.716	0.001
	FeOH+	4.362e-008	3.934e-008	-7.360	-7.405	-0.045
	FeCl+	2.064e-009	1.861e-009	-8.685	-8.730	-0.045
	FeHSO4+	3.090e-014	2.787e-014	-13.510	-13.555	-0.045
	Fe(HS)2	0.000e+000	0.000e+000	-141.812	-141.811	0.001
	Fe(HS)3-	0.000e+000	0.000e+000	-212.275	-212.319	-0.045
Fe(3)		1.856e-004				
	Fe(OH)3	1.525e-004	1.529e-004	-3.817	-3.816	0.001
	Fe(OH)2+	2.500e-005	2.255e-005	-4.602	-4.647	-0.045
	Fe(OH)4-	8.050e-006	7.260e-006	-5.094	-5.139	-0.045
	FeOH+2	1.991e-009	1.317e-009	-8.701	-8.880	-0.179
	FeSO4+	2.292e-014	2.067e-014	-13.640	-13.685	-0.045
	Fe+3	8.354e-015	3.694e-015	-14.078	-14.433	-0.354
	Fe(SO4)2-	2.416e-016	2.179e-016	-15.617	-15.662	-0.045
	Fe2(OH)2+4	2.139e-016	4.099e-017	-15.670	-16.387	-0.718
	FeCl+2	1.172e-016	7.754e-017	-15.931	-16.110	-0.179
	Fe3(OH)4+5	1.910e-018	1.445e-019	-17.719	-18.840	-1.121
	FeCl2+	2.187e-019	1.973e-019	-18.660	-18.705	-0.045
	FeHSO4+2	1.824e-021	1.207e-021	-20.739	-20.918	-0.179
	FeCl3	1.238e-023	1.241e-023	-22.907	-22.906	0.001
H(0)		2.816e-027				

```
         H2                  1.408e-027  1.411e-027   -26.851   -26.850     0.001
K                    1.591e-004
         K+                  1.585e-004  1.427e-004    -3.800    -3.846    -0.046
         KSO4-               5.591e-007  5.042e-007    -6.253    -6.297    -0.045
         KOH                 2.266e-011  2.271e-011   -10.645   -10.644     0.001
Mg                   2.688e-003
         Mg+2                2.485e-003  1.677e-003    -2.605    -2.775    -0.171
         MgSO4               2.024e-004  2.029e-004    -3.694    -3.693     0.001
         MgOH+               4.115e-007  3.712e-007    -6.386    -6.430    -0.045
Na                   9.402e-004
         Na+                 9.379e-004  8.469e-004    -3.028    -3.072    -0.044
         NaSO4-              2.285e-006  2.061e-006    -5.641    -5.686    -0.045
         NaOH                2.562e-010  2.568e-010    -9.591    -9.590     0.001
O(0)                 4.317e-038
         O2                  2.159e-038  2.164e-038   -37.666   -37.665     0.001
Pb                   8.769e-009
         Pb+2                4.704e-009  3.112e-009    -8.328    -8.507    -0.179
         PbOH+               3.088e-009  2.785e-009    -8.510    -8.555    -0.045
         PbSO4               8.311e-010  8.330e-010    -9.080    -9.079     0.001
         PbCl+               9.344e-011  8.427e-011   -10.029   -10.074    -0.045
         Pb(OH)2             4.960e-011  4.972e-011   -10.304   -10.304     0.001
         Pb(SO4)2-2          3.145e-012  2.081e-012   -11.502   -11.682    -0.179
         PbCl2               7.906e-014  7.924e-014   -13.102   -13.101     0.001
         Pb(OH)3-            2.905e-014  2.620e-014   -13.537   -13.582    -0.045
         Pb2OH+3             4.914e-016  1.940e-016   -15.309   -15.712    -0.404
         PbCl3-              4.477e-017  4.038e-017   -16.349   -16.394    -0.045
         Pb(OH)4-2           4.162e-018  2.754e-018   -17.381   -17.560    -0.179
         PbCl4-2             1.883e-020  1.246e-020   -19.725   -19.905    -0.179
S(-2)                0.000e+000
         HS-                 0.000e+000  0.000e+000   -72.500   -72.546    -0.046
         H2S                 0.000e+000  0.000e+000   -73.307   -73.306     0.001
         S-2                 0.000e+000  0.000e+000   -77.533   -77.709    -0.175
         Fe(HS)2             0.000e+000  0.000e+000  -141.812  -141.811     0.001
         Fe(HS)3-            0.000e+000  0.000e+000  -212.275  -212.319    -0.045
S(6)                 1.004e-003
         SO4-2               7.133e-004  4.760e-004    -3.147    -3.322    -0.176
         MgSO4               2.024e-004  2.029e-004    -3.694    -3.693     0.001
         CaSO4               8.430e-005  8.450e-005    -4.074    -4.073     0.001
         NaSO4-              2.285e-006  2.061e-006    -5.641    -5.686    -0.045
         ZnSO4               6.038e-007  6.051e-007    -6.219    -6.218     0.001
         KSO4-               5.591e-007  5.042e-007    -6.253    -6.297    -0.045
         FeSO4               1.917e-007  1.921e-007    -6.717    -6.716     0.001
         Zn(SO4)2-2          3.454e-009  2.285e-009    -8.462    -8.641    -0.179
         HSO4-               1.199e-009  1.082e-009    -8.921    -8.966    -0.045
         PbSO4               8.311e-010  8.330e-010    -9.080    -9.079     0.001
         CdSO4               2.830e-010  2.836e-010    -9.548    -9.547     0.001
         CuSO4               4.724e-011  4.734e-011   -10.326   -10.325     0.001
         CaHSO4+             1.246e-011  1.124e-011   -10.905   -10.949    -0.045
         Pb(SO4)2-2          3.145e-012  2.081e-012   -11.502   -11.682    -0.179
         Cd(SO4)2-2          2.195e-012  1.452e-012   -11.659   -11.838    -0.179
         FeHSO4+             3.090e-014  2.787e-014   -13.510   -13.555    -0.045
         FeSO4+              2.292e-014  2.067e-014   -13.640   -13.685    -0.045
         Fe(SO4)2-           2.416e-016  2.179e-016   -15.617   -15.662    -0.045
         FeHSO4+2            1.824e-021  1.207e-021   -20.739   -20.918    -0.179
Zn                   9.059e-006
         Zn+2                7.925e-006  5.294e-006    -5.101    -5.276    -0.175
         ZnSO4               6.038e-007  6.051e-007    -6.219    -6.218     0.001
         ZnOH+               3.749e-007  3.381e-007    -6.426    -6.471    -0.045
         Zn(OH)2             1.400e-007  1.403e-007    -6.854    -6.853     0.001
         ZnCl+               1.142e-008  1.030e-008    -7.942    -7.987    -0.045
         Zn(SO4)2-2          3.454e-009  2.285e-009    -8.462    -8.641    -0.179
         Zn(OH)3-            2.258e-011  2.037e-011   -10.646   -10.691    -0.045
         ZnCl2               6.855e-012  6.871e-012   -11.164   -11.163     0.001
         ZnCl3-              5.481e-015  4.943e-015   -14.261   -14.306    -0.045
         Zn(OH)4-2           2.239e-016  1.481e-016   -15.650   -15.829    -0.179
         ZnCl4-2             2.415e-018  1.598e-018   -17.617   -17.796    -0.179

------------------------------Saturation indices------------------------------

         Phase               SI log IAP  log KT

         Anglesite        -4.06  -11.83   -7.77  PbSO4
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```
    Anhydrite          -2.01   -6.39   -4.38  CaSO4
    Cd(OH)2            -7.02    6.63   13.65  Cd(OH)2
    CdSO4             -11.80  -12.02   -0.21  CdSO4
    Fe(OH)3(a)          3.66    8.55    4.89  Fe(OH)3
    FeS(ppt)          -66.64  -70.55   -3.92  FeS
    Goethite            9.66    8.55   -1.11  FeOOH
    Gypsum             -1.80   -6.39   -4.58  CaSO4:2H2O
    H2(g)             -23.69  -26.85   -3.16  H2
    H2O(g)             -1.43   -0.00    1.43  H2O
    H2S(g)            -72.27  -73.31   -1.03  H2S
    Halite             -7.86   -6.27    1.59  NaCl
    Hematite           21.35   17.11   -4.25  Fe2O3
    Jarosite-K          1.63   -7.82   -9.45  KFe3(SO4)2(OH)6
    Mackinawite       -65.90  -70.55   -4.65  FeS
    Melanterite        -6.82   -8.99   -2.17  FeSO4:7H2O
    O2(g)             -34.69  -37.66   -2.97  O2
    Pb(OH)2            -1.23    6.82    8.04  Pb(OH)2
    Pyrite           -108.68 -127.07  -18.39  FeS2
    Sphalerite        -58.61  -70.16  -11.55  ZnS
    Sulfur            -54.43  -49.62    4.81  S
    Zn(OH)2(e)         -1.45   10.05   11.50  Zn(OH)2

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End of simulation.
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Reading input data for simulation 3.
------------------------------------

    SOLUTION 1 River water
        temp      28.4
        pH        8.2
        pe        2.63
        redox     pe
        units     mg/l
        density   1
        S(6)      6.4
        Ca        48.7
        Cd        6e-005
        Cl        15.3
        Cu        0.001
        Fe        10
        K         4.2
        Mg        47
        Na        10.6
        Pb        0.00055
        Zn        0.0104
        water    1 # kg
    SOLUTION 2 PAF Leachate
        temp      25
        pH        3.98
        pe        11.85
        redox     pe
        units     mg/l
        density   1
        Ca        358
        Cd        0.0631
        Cl        1
        Cu        0.058
        Fe        307
        K         4
        Mg        2560
        Na        6
        Pb        0.286
        S(6)      5000
        Zn        134
        water    1 # kg
    SOLUTION 3 NAF Leachate
        temp      25
        pH        6.5
        pe        1.84
```

```
    redox     pe
    units     mg/l
    density   1
    Ca        193
    Cd        0.0025
    Cl        64
    Cu        0.005
    Fe        0.01
    K         38
    Mg        226
    Na        61
    Pb        0.005
    S(6)      1450
    Zn        1.53
    water    1 # kg
SOLUTION 4 Rainwater
    temp      25
    pH        4.59
    pe        10.15
    redox     pe
    units     mg/l
    density   1
    Ca        0.1002
    Cd        0
    Cl        0.2375
    Cu        0
    Fe        0
    K         0.0586
    Mg        0.0316
    Na        0.15869
    Pb        0
    S(6)      0.7781
    Zn        0.01
    water    1 # kg
SOLUTION 5 Tailings Seepage
    temp      25
    pH        6.56
    pe        1.69
    redox     pe
    units     mg/l
    density   1
    Ca        405
    Cd        0.00008
    Cl        2610
    Cu        0.0174
    Fe        0.00315
    K         297
    Mg        1070
    Na        3030
    Pb        0.00029
    S(6)      6190
    Zn        0.327
    water    1 # kg
MIX 1 Mixing of water in open pit - best case Scenario 3
    1    0.9989
    2    0
    3    0
    4    0.0009
    5    0.0001
PRINT
    warnings              -1
SELECTED_OUTPUT
    file                 MRM1_Scenario3.txt
    totals               Ca  Cd  Cl  Cu  K  Mg  Mn
                          Na  Pb  S(-2)  Zn  S(6)  Al  Alkalinity
                          B  Ba  Br  C  C(4)  C(-4)  Cu(1)
                          Cu(2)  N  Mn(3)  Mn(2)  Li  Hfo_w  Hfo_s
                          H(0)  Fe(3)  Fe(2)  F  Fe  N(0)  N(3)
                          N(-3)  N(5)  O(0)  P  S  Si  Sr
                          X
    molalities           Ca+2  CaCO3  CaF+  CaH2PO4+
                          CaHCO3+  CaHPO4  CaHSO4+  CaOH+
```

```
                            CaPO4-  CaSO4  CaX2  Cd(CO3)2-2
                            Cd(OH)2  Cd(OH)3-  Cd(OH)4-2  Cd(SO4)2-2
                            Cd+2  CdCl+  CdCl2  CdCl3-
                            CdCO3  CdHCO3+  CdOH+  CdSO4
                            CdX2  Cl-  CO2  CO3-2
                            Cu(OH)2  Cu(OH)3-  Cu(OH)4-2  Cu+
                            Cu+2  CuOH+  CuSO4  CuX2
                            Fe(HS)2  Fe(HS)3-  Fe(OH)2+  FeH2PO4+
                            FeF3  FeF2+  FeF+2  FeF+
                            FeCO3  FeCl3  FeCl2+  FeCl+2
                            FeCl+  Fe3(OH)4+5  Fe2(OH)2+4  Fe+3
                            Fe+2  Fe(SO4)2-  Fe(OH)4-  Fe(OH)3
                            FeX2  FeSO4+  FeSO4  FeOH+2
                            FeOH+  FeHSO4+2  FeHSO4+  FeHPO4+
                            FeHPO4  FeHCO3+  FeH2PO4+2  H2S
                            HSO4-  HS-  K+  KHPO4-
                            KOH  KSO4-  KX  Mg+2
                            MgCO3  MgF+  MgH2PO4+  MgHCO3+
                            MgHPO4  MgOH+  MgPO4-  MgSO4
                            MgX2  Mn(NO3)2  Mn+2  Mn+3
                            MnCl+  MnCl2  MnCl3-  MnCO3
                            MnF+  MnHCO3+  MnOH+  MnSO4
                            MnX2  Na+  NaCO3-  NaF
                            NaHCO3  NaHPO4-  NaOH  NaSO4-
                            NaX  NH3  NH4+  NH4SO4-
                            NH4X  Pb(CO3)2-2  Pb(OH)2  Pb(OH)3-
                            Pb(OH)4-2  Pb(SO4)2-2  Pb+2  Pb2OH+3
                            PbCl+  PbCl2  PbCl3-  PbCl4-2
                            PbCO3  PbHCO3+  PbNO3+  PbOH+
                            PbSO4  PbX2  PO4-3  SO4-2
                            Zn(CO3)2-2  Zn(OH)2  Zn(OH)3-  Zn(OH)4-2
                            Zn(SO4)2-2  Zn+2  ZnCl+  ZnCl2
                            ZnCl3-  ZnCl4-2  ZnCO3  ZnHCO3+
                            ZnOH+  ZnSO4  ZnX2  Al(OH)2+
                            Al(OH)3  Al(OH)4-  Al(SO4)2-  Al+3
                            AlF+2  AlF2+  AlF3  AlF4-
                            AlF5-2  AlF6-3  AlHSO4+2  AlOH+2
                            AlOHX2  AlSO4+  AlX3  Ba+2
                            BaCO3  BaHCO3+  BaOH+  BaSO4
                            BaX2  BF(OH)3-  BF2(OH)2-  BF3OH-
                            BF4-  Br-  CH4  F-
                            H+  H2  H2BO3-  H2O
                            H2PO4-  H2SiO4-2  H3BO3  H3SiO4-
                            H4SiO4  HCO3-  HF  HF2-
                            Hfo_psi  Hfo_sO-  Hfo_sOCd+  Hfo_sOCu+
                            Hfo_sOFe+  Hfo_sOH  Hfo_sOH2+  Hfo_sOHBa+2
                            Hfo_sOHCa+2  Hfo_sOHSr+2  Hfo_sOMn+  Hfo_sOPb+
                            Hfo_sOZn+  Hfo_wF  Hfo_wH2BO3  Hfo_wH2PO4
                            Hfo_wHPO4-  Hfo_wO-  Hfo_wOBa+  Hfo_wOCa+
                            Hfo_wOCd+  Hfo_wOCu+  Hfo_wOFe+  Hfo_wOFeOH
                            Hfo_wOH  Hfo_wOH2+  Hfo_wOHF-  Hfo_wOHSO4-2
                            Hfo_wOMg+  Hfo_wOMn+  Hfo_wOPb+  Hfo_wOSr+
                            Hfo_wOSrOH  Hfo_wOZn+  Hfo_wPO4-2  Hfo_wSO4-
                            HPO4-2  Li+  LiOH  LiSO4-
                            LiX  N2  NO2-  NO3-
                            O2  OH-  S-2  SiF6-2
                            Sr+2  SrCO3  SrHCO3+  SrOH+
                            SrSO4  SrX2  X-
activities                 Al(OH)2+  Al(OH)3  Al(OH)4-  Al(SO4)2-
                            Al+3  AlF+2  AlF2+  AlF3
                            AlF4-  AlF5-2  AlF6-3  AlHSO4+2
                            AlOH+2  AlOHX2  AlSO4+  AlX3
                            Ba+2  BaCO3  BaHCO3+  BaOH+
                            BaSO4  BaX2  BF(OH)3-  BF2(OH)2-
                            BF3OH-  BF4-  Br-  Ca+2
                            CaCO3  CaF+  CaH2PO4+  CaHCO3+
                            CaHPO4  CaHSO4+  CaOH+  CaPO4-
                            CaSO4  CaX2  Cd(CO3)2-2  Cd(OH)2
                            Cd(OH)3-  Cd(OH)4-2  Cd(SO4)2-2  Cd+2
                            CdCl+  CdCl2  CdCl3-  CdCO3
                            CdHCO3+  CdOH+  CdSO4  CdX2
                            CH4  Cl-  CO2  CO3-2
```

```
                      Cu(OH)2  Cu(OH)3-  Cu(OH)4-2  Cu+
                      Cu+2  CuOH+  CuSO4  CuX2
                      Fe(HS)2  Fe(HS)3-  Fe(OH)2+  F-
                      Fe(OH)3  Fe(OH)4-  Fe(SO4)2-  Fe+2
                      Fe+3  Fe2(OH)2+4  Fe3(OH)4+5  FeCl+
                      FeCl+2  FeCl2+  FeCl3  FeCO3
                      FeF+  FeF+2  FeF2+  FeF3
                      FeH2PO4+  FeH2PO4+2  FeHCO3+  FeHPO4
                      FeHPO4+  FeHSO4+  FeHSO4+2  FeOH+
                      FeOH+2  FeSO4  FeSO4+  FeX2
                      H+  H2  H2BO3-  H2O
                      H2PO4-  H2S  H2SiO4-2  H3BO3
                      H3SiO4-  H4SiO4  HCO3-  HF
                      HF2-  Hfo_psi  Hfo_sO-  Hfo_sOCd+
                      Hfo_sOCu+  Hfo_sOFe+  Hfo_sOH  Hfo_sOH2+
                      Hfo_sOHBa+2  Hfo_sOHCa+2  Hfo_sOHSr+2  Hfo_sOMn+
                      Hfo_sOPb+  Hfo_sOZn+  Hfo_wF  Hfo_wH2BO3
                      Hfo_wH2PO4  Hfo_wHPO4-  Hfo_wO-  Hfo_wOBa+
                      Hfo_wOCa+  Hfo_wOCd+  Hfo_wOCu+  Hfo_wOFe+
                      Hfo_wOFeOH  Hfo_wOH  Hfo_wOH2+  Hfo_wOHF-
                      Hfo_wOHSO4-2  Hfo_wOMg+  Hfo_wOMn+  Hfo_wOPb+
                      Hfo_wOSr+  Hfo_wOSrOH  Hfo_wOZn+  Hfo_wPO4-2
                      Hfo_wSO4-  HPO4-2  HS-  HSO4-
                      K+  KHPO4-  KOH  KSO4-
                      KX  Li+  LiOH  LiSO4-
                      LiX  Mg+2  MgCO3  MgF+
                      MgH2PO4+  MgHCO3+  MgHPO4  MgOH+
                      MgPO4-  MgSO4  MgX2  Mn(NO3)2
                      Mn+2  Mn+3  MnCl+  MnCl2
                      MnCl3-  MnCO3  MnF+  MnHCO3+
                      MnOH+  MnSO4  MnX2  N2
                      Na+  NaCO3-  NaF  NaHCO3
                      NaHPO4-  NaOH  NaSO4-  NaX
                      NH3  NH4+  NH4SO4-  NH4X
                      NO2-  NO3-  O2  OH-
                      Pb(CO3)2-2  Pb(OH)2  Pb(OH)3-  Pb(OH)4-2
                      Pb(SO4)2-2  Pb+2  Pb2OH+3  PbCl+
                      PbCl2  PbCl3-  PbCl4-2  PbCO3
                      PbHCO3+  PbNO3+  PbOH+  PbSO4
                      PbX2  PO4-3  S-2  SiF6-2
                      SO4-2  Sr+2  SrCO3  SrHCO3+
                      SrOH+  SrSO4  SrX2  X-
                      Zn(CO3)2-2  Zn(OH)2  Zn(OH)3-  Zn(OH)4-2
                      Zn(SO4)2-2  Zn+2  ZnCl+  ZnCl2
                      ZnCl3-  ZnCl4-2  ZnCO3  ZnHCO3+
                      ZnOH+  ZnSO4  ZnX2
equilibrium_phases   Al(OH)3(a)  Albite  Alunite  Anglesite
                      Anhydrite  Anorthite  Aragonite  Barite
                      Calcite  Ca-Montmorillonite  Cd(OH)2  CdSiO3
                      CdSO4  Celestite  Cerrusite  CH4(g)
                      Chalcedony  Hydroxyapatite  Hematite  Hausmannite
                      Halite  H2S(g)  H2O(g)  H2(g)
                      Gypsum  Goethite  Gibbsite  Fluorite
                      FeS(ppt)  Fe(OH)3(a)  Dolomite  CO2(g)
                      Chrysotile  Chlorite(14A)  Illite  Jarosite-K
                      Kaolinite  K-feldspar  K-mica  Mackinawite
                      Manganite  Melanterite  N2(g)  NH3(g)
                      O2(g)  Otavite  Pb(OH)2  Pyrite
                      Pyrochroite  Pyrolusite  Quartz  Rhodochrosite
                      Sepiolite  Sepiolite(d)  Siderite  SiO2(a)
                      Smithsonite  Sphalerite  Strontianite  Sulfur
                      Talc  Vivianite  Willemite  Witherite
                      Zn(OH)2(e)
saturation_indices   Al(OH)3(a)  Zn(OH)2(e)  Witherite  Willemite
                      Vivianite  Talc  Sulfur  Strontianite
                      Sphalerite  Smithsonite  SiO2(a)  Siderite
                      Sepiolite(d)  Sepiolite  Rhodochrosite  Quartz
                      Pyrolusite  Pyrochroite  Pyrite  Pb(OH)2
                      Otavite  O2(g)  NH3(g)  N2(g)
                      Melanterite  Manganite  Mackinawite  K-mica
                      K-feldspar  Kaolinite  Jarosite-K  Illite
                      Hydroxyapatite  Hematite  Hausmannite  Halite
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                             H2S(g)  H2O(g)  H2(g)  Gypsum
                             Goethite  Gibbsite  Fluorite  FeS(ppt)
                             Fe(OH)3(a)  Dolomite  CO2(g)  Chrysotile
                             Chlorite(14A)  Chalcedony  CH4(g)  Cerrusite
                             Celestite  CdSO4  CdSiO3  Cd(OH)2
                             Ca-Montmorillonite  Calcite  Barite  Aragonite
                             Anorthite  Anhydrite  Anglesite  Alunite
                             Albite
        gases               CH4(g)  CO2(g)  H2(g)  H2O(g)
                             H2S(g)  N2(g)  NH3(g)  O2(g)
        kinetic_reactants   Albite  Calcite  K-feldspar  Organic_C
                             Pyrite  Pyrolusite
    END
-------------------------------------------
Beginning of initial solution calculations.
-------------------------------------------

Initial solution 1.   River water

-----------------------------Solution composition------------------------------

    Elements           Molality       Moles

    Ca              1.215e-003  1.215e-003
    Cd              5.339e-010  5.339e-010
    Cl              4.316e-004  4.316e-004
    Cu              1.574e-008  1.574e-008
    Fe              1.791e-004  1.791e-004
    K               1.074e-004  1.074e-004
    Mg              1.933e-003  1.933e-003
    Na              4.611e-004  4.611e-004
    Pb              2.655e-009  2.655e-009
    S(6)            6.663e-005  6.663e-005
    Zn              1.591e-007  1.591e-007

----------------------------Description of solution----------------------------

                                       pH  =   8.200
                                       pe  =   2.630
                        Activity of water  =   1.000
                           Ionic strength  =  6.879e-003
                       Mass of water (kg)  =  1.000e+000
                 Total alkalinity (eq/kg)  =  1.996e-004
                    Total carbon (mol/kg)  =  0.000e+000
                       Total CO2 (mol/kg)  =  0.000e+000
                      Temperature (deg C)  =  28.400
                  Electrical balance (eq)  =  6.283e-003
 Percent error, 100*(Cat-|An|)/(Cat+|An|)  =  84.94
                               Iterations  =   4
                                  Total H  = 1.110130e+002
                                  Total O  = 5.550704e+001

----------------------------Distribution of species----------------------------

                                               Log       Log         Log
    Species           Molality    Activity  Molality  Activity     Gamma

    OH-             2.233e-006  2.043e-006    -5.651    -5.690    -0.039
    H+              6.825e-009  6.310e-009    -8.166    -8.200    -0.034
    H2O             5.551e+001  9.999e-001     1.744    -0.000     0.000
Ca             1.215e-003
    Ca+2            1.209e-003  8.591e-004    -2.918    -3.066    -0.148
    CaSO4           6.060e-006  6.069e-006    -5.218    -5.217     0.001
    CaOH+           2.467e-008  2.260e-008    -7.608    -7.646    -0.038
    CaHSO4+         2.559e-013  2.344e-013   -12.592   -12.630    -0.038
Cd             5.339e-010
    Cd+2            5.087e-010  3.579e-010    -9.294    -9.446    -0.153
    CdCl+           1.490e-011  1.365e-011   -10.827   -10.865    -0.038
    CdOH+           6.609e-012  6.053e-012   -11.180   -11.218    -0.038
    CdSO4           3.609e-012  3.615e-012   -11.443   -11.442     0.001
    Cd(OH)2         4.009e-014  4.015e-014   -13.397   -13.396     0.001
    CdCl2           2.271e-014  2.274e-014   -13.644   -13.643     0.001
```

Cd(SO4)2-2	1.894e-015	1.332e-015	-14.723	-14.875	-0.153
CdCl3-	6.507e-018	5.960e-018	-17.187	-17.225	-0.038
Cd(OH)3-	7.795e-019	7.139e-019	-18.108	-18.146	-0.038
Cd(OH)4-2	1.433e-024	1.008e-024	-23.844	-23.996	-0.153
Cl	4.316e-004				
Cl-	4.316e-004	3.948e-004	-3.365	-3.404	-0.039
FeCl+	9.966e-010	9.127e-010	-9.001	-9.040	-0.038
ZnCl+	1.081e-010	9.898e-011	-9.966	-10.004	-0.038
CdCl+	1.490e-011	1.365e-011	-10.827	-10.865	-0.038
PbCl+	9.858e-012	9.029e-012	-11.006	-11.044	-0.038
ZnCl2	4.141e-014	4.148e-014	-13.383	-13.382	0.001
CdCl2	2.271e-014	2.274e-014	-13.644	-13.643	0.001
PbCl2	5.298e-015	5.306e-015	-14.276	-14.275	0.001
ZnCl3-	2.047e-017	1.875e-017	-16.689	-16.727	-0.038
CdCl3-	6.507e-018	5.960e-018	-17.187	-17.225	-0.038
PbCl3-	1.855e-018	1.699e-018	-17.732	-17.770	-0.038
FeCl+2	1.546e-018	1.088e-018	-17.811	-17.963	-0.153
ZnCl4-2	5.416e-021	3.810e-021	-20.266	-20.419	-0.153
FeCl2+	1.883e-021	1.725e-021	-20.725	-20.763	-0.038
PbCl4-2	4.683e-022	3.295e-022	-21.329	-21.482	-0.153
FeCl3	6.800e-026	6.810e-026	-25.168	-25.167	0.001
Cu(1)	4.144e-011				
Cu+	4.144e-011	3.781e-011	-10.383	-10.422	-0.040
Cu(2)	1.570e-008				
Cu(OH)2	1.560e-008	1.563e-008	-7.807	-7.806	0.001
CuOH+	5.155e-011	4.720e-011	-10.288	-10.326	-0.038
Cu+2	4.169e-011	2.978e-011	-10.380	-10.526	-0.146
CuSO4	2.132e-013	2.136e-013	-12.671	-12.670	0.001
Cu(OH)3-	1.630e-013	1.492e-013	-12.788	-12.826	-0.038
Cu(OH)4-2	6.708e-018	4.719e-018	-17.173	-17.326	-0.153
Fe(2)	2.474e-006				
Fe+2	2.344e-006	1.675e-006	-5.630	-5.776	-0.146
FeOH+	1.178e-007	1.079e-007	-6.929	-6.967	-0.038
FeSO4	1.085e-008	1.087e-008	-7.965	-7.964	0.001
FeCl+	9.966e-010	9.127e-010	-9.001	-9.040	-0.038
FeHSO4+	4.989e-016	4.569e-016	-15.302	-15.340	-0.038
Fe(3)	1.766e-004				
Fe(OH)3	1.439e-004	1.441e-004	-3.842	-3.841	0.001
Fe(OH)4-	2.604e-005	2.385e-005	-4.584	-4.623	-0.038
Fe(OH)2+	6.658e-006	6.098e-006	-5.177	-5.215	-0.038
FeOH+2	1.454e-010	1.023e-010	-9.837	-9.990	-0.153
Fe+3	1.663e-016	8.202e-017	-15.779	-16.086	-0.307
FeSO4+	3.630e-017	3.324e-017	-16.440	-16.478	-0.038
FeCl+2	1.546e-018	1.088e-018	-17.811	-17.963	-0.153
Fe2(OH)2+4	1.001e-018	2.451e-019	-18.000	-18.611	-0.611
Fe(SO4)2-	2.761e-020	2.528e-020	-19.559	-19.597	-0.038
Fe3(OH)4+5	2.062e-021	2.290e-022	-20.686	-21.640	-0.954
FeCl2+	1.883e-021	1.725e-021	-20.725	-20.763	-0.038
FeHSO4+2	7.990e-025	5.621e-025	-24.097	-24.250	-0.153
FeCl3	6.800e-026	6.810e-026	-25.168	-25.167	0.001
H(0)	2.991e-025				
H2	1.495e-025	1.498e-025	-24.825	-24.825	0.001
K	1.074e-004				
K+	1.074e-004	9.825e-005	-3.969	-4.008	-0.039
KSO4-	2.742e-008	2.512e-008	-7.562	-7.600	-0.038
KOH	5.390e-011	5.399e-011	-10.268	-10.268	0.001
Mg	1.933e-003				
Mg+2	1.920e-003	1.371e-003	-2.717	-2.863	-0.146
MgSO4	1.200e-005	1.202e-005	-4.921	-4.920	0.001
MgOH+	1.167e-006	1.068e-006	-5.933	-5.971	-0.038
Na	4.611e-004				
Na+	4.611e-004	4.226e-004	-3.336	-3.374	-0.038
NaSO4-	8.107e-008	7.424e-008	-7.091	-7.129	-0.038
NaOH	4.418e-010	4.425e-010	-9.355	-9.354	0.001
O(0)	0.000e+000				
O2	0.000e+000	0.000e+000	-41.647	-41.646	0.001
Pb	2.655e-009				
PbOH+	1.783e-009	1.633e-009	-8.749	-8.787	-0.038
Pb+2	7.512e-010	5.285e-010	-9.124	-9.277	-0.153
Pb(OH)2	1.005e-010	1.007e-010	-9.998	-9.997	0.001
PbSO4	1.018e-011	1.020e-011	-10.992	-10.992	0.001
PbCl+	9.858e-012	9.029e-012	-11.006	-11.044	-0.038

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     Pb(OH)3-          2.000e-013  1.832e-013   -12.699   -12.737    -0.038
     PbCl2             5.298e-015  5.306e-015   -14.276   -14.275     0.001
     Pb(SO4)2-2        2.610e-015  1.836e-015   -14.583   -14.736    -0.153
     Pb(OH)4-2         9.454e-017  6.651e-017   -16.024   -16.177    -0.153
     Pb2OH+3           4.262e-017  1.932e-017   -16.370   -16.714    -0.344
     PbCl3-            1.855e-018  1.699e-018   -17.732   -17.770    -0.038
     PbCl4-2           4.683e-022  3.295e-022   -21.329   -21.482    -0.153
S(6)              6.663e-005
     SO4-2             4.845e-005  3.431e-005    -4.315    -4.465    -0.150
     MgSO4             1.200e-005  1.202e-005    -4.921    -4.920     0.001
     CaSO4             6.060e-006  6.069e-006    -5.218    -5.217     0.001
     NaSO4-            8.107e-008  7.424e-008    -7.091    -7.129    -0.038
     KSO4-             2.742e-008  2.512e-008    -7.562    -7.600    -0.038
     FeSO4             1.085e-008  1.087e-008    -7.965    -7.964     0.001
     ZnSO4             6.618e-010  6.629e-010    -9.179    -9.179     0.001
     HSO4-             2.478e-011  2.269e-011   -10.606   -10.644    -0.038
     PbSO4             1.018e-011  1.020e-011   -10.992   -10.992     0.001
     CdSO4             3.609e-012  3.615e-012   -11.443   -11.442     0.001
     Zn(SO4)2-2        2.561e-013  1.801e-013   -12.592   -12.744    -0.153
     CaHSO4+           2.559e-013  2.344e-013   -12.592   -12.630    -0.038
     CuSO4             2.132e-013  2.136e-013   -12.671   -12.670     0.001
     Pb(SO4)2-2        2.610e-015  1.836e-015   -14.583   -14.736    -0.153
     Cd(SO4)2-2        1.894e-015  1.332e-015   -14.723   -14.875    -0.153
     FeHSO4+           4.989e-016  4.569e-016   -15.302   -15.340    -0.038
     FeSO4+            3.630e-017  3.324e-017   -16.440   -16.478    -0.038
     Fe(SO4)2-         2.761e-020  2.528e-020   -19.559   -19.597    -0.038
     FeHSO4+2          7.990e-025  5.621e-025   -24.097   -24.250    -0.153
Zn                1.591e-007
     Zn+2              1.133e-007  8.030e-008    -6.946    -7.095    -0.150
     Zn(OH)2           2.535e-008  2.539e-008    -7.596    -7.595     0.001
     ZnOH+             1.966e-008  1.801e-008    -7.706    -7.745    -0.038
     ZnSO4             6.618e-010  6.629e-010    -9.179    -9.179     0.001
     ZnCl+             1.081e-010  9.898e-011    -9.966   -10.004    -0.038
     Zn(OH)3-          1.389e-011  1.272e-011   -10.857   -10.895    -0.038
     Zn(SO4)2-2        2.561e-013  1.801e-013   -12.592   -12.744    -0.153
     ZnCl2             4.141e-014  4.148e-014   -13.383   -13.382     0.001
     Zn(OH)4-2         4.543e-016  3.196e-016   -15.343   -15.495    -0.153
     ZnCl3-            2.047e-017  1.875e-017   -16.689   -16.727    -0.038
     ZnCl4-2           5.416e-021  3.810e-021   -20.266   -20.419    -0.153

------------------------------Saturation indices------------------------------

     Phase               SI log IAP  log KT

     Anglesite        -5.97  -13.74   -7.77  PbSO4
     Anhydrite        -3.15   -7.53   -4.38  CaSO4
     Cd(OH)2          -6.70    6.95   13.65  Cd(OH)2
     CdSO4           -13.69  -13.91   -0.22  CdSO4
     Fe(OH)3(a)        3.62    8.51    4.89  Fe(OH)3
     Goethite          9.63    8.51   -1.12  FeOOH
     Gypsum           -2.95   -7.53   -4.58  CaSO4:2H2O
     H2(g)           -21.66  -24.82   -3.16  H2
     H2O(g)           -1.42   -0.00    1.42  H2O
     Halite           -8.37   -6.78    1.59  NaCl
     Hematite         21.29   17.03   -4.26  Fe2O3
     Jarosite-K       -2.53  -12.00   -9.47  KFe3(SO4)2(OH)6
     Melanterite      -8.07  -10.24   -2.17  FeSO4:7H2O
     O2(g)           -38.67  -41.65   -2.98  O2
     Pb(OH)2          -0.91    7.12    8.03  Pb(OH)2
     Zn(OH)2(e)       -2.20    9.30   11.50  Zn(OH)2

Initial solution 2.   PAF Leachate

-----------------------------Solution composition-----------------------------

     Elements           Molality       Moles

     Ca                9.008e-003  9.008e-003
     Cd                5.661e-007  5.661e-007
     Cl                2.844e-005  2.844e-005
     Cu                9.204e-007  9.204e-007
     Fe                5.544e-003  5.544e-003
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    K              1.032e-004  1.032e-004
    Mg             1.062e-001  1.062e-001
    Na             2.632e-004  2.632e-004
    Pb             1.392e-006  1.392e-006
    S(6)           5.249e-002  5.249e-002
    Zn             2.067e-003  2.067e-003

----------------------------Description of solution----------------------------

                                       pH  =   3.980
                                       pe  =  11.850
                        Activity of water  =   0.998
                           Ionic strength  =  2.210e-001
                       Mass of water (kg)  =  1.000e+000
                 Total alkalinity (eq/kg)  = -3.984e-003
                    Total carbon (mol/kg)  =  0.000e+000
                       Total CO2 (mol/kg)  =  0.000e+000
                      Temperature (deg C)  =  25.000
                  Electrical balance (eq)  =  1.397e-001
 Percent error, 100*(Cat-|An|)/(Cat+|An|)  =  64.77
                               Iterations  =  13
                                  Total H  = 1.110194e+002
                                  Total O  = 5.572292e+001

----------------------------Distribution of species----------------------------

                                                Log       Log         Log
    Species          Molality    Activity  Molality  Activity       Gamma

    H+             1.319e-004  1.047e-004    -3.880    -3.980      -0.100
    OH-            1.364e-010  9.537e-011    -9.865   -10.021      -0.155
    H2O            5.551e+001  9.976e-001     1.744    -0.001       0.000
Ca              9.008e-003
    Ca+2           6.844e-003  2.144e-003    -2.165    -2.669      -0.504
    CaSO4          2.162e-003  2.275e-003    -2.665    -2.643       0.022
    CaHSO4+        1.878e-006  1.395e-006    -5.726    -5.855      -0.129
    CaOH+          4.563e-012  3.390e-012   -11.341   -11.470      -0.129
Cd              5.661e-007
    Cd+2           3.690e-007  1.124e-007    -6.433    -6.949      -0.516
    CdSO4          1.638e-007  1.723e-007    -6.786    -6.764       0.022
    Cd(SO4)2-2     3.300e-008  1.005e-008    -7.482    -7.998      -0.516
    CdCl+          2.891e-010  2.147e-010    -9.539    -9.668      -0.129
    CdOH+          1.199e-013  8.906e-014   -12.921   -13.050      -0.129
    CdCl2          1.702e-014  1.791e-014   -13.769   -13.747       0.022
    CdCl3-         3.044e-019  2.261e-019   -18.517   -18.646      -0.129
    Cd(OH)2        4.330e-020  4.556e-020   -19.363   -19.341       0.022
    Cd(OH)3-       6.557e-029  4.871e-029   -28.183   -28.312      -0.129
    Cd(OH)4-2      1.358e-038  4.136e-039   -37.867   -38.383      -0.516
Cl              2.844e-005
    Cl-            2.840e-005  2.001e-005    -4.547    -4.699      -0.152
    ZnCl+          3.100e-008  2.303e-008    -7.509    -7.638      -0.129
    FeCl+2         9.273e-009  2.824e-009    -8.033    -8.549      -0.516
    FeCl+          2.570e-009  1.909e-009    -8.590    -8.719      -0.129
    CdCl+          2.891e-010  2.147e-010    -9.539    -9.668      -0.129
    PbCl+          2.332e-010  1.732e-010    -9.632    -9.761      -0.129
    ZnCl2          4.586e-013  4.825e-013   -12.339   -12.316       0.022
    FeCl2+         3.397e-013  2.524e-013   -12.469   -12.598      -0.129
    CdCl2          1.702e-014  1.791e-014   -13.769   -13.747       0.022
    PbCl2          5.220e-015  5.493e-015   -14.282   -14.260       0.022
    ZnCl3-         1.458e-017  1.083e-017   -16.836   -16.965      -0.129
    FeCl3          4.799e-019  5.049e-019   -18.319   -18.297       0.022
    CdCl3-         3.044e-019  2.261e-019   -18.517   -18.646      -0.129
    PbCl3-         1.175e-019  8.730e-020   -18.930   -19.059      -0.129
    ZnCl4-2        3.567e-022  1.086e-022   -21.448   -21.964      -0.516
    PbCl4-2        2.745e-024  8.360e-025   -23.561   -24.078      -0.516
Cu(1)           2.433e-016
    Cu+            2.433e-016  1.635e-016   -15.614   -15.787      -0.173
Cu(2)           9.204e-007
    Cu+2           6.929e-007  2.205e-007    -6.159    -6.657      -0.497
    CuSO4          2.275e-007  2.394e-007    -6.643    -6.621       0.022
    CuOH+          2.954e-011  2.101e-011   -10.530   -10.678      -0.148
    Cu(OH)2        3.974e-013  4.182e-013   -12.401   -12.379       0.022
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     Cu(OH)3-          3.231e-022  2.401e-022   -21.491   -21.620    -0.129
     Cu(OH)4-2         1.498e-030  4.563e-031   -29.824   -30.341    -0.516
Fe(2)             2.794e-004
     Fe+2              2.172e-004  6.912e-005    -3.663    -4.160    -0.497
     FeSO4             6.212e-005  6.536e-005    -4.207    -4.185     0.022
     FeHSO4+           6.056e-008  4.499e-008    -7.218    -7.347    -0.129
     FeCl+             2.570e-009  1.909e-009    -8.590    -8.719    -0.129
     FeOH+             2.803e-010  2.083e-010    -9.552    -9.681    -0.129
Fe(3)             5.264e-003
     Fe(OH)2+          1.221e-003  9.069e-004    -2.913    -3.042    -0.129
     FeOH+2            9.440e-004  2.875e-004    -3.025    -3.541    -0.516
     Fe3(OH)4+5        7.114e-004  4.214e-007    -3.148    -6.375    -3.227
     FeSO4+            3.668e-004  2.725e-004    -3.436    -3.565    -0.129
     Fe2(OH)2+4        2.586e-004  2.224e-006    -3.587    -5.653    -2.066
     Fe(SO4)2-         4.267e-005  3.170e-005    -4.370    -4.499    -0.129
     Fe+3              3.729e-005  4.673e-006    -4.428    -5.330    -0.902
     Fe(OH)3           1.058e-006  1.113e-006    -5.976    -5.953     0.022
     FeHSO4+2          2.509e-007  7.640e-008    -6.601    -7.117    -0.516
     FeCl+2            9.273e-009  2.824e-009    -8.033    -8.549    -0.516
     Fe(OH)4-          1.302e-011  9.671e-012   -10.885   -11.015    -0.129
     FeCl2+            3.397e-013  2.524e-013   -12.469   -12.598    -0.129
     FeCl3             4.799e-019  5.049e-019   -18.319   -18.297     0.022
H(0)              2.944e-035
     H2                1.472e-035  1.549e-035   -34.832   -34.810     0.022
K                 1.032e-004
     K+                9.963e-005  7.019e-005    -4.002    -4.154    -0.152
     KSO4-             3.530e-006  2.622e-006    -5.452    -5.581    -0.129
     KOH               2.204e-015  2.319e-015   -14.657   -14.635     0.022
Mg                1.062e-001
     Mg+2              7.596e-002  2.551e-002    -1.119    -1.593    -0.474
     MgSO4             3.023e-002  3.180e-002    -1.520    -1.498     0.022
     MgOH+             1.188e-009  8.826e-010    -8.925    -9.054    -0.129
Na                2.632e-004
     Na+               2.564e-004  1.894e-004    -3.591    -3.723    -0.131
     NaSO4-            6.796e-006  5.048e-006    -5.168    -5.297    -0.129
     NaOH              1.133e-014  1.192e-014   -13.946   -13.924     0.022
O(0)              3.287e-023
     O2                1.644e-023  1.730e-023   -22.784   -22.762     0.022
Pb                1.392e-006
     Pb+2              7.141e-007  2.175e-007    -6.146    -6.663    -0.516
     PbSO4             6.180e-007  6.503e-007    -6.209    -6.187     0.022
     Pb(SO4)2-2        5.959e-008  1.815e-008    -7.225    -7.741    -0.516
     PbCl+             2.332e-010  1.732e-010    -9.632    -9.761    -0.129
     PbOH+             5.438e-011  4.040e-011   -10.265   -10.394    -0.129
     PbCl2             5.220e-015  5.493e-015   -14.282   -14.260     0.022
     Pb2OH+3           2.855e-015  1.967e-016   -14.544   -15.706    -1.162
     Pb(OH)2           1.423e-016  1.497e-016   -15.847   -15.825     0.022
     PbCl3-            1.175e-019  8.730e-020   -18.930   -19.059    -0.129
     Pb(OH)3-          2.205e-023  1.638e-023   -22.657   -22.786    -0.129
     PbCl4-2           2.745e-024  8.360e-025   -23.561   -24.078    -0.516
     Pb(OH)4-2         1.174e-030  3.575e-031   -29.930   -30.447    -0.516
S(6)              5.249e-002
     MgSO4             3.023e-002  3.180e-002    -1.520    -1.498     0.022
     SO4-2             1.884e-002  5.317e-003    -1.725    -2.274    -0.549
     CaSO4             2.162e-003  2.275e-003    -2.665    -2.643     0.022
     ZnSO4             5.067e-004  5.331e-004    -3.295    -3.273     0.022
     FeSO4+            3.668e-004  2.725e-004    -3.436    -3.565    -0.129
     Zn(SO4)2-2        7.567e-005  2.304e-005    -4.121    -4.637    -0.516
     HSO4-             7.287e-005  5.413e-005    -4.137    -4.267    -0.129
     FeSO4             6.212e-005  6.536e-005    -4.207    -4.185     0.022
     Fe(SO4)2-         4.267e-005  3.170e-005    -4.370    -4.499    -0.129
     NaSO4-            6.796e-006  5.048e-006    -5.168    -5.297    -0.129
     KSO4-             3.530e-006  2.622e-006    -5.452    -5.581    -0.129
     CaHSO4+           1.878e-006  1.395e-006    -5.726    -5.855    -0.129
     PbSO4             6.180e-007  6.503e-007    -6.209    -6.187     0.022
     FeHSO4+2          2.509e-007  7.640e-008    -6.601    -7.117    -0.516
     CuSO4             2.275e-007  2.394e-007    -6.643    -6.621     0.022
     CdSO4             1.638e-007  1.723e-007    -6.786    -6.764     0.022
     FeHSO4+           6.056e-008  4.499e-008    -7.218    -7.347    -0.129
     Pb(SO4)2-2        5.959e-008  1.815e-008    -7.225    -7.741    -0.516
     Cd(SO4)2-2        3.300e-008  1.005e-008    -7.482    -7.998    -0.516
Zn                2.067e-003
```

Zn+2	1.485e-003	4.277e-004	-2.828	-3.369	-0.541
ZnSO4	5.067e-004	5.331e-004	-3.295	-3.273	0.022
Zn(SO4)2-2	7.567e-005	2.304e-005	-4.121	-4.637	-0.516
ZnCl+	3.100e-008	2.303e-008	-7.509	-7.638	-0.129
ZnOH+	6.014e-009	4.468e-009	-8.221	-8.350	-0.129
Zn(OH)2	4.645e-013	4.887e-013	-12.333	-12.311	0.022
ZnCl2	4.586e-013	4.825e-013	-12.339	-12.316	0.022
ZnCl3-	1.458e-017	1.083e-017	-16.836	-16.965	-0.129
Zn(OH)3-	1.982e-020	1.472e-020	-19.703	-19.832	-0.129
ZnCl4-2	3.567e-022	1.086e-022	-21.448	-21.964	-0.516
Zn(OH)4-2	7.300e-029	2.223e-029	-28.137	-28.653	-0.516

------------------------------Saturation indices-------------------------------

Phase	SI	log IAP	log KT	
Anglesite	-1.15	-8.94	-7.79	PbSO4
Anhydrite	-0.58	-4.94	-4.36	CaSO4
Cd(OH)2	-12.64	1.01	13.65	Cd(OH)2
CdSO4	-9.12	-9.22	-0.10	CdSO4
Fe(OH)3(a)	1.72	6.61	4.89	Fe(OH)3
Goethite	7.61	6.61	-1.00	FeOOH
Gypsum	-0.36	-4.95	-4.58	CaSO4:2H2O
H2(g)	-31.66	-34.81	-3.15	H2
H2O(g)	-1.51	-0.00	1.51	H2O
Halite	-10.00	-8.42	1.58	NaCl
Hematite	17.22	13.22	-4.01	Fe2O3
Jarosite-K	8.39	-0.82	-9.21	KFe3(SO4)2(OH)6
Melanterite	-4.23	-6.44	-2.21	FeSO4:7H2O
O2(g)	-19.80	-22.76	-2.96	O2
Pb(OH)2	-6.85	1.30	8.15	Pb(OH)2
Zn(OH)2(e)	-6.91	4.59	11.50	Zn(OH)2

Initial solution 3.   NAF Leachate

-----------------------------Solution composition------------------------------

Elements	Molality	Moles
Ca	4.825e-003	4.825e-003
Cd	2.229e-008	2.229e-008
Cl	1.809e-003	1.809e-003
Cu	7.884e-008	7.884e-008
Fe	1.794e-007	1.794e-007
K	9.738e-004	9.738e-004
Mg	9.315e-003	9.315e-003
Na	2.659e-003	2.659e-003
Pb	2.418e-008	2.418e-008
S(6)	1.512e-002	1.512e-002
Zn	2.345e-005	2.345e-005

----------------------------Description of solution----------------------------

```
                                       pH  =   6.500
                                       pe  =   1.840
                        Activity of water  =   0.999
                           Ionic strength  =  4.115e-002
                       Mass of water (kg)  =  1.000e+000
                 Total alkalinity (eq/kg)  = -4.358e-007
                    Total carbon (mol/kg)  =  0.000e+000
                       Total CO2 (mol/kg)  =  0.000e+000
                      Temperature (deg C)  =  25.000
                  Electrical balance (eq)  = -9.827e-005
 Percent error, 100*(Cat-|An|)/(Cat+|An|)  =  -0.22
                               Iterations  =   6
                                  Total H  = 1.110124e+002
                                  Total O  = 5.556672e+001
```

----------------------------Distribution of species----------------------------

Species	Molality	Activity	Log Molality	Log Activity	Log Gamma

	H+	3.669e-007	3.162e-007	-6.435	-6.500	-0.065
	OH-	3.837e-008	3.164e-008	-7.416	-7.500	-0.084
	H2O	5.551e+001	9.995e-001	1.744	-0.000	0.000
Ca		4.825e-003				
	Ca+2	3.257e-003	1.620e-003	-2.487	-2.790	-0.303
	CaSO4	1.568e-003	1.583e-003	-2.805	-2.800	0.004
	CaHSO4+	3.523e-009	2.933e-009	-8.453	-8.533	-0.080
	CaOH+	1.021e-009	8.498e-010	-8.991	-9.071	-0.080
Cd		2.229e-008				
	Cd+2	1.217e-008	5.847e-009	-7.915	-8.233	-0.318
	CdSO4	8.183e-009	8.260e-009	-8.087	-8.083	0.004
	CdCl+	1.002e-009	8.340e-010	-8.999	-9.079	-0.080
	Cd(SO4)2-2	9.236e-010	4.437e-010	-9.035	-9.353	-0.318
	CdCl2	5.144e-012	5.193e-012	-11.289	-11.285	0.004
	CdOH+	1.846e-012	1.537e-012	-11.734	-11.813	-0.080
	CdCl3-	5.878e-015	4.894e-015	-14.231	-14.310	-0.080
	Cd(OH)2	2.585e-016	2.609e-016	-15.588	-15.583	0.004
	Cd(OH)3-	1.111e-022	9.253e-023	-21.954	-22.034	-0.080
	Cd(OH)4-2	5.426e-030	2.607e-030	-29.266	-29.584	-0.318
Cl		1.809e-003				
	Cl-	1.809e-003	1.494e-003	-2.743	-2.826	-0.083
	ZnCl+	3.449e-008	2.871e-008	-7.462	-7.542	-0.080
	CdCl+	1.002e-009	8.340e-010	-8.999	-9.079	-0.080
	PbCl+	3.384e-010	2.817e-010	-9.471	-9.550	-0.080
	FeCl+	1.564e-010	1.302e-010	-9.806	-9.885	-0.080
	ZnCl2	4.448e-011	4.491e-011	-10.352	-10.348	0.004
	CdCl2	5.144e-012	5.193e-012	-11.289	-11.285	0.004
	PbCl2	6.607e-013	6.669e-013	-12.180	-12.176	0.004
	ZnCl3-	9.039e-014	7.526e-014	-13.044	-13.123	-0.080
	CdCl3-	5.878e-015	4.894e-015	-14.231	-14.310	-0.080
	PbCl3-	9.504e-016	7.913e-016	-15.022	-15.102	-0.080
	ZnCl4-2	1.173e-016	5.633e-017	-15.931	-16.249	-0.318
	PbCl4-2	1.178e-018	5.657e-019	-17.929	-18.247	-0.318
	FeCl+2	3.919e-020	1.882e-020	-19.407	-19.725	-0.318
	FeCl2+	1.509e-022	1.256e-022	-21.821	-21.901	-0.080
	FeCl3	1.858e-026	1.876e-026	-25.731	-25.727	0.004
Cu(1)		5.862e-008				
	Cu+	5.862e-008	4.780e-008	-7.232	-7.321	-0.089
Cu(2)		2.022e-008				
	Cu+2	1.244e-008	6.302e-009	-7.905	-8.201	-0.295
	CuSO4	6.243e-009	6.303e-009	-8.205	-8.200	0.004
	Cu(OH)2	1.303e-009	1.315e-009	-8.885	-8.881	0.004
	CuOH+	2.403e-010	1.992e-010	-9.619	-9.701	-0.082
	Cu(OH)3-	3.009e-016	2.505e-016	-15.522	-15.601	-0.080
	Cu(OH)4-2	3.289e-022	1.580e-022	-21.483	-21.801	-0.318
Fe(2)		1.794e-007				
	Fe+2	1.247e-007	6.317e-008	-6.904	-7.200	-0.295
	FeSO4	5.450e-008	5.502e-008	-7.264	-7.259	0.004
	FeCl+	1.564e-010	1.302e-010	-9.806	-9.885	-0.080
	FeOH+	7.584e-011	6.314e-011	-10.120	-10.200	-0.080
	FeHSO4+	1.374e-013	1.144e-013	-12.862	-12.942	-0.080
Fe(3)		1.433e-011				
	Fe(OH)2+	1.071e-011	8.914e-012	-10.970	-11.050	-0.080
	Fe(OH)3	3.595e-012	3.629e-012	-11.444	-11.440	0.004
	FeOH+2	1.773e-014	8.517e-015	-13.751	-14.070	-0.318
	Fe(OH)4-	1.257e-014	1.046e-014	-13.901	-13.980	-0.080
	FeSO4+	2.693e-017	2.242e-017	-16.570	-16.649	-0.080
	Fe(SO4)2-	2.885e-018	2.402e-018	-17.540	-17.619	-0.080
	Fe+3	1.592e-018	4.173e-019	-17.798	-18.380	-0.581
	FeCl+2	3.919e-020	1.882e-020	-19.407	-19.725	-0.318
	FeCl2+	1.509e-022	1.256e-022	-21.821	-21.901	-0.080
	FeHSO4+2	3.951e-023	1.898e-023	-22.403	-22.722	-0.318
	Fe2(OH)2+4	3.667e-026	1.952e-027	-25.436	-26.709	-1.274
	FeCl3	1.858e-026	1.876e-026	-25.731	-25.727	0.004
	Fe3(OH)4+5	3.554e-034	3.636e-036	-33.449	-35.439	-1.990
H(0)		2.930e-020				
	H2	1.465e-020	1.479e-020	-19.834	-19.830	0.004
K		9.738e-004				
	K+	9.417e-004	7.775e-004	-3.026	-3.109	-0.083
	KSO4-	3.215e-005	2.676e-005	-4.493	-4.572	-0.080
	KOH	8.441e-012	8.521e-012	-11.074	-11.069	0.004

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Mg               9.315e-003
    Mg+2              5.904e-003  2.998e-003    -2.229    -2.523    -0.294
    MgSO4             3.411e-003  3.443e-003    -2.467    -2.463     0.004
    MgOH+             4.133e-008  3.441e-008    -7.384    -7.463    -0.080
Na               2.659e-003
    Na+               2.595e-003  2.166e-003    -2.586    -2.664    -0.078
    NaSO4-            6.387e-005  5.317e-005    -4.195    -4.274    -0.080
    NaOH              4.480e-011  4.523e-011   -10.349   -10.345     0.004
O(0)             0.000e+000
    O2                0.000e+000  0.000e+000   -52.725   -52.720     0.004
Pb               2.418e-008
    PbSO4             1.293e-008  1.305e-008    -7.888    -7.884     0.004
    Pb+2              9.864e-009  4.738e-009    -8.006    -8.324    -0.318
    Pb(SO4)2-2        6.985e-010  3.355e-010    -9.156    -9.474    -0.318
    PbOH+             3.508e-010  2.920e-010    -9.455    -9.535    -0.080
    PbCl+             3.384e-010  2.817e-010    -9.471    -9.550    -0.080
    PbCl2             6.607e-013  6.669e-013   -12.180   -12.176     0.004
    Pb(OH)2           3.557e-013  3.591e-013   -12.449   -12.445     0.004
    PbCl3-            9.504e-016  7.913e-016   -15.022   -15.102    -0.080
    Pb2OH+3           1.612e-016  3.098e-017   -15.793   -16.509    -0.716
    Pb(OH)3-          1.565e-017  1.303e-017   -16.805   -16.885    -0.080
    PbCl4-2           1.178e-018  5.657e-019   -17.929   -18.247    -0.318
    Pb(OH)4-2         1.964e-022  9.435e-023   -21.707   -22.025    -0.318
S(6)             1.512e-002
    SO4-2             1.004e-002  4.898e-003    -1.998    -2.310    -0.312
    MgSO4             3.411e-003  3.443e-003    -2.467    -2.463     0.004
    CaSO4             1.568e-003  1.583e-003    -2.805    -2.800     0.004
    NaSO4-            6.387e-005  5.317e-005    -4.195    -4.274    -0.080
    KSO4-             3.215e-005  2.676e-005    -4.493    -4.572    -0.080
    ZnSO4             8.124e-006  8.201e-006    -5.090    -5.086     0.004
    Zn(SO4)2-2        6.798e-007  3.265e-007    -6.168    -6.486    -0.318
    HSO4-             1.809e-007  1.506e-007    -6.743    -6.822    -0.080
    FeSO4             5.450e-008  5.502e-008    -7.264    -7.259     0.004
    PbSO4             1.293e-008  1.305e-008    -7.888    -7.884     0.004
    CdSO4             8.183e-009  8.260e-009    -8.087    -8.083     0.004
    CuSO4             6.243e-009  6.303e-009    -8.205    -8.200     0.004
    CaHSO4+           3.523e-009  2.933e-009    -8.453    -8.533    -0.080
    Cd(SO4)2-2        9.236e-010  4.437e-010    -9.035    -9.353    -0.318
    Pb(SO4)2-2        6.985e-010  3.355e-010    -9.156    -9.474    -0.318
    FeHSO4+           1.374e-013  1.144e-013   -12.862   -12.942    -0.080
    FeSO4+            2.693e-017  2.242e-017   -16.570   -16.649    -0.080
    Fe(SO4)2-         2.885e-018  2.402e-018   -17.540   -17.619    -0.080
    FeHSO4+2          3.951e-023  1.898e-023   -22.403   -22.722    -0.318
Zn               2.345e-005
    Zn+2              1.458e-005  7.142e-006    -4.836    -5.146    -0.310
    ZnSO4             8.124e-006  8.201e-006    -5.090    -5.086     0.004
    Zn(SO4)2-2        6.798e-007  3.265e-007    -6.168    -6.486    -0.318
    ZnCl+             3.449e-008  2.871e-008    -7.462    -7.542    -0.080
    ZnOH+             2.973e-008  2.475e-008    -7.527    -7.606    -0.080
    Zn(OH)2           8.898e-010  8.983e-010    -9.051    -9.047     0.004
    ZnCl2             4.448e-011  4.491e-011   -10.352   -10.348     0.004
    ZnCl3-            9.039e-014  7.526e-014   -13.044   -13.123    -0.080
    Zn(OH)3-          1.078e-014  8.978e-015   -13.967   -14.047    -0.080
    ZnCl4-2           1.173e-016  5.633e-017   -15.931   -16.249    -0.318
    Zn(OH)4-2         9.362e-021  4.497e-021   -20.029   -20.347    -0.318

------------------------------Saturation indices------------------------------

    Phase               SI log IAP  log KT

    Anglesite        -2.84  -10.63   -7.79  PbSO4
    Anhydrite        -0.74   -5.10   -4.36  CaSO4
    Cd(OH)2          -8.88    4.77   13.65  Cd(OH)2
    CdSO4           -10.44  -10.54   -0.10  CdSO4
    Fe(OH)3(a)       -3.77    1.12    4.89  Fe(OH)3
    Goethite          2.12    1.12   -1.00  FeOOH
    Gypsum           -0.52   -5.10   -4.58  CaSO4:2H2O
    H2(g)           -16.68  -19.83   -3.15  H2
    H2O(g)           -1.51   -0.00    1.51  H2O
    Halite           -7.07   -5.49    1.58  NaCl
    Hematite          6.25    2.24   -4.01  Fe2O3
    Jarosite-K      -14.66  -23.87   -9.21  KFe3(SO4)2(OH)6
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    Melanterite      -7.30   -9.51   -2.21  FeSO4:7H2O
    O2(g)           -49.76  -52.72   -2.96  O2
    Pb(OH)2          -3.47    4.68    8.15  Pb(OH)2
    Zn(OH)2(e)       -3.65    7.85   11.50  Zn(OH)2

Initial solution 4.   Rainwater

-----------------------------Solution composition------------------------------

    Elements           Molality       Moles

    Ca               2.500e-006  2.500e-006
    Cl               6.699e-006  6.699e-006
    K                1.499e-006  1.499e-006
    Mg               1.300e-006  1.300e-006
    Na               6.903e-006  6.903e-006
    S(6)             8.100e-006  8.100e-006
    Zn               1.530e-007  1.530e-007

----------------------------Description of solution----------------------------

                                       pH  =   4.590
                                       pe  =  10.150
                        Activity of water  =   1.000
                           Ionic strength  =  4.455e-005
                       Mass of water (kg)  =  1.000e+000
                 Total alkalinity (eq/kg)  = -2.592e-005
                    Total carbon (mol/kg)  =  0.000e+000
                       Total CO2 (mol/kg)  =  0.000e+000
                      Temperature (deg C)  =  25.000
                  Electrical balance (eq)  =  1.933e-005
 Percent error, 100*(Cat-|An|)/(Cat+|An|)  =  29.71
                               Iterations  =   3
                                  Total H  = 1.110125e+002
                                  Total O  = 5.550625e+001

----------------------------Distribution of species----------------------------

                                                    Log       Log         Log
    Species            Molality    Activity  Molality  Activity     Gamma

    H+               2.590e-005  2.570e-005    -4.587    -4.590    -0.003
    OH-              3.925e-010  3.895e-010    -9.406    -9.410    -0.003
    H2O              5.551e+001  1.000e+000     1.744    -0.000     0.000
Ca              2.500e-006
    Ca+2             2.496e-006  2.420e-006    -5.603    -5.616    -0.013
    CaSO4            3.780e-009  3.780e-009    -8.423    -8.423     0.000
    CaHSO4+          5.736e-013  5.691e-013   -12.241   -12.245    -0.003
    CaOH+            1.575e-014  1.563e-014   -13.803   -13.806    -0.003
Cl              6.699e-006
    Cl-              6.699e-006  6.647e-006    -5.174    -5.177    -0.003
    ZnCl+            2.669e-012  2.649e-012   -11.574   -11.577    -0.003
    ZnCl2            1.844e-017  1.844e-017   -16.734   -16.734     0.000
    ZnCl3-           1.386e-022  1.375e-022   -21.858   -21.862    -0.003
    ZnCl4-2          4.725e-028  4.581e-028   -27.326   -27.339    -0.013
H(0)            4.688e-033
    H2               2.344e-033  2.344e-033   -32.630   -32.630     0.000
K               1.499e-006
    K+               1.499e-006  1.487e-006    -5.824    -5.828    -0.003
    KSO4-            8.242e-011  8.178e-011   -10.084   -10.087    -0.003
    KOH              2.006e-016  2.006e-016   -15.698   -15.698     0.000
Mg              1.300e-006
    Mg+2             1.297e-006  1.258e-006    -5.887    -5.900    -0.013
    MgSO4            2.308e-009  2.308e-009    -8.637    -8.637     0.000
    MgOH+            1.791e-013  1.777e-013   -12.747   -12.750    -0.003
Na              6.903e-006
    Na+              6.902e-006  6.849e-006    -5.161    -5.164    -0.003
    NaSO4-           2.708e-010  2.687e-010    -9.567    -9.571    -0.003
    NaOH             1.760e-015  1.760e-015   -14.754   -14.754     0.000
O(0)            1.517e-027
    O2               7.586e-028  7.586e-028   -27.120   -27.120     0.000
S(6)            8.100e-006
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     SO4-2           8.073e-006  7.827e-006    -5.093    -5.106    -0.013
     HSO4-           1.971e-008  1.956e-008    -7.705    -7.709    -0.003
     CaSO4           3.780e-009  3.780e-009    -8.423    -8.423     0.000
     MgSO4           2.308e-009  2.308e-009    -8.637    -8.637     0.000
     ZnSO4           2.716e-010  2.716e-010    -9.566    -9.566     0.000
     NaSO4-          2.708e-010  2.687e-010    -9.567    -9.571    -0.003
     KSO4-           8.242e-011  8.178e-011   -10.084   -10.087    -0.003
     CaHSO4+         5.736e-013  5.691e-013   -12.241   -12.245    -0.003
     Zn(SO4)2-2      1.783e-014  1.728e-014   -13.749   -13.762    -0.013
Zn              1.530e-007
     Zn+2            1.527e-007  1.480e-007    -6.816    -6.830    -0.013
     ZnSO4           2.716e-010  2.716e-010    -9.566    -9.566     0.000
     ZnOH+           6.364e-012  6.315e-012   -11.196   -11.200    -0.003
     ZnCl+           2.669e-012  2.649e-012   -11.574   -11.577    -0.003
     Zn(SO4)2-2      1.783e-014  1.728e-014   -13.749   -13.762    -0.013
     Zn(OH)2         2.821e-015  2.821e-015   -14.550   -14.550     0.000
     ZnCl2           1.844e-017  1.844e-017   -16.734   -16.734     0.000
     Zn(OH)3-        3.497e-022  3.470e-022   -21.456   -21.460    -0.003
     ZnCl3-          1.386e-022  1.375e-022   -21.858   -21.862    -0.003
     ZnCl4-2         4.725e-028  4.581e-028   -27.326   -27.339    -0.013
     Zn(OH)4-2       2.207e-030  2.140e-030   -29.656   -29.670    -0.013

------------------------------Saturation indices------------------------------

     Phase               SI log IAP  log KT

     Anhydrite        -6.36  -10.72   -4.36  CaSO4
     Gypsum           -6.14  -10.72   -4.58  CaSO4:2H2O
     H2(g)           -29.48  -32.63   -3.15  H2
     H2O(g)           -1.51   -0.00    1.51  H2O
     Halite          -11.92  -10.34    1.58  NaCl
     O2(g)           -24.16  -27.12   -2.96  O2
     Zn(OH)2(e)       -9.15    2.35   11.50  Zn(OH)2

Initial solution 5.   Tailings Seepage

-----------------------------Solution composition------------------------------

     Elements           Molality       Moles

     Ca              1.024e-002  1.024e-002
     Cd              7.216e-010  7.216e-010
     Cl              7.463e-002  7.463e-002
     Cu              2.776e-007  2.776e-007
     Fe              5.718e-008  5.718e-008
     K               7.700e-003  7.700e-003
     Mg              4.462e-002  4.462e-002
     Na              1.336e-001  1.336e-001
     Pb              1.419e-009  1.419e-009
     S(6)            6.532e-002  6.532e-002
     Zn              5.071e-006  5.071e-006

----------------------------Description of solution----------------------------

                                       pH  =   6.560
                                       pe  =   1.690
                        Activity of water  =   0.995
                           Ionic strength  =  2.457e-001
                       Mass of water (kg)  =  1.000e+000
                 Total alkalinity (eq/kg)  = -4.947e-007
                    Total carbon (mol/kg)  =  0.000e+000
                       Total CO2 (mol/kg)  =  0.000e+000
                      Temperature (deg C)  =  25.000
                  Electrical balance (eq)  =  4.577e-002
 Percent error, 100*(Cat-|An|)/(Cat+|An|)  =  12.94
                               Iterations  =   8
                                  Total H  = 1.110124e+002
                                  Total O  = 5.576752e+001

----------------------------Distribution of species----------------------------

                                                Log       Log         Log
```

	Species	Molality	Activity	Log Molality	Log Activity	Log Gamma
	Species	Molality	Activity	Molality	Activity	Gamma
	H+	3.487e-007	2.754e-007	-6.458	-6.560	-0.102
	OH-	5.236e-008	3.616e-008	-7.281	-7.442	-0.161
	H2O	5.551e+001	9.948e-001	1.744	-0.002	0.000
Ca		1.024e-002				
	Ca+2	6.543e-003	1.993e-003	-2.184	-2.700	-0.516
	CaSO4	3.701e-003	3.916e-003	-2.432	-2.407	0.025
	CaHSO4+	8.548e-009	6.319e-009	-8.068	-8.199	-0.131
	CaOH+	1.616e-009	1.195e-009	-8.791	-8.923	-0.131
Cd		7.216e-010				
	CdCl+	3.265e-010	2.414e-010	-9.486	-9.617	-0.131
	Cd+2	1.629e-010	4.863e-011	-9.788	-10.313	-0.525
	CdSO4	1.305e-010	1.381e-010	-9.884	-9.860	0.025
	Cd(SO4)2-2	4.993e-011	1.491e-011	-10.302	-10.827	-0.525
	CdCl2	4.942e-011	5.229e-011	-10.306	-10.282	0.025
	CdCl3-	2.320e-012	1.715e-012	-11.635	-11.766	-0.131
	CdOH+	1.976e-014	1.461e-014	-13.704	-13.835	-0.131
	Cd(OH)2	2.678e-018	2.834e-018	-17.572	-17.548	0.025
	Cd(OH)3-	1.553e-024	1.148e-024	-23.809	-23.940	-0.131
	Cd(OH)4-2	1.238e-031	3.696e-032	-30.907	-31.432	-0.525
Cl		7.463e-002				
	Cl-	7.463e-002	5.197e-002	-1.127	-1.284	-0.157
	ZnCl+	1.453e-007	1.074e-007	-6.838	-6.969	-0.131
	ZnCl2	5.523e-009	5.845e-009	-8.258	-8.233	0.025
	FeCl+	1.111e-009	8.211e-010	-8.954	-9.086	-0.131
	ZnCl3-	4.611e-010	3.408e-010	-9.336	-9.467	-0.131
	CdCl+	3.265e-010	2.414e-010	-9.486	-9.617	-0.131
	PbCl+	3.151e-010	2.329e-010	-9.502	-9.633	-0.131
	CdCl2	4.942e-011	5.229e-011	-10.306	-10.282	0.025
	ZnCl4-2	2.974e-011	8.878e-012	-10.527	-11.052	-0.525
	PbCl2	1.813e-011	1.919e-011	-10.742	-10.717	0.025
	CdCl3-	2.320e-012	1.715e-012	-11.635	-11.766	-0.131
	PbCl3-	1.072e-012	7.921e-013	-11.970	-12.101	-0.131
	PbCl4-2	6.600e-014	1.970e-014	-13.180	-13.705	-0.525
	FeCl+2	2.814e-019	8.403e-020	-18.551	-19.076	-0.525
	FeCl2+	2.639e-020	1.951e-020	-19.579	-19.710	-0.131
	FeCl3	9.581e-023	1.014e-022	-22.019	-21.994	0.025
Cu(1)		2.077e-007				
	Cu+	2.077e-007	1.374e-007	-6.683	-6.862	-0.179
Cu(2)		6.990e-008				
	Cu+2	4.158e-008	1.282e-008	-7.381	-7.892	-0.511
	CuSO4	2.436e-008	2.578e-008	-7.613	-7.589	0.025
	Cu(OH)2	3.303e-009	3.495e-009	-8.481	-8.457	0.025
	CuOH+	6.586e-010	4.631e-010	-9.181	-9.334	-0.153
	Cu(OH)3-	1.029e-015	7.606e-016	-14.988	-15.119	-0.131
	Cu(OH)4-2	1.836e-021	5.481e-022	-20.736	-21.261	-0.525
Fe(2)		5.718e-008				
	Fe+2	3.711e-008	1.145e-008	-7.430	-7.941	-0.511
	FeSO4	1.894e-008	2.004e-008	-7.723	-7.698	0.025
	FeCl+	1.111e-009	8.211e-010	-8.954	-9.086	-0.131
	FeOH+	1.768e-011	1.307e-011	-10.752	-10.884	-0.131
	FeHSO4+	4.908e-014	3.628e-014	-13.309	-13.440	-0.131
Fe(3)		2.684e-012				
	Fe(OH)2+	2.020e-012	1.493e-012	-11.695	-11.826	-0.131
	Fe(OH)3	6.565e-013	6.947e-013	-12.183	-12.158	0.025
	FeOH+2	4.181e-015	1.248e-015	-14.379	-14.904	-0.525
	Fe(OH)4-	3.096e-015	2.288e-015	-14.509	-14.640	-0.131
	FeSO4+	7.818e-018	5.779e-018	-17.107	-17.238	-0.131
	Fe(SO4)2-	1.684e-018	1.245e-018	-17.774	-17.905	-0.131
	Fe+3	4.472e-019	5.353e-020	-18.350	-19.271	-0.922
	FeCl+2	2.814e-019	8.403e-020	-18.551	-19.076	-0.525
	FeCl2+	2.639e-020	1.951e-020	-19.579	-19.710	-0.131
	FeCl3	9.581e-023	1.014e-022	-22.019	-21.994	0.025
	FeHSO4+2	1.428e-023	4.262e-024	-22.845	-23.370	-0.525
	Fe2(OH)2+4	5.280e-027	4.195e-029	-26.277	-28.377	-2.100
	Fe3(OH)4+5	2.500e-035	1.309e-038	-34.602	-37.883	-3.281
H(0)		4.231e-020				
	H2	2.116e-020	2.239e-020	-19.675	-19.650	0.025
K		7.700e-003				
	K+	7.229e-003	5.034e-003	-2.141	-2.298	-0.157
	KSO4-	4.712e-004	3.483e-004	-3.327	-3.458	-0.131

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         KOH                5.958e-011  6.305e-011   -10.225   -10.200     0.025
Mg                4.462e-002
         Mg+2               2.600e-002  8.536e-003    -1.585    -2.069    -0.484
         MgSO4              1.862e-002  1.970e-002    -1.730    -1.705     0.025
         MgOH+              1.514e-007  1.119e-007    -6.820    -6.951    -0.131
Na                1.336e-001
         Na+                1.274e-001  9.346e-002    -0.895    -1.029    -0.134
         NaSO4-             6.239e-003  4.612e-003    -2.205    -2.336    -0.131
         NaOH               2.108e-009  2.230e-009    -8.676    -8.652     0.025
O(0)              0.000e+000
         O2                 0.000e+000  0.000e+000   -53.109   -53.085     0.025
Pb                1.419e-009
         PbSO4              5.890e-010  6.233e-010    -9.230    -9.205     0.025
         Pb+2               3.770e-010  1.126e-010    -9.424    -9.949    -0.525
         PbCl+              3.151e-010  2.329e-010    -9.502    -9.633    -0.131
         Pb(SO4)2-2         1.079e-010  3.220e-011    -9.967   -10.492    -0.525
         PbCl2              1.813e-011  1.919e-011   -10.742   -10.717     0.025
         PbOH+              1.072e-011  7.928e-012   -10.970   -11.101    -0.131
         PbCl3-             1.072e-012  7.921e-013   -11.970   -12.101    -0.131
         PbCl4-2            6.600e-014  1.970e-014   -13.180   -13.705    -0.525
         Pb(OH)2            1.053e-014  1.114e-014   -13.978   -13.953     0.025
         Pb(OH)3-           6.249e-019  4.619e-019   -18.204   -18.335    -0.131
         Pb2OH+3            3.032e-019  1.998e-020   -18.518   -19.699    -1.181
         Pb(OH)4-2          1.280e-023  3.822e-024   -22.893   -23.418    -0.525
S(6)              6.532e-002
         SO4-2              3.629e-002  9.846e-003    -1.440    -2.007    -0.567
         MgSO4              1.862e-002  1.970e-002    -1.730    -1.705     0.025
         NaSO4-             6.239e-003  4.612e-003    -2.205    -2.336    -0.131
         CaSO4              3.701e-003  3.916e-003    -2.432    -2.407     0.025
         KSO4-              4.712e-004  3.483e-004    -3.327    -3.458    -0.131
         ZnSO4              1.674e-006  1.772e-006    -5.776    -5.752     0.025
         Zn(SO4)2-2         4.749e-007  1.418e-007    -6.323    -6.848    -0.525
         HSO4-              3.567e-007  2.636e-007    -6.448    -6.579    -0.131
         CuSO4              2.436e-008  2.578e-008    -7.613    -7.589     0.025
         FeSO4              1.894e-008  2.004e-008    -7.723    -7.698     0.025
         CaHSO4+            8.548e-009  6.319e-009    -8.068    -8.199    -0.131
         PbSO4              5.890e-010  6.233e-010    -9.230    -9.205     0.025
         CdSO4              1.305e-010  1.381e-010    -9.884    -9.860     0.025
         Pb(SO4)2-2         1.079e-010  3.220e-011    -9.967   -10.492    -0.525
         Cd(SO4)2-2         4.993e-011  1.491e-011   -10.302   -10.827    -0.525
         FeHSO4+            4.908e-014  3.628e-014   -13.309   -13.440    -0.131
         FeSO4+             7.818e-018  5.779e-018   -17.107   -17.238    -0.131
         Fe(SO4)2-          1.684e-018  1.245e-018   -17.774   -17.905    -0.131
         FeHSO4+2           1.428e-023  4.262e-024   -22.845   -23.370    -0.525
Zn                5.071e-006
         Zn+2               2.766e-006  7.677e-007    -5.558    -6.115    -0.557
         ZnSO4              1.674e-006  1.772e-006    -5.776    -5.752     0.025
         Zn(SO4)2-2         4.749e-007  1.418e-007    -6.323    -6.848    -0.525
         ZnCl+              1.453e-007  1.074e-007    -6.838    -6.969    -0.131
         ZnCl2              5.523e-009  5.845e-009    -8.258    -8.233     0.025
         ZnOH+              4.113e-009  3.040e-009    -8.386    -8.517    -0.131
         ZnCl3-             4.611e-010  3.408e-010    -9.336    -9.467    -0.131
         Zn(OH)2            1.191e-010  1.261e-010    -9.924    -9.899     0.025
         ZnCl4-2            2.974e-011  8.878e-012   -10.527   -11.052    -0.525
         Zn(OH)3-           1.948e-015  1.440e-015   -14.710   -14.842    -0.131
         Zn(OH)4-2          2.761e-021  8.243e-022   -20.559   -21.084    -0.525

------------------------------Saturation indices-------------------------------

         Phase               SI log IAP  log KT

         Anglesite        -4.17  -11.96   -7.79  PbSO4
         Anhydrite        -0.35   -4.71   -4.36  CaSO4
         Cd(OH)2         -10.85    2.80   13.65  Cd(OH)2
         CdSO4           -12.22  -12.32   -0.10  CdSO4
         Fe(OH)3(a)       -4.49    0.40    4.89  Fe(OH)3
         Goethite          1.40    0.40   -1.00  FeOOH
         Gypsum           -0.13   -4.71   -4.58  CaSO4:2H2O
         H2(g)           -16.50  -19.65   -3.15  H2
         H2O(g)           -1.51   -0.00    1.51  H2O
         Halite           -3.90   -2.31    1.58  NaCl
         Hematite          4.82    0.81   -4.01  Fe2O3
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    Jarosite-K      -15.57  -24.78   -9.21  KFe3(SO4)2(OH)6
    Melanterite      -7.75   -9.96   -2.21  FeSO4:7H2O
    O2(g)           -50.12  -53.08   -2.96  O2
    Pb(OH)2          -4.98    3.17    8.15  Pb(OH)2
    Zn(OH)2(e)       -4.50    7.00   11.50  Zn(OH)2

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Beginning of batch-reaction calculations.
-----------------------------------------

Reaction step 1.

Using mix 1.  Mixing of water in open pit - best case Scenario 3

Mixture 1.   Mixing of water in open pit - best case Scenario 3

     9.989e-001 Solution 1River water
     0.000e+000 Solution 2PAF Leachate
     0.000e+000 Solution 3NAF Leachate
     9.000e-004 Solution 4Rainwater
     1.000e-004 Solution 5Tailings Seepage

-----------------------------Solution composition------------------------------

    Elements           Molality       Moles

    Ca               1.215e-003  1.215e-003
    Cd               5.334e-010  5.334e-010
    Cl               4.387e-004  4.386e-004
    Cu               1.575e-008  1.575e-008
    Fe               1.789e-004  1.789e-004
    K                1.081e-004  1.081e-004
    Mg               1.936e-003  1.936e-003
    Na               4.740e-004  4.740e-004
    Pb               2.652e-009  2.652e-009
    S                7.311e-005  7.310e-005
    Zn               1.596e-007  1.596e-007

----------------------------Description of solution----------------------------

                                       pH  =   8.200      Charge balance
                                       pe  =   2.632      Adjusted to redox equilibrium
                        Activity of water  =   1.000
                           Ionic strength  =  6.900e-003
                       Mass of water (kg)  =  9.999e-001
                 Total alkalinity (eq/kg)  =  1.994e-004
                    Total carbon (mol/kg)  =  0.000e+000
                       Total CO2 (mol/kg)  =  0.000e+000
                      Temperature (deg C)  =  28.397
                  Electrical balance (eq)  =  6.281e-003
 Percent error, 100*(Cat-|An|)/(Cat+|An|)  =  84.56
                               Iterations  =   3
                                  Total H  = 1.110019e+002
                                  Total O  = 5.550151e+001

----------------------------Distribution of species----------------------------

                                                    Log       Log        Log
    Species            Molality    Activity  Molality  Activity     Gamma

    OH-              2.231e-006  2.041e-006    -5.651    -5.690    -0.039
    H+               6.831e-009  6.314e-009    -8.166    -8.200    -0.034
    H2O              5.551e+001  9.999e-001     1.744    -0.000     0.000
Ca              1.215e-003
    Ca+2             1.208e-003  8.582e-004    -2.918    -3.066    -0.149
    CaSO4            6.639e-006  6.649e-006    -5.178    -5.177     0.001
    CaOH+            2.463e-008  2.255e-008    -7.609    -7.647    -0.038
    CaHSO4+          2.806e-013  2.570e-013   -12.552   -12.590    -0.038
Cd              5.334e-010
    Cd+2             5.077e-010  3.570e-010    -9.294    -9.447    -0.153
    CdCl+            1.511e-011  1.383e-011   -10.821   -10.859    -0.038
    CdOH+            6.588e-012  6.033e-012   -11.181   -11.219    -0.038
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     CdSO4           3.949e-012  3.955e-012   -11.404   -11.403     0.001
     Cd(OH)2         3.993e-014  4.000e-014   -13.399   -13.398     0.001
     CdCl2           2.339e-014  2.343e-014   -13.631   -13.630     0.001
     Cd(SO4)2-2      2.274e-015  1.599e-015   -14.643   -14.796    -0.153
     CdCl3-          6.812e-018  6.238e-018   -17.167   -17.205    -0.038
     Cd(OH)3-        7.761e-019  7.107e-019   -18.110   -18.148    -0.038
     Cd(OH)4-2       1.426e-024  1.003e-024   -23.846   -23.999    -0.153
Cl              4.387e-004
     Cl-             4.387e-004  4.012e-004    -3.358    -3.397    -0.039
     FeCl+           1.011e-009  9.258e-010    -8.995    -9.033    -0.038
     ZnCl+           1.101e-010  1.008e-010    -9.958    -9.996    -0.038
     CdCl+           1.511e-011  1.383e-011   -10.821   -10.859    -0.038
     PbCl+           1.001e-011  9.164e-012   -11.000   -11.038    -0.038
     ZnCl2           4.287e-014  4.294e-014   -13.368   -13.367     0.001
     CdCl2           2.339e-014  2.343e-014   -13.631   -13.630     0.001
     PbCl2           5.464e-015  5.473e-015   -14.262   -14.262     0.001
     ZnCl3-          2.154e-017  1.972e-017   -16.667   -16.705    -0.038
     CdCl3-          6.812e-018  6.238e-018   -17.167   -17.205    -0.038
     PbCl3-          1.945e-018  1.781e-018   -17.711   -17.749    -0.038
     FeCl+2          1.575e-018  1.107e-018   -17.803   -17.956    -0.153
     ZnCl4-2         5.792e-021  4.073e-021   -20.237   -20.390    -0.153
     FeCl2+          1.948e-021  1.784e-021   -20.710   -20.749    -0.038
     PbCl4-2         4.991e-022  3.509e-022   -21.302   -21.455    -0.153
     FeCl3           7.147e-026  7.159e-026   -25.146   -25.145     0.001
Cu(1)           4.138e-011
     Cu+             4.138e-011  3.775e-011   -10.383   -10.423    -0.040
Cu(2)           1.571e-008
     Cu(OH)2         1.562e-008  1.564e-008    -7.806    -7.806     0.001
     CuOH+           5.164e-011  4.727e-011   -10.287   -10.325    -0.038
     Cu+2            4.180e-011  2.985e-011   -10.379   -10.525    -0.146
     CuSO4           2.344e-013  2.347e-013   -12.630   -12.629     0.001
     Cu(OH)3-        1.630e-013  1.492e-013   -12.788   -12.826    -0.038
     Cu(OH)4-2       6.706e-018  4.716e-018   -17.174   -17.326    -0.153
Fe(2)           2.471e-006
     Fe+2            2.341e-006  1.672e-006    -5.631    -5.777    -0.146
     FeOH+           1.175e-007  1.076e-007    -6.930    -6.968    -0.038
     FeSO4           1.188e-008  1.190e-008    -7.925    -7.925     0.001
     FeCl+           1.011e-009  9.258e-010    -8.995    -9.033    -0.038
     FeHSO4+         5.466e-016  5.005e-016   -15.262   -15.301    -0.038
     Fe(HS)2         0.000e+000  0.000e+000  -129.069  -129.068     0.001
     Fe(HS)3-        0.000e+000  0.000e+000  -193.114  -193.152    -0.038
Fe(3)           1.764e-004
     Fe(OH)3         1.438e-004  1.440e-004    -3.842    -3.842     0.001
     Fe(OH)4-        2.600e-005  2.380e-005    -4.585    -4.623    -0.038
     Fe(OH)2+        6.659e-006  6.098e-006    -5.177    -5.215    -0.038
     FeOH+2          1.456e-010  1.024e-010    -9.837    -9.990    -0.153
     Fe+3            1.668e-016  8.216e-017   -15.778   -16.085    -0.307
     FeSO4+          3.988e-017  3.652e-017   -16.399   -16.437    -0.038
     FeCl+2          1.575e-018  1.107e-018   -17.803   -17.956    -0.153
     Fe2(OH)2+4      1.004e-018  2.455e-019   -17.998   -18.610    -0.612
     Fe(SO4)2-       3.327e-020  3.047e-020   -19.478   -19.516    -0.038
     Fe3(OH)4+5      2.072e-021  2.295e-022   -20.684   -21.639    -0.956
     FeCl2+          1.948e-021  1.784e-021   -20.710   -20.749    -0.038
     FeHSO4+2        8.788e-025  6.180e-025   -24.056   -24.209    -0.153
     FeCl3           7.147e-026  7.159e-026   -25.146   -25.145     0.001
H(0)            2.973e-025
     H2              1.487e-025  1.489e-025   -24.828   -24.827     0.001
K               1.081e-004
     K+              1.081e-004  9.884e-005    -3.966    -4.005    -0.039
     KSO4-           3.026e-008  2.771e-008    -7.519    -7.557    -0.038
     KOH             5.419e-011  5.427e-011   -10.266   -10.265     0.001
Mg              1.936e-003
     Mg+2            1.922e-003  1.371e-003    -2.716    -2.863    -0.147
     MgSO4           1.317e-005  1.319e-005    -4.880    -4.880     0.001
     MgOH+           1.166e-006  1.068e-006    -5.933    -5.972    -0.038
Na              4.740e-004
     Na+             4.740e-004  4.344e-004    -3.324    -3.362    -0.038
     NaSO4-          9.140e-008  8.370e-008    -7.039    -7.077    -0.038
     NaOH            4.538e-010  4.545e-010    -9.343    -9.342     0.001
O(0)            0.000e+000
     O2              0.000e+000  0.000e+000   -41.643   -41.642     0.001
Pb              2.652e-009
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     PbOH+            1.780e-009  1.630e-009    -8.750     -8.788    -0.038
     Pb+2             7.507e-010  5.279e-010    -9.125     -9.277    -0.153
     Pb(OH)2          1.003e-010  1.004e-010    -9.999     -9.998     0.001
     PbSO4            1.115e-011  1.117e-011   -10.953    -10.952     0.001
     PbCl+            1.001e-011  9.164e-012   -11.000    -11.038    -0.038
     Pb(OH)3-         1.994e-013  1.826e-013   -12.700    -12.738    -0.038
     PbCl2            5.464e-015  5.473e-015   -14.262    -14.262     0.001
     Pb(SO4)2-2       3.138e-015  2.207e-015   -14.503    -14.656    -0.153
     Pb(OH)4-2        9.421e-017  6.625e-017   -16.026    -16.179    -0.153
     Pb2OH+3          4.254e-017  1.926e-017   -16.371    -16.715    -0.344
     PbCl3-           1.945e-018  1.781e-018   -17.711    -17.749    -0.038
     PbCl4-2          4.991e-022  3.509e-022   -21.302    -21.455    -0.153
S(-2)            0.000e+000
     HS-              0.000e+000  0.000e+000   -66.082    -66.121    -0.039
     H2S              0.000e+000  0.000e+000   -67.422    -67.422     0.001
     S-2              0.000e+000  0.000e+000   -70.589    -70.739    -0.150
     Fe(HS)2          0.000e+000  0.000e+000  -129.069   -129.068     0.001
     Fe(HS)3-         0.000e+000  0.000e+000  -193.114   -193.152    -0.038
S(6)             7.311e-005
     SO4-2            5.316e-005  3.763e-005    -4.274     -4.424    -0.150
     MgSO4            1.317e-005  1.319e-005    -4.880     -4.880     0.001
     CaSO4            6.639e-006  6.649e-006    -5.178     -5.177     0.001
     NaSO4-           9.140e-008  8.370e-008    -7.039     -7.077    -0.038
     KSO4-            3.026e-008  2.771e-008    -7.519     -7.557    -0.038
     FeSO4            1.188e-008  1.190e-008    -7.925     -7.925     0.001
     ZnSO4            7.278e-010  7.289e-010    -9.138     -9.137     0.001
     HSO4-            2.720e-011  2.491e-011   -10.565    -10.604    -0.038
     PbSO4            1.115e-011  1.117e-011   -10.953    -10.952     0.001
     CdSO4            3.949e-012  3.955e-012   -11.404    -11.403     0.001
     Zn(SO4)2-2       3.090e-013  2.173e-013   -12.510    -12.663    -0.153
     CaHSO4+          2.806e-013  2.570e-013   -12.552    -12.590    -0.038
     CuSO4            2.344e-013  2.347e-013   -12.630    -12.629     0.001
     Pb(SO4)2-2       3.138e-015  2.207e-015   -14.503    -14.656    -0.153
     Cd(SO4)2-2       2.274e-015  1.599e-015   -14.643    -14.796    -0.153
     FeHSO4+          5.466e-016  5.005e-016   -15.262    -15.301    -0.038
     FeSO4+           3.988e-017  3.652e-017   -16.399    -16.437    -0.038
     Fe(SO4)2-        3.327e-020  3.047e-020   -19.478    -19.516    -0.038
     FeHSO4+2         8.788e-025  6.180e-025   -24.056    -24.209    -0.153
Zn               1.596e-007
     Zn+2             1.137e-007  8.052e-008    -6.944     -7.094    -0.150
     Zn(OH)2          2.538e-008  2.542e-008    -7.595     -7.595     0.001
     ZnOH+            1.970e-008  1.804e-008    -7.706     -7.744    -0.038
     ZnSO4            7.278e-010  7.289e-010    -9.138     -9.137     0.001
     ZnCl+            1.101e-010  1.008e-010    -9.958     -9.996    -0.038
     Zn(OH)3-         1.390e-011  1.273e-011   -10.857    -10.895    -0.038
     Zn(SO4)2-2       3.090e-013  2.173e-013   -12.510    -12.663    -0.153
     ZnCl2            4.287e-014  4.294e-014   -13.368    -13.367     0.001
     Zn(OH)4-2        4.544e-016  3.195e-016   -15.343    -15.495    -0.153
     ZnCl3-           2.154e-017  1.972e-017   -16.667    -16.705    -0.038
     ZnCl4-2          5.792e-021  4.073e-021   -20.237    -20.390    -0.153

------------------------------Saturation indices-------------------------------

     Phase               SI  log IAP  log KT

     Anglesite        -5.93  -13.70   -7.77  PbSO4
     Anhydrite        -3.11   -7.49   -4.38  CaSO4
     Cd(OH)2          -6.70    6.95   13.65  Cd(OH)2
     CdSO4           -13.65  -13.87   -0.22  CdSO4
     Fe(OH)3(a)        3.62    8.51    4.89  Fe(OH)3
     FeS(ppt)        -59.78  -63.70   -3.92  FeS
     Goethite          9.63    8.51   -1.12  FeOOH
     Gypsum           -2.91   -7.49   -4.58  CaSO4:2H2O
     H2(g)           -21.66  -24.83   -3.16  H2
     H2O(g)           -1.42   -0.00    1.42  H2O
     H2S(g)          -66.39  -67.42   -1.03  H2S
     Halite           -8.35   -6.76    1.59  NaCl
     Hematite         21.29   17.03   -4.26  Fe2O3
     Jarosite-K       -2.44  -11.91   -9.47  KFe3(SO4)2(OH)6
     Mackinawite     -59.05  -63.70   -4.65  FeS
     Melanterite      -8.03  -10.20   -2.17  FeSO4:7H2O
     O2(g)           -38.67  -41.64   -2.98  O2
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    Pb(OH)2          -0.91    7.12    8.03  Pb(OH)2
    Pyrite          -97.97 -116.36  -18.39  FeS2
    Sphalerite      -53.47  -65.02  -11.55  ZnS
    Sulfur          -50.56  -45.76    4.80  S
    Zn(OH)2(e)       -2.19    9.31   11.50  Zn(OH)2

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End of simulation.
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Reading input data for simulation 4.
------------------------------------

    SOLUTION 1 River water
        temp      28.4
        pH        8.2
        pe        2.63
        redox     pe
        units     mg/l
        density   1
        S(6)      6.4
        Ca        48.7
        Cd        6e-005
        Cl        15.3
        Cu        0.001
        Fe        10
        K         4.2
        Mg        47
        Na        10.6
        Pb        0.00055
        Zn        0.0104
        water    1 # kg
    SOLUTION 2 PAF Leachate
        temp      25
        pH        3.98
        pe        11.85
        redox     pe
        units     mg/l
        density   1
        Ca        358
        Cd        0.0631
        Cl        1
        Cu        0.058
        Fe        307
        K         4
        Mg        2560
        Na        6
        Pb        0.286
        S(6)      5000
        Zn        134
        water    1 # kg
    SOLUTION 3 NAF Leachate
        temp      25
        pH        6.5
        pe        1.84
        redox     pe
        units     mg/l
        density   1
        Ca        193
        Cd        0.0025
        Cl        64
        Cu        0.005
        Fe        0.01
        K         38
        Mg        226
        Na        61
        Pb        0.005
        S(6)      1450
        Zn        1.53
        water    1 # kg
    SOLUTION 4 Rainwater
```

```
    temp      25
    pH        4.59
    pe        10.15
    redox     pe
    units     mg/l
    density   1
    Ca        0.1002
    Cd        0
    Cl        0.2375
    Cu        0
    Fe        0
    K         0.0586
    Mg        0.0316
    Na        0.15869
    Pb        0
    S(6)      0.7781
    Zn        0.01
    water    1 # kg
SOLUTION 5 Tailings Seepage
    temp      25
    pH        6.56
    pe        1.69
    redox     pe
    units     mg/l
    density   1
    Ca        405
    Cd        0.00008
    Cl        2610
    Cu        0.0174
    Fe        0.00315
    K         297
    Mg        1070
    Na        3030
    Pb        0.00029
    S(6)      6190
    Zn        0.327
    water    1 # kg
MIX 1 Mixing of water in open pit - best case Scenario 4
    1    0.9940
    2    0
    3    0.0004
    4    0.0049
    5    0.0006
PRINT
    warnings               -1
SELECTED_OUTPUT
    file                  MRM1_Scenario4.txt
    totals                Ca  Cd  Cl  Cu  K  Mg  Mn
                           Na  Pb  S(-2)  Zn  S(6)  Al  Alkalinity
                           B  Ba  Br  C  C(4)  C(-4)  Cu(1)
                           Cu(2)  N  Mn(3)  Mn(2)  Li  Hfo_w  Hfo_s
                           H(0)  Fe(3)  Fe(2)  F  Fe  N(0)  N(3)
                           N(-3)  N(5)  O(0)  P  S  Si  Sr
                           X
    molalities            Ca+2  CaCO3  CaF+  CaH2PO4+
                           CaHCO3+  CaHPO4  CaHSO4+  CaOH+
                           CaPO4-  CaSO4  CaX2  Cd(CO3)2-2
                           Cd(OH)2  Cd(OH)3-  Cd(OH)4-2  Cd(SO4)2-2
                           Cd+2  CdCl+  CdCl2  CdCl3-
                           CdCO3  CdHCO3+  CdOH+  CdSO4
                           CdX2  Cl-  CO2  CO3-2
                           Cu(OH)2  Cu(OH)3-  Cu(OH)4-2  Cu+
                           Cu+2  CuOH+  CuSO4  CuX2
                           Fe(HS)2  Fe(HS)3-  Fe(OH)2+  FeH2PO4+
                           FeF3  FeF2+  FeF+2  FeF+
                           FeCO3  FeCl3  FeCl2+  FeCl+2
                           FeCl+  Fe3(OH)4+5  Fe2(OH)2+4  Fe+3
                           Fe+2  Fe(SO4)2-  Fe(OH)4-  Fe(OH)3
                           FeX2  FeSO4+  FeSO4  FeOH+2
                           FeOH+  FeHSO4+2  FeHSO4+  FeHPO4+
                           FeHPO4  FeHCO3+  FeH2PO4+2  H2S
                           HSO4-  HS-  K+  KHPO4-
```

```
                         KOH  KSO4-  KX  Mg+2
                         MgCO3  MgF+  MgH2PO4+  MgHCO3+
                         MgHPO4  MgOH+  MgPO4-  MgSO4
                         MgX2  Mn(NO3)2  Mn+2  Mn+3
                         MnCl+  MnCl2  MnCl3-  MnCO3
                         MnF+  MnHCO3+  MnOH+  MnSO4
                         MnX2  Na+  NaCO3-  NaF
                         NaHCO3  NaHPO4-  NaOH  NaSO4-
                         NaX  NH3  NH4+  NH4SO4-
                         NH4X  Pb(CO3)2-2  Pb(OH)2  Pb(OH)3-
                         Pb(OH)4-2  Pb(SO4)2-2  Pb+2  Pb2OH+3
                         PbCl+  PbCl2  PbCl3-  PbCl4-2
                         PbCO3  PbHCO3+  PbNO3+  PbOH+
                         PbSO4  PbX2  PO4-3  SO4-2
                         Zn(CO3)2-2  Zn(OH)2  Zn(OH)3-  Zn(OH)4-2
                         Zn(SO4)2-2  Zn+2  ZnCl+  ZnCl2
                         ZnCl3-  ZnCl4-2  ZnCO3  ZnHCO3+
                         ZnOH+  ZnSO4  ZnX2  Al(OH)2+
                         Al(OH)3  Al(OH)4-  Al(SO4)2-  Al+3
                         AlF+2  AlF2+  AlF3  AlF4-
                         AlF5-2  AlF6-3  AlHSO4+2  AlOH+2
                         AlOHX2  AlSO4+  AlX3  Ba+2
                         BaCO3  BaHCO3+  BaOH+  BaSO4
                         BaX2  BF(OH)3-  BF2(OH)2-  BF3OH-
                         BF4-  Br-  CH4  F-
                         H+  H2  H2BO3-  H2O
                         H2PO4-  H2SiO4-2  H3BO3  H3SiO4-
                         H4SiO4  HCO3-  HF  HF2-
                         Hfo_psi  Hfo_sO-  Hfo_sOCd+  Hfo_sOCu+
                         Hfo_sOFe+  Hfo_sOH  Hfo_sOH2+  Hfo_sOHBa+2
                         Hfo_sOHCa+2  Hfo_sOHSr+2  Hfo_sOMn+  Hfo_sOPb+
                         Hfo_sOZn+  Hfo_wF  Hfo_wH2BO3  Hfo_wH2PO4
                         Hfo_wHPO4-  Hfo_wO-  Hfo_wOBa+  Hfo_wOCa+
                         Hfo_wOCd+  Hfo_wOCu+  Hfo_wOFe+  Hfo_wOFeOH
                         Hfo_wOH  Hfo_wOH2+  Hfo_wOHF-  Hfo_wOHSO4-2
                         Hfo_wOMg+  Hfo_wOMn+  Hfo_wOPb+  Hfo_wOSr+
                         Hfo_wOSrOH  Hfo_wOZn+  Hfo_wPO4-2  Hfo_wSO4-
                         HPO4-2  Li+  LiOH  LiSO4-
                         LiX  N2  NO2-  NO3-
                         O2  OH-  S-2  SiF6-2
                         Sr+2  SrCO3  SrHCO3+  SrOH+
                         SrSO4  SrX2  X-
activities              Al(OH)2+  Al(OH)3  Al(OH)4-  Al(SO4)2-
                         Al+3  AlF+2  AlF2+  AlF3
                         AlF4-  AlF5-2  AlF6-3  AlHSO4+2
                         AlOH+2  AlOHX2  AlSO4+  AlX3
                         Ba+2  BaCO3  BaHCO3+  BaOH+
                         BaSO4  BaX2  BF(OH)3-  BF2(OH)2-
                         BF3OH-  BF4-  Br-  Ca+2
                         CaCO3  CaF+  CaH2PO4+  CaHCO3+
                         CaHPO4  CaHSO4+  CaOH+  CaPO4-
                         CaSO4  CaX2  Cd(CO3)2-2  Cd(OH)2
                         Cd(OH)3-  Cd(OH)4-2  Cd(SO4)2-2  Cd+2
                         CdCl+  CdCl2  CdCl3-  CdCO3
                         CdHCO3+  CdOH+  CdSO4  CdX2
                         CH4  Cl-  CO2  CO3-2
                         Cu(OH)2  Cu(OH)3-  Cu(OH)4-2  Cu+
                         Cu+2  CuOH+  CuSO4  CuX2
                         Fe(HS)2  Fe(HS)3-  Fe(OH)2+  F-
                         Fe(OH)3  Fe(OH)4-  Fe(SO4)2-  Fe+2
                         Fe+3  Fe2(OH)2+4  Fe3(OH)4+5  FeCl+
                         FeCl+2  FeCl2+  FeCl3  FeCO3
                         FeF+  FeF+2  FeF2+  FeF3
                         FeH2PO4+  FeH2PO4+2  FeHCO3+  FeHPO4
                         FeHPO4+  FeHSO4+  FeHSO4+2  FeOH+
                         FeOH+2  FeSO4  FeSO4+  FeX2
                         H+  H2  H2BO3-  H2O
                         H2PO4-  H2S  H2SiO4-2  H3BO3
                         H3SiO4-  H4SiO4  HCO3-  HF
                         HF2-  Hfo_psi  Hfo_sO-  Hfo_sOCd+
                         Hfo_sOCu+  Hfo_sOFe+  Hfo_sOH  Hfo_sOH2+
                         Hfo_sOHBa+2  Hfo_sOHCa+2  Hfo_sOHSr+2  Hfo_sOMn+
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                          Hfo_sOPb+  Hfo_sOZn+  Hfo_wF  Hfo_wH2BO3
                          Hfo_wH2PO4  Hfo_wHPO4-  Hfo_wO-  Hfo_wOBa+
                          Hfo_wOCa+  Hfo_wOCd+  Hfo_wOCu+  Hfo_wOFe+
                          Hfo_wOFeOH  Hfo_wOH  Hfo_wOH2+  Hfo_wOHF-
                          Hfo_wOHSO4-2  Hfo_wOMg+  Hfo_wOMn+  Hfo_wOPb+
                          Hfo_wOSr+  Hfo_wOSrOH  Hfo_wOZn+  Hfo_wPO4-2
                          Hfo_wSO4-  HPO4-2  HS-  HSO4-
                          K+  KHPO4-  KOH  KSO4-
                          KX  Li+  LiOH  LiSO4-
                          LiX  Mg+2  MgCO3  MgF+
                          MgH2PO4+  MgHCO3+  MgHPO4  MgOH+
                          MgPO4-  MgSO4  MgX2  Mn(NO3)2
                          Mn+2  Mn+3  MnCl+  MnCl2
                          MnCl3-  MnCO3  MnF+  MnHCO3+
                          MnOH+  MnSO4  MnX2  N2
                          Na+  NaCO3-  NaF  NaHCO3
                          NaHPO4-  NaOH  NaSO4-  NaX
                          NH3  NH4+  NH4SO4-  NH4X
                          NO2-  NO3-  O2  OH-
                          Pb(CO3)2-2  Pb(OH)2  Pb(OH)3-  Pb(OH)4-2
                          Pb(SO4)2-2  Pb+2  Pb2OH+3  PbCl+
                          PbCl2  PbCl3-  PbCl4-2  PbCO3
                          PbHCO3+  PbNO3+  PbOH+  PbSO4
                          PbX2  PO4-3  S-2  SiF6-2
                          SO4-2  Sr+2  SrCO3  SrHCO3+
                          SrOH+  SrSO4  SrX2  X-
                          Zn(CO3)2-2  Zn(OH)2  Zn(OH)3-  Zn(OH)4-2
                          Zn(SO4)2-2  Zn+2  ZnCl+  ZnCl2
                          ZnCl3-  ZnCl4-2  ZnCO3  ZnHCO3+
                          ZnOH+  ZnSO4  ZnX2
     equilibrium_phases  Al(OH)3(a)  Albite  Alunite  Anglesite
                          Anhydrite  Anorthite  Aragonite  Barite
                          Calcite  Ca-Montmorillonite  Cd(OH)2  CdSiO3
                          CdSO4  Celestite  Cerrusite  CH4(g)
                          Chalcedony  Hydroxyapatite  Hematite  Hausmannite
                          Halite  H2S(g)  H2O(g)  H2(g)
                          Gypsum  Goethite  Gibbsite  Fluorite
                          FeS(ppt)  Fe(OH)3(a)  Dolomite  CO2(g)
                          Chrysotile  Chlorite(14A)  Illite  Jarosite-K
                          Kaolinite  K-feldspar  K-mica  Mackinawite
                          Manganite  Melanterite  N2(g)  NH3(g)
                          O2(g)  Otavite  Pb(OH)2  Pyrite
                          Pyrochroite  Pyrolusite  Quartz  Rhodochrosite
                          Sepiolite  Sepiolite(d)  Siderite  SiO2(a)
                          Smithsonite  Sphalerite  Strontianite  Sulfur
                          Talc  Vivianite  Willemite  Witherite
                          Zn(OH)2(e)
     saturation_indices  Al(OH)3(a)  Zn(OH)2(e)  Witherite  Willemite
                          Vivianite  Talc  Sulfur  Strontianite
                          Sphalerite  Smithsonite  SiO2(a)  Siderite
                          Sepiolite(d)  Sepiolite  Rhodochrosite  Quartz
                          Pyrolusite  Pyrochroite  Pyrite  Pb(OH)2
                          Otavite  O2(g)  NH3(g)  N2(g)
                          Melanterite  Manganite  Mackinawite  K-mica
                          K-feldspar  Kaolinite  Jarosite-K  Illite
                          Hydroxyapatite  Hematite  Hausmannite  Halite
                          H2S(g)  H2O(g)  H2(g)  Gypsum
                          Goethite  Gibbsite  Fluorite  FeS(ppt)
                          Fe(OH)3(a)  Dolomite  CO2(g)  Chrysotile
                          Chlorite(14A)  Chalcedony  CH4(g)  Cerrusite
                          Celestite  CdSO4  CdSiO3  Cd(OH)2
                          Ca-Montmorillonite  Calcite  Barite  Aragonite
                          Anorthite  Anhydrite  Anglesite  Alunite
                          Albite
     gases               CH4(g)  CO2(g)  H2(g)  H2O(g)
                          H2S(g)  N2(g)  NH3(g)  O2(g)
     kinetic_reactants   Albite  Calcite  K-feldspar  Organic_C
                          Pyrite  Pyrolusite
   END
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Beginning of initial solution calculations.
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Initial solution 1.   River water

-----------------------------Solution composition------------------------------

    Elements           Molality       Moles

    Ca               1.215e-003  1.215e-003
    Cd               5.339e-010  5.339e-010
    Cl               4.316e-004  4.316e-004
    Cu               1.574e-008  1.574e-008
    Fe               1.791e-004  1.791e-004
    K                1.074e-004  1.074e-004
    Mg               1.933e-003  1.933e-003
    Na               4.611e-004  4.611e-004
    Pb               2.655e-009  2.655e-009
    S(6)             6.663e-005  6.663e-005
    Zn               1.591e-007  1.591e-007

----------------------------Description of solution----------------------------

                                       pH  =   8.200
                                       pe  =   2.630
                        Activity of water  =   1.000
                           Ionic strength  =  6.879e-003
                       Mass of water (kg)  =  1.000e+000
                 Total alkalinity (eq/kg)  =  1.996e-004
                    Total carbon (mol/kg)  =  0.000e+000
                       Total CO2 (mol/kg)  =  0.000e+000
                      Temperature (deg C)  =  28.400
                  Electrical balance (eq)  =  6.283e-003
 Percent error, 100*(Cat-|An|)/(Cat+|An|)  =  84.94
                               Iterations  =   4
                                  Total H  = 1.110130e+002
                                  Total O  = 5.550704e+001

----------------------------Distribution of species----------------------------

                                                    Log       Log         Log
    Species          Molality    Activity  Molality  Activity     Gamma

    OH-              2.233e-006  2.043e-006    -5.651    -5.690    -0.039
    H+               6.825e-009  6.310e-009    -8.166    -8.200    -0.034
    H2O              5.551e+001  9.999e-001     1.744    -0.000     0.000
Ca              1.215e-003
    Ca+2             1.209e-003  8.591e-004    -2.918    -3.066    -0.148
    CaSO4            6.060e-006  6.069e-006    -5.218    -5.217     0.001
    CaOH+            2.467e-008  2.260e-008    -7.608    -7.646    -0.038
    CaHSO4+          2.559e-013  2.344e-013   -12.592   -12.630    -0.038
Cd              5.339e-010
    Cd+2             5.087e-010  3.579e-010    -9.294    -9.446    -0.153
    CdCl+            1.490e-011  1.365e-011   -10.827   -10.865    -0.038
    CdOH+            6.609e-012  6.053e-012   -11.180   -11.218    -0.038
    CdSO4            3.609e-012  3.615e-012   -11.443   -11.442     0.001
    Cd(OH)2          4.009e-014  4.015e-014   -13.397   -13.396     0.001
    CdCl2            2.271e-014  2.274e-014   -13.644   -13.643     0.001
    Cd(SO4)2-2       1.894e-015  1.332e-015   -14.723   -14.875    -0.153
    CdCl3-           6.507e-018  5.960e-018   -17.187   -17.225    -0.038
    Cd(OH)3-         7.795e-019  7.139e-019   -18.108   -18.146    -0.038
    Cd(OH)4-2        1.433e-024  1.008e-024   -23.844   -23.996    -0.153
Cl              4.316e-004
    Cl-              4.316e-004  3.948e-004    -3.365    -3.404    -0.039
    FeCl+            9.966e-010  9.127e-010    -9.001    -9.040    -0.038
    ZnCl+            1.081e-010  9.898e-011    -9.966   -10.004    -0.038
    CdCl+            1.490e-011  1.365e-011   -10.827   -10.865    -0.038
    PbCl+            9.858e-012  9.029e-012   -11.006   -11.044    -0.038
    ZnCl2            4.141e-014  4.148e-014   -13.383   -13.382     0.001
    CdCl2            2.271e-014  2.274e-014   -13.644   -13.643     0.001
    PbCl2            5.298e-015  5.306e-015   -14.276   -14.275     0.001
    ZnCl3-           2.047e-017  1.875e-017   -16.689   -16.727    -0.038
    CdCl3-           6.507e-018  5.960e-018   -17.187   -17.225    -0.038
    PbCl3-           1.855e-018  1.699e-018   -17.732   -17.770    -0.038
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FeCl+2	1.546e-018	1.088e-018	-17.811	-17.963	-0.153
ZnCl4-2	5.416e-021	3.810e-021	-20.266	-20.419	-0.153
FeCl2+	1.883e-021	1.725e-021	-20.725	-20.763	-0.038
PbCl4-2	4.683e-022	3.295e-022	-21.329	-21.482	-0.153
FeCl3	6.800e-026	6.810e-026	-25.168	-25.167	0.001
Cu(1)	4.144e-011				
Cu+	4.144e-011	3.781e-011	-10.383	-10.422	-0.040
Cu(2)	1.570e-008				
Cu(OH)2	1.560e-008	1.563e-008	-7.807	-7.806	0.001
CuOH+	5.155e-011	4.720e-011	-10.288	-10.326	-0.038
Cu+2	4.169e-011	2.978e-011	-10.380	-10.526	-0.146
CuSO4	2.132e-013	2.136e-013	-12.671	-12.670	0.001
Cu(OH)3-	1.630e-013	1.492e-013	-12.788	-12.826	-0.038
Cu(OH)4-2	6.708e-018	4.719e-018	-17.173	-17.326	-0.153
Fe(2)	2.474e-006				
Fe+2	2.344e-006	1.675e-006	-5.630	-5.776	-0.146
FeOH+	1.178e-007	1.079e-007	-6.929	-6.967	-0.038
FeSO4	1.085e-008	1.087e-008	-7.965	-7.964	0.001
FeCl+	9.966e-010	9.127e-010	-9.001	-9.040	-0.038
FeHSO4+	4.989e-016	4.569e-016	-15.302	-15.340	-0.038
Fe(3)	1.766e-004				
Fe(OH)3	1.439e-004	1.441e-004	-3.842	-3.841	0.001
Fe(OH)4-	2.604e-005	2.385e-005	-4.584	-4.623	-0.038
Fe(OH)2+	6.658e-006	6.098e-006	-5.177	-5.215	-0.038
FeOH+2	1.454e-010	1.023e-010	-9.837	-9.990	-0.153
Fe+3	1.663e-016	8.202e-017	-15.779	-16.086	-0.307
FeSO4+	3.630e-017	3.324e-017	-16.440	-16.478	-0.038
FeCl+2	1.546e-018	1.088e-018	-17.811	-17.963	-0.153
Fe2(OH)2+4	1.001e-018	2.451e-019	-18.000	-18.611	-0.611
Fe(SO4)2-	2.761e-020	2.528e-020	-19.559	-19.597	-0.038
Fe3(OH)4+5	2.062e-021	2.290e-022	-20.686	-21.640	-0.954
FeCl2+	1.883e-021	1.725e-021	-20.725	-20.763	-0.038
FeHSO4+2	7.990e-025	5.621e-025	-24.097	-24.250	-0.153
FeCl3	6.800e-026	6.810e-026	-25.168	-25.167	0.001
H(0)	2.991e-025				
H2	1.495e-025	1.498e-025	-24.825	-24.825	0.001
K	1.074e-004				
K+	1.074e-004	9.825e-005	-3.969	-4.008	-0.039
KSO4-	2.742e-008	2.512e-008	-7.562	-7.600	-0.038
KOH	5.390e-011	5.399e-011	-10.268	-10.268	0.001
Mg	1.933e-003				
Mg+2	1.920e-003	1.371e-003	-2.717	-2.863	-0.146
MgSO4	1.200e-005	1.202e-005	-4.921	-4.920	0.001
MgOH+	1.167e-006	1.068e-006	-5.933	-5.971	-0.038
Na	4.611e-004				
Na+	4.611e-004	4.226e-004	-3.336	-3.374	-0.038
NaSO4-	8.107e-008	7.424e-008	-7.091	-7.129	-0.038
NaOH	4.418e-010	4.425e-010	-9.355	-9.354	0.001
O(0)	0.000e+000				
O2	0.000e+000	0.000e+000	-41.647	-41.646	0.001
Pb	2.655e-009				
PbOH+	1.783e-009	1.633e-009	-8.749	-8.787	-0.038
Pb+2	7.512e-010	5.285e-010	-9.124	-9.277	-0.153
Pb(OH)2	1.005e-010	1.007e-010	-9.998	-9.997	0.001
PbSO4	1.018e-011	1.020e-011	-10.992	-10.992	0.001
PbCl+	9.858e-012	9.029e-012	-11.006	-11.044	-0.038
Pb(OH)3-	2.000e-013	1.832e-013	-12.699	-12.737	-0.038
PbCl2	5.298e-015	5.306e-015	-14.276	-14.275	0.001
Pb(SO4)2-2	2.610e-015	1.836e-015	-14.583	-14.736	-0.153
Pb(OH)4-2	9.454e-017	6.651e-017	-16.024	-16.177	-0.153
Pb2OH+3	4.262e-017	1.932e-017	-16.370	-16.714	-0.344
PbCl3-	1.855e-018	1.699e-018	-17.732	-17.770	-0.038
PbCl4-2	4.683e-022	3.295e-022	-21.329	-21.482	-0.153
S(6)	6.663e-005				
SO4-2	4.845e-005	3.431e-005	-4.315	-4.465	-0.150
MgSO4	1.200e-005	1.202e-005	-4.921	-4.920	0.001
CaSO4	6.060e-006	6.069e-006	-5.218	-5.217	0.001
NaSO4-	8.107e-008	7.424e-008	-7.091	-7.129	-0.038
KSO4-	2.742e-008	2.512e-008	-7.562	-7.600	-0.038
FeSO4	1.085e-008	1.087e-008	-7.965	-7.964	0.001
ZnSO4	6.618e-010	6.629e-010	-9.179	-9.179	0.001
HSO4-	2.478e-011	2.269e-011	-10.606	-10.644	-0.038

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     PbSO4            1.018e-011  1.020e-011   -10.992   -10.992     0.001
     CdSO4            3.609e-012  3.615e-012   -11.443   -11.442     0.001
     Zn(SO4)2-2       2.561e-013  1.801e-013   -12.592   -12.744    -0.153
     CaHSO4+          2.559e-013  2.344e-013   -12.592   -12.630    -0.038
     CuSO4            2.132e-013  2.136e-013   -12.671   -12.670     0.001
     Pb(SO4)2-2       2.610e-015  1.836e-015   -14.583   -14.736    -0.153
     Cd(SO4)2-2       1.894e-015  1.332e-015   -14.723   -14.875    -0.153
     FeHSO4+          4.989e-016  4.569e-016   -15.302   -15.340    -0.038
     FeSO4+           3.630e-017  3.324e-017   -16.440   -16.478    -0.038
     Fe(SO4)2-        2.761e-020  2.528e-020   -19.559   -19.597    -0.038
     FeHSO4+2         7.990e-025  5.621e-025   -24.097   -24.250    -0.153
Zn              1.591e-007
     Zn+2             1.133e-007  8.030e-008    -6.946    -7.095    -0.150
     Zn(OH)2          2.535e-008  2.539e-008    -7.596    -7.595     0.001
     ZnOH+            1.966e-008  1.801e-008    -7.706    -7.745    -0.038
     ZnSO4            6.618e-010  6.629e-010    -9.179    -9.179     0.001
     ZnCl+            1.081e-010  9.898e-011    -9.966   -10.004    -0.038
     Zn(OH)3-         1.389e-011  1.272e-011   -10.857   -10.895    -0.038
     Zn(SO4)2-2       2.561e-013  1.801e-013   -12.592   -12.744    -0.153
     ZnCl2            4.141e-014  4.148e-014   -13.383   -13.382     0.001
     Zn(OH)4-2        4.543e-016  3.196e-016   -15.343   -15.495    -0.153
     ZnCl3-           2.047e-017  1.875e-017   -16.689   -16.727    -0.038
     ZnCl4-2          5.416e-021  3.810e-021   -20.266   -20.419    -0.153

------------------------------Saturation indices-------------------------------

     Phase               SI  log IAP  log KT

     Anglesite        -5.97  -13.74   -7.77  PbSO4
     Anhydrite        -3.15   -7.53   -4.38  CaSO4
     Cd(OH)2          -6.70    6.95   13.65  Cd(OH)2
     CdSO4           -13.69  -13.91   -0.22  CdSO4
     Fe(OH)3(a)        3.62    8.51    4.89  Fe(OH)3
     Goethite          9.63    8.51   -1.12  FeOOH
     Gypsum           -2.95   -7.53   -4.58  CaSO4:2H2O
     H2(g)           -21.66  -24.82   -3.16  H2
     H2O(g)           -1.42   -0.00    1.42  H2O
     Halite           -8.37   -6.78    1.59  NaCl
     Hematite         21.29   17.03   -4.26  Fe2O3
     Jarosite-K       -2.53  -12.00   -9.47  KFe3(SO4)2(OH)6
     Melanterite      -8.07  -10.24   -2.17  FeSO4:7H2O
     O2(g)           -38.67  -41.65   -2.98  O2
     Pb(OH)2          -0.91    7.12    8.03  Pb(OH)2
     Zn(OH)2(e)       -2.20    9.30   11.50  Zn(OH)2

Initial solution 2.   PAF Leachate

-----------------------------Solution composition------------------------------

     Elements           Molality       Moles

     Ca               9.008e-003  9.008e-003
     Cd               5.661e-007  5.661e-007
     Cl               2.844e-005  2.844e-005
     Cu               9.204e-007  9.204e-007
     Fe               5.544e-003  5.544e-003
     K                1.032e-004  1.032e-004
     Mg               1.062e-001  1.062e-001
     Na               2.632e-004  2.632e-004
     Pb               1.392e-006  1.392e-006
     S(6)             5.249e-002  5.249e-002
     Zn               2.067e-003  2.067e-003

----------------------------Description of solution----------------------------

                                       pH  =   3.980
                                       pe  =  11.850
                        Activity of water  =   0.998
                           Ionic strength  =  2.210e-001
                       Mass of water (kg)  =  1.000e+000
                 Total alkalinity (eq/kg)  = -3.984e-003
                    Total carbon (mol/kg)  =  0.000e+000
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                        Total CO2 (mol/kg)  =  0.000e+000
                       Temperature (deg C)  =  25.000
                    Electrical balance (eq)  =  1.397e-001
 Percent error, 100*(Cat-|An|)/(Cat+|An|)  =  64.77
                                Iterations  =  13
                                   Total H  = 1.110194e+002
                                   Total O  = 5.572292e+001
```

----------------------------Distribution of species----------------------------

Species		Molality	Activity	Log Molality	Log Activity	Log Gamma
	H+	1.319e-004	1.047e-004	-3.880	-3.980	-0.100
	OH-	1.364e-010	9.537e-011	-9.865	-10.021	-0.155
	H2O	5.551e+001	9.976e-001	1.744	-0.001	0.000
Ca		9.008e-003				
	Ca+2	6.844e-003	2.144e-003	-2.165	-2.669	-0.504
	CaSO4	2.162e-003	2.275e-003	-2.665	-2.643	0.022
	CaHSO4+	1.878e-006	1.395e-006	-5.726	-5.855	-0.129
	CaOH+	4.563e-012	3.390e-012	-11.341	-11.470	-0.129
Cd		5.661e-007				
	Cd+2	3.690e-007	1.124e-007	-6.433	-6.949	-0.516
	CdSO4	1.638e-007	1.723e-007	-6.786	-6.764	0.022
	Cd(SO4)2-2	3.300e-008	1.005e-008	-7.482	-7.998	-0.516
	CdCl+	2.891e-010	2.147e-010	-9.539	-9.668	-0.129
	CdOH+	1.199e-013	8.906e-014	-12.921	-13.050	-0.129
	CdCl2	1.702e-014	1.791e-014	-13.769	-13.747	0.022
	CdCl3-	3.044e-019	2.261e-019	-18.517	-18.646	-0.129
	Cd(OH)2	4.330e-020	4.556e-020	-19.363	-19.341	0.022
	Cd(OH)3-	6.557e-029	4.871e-029	-28.183	-28.312	-0.129
	Cd(OH)4-2	1.358e-038	4.136e-039	-37.867	-38.383	-0.516
Cl		2.844e-005				
	Cl-	2.840e-005	2.001e-005	-4.547	-4.699	-0.152
	ZnCl+	3.100e-008	2.303e-008	-7.509	-7.638	-0.129
	FeCl+2	9.273e-009	2.824e-009	-8.033	-8.549	-0.516
	FeCl+	2.570e-009	1.909e-009	-8.590	-8.719	-0.129
	CdCl+	2.891e-010	2.147e-010	-9.539	-9.668	-0.129
	PbCl+	2.332e-010	1.732e-010	-9.632	-9.761	-0.129
	ZnCl2	4.586e-013	4.825e-013	-12.339	-12.316	0.022
	FeCl2+	3.397e-013	2.524e-013	-12.469	-12.598	-0.129
	CdCl2	1.702e-014	1.791e-014	-13.769	-13.747	0.022
	PbCl2	5.220e-015	5.493e-015	-14.282	-14.260	0.022
	ZnCl3-	1.458e-017	1.083e-017	-16.836	-16.965	-0.129
	FeCl3	4.799e-019	5.049e-019	-18.319	-18.297	0.022
	CdCl3-	3.044e-019	2.261e-019	-18.517	-18.646	-0.129
	PbCl3-	1.175e-019	8.730e-020	-18.930	-19.059	-0.129
	ZnCl4-2	3.567e-022	1.086e-022	-21.448	-21.964	-0.516
	PbCl4-2	2.745e-024	8.360e-025	-23.561	-24.078	-0.516
Cu(1)		2.433e-016				
	Cu+	2.433e-016	1.635e-016	-15.614	-15.787	-0.173
Cu(2)		9.204e-007				
	Cu+2	6.929e-007	2.205e-007	-6.159	-6.657	-0.497
	CuSO4	2.275e-007	2.394e-007	-6.643	-6.621	0.022
	CuOH+	2.954e-011	2.101e-011	-10.530	-10.678	-0.148
	Cu(OH)2	3.974e-013	4.182e-013	-12.401	-12.379	0.022
	Cu(OH)3-	3.231e-022	2.401e-022	-21.491	-21.620	-0.129
	Cu(OH)4-2	1.498e-030	4.563e-031	-29.824	-30.341	-0.516
Fe(2)		2.794e-004				
	Fe+2	2.172e-004	6.912e-005	-3.663	-4.160	-0.497
	FeSO4	6.212e-005	6.536e-005	-4.207	-4.185	0.022
	FeHSO4+	6.056e-008	4.499e-008	-7.218	-7.347	-0.129
	FeCl+	2.570e-009	1.909e-009	-8.590	-8.719	-0.129
	FeOH+	2.803e-010	2.083e-010	-9.552	-9.681	-0.129
Fe(3)		5.264e-003				
	Fe(OH)2+	1.221e-003	9.069e-004	-2.913	-3.042	-0.129
	FeOH+2	9.440e-004	2.875e-004	-3.025	-3.541	-0.516
	Fe3(OH)4+5	7.114e-004	4.214e-007	-3.148	-6.375	-3.227
	FeSO4+	3.668e-004	2.725e-004	-3.436	-3.565	-0.129
	Fe2(OH)2+4	2.586e-004	2.224e-006	-3.587	-5.653	-2.066
	Fe(SO4)2-	4.267e-005	3.170e-005	-4.370	-4.499	-0.129
	Fe+3	3.729e-005	4.673e-006	-4.428	-5.330	-0.902

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    Fe(OH)3           1.058e-006  1.113e-006    -5.976    -5.953     0.022
    FeHSO4+2          2.509e-007  7.640e-008    -6.601    -7.117    -0.516
    FeCl+2            9.273e-009  2.824e-009    -8.033    -8.549    -0.516
    Fe(OH)4-          1.302e-011  9.671e-012   -10.885   -11.015    -0.129
    FeCl2+            3.397e-013  2.524e-013   -12.469   -12.598    -0.129
    FeCl3             4.799e-019  5.049e-019   -18.319   -18.297     0.022
H(0)             2.944e-035
    H2                1.472e-035  1.549e-035   -34.832   -34.810     0.022
K                1.032e-004
    K+                9.963e-005  7.019e-005    -4.002    -4.154    -0.152
    KSO4-             3.530e-006  2.622e-006    -5.452    -5.581    -0.129
    KOH               2.204e-015  2.319e-015   -14.657   -14.635     0.022
Mg               1.062e-001
    Mg+2              7.596e-002  2.551e-002    -1.119    -1.593    -0.474
    MgSO4             3.023e-002  3.180e-002    -1.520    -1.498     0.022
    MgOH+             1.188e-009  8.826e-010    -8.925    -9.054    -0.129
Na               2.632e-004
    Na+               2.564e-004  1.894e-004    -3.591    -3.723    -0.131
    NaSO4-            6.796e-006  5.048e-006    -5.168    -5.297    -0.129
    NaOH              1.133e-014  1.192e-014   -13.946   -13.924     0.022
O(0)             3.287e-023
    O2                1.644e-023  1.730e-023   -22.784   -22.762     0.022
Pb               1.392e-006
    Pb+2              7.141e-007  2.175e-007    -6.146    -6.663    -0.516
    PbSO4             6.180e-007  6.503e-007    -6.209    -6.187     0.022
    Pb(SO4)2-2        5.959e-008  1.815e-008    -7.225    -7.741    -0.516
    PbCl+             2.332e-010  1.732e-010    -9.632    -9.761    -0.129
    PbOH+             5.438e-011  4.040e-011   -10.265   -10.394    -0.129
    PbCl2             5.220e-015  5.493e-015   -14.282   -14.260     0.022
    Pb2OH+3           2.855e-015  1.967e-016   -14.544   -15.706    -1.162
    Pb(OH)2           1.423e-016  1.497e-016   -15.847   -15.825     0.022
    PbCl3-            1.175e-019  8.730e-020   -18.930   -19.059    -0.129
    Pb(OH)3-          2.205e-023  1.638e-023   -22.657   -22.786    -0.129
    PbCl4-2           2.745e-024  8.360e-025   -23.561   -24.078    -0.516
    Pb(OH)4-2         1.174e-030  3.575e-031   -29.930   -30.447    -0.516
S(6)             5.249e-002
    MgSO4             3.023e-002  3.180e-002    -1.520    -1.498     0.022
    SO4-2             1.884e-002  5.317e-003    -1.725    -2.274    -0.549
    CaSO4             2.162e-003  2.275e-003    -2.665    -2.643     0.022
    ZnSO4             5.067e-004  5.331e-004    -3.295    -3.273     0.022
    FeSO4+            3.668e-004  2.725e-004    -3.436    -3.565    -0.129
    Zn(SO4)2-2        7.567e-005  2.304e-005    -4.121    -4.637    -0.516
    HSO4-             7.287e-005  5.413e-005    -4.137    -4.267    -0.129
    FeSO4             6.212e-005  6.536e-005    -4.207    -4.185     0.022
    Fe(SO4)2-         4.267e-005  3.170e-005    -4.370    -4.499    -0.129
    NaSO4-            6.796e-006  5.048e-006    -5.168    -5.297    -0.129
    KSO4-             3.530e-006  2.622e-006    -5.452    -5.581    -0.129
    CaHSO4+           1.878e-006  1.395e-006    -5.726    -5.855    -0.129
    PbSO4             6.180e-007  6.503e-007    -6.209    -6.187     0.022
    FeHSO4+2          2.509e-007  7.640e-008    -6.601    -7.117    -0.516
    CuSO4             2.275e-007  2.394e-007    -6.643    -6.621     0.022
    CdSO4             1.638e-007  1.723e-007    -6.786    -6.764     0.022
    FeHSO4+           6.056e-008  4.499e-008    -7.218    -7.347    -0.129
    Pb(SO4)2-2        5.959e-008  1.815e-008    -7.225    -7.741    -0.516
    Cd(SO4)2-2        3.300e-008  1.005e-008    -7.482    -7.998    -0.516
Zn               2.067e-003
    Zn+2              1.485e-003  4.277e-004    -2.828    -3.369    -0.541
    ZnSO4             5.067e-004  5.331e-004    -3.295    -3.273     0.022
    Zn(SO4)2-2        7.567e-005  2.304e-005    -4.121    -4.637    -0.516
    ZnCl+             3.100e-008  2.303e-008    -7.509    -7.638    -0.129
    ZnOH+             6.014e-009  4.468e-009    -8.221    -8.350    -0.129
    Zn(OH)2           4.645e-013  4.887e-013   -12.333   -12.311     0.022
    ZnCl2             4.586e-013  4.825e-013   -12.339   -12.316     0.022
    ZnCl3-            1.458e-017  1.083e-017   -16.836   -16.965    -0.129
    Zn(OH)3-          1.982e-020  1.472e-020   -19.703   -19.832    -0.129
    ZnCl4-2           3.567e-022  1.086e-022   -21.448   -21.964    -0.516
    Zn(OH)4-2         7.300e-029  2.223e-029   -28.137   -28.653    -0.516

------------------------------Saturation indices-------------------------------

    Phase               SI log IAP  log KT
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     Anglesite          -1.15   -8.94   -7.79  PbSO4
     Anhydrite          -0.58   -4.94   -4.36  CaSO4
     Cd(OH)2           -12.64    1.01   13.65  Cd(OH)2
     CdSO4              -9.12   -9.22   -0.10  CdSO4
     Fe(OH)3(a)          1.72    6.61    4.89  Fe(OH)3
     Goethite            7.61    6.61   -1.00  FeOOH
     Gypsum             -0.36   -4.95   -4.58  CaSO4:2H2O
     H2(g)             -31.66  -34.81   -3.15  H2
     H2O(g)             -1.51   -0.00    1.51  H2O
     Halite            -10.00   -8.42    1.58  NaCl
     Hematite           17.22   13.22   -4.01  Fe2O3
     Jarosite-K          8.39   -0.82   -9.21  KFe3(SO4)2(OH)6
     Melanterite        -4.23   -6.44   -2.21  FeSO4:7H2O
     O2(g)             -19.80  -22.76   -2.96  O2
     Pb(OH)2            -6.85    1.30    8.15  Pb(OH)2
     Zn(OH)2(e)         -6.91    4.59   11.50  Zn(OH)2

Initial solution 3.   NAF Leachate

-----------------------------Solution composition------------------------------

     Elements           Molality       Moles

     Ca               4.825e-003  4.825e-003
     Cd               2.229e-008  2.229e-008
     Cl               1.809e-003  1.809e-003
     Cu               7.884e-008  7.884e-008
     Fe               1.794e-007  1.794e-007
     K                9.738e-004  9.738e-004
     Mg               9.315e-003  9.315e-003
     Na               2.659e-003  2.659e-003
     Pb               2.418e-008  2.418e-008
     S(6)             1.512e-002  1.512e-002
     Zn               2.345e-005  2.345e-005

----------------------------Description of solution----------------------------

                                       pH  =   6.500
                                       pe  =   1.840
                        Activity of water  =   0.999
                           Ionic strength  =  4.115e-002
                       Mass of water (kg)  =  1.000e+000
                 Total alkalinity (eq/kg)  = -4.358e-007
                    Total carbon (mol/kg)  =  0.000e+000
                       Total CO2 (mol/kg)  =  0.000e+000
                      Temperature (deg C)  =  25.000
                  Electrical balance (eq)  = -9.827e-005
 Percent error, 100*(Cat-|An|)/(Cat+|An|)  =  -0.22
                               Iterations  =   6
                                  Total H  = 1.110124e+002
                                  Total O  = 5.556672e+001

----------------------------Distribution of species----------------------------

                                                Log       Log         Log
     Species            Molality    Activity  Molality  Activity     Gamma

     H+               3.669e-007  3.162e-007    -6.435    -6.500    -0.065
     OH-              3.837e-008  3.164e-008    -7.416    -7.500    -0.084
     H2O              5.551e+001  9.995e-001     1.744    -0.000     0.000
Ca              4.825e-003
     Ca+2             3.257e-003  1.620e-003    -2.487    -2.790    -0.303
     CaSO4            1.568e-003  1.583e-003    -2.805    -2.800     0.004
     CaHSO4+          3.523e-009  2.933e-009    -8.453    -8.533    -0.080
     CaOH+            1.021e-009  8.498e-010    -8.991    -9.071    -0.080
Cd              2.229e-008
     Cd+2             1.217e-008  5.847e-009    -7.915    -8.233    -0.318
     CdSO4            8.183e-009  8.260e-009    -8.087    -8.083     0.004
     CdCl+            1.002e-009  8.340e-010    -8.999    -9.079    -0.080
     Cd(SO4)2-2       9.236e-010  4.437e-010    -9.035    -9.353    -0.318
     CdCl2            5.144e-012  5.193e-012   -11.289   -11.285     0.004
     CdOH+            1.846e-012  1.537e-012   -11.734   -11.813    -0.080
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     CdCl3-          5.878e-015  4.894e-015   -14.231    -14.310    -0.080
     Cd(OH)2         2.585e-016  2.609e-016   -15.588    -15.583     0.004
     Cd(OH)3-        1.111e-022  9.253e-023   -21.954    -22.034    -0.080
     Cd(OH)4-2       5.426e-030  2.607e-030   -29.266    -29.584    -0.318
Cl              1.809e-003
     Cl-             1.809e-003  1.494e-003    -2.743     -2.826    -0.083
     ZnCl+           3.449e-008  2.871e-008    -7.462     -7.542    -0.080
     CdCl+           1.002e-009  8.340e-010    -8.999     -9.079    -0.080
     PbCl+           3.384e-010  2.817e-010    -9.471     -9.550    -0.080
     FeCl+           1.564e-010  1.302e-010    -9.806     -9.885    -0.080
     ZnCl2           4.448e-011  4.491e-011   -10.352    -10.348     0.004
     CdCl2           5.144e-012  5.193e-012   -11.289    -11.285     0.004
     PbCl2           6.607e-013  6.669e-013   -12.180    -12.176     0.004
     ZnCl3-          9.039e-014  7.526e-014   -13.044    -13.123    -0.080
     CdCl3-          5.878e-015  4.894e-015   -14.231    -14.310    -0.080
     PbCl3-          9.504e-016  7.913e-016   -15.022    -15.102    -0.080
     ZnCl4-2         1.173e-016  5.633e-017   -15.931    -16.249    -0.318
     PbCl4-2         1.178e-018  5.657e-019   -17.929    -18.247    -0.318
     FeCl+2          3.919e-020  1.882e-020   -19.407    -19.725    -0.318
     FeCl2+          1.509e-022  1.256e-022   -21.821    -21.901    -0.080
     FeCl3           1.858e-026  1.876e-026   -25.731    -25.727     0.004
Cu(1)           5.862e-008
     Cu+             5.862e-008  4.780e-008    -7.232     -7.321    -0.089
Cu(2)           2.022e-008
     Cu+2            1.244e-008  6.302e-009    -7.905     -8.201    -0.295
     CuSO4           6.243e-009  6.303e-009    -8.205     -8.200     0.004
     Cu(OH)2         1.303e-009  1.315e-009    -8.885     -8.881     0.004
     CuOH+           2.403e-010  1.992e-010    -9.619     -9.701    -0.082
     Cu(OH)3-        3.009e-016  2.505e-016   -15.522    -15.601    -0.080
     Cu(OH)4-2       3.289e-022  1.580e-022   -21.483    -21.801    -0.318
Fe(2)           1.794e-007
     Fe+2            1.247e-007  6.317e-008    -6.904     -7.200    -0.295
     FeSO4           5.450e-008  5.502e-008    -7.264     -7.259     0.004
     FeCl+           1.564e-010  1.302e-010    -9.806     -9.885    -0.080
     FeOH+           7.584e-011  6.314e-011   -10.120    -10.200    -0.080
     FeHSO4+         1.374e-013  1.144e-013   -12.862    -12.942    -0.080
Fe(3)           1.433e-011
     Fe(OH)2+        1.071e-011  8.914e-012   -10.970    -11.050    -0.080
     Fe(OH)3         3.595e-012  3.629e-012   -11.444    -11.440     0.004
     FeOH+2          1.773e-014  8.517e-015   -13.751    -14.070    -0.318
     Fe(OH)4-        1.257e-014  1.046e-014   -13.901    -13.980    -0.080
     FeSO4+          2.693e-017  2.242e-017   -16.570    -16.649    -0.080
     Fe(SO4)2-       2.885e-018  2.402e-018   -17.540    -17.619    -0.080
     Fe+3            1.592e-018  4.173e-019   -17.798    -18.380    -0.581
     FeCl+2          3.919e-020  1.882e-020   -19.407    -19.725    -0.318
     FeCl2+          1.509e-022  1.256e-022   -21.821    -21.901    -0.080
     FeHSO4+2        3.951e-023  1.898e-023   -22.403    -22.722    -0.318
     Fe2(OH)2+4      3.667e-026  1.952e-027   -25.436    -26.709    -1.274
     FeCl3           1.858e-026  1.876e-026   -25.731    -25.727     0.004
     Fe3(OH)4+5      3.554e-034  3.636e-036   -33.449    -35.439    -1.990
H(0)            2.930e-020
     H2              1.465e-020  1.479e-020   -19.834    -19.830     0.004
K               9.738e-004
     K+              9.417e-004  7.775e-004    -3.026     -3.109    -0.083
     KSO4-           3.215e-005  2.676e-005    -4.493     -4.572    -0.080
     KOH             8.441e-012  8.521e-012   -11.074    -11.069     0.004
Mg              9.315e-003
     Mg+2            5.904e-003  2.998e-003    -2.229     -2.523    -0.294
     MgSO4           3.411e-003  3.443e-003    -2.467     -2.463     0.004
     MgOH+           4.133e-008  3.441e-008    -7.384     -7.463    -0.080
Na              2.659e-003
     Na+             2.595e-003  2.166e-003    -2.586     -2.664    -0.078
     NaSO4-          6.387e-005  5.317e-005    -4.195     -4.274    -0.080
     NaOH            4.480e-011  4.523e-011   -10.349    -10.345     0.004
O(0)            0.000e+000
     O2              0.000e+000  0.000e+000   -52.725    -52.720     0.004
Pb              2.418e-008
     PbSO4           1.293e-008  1.305e-008    -7.888     -7.884     0.004
     Pb+2            9.864e-009  4.738e-009    -8.006     -8.324    -0.318
     Pb(SO4)2-2      6.985e-010  3.355e-010    -9.156     -9.474    -0.318
     PbOH+           3.508e-010  2.920e-010    -9.455     -9.535    -0.080
     PbCl+           3.384e-010  2.817e-010    -9.471     -9.550    -0.080
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        PbCl2             6.607e-013  6.669e-013   -12.180    -12.176      0.004
        Pb(OH)2           3.557e-013  3.591e-013   -12.449    -12.445      0.004
        PbCl3-            9.504e-016  7.913e-016   -15.022    -15.102     -0.080
        Pb2OH+3           1.612e-016  3.098e-017   -15.793    -16.509     -0.716
        Pb(OH)3-          1.565e-017  1.303e-017   -16.805    -16.885     -0.080
        PbCl4-2           1.178e-018  5.657e-019   -17.929    -18.247     -0.318
        Pb(OH)4-2         1.964e-022  9.435e-023   -21.707    -22.025     -0.318
S(6)                 1.512e-002
        SO4-2             1.004e-002  4.898e-003    -1.998     -2.310     -0.312
        MgSO4             3.411e-003  3.443e-003    -2.467     -2.463      0.004
        CaSO4             1.568e-003  1.583e-003    -2.805     -2.800      0.004
        NaSO4-            6.387e-005  5.317e-005    -4.195     -4.274     -0.080
        KSO4-             3.215e-005  2.676e-005    -4.493     -4.572     -0.080
        ZnSO4             8.124e-006  8.201e-006    -5.090     -5.086      0.004
        Zn(SO4)2-2        6.798e-007  3.265e-007    -6.168     -6.486     -0.318
        HSO4-             1.809e-007  1.506e-007    -6.743     -6.822     -0.080
        FeSO4             5.450e-008  5.502e-008    -7.264     -7.259      0.004
        PbSO4             1.293e-008  1.305e-008    -7.888     -7.884      0.004
        CdSO4             8.183e-009  8.260e-009    -8.087     -8.083      0.004
        CuSO4             6.243e-009  6.303e-009    -8.205     -8.200      0.004
        CaHSO4+           3.523e-009  2.933e-009    -8.453     -8.533     -0.080
        Cd(SO4)2-2        9.236e-010  4.437e-010    -9.035     -9.353     -0.318
        Pb(SO4)2-2        6.985e-010  3.355e-010    -9.156     -9.474     -0.318
        FeHSO4+           1.374e-013  1.144e-013   -12.862    -12.942     -0.080
        FeSO4+            2.693e-017  2.242e-017   -16.570    -16.649     -0.080
        Fe(SO4)2-         2.885e-018  2.402e-018   -17.540    -17.619     -0.080
        FeHSO4+2          3.951e-023  1.898e-023   -22.403    -22.722     -0.318
Zn                   2.345e-005
        Zn+2              1.458e-005  7.142e-006    -4.836     -5.146     -0.310
        ZnSO4             8.124e-006  8.201e-006    -5.090     -5.086      0.004
        Zn(SO4)2-2        6.798e-007  3.265e-007    -6.168     -6.486     -0.318
        ZnCl+             3.449e-008  2.871e-008    -7.462     -7.542     -0.080
        ZnOH+             2.973e-008  2.475e-008    -7.527     -7.606     -0.080
        Zn(OH)2           8.898e-010  8.983e-010    -9.051     -9.047      0.004
        ZnCl2             4.448e-011  4.491e-011   -10.352    -10.348      0.004
        ZnCl3-            9.039e-014  7.526e-014   -13.044    -13.123     -0.080
        Zn(OH)3-          1.078e-014  8.978e-015   -13.967    -14.047     -0.080
        ZnCl4-2           1.173e-016  5.633e-017   -15.931    -16.249     -0.318
        Zn(OH)4-2         9.362e-021  4.497e-021   -20.029    -20.347     -0.318

------------------------------Saturation indices-------------------------------

        Phase               SI log IAP  log KT

        Anglesite        -2.84  -10.63   -7.79  PbSO4
        Anhydrite        -0.74   -5.10   -4.36  CaSO4
        Cd(OH)2          -8.88    4.77   13.65  Cd(OH)2
        CdSO4           -10.44  -10.54   -0.10  CdSO4
        Fe(OH)3(a)       -3.77    1.12    4.89  Fe(OH)3
        Goethite          2.12    1.12   -1.00  FeOOH
        Gypsum           -0.52   -5.10   -4.58  CaSO4:2H2O
        H2(g)           -16.68  -19.83   -3.15  H2
        H2O(g)           -1.51   -0.00    1.51  H2O
        Halite           -7.07   -5.49    1.58  NaCl
        Hematite          6.25    2.24   -4.01  Fe2O3
        Jarosite-K      -14.66  -23.87   -9.21  KFe3(SO4)2(OH)6
        Melanterite      -7.30   -9.51   -2.21  FeSO4:7H2O
        O2(g)           -49.76  -52.72   -2.96  O2
        Pb(OH)2          -3.47    4.68    8.15  Pb(OH)2
        Zn(OH)2(e)       -3.65    7.85   11.50  Zn(OH)2

Initial solution 4.    Rainwater

-----------------------------Solution composition------------------------------

        Elements           Molality       Moles

        Ca                2.500e-006  2.500e-006
        Cl                6.699e-006  6.699e-006
        K                 1.499e-006  1.499e-006
        Mg                1.300e-006  1.300e-006
        Na                6.903e-006  6.903e-006
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    S(6)             8.100e-006  8.100e-006
    Zn               1.530e-007  1.530e-007

----------------------------Description of solution----------------------------

                                       pH  =   4.590
                                       pe  =  10.150
                        Activity of water  =   1.000
                           Ionic strength  =  4.455e-005
                       Mass of water (kg)  =  1.000e+000
                 Total alkalinity (eq/kg)  = -2.592e-005
                    Total carbon (mol/kg)  =  0.000e+000
                       Total CO2 (mol/kg)  =  0.000e+000
                      Temperature (deg C)  =  25.000
                  Electrical balance (eq)  =  1.933e-005
 Percent error, 100*(Cat-|An|)/(Cat+|An|)  =  29.71
                               Iterations  =   3
                                  Total H  = 1.110125e+002
                                  Total O  = 5.550625e+001

----------------------------Distribution of species----------------------------

                                                    Log       Log         Log
    Species            Molality    Activity  Molality  Activity       Gamma

    H+               2.590e-005  2.570e-005    -4.587    -4.590      -0.003
    OH-              3.925e-010  3.895e-010    -9.406    -9.410      -0.003
    H2O              5.551e+001  1.000e+000     1.744    -0.000       0.000
Ca              2.500e-006
    Ca+2             2.496e-006  2.420e-006    -5.603    -5.616      -0.013
    CaSO4            3.780e-009  3.780e-009    -8.423    -8.423       0.000
    CaHSO4+          5.736e-013  5.691e-013   -12.241   -12.245      -0.003
    CaOH+            1.575e-014  1.563e-014   -13.803   -13.806      -0.003
Cl              6.699e-006
    Cl-              6.699e-006  6.647e-006    -5.174    -5.177      -0.003
    ZnCl+            2.669e-012  2.649e-012   -11.574   -11.577      -0.003
    ZnCl2            1.844e-017  1.844e-017   -16.734   -16.734       0.000
    ZnCl3-           1.386e-022  1.375e-022   -21.858   -21.862      -0.003
    ZnCl4-2          4.725e-028  4.581e-028   -27.326   -27.339      -0.013
H(0)            4.688e-033
    H2               2.344e-033  2.344e-033   -32.630   -32.630       0.000
K               1.499e-006
    K+               1.499e-006  1.487e-006    -5.824    -5.828      -0.003
    KSO4-            8.242e-011  8.178e-011   -10.084   -10.087      -0.003
    KOH              2.006e-016  2.006e-016   -15.698   -15.698       0.000
Mg              1.300e-006
    Mg+2             1.297e-006  1.258e-006    -5.887    -5.900      -0.013
    MgSO4            2.308e-009  2.308e-009    -8.637    -8.637       0.000
    MgOH+            1.791e-013  1.777e-013   -12.747   -12.750      -0.003
Na              6.903e-006
    Na+              6.902e-006  6.849e-006    -5.161    -5.164      -0.003
    NaSO4-           2.708e-010  2.687e-010    -9.567    -9.571      -0.003
    NaOH             1.760e-015  1.760e-015   -14.754   -14.754       0.000
O(0)            1.517e-027
    O2               7.586e-028  7.586e-028   -27.120   -27.120       0.000
S(6)            8.100e-006
    SO4-2            8.073e-006  7.827e-006    -5.093    -5.106      -0.013
    HSO4-            1.971e-008  1.956e-008    -7.705    -7.709      -0.003
    CaSO4            3.780e-009  3.780e-009    -8.423    -8.423       0.000
    MgSO4            2.308e-009  2.308e-009    -8.637    -8.637       0.000
    ZnSO4            2.716e-010  2.716e-010    -9.566    -9.566       0.000
    NaSO4-           2.708e-010  2.687e-010    -9.567    -9.571      -0.003
    KSO4-            8.242e-011  8.178e-011   -10.084   -10.087      -0.003
    CaHSO4+          5.736e-013  5.691e-013   -12.241   -12.245      -0.003
    Zn(SO4)2-2       1.783e-014  1.728e-014   -13.749   -13.762      -0.013
Zn              1.530e-007
    Zn+2             1.527e-007  1.480e-007    -6.816    -6.830      -0.013
    ZnSO4            2.716e-010  2.716e-010    -9.566    -9.566       0.000
    ZnOH+            6.364e-012  6.315e-012   -11.196   -11.200      -0.003
    ZnCl+            2.669e-012  2.649e-012   -11.574   -11.577      -0.003
    Zn(SO4)2-2       1.783e-014  1.728e-014   -13.749   -13.762      -0.013
    Zn(OH)2          2.821e-015  2.821e-015   -14.550   -14.550       0.000
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    ZnCl2            1.844e-017  1.844e-017   -16.734   -16.734     0.000
    Zn(OH)3-         3.497e-022  3.470e-022   -21.456   -21.460    -0.003
    ZnCl3-           1.386e-022  1.375e-022   -21.858   -21.862    -0.003
    ZnCl4-2          4.725e-028  4.581e-028   -27.326   -27.339    -0.013
    Zn(OH)4-2        2.207e-030  2.140e-030   -29.656   -29.670    -0.013

------------------------------Saturation indices------------------------------

    Phase               SI  log IAP   log KT

    Anhydrite        -6.36  -10.72   -4.36  CaSO4
    Gypsum           -6.14  -10.72   -4.58  CaSO4:2H2O
    H2(g)           -29.48  -32.63   -3.15  H2
    H2O(g)           -1.51   -0.00    1.51  H2O
    Halite          -11.92  -10.34    1.58  NaCl
    O2(g)           -24.16  -27.12   -2.96  O2
    Zn(OH)2(e)       -9.15    2.35   11.50  Zn(OH)2

Initial solution 5.   Tailings Seepage

-----------------------------Solution composition-----------------------------

    Elements           Molality       Moles

    Ca               1.024e-002  1.024e-002
    Cd               7.216e-010  7.216e-010
    Cl               7.463e-002  7.463e-002
    Cu               2.776e-007  2.776e-007
    Fe               5.718e-008  5.718e-008
    K                7.700e-003  7.700e-003
    Mg               4.462e-002  4.462e-002
    Na               1.336e-001  1.336e-001
    Pb               1.419e-009  1.419e-009
    S(6)             6.532e-002  6.532e-002
    Zn               5.071e-006  5.071e-006

----------------------------Description of solution----------------------------

                                       pH  =   6.560
                                       pe  =   1.690
                        Activity of water  =   0.995
                           Ionic strength  =  2.457e-001
                       Mass of water (kg)  =  1.000e+000
                 Total alkalinity (eq/kg)  = -4.947e-007
                    Total carbon (mol/kg)  =  0.000e+000
                       Total CO2 (mol/kg)  =  0.000e+000
                      Temperature (deg C)  =  25.000
                  Electrical balance (eq)  =  4.577e-002
 Percent error, 100*(Cat-|An|)/(Cat+|An|)  =  12.94
                               Iterations  =   8
                                  Total H  = 1.110124e+002
                                  Total O  = 5.576752e+001

----------------------------Distribution of species----------------------------

                                                    Log       Log         Log
    Species            Molality    Activity  Molality  Activity       Gamma

    H+               3.487e-007  2.754e-007    -6.458    -6.560    -0.102
    OH-              5.236e-008  3.616e-008    -7.281    -7.442    -0.161
    H2O              5.551e+001  9.948e-001     1.744    -0.002     0.000
Ca              1.024e-002
    Ca+2             6.543e-003  1.993e-003    -2.184    -2.700    -0.516
    CaSO4            3.701e-003  3.916e-003    -2.432    -2.407     0.025
    CaHSO4+          8.548e-009  6.319e-009    -8.068    -8.199    -0.131
    CaOH+            1.616e-009  1.195e-009    -8.791    -8.923    -0.131
Cd              7.216e-010
    CdCl+            3.265e-010  2.414e-010    -9.486    -9.617    -0.131
    Cd+2             1.629e-010  4.863e-011    -9.788   -10.313    -0.525
    CdSO4            1.305e-010  1.381e-010    -9.884    -9.860     0.025
    Cd(SO4)2-2       4.993e-011  1.491e-011   -10.302   -10.827    -0.525
    CdCl2            4.942e-011  5.229e-011   -10.306   -10.282     0.025
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     CdCl3-           2.320e-012  1.715e-012  -11.635  -11.766   -0.131
     CdOH+            1.976e-014  1.461e-014  -13.704  -13.835   -0.131
     Cd(OH)2          2.678e-018  2.834e-018  -17.572  -17.548    0.025
     Cd(OH)3-         1.553e-024  1.148e-024  -23.809  -23.940   -0.131
     Cd(OH)4-2        1.238e-031  3.696e-032  -30.907  -31.432   -0.525
Cl               7.463e-002
     Cl-              7.463e-002  5.197e-002   -1.127   -1.284   -0.157
     ZnCl+            1.453e-007  1.074e-007   -6.838   -6.969   -0.131
     ZnCl2            5.523e-009  5.845e-009   -8.258   -8.233    0.025
     FeCl+            1.111e-009  8.211e-010   -8.954   -9.086   -0.131
     ZnCl3-           4.611e-010  3.408e-010   -9.336   -9.467   -0.131
     CdCl+            3.265e-010  2.414e-010   -9.486   -9.617   -0.131
     PbCl+            3.151e-010  2.329e-010   -9.502   -9.633   -0.131
     CdCl2            4.942e-011  5.229e-011  -10.306  -10.282    0.025
     ZnCl4-2          2.974e-011  8.878e-012  -10.527  -11.052   -0.525
     PbCl2            1.813e-011  1.919e-011  -10.742  -10.717    0.025
     CdCl3-           2.320e-012  1.715e-012  -11.635  -11.766   -0.131
     PbCl3-           1.072e-012  7.921e-013  -11.970  -12.101   -0.131
     PbCl4-2          6.600e-014  1.970e-014  -13.180  -13.705   -0.525
     FeCl+2           2.814e-019  8.403e-020  -18.551  -19.076   -0.525
     FeCl2+           2.639e-020  1.951e-020  -19.579  -19.710   -0.131
     FeCl3            9.581e-023  1.014e-022  -22.019  -21.994    0.025
Cu(1)            2.077e-007
     Cu+              2.077e-007  1.374e-007   -6.683   -6.862   -0.179
Cu(2)            6.990e-008
     Cu+2             4.158e-008  1.282e-008   -7.381   -7.892   -0.511
     CuSO4            2.436e-008  2.578e-008   -7.613   -7.589    0.025
     Cu(OH)2          3.303e-009  3.495e-009   -8.481   -8.457    0.025
     CuOH+            6.586e-010  4.631e-010   -9.181   -9.334   -0.153
     Cu(OH)3-         1.029e-015  7.606e-016  -14.988  -15.119   -0.131
     Cu(OH)4-2        1.836e-021  5.481e-022  -20.736  -21.261   -0.525
Fe(2)            5.718e-008
     Fe+2             3.711e-008  1.145e-008   -7.430   -7.941   -0.511
     FeSO4            1.894e-008  2.004e-008   -7.723   -7.698    0.025
     FeCl+            1.111e-009  8.211e-010   -8.954   -9.086   -0.131
     FeOH+            1.768e-011  1.307e-011  -10.752  -10.884   -0.131
     FeHSO4+          4.908e-014  3.628e-014  -13.309  -13.440   -0.131
Fe(3)            2.684e-012
     Fe(OH)2+         2.020e-012  1.493e-012  -11.695  -11.826   -0.131
     Fe(OH)3          6.565e-013  6.947e-013  -12.183  -12.158    0.025
     FeOH+2           4.181e-015  1.248e-015  -14.379  -14.904   -0.525
     Fe(OH)4-         3.096e-015  2.288e-015  -14.509  -14.640   -0.131
     FeSO4+           7.818e-018  5.779e-018  -17.107  -17.238   -0.131
     Fe(SO4)2-        1.684e-018  1.245e-018  -17.774  -17.905   -0.131
     Fe+3             4.472e-019  5.353e-020  -18.350  -19.271   -0.922
     FeCl+2           2.814e-019  8.403e-020  -18.551  -19.076   -0.525
     FeCl2+           2.639e-020  1.951e-020  -19.579  -19.710   -0.131
     FeCl3            9.581e-023  1.014e-022  -22.019  -21.994    0.025
     FeHSO4+2         1.428e-023  4.262e-024  -22.845  -23.370   -0.525
     Fe2(OH)2+4       5.280e-027  4.195e-029  -26.277  -28.377   -2.100
     Fe3(OH)4+5       2.500e-035  1.309e-038  -34.602  -37.883   -3.281
H(0)             4.231e-020
     H2               2.116e-020  2.239e-020  -19.675  -19.650    0.025
K                7.700e-003
     K+               7.229e-003  5.034e-003   -2.141   -2.298   -0.157
     KSO4-            4.712e-004  3.483e-004   -3.327   -3.458   -0.131
     KOH              5.958e-011  6.305e-011  -10.225  -10.200    0.025
Mg               4.462e-002
     Mg+2             2.600e-002  8.536e-003   -1.585   -2.069   -0.484
     MgSO4            1.862e-002  1.970e-002   -1.730   -1.705    0.025
     MgOH+            1.514e-007  1.119e-007   -6.820   -6.951   -0.131
Na               1.336e-001
     Na+              1.274e-001  9.346e-002   -0.895   -1.029   -0.134
     NaSO4-           6.239e-003  4.612e-003   -2.205   -2.336   -0.131
     NaOH             2.108e-009  2.230e-009   -8.676   -8.652    0.025
O(0)             0.000e+000
     O2               0.000e+000  0.000e+000  -53.109  -53.085    0.025
Pb               1.419e-009
     PbSO4            5.890e-010  6.233e-010   -9.230   -9.205    0.025
     Pb+2             3.770e-010  1.126e-010   -9.424   -9.949   -0.525
     PbCl+            3.151e-010  2.329e-010   -9.502   -9.633   -0.131
     Pb(SO4)2-2       1.079e-010  3.220e-011   -9.967  -10.492   -0.525
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     PbCl2            1.813e-011  1.919e-011   -10.742   -10.717     0.025
     PbOH+            1.072e-011  7.928e-012   -10.970   -11.101    -0.131
     PbCl3-           1.072e-012  7.921e-013   -11.970   -12.101    -0.131
     PbCl4-2          6.600e-014  1.970e-014   -13.180   -13.705    -0.525
     Pb(OH)2          1.053e-014  1.114e-014   -13.978   -13.953     0.025
     Pb(OH)3-         6.249e-019  4.619e-019   -18.204   -18.335    -0.131
     Pb2OH+3          3.032e-019  1.998e-020   -18.518   -19.699    -1.181
     Pb(OH)4-2        1.280e-023  3.822e-024   -22.893   -23.418    -0.525
S(6)             6.532e-002
     SO4-2            3.629e-002  9.846e-003    -1.440    -2.007    -0.567
     MgSO4            1.862e-002  1.970e-002    -1.730    -1.705     0.025
     NaSO4-           6.239e-003  4.612e-003    -2.205    -2.336    -0.131
     CaSO4            3.701e-003  3.916e-003    -2.432    -2.407     0.025
     KSO4-            4.712e-004  3.483e-004    -3.327    -3.458    -0.131
     ZnSO4            1.674e-006  1.772e-006    -5.776    -5.752     0.025
     Zn(SO4)2-2       4.749e-007  1.418e-007    -6.323    -6.848    -0.525
     HSO4-            3.567e-007  2.636e-007    -6.448    -6.579    -0.131
     CuSO4            2.436e-008  2.578e-008    -7.613    -7.589     0.025
     FeSO4            1.894e-008  2.004e-008    -7.723    -7.698     0.025
     CaHSO4+          8.548e-009  6.319e-009    -8.068    -8.199    -0.131
     PbSO4            5.890e-010  6.233e-010    -9.230    -9.205     0.025
     CdSO4            1.305e-010  1.381e-010    -9.884    -9.860     0.025
     Pb(SO4)2-2       1.079e-010  3.220e-011    -9.967   -10.492    -0.525
     Cd(SO4)2-2       4.993e-011  1.491e-011   -10.302   -10.827    -0.525
     FeHSO4+          4.908e-014  3.628e-014   -13.309   -13.440    -0.131
     FeSO4+           7.818e-018  5.779e-018   -17.107   -17.238    -0.131
     Fe(SO4)2-        1.684e-018  1.245e-018   -17.774   -17.905    -0.131
     FeHSO4+2         1.428e-023  4.262e-024   -22.845   -23.370    -0.525
Zn               5.071e-006
     Zn+2             2.766e-006  7.677e-007    -5.558    -6.115    -0.557
     ZnSO4            1.674e-006  1.772e-006    -5.776    -5.752     0.025
     Zn(SO4)2-2       4.749e-007  1.418e-007    -6.323    -6.848    -0.525
     ZnCl+            1.453e-007  1.074e-007    -6.838    -6.969    -0.131
     ZnCl2            5.523e-009  5.845e-009    -8.258    -8.233     0.025
     ZnOH+            4.113e-009  3.040e-009    -8.386    -8.517    -0.131
     ZnCl3-           4.611e-010  3.408e-010    -9.336    -9.467    -0.131
     Zn(OH)2          1.191e-010  1.261e-010    -9.924    -9.899     0.025
     ZnCl4-2          2.974e-011  8.878e-012   -10.527   -11.052    -0.525
     Zn(OH)3-         1.948e-015  1.440e-015   -14.710   -14.842    -0.131
     Zn(OH)4-2        2.761e-021  8.243e-022   -20.559   -21.084    -0.525

------------------------------Saturation indices-------------------------------

     Phase               SI  log IAP  log KT

     Anglesite        -4.17  -11.96   -7.79  PbSO4
     Anhydrite        -0.35   -4.71   -4.36  CaSO4
     Cd(OH)2         -10.85    2.80   13.65  Cd(OH)2
     CdSO4           -12.22  -12.32   -0.10  CdSO4
     Fe(OH)3(a)       -4.49    0.40    4.89  Fe(OH)3
     Goethite          1.40    0.40   -1.00  FeOOH
     Gypsum           -0.13   -4.71   -4.58  CaSO4:2H2O
     H2(g)           -16.50  -19.65   -3.15  H2
     H2O(g)           -1.51   -0.00    1.51  H2O
     Halite           -3.90   -2.31    1.58  NaCl
     Hematite          4.82    0.81   -4.01  Fe2O3
     Jarosite-K      -15.57  -24.78   -9.21  KFe3(SO4)2(OH)6
     Melanterite      -7.75   -9.96   -2.21  FeSO4:7H2O
     O2(g)           -50.12  -53.08   -2.96  O2
     Pb(OH)2          -4.98    3.17    8.15  Pb(OH)2
     Zn(OH)2(e)       -4.50    7.00   11.50  Zn(OH)2

-----------------------------------------
Beginning of batch-reaction calculations.
-----------------------------------------

Reaction step 1.

Using mix 1.  Mixing of water in open pit - best case Scenario 4

Mixture 1.    Mixing of water in open pit - best case Scenario 4
```

```
     9.940e-001 Solution 1River water
     0.000e+000 Solution 2PAF Leachate
     4.000e-004 Solution 3NAF Leachate
     4.900e-003 Solution 4Rainwater
     6.000e-004 Solution 5Tailings Seepage

-----------------------------Solution composition------------------------------

    Elements           Molality       Moles

    Ca               1.216e-003  1.216e-003
    Cd               5.401e-010  5.400e-010
    Cl               4.746e-004  4.746e-004
    Cu               1.584e-008  1.584e-008
    Fe               1.780e-004  1.780e-004
    K                1.118e-004  1.118e-004
    Mg               1.953e-003  1.952e-003
    Na               5.397e-004  5.396e-004
    Pb               2.650e-009  2.650e-009
    S                1.115e-004  1.115e-004
    Zn               1.714e-007  1.713e-007

----------------------------Description of solution----------------------------

                                       pH  =   8.198      Charge balance
                                       pe  =   2.640      Adjusted to redox equilibrium
                        Activity of water  =   1.000
                           Ionic strength  =  7.023e-003
                       Mass of water (kg)  =  9.999e-001
                 Total alkalinity (eq/kg)  =  1.983e-004
                    Total carbon (mol/kg)  =  0.000e+000
                       Total CO2 (mol/kg)  =  0.000e+000
                      Temperature (deg C)  =  28.380
                  Electrical balance (eq)  =  6.273e-003
 Percent error, 100*(Cat-|An|)/(Cat+|An|)  =  82.51
                               Iterations  =   4
                                  Total H  = 1.110019e+002
                                  Total O  = 5.550166e+001

----------------------------Distribution of species----------------------------

                                                    Log       Log         Log
    Species            Molality    Activity  Molality  Activity     Gamma

    OH-              2.223e-006  2.031e-006    -5.653    -5.692    -0.039
    H+               6.858e-009  6.336e-009    -8.164    -8.198    -0.034
    H2O              5.551e+001  9.999e-001     1.744    -0.000     0.000
Ca              1.216e-003
    Ca+2             1.206e-003  8.543e-004    -2.919    -3.068    -0.150
    CaSO4            1.006e-005  1.008e-005    -4.997    -4.997     0.001
    CaOH+            2.445e-008  2.237e-008    -7.612    -7.650    -0.039
    CaHSO4+          4.269e-013  3.906e-013   -12.370   -12.408    -0.039
Cd              5.401e-010
    Cd+2             5.110e-010  3.583e-010    -9.292    -9.446    -0.154
    CdCl+            1.640e-011  1.501e-011   -10.785   -10.824    -0.039
    CdOH+            6.586e-012  6.027e-012   -11.181   -11.220    -0.039
    CdSO4            6.033e-012  6.043e-012   -11.219   -11.219     0.001
    Cd(OH)2          3.980e-014  3.987e-014   -13.400   -13.399     0.001
    CdCl2            2.744e-014  2.748e-014   -13.562   -13.561     0.001
    Cd(SO4)2-2       5.304e-015  3.720e-015   -14.275   -14.430    -0.154
    CdCl3-           8.644e-018  7.910e-018   -17.063   -17.102    -0.039
    Cd(OH)3-         7.714e-019  7.059e-019   -18.113   -18.151    -0.039
    Cd(OH)4-2        1.416e-024  9.929e-025   -23.849   -24.003    -0.154
Cl              4.746e-004
    Cl-              4.746e-004  4.338e-004    -3.324    -3.363    -0.039
    FeCl+            1.083e-009  9.915e-010    -8.965    -9.004    -0.039
    ZnCl+            1.275e-010  1.166e-010    -9.895    -9.933    -0.039
    CdCl+            1.640e-011  1.501e-011   -10.785   -10.824    -0.039
    PbCl+            1.080e-011  9.883e-012   -10.967   -11.005    -0.039
    ZnCl2            5.361e-014  5.370e-014   -13.271   -13.270     0.001
    CdCl2            2.744e-014  2.748e-014   -13.562   -13.561     0.001
    PbCl2            6.373e-015  6.383e-015   -14.196   -14.195     0.001
```

ZnCl3-	2.914e-017	2.667e-017	-16.536	-16.574	-0.039
CdCl3-	8.644e-018	7.910e-018	-17.063	-17.102	-0.039
PbCl3-	2.454e-018	2.245e-018	-17.610	-17.649	-0.039
FeCl+2	1.720e-018	1.206e-018	-17.764	-17.919	-0.154
ZnCl4-2	8.489e-021	5.953e-021	-20.071	-20.225	-0.154
FeCl2+	2.298e-021	2.103e-021	-20.639	-20.677	-0.039
PbCl4-2	6.822e-022	4.784e-022	-21.166	-21.320	-0.154
FeCl3	9.106e-026	9.121e-026	-25.041	-25.040	0.001
Cu(1)	4.117e-011				
Cu+	4.117e-011	3.753e-011	-10.385	-10.426	-0.040
Cu(2)	1.580e-008				
Cu(OH)2	1.571e-008	1.573e-008	-7.804	-7.803	0.001
CuOH+	5.216e-011	4.772e-011	-10.283	-10.321	-0.039
Cu+2	4.245e-011	3.023e-011	-10.372	-10.519	-0.147
CuSO4	3.614e-013	3.619e-013	-12.442	-12.441	0.001
Cu(OH)3-	1.635e-013	1.496e-013	-12.786	-12.825	-0.039
Cu(OH)4-2	6.718e-018	4.711e-018	-17.173	-17.327	-0.154
Fe(2)	2.460e-006				
Fe+2	2.325e-006	1.656e-006	-5.634	-5.781	-0.147
FeOH+	1.159e-007	1.061e-007	-6.936	-6.974	-0.039
FeSO4	1.790e-008	1.793e-008	-7.747	-7.746	0.001
FeCl+	1.083e-009	9.915e-010	-8.965	-9.004	-0.039
FeHSO4+	8.273e-016	7.571e-016	-15.082	-15.121	-0.039
Fe(HS)2	0.000e+000	0.000e+000	-128.805	-128.805	0.001
Fe(HS)3-	0.000e+000	0.000e+000	-192.716	-192.754	-0.039
Fe(3)	1.756e-004				
Fe(OH)3	1.431e-004	1.434e-004	-3.844	-3.844	0.001
Fe(OH)4-	2.579e-005	2.360e-005	-4.589	-4.627	-0.039
Fe(OH)2+	6.661e-006	6.095e-006	-5.176	-5.215	-0.039
FeOH+2	1.465e-010	1.027e-010	-9.834	-9.988	-0.154
Fe+3	1.690e-016	8.283e-017	-15.772	-16.082	-0.310
FeSO4+	6.123e-017	5.603e-017	-16.213	-16.252	-0.039
FeCl+2	1.720e-018	1.206e-018	-17.764	-17.919	-0.154
Fe2(OH)2+4	1.024e-018	2.475e-019	-17.990	-18.606	-0.617
Fe(SO4)2-	7.775e-020	7.115e-020	-19.109	-19.148	-0.039
FeCl2+	2.298e-021	2.103e-021	-20.639	-20.677	-0.039
Fe3(OH)4+5	2.128e-021	2.315e-022	-20.672	-21.635	-0.963
FeHSO4+2	1.357e-024	9.513e-025	-23.868	-24.022	-0.154
FeCl3	9.106e-026	9.121e-026	-25.041	-25.040	0.001
H(0)	2.885e-025				
H2	1.443e-025	1.445e-025	-24.841	-24.840	0.001
K	1.118e-004				
K+	1.118e-004	1.022e-004	-3.952	-3.991	-0.039
KSO4-	4.764e-008	4.359e-008	-7.322	-7.361	-0.039
KOH	5.581e-011	5.590e-011	-10.253	-10.253	0.001
Mg	1.953e-003				
Mg+2	1.931e-003	1.374e-003	-2.714	-2.862	-0.148
MgSO4	2.009e-005	2.012e-005	-4.697	-4.696	0.001
MgOH+	1.164e-006	1.065e-006	-5.934	-5.973	-0.039
Na	5.397e-004				
Na+	5.395e-004	4.942e-004	-3.268	-3.306	-0.038
NaSO4-	1.584e-007	1.449e-007	-6.800	-6.839	-0.039
NaOH	5.144e-010	5.153e-010	-9.289	-9.288	0.001
O(0)	0.000e+000				
O2	0.000e+000	0.000e+000	-41.622	-41.621	0.001
Pb	2.650e-009				
PbOH+	1.771e-009	1.621e-009	-8.752	-8.790	-0.039
Pb+2	7.512e-010	5.268e-010	-9.124	-9.278	-0.154
Pb(OH)2	9.936e-011	9.952e-011	-10.003	-10.002	0.001
PbSO4	1.694e-011	1.697e-011	-10.771	-10.770	0.001
PbCl+	1.080e-011	9.883e-012	-10.967	-11.005	-0.039
Pb(OH)3-	1.971e-013	1.803e-013	-12.705	-12.744	-0.039
Pb(SO4)2-2	7.277e-015	5.103e-015	-14.138	-14.292	-0.154
PbCl2	6.373e-015	6.383e-015	-14.196	-14.195	0.001
Pb(OH)4-2	9.298e-017	6.520e-017	-16.032	-16.186	-0.154
Pb2OH+3	4.248e-017	1.911e-017	-16.372	-16.719	-0.347
PbCl3-	2.454e-018	2.245e-018	-17.610	-17.649	-0.039
PbCl4-2	6.822e-022	4.784e-022	-21.166	-21.320	-0.154
S(-2)	0.000e+000				
HS-	0.000e+000	0.000e+000	-65.948	-65.987	-0.039
H2S	0.000e+000	0.000e+000	-67.287	-67.286	0.001
S-2	0.000e+000	0.000e+000	-70.456	-70.607	-0.151

```
     Fe(HS)2           0.000e+000  0.000e+000  -128.805  -128.805     0.001
     Fe(HS)3-          0.000e+000  0.000e+000  -192.716  -192.754    -0.039
S(6)              1.115e-004
     SO4-2             8.116e-005  5.729e-005    -4.091    -4.242    -0.151
     MgSO4             2.009e-005  2.012e-005    -4.697    -4.696     0.001
     CaSO4             1.006e-005  1.008e-005    -4.997    -4.997     0.001
     NaSO4-            1.584e-007  1.449e-007    -6.800    -6.839    -0.039
     KSO4-             4.764e-008  4.359e-008    -7.322    -7.361    -0.039
     FeSO4             1.790e-008  1.793e-008    -7.747    -7.746     0.001
     ZnSO4             1.186e-009  1.188e-009    -8.926    -8.925     0.001
     HSO4-             4.156e-011  3.803e-011   -10.381   -10.420    -0.039
     PbSO4             1.694e-011  1.697e-011   -10.771   -10.770     0.001
     CdSO4             6.033e-012  6.043e-012   -11.219   -11.219     0.001
     Zn(SO4)2-2        7.689e-013  5.392e-013   -12.114   -12.268    -0.154
     CaHSO4+           4.269e-013  3.906e-013   -12.370   -12.408    -0.039
     CuSO4             3.614e-013  3.619e-013   -12.442   -12.441     0.001
     Pb(SO4)2-2        7.277e-015  5.103e-015   -14.138   -14.292    -0.154
     Cd(SO4)2-2        5.304e-015  3.720e-015   -14.275   -14.430    -0.154
     FeHSO4+           8.273e-016  7.571e-016   -15.082   -15.121    -0.039
     FeSO4+            6.123e-017  5.603e-017   -16.213   -16.252    -0.039
     Fe(SO4)2-         7.775e-020  7.115e-020   -19.109   -19.148    -0.039
     FeHSO4+2          1.357e-024  9.513e-025   -23.868   -24.022    -0.154
Zn                1.714e-007
     Zn+2              1.220e-007  8.621e-008    -6.914    -7.064    -0.151
     Zn(OH)2           2.699e-008  2.703e-008    -7.569    -7.568     0.001
     ZnOH+             2.101e-008  1.922e-008    -7.678    -7.716    -0.039
     ZnSO4             1.186e-009  1.188e-009    -8.926    -8.925     0.001
     ZnCl+             1.275e-010  1.166e-010    -9.895    -9.933    -0.039
     Zn(OH)3-          1.474e-011  1.349e-011   -10.831   -10.870    -0.039
     Zn(SO4)2-2        7.689e-013  5.392e-013   -12.114   -12.268    -0.154
     ZnCl2             5.361e-014  5.370e-014   -13.271   -13.270     0.001
     Zn(OH)4-2         4.812e-016  3.374e-016   -15.318   -15.472    -0.154
     ZnCl3-            2.914e-017  2.667e-017   -16.536   -16.574    -0.039
     ZnCl4-2           8.489e-021  5.953e-021   -20.071   -20.225    -0.154

------------------------------Saturation indices-------------------------------

     Phase               SI  log IAP  log KT

     Anglesite        -5.75  -13.52   -7.77  PbSO4
     Anhydrite        -2.93   -7.31   -4.38  CaSO4
     Cd(OH)2          -6.70    6.95   13.65  Cd(OH)2
     CdSO4           -13.47  -13.69   -0.22  CdSO4
     Fe(OH)3(a)        3.62    8.51    4.89  Fe(OH)3
     FeS(ppt)        -59.65  -63.57   -3.92  FeS
     Goethite          9.63    8.51   -1.12  FeOOH
     Gypsum           -2.73   -7.31   -4.58  CaSO4:2H2O
     H2(g)           -21.68  -24.84   -3.16  H2
     H2O(g)           -1.42   -0.00    1.42  H2O
     H2S(g)          -66.25  -67.29   -1.03  H2S
     Halite           -8.26   -6.67    1.59  NaCl
     Hematite         21.29   17.03   -4.26  Fe2O3
     Jarosite-K       -2.06  -11.53   -9.47  KFe3(SO4)2(OH)6
     Mackinawite     -58.92  -63.57   -4.65  FeS
     Melanterite      -7.85  -10.02   -2.17  FeSO4:7H2O
     O2(g)           -38.65  -41.62   -2.98  O2
     Pb(OH)2          -0.92    7.12    8.04  Pb(OH)2
     Pyrite          -97.69 -116.08  -18.39  FeS2
     Sphalerite      -53.30  -64.85  -11.55  ZnS
     Sulfur          -50.41  -45.61    4.80  S
     Zn(OH)2(e)       -2.17    9.33   11.50  Zn(OH)2

------------------
End of simulation.
------------------

------------------------------------
Reading input data for simulation 5.
------------------------------------

-----------
End of run.
```

Appendix A
Geochemical Equilibrium Model Input and Output

```
   Input file: C:\Documents and Settings\SXDENNE0\My Documents\MRM2.pqi
  Output file: C:\Documents and Settings\SXDENNE0\My Documents\MRM2.pqo
Database file: C:\Program Files\USGS\Phreeqc Interactive 2.11\phreeqc.dat

------------------
Reading data base.
------------------

    SOLUTION_MASTER_SPECIES
    SOLUTION_SPECIES
    PHASES
    EXCHANGE_MASTER_SPECIES
    EXCHANGE_SPECIES
    SURFACE_MASTER_SPECIES
    SURFACE_SPECIES
    RATES
    END
------------------------------------
Reading input data for simulation 1.
------------------------------------

    DATABASE C:\Program Files\USGS\Phreeqc Interactive 2.11\phreeqc.dat
    SOLUTION 1 River water
        temp      28.4
        pH        8.2
        pe        2.63
        redox     pe
        units     mg/l
        density   1
        S(6)      6.4
        Ca        48.7
        Cd        6e-005
        Cl        15.3
        Cu        0.001
        Fe        10
        K         4.2
        Mg        47
        Na        10.6
        Pb        0.00055
        Zn        0.0104
        water    1 # kg
    SOLUTION 2 PAF Leachate
        temp      25
        pH        3.98
        pe        11.85
        redox     pe
        units     mg/l
        density   1
        Ca        358
        Cd        0.0631
        Cl        1
        Cu        0.058
        Fe        307
        K         4
        Mg        2560
        Na        6
        Pb        0.286
        S(6)      20000
        Zn        134
        water    1 # kg
    SOLUTION 3 NAF Leachate
        temp      25
        pH        6.5
        pe        1.84
        redox     pe
        units     mg/l
        density   1
        Ca        193
        Cd        0.0025
        Cl        64
        Cu        0.005
        Fe        0.01
```

```
    K         38
    Mg        226
    Na        61
    Pb        0.005
    S(6)      1450
    Zn        1.53
    water    1 # kg
SOLUTION 4 Rainwater
    temp      25
    pH        4.59
    pe        10.15
    redox     pe
    units     mg/l
    density   1
    Ca        0.1002
    Cd        0
    Cl        0.2375
    Cu        0
    Fe        0
    K         0.0586
    Mg        0.0316
    Na        0.15869
    Pb        0
    S(6)      0.7781
    Zn        0.01
    water    1 # kg
SOLUTION 5 Tailings Seepage
    temp      25
    pH        6.56
    pe        1.69
    redox     pe
    units     mg/l
    density   1
    Ca        405
    Cd        0.00008
    Cl        2610
    Cu        0.0174
    Fe        0.00315
    K         297
    Mg        1070
    Na        3030
    Pb        0.00029
    S(6)      6190
    Zn        0.327
    water    1 # kg
MIX 1 Mixing of water in open pit - worst case Scenario 1
    1    0
    2    0.0727
    3    0.6544
    4    0.2410
    5    0.0319
PRINT
    warnings              -1
SELECTED_OUTPUT
    file                 MRM2_Scenario1.txt
    totals               Ca  Cd  Cl  Cu  K  Mg  Mn
                          Na  Pb  S(-2)  Zn  S(6)  Al  Alkalinity
                          B  Ba  Br  C  C(4)  C(-4)  Cu(1)
                          Cu(2)  N  Mn(3)  Mn(2)  Li  Hfo_w  Hfo_s
                          H(0)  Fe(3)  Fe(2)  F  Fe  N(0)  N(3)
                          N(-3)  N(5)  O(0)  P  S  Si  Sr
                          X
    molalities           Ca+2  CaCO3  CaF+  CaH2PO4+
                          CaHCO3+  CaHPO4  CaHSO4+  CaOH+
                          CaPO4-  CaSO4  CaX2  Cd(CO3)2-2
                          Cd(OH)2  Cd(OH)3-  Cd(OH)4-2  Cd(SO4)2-2
                          Cd+2  CdCl+  CdCl2  CdCl3-
                          CdCO3  CdHCO3+  CdOH+  CdSO4
                          CdX2  Cl-  CO2  CO3-2
                          Cu(OH)2  Cu(OH)3-  Cu(OH)4-2  Cu+
                          Cu+2  CuOH+  CuSO4  CuX2
                          Fe(HS)2  Fe(HS)3-  Fe(OH)2+  FeH2PO4+
```

```
                    FeF3  FeF2+  FeF+2  FeF+
                    FeCO3  FeCl3  FeCl2+  FeCl+2
                    FeCl+  Fe3(OH)4+5  Fe2(OH)2+4  Fe+3
                    Fe+2  Fe(SO4)2-  Fe(OH)4-  Fe(OH)3
                    FeX2  FeSO4+  FeSO4  FeOH+2
                    FeOH+  FeHSO4+2  FeHSO4+  FeHPO4+
                    FeHPO4  FeHCO3+  FeH2PO4+2  H2S
                    HSO4-  HS-  K+  KHPO4-
                    KOH  KSO4-  KX  Mg+2
                    MgCO3  MgF+  MgH2PO4+  MgHCO3+
                    MgHPO4  MgOH+  MgPO4-  MgSO4
                    MgX2  Mn(NO3)2  Mn+2  Mn+3
                    MnCl+  MnCl2  MnCl3-  MnCO3
                    MnF+  MnHCO3+  MnOH+  MnSO4
                    MnX2  Na+  NaCO3-  NaF
                    NaHCO3  NaHPO4-  NaOH  NaSO4-
                    NaX  NH3  NH4+  NH4SO4-
                    NH4X  Pb(CO3)2-2  Pb(OH)2  Pb(OH)3-
                    Pb(OH)4-2  Pb(SO4)2-2  Pb+2  Pb2OH+3
                    PbCl+  PbCl2  PbCl3-  PbCl4-2
                    PbCO3  PbHCO3+  PbNO3+  PbOH+
                    PbSO4  PbX2  PO4-3  SO4-2
                    Zn(CO3)2-2  Zn(OH)2  Zn(OH)3-  Zn(OH)4-2
                    Zn(SO4)2-2  Zn+2  ZnCl+  ZnCl2
                    ZnCl3-  ZnCl4-2  ZnCO3  ZnHCO3+
                    ZnOH+  ZnSO4  ZnX2  Al(OH)2+
                    Al(OH)3  Al(OH)4-  Al(SO4)2-  Al+3
                    AlF+2  AlF2+  AlF3  AlF4-
                    AlF5-2  AlF6-3  AlHSO4+2  AlOH+2
                    AlOHX2  AlSO4+  AlX3  Ba+2
                    BaCO3  BaHCO3+  BaOH+  BaSO4
                    BaX2  BF(OH)3-  BF2(OH)2-  BF3OH-
                    BF4-  Br-  CH4  F-
                    H+  H2  H2BO3-  H2O
                    H2PO4-  H2SiO4-2  H3BO3  H3SiO4-
                    H4SiO4  HCO3-  HF  HF2-
                    Hfo_psi  Hfo_sO-  Hfo_sOCd+  Hfo_sOCu+
                    Hfo_sOFe+  Hfo_sOH  Hfo_sOH2+  Hfo_sOHBa+2
                    Hfo_sOHCa+2  Hfo_sOHSr+2  Hfo_sOMn+  Hfo_sOPb+
                    Hfo_sOZn+  Hfo_wF  Hfo_wH2BO3  Hfo_wH2PO4
                    Hfo_wHPO4-  Hfo_wO-  Hfo_wOBa+  Hfo_wOCa+
                    Hfo_wOCd+  Hfo_wOCu+  Hfo_wOFe+  Hfo_wOFeOH
                    Hfo_wOH  Hfo_wOH2+  Hfo_wOHF-  Hfo_wOHSO4-2
                    Hfo_wOMg+  Hfo_wOMn+  Hfo_wOPb+  Hfo_wOSr+
                    Hfo_wOSrOH  Hfo_wOZn+  Hfo_wPO4-2  Hfo_wSO4-
                    HPO4-2  Li+  LiOH  LiSO4-
                    LiX  N2  NO2-  NO3-
                    O2  OH-  S-2  SiF6-2
                    Sr+2  SrCO3  SrHCO3+  SrOH+
                    SrSO4  SrX2  X-
activities         Al(OH)2+  Al(OH)3  Al(OH)4-  Al(SO4)2-
                    Al+3  AlF+2  AlF2+  AlF3
                    AlF4-  AlF5-2  AlF6-3  AlHSO4+2
                    AlOH+2  AlOHX2  AlSO4+  AlX3
                    Ba+2  BaCO3  BaHCO3+  BaOH+
                    BaSO4  BaX2  BF(OH)3-  BF2(OH)2-
                    BF3OH-  BF4-  Br-  Ca+2
                    CaCO3  CaF+  CaH2PO4+  CaHCO3+
                    CaHPO4  CaHSO4+  CaOH+  CaPO4-
                    CaSO4  CaX2  Cd(CO3)2-2  Cd(OH)2
                    Cd(OH)3-  Cd(OH)4-2  Cd(SO4)2-2  Cd+2
                    CdCl+  CdCl2  CdCl3-  CdCO3
                    CdHCO3+  CdOH+  CdSO4  CdX2
                    CH4  Cl-  CO2  CO3-2
                    Cu(OH)2  Cu(OH)3-  Cu(OH)4-2  Cu+
                    Cu+2  CuOH+  CuSO4  CuX2
                    Fe(HS)2  Fe(HS)3-  Fe(OH)2+  F-
                    Fe(OH)3  Fe(OH)4-  Fe(SO4)2-  Fe+2
                    Fe+3  Fe2(OH)2+4  Fe3(OH)4+5  FeCl+
                    FeCl+2  FeCl2+  FeCl3  FeCO3
                    FeF+  FeF+2  FeF2+  FeF3
                    FeH2PO4+  FeH2PO4+2  FeHCO3+  FeHPO4
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                      FeHPO4+  FeHSO4+  FeHSO4+2  FeOH+
                      FeOH+2  FeSO4  FeSO4+  FeX2
                      H+  H2  H2BO3-  H2O
                      H2PO4-  H2S  H2SiO4-2  H3BO3
                      H3SiO4-  H4SiO4  HCO3-  HF
                      HF2-  Hfo_psi  Hfo_sO-  Hfo_sOCd+
                      Hfo_sOCu+  Hfo_sOFe+  Hfo_sOH  Hfo_sOH2+
                      Hfo_sOHBa+2  Hfo_sOHCa+2  Hfo_sOHSr+2  Hfo_sOMn+
                      Hfo_sOPb+  Hfo_sOZn+  Hfo_wF  Hfo_wH2BO3
                      Hfo_wH2PO4  Hfo_wHPO4-  Hfo_wO-  Hfo_wOBa+
                      Hfo_wOCa+  Hfo_wOCd+  Hfo_wOCu+  Hfo_wOFe+
                      Hfo_wOFeOH  Hfo_wOH  Hfo_wOH2+  Hfo_wOHF-
                      Hfo_wOHSO4-2  Hfo_wOMg+  Hfo_wOMn+  Hfo_wOPb+
                      Hfo_wOSr+  Hfo_wOSrOH  Hfo_wOZn+  Hfo_wPO4-2
                      Hfo_wSO4-  HPO4-2  HS-  HSO4-
                      K+  KHPO4-  KOH  KSO4-
                      KX  Li+  LiOH  LiSO4-
                      LiX  Mg+2  MgCO3  MgF+
                      MgH2PO4+  MgHCO3+  MgHPO4  MgOH+
                      MgPO4-  MgSO4  MgX2  Mn(NO3)2
                      Mn+2  Mn+3  MnCl+  MnCl2
                      MnCl3-  MnCO3  MnF+  MnHCO3+
                      MnOH+  MnSO4  MnX2  N2
                      Na+  NaCO3-  NaF  NaHCO3
                      NaHPO4-  NaOH  NaSO4-  NaX
                      NH3  NH4+  NH4SO4-  NH4X
                      NO2-  NO3-  O2  OH-
                      Pb(CO3)2-2  Pb(OH)2  Pb(OH)3-  Pb(OH)4-2
                      Pb(SO4)2-2  Pb+2  Pb2OH+3  PbCl+
                      PbCl2  PbCl3-  PbCl4-2  PbCO3
                      PbHCO3+  PbNO3+  PbOH+  PbSO4
                      PbX2  PO4-3  S-2  SiF6-2
                      SO4-2  Sr+2  SrCO3  SrHCO3+
                      SrOH+  SrSO4  SrX2  X-
                      Zn(CO3)2-2  Zn(OH)2  Zn(OH)3-  Zn(OH)4-2
                      Zn(SO4)2-2  Zn+2  ZnCl+  ZnCl2
                      ZnCl3-  ZnCl4-2  ZnCO3  ZnHCO3+
                      ZnOH+  ZnSO4  ZnX2
equilibrium_phases   Al(OH)3(a)  Albite  Alunite  Anglesite
                      Anhydrite  Anorthite  Aragonite  Barite
                      Calcite  Ca-Montmorillonite  Cd(OH)2  CdSiO3
                      CdSO4  Celestite  Cerrusite  CH4(g)
                      Chalcedony  Hydroxyapatite  Hematite  Hausmannite
                      Halite  H2S(g)  H2O(g)  H2(g)
                      Gypsum  Goethite  Gibbsite  Fluorite
                      FeS(ppt)  Fe(OH)3(a)  Dolomite  CO2(g)
                      Chrysotile  Chlorite(14A)  Illite  Jarosite-K
                      Kaolinite  K-feldspar  K-mica  Mackinawite
                      Manganite  Melanterite  N2(g)  NH3(g)
                      O2(g)  Otavite  Pb(OH)2  Pyrite
                      Pyrochroite  Pyrolusite  Quartz  Rhodochrosite
                      Sepiolite  Sepiolite(d)  Siderite  SiO2(a)
                      Smithsonite  Sphalerite  Strontianite  Sulfur
                      Talc  Vivianite  Willemite  Witherite
                      Zn(OH)2(e)
saturation_indices   Al(OH)3(a)  Zn(OH)2(e)  Witherite  Willemite
                      Vivianite  Talc  Sulfur  Strontianite
                      Sphalerite  Smithsonite  SiO2(a)  Siderite
                      Sepiolite(d)  Sepiolite  Rhodochrosite  Quartz
                      Pyrolusite  Pyrochroite  Pyrite  Pb(OH)2
                      Otavite  O2(g)  NH3(g)  N2(g)
                      Melanterite  Manganite  Mackinawite  K-mica
                      K-feldspar  Kaolinite  Jarosite-K  Illite
                      Hydroxyapatite  Hematite  Hausmannite  Halite
                      H2S(g)  H2O(g)  H2(g)  Gypsum
                      Goethite  Gibbsite  Fluorite  FeS(ppt)
                      Fe(OH)3(a)  Dolomite  CO2(g)  Chrysotile
                      Chlorite(14A)  Chalcedony  CH4(g)  Cerrusite
                      Celestite  CdSO4  CdSiO3  Cd(OH)2
                      Ca-Montmorillonite  Calcite  Barite  Aragonite
                      Anorthite  Anhydrite  Anglesite  Alunite
                      Albite
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        gases                CH4(g)  CO2(g)  H2(g)  H2O(g)
                              H2S(g)  N2(g)  NH3(g)  O2(g)
        kinetic_reactants    Albite  Calcite  K-feldspar  Organic_C
                              Pyrite  Pyrolusite
    END
-------------------------------------------
Beginning of initial solution calculations.
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Initial solution 1.   River water

-----------------------------Solution composition------------------------------

    Elements           Molality       Moles

    Ca               1.215e-003  1.215e-003
    Cd               5.339e-010  5.339e-010
    Cl               4.316e-004  4.316e-004
    Cu               1.574e-008  1.574e-008
    Fe               1.791e-004  1.791e-004
    K                1.074e-004  1.074e-004
    Mg               1.933e-003  1.933e-003
    Na               4.611e-004  4.611e-004
    Pb               2.655e-009  2.655e-009
    S(6)             6.663e-005  6.663e-005
    Zn               1.591e-007  1.591e-007

----------------------------Description of solution----------------------------

                                       pH  =   8.200
                                       pe  =   2.630
                        Activity of water  =   1.000
                           Ionic strength  =  6.879e-003
                       Mass of water (kg)  =  1.000e+000
                 Total alkalinity (eq/kg)  =  1.996e-004
                    Total carbon (mol/kg)  =  0.000e+000
                       Total CO2 (mol/kg)  =  0.000e+000
                      Temperature (deg C)  =  28.400
                  Electrical balance (eq)  =  6.283e-003
 Percent error, 100*(Cat-|An|)/(Cat+|An|)  =  84.94
                               Iterations  =   4
                                  Total H  = 1.110130e+002
                                  Total O  = 5.550704e+001

----------------------------Distribution of species----------------------------

                                                    Log       Log         Log
    Species            Molality    Activity   Molality  Activity     Gamma

    OH-              2.233e-006  2.043e-006    -5.651    -5.690    -0.039
    H+               6.825e-009  6.310e-009    -8.166    -8.200    -0.034
    H2O              5.551e+001  9.999e-001     1.744    -0.000     0.000
Ca              1.215e-003
    Ca+2             1.209e-003  8.591e-004    -2.918    -3.066    -0.148
    CaSO4            6.060e-006  6.069e-006    -5.218    -5.217     0.001
    CaOH+            2.467e-008  2.260e-008    -7.608    -7.646    -0.038
    CaHSO4+          2.559e-013  2.344e-013   -12.592   -12.630    -0.038
Cd              5.339e-010
    Cd+2             5.087e-010  3.579e-010    -9.294    -9.446    -0.153
    CdCl+            1.490e-011  1.365e-011   -10.827   -10.865    -0.038
    CdOH+            6.609e-012  6.053e-012   -11.180   -11.218    -0.038
    CdSO4            3.609e-012  3.615e-012   -11.443   -11.442     0.001
    Cd(OH)2          4.009e-014  4.015e-014   -13.397   -13.396     0.001
    CdCl2            2.271e-014  2.274e-014   -13.644   -13.643     0.001
    Cd(SO4)2-2       1.894e-015  1.332e-015   -14.723   -14.875    -0.153
    CdCl3-           6.507e-018  5.960e-018   -17.187   -17.225    -0.038
    Cd(OH)3-         7.795e-019  7.139e-019   -18.108   -18.146    -0.038
    Cd(OH)4-2        1.433e-024  1.008e-024   -23.844   -23.996    -0.153
Cl              4.316e-004
    Cl-              4.316e-004  3.948e-004    -3.365    -3.404    -0.039
    FeCl+            9.966e-010  9.127e-010    -9.001    -9.040    -0.038
    ZnCl+            1.081e-010  9.898e-011    -9.966   -10.004    -0.038
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CdCl+	1.490e-011	1.365e-011	-10.827	-10.865	-0.038
PbCl+	9.858e-012	9.029e-012	-11.006	-11.044	-0.038
ZnCl2	4.141e-014	4.148e-014	-13.383	-13.382	0.001
CdCl2	2.271e-014	2.274e-014	-13.644	-13.643	0.001
PbCl2	5.298e-015	5.306e-015	-14.276	-14.275	0.001
ZnCl3-	2.047e-017	1.875e-017	-16.689	-16.727	-0.038
CdCl3-	6.507e-018	5.960e-018	-17.187	-17.225	-0.038
PbCl3-	1.855e-018	1.699e-018	-17.732	-17.770	-0.038
FeCl+2	1.546e-018	1.088e-018	-17.811	-17.963	-0.153
ZnCl4-2	5.416e-021	3.810e-021	-20.266	-20.419	-0.153
FeCl2+	1.883e-021	1.725e-021	-20.725	-20.763	-0.038
PbCl4-2	4.683e-022	3.295e-022	-21.329	-21.482	-0.153
FeCl3	6.800e-026	6.810e-026	-25.168	-25.167	0.001
Cu(1)	4.144e-011				
Cu+	4.144e-011	3.781e-011	-10.383	-10.422	-0.040
Cu(2)	1.570e-008				
Cu(OH)2	1.560e-008	1.563e-008	-7.807	-7.806	0.001
CuOH+	5.155e-011	4.720e-011	-10.288	-10.326	-0.038
Cu+2	4.169e-011	2.978e-011	-10.380	-10.526	-0.146
CuSO4	2.132e-013	2.136e-013	-12.671	-12.670	0.001
Cu(OH)3-	1.630e-013	1.492e-013	-12.788	-12.826	-0.038
Cu(OH)4-2	6.708e-018	4.719e-018	-17.173	-17.326	-0.153
Fe(2)	2.474e-006				
Fe+2	2.344e-006	1.675e-006	-5.630	-5.776	-0.146
FeOH+	1.178e-007	1.079e-007	-6.929	-6.967	-0.038
FeSO4	1.085e-008	1.087e-008	-7.965	-7.964	0.001
FeCl+	9.966e-010	9.127e-010	-9.001	-9.040	-0.038
FeHSO4+	4.989e-016	4.569e-016	-15.302	-15.340	-0.038
Fe(3)	1.766e-004				
Fe(OH)3	1.439e-004	1.441e-004	-3.842	-3.841	0.001
Fe(OH)4-	2.604e-005	2.385e-005	-4.584	-4.623	-0.038
Fe(OH)2+	6.658e-006	6.098e-006	-5.177	-5.215	-0.038
FeOH+2	1.454e-010	1.023e-010	-9.837	-9.990	-0.153
Fe+3	1.663e-016	8.202e-017	-15.779	-16.086	-0.307
FeSO4+	3.630e-017	3.324e-017	-16.440	-16.478	-0.038
FeCl+2	1.546e-018	1.088e-018	-17.811	-17.963	-0.153
Fe2(OH)2+4	1.001e-018	2.451e-019	-18.000	-18.611	-0.611
Fe(SO4)2-	2.761e-020	2.528e-020	-19.559	-19.597	-0.038
Fe3(OH)4+5	2.062e-021	2.290e-022	-20.686	-21.640	-0.954
FeCl2+	1.883e-021	1.725e-021	-20.725	-20.763	-0.038
FeHSO4+2	7.990e-025	5.621e-025	-24.097	-24.250	-0.153
FeCl3	6.800e-026	6.810e-026	-25.168	-25.167	0.001
H(0)	2.991e-025				
H2	1.495e-025	1.498e-025	-24.825	-24.825	0.001
K	1.074e-004				
K+	1.074e-004	9.825e-005	-3.969	-4.008	-0.039
KSO4-	2.742e-008	2.512e-008	-7.562	-7.600	-0.038
KOH	5.390e-011	5.399e-011	-10.268	-10.268	0.001
Mg	1.933e-003				
Mg+2	1.920e-003	1.371e-003	-2.717	-2.863	-0.146
MgSO4	1.200e-005	1.202e-005	-4.921	-4.920	0.001
MgOH+	1.167e-006	1.068e-006	-5.933	-5.971	-0.038
Na	4.611e-004				
Na+	4.611e-004	4.226e-004	-3.336	-3.374	-0.038
NaSO4-	8.107e-008	7.424e-008	-7.091	-7.129	-0.038
NaOH	4.418e-010	4.425e-010	-9.355	-9.354	0.001
O(0)	0.000e+000				
O2	0.000e+000	0.000e+000	-41.647	-41.646	0.001
Pb	2.655e-009				
PbOH+	1.783e-009	1.633e-009	-8.749	-8.787	-0.038
Pb+2	7.512e-010	5.285e-010	-9.124	-9.277	-0.153
Pb(OH)2	1.005e-010	1.007e-010	-9.998	-9.997	0.001
PbSO4	1.018e-011	1.020e-011	-10.992	-10.992	0.001
PbCl+	9.858e-012	9.029e-012	-11.006	-11.044	-0.038
Pb(OH)3-	2.000e-013	1.832e-013	-12.699	-12.737	-0.038
PbCl2	5.298e-015	5.306e-015	-14.276	-14.275	0.001
Pb(SO4)2-2	2.610e-015	1.836e-015	-14.583	-14.736	-0.153
Pb(OH)4-2	9.454e-017	6.651e-017	-16.024	-16.177	-0.153
Pb2OH+3	4.262e-017	1.932e-017	-16.370	-16.714	-0.344
PbCl3-	1.855e-018	1.699e-018	-17.732	-17.770	-0.038
PbCl4-2	4.683e-022	3.295e-022	-21.329	-21.482	-0.153
S(6)	6.663e-005				

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        SO4-2              4.845e-005  3.431e-005    -4.315    -4.465    -0.150
        MgSO4              1.200e-005  1.202e-005    -4.921    -4.920     0.001
        CaSO4              6.060e-006  6.069e-006    -5.218    -5.217     0.001
        NaSO4-             8.107e-008  7.424e-008    -7.091    -7.129    -0.038
        KSO4-              2.742e-008  2.512e-008    -7.562    -7.600    -0.038
        FeSO4              1.085e-008  1.087e-008    -7.965    -7.964     0.001
        ZnSO4              6.618e-010  6.629e-010    -9.179    -9.179     0.001
        HSO4-              2.478e-011  2.269e-011   -10.606   -10.644    -0.038
        PbSO4              1.018e-011  1.020e-011   -10.992   -10.992     0.001
        CdSO4              3.609e-012  3.615e-012   -11.443   -11.442     0.001
        Zn(SO4)2-2         2.561e-013  1.801e-013   -12.592   -12.744    -0.153
        CaHSO4+            2.559e-013  2.344e-013   -12.592   -12.630    -0.038
        CuSO4              2.132e-013  2.136e-013   -12.671   -12.670     0.001
        Pb(SO4)2-2         2.610e-015  1.836e-015   -14.583   -14.736    -0.153
        Cd(SO4)2-2         1.894e-015  1.332e-015   -14.723   -14.875    -0.153
        FeHSO4+            4.989e-016  4.569e-016   -15.302   -15.340    -0.038
        FeSO4+             3.630e-017  3.324e-017   -16.440   -16.478    -0.038
        Fe(SO4)2-          2.761e-020  2.528e-020   -19.559   -19.597    -0.038
        FeHSO4+2           7.990e-025  5.621e-025   -24.097   -24.250    -0.153
Zn                    1.591e-007
        Zn+2               1.133e-007  8.030e-008    -6.946    -7.095    -0.150
        Zn(OH)2            2.535e-008  2.539e-008    -7.596    -7.595     0.001
        ZnOH+              1.966e-008  1.801e-008    -7.706    -7.745    -0.038
        ZnSO4              6.618e-010  6.629e-010    -9.179    -9.179     0.001
        ZnCl+              1.081e-010  9.898e-011    -9.966   -10.004    -0.038
        Zn(OH)3-           1.389e-011  1.272e-011   -10.857   -10.895    -0.038
        Zn(SO4)2-2         2.561e-013  1.801e-013   -12.592   -12.744    -0.153
        ZnCl2              4.141e-014  4.148e-014   -13.383   -13.382     0.001
        Zn(OH)4-2          4.543e-016  3.196e-016   -15.343   -15.495    -0.153
        ZnCl3-             2.047e-017  1.875e-017   -16.689   -16.727    -0.038
        ZnCl4-2            5.416e-021  3.810e-021   -20.266   -20.419    -0.153

------------------------------Saturation indices-------------------------------

        Phase               SI log IAP  log KT

        Anglesite        -5.97  -13.74   -7.77  PbSO4
        Anhydrite        -3.15   -7.53   -4.38  CaSO4
        Cd(OH)2          -6.70    6.95   13.65  Cd(OH)2
        CdSO4           -13.69  -13.91   -0.22  CdSO4
        Fe(OH)3(a)        3.62    8.51    4.89  Fe(OH)3
        Goethite          9.63    8.51   -1.12  FeOOH
        Gypsum           -2.95   -7.53   -4.58  CaSO4:2H2O
        H2(g)           -21.66  -24.82   -3.16  H2
        H2O(g)           -1.42   -0.00    1.42  H2O
        Halite           -8.37   -6.78    1.59  NaCl
        Hematite         21.29   17.03   -4.26  Fe2O3
        Jarosite-K       -2.53  -12.00   -9.47  KFe3(SO4)2(OH)6
        Melanterite      -8.07  -10.24   -2.17  FeSO4:7H2O
        O2(g)           -38.67  -41.65   -2.98  O2
        Pb(OH)2          -0.91    7.12    8.03  Pb(OH)2
        Zn(OH)2(e)       -2.20    9.30   11.50  Zn(OH)2

Initial solution 2.   PAF Leachate

-----------------------------Solution composition------------------------------

        Elements           Molality       Moles

        Ca                 9.146e-003  9.146e-003
        Cd                 5.748e-007  5.748e-007
        Cl                 2.888e-005  2.888e-005
        Cu                 9.346e-007  9.346e-007
        Fe                 5.629e-003  5.629e-003
        K                  1.047e-004  1.047e-004
        Mg                 1.078e-001  1.078e-001
        Na                 2.672e-004  2.672e-004
        Pb                 1.413e-006  1.413e-006
        S(6)               2.132e-001  2.132e-001
        Zn                 2.099e-003  2.099e-003

----------------------------Description of solution----------------------------
```

```
                                          pH  =   3.980
                                          pe  =  11.850
                           Activity of water  =   0.996
                              Ionic strength  =  3.474e-001
                          Mass of water (kg)  =  1.000e+000
                    Total alkalinity (eq/kg)  = -7.087e-003
                       Total carbon (mol/kg)  =  0.000e+000
                          Total CO2 (mol/kg)  =  0.000e+000
                         Temperature (deg C)  =  25.000
                     Electrical balance (eq)  = -1.748e-001
 Percent error, 100*(Cat-|An|)/(Cat+|An|)  = -50.44
                                  Iterations  =  14
                                     Total H  = 1.110169e+002
                                     Total O  = 5.636285e+001

----------------------------Distribution of species----------------------------

                                                    Log       Log         Log
    Species            Molality    Activity  Molality  Activity       Gamma

    H+                1.347e-004  1.047e-004    -3.871    -3.980      -0.109
    OH-               1.437e-010  9.519e-011    -9.842   -10.021      -0.179
    H2O               5.551e+001  9.957e-001     1.744    -0.002       0.000
Ca               9.146e-003
    CaSO4             5.595e-003  6.061e-003    -2.252    -2.217       0.035
    Ca+2              3.546e-003  9.926e-004    -2.450    -3.003      -0.553
    CaHSO4+           5.083e-006  3.718e-006    -5.294    -5.430      -0.136
    CaOH+             2.141e-012  1.566e-012   -11.669   -11.805      -0.136
Cd               5.748e-007
    Cd(SO4)2-2        2.704e-007  7.742e-008    -6.568    -7.111      -0.543
    CdSO4             2.130e-007  2.308e-007    -6.672    -6.637       0.035
    Cd+2              9.132e-008  2.615e-008    -7.039    -7.583      -0.543
    CdCl+             6.604e-011  4.831e-011   -10.180   -10.316      -0.136
    CdOH+             2.827e-014  2.068e-014   -13.549   -13.684      -0.136
    CdCl2             3.596e-015  3.896e-015   -14.444   -14.409       0.035
    CdCl3-            6.501e-020  4.756e-020   -19.187   -19.323      -0.136
    Cd(OH)2           9.748e-021  1.056e-020   -20.011   -19.976       0.035
    Cd(OH)3-          1.540e-029  1.127e-029   -28.812   -28.948      -0.136
    Cd(OH)4-2         3.335e-039  9.548e-040   -38.477   -39.020      -0.543
Cl               2.888e-005
    Cl-               2.886e-005  1.935e-005    -4.540    -4.713      -0.174
    ZnCl+             8.825e-009  6.455e-009    -8.054    -8.190      -0.136
    FeCl+2            6.446e-009  1.846e-009    -8.191    -8.734      -0.543
    FeCl+             1.706e-009  1.248e-009    -8.768    -8.904      -0.136
    CdCl+             6.604e-011  4.831e-011   -10.180   -10.316      -0.136
    PbCl+             5.126e-011  3.750e-011   -10.290   -10.426      -0.136
    FeCl2+            2.180e-013  1.595e-013   -12.662   -12.797      -0.136
    ZnCl2             1.207e-013  1.308e-013   -12.918   -12.883       0.035
    CdCl2             3.596e-015  3.896e-015   -14.444   -14.409       0.035
    PbCl2             1.061e-015  1.150e-015   -14.974   -14.939       0.035
    ZnCl3-            3.881e-018  2.839e-018   -17.411   -17.547      -0.136
    FeCl3             2.848e-019  3.085e-019   -18.545   -18.511       0.035
    CdCl3-            6.501e-020  4.756e-020   -19.187   -19.323      -0.136
    PbCl3-            2.415e-020  1.767e-020   -19.617   -19.753      -0.136
    ZnCl4-2           9.613e-023  2.752e-023   -22.017   -22.560      -0.543
    PbCl4-2           5.714e-025  1.636e-025   -24.243   -24.786      -0.543
Cu(1)            1.179e-016
    Cu+               1.179e-016  7.400e-017   -15.928   -16.131      -0.202
Cu(2)            9.346e-007
    CuSO4             5.757e-007  6.237e-007    -6.240    -6.205       0.035
    Cu+2              3.588e-007  9.982e-008    -6.445    -7.001      -0.556
    CuOH+             1.401e-011  9.492e-012   -10.853   -11.023      -0.169
    Cu(OH)2           1.741e-013  1.886e-013   -12.759   -12.725       0.035
    Cu(OH)3-          1.477e-022  1.080e-022   -21.831   -21.966      -0.136
    Cu(OH)4-2         7.159e-031  2.050e-031   -30.145   -30.688      -0.543
Fe(2)            4.029e-004
    FeSO4             2.347e-004  2.542e-004    -3.629    -3.595       0.035
    Fe+2              1.679e-004  4.672e-005    -3.775    -4.330      -0.556
    FeHSO4+           2.392e-007  1.750e-007    -6.621    -6.757      -0.136
    FeCl+             1.706e-009  1.248e-009    -8.768    -8.904      -0.136
    FeOH+             1.921e-010  1.405e-010    -9.717    -9.852      -0.136
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Fe(3)		5.226e-003				
	FeSO4+	1.449e-003	1.060e-003	-2.839	-2.975	-0.136
	Fe(SO4)2-	9.700e-004	7.095e-004	-3.013	-3.149	-0.136
	Fe(OH)2+	8.348e-004	6.106e-004	-3.078	-3.214	-0.136
	FeOH+2	6.773e-004	1.939e-004	-3.169	-3.712	-0.543
	Fe3(OH)4+5	3.204e-004	1.291e-007	-3.494	-6.889	-3.395
	Fe2(OH)2+4	1.506e-004	1.012e-006	-3.822	-5.995	-2.173
	Fe+3	3.055e-005	3.159e-006	-4.515	-5.500	-0.985
	FeHSO4+2	1.038e-006	2.972e-007	-5.984	-6.527	-0.543
	Fe(OH)3	6.905e-007	7.480e-007	-6.161	-6.126	0.035
	FeCl+2	6.446e-009	1.846e-009	-8.191	-8.734	-0.543
	Fe(OH)4-	8.868e-012	6.487e-012	-11.052	-11.188	-0.136
	FeCl2+	2.180e-013	1.595e-013	-12.662	-12.797	-0.136
	FeCl3	2.848e-019	3.085e-019	-18.545	-18.511	0.035
H(0)		2.859e-035				
	H2	1.430e-035	1.549e-035	-34.845	-34.810	0.035
K		1.047e-004				
	K+	8.751e-005	5.865e-005	-4.058	-4.232	-0.174
	KSO4-	1.724e-005	1.261e-005	-4.763	-4.899	-0.136
	KOH	1.785e-015	1.934e-015	-14.748	-14.714	0.035
Mg		1.078e-001				
	MgSO4	7.230e-002	7.833e-002	-1.141	-1.106	0.035
	Mg+2	3.551e-002	1.092e-002	-1.450	-1.962	-0.512
	MgOH+	5.153e-010	3.770e-010	-9.288	-9.424	-0.136
Na		2.672e-004				
	Na+	2.322e-004	1.670e-004	-3.634	-3.777	-0.143
	NaSO4-	3.501e-005	2.561e-005	-4.456	-4.592	-0.136
	NaOH	9.685e-015	1.049e-014	-14.014	-13.979	0.035
O(0)		3.181e-023				
	O2	1.590e-023	1.723e-023	-22.798	-22.764	0.035
Pb		1.413e-006				
	PbSO4	7.734e-007	8.378e-007	-6.112	-6.077	0.035
	Pb(SO4)2-2	4.699e-007	1.345e-007	-6.328	-6.871	-0.543
	Pb+2	1.700e-007	4.869e-008	-6.769	-7.313	-0.543
	PbCl+	5.126e-011	3.750e-011	-10.290	-10.426	-0.136
	PbOH+	1.234e-011	9.027e-012	-10.909	-11.044	-0.136
	PbCl2	1.061e-015	1.150e-015	-14.974	-14.939	0.035
	Pb2OH+3	1.641e-016	9.839e-018	-15.785	-17.007	-1.222
	Pb(OH)2	3.083e-017	3.339e-017	-16.511	-16.476	0.035
	PbCl3-	2.415e-020	1.767e-020	-19.617	-19.753	-0.136
	Pb(OH)3-	4.984e-024	3.646e-024	-23.302	-23.438	-0.136
	PbCl4-2	5.714e-025	1.636e-025	-24.243	-24.786	-0.543
	Pb(OH)4-2	2.774e-031	7.942e-032	-30.557	-31.100	-0.543
S(6)		2.132e-001				
	SO4-2	1.288e-001	3.060e-002	-0.890	-1.514	-0.624
	MgSO4	7.230e-002	7.833e-002	-1.141	-1.106	0.035
	CaSO4	5.595e-003	6.061e-003	-2.252	-2.217	0.035
	FeSO4+	1.449e-003	1.060e-003	-2.839	-2.975	-0.136
	Fe(SO4)2-	9.700e-004	7.095e-004	-3.013	-3.149	-0.136
	ZnSO4	8.210e-004	8.893e-004	-3.086	-3.051	0.035
	Zn(SO4)2-2	7.726e-004	2.212e-004	-3.112	-3.655	-0.543
	HSO4-	4.259e-004	3.115e-004	-3.371	-3.506	-0.136
	FeSO4	2.347e-004	2.542e-004	-3.629	-3.595	0.035
	NaSO4-	3.501e-005	2.561e-005	-4.456	-4.592	-0.136
	KSO4-	1.724e-005	1.261e-005	-4.763	-4.899	-0.136
	CaHSO4+	5.083e-006	3.718e-006	-5.294	-5.430	-0.136
	FeHSO4+2	1.038e-006	2.972e-007	-5.984	-6.527	-0.543
	PbSO4	7.734e-007	8.378e-007	-6.112	-6.077	0.035
	CuSO4	5.757e-007	6.237e-007	-6.240	-6.205	0.035
	Pb(SO4)2-2	4.699e-007	1.345e-007	-6.328	-6.871	-0.543
	Cd(SO4)2-2	2.704e-007	7.742e-008	-6.568	-7.111	-0.543
	FeHSO4+	2.392e-007	1.750e-007	-6.621	-6.757	-0.136
	CdSO4	2.130e-007	2.308e-007	-6.672	-6.637	0.035
Zn		2.099e-003				
	ZnSO4	8.210e-004	8.893e-004	-3.086	-3.051	0.035
	Zn(SO4)2-2	7.726e-004	2.212e-004	-3.112	-3.655	-0.543
	Zn+2	5.054e-004	1.240e-004	-3.296	-3.907	-0.610
	ZnCl+	8.825e-009	6.455e-009	-8.054	-8.190	-0.136
	ZnOH+	1.767e-009	1.293e-009	-8.753	-8.889	-0.136
	Zn(OH)2	1.303e-013	1.411e-013	-12.885	-12.850	0.035
	ZnCl2	1.207e-013	1.308e-013	-12.918	-12.883	0.035
	ZnCl3-	3.881e-018	2.839e-018	-17.411	-17.547	-0.136

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    Zn(OH)3-         5.801e-021  4.243e-021   -20.237   -20.372    -0.136
    ZnCl4-2          9.613e-023  2.752e-023   -22.017   -22.560    -0.543
    Zn(OH)4-2        2.233e-029  6.395e-030   -28.651   -29.194    -0.543

------------------------------Saturation indices-------------------------------

    Phase                SI log IAP  log KT

    Anglesite        -1.04   -8.83   -7.79  PbSO4
    Anhydrite        -0.16   -4.52   -4.36  CaSO4
    Cd(OH)2         -13.28    0.37   13.65  Cd(OH)2
    CdSO4            -9.00   -9.10   -0.10  CdSO4
    Fe(OH)3(a)        1.54    6.43    4.89  Fe(OH)3
    Goethite          7.44    6.44   -1.00  FeOOH
    Gypsum            0.06   -4.52   -4.58  CaSO4:2H2O
    H2(g)           -31.66  -34.81   -3.15  H2
    H2O(g)           -1.51   -0.00    1.51  H2O
    Halite          -10.07   -8.49    1.58  NaCl
    Hematite         16.88   12.87   -4.01  Fe2O3
    Jarosite-K        9.32    0.11   -9.21  KFe3(SO4)2(OH)6
    Melanterite      -3.65   -5.86   -2.21  FeSO4:7H2O
    O2(g)           -19.80  -22.76   -2.96  O2
    Pb(OH)2          -7.51    0.64    8.15  Pb(OH)2
    Zn(OH)2(e)       -7.45    4.05   11.50  Zn(OH)2

Initial solution 3.   NAF Leachate

-----------------------------Solution composition------------------------------

    Elements           Molality       Moles

    Ca               4.825e-003  4.825e-003
    Cd               2.229e-008  2.229e-008
    Cl               1.809e-003  1.809e-003
    Cu               7.884e-008  7.884e-008
    Fe               1.794e-007  1.794e-007
    K                9.738e-004  9.738e-004
    Mg               9.315e-003  9.315e-003
    Na               2.659e-003  2.659e-003
    Pb               2.418e-008  2.418e-008
    S(6)             1.512e-002  1.512e-002
    Zn               2.345e-005  2.345e-005

----------------------------Description of solution----------------------------

                                       pH  =   6.500
                                       pe  =   1.840
                        Activity of water  =   0.999
                           Ionic strength  =  4.115e-002
                       Mass of water (kg)  =  1.000e+000
                 Total alkalinity (eq/kg)  = -4.358e-007
                    Total carbon (mol/kg)  =  0.000e+000
                       Total CO2 (mol/kg)  =  0.000e+000
                      Temperature (deg C)  =  25.000
                  Electrical balance (eq)  = -9.827e-005
 Percent error, 100*(Cat-|An|)/(Cat+|An|)  =  -0.22
                               Iterations  =   6
                                  Total H  = 1.110124e+002
                                  Total O  = 5.556672e+001

----------------------------Distribution of species----------------------------

                                                    Log       Log         Log
    Species            Molality    Activity  Molality  Activity       Gamma

    H+               3.669e-007  3.162e-007    -6.435    -6.500    -0.065
    OH-              3.837e-008  3.164e-008    -7.416    -7.500    -0.084
    H2O              5.551e+001  9.995e-001     1.744    -0.000     0.000
Ca              4.825e-003
    Ca+2             3.257e-003  1.620e-003    -2.487    -2.790    -0.303
    CaSO4            1.568e-003  1.583e-003    -2.805    -2.800     0.004
    CaHSO4+          3.523e-009  2.933e-009    -8.453    -8.533    -0.080
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CaOH+	1.021e-009	8.498e-010	-8.991	-9.071	-0.080
Cd	2.229e-008				
Cd+2	1.217e-008	5.847e-009	-7.915	-8.233	-0.318
CdSO4	8.183e-009	8.260e-009	-8.087	-8.083	0.004
CdCl+	1.002e-009	8.340e-010	-8.999	-9.079	-0.080
Cd(SO4)2-2	9.236e-010	4.437e-010	-9.035	-9.353	-0.318
CdCl2	5.144e-012	5.193e-012	-11.289	-11.285	0.004
CdOH+	1.846e-012	1.537e-012	-11.734	-11.813	-0.080
CdCl3-	5.878e-015	4.894e-015	-14.231	-14.310	-0.080
Cd(OH)2	2.585e-016	2.609e-016	-15.588	-15.583	0.004
Cd(OH)3-	1.111e-022	9.253e-023	-21.954	-22.034	-0.080
Cd(OH)4-2	5.426e-030	2.607e-030	-29.266	-29.584	-0.318
Cl	1.809e-003				
Cl-	1.809e-003	1.494e-003	-2.743	-2.826	-0.083
ZnCl+	3.449e-008	2.871e-008	-7.462	-7.542	-0.080
CdCl+	1.002e-009	8.340e-010	-8.999	-9.079	-0.080
PbCl+	3.384e-010	2.817e-010	-9.471	-9.550	-0.080
FeCl+	1.564e-010	1.302e-010	-9.806	-9.885	-0.080
ZnCl2	4.448e-011	4.491e-011	-10.352	-10.348	0.004
CdCl2	5.144e-012	5.193e-012	-11.289	-11.285	0.004
PbCl2	6.607e-013	6.669e-013	-12.180	-12.176	0.004
ZnCl3-	9.039e-014	7.526e-014	-13.044	-13.123	-0.080
CdCl3-	5.878e-015	4.894e-015	-14.231	-14.310	-0.080
PbCl3-	9.504e-016	7.913e-016	-15.022	-15.102	-0.080
ZnCl4-2	1.173e-016	5.633e-017	-15.931	-16.249	-0.318
PbCl4-2	1.178e-018	5.657e-019	-17.929	-18.247	-0.318
FeCl+2	3.919e-020	1.882e-020	-19.407	-19.725	-0.318
FeCl2+	1.509e-022	1.256e-022	-21.821	-21.901	-0.080
FeCl3	1.858e-026	1.876e-026	-25.731	-25.727	0.004
Cu(1)	5.862e-008				
Cu+	5.862e-008	4.780e-008	-7.232	-7.321	-0.089
Cu(2)	2.022e-008				
Cu+2	1.244e-008	6.302e-009	-7.905	-8.201	-0.295
CuSO4	6.243e-009	6.303e-009	-8.205	-8.200	0.004
Cu(OH)2	1.303e-009	1.315e-009	-8.885	-8.881	0.004
CuOH+	2.403e-010	1.992e-010	-9.619	-9.701	-0.082
Cu(OH)3-	3.009e-016	2.505e-016	-15.522	-15.601	-0.080
Cu(OH)4-2	3.289e-022	1.580e-022	-21.483	-21.801	-0.318
Fe(2)	1.794e-007				
Fe+2	1.247e-007	6.317e-008	-6.904	-7.200	-0.295
FeSO4	5.450e-008	5.502e-008	-7.264	-7.259	0.004
FeCl+	1.564e-010	1.302e-010	-9.806	-9.885	-0.080
FeOH+	7.584e-011	6.314e-011	-10.120	-10.200	-0.080
FeHSO4+	1.374e-013	1.144e-013	-12.862	-12.942	-0.080
Fe(3)	1.433e-011				
Fe(OH)2+	1.071e-011	8.914e-012	-10.970	-11.050	-0.080
Fe(OH)3	3.595e-012	3.629e-012	-11.444	-11.440	0.004
FeOH+2	1.773e-014	8.517e-015	-13.751	-14.070	-0.318
Fe(OH)4-	1.257e-014	1.046e-014	-13.901	-13.980	-0.080
FeSO4+	2.693e-017	2.242e-017	-16.570	-16.649	-0.080
Fe(SO4)2-	2.885e-018	2.402e-018	-17.540	-17.619	-0.080
Fe+3	1.592e-018	4.173e-019	-17.798	-18.380	-0.581
FeCl+2	3.919e-020	1.882e-020	-19.407	-19.725	-0.318
FeCl2+	1.509e-022	1.256e-022	-21.821	-21.901	-0.080
FeHSO4+2	3.951e-023	1.898e-023	-22.403	-22.722	-0.318
Fe2(OH)2+4	3.667e-026	1.952e-027	-25.436	-26.709	-1.274
FeCl3	1.858e-026	1.876e-026	-25.731	-25.727	0.004
Fe3(OH)4+5	3.554e-034	3.636e-036	-33.449	-35.439	-1.990
H(0)	2.930e-020				
H2	1.465e-020	1.479e-020	-19.834	-19.830	0.004
K	9.738e-004				
K+	9.417e-004	7.775e-004	-3.026	-3.109	-0.083
KSO4-	3.215e-005	2.676e-005	-4.493	-4.572	-0.080
KOH	8.441e-012	8.521e-012	-11.074	-11.069	0.004
Mg	9.315e-003				
Mg+2	5.904e-003	2.998e-003	-2.229	-2.523	-0.294
MgSO4	3.411e-003	3.443e-003	-2.467	-2.463	0.004
MgOH+	4.133e-008	3.441e-008	-7.384	-7.463	-0.080
Na	2.659e-003				
Na+	2.595e-003	2.166e-003	-2.586	-2.664	-0.078
NaSO4-	6.387e-005	5.317e-005	-4.195	-4.274	-0.080
NaOH	4.480e-011	4.523e-011	-10.349	-10.345	0.004

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O(0)            0.000e+000
    O2               0.000e+000  0.000e+000   -52.725   -52.720     0.004
Pb              2.418e-008
    PbSO4            1.293e-008  1.305e-008    -7.888    -7.884     0.004
    Pb+2             9.864e-009  4.738e-009    -8.006    -8.324    -0.318
    Pb(SO4)2-2       6.985e-010  3.355e-010    -9.156    -9.474    -0.318
    PbOH+            3.508e-010  2.920e-010    -9.455    -9.535    -0.080
    PbCl+            3.384e-010  2.817e-010    -9.471    -9.550    -0.080
    PbCl2            6.607e-013  6.669e-013   -12.180   -12.176     0.004
    Pb(OH)2          3.557e-013  3.591e-013   -12.449   -12.445     0.004
    PbCl3-           9.504e-016  7.913e-016   -15.022   -15.102    -0.080
    Pb2OH+3          1.612e-016  3.098e-017   -15.793   -16.509    -0.716
    Pb(OH)3-         1.565e-017  1.303e-017   -16.805   -16.885    -0.080
    PbCl4-2          1.178e-018  5.657e-019   -17.929   -18.247    -0.318
    Pb(OH)4-2        1.964e-022  9.435e-023   -21.707   -22.025    -0.318
S(6)            1.512e-002
    SO4-2            1.004e-002  4.898e-003    -1.998    -2.310    -0.312
    MgSO4            3.411e-003  3.443e-003    -2.467    -2.463     0.004
    CaSO4            1.568e-003  1.583e-003    -2.805    -2.800     0.004
    NaSO4-           6.387e-005  5.317e-005    -4.195    -4.274    -0.080
    KSO4-            3.215e-005  2.676e-005    -4.493    -4.572    -0.080
    ZnSO4            8.124e-006  8.201e-006    -5.090    -5.086     0.004
    Zn(SO4)2-2       6.798e-007  3.265e-007    -6.168    -6.486    -0.318
    HSO4-            1.809e-007  1.506e-007    -6.743    -6.822    -0.080
    FeSO4            5.450e-008  5.502e-008    -7.264    -7.259     0.004
    PbSO4            1.293e-008  1.305e-008    -7.888    -7.884     0.004
    CdSO4            8.183e-009  8.260e-009    -8.087    -8.083     0.004
    CuSO4            6.243e-009  6.303e-009    -8.205    -8.200     0.004
    CaHSO4+          3.523e-009  2.933e-009    -8.453    -8.533    -0.080
    Cd(SO4)2-2       9.236e-010  4.437e-010    -9.035    -9.353    -0.318
    Pb(SO4)2-2       6.985e-010  3.355e-010    -9.156    -9.474    -0.318
    FeHSO4+          1.374e-013  1.144e-013   -12.862   -12.942    -0.080
    FeSO4+           2.693e-017  2.242e-017   -16.570   -16.649    -0.080
    Fe(SO4)2-        2.885e-018  2.402e-018   -17.540   -17.619    -0.080
    FeHSO4+2         3.951e-023  1.898e-023   -22.403   -22.722    -0.318
Zn              2.345e-005
    Zn+2             1.458e-005  7.142e-006    -4.836    -5.146    -0.310
    ZnSO4            8.124e-006  8.201e-006    -5.090    -5.086     0.004
    Zn(SO4)2-2       6.798e-007  3.265e-007    -6.168    -6.486    -0.318
    ZnCl+            3.449e-008  2.871e-008    -7.462    -7.542    -0.080
    ZnOH+            2.973e-008  2.475e-008    -7.527    -7.606    -0.080
    Zn(OH)2          8.898e-010  8.983e-010    -9.051    -9.047     0.004
    ZnCl2            4.448e-011  4.491e-011   -10.352   -10.348     0.004
    ZnCl3-           9.039e-014  7.526e-014   -13.044   -13.123    -0.080
    Zn(OH)3-         1.078e-014  8.978e-015   -13.967   -14.047    -0.080
    ZnCl4-2          1.173e-016  5.633e-017   -15.931   -16.249    -0.318
    Zn(OH)4-2        9.362e-021  4.497e-021   -20.029   -20.347    -0.318

------------------------------Saturation indices-------------------------------

    Phase               SI log IAP  log KT

    Anglesite        -2.84  -10.63   -7.79  PbSO4
    Anhydrite        -0.74   -5.10   -4.36  CaSO4
    Cd(OH)2          -8.88    4.77   13.65  Cd(OH)2
    CdSO4           -10.44  -10.54   -0.10  CdSO4
    Fe(OH)3(a)       -3.77    1.12    4.89  Fe(OH)3
    Goethite          2.12    1.12   -1.00  FeOOH
    Gypsum           -0.52   -5.10   -4.58  CaSO4:2H2O
    H2(g)           -16.68  -19.83   -3.15  H2
    H2O(g)           -1.51   -0.00    1.51  H2O
    Halite           -7.07   -5.49    1.58  NaCl
    Hematite          6.25    2.24   -4.01  Fe2O3
    Jarosite-K      -14.66  -23.87   -9.21  KFe3(SO4)2(OH)6
    Melanterite      -7.30   -9.51   -2.21  FeSO4:7H2O
    O2(g)           -49.76  -52.72   -2.96  O2
    Pb(OH)2          -3.47    4.68    8.15  Pb(OH)2
    Zn(OH)2(e)       -3.65    7.85   11.50  Zn(OH)2

Initial solution 4.   Rainwater

-----------------------------Solution composition------------------------------
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    Elements             Molality       Moles

    Ca                  2.500e-006  2.500e-006
    Cl                  6.699e-006  6.699e-006
    K                   1.499e-006  1.499e-006
    Mg                  1.300e-006  1.300e-006
    Na                  6.903e-006  6.903e-006
    S(6)                8.100e-006  8.100e-006
    Zn                  1.530e-007  1.530e-007

----------------------------Description of solution----------------------------

                                       pH  =   4.590
                                       pe  =  10.150
                        Activity of water  =   1.000
                           Ionic strength  =  4.455e-005
                       Mass of water (kg)  =  1.000e+000
                 Total alkalinity (eq/kg)  = -2.592e-005
                    Total carbon (mol/kg)  =  0.000e+000
                       Total CO2 (mol/kg)  =  0.000e+000
                      Temperature (deg C)  =  25.000
                  Electrical balance (eq)  =  1.933e-005
 Percent error, 100*(Cat-|An|)/(Cat+|An|)  =  29.71
                               Iterations  =   3
                                  Total H  = 1.110125e+002
                                  Total O  = 5.550625e+001

----------------------------Distribution of species----------------------------

                                                Log       Log         Log
    Species              Molality    Activity  Molality  Activity     Gamma

    H+                  2.590e-005  2.570e-005    -4.587    -4.590    -0.003
    OH-                 3.925e-010  3.895e-010    -9.406    -9.410    -0.003
    H2O                 5.551e+001  1.000e+000     1.744    -0.000     0.000
Ca                 2.500e-006
    Ca+2                2.496e-006  2.420e-006    -5.603    -5.616    -0.013
    CaSO4               3.780e-009  3.780e-009    -8.423    -8.423     0.000
    CaHSO4+             5.736e-013  5.691e-013   -12.241   -12.245    -0.003
    CaOH+               1.575e-014  1.563e-014   -13.803   -13.806    -0.003
Cl                 6.699e-006
    Cl-                 6.699e-006  6.647e-006    -5.174    -5.177    -0.003
    ZnCl+               2.669e-012  2.649e-012   -11.574   -11.577    -0.003
    ZnCl2               1.844e-017  1.844e-017   -16.734   -16.734     0.000
    ZnCl3-              1.386e-022  1.375e-022   -21.858   -21.862    -0.003
    ZnCl4-2             4.725e-028  4.581e-028   -27.326   -27.339    -0.013
H(0)               4.688e-033
    H2                  2.344e-033  2.344e-033   -32.630   -32.630     0.000
K                  1.499e-006
    K+                  1.499e-006  1.487e-006    -5.824    -5.828    -0.003
    KSO4-               8.242e-011  8.178e-011   -10.084   -10.087    -0.003
    KOH                 2.006e-016  2.006e-016   -15.698   -15.698     0.000
Mg                 1.300e-006
    Mg+2                1.297e-006  1.258e-006    -5.887    -5.900    -0.013
    MgSO4               2.308e-009  2.308e-009    -8.637    -8.637     0.000
    MgOH+               1.791e-013  1.777e-013   -12.747   -12.750    -0.003
Na                 6.903e-006
    Na+                 6.902e-006  6.849e-006    -5.161    -5.164    -0.003
    NaSO4-              2.708e-010  2.687e-010    -9.567    -9.571    -0.003
    NaOH                1.760e-015  1.760e-015   -14.754   -14.754     0.000
O(0)               1.517e-027
    O2                  7.586e-028  7.586e-028   -27.120   -27.120     0.000
S(6)               8.100e-006
    SO4-2               8.073e-006  7.827e-006    -5.093    -5.106    -0.013
    HSO4-               1.971e-008  1.956e-008    -7.705    -7.709    -0.003
    CaSO4               3.780e-009  3.780e-009    -8.423    -8.423     0.000
    MgSO4               2.308e-009  2.308e-009    -8.637    -8.637     0.000
    ZnSO4               2.716e-010  2.716e-010    -9.566    -9.566     0.000
    NaSO4-              2.708e-010  2.687e-010    -9.567    -9.571    -0.003
    KSO4-               8.242e-011  8.178e-011   -10.084   -10.087    -0.003
    CaHSO4+             5.736e-013  5.691e-013   -12.241   -12.245    -0.003
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    Zn(SO4)2-2        1.783e-014  1.728e-014   -13.749   -13.762    -0.013
Zn            1.530e-007
    Zn+2              1.527e-007  1.480e-007    -6.816    -6.830    -0.013
    ZnSO4             2.716e-010  2.716e-010    -9.566    -9.566     0.000
    ZnOH+             6.364e-012  6.315e-012   -11.196   -11.200    -0.003
    ZnCl+             2.669e-012  2.649e-012   -11.574   -11.577    -0.003
    Zn(SO4)2-2        1.783e-014  1.728e-014   -13.749   -13.762    -0.013
    Zn(OH)2           2.821e-015  2.821e-015   -14.550   -14.550     0.000
    ZnCl2             1.844e-017  1.844e-017   -16.734   -16.734     0.000
    Zn(OH)3-          3.497e-022  3.470e-022   -21.456   -21.460    -0.003
    ZnCl3-            1.386e-022  1.375e-022   -21.858   -21.862    -0.003
    ZnCl4-2           4.725e-028  4.581e-028   -27.326   -27.339    -0.013
    Zn(OH)4-2         2.207e-030  2.140e-030   -29.656   -29.670    -0.013

------------------------------Saturation indices------------------------------

    Phase               SI log IAP  log KT

    Anhydrite        -6.36  -10.72   -4.36  CaSO4
    Gypsum           -6.14  -10.72   -4.58  CaSO4:2H2O
    H2(g)           -29.48  -32.63   -3.15  H2
    H2O(g)           -1.51   -0.00    1.51  H2O
    Halite          -11.92  -10.34    1.58  NaCl
    O2(g)           -24.16  -27.12   -2.96  O2
    Zn(OH)2(e)       -9.15    2.35   11.50  Zn(OH)2

Initial solution 5.   Tailings Seepage

-----------------------------Solution composition------------------------------

    Elements           Molality       Moles

    Ca                1.024e-002  1.024e-002
    Cd                7.216e-010  7.216e-010
    Cl                7.463e-002  7.463e-002
    Cu                2.776e-007  2.776e-007
    Fe                5.718e-008  5.718e-008
    K                 7.700e-003  7.700e-003
    Mg                4.462e-002  4.462e-002
    Na                1.336e-001  1.336e-001
    Pb                1.419e-009  1.419e-009
    S(6)              6.532e-002  6.532e-002
    Zn                5.071e-006  5.071e-006

----------------------------Description of solution----------------------------

                                       pH  =   6.560
                                       pe  =   1.690
                        Activity of water  =   0.995
                           Ionic strength  =  2.457e-001
                       Mass of water (kg)  =  1.000e+000
                 Total alkalinity (eq/kg)  = -4.947e-007
                    Total carbon (mol/kg)  =  0.000e+000
                       Total CO2 (mol/kg)  =  0.000e+000
                      Temperature (deg C)  =  25.000
                  Electrical balance (eq)  =  4.577e-002
 Percent error, 100*(Cat-|An|)/(Cat+|An|)  =  12.94
                               Iterations  =   8
                                  Total H  = 1.110124e+002
                                  Total O  = 5.576752e+001

----------------------------Distribution of species----------------------------

                                                Log       Log         Log
    Species            Molality    Activity  Molality  Activity      Gamma

    H+                3.487e-007  2.754e-007    -6.458    -6.560    -0.102
    OH-               5.236e-008  3.616e-008    -7.281    -7.442    -0.161
    H2O               5.551e+001  9.948e-001     1.744    -0.002     0.000
Ca            1.024e-002
    Ca+2              6.543e-003  1.993e-003    -2.184    -2.700    -0.516
    CaSO4             3.701e-003  3.916e-003    -2.432    -2.407     0.025
```

	CaHSO4+	8.548e-009	6.319e-009	-8.068	-8.199	-0.131
	CaOH+	1.616e-009	1.195e-009	-8.791	-8.923	-0.131
Cd		7.216e-010				
	CdCl+	3.265e-010	2.414e-010	-9.486	-9.617	-0.131
	Cd+2	1.629e-010	4.863e-011	-9.788	-10.313	-0.525
	CdSO4	1.305e-010	1.381e-010	-9.884	-9.860	0.025
	Cd(SO4)2-2	4.993e-011	1.491e-011	-10.302	-10.827	-0.525
	CdCl2	4.942e-011	5.229e-011	-10.306	-10.282	0.025
	CdCl3-	2.320e-012	1.715e-012	-11.635	-11.766	-0.131
	CdOH+	1.976e-014	1.461e-014	-13.704	-13.835	-0.131
	Cd(OH)2	2.678e-018	2.834e-018	-17.572	-17.548	0.025
	Cd(OH)3-	1.553e-024	1.148e-024	-23.809	-23.940	-0.131
	Cd(OH)4-2	1.238e-031	3.696e-032	-30.907	-31.432	-0.525
Cl		7.463e-002				
	Cl-	7.463e-002	5.197e-002	-1.127	-1.284	-0.157
	ZnCl+	1.453e-007	1.074e-007	-6.838	-6.969	-0.131
	ZnCl2	5.523e-009	5.845e-009	-8.258	-8.233	0.025
	FeCl+	1.111e-009	8.211e-010	-8.954	-9.086	-0.131
	ZnCl3-	4.611e-010	3.408e-010	-9.336	-9.467	-0.131
	CdCl+	3.265e-010	2.414e-010	-9.486	-9.617	-0.131
	PbCl+	3.151e-010	2.329e-010	-9.502	-9.633	-0.131
	CdCl2	4.942e-011	5.229e-011	-10.306	-10.282	0.025
	ZnCl4-2	2.974e-011	8.878e-012	-10.527	-11.052	-0.525
	PbCl2	1.813e-011	1.919e-011	-10.742	-10.717	0.025
	CdCl3-	2.320e-012	1.715e-012	-11.635	-11.766	-0.131
	PbCl3-	1.072e-012	7.921e-013	-11.970	-12.101	-0.131
	PbCl4-2	6.600e-014	1.970e-014	-13.180	-13.705	-0.525
	FeCl+2	2.814e-019	8.403e-020	-18.551	-19.076	-0.525
	FeCl2+	2.639e-020	1.951e-020	-19.579	-19.710	-0.131
	FeCl3	9.581e-023	1.014e-022	-22.019	-21.994	0.025
Cu(1)		2.077e-007				
	Cu+	2.077e-007	1.374e-007	-6.683	-6.862	-0.179
Cu(2)		6.990e-008				
	Cu+2	4.158e-008	1.282e-008	-7.381	-7.892	-0.511
	CuSO4	2.436e-008	2.578e-008	-7.613	-7.589	0.025
	Cu(OH)2	3.303e-009	3.495e-009	-8.481	-8.457	0.025
	CuOH+	6.586e-010	4.631e-010	-9.181	-9.334	-0.153
	Cu(OH)3-	1.029e-015	7.606e-016	-14.988	-15.119	-0.131
	Cu(OH)4-2	1.836e-021	5.481e-022	-20.736	-21.261	-0.525
Fe(2)		5.718e-008				
	Fe+2	3.711e-008	1.145e-008	-7.430	-7.941	-0.511
	FeSO4	1.894e-008	2.004e-008	-7.723	-7.698	0.025
	FeCl+	1.111e-009	8.211e-010	-8.954	-9.086	-0.131
	FeOH+	1.768e-011	1.307e-011	-10.752	-10.884	-0.131
	FeHSO4+	4.908e-014	3.628e-014	-13.309	-13.440	-0.131
Fe(3)		2.684e-012				
	Fe(OH)2+	2.020e-012	1.493e-012	-11.695	-11.826	-0.131
	Fe(OH)3	6.565e-013	6.947e-013	-12.183	-12.158	0.025
	FeOH+2	4.181e-015	1.248e-015	-14.379	-14.904	-0.525
	Fe(OH)4-	3.096e-015	2.288e-015	-14.509	-14.640	-0.131
	FeSO4+	7.818e-018	5.779e-018	-17.107	-17.238	-0.131
	Fe(SO4)2-	1.684e-018	1.245e-018	-17.774	-17.905	-0.131
	Fe+3	4.472e-019	5.353e-020	-18.350	-19.271	-0.922
	FeCl+2	2.814e-019	8.403e-020	-18.551	-19.076	-0.525
	FeCl2+	2.639e-020	1.951e-020	-19.579	-19.710	-0.131
	FeCl3	9.581e-023	1.014e-022	-22.019	-21.994	0.025
	FeHSO4+2	1.428e-023	4.262e-024	-22.845	-23.370	-0.525
	Fe2(OH)2+4	5.280e-027	4.195e-029	-26.277	-28.377	-2.100
	Fe3(OH)4+5	2.500e-035	1.309e-038	-34.602	-37.883	-3.281
H(0)		4.231e-020				
	H2	2.116e-020	2.239e-020	-19.675	-19.650	0.025
K		7.700e-003				
	K+	7.229e-003	5.034e-003	-2.141	-2.298	-0.157
	KSO4-	4.712e-004	3.483e-004	-3.327	-3.458	-0.131
	KOH	5.958e-011	6.305e-011	-10.225	-10.200	0.025
Mg		4.462e-002				
	Mg+2	2.600e-002	8.536e-003	-1.585	-2.069	-0.484
	MgSO4	1.862e-002	1.970e-002	-1.730	-1.705	0.025
	MgOH+	1.514e-007	1.119e-007	-6.820	-6.951	-0.131
Na		1.336e-001				
	Na+	1.274e-001	9.346e-002	-0.895	-1.029	-0.134
	NaSO4-	6.239e-003	4.612e-003	-2.205	-2.336	-0.131

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     NaOH              2.108e-009  2.230e-009    -8.676    -8.652     0.025
O(0)              0.000e+000
     O2                0.000e+000  0.000e+000   -53.109   -53.085     0.025
Pb                1.419e-009
     PbSO4             5.890e-010  6.233e-010    -9.230    -9.205     0.025
     Pb+2              3.770e-010  1.126e-010    -9.424    -9.949    -0.525
     PbCl+             3.151e-010  2.329e-010    -9.502    -9.633    -0.131
     Pb(SO4)2-2        1.079e-010  3.220e-011    -9.967   -10.492    -0.525
     PbCl2             1.813e-011  1.919e-011   -10.742   -10.717     0.025
     PbOH+             1.072e-011  7.928e-012   -10.970   -11.101    -0.131
     PbCl3-            1.072e-012  7.921e-013   -11.970   -12.101    -0.131
     PbCl4-2           6.600e-014  1.970e-014   -13.180   -13.705    -0.525
     Pb(OH)2           1.053e-014  1.114e-014   -13.978   -13.953     0.025
     Pb(OH)3-          6.249e-019  4.619e-019   -18.204   -18.335    -0.131
     Pb2OH+3           3.032e-019  1.998e-020   -18.518   -19.699    -1.181
     Pb(OH)4-2         1.280e-023  3.822e-024   -22.893   -23.418    -0.525
S(6)              6.532e-002
     SO4-2             3.629e-002  9.846e-003    -1.440    -2.007    -0.567
     MgSO4             1.862e-002  1.970e-002    -1.730    -1.705     0.025
     NaSO4-            6.239e-003  4.612e-003    -2.205    -2.336    -0.131
     CaSO4             3.701e-003  3.916e-003    -2.432    -2.407     0.025
     KSO4-             4.712e-004  3.483e-004    -3.327    -3.458    -0.131
     ZnSO4             1.674e-006  1.772e-006    -5.776    -5.752     0.025
     Zn(SO4)2-2        4.749e-007  1.418e-007    -6.323    -6.848    -0.525
     HSO4-             3.567e-007  2.636e-007    -6.448    -6.579    -0.131
     CuSO4             2.436e-008  2.578e-008    -7.613    -7.589     0.025
     FeSO4             1.894e-008  2.004e-008    -7.723    -7.698     0.025
     CaHSO4+           8.548e-009  6.319e-009    -8.068    -8.199    -0.131
     PbSO4             5.890e-010  6.233e-010    -9.230    -9.205     0.025
     CdSO4             1.305e-010  1.381e-010    -9.884    -9.860     0.025
     Pb(SO4)2-2        1.079e-010  3.220e-011    -9.967   -10.492    -0.525
     Cd(SO4)2-2        4.993e-011  1.491e-011   -10.302   -10.827    -0.525
     FeHSO4+           4.908e-014  3.628e-014   -13.309   -13.440    -0.131
     FeSO4+            7.818e-018  5.779e-018   -17.107   -17.238    -0.131
     Fe(SO4)2-         1.684e-018  1.245e-018   -17.774   -17.905    -0.131
     FeHSO4+2          1.428e-023  4.262e-024   -22.845   -23.370    -0.525
Zn                5.071e-006
     Zn+2              2.766e-006  7.677e-007    -5.558    -6.115    -0.557
     ZnSO4             1.674e-006  1.772e-006    -5.776    -5.752     0.025
     Zn(SO4)2-2        4.749e-007  1.418e-007    -6.323    -6.848    -0.525
     ZnCl+             1.453e-007  1.074e-007    -6.838    -6.969    -0.131
     ZnCl2             5.523e-009  5.845e-009    -8.258    -8.233     0.025
     ZnOH+             4.113e-009  3.040e-009    -8.386    -8.517    -0.131
     ZnCl3-            4.611e-010  3.408e-010    -9.336    -9.467    -0.131
     Zn(OH)2           1.191e-010  1.261e-010    -9.924    -9.899     0.025
     ZnCl4-2           2.974e-011  8.878e-012   -10.527   -11.052    -0.525
     Zn(OH)3-          1.948e-015  1.440e-015   -14.710   -14.842    -0.131
     Zn(OH)4-2         2.761e-021  8.243e-022   -20.559   -21.084    -0.525

------------------------------Saturation indices-------------------------------

     Phase               SI log IAP  log KT

     Anglesite        -4.17  -11.96   -7.79  PbSO4
     Anhydrite        -0.35   -4.71   -4.36  CaSO4
     Cd(OH)2         -10.85    2.80   13.65  Cd(OH)2
     CdSO4           -12.22  -12.32   -0.10  CdSO4
     Fe(OH)3(a)       -4.49    0.40    4.89  Fe(OH)3
     Goethite          1.40    0.40   -1.00  FeOOH
     Gypsum           -0.13   -4.71   -4.58  CaSO4:2H2O
     H2(g)           -16.50  -19.65   -3.15  H2
     H2O(g)           -1.51   -0.00    1.51  H2O
     Halite           -3.90   -2.31    1.58  NaCl
     Hematite          4.82    0.81   -4.01  Fe2O3
     Jarosite-K      -15.57  -24.78   -9.21  KFe3(SO4)2(OH)6
     Melanterite      -7.75   -9.96   -2.21  FeSO4:7H2O
     O2(g)           -50.12  -53.08   -2.96  O2
     Pb(OH)2          -4.98    3.17    8.15  Pb(OH)2
     Zn(OH)2(e)       -4.50    7.00   11.50  Zn(OH)2

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Beginning of batch-reaction calculations.
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Reaction step 1.

Using mix 1.  Mixing of water in open pit - worst case Scenario 1

Mixture 1.    Mixing of water in open pit - worst case Scenario 1

      0.000e+000 Solution 1River water
      7.270e-002 Solution 2PAF Leachate
      6.544e-001 Solution 3NAF Leachate
      2.410e-001 Solution 4Rainwater
      3.190e-002 Solution 5Tailings Seepage

-----------------------------Solution composition------------------------------

    Elements           Molality       Moles

    Ca               4.150e-003  4.150e-003
    Cd               5.640e-008  5.640e-008
    Cl               3.568e-003  3.568e-003
    Cu               1.284e-007  1.284e-007
    Fe               4.093e-004  4.093e-004
    K                8.909e-004  8.909e-004
    Mg               1.536e-002  1.536e-002
    Na               6.023e-003  6.023e-003
    Pb               1.186e-007  1.186e-007
    S                2.748e-002  2.748e-002
    Zn               1.681e-004  1.681e-004

----------------------------Description of solution----------------------------

                                       pH  =   3.981      Charge balance
                                       pe  =  11.966      Adjusted to redox equilibrium
                        Activity of water  =   0.999
                           Ionic strength  =  6.427e-002
                       Mass of water (kg)  =  1.000e+000
                 Total alkalinity (eq/kg)  = -5.217e-004
                    Total carbon (mol/kg)  =  0.000e+000
                       Total CO2 (mol/kg)  =  0.000e+000
                      Temperature (deg C)  =  25.000
                  Electrical balance (eq)  = -1.130e-002
 Percent error, 100*(Cat-|An|)/(Cat+|An|)  = -16.21
                               Iterations  =  11
                                  Total H  = 1.110128e+002
                                  Total O  = 5.561643e+001

----------------------------Distribution of species----------------------------

                                               Log       Log        Log
    Species            Molality    Activity  Molality  Activity    Gamma

    H+               1.239e-004  1.045e-004    -3.907    -3.981    -0.074
    OH-              1.205e-010  9.571e-011    -9.919   -10.019    -0.100
    H2O              5.551e+001  9.992e-001     1.744    -0.000     0.000
Ca              4.150e-003
    Ca+2             2.466e-003  1.091e-003    -2.608    -2.962    -0.354
    CaSO4            1.683e-003  1.708e-003    -2.774    -2.768     0.006
    CaHSO4+          1.296e-006  1.046e-006    -5.887    -5.981    -0.093
    CaOH+            2.146e-012  1.731e-012   -11.668   -11.762    -0.093
Cd              5.640e-008
    Cd+2             2.470e-008  1.047e-008    -7.607    -7.980    -0.373
    CdSO4            2.334e-008  2.369e-008    -7.632    -7.625     0.006
    Cd(SO4)2-2       4.806e-009  2.037e-009    -8.318    -8.691    -0.373
    CdCl+            3.520e-009  2.840e-009    -8.454    -8.547    -0.093
    CdCl2            3.313e-011  3.363e-011   -10.480   -10.473     0.006
    CdCl3-           7.468e-014  6.026e-014   -13.127   -13.220    -0.093
    CdOH+            1.032e-014  8.326e-015   -13.986   -14.080    -0.093
    Cd(OH)2          4.212e-021  4.275e-021   -20.376   -20.369     0.006
    Cd(OH)3-         5.683e-030  4.586e-030   -29.245   -29.339    -0.093
    Cd(OH)4-2        9.218e-040  3.908e-040   -39.035   -39.408    -0.373
Cl              3.568e-003
```

	Cl-	3.568e-003	2.840e-003	-2.448	-2.547	-0.099
	ZnCl+	3.609e-007	2.912e-007	-6.443	-6.536	-0.093
	FeCl+2	1.467e-007	6.220e-008	-6.833	-7.206	-0.373
	FeCl+	3.986e-008	3.216e-008	-7.400	-7.493	-0.093
	CdCl+	3.520e-009	2.840e-009	-8.454	-8.547	-0.093
	PbCl+	2.285e-009	1.844e-009	-8.641	-8.734	-0.093
	FeCl2+	9.780e-010	7.892e-010	-9.010	-9.103	-0.093
	ZnCl2	8.534e-010	8.661e-010	-9.069	-9.062	0.006
	CdCl2	3.313e-011	3.363e-011	-10.480	-10.473	0.006
	PbCl2	8.178e-012	8.300e-012	-11.087	-11.081	0.006
	ZnCl3-	3.421e-012	2.760e-012	-11.466	-11.559	-0.093
	FeCl3	2.209e-013	2.241e-013	-12.656	-12.649	0.006
	CdCl3-	7.468e-014	6.026e-014	-13.127	-13.220	-0.093
	PbCl3-	2.321e-014	1.873e-014	-13.634	-13.728	-0.093
	ZnCl4-2	9.269e-015	3.929e-015	-14.033	-14.406	-0.373
	PbCl4-2	6.005e-017	2.546e-017	-16.221	-16.594	-0.373
Cu(1)		2.457e-017				
	Cu+	2.457e-017	1.921e-017	-16.610	-16.716	-0.107
Cu(2)		1.284e-007				
	Cu+2	7.491e-008	3.389e-008	-7.125	-7.470	-0.344
	CuSO4	5.348e-008	5.428e-008	-7.272	-7.265	0.006
	CuOH+	4.050e-012	3.240e-012	-11.393	-11.489	-0.097
	Cu(OH)2	6.377e-014	6.472e-014	-13.195	-13.189	0.006
	Cu(OH)3-	4.621e-023	3.729e-023	-22.335	-22.428	-0.093
	Cu(OH)4-2	1.678e-031	7.113e-032	-30.775	-31.148	-0.373
Fe(2)		2.945e-005				
	Fe+2	1.813e-005	8.202e-006	-4.742	-5.086	-0.344
	FeSO4	1.127e-005	1.144e-005	-4.948	-4.941	0.006
	FeCl+	3.986e-008	3.216e-008	-7.400	-7.493	-0.093
	FeHSO4+	9.741e-009	7.860e-009	-8.011	-8.105	-0.093
	FeOH+	3.073e-011	2.480e-011	-10.512	-10.606	-0.093
	Fe(HS)2	0.000e+000	0.000e+000	-196.170	-196.163	0.006
	Fe(HS)3-	0.000e+000	0.000e+000	-294.047	-294.140	-0.093
Fe(3)		3.799e-004				
	Fe(OH)2+	1.756e-004	1.417e-004	-3.755	-3.849	-0.093
	FeOH+2	1.056e-004	4.476e-005	-3.976	-4.349	-0.373
	FeSO4+	7.730e-005	6.237e-005	-4.112	-4.205	-0.093
	Fe(SO4)2-	1.327e-005	1.070e-005	-4.877	-4.970	-0.093
	Fe+3	3.348e-006	7.252e-007	-5.475	-6.140	-0.664
	Fe2(OH)2+4	1.670e-006	5.393e-008	-5.777	-7.268	-1.491
	Fe3(OH)4+5	3.411e-007	1.597e-009	-6.467	-8.797	-2.330
	Fe(OH)3	1.720e-007	1.745e-007	-6.765	-6.758	0.006
	FeCl+2	1.467e-007	6.220e-008	-6.833	-7.206	-0.373
	FeHSO4+2	4.118e-008	1.746e-008	-7.385	-7.758	-0.373
	FeCl2+	9.780e-010	7.892e-010	-9.010	-9.103	-0.093
	Fe(OH)4-	1.886e-012	1.522e-012	-11.724	-11.818	-0.093
	FeCl3	2.209e-013	2.241e-013	-12.656	-12.649	0.006
H(0)		1.778e-035				
	H2	8.890e-036	9.022e-036	-35.051	-35.045	0.006
K		8.909e-004				
	K+	8.449e-004	6.727e-004	-3.073	-3.172	-0.099
	KSO4-	4.595e-005	3.708e-005	-4.338	-4.431	-0.093
	KOH	2.197e-014	2.230e-014	-13.658	-13.652	0.006
Mg		1.536e-002				
	Mg+2	8.413e-003	3.833e-003	-2.075	-2.416	-0.341
	MgSO4	6.945e-003	7.048e-003	-2.158	-2.152	0.006
	MgOH+	1.649e-010	1.330e-010	-9.783	-9.876	-0.093
Na		6.023e-003				
	Na+	5.795e-003	4.688e-003	-2.237	-2.329	-0.092
	NaSO4-	2.284e-004	1.843e-004	-3.641	-3.734	-0.093
	NaOH	2.918e-013	2.961e-013	-12.535	-12.529	0.006
O(0)		1.008e-022				
	O2	5.038e-023	5.113e-023	-22.298	-22.291	0.006
Pb		1.186e-007				
	PbSO4	7.088e-008	7.193e-008	-7.150	-7.143	0.006
	Pb+2	3.847e-008	1.631e-008	-7.415	-7.788	-0.373
	Pb(SO4)2-2	6.986e-009	2.961e-009	-8.156	-8.529	-0.373
	PbCl+	2.285e-009	1.844e-009	-8.641	-8.734	-0.093
	PbCl2	8.178e-012	8.300e-012	-11.087	-11.081	0.006
	PbOH+	3.767e-012	3.040e-012	-11.424	-11.517	-0.093
	PbCl3-	2.321e-014	1.873e-014	-13.634	-13.728	-0.093
	PbCl4-2	6.005e-017	2.546e-017	-16.221	-16.594	-0.373

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    Pb(OH)2          1.114e-017  1.131e-017   -16.953    -16.947     0.006
    Pb2OH+3          7.653e-018  1.110e-018   -17.116    -17.955    -0.839
    Pb(OH)3-         1.538e-024  1.241e-024   -23.813    -23.906    -0.093
    Pb(OH)4-2        6.413e-032  2.718e-032   -31.193    -31.566    -0.373
S(-2)           0.000e+000
    H2S              0.000e+000  0.000e+000   -97.059    -97.053     0.006
    HS-              0.000e+000  0.000e+000   -99.914   -100.014    -0.100
    S-2              0.000e+000  0.000e+000  -108.586   -108.951    -0.365
    Fe(HS)2          0.000e+000  0.000e+000  -196.170   -196.163     0.006
    Fe(HS)3-         0.000e+000  0.000e+000  -294.047   -294.140    -0.093
S(6)            2.748e-002
    SO4-2            1.827e-002  7.845e-003    -1.738     -2.105    -0.367
    MgSO4            6.945e-003  7.048e-003    -2.158     -2.152     0.006
    CaSO4            1.683e-003  1.708e-003    -2.774     -2.768     0.006
    NaSO4-           2.284e-004  1.843e-004    -3.641     -3.734    -0.093
    HSO4-            9.878e-005  7.971e-005    -4.005     -4.099    -0.093
    FeSO4+           7.730e-005  6.237e-005    -4.112     -4.205    -0.093
    ZnSO4            6.902e-005  7.005e-005    -4.161     -4.155     0.006
    KSO4-            4.595e-005  3.708e-005    -4.338     -4.431    -0.093
    Fe(SO4)2-        1.327e-005  1.070e-005    -4.877     -4.970    -0.093
    FeSO4            1.127e-005  1.144e-005    -4.948     -4.941     0.006
    Zn(SO4)2-2       1.054e-005  4.467e-006    -4.977     -5.350    -0.373
    CaHSO4+          1.296e-006  1.046e-006    -5.887     -5.981    -0.093
    PbSO4            7.088e-008  7.193e-008    -7.150     -7.143     0.006
    CuSO4            5.348e-008  5.428e-008    -7.272     -7.265     0.006
    FeHSO4+2         4.118e-008  1.746e-008    -7.385     -7.758    -0.373
    CdSO4            2.334e-008  2.369e-008    -7.632     -7.625     0.006
    FeHSO4+          9.741e-009  7.860e-009    -8.011     -8.105    -0.093
    Pb(SO4)2-2       6.986e-009  2.961e-009    -8.156     -8.529    -0.373
    Cd(SO4)2-2       4.806e-009  2.037e-009    -8.318     -8.691    -0.373
Zn              1.681e-004
    Zn+2             8.822e-005  3.809e-005    -4.054     -4.419    -0.365
    ZnSO4            6.902e-005  7.005e-005    -4.161     -4.155     0.006
    Zn(SO4)2-2       1.054e-005  4.467e-006    -4.977     -5.350    -0.373
    ZnCl+            3.609e-007  2.912e-007    -6.443     -6.536    -0.093
    ZnCl2            8.534e-010  8.661e-010    -9.069     -9.062     0.006
    ZnOH+            4.949e-010  3.993e-010    -9.305     -9.399    -0.093
    ZnCl3-           3.421e-012  2.760e-012   -11.466    -11.559    -0.093
    Zn(OH)2          4.319e-014  4.384e-014   -13.365    -13.358     0.006
    ZnCl4-2          9.269e-015  3.929e-015   -14.033    -14.406    -0.373
    Zn(OH)3-         1.642e-021  1.325e-021   -20.784    -20.878    -0.093
    Zn(OH)4-2        4.737e-030  2.008e-030   -29.324    -29.697    -0.373

------------------------------Saturation indices-------------------------------

    Phase               SI  log IAP  log KT

    Anglesite        -2.10   -9.89   -7.79  PbSO4
    Anhydrite        -0.71   -5.07   -4.36  CaSO4
    Cd(OH)2         -13.67   -0.02   13.65  Cd(OH)2
    CdSO4            -9.99  -10.09   -0.10  CdSO4
    Fe(OH)3(a)        0.91    5.80    4.89  Fe(OH)3
    FeS(ppt)        -97.20 -101.12   -3.92  FeS
    Goethite          6.80    5.80   -1.00  FeOOH
    Gypsum           -0.49   -5.07   -4.58  CaSO4:2H2O
    H2(g)           -31.89  -35.04   -3.15  H2
    H2O(g)           -1.51   -0.00    1.51  H2O
    H2S(g)          -96.06  -97.05   -1.00  H2S
    Halite           -6.46   -4.88    1.58  NaCl
    Hematite         15.61   11.60   -4.01  Fe2O3
    Jarosite-K        7.29   -1.92   -9.21  KFe3(SO4)2(OH)6
    Mackinawite     -96.47 -101.12   -4.65  FeS
    Melanterite      -4.98   -7.19   -2.21  FeSO4:7H2O
    O2(g)           -19.33  -22.29   -2.96  O2
    Pb(OH)2          -7.98    0.17    8.15  Pb(OH)2
    Pyrite         -154.74 -173.22  -18.48  FeS2
    Sphalerite      -88.83 -100.45  -11.62  ZnS
    Sulfur          -70.04  -65.16    4.88  S
    Zn(OH)2(e)       -7.96    3.54   11.50  Zn(OH)2

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End of simulation.
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Reading input data for simulation 2.
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    SOLUTION 1 River water
        temp      28.4
        pH        8.2
        pe        2.63
        redox     pe
        units     mg/l
        density   1
        S(6)      6.4
        Ca        48.7
        Cd        6e-005
        Cl        15.3
        Cu        0.001
        Fe        10
        K         4.2
        Mg        47
        Na        10.6
        Pb        0.00055
        Zn        0.0104
        water    1 # kg
    SOLUTION 2 PAF Leachate
        temp      25
        pH        3.98
        pe        11.85
        redox     pe
        units     mg/l
        density   1
        Ca        358
        Cd        0.0631
        Cl        1
        Cu        0.058
        Fe        307
        K         4
        Mg        2560
        Na        6
        Pb        0.286
        S(6)      20000
        Zn        134
        water    1 # kg
    SOLUTION 3 NAF Leachate
        temp      25
        pH        6.5
        pe        1.84
        redox     pe
        units     mg/l
        density   1
        Ca        193
        Cd        0.0025
        Cl        64
        Cu        0.005
        Fe        0.01
        K         38
        Mg        226
        Na        61
        Pb        0.005
        S(6)      1450
        Zn        1.53
        water    1 # kg
    SOLUTION 4 Rainwater
        temp      25
        pH        4.59
        pe        10.15
        redox     pe
        units     mg/l
        density   1
        Ca        0.1002
        Cd        0
```

```
    Cl        0.2375
    Cu        0
    Fe        0
    K         0.0586
    Mg        0.0316
    Na        0.15869
    Pb        0
    S(6)      0.7781
    Zn        0.01
    water    1 # kg
SOLUTION 5 Tailings Seepage
    temp      25
    pH        6.56
    pe        1.69
    redox     pe
    units     mg/l
    density   1
    Ca        405
    Cd        0.00008
    Cl        2610
    Cu        0.0174
    Fe        0.00315
    K         297
    Mg        1070
    Na        3030
    Pb        0.00029
    S(6)      6190
    Zn        0.327
    water    1 # kg
MIX 1 Mixing of water in open pit - worst case Scenario 2
    1    0.9344
    2    0.0039
    3    0.0353
    4    0.0232
    5    0.0031
PRINT
    warnings              -1
SELECTED_OUTPUT
    file                 MRM2_Scenario2.txt
    totals               Ca  Cd  Cl  Cu  K  Mg  Mn
                          Na  Pb  S(-2)  Zn  S(6)  Al  Alkalinity
                          B  Ba  Br  C  C(4)  C(-4)  Cu(1)
                          Cu(2)  N  Mn(3)  Mn(2)  Li  Hfo_w  Hfo_s
                          H(0)  Fe(3)  Fe(2)  F  Fe  N(0)  N(3)
                          N(-3)  N(5)  O(0)  P  S  Si  Sr
                          X
    molalities           Ca+2  CaCO3  CaF+  CaH2PO4+
                          CaHCO3+  CaHPO4  CaHSO4+  CaOH+
                          CaPO4-  CaSO4  CaX2  Cd(CO3)2-2
                          Cd(OH)2  Cd(OH)3-  Cd(OH)4-2  Cd(SO4)2-2
                          Cd+2  CdCl+  CdCl2  CdCl3-
                          CdCO3  CdHCO3+  CdOH+  CdSO4
                          CdX2  Cl-  CO2  CO3-2
                          Cu(OH)2  Cu(OH)3-  Cu(OH)4-2  Cu+
                          Cu+2  CuOH+  CuSO4  CuX2
                          Fe(HS)2  Fe(HS)3-  Fe(OH)2+  FeH2PO4+
                          FeF3  FeF2+  FeF+2  FeF+
                          FeCO3  FeCl3  FeCl2+  FeCl+2
                          FeCl+  Fe3(OH)4+5  Fe2(OH)2+4  Fe+3
                          Fe+2  Fe(SO4)2-  Fe(OH)4-  Fe(OH)3
                          FeX2  FeSO4+  FeSO4  FeOH+2
                          FeOH+  FeHSO4+2  FeHSO4+  FeHPO4+
                          FeHPO4  FeHCO3+  FeH2PO4+2  H2S
                          HSO4-  HS-  K+  KHPO4-
                          KOH  KSO4-  KX  Mg+2
                          MgCO3  MgF+  MgH2PO4+  MgHCO3+
                          MgHPO4  MgOH+  MgPO4-  MgSO4
                          MgX2  Mn(NO3)2  Mn+2  Mn+3
                          MnCl+  MnCl2  MnCl3-  MnCO3
                          MnF+  MnHCO3+  MnOH+  MnSO4
                          MnX2  Na+  NaCO3-  NaF
                          NaHCO3  NaHPO4-  NaOH  NaSO4-
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                        NaX  NH3  NH4+  NH4SO4-
                        NH4X  Pb(CO3)2-2  Pb(OH)2  Pb(OH)3-
                        Pb(OH)4-2  Pb(SO4)2-2  Pb+2  Pb2OH+3
                        PbCl+  PbCl2  PbCl3-  PbCl4-2
                        PbCO3  PbHCO3+  PbNO3+  PbOH+
                        PbSO4  PbX2  PO4-3  SO4-2
                        Zn(CO3)2-2  Zn(OH)2  Zn(OH)3-  Zn(OH)4-2
                        Zn(SO4)2-2  Zn+2  ZnCl+  ZnCl2
                        ZnCl3-  ZnCl4-2  ZnCO3  ZnHCO3+
                        ZnOH+  ZnSO4  ZnX2  Al(OH)2+
                        Al(OH)3  Al(OH)4-  Al(SO4)2-  Al+3
                        AlF+2  AlF2+  AlF3  AlF4-
                        AlF5-2  AlF6-3  AlHSO4+2  AlOH+2
                        AlOHX2  AlSO4+  AlX3  Ba+2
                        BaCO3  BaHCO3+  BaOH+  BaSO4
                        BaX2  BF(OH)3-  BF2(OH)2-  BF3OH-
                        BF4-  Br-  CH4  F-
                        H+  H2  H2BO3-  H2O
                        H2PO4-  H2SiO4-2  H3BO3  H3SiO4-
                        H4SiO4  HCO3-  HF  HF2-
                        Hfo_psi  Hfo_sO-  Hfo_sOCd+  Hfo_sOCu+
                        Hfo_sOFe+  Hfo_sOH  Hfo_sOH2+  Hfo_sOHBa+2
                        Hfo_sOHCa+2  Hfo_sOHSr+2  Hfo_sOMn+  Hfo_sOPb+
                        Hfo_sOZn+  Hfo_wF  Hfo_wH2BO3  Hfo_wH2PO4
                        Hfo_wHPO4-  Hfo_wO-  Hfo_wOBa+  Hfo_wOCa+
                        Hfo_wOCd+  Hfo_wOCu+  Hfo_wOFe+  Hfo_wOFeOH
                        Hfo_wOH  Hfo_wOH2+  Hfo_wOHF-  Hfo_wOHSO4-2
                        Hfo_wOMg+  Hfo_wOMn+  Hfo_wOPb+  Hfo_wOSr+
                        Hfo_wOSrOH  Hfo_wOZn+  Hfo_wPO4-2  Hfo_wSO4-
                        HPO4-2  Li+  LiOH  LiSO4-
                        LiX  N2  NO2-  NO3-
                        O2  OH-  S-2  SiF6-2
                        Sr+2  SrCO3  SrHCO3+  SrOH+
                        SrSO4  SrX2  X-
activities             Al(OH)2+  Al(OH)3  Al(OH)4-  Al(SO4)2-
                        Al+3  AlF+2  AlF2+  AlF3
                        AlF4-  AlF5-2  AlF6-3  AlHSO4+2
                        AlOH+2  AlOHX2  AlSO4+  AlX3
                        Ba+2  BaCO3  BaHCO3+  BaOH+
                        BaSO4  BaX2  BF(OH)3-  BF2(OH)2-
                        BF3OH-  BF4-  Br-  Ca+2
                        CaCO3  CaF+  CaH2PO4+  CaHCO3+
                        CaHPO4  CaHSO4+  CaOH+  CaPO4-
                        CaSO4  CaX2  Cd(CO3)2-2  Cd(OH)2
                        Cd(OH)3-  Cd(OH)4-2  Cd(SO4)2-2  Cd+2
                        CdCl+  CdCl2  CdCl3-  CdCO3
                        CdHCO3+  CdOH+  CdSO4  CdX2
                        CH4  Cl-  CO2  CO3-2
                        Cu(OH)2  Cu(OH)3-  Cu(OH)4-2  Cu+
                        Cu+2  CuOH+  CuSO4  CuX2
                        Fe(HS)2  Fe(HS)3-  Fe(OH)2+  F-
                        Fe(OH)3  Fe(OH)4-  Fe(SO4)2-  Fe+2
                        Fe+3  Fe2(OH)2+4  Fe3(OH)4+5  FeCl+
                        FeCl+2  FeCl2+  FeCl3  FeCO3
                        FeF+  FeF+2  FeF2+  FeF3
                        FeH2PO4+  FeH2PO4+2  FeHCO3+  FeHPO4
                        FeHPO4+  FeHSO4+  FeHSO4+2  FeOH+
                        FeOH+2  FeSO4  FeSO4+  FeX2
                        H+  H2  H2BO3-  H2O
                        H2PO4-  H2S  H2SiO4-2  H3BO3
                        H3SiO4-  H4SiO4  HCO3-  HF
                        HF2-  Hfo_psi  Hfo_sO-  Hfo_sOCd+
                        Hfo_sOCu+  Hfo_sOFe+  Hfo_sOH  Hfo_sOH2+
                        Hfo_sOHBa+2  Hfo_sOHCa+2  Hfo_sOHSr+2  Hfo_sOMn+
                        Hfo_sOPb+  Hfo_sOZn+  Hfo_wF  Hfo_wH2BO3
                        Hfo_wH2PO4  Hfo_wHPO4-  Hfo_wO-  Hfo_wOBa+
                        Hfo_wOCa+  Hfo_wOCd+  Hfo_wOCu+  Hfo_wOFe+
                        Hfo_wOFeOH  Hfo_wOH  Hfo_wOH2+  Hfo_wOHF-
                        Hfo_wOHSO4-2  Hfo_wOMg+  Hfo_wOMn+  Hfo_wOPb+
                        Hfo_wOSr+  Hfo_wOSrOH  Hfo_wOZn+  Hfo_wPO4-2
                        Hfo_wSO4-  HPO4-2  HS-  HSO4-
                        K+  KHPO4-  KOH  KSO4-
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                              KX  Li+  LiOH  LiSO4-
                              LiX  Mg+2  MgCO3  MgF+
                              MgH2PO4+  MgHCO3+  MgHPO4  MgOH+
                              MgPO4-  MgSO4  MgX2  Mn(NO3)2
                              Mn+2  Mn+3  MnCl+  MnCl2
                              MnCl3-  MnCO3  MnF+  MnHCO3+
                              MnOH+  MnSO4  MnX2  N2
                              Na+  NaCO3-  NaF  NaHCO3
                              NaHPO4-  NaOH  NaSO4-  NaX
                              NH3  NH4+  NH4SO4-  NH4X
                              NO2-  NO3-  O2  OH-
                              Pb(CO3)2-2  Pb(OH)2  Pb(OH)3-  Pb(OH)4-2
                              Pb(SO4)2-2  Pb+2  Pb2OH+3  PbCl+
                              PbCl2  PbCl3-  PbCl4-2  PbCO3
                              PbHCO3+  PbNO3+  PbOH+  PbSO4
                              PbX2  PO4-3  S-2  SiF6-2
                              SO4-2  Sr+2  SrCO3  SrHCO3+
                              SrOH+  SrSO4  SrX2  X-
                              Zn(CO3)2-2  Zn(OH)2  Zn(OH)3-  Zn(OH)4-2
                              Zn(SO4)2-2  Zn+2  ZnCl+  ZnCl2
                              ZnCl3-  ZnCl4-2  ZnCO3  ZnHCO3+
                              ZnOH+  ZnSO4  ZnX2
        equilibrium_phases   Al(OH)3(a)  Albite  Alunite  Anglesite
                              Anhydrite  Anorthite  Aragonite  Barite
                              Calcite  Ca-Montmorillonite  Cd(OH)2  CdSiO3
                              CdSO4  Celestite  Cerrusite  CH4(g)
                              Chalcedony  Hydroxyapatite  Hematite  Hausmannite
                              Halite  H2S(g)  H2O(g)  H2(g)
                              Gypsum  Goethite  Gibbsite  Fluorite
                              FeS(ppt)  Fe(OH)3(a)  Dolomite  CO2(g)
                              Chrysotile  Chlorite(14A)  Illite  Jarosite-K
                              Kaolinite  K-feldspar  K-mica  Mackinawite
                              Manganite  Melanterite  N2(g)  NH3(g)
                              O2(g)  Otavite  Pb(OH)2  Pyrite
                              Pyrochroite  Pyrolusite  Quartz  Rhodochrosite
                              Sepiolite  Sepiolite(d)  Siderite  SiO2(a)
                              Smithsonite  Sphalerite  Strontianite  Sulfur
                              Talc  Vivianite  Willemite  Witherite
                              Zn(OH)2(e)
        saturation_indices   Al(OH)3(a)  Zn(OH)2(e)  Witherite  Willemite
                              Vivianite  Talc  Sulfur  Strontianite
                              Sphalerite  Smithsonite  SiO2(a)  Siderite
                              Sepiolite(d)  Sepiolite  Rhodochrosite  Quartz
                              Pyrolusite  Pyrochroite  Pyrite  Pb(OH)2
                              Otavite  O2(g)  NH3(g)  N2(g)
                              Melanterite  Manganite  Mackinawite  K-mica
                              K-feldspar  Kaolinite  Jarosite-K  Illite
                              Hydroxyapatite  Hematite  Hausmannite  Halite
                              H2S(g)  H2O(g)  H2(g)  Gypsum
                              Goethite  Gibbsite  Fluorite  FeS(ppt)
                              Fe(OH)3(a)  Dolomite  CO2(g)  Chrysotile
                              Chlorite(14A)  Chalcedony  CH4(g)  Cerrusite
                              Celestite  CdSO4  CdSiO3  Cd(OH)2
                              Ca-Montmorillonite  Calcite  Barite  Aragonite
                              Anorthite  Anhydrite  Anglesite  Alunite
                              Albite
        gases                CH4(g)  CO2(g)  H2(g)  H2O(g)
                              H2S(g)  N2(g)  NH3(g)  O2(g)
        kinetic_reactants    Albite  Calcite  K-feldspar  Organic_C
                              Pyrite  Pyrolusite
    END
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Beginning of initial solution calculations.
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Initial solution 1.   River water

-----------------------------Solution composition------------------------------

    Elements           Molality       Moles

    Ca               1.215e-003  1.215e-003
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    Cd               5.339e-010  5.339e-010
    Cl               4.316e-004  4.316e-004
    Cu               1.574e-008  1.574e-008
    Fe               1.791e-004  1.791e-004
    K                1.074e-004  1.074e-004
    Mg               1.933e-003  1.933e-003
    Na               4.611e-004  4.611e-004
    Pb               2.655e-009  2.655e-009
    S(6)             6.663e-005  6.663e-005
    Zn               1.591e-007  1.591e-007

----------------------------Description of solution----------------------------

                                       pH  =   8.200
                                       pe  =   2.630
                        Activity of water  =   1.000
                           Ionic strength  =  6.879e-003
                       Mass of water (kg)  =  1.000e+000
                 Total alkalinity (eq/kg)  =  1.996e-004
                    Total carbon (mol/kg)  =  0.000e+000
                       Total CO2 (mol/kg)  =  0.000e+000
                      Temperature (deg C)  =  28.400
                  Electrical balance (eq)  =  6.283e-003
 Percent error, 100*(Cat-|An|)/(Cat+|An|)  =  84.94
                               Iterations  =   4
                                  Total H  = 1.110130e+002
                                  Total O  = 5.550704e+001

----------------------------Distribution of species----------------------------

                                                    Log       Log         Log
    Species              Molality    Activity  Molality  Activity       Gamma

    OH-               2.233e-006  2.043e-006    -5.651    -5.690      -0.039
    H+                6.825e-009  6.310e-009    -8.166    -8.200      -0.034
    H2O               5.551e+001  9.999e-001     1.744    -0.000       0.000
Ca               1.215e-003
    Ca+2              1.209e-003  8.591e-004    -2.918    -3.066      -0.148
    CaSO4             6.060e-006  6.069e-006    -5.218    -5.217       0.001
    CaOH+             2.467e-008  2.260e-008    -7.608    -7.646      -0.038
    CaHSO4+           2.559e-013  2.344e-013   -12.592   -12.630      -0.038
Cd               5.339e-010
    Cd+2              5.087e-010  3.579e-010    -9.294    -9.446      -0.153
    CdCl+             1.490e-011  1.365e-011   -10.827   -10.865      -0.038
    CdOH+             6.609e-012  6.053e-012   -11.180   -11.218      -0.038
    CdSO4             3.609e-012  3.615e-012   -11.443   -11.442       0.001
    Cd(OH)2           4.009e-014  4.015e-014   -13.397   -13.396       0.001
    CdCl2             2.271e-014  2.274e-014   -13.644   -13.643       0.001
    Cd(SO4)2-2        1.894e-015  1.332e-015   -14.723   -14.875      -0.153
    CdCl3-            6.507e-018  5.960e-018   -17.187   -17.225      -0.038
    Cd(OH)3-          7.795e-019  7.139e-019   -18.108   -18.146      -0.038
    Cd(OH)4-2         1.433e-024  1.008e-024   -23.844   -23.996      -0.153
Cl               4.316e-004
    Cl-               4.316e-004  3.948e-004    -3.365    -3.404      -0.039
    FeCl+             9.966e-010  9.127e-010    -9.001    -9.040      -0.038
    ZnCl+             1.081e-010  9.898e-011    -9.966   -10.004      -0.038
    CdCl+             1.490e-011  1.365e-011   -10.827   -10.865      -0.038
    PbCl+             9.858e-012  9.029e-012   -11.006   -11.044      -0.038
    ZnCl2             4.141e-014  4.148e-014   -13.383   -13.382       0.001
    CdCl2             2.271e-014  2.274e-014   -13.644   -13.643       0.001
    PbCl2             5.298e-015  5.306e-015   -14.276   -14.275       0.001
    ZnCl3-            2.047e-017  1.875e-017   -16.689   -16.727      -0.038
    CdCl3-            6.507e-018  5.960e-018   -17.187   -17.225      -0.038
    PbCl3-            1.855e-018  1.699e-018   -17.732   -17.770      -0.038
    FeCl+2            1.546e-018  1.088e-018   -17.811   -17.963      -0.153
    ZnCl4-2           5.416e-021  3.810e-021   -20.266   -20.419      -0.153
    FeCl2+            1.883e-021  1.725e-021   -20.725   -20.763      -0.038
    PbCl4-2           4.683e-022  3.295e-022   -21.329   -21.482      -0.153
    FeCl3             6.800e-026  6.810e-026   -25.168   -25.167       0.001
Cu(1)            4.144e-011
    Cu+               4.144e-011  3.781e-011   -10.383   -10.422      -0.040
Cu(2)            1.570e-008
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Cu(OH)2	1.560e-008	1.563e-008	-7.807	-7.806	0.001
CuOH+	5.155e-011	4.720e-011	-10.288	-10.326	-0.038
Cu+2	4.169e-011	2.978e-011	-10.380	-10.526	-0.146
CuSO4	2.132e-013	2.136e-013	-12.671	-12.670	0.001
Cu(OH)3-	1.630e-013	1.492e-013	-12.788	-12.826	-0.038
Cu(OH)4-2	6.708e-018	4.719e-018	-17.173	-17.326	-0.153
Fe(2)	2.474e-006				
Fe+2	2.344e-006	1.675e-006	-5.630	-5.776	-0.146
FeOH+	1.178e-007	1.079e-007	-6.929	-6.967	-0.038
FeSO4	1.085e-008	1.087e-008	-7.965	-7.964	0.001
FeCl+	9.966e-010	9.127e-010	-9.001	-9.040	-0.038
FeHSO4+	4.989e-016	4.569e-016	-15.302	-15.340	-0.038
Fe(3)	1.766e-004				
Fe(OH)3	1.439e-004	1.441e-004	-3.842	-3.841	0.001
Fe(OH)4-	2.604e-005	2.385e-005	-4.584	-4.623	-0.038
Fe(OH)2+	6.658e-006	6.098e-006	-5.177	-5.215	-0.038
FeOH+2	1.454e-010	1.023e-010	-9.837	-9.990	-0.153
Fe+3	1.663e-016	8.202e-017	-15.779	-16.086	-0.307
FeSO4+	3.630e-017	3.324e-017	-16.440	-16.478	-0.038
FeCl+2	1.546e-018	1.088e-018	-17.811	-17.963	-0.153
Fe2(OH)2+4	1.001e-018	2.451e-019	-18.000	-18.611	-0.611
Fe(SO4)2-	2.761e-020	2.528e-020	-19.559	-19.597	-0.038
Fe3(OH)4+5	2.062e-021	2.290e-022	-20.686	-21.640	-0.954
FeCl2+	1.883e-021	1.725e-021	-20.725	-20.763	-0.038
FeHSO4+2	7.990e-025	5.621e-025	-24.097	-24.250	-0.153
FeCl3	6.800e-026	6.810e-026	-25.168	-25.167	0.001
H(0)	2.991e-025				
H2	1.495e-025	1.498e-025	-24.825	-24.825	0.001
K	1.074e-004				
K+	1.074e-004	9.825e-005	-3.969	-4.008	-0.039
KSO4-	2.742e-008	2.512e-008	-7.562	-7.600	-0.038
KOH	5.390e-011	5.399e-011	-10.268	-10.268	0.001
Mg	1.933e-003				
Mg+2	1.920e-003	1.371e-003	-2.717	-2.863	-0.146
MgSO4	1.200e-005	1.202e-005	-4.921	-4.920	0.001
MgOH+	1.167e-006	1.068e-006	-5.933	-5.971	-0.038
Na	4.611e-004				
Na+	4.611e-004	4.226e-004	-3.336	-3.374	-0.038
NaSO4-	8.107e-008	7.424e-008	-7.091	-7.129	-0.038
NaOH	4.418e-010	4.425e-010	-9.355	-9.354	0.001
O(0)	0.000e+000				
O2	0.000e+000	0.000e+000	-41.647	-41.646	0.001
Pb	2.655e-009				
PbOH+	1.783e-009	1.633e-009	-8.749	-8.787	-0.038
Pb+2	7.512e-010	5.285e-010	-9.124	-9.277	-0.153
Pb(OH)2	1.005e-010	1.007e-010	-9.998	-9.997	0.001
PbSO4	1.018e-011	1.020e-011	-10.992	-10.992	0.001
PbCl+	9.858e-012	9.029e-012	-11.006	-11.044	-0.038
Pb(OH)3-	2.000e-013	1.832e-013	-12.699	-12.737	-0.038
PbCl2	5.298e-015	5.306e-015	-14.276	-14.275	0.001
Pb(SO4)2-2	2.610e-015	1.836e-015	-14.583	-14.736	-0.153
Pb(OH)4-2	9.454e-017	6.651e-017	-16.024	-16.177	-0.153
Pb2OH+3	4.262e-017	1.932e-017	-16.370	-16.714	-0.344
PbCl3-	1.855e-018	1.699e-018	-17.732	-17.770	-0.038
PbCl4-2	4.683e-022	3.295e-022	-21.329	-21.482	-0.153
S(6)	6.663e-005				
SO4-2	4.845e-005	3.431e-005	-4.315	-4.465	-0.150
MgSO4	1.200e-005	1.202e-005	-4.921	-4.920	0.001
CaSO4	6.060e-006	6.069e-006	-5.218	-5.217	0.001
NaSO4-	8.107e-008	7.424e-008	-7.091	-7.129	-0.038
KSO4-	2.742e-008	2.512e-008	-7.562	-7.600	-0.038
FeSO4	1.085e-008	1.087e-008	-7.965	-7.964	0.001
ZnSO4	6.618e-010	6.629e-010	-9.179	-9.179	0.001
HSO4-	2.478e-011	2.269e-011	-10.606	-10.644	-0.038
PbSO4	1.018e-011	1.020e-011	-10.992	-10.992	0.001
CdSO4	3.609e-012	3.615e-012	-11.443	-11.442	0.001
Zn(SO4)2-2	2.561e-013	1.801e-013	-12.592	-12.744	-0.153
CaHSO4+	2.559e-013	2.344e-013	-12.592	-12.630	-0.038
CuSO4	2.132e-013	2.136e-013	-12.671	-12.670	0.001
Pb(SO4)2-2	2.610e-015	1.836e-015	-14.583	-14.736	-0.153
Cd(SO4)2-2	1.894e-015	1.332e-015	-14.723	-14.875	-0.153
FeHSO4+	4.989e-016	4.569e-016	-15.302	-15.340	-0.038

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     FeSO4+            3.630e-017  3.324e-017   -16.440   -16.478    -0.038
     Fe(SO4)2-         2.761e-020  2.528e-020   -19.559   -19.597    -0.038
     FeHSO4+2          7.990e-025  5.621e-025   -24.097   -24.250    -0.153
Zn              1.591e-007
     Zn+2              1.133e-007  8.030e-008    -6.946    -7.095    -0.150
     Zn(OH)2           2.535e-008  2.539e-008    -7.596    -7.595     0.001
     ZnOH+             1.966e-008  1.801e-008    -7.706    -7.745    -0.038
     ZnSO4             6.618e-010  6.629e-010    -9.179    -9.179     0.001
     ZnCl+             1.081e-010  9.898e-011    -9.966   -10.004    -0.038
     Zn(OH)3-          1.389e-011  1.272e-011   -10.857   -10.895    -0.038
     Zn(SO4)2-2        2.561e-013  1.801e-013   -12.592   -12.744    -0.153
     ZnCl2             4.141e-014  4.148e-014   -13.383   -13.382     0.001
     Zn(OH)4-2         4.543e-016  3.196e-016   -15.343   -15.495    -0.153
     ZnCl3-            2.047e-017  1.875e-017   -16.689   -16.727    -0.038
     ZnCl4-2           5.416e-021  3.810e-021   -20.266   -20.419    -0.153

------------------------------Saturation indices-------------------------------

     Phase               SI  log IAP  log KT

     Anglesite        -5.97  -13.74   -7.77  PbSO4
     Anhydrite        -3.15   -7.53   -4.38  CaSO4
     Cd(OH)2          -6.70    6.95   13.65  Cd(OH)2
     CdSO4           -13.69  -13.91   -0.22  CdSO4
     Fe(OH)3(a)        3.62    8.51    4.89  Fe(OH)3
     Goethite          9.63    8.51   -1.12  FeOOH
     Gypsum           -2.95   -7.53   -4.58  CaSO4:2H2O
     H2(g)           -21.66  -24.82   -3.16  H2
     H2O(g)           -1.42   -0.00    1.42  H2O
     Halite           -8.37   -6.78    1.59  NaCl
     Hematite         21.29   17.03   -4.26  Fe2O3
     Jarosite-K       -2.53  -12.00   -9.47  KFe3(SO4)2(OH)6
     Melanterite      -8.07  -10.24   -2.17  FeSO4:7H2O
     O2(g)           -38.67  -41.65   -2.98  O2
     Pb(OH)2          -0.91    7.12    8.03  Pb(OH)2
     Zn(OH)2(e)       -2.20    9.30   11.50  Zn(OH)2

Initial solution 2.   PAF Leachate

-----------------------------Solution composition------------------------------

     Elements           Molality       Moles

     Ca                9.146e-003  9.146e-003
     Cd                5.748e-007  5.748e-007
     Cl                2.888e-005  2.888e-005
     Cu                9.346e-007  9.346e-007
     Fe                5.629e-003  5.629e-003
     K                 1.047e-004  1.047e-004
     Mg                1.078e-001  1.078e-001
     Na                2.672e-004  2.672e-004
     Pb                1.413e-006  1.413e-006
     S(6)              2.132e-001  2.132e-001
     Zn                2.099e-003  2.099e-003

----------------------------Description of solution----------------------------

                                       pH  =   3.980
                                       pe  =  11.850
                        Activity of water  =   0.996
                           Ionic strength  =  3.474e-001
                       Mass of water (kg)  =  1.000e+000
                 Total alkalinity (eq/kg)  = -7.087e-003
                    Total carbon (mol/kg)  =  0.000e+000
                       Total CO2 (mol/kg)  =  0.000e+000
                      Temperature (deg C)  =  25.000
                  Electrical balance (eq)  = -1.748e-001
 Percent error, 100*(Cat-|An|)/(Cat+|An|)  = -50.44
                               Iterations  =  14
                                  Total H  = 1.110169e+002
                                  Total O  = 5.636285e+001
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----------------------------Distribution of species---------------------------

                                                   Log       Log        Log
    Species          Molality    Activity  Molality  Activity      Gamma

    H+              1.347e-004  1.047e-004    -3.871    -3.980    -0.109
    OH-             1.437e-010  9.519e-011    -9.842   -10.021    -0.179
    H2O             5.551e+001  9.957e-001     1.744    -0.002     0.000
Ca              9.146e-003
    CaSO4           5.595e-003  6.061e-003    -2.252    -2.217     0.035
    Ca+2            3.546e-003  9.926e-004    -2.450    -3.003    -0.553
    CaHSO4+         5.083e-006  3.718e-006    -5.294    -5.430    -0.136
    CaOH+           2.141e-012  1.566e-012   -11.669   -11.805    -0.136
Cd              5.748e-007
    Cd(SO4)2-2      2.704e-007  7.742e-008    -6.568    -7.111    -0.543
    CdSO4           2.130e-007  2.308e-007    -6.672    -6.637     0.035
    Cd+2            9.132e-008  2.615e-008    -7.039    -7.583    -0.543
    CdCl+           6.604e-011  4.831e-011   -10.180   -10.316    -0.136
    CdOH+           2.827e-014  2.068e-014   -13.549   -13.684    -0.136
    CdCl2           3.596e-015  3.896e-015   -14.444   -14.409     0.035
    CdCl3-          6.501e-020  4.756e-020   -19.187   -19.323    -0.136
    Cd(OH)2         9.748e-021  1.056e-020   -20.011   -19.976     0.035
    Cd(OH)3-        1.540e-029  1.127e-029   -28.812   -28.948    -0.136
    Cd(OH)4-2       3.335e-039  9.548e-040   -38.477   -39.020    -0.543
Cl              2.888e-005
    Cl-             2.886e-005  1.935e-005    -4.540    -4.713    -0.174
    ZnCl+           8.825e-009  6.455e-009    -8.054    -8.190    -0.136
    FeCl+2          6.446e-009  1.846e-009    -8.191    -8.734    -0.543
    FeCl+           1.706e-009  1.248e-009    -8.768    -8.904    -0.136
    CdCl+           6.604e-011  4.831e-011   -10.180   -10.316    -0.136
    PbCl+           5.126e-011  3.750e-011   -10.290   -10.426    -0.136
    FeCl2+          2.180e-013  1.595e-013   -12.662   -12.797    -0.136
    ZnCl2           1.207e-013  1.308e-013   -12.918   -12.883     0.035
    CdCl2           3.596e-015  3.896e-015   -14.444   -14.409     0.035
    PbCl2           1.061e-015  1.150e-015   -14.974   -14.939     0.035
    ZnCl3-          3.881e-018  2.839e-018   -17.411   -17.547    -0.136
    FeCl3           2.848e-019  3.085e-019   -18.545   -18.511     0.035
    CdCl3-          6.501e-020  4.756e-020   -19.187   -19.323    -0.136
    PbCl3-          2.415e-020  1.767e-020   -19.617   -19.753    -0.136
    ZnCl4-2         9.613e-023  2.752e-023   -22.017   -22.560    -0.543
    PbCl4-2         5.714e-025  1.636e-025   -24.243   -24.786    -0.543
Cu(1)           1.179e-016
    Cu+             1.179e-016  7.400e-017   -15.928   -16.131    -0.202
Cu(2)           9.346e-007
    CuSO4           5.757e-007  6.237e-007    -6.240    -6.205     0.035
    Cu+2            3.588e-007  9.982e-008    -6.445    -7.001    -0.556
    CuOH+           1.401e-011  9.492e-012   -10.853   -11.023    -0.169
    Cu(OH)2         1.741e-013  1.886e-013   -12.759   -12.725     0.035
    Cu(OH)3-        1.477e-022  1.080e-022   -21.831   -21.966    -0.136
    Cu(OH)4-2       7.159e-031  2.050e-031   -30.145   -30.688    -0.543
Fe(2)           4.029e-004
    FeSO4           2.347e-004  2.542e-004    -3.629    -3.595     0.035
    Fe+2            1.679e-004  4.672e-005    -3.775    -4.330    -0.556
    FeHSO4+         2.392e-007  1.750e-007    -6.621    -6.757    -0.136
    FeCl+           1.706e-009  1.248e-009    -8.768    -8.904    -0.136
    FeOH+           1.921e-010  1.405e-010    -9.717    -9.852    -0.136
Fe(3)           5.226e-003
    FeSO4+          1.449e-003  1.060e-003    -2.839    -2.975    -0.136
    Fe(SO4)2-       9.700e-004  7.095e-004    -3.013    -3.149    -0.136
    Fe(OH)2+        8.348e-004  6.106e-004    -3.078    -3.214    -0.136
    FeOH+2          6.773e-004  1.939e-004    -3.169    -3.712    -0.543
    Fe3(OH)4+5      3.204e-004  1.291e-007    -3.494    -6.889    -3.395
    Fe2(OH)2+4      1.506e-004  1.012e-006    -3.822    -5.995    -2.173
    Fe+3            3.055e-005  3.159e-006    -4.515    -5.500    -0.985
    FeHSO4+2        1.038e-006  2.972e-007    -5.984    -6.527    -0.543
    Fe(OH)3         6.905e-007  7.480e-007    -6.161    -6.126     0.035
    FeCl+2          6.446e-009  1.846e-009    -8.191    -8.734    -0.543
    Fe(OH)4-        8.868e-012  6.487e-012   -11.052   -11.188    -0.136
    FeCl2+          2.180e-013  1.595e-013   -12.662   -12.797    -0.136
    FeCl3           2.848e-019  3.085e-019   -18.545   -18.511     0.035
H(0)            2.859e-035
    H2              1.430e-035  1.549e-035   -34.845   -34.810     0.035
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K                1.047e-004
     K+                8.751e-005  5.865e-005    -4.058    -4.232    -0.174
     KSO4-             1.724e-005  1.261e-005    -4.763    -4.899    -0.136
     KOH               1.785e-015  1.934e-015   -14.748   -14.714     0.035
Mg               1.078e-001
     MgSO4             7.230e-002  7.833e-002    -1.141    -1.106     0.035
     Mg+2              3.551e-002  1.092e-002    -1.450    -1.962    -0.512
     MgOH+             5.153e-010  3.770e-010    -9.288    -9.424    -0.136
Na               2.672e-004
     Na+               2.322e-004  1.670e-004    -3.634    -3.777    -0.143
     NaSO4-            3.501e-005  2.561e-005    -4.456    -4.592    -0.136
     NaOH              9.685e-015  1.049e-014   -14.014   -13.979     0.035
O(0)             3.181e-023
     O2                1.590e-023  1.723e-023   -22.798   -22.764     0.035
Pb               1.413e-006
     PbSO4             7.734e-007  8.378e-007    -6.112    -6.077     0.035
     Pb(SO4)2-2        4.699e-007  1.345e-007    -6.328    -6.871    -0.543
     Pb+2              1.700e-007  4.869e-008    -6.769    -7.313    -0.543
     PbCl+             5.126e-011  3.750e-011   -10.290   -10.426    -0.136
     PbOH+             1.234e-011  9.027e-012   -10.909   -11.044    -0.136
     PbCl2             1.061e-015  1.150e-015   -14.974   -14.939     0.035
     Pb2OH+3           1.641e-016  9.839e-018   -15.785   -17.007    -1.222
     Pb(OH)2           3.083e-017  3.339e-017   -16.511   -16.476     0.035
     PbCl3-            2.415e-020  1.767e-020   -19.617   -19.753    -0.136
     Pb(OH)3-          4.984e-024  3.646e-024   -23.302   -23.438    -0.136
     PbCl4-2           5.714e-025  1.636e-025   -24.243   -24.786    -0.543
     Pb(OH)4-2         2.774e-031  7.942e-032   -30.557   -31.100    -0.543
S(6)             2.132e-001
     SO4-2             1.288e-001  3.060e-002    -0.890    -1.514    -0.624
     MgSO4             7.230e-002  7.833e-002    -1.141    -1.106     0.035
     CaSO4             5.595e-003  6.061e-003    -2.252    -2.217     0.035
     FeSO4+            1.449e-003  1.060e-003    -2.839    -2.975    -0.136
     Fe(SO4)2-         9.700e-004  7.095e-004    -3.013    -3.149    -0.136
     ZnSO4             8.210e-004  8.893e-004    -3.086    -3.051     0.035
     Zn(SO4)2-2        7.726e-004  2.212e-004    -3.112    -3.655    -0.543
     HSO4-             4.259e-004  3.115e-004    -3.371    -3.506    -0.136
     FeSO4             2.347e-004  2.542e-004    -3.629    -3.595     0.035
     NaSO4-            3.501e-005  2.561e-005    -4.456    -4.592    -0.136
     KSO4-             1.724e-005  1.261e-005    -4.763    -4.899    -0.136
     CaHSO4+           5.083e-006  3.718e-006    -5.294    -5.430    -0.136
     FeHSO4+2          1.038e-006  2.972e-007    -5.984    -6.527    -0.543
     PbSO4             7.734e-007  8.378e-007    -6.112    -6.077     0.035
     CuSO4             5.757e-007  6.237e-007    -6.240    -6.205     0.035
     Pb(SO4)2-2        4.699e-007  1.345e-007    -6.328    -6.871    -0.543
     Cd(SO4)2-2        2.704e-007  7.742e-008    -6.568    -7.111    -0.543
     FeHSO4+           2.392e-007  1.750e-007    -6.621    -6.757    -0.136
     CdSO4             2.130e-007  2.308e-007    -6.672    -6.637     0.035
Zn               2.099e-003
     ZnSO4             8.210e-004  8.893e-004    -3.086    -3.051     0.035
     Zn(SO4)2-2        7.726e-004  2.212e-004    -3.112    -3.655    -0.543
     Zn+2              5.054e-004  1.240e-004    -3.296    -3.907    -0.610
     ZnCl+             8.825e-009  6.455e-009    -8.054    -8.190    -0.136
     ZnOH+             1.767e-009  1.293e-009    -8.753    -8.889    -0.136
     Zn(OH)2           1.303e-013  1.411e-013   -12.885   -12.850     0.035
     ZnCl2             1.207e-013  1.308e-013   -12.918   -12.883     0.035
     ZnCl3-            3.881e-018  2.839e-018   -17.411   -17.547    -0.136
     Zn(OH)3-          5.801e-021  4.243e-021   -20.237   -20.372    -0.136
     ZnCl4-2           9.613e-023  2.752e-023   -22.017   -22.560    -0.543
     Zn(OH)4-2         2.233e-029  6.395e-030   -28.651   -29.194    -0.543

------------------------------Saturation indices-------------------------------

     Phase               SI log IAP  log KT

     Anglesite        -1.04   -8.83   -7.79  PbSO4
     Anhydrite        -0.16   -4.52   -4.36  CaSO4
     Cd(OH)2         -13.28    0.37   13.65  Cd(OH)2
     CdSO4            -9.00   -9.10   -0.10  CdSO4
     Fe(OH)3(a)        1.54    6.43    4.89  Fe(OH)3
     Goethite          7.44    6.44   -1.00  FeOOH
     Gypsum            0.06   -4.52   -4.58  CaSO4:2H2O
     H2(g)           -31.66  -34.81   -3.15  H2
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    H2O(g)           -1.51   -0.00    1.51  H2O
    Halite          -10.07   -8.49    1.58  NaCl
    Hematite         16.88   12.87   -4.01  Fe2O3
    Jarosite-K        9.32    0.11   -9.21  KFe3(SO4)2(OH)6
    Melanterite      -3.65   -5.86   -2.21  FeSO4:7H2O
    O2(g)           -19.80  -22.76   -2.96  O2
    Pb(OH)2          -7.51    0.64    8.15  Pb(OH)2
    Zn(OH)2(e)       -7.45    4.05   11.50  Zn(OH)2

Initial solution 3.   NAF Leachate

-----------------------------Solution composition------------------------------

    Elements           Molality       Moles

    Ca                4.825e-003  4.825e-003
    Cd                2.229e-008  2.229e-008
    Cl                1.809e-003  1.809e-003
    Cu                7.884e-008  7.884e-008
    Fe                1.794e-007  1.794e-007
    K                 9.738e-004  9.738e-004
    Mg                9.315e-003  9.315e-003
    Na                2.659e-003  2.659e-003
    Pb                2.418e-008  2.418e-008
    S(6)              1.512e-002  1.512e-002
    Zn                2.345e-005  2.345e-005

----------------------------Description of solution----------------------------

                                       pH  =   6.500
                                       pe  =   1.840
                        Activity of water  =   0.999
                           Ionic strength  =  4.115e-002
                       Mass of water (kg)  =  1.000e+000
                 Total alkalinity (eq/kg)  = -4.358e-007
                    Total carbon (mol/kg)  =  0.000e+000
                       Total CO2 (mol/kg)  =  0.000e+000
                      Temperature (deg C)  =  25.000
                  Electrical balance (eq)  = -9.827e-005
 Percent error, 100*(Cat-|An|)/(Cat+|An|)  =  -0.22
                               Iterations  =   6
                                  Total H  = 1.110124e+002
                                  Total O  = 5.556672e+001

----------------------------Distribution of species----------------------------

                                                    Log       Log         Log
    Species            Molality    Activity  Molality  Activity     Gamma

    H+                3.669e-007  3.162e-007    -6.435    -6.500    -0.065
    OH-               3.837e-008  3.164e-008    -7.416    -7.500    -0.084
    H2O               5.551e+001  9.995e-001     1.744    -0.000     0.000
Ca               4.825e-003
    Ca+2              3.257e-003  1.620e-003    -2.487    -2.790    -0.303
    CaSO4             1.568e-003  1.583e-003    -2.805    -2.800     0.004
    CaHSO4+           3.523e-009  2.933e-009    -8.453    -8.533    -0.080
    CaOH+             1.021e-009  8.498e-010    -8.991    -9.071    -0.080
Cd               2.229e-008
    Cd+2              1.217e-008  5.847e-009    -7.915    -8.233    -0.318
    CdSO4             8.183e-009  8.260e-009    -8.087    -8.083     0.004
    CdCl+             1.002e-009  8.340e-010    -8.999    -9.079    -0.080
    Cd(SO4)2-2        9.236e-010  4.437e-010    -9.035    -9.353    -0.318
    CdCl2             5.144e-012  5.193e-012   -11.289   -11.285     0.004
    CdOH+             1.846e-012  1.537e-012   -11.734   -11.813    -0.080
    CdCl3-            5.878e-015  4.894e-015   -14.231   -14.310    -0.080
    Cd(OH)2           2.585e-016  2.609e-016   -15.588   -15.583     0.004
    Cd(OH)3-          1.111e-022  9.253e-023   -21.954   -22.034    -0.080
    Cd(OH)4-2         5.426e-030  2.607e-030   -29.266   -29.584    -0.318
Cl               1.809e-003
    Cl-               1.809e-003  1.494e-003    -2.743    -2.826    -0.083
    ZnCl+             3.449e-008  2.871e-008    -7.462    -7.542    -0.080
    CdCl+             1.002e-009  8.340e-010    -8.999    -9.079    -0.080
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PbCl+		3.384e-010	2.817e-010	-9.471	-9.550	-0.080
FeCl+		1.564e-010	1.302e-010	-9.806	-9.885	-0.080
ZnCl2		4.448e-011	4.491e-011	-10.352	-10.348	0.004
CdCl2		5.144e-012	5.193e-012	-11.289	-11.285	0.004
PbCl2		6.607e-013	6.669e-013	-12.180	-12.176	0.004
ZnCl3-		9.039e-014	7.526e-014	-13.044	-13.123	-0.080
CdCl3-		5.878e-015	4.894e-015	-14.231	-14.310	-0.080
PbCl3-		9.504e-016	7.913e-016	-15.022	-15.102	-0.080
ZnCl4-2		1.173e-016	5.633e-017	-15.931	-16.249	-0.318
PbCl4-2		1.178e-018	5.657e-019	-17.929	-18.247	-0.318
FeCl+2		3.919e-020	1.882e-020	-19.407	-19.725	-0.318
FeCl2+		1.509e-022	1.256e-022	-21.821	-21.901	-0.080
FeCl3		1.858e-026	1.876e-026	-25.731	-25.727	0.004
Cu(1)	5.862e-008					
Cu+		5.862e-008	4.780e-008	-7.232	-7.321	-0.089
Cu(2)	2.022e-008					
Cu+2		1.244e-008	6.302e-009	-7.905	-8.201	-0.295
CuSO4		6.243e-009	6.303e-009	-8.205	-8.200	0.004
Cu(OH)2		1.303e-009	1.315e-009	-8.885	-8.881	0.004
CuOH+		2.403e-010	1.992e-010	-9.619	-9.701	-0.082
Cu(OH)3-		3.009e-016	2.505e-016	-15.522	-15.601	-0.080
Cu(OH)4-2		3.289e-022	1.580e-022	-21.483	-21.801	-0.318
Fe(2)	1.794e-007					
Fe+2		1.247e-007	6.317e-008	-6.904	-7.200	-0.295
FeSO4		5.450e-008	5.502e-008	-7.264	-7.259	0.004
FeCl+		1.564e-010	1.302e-010	-9.806	-9.885	-0.080
FeOH+		7.584e-011	6.314e-011	-10.120	-10.200	-0.080
FeHSO4+		1.374e-013	1.144e-013	-12.862	-12.942	-0.080
Fe(3)	1.433e-011					
Fe(OH)2+		1.071e-011	8.914e-012	-10.970	-11.050	-0.080
Fe(OH)3		3.595e-012	3.629e-012	-11.444	-11.440	0.004
FeOH+2		1.773e-014	8.517e-015	-13.751	-14.070	-0.318
Fe(OH)4-		1.257e-014	1.046e-014	-13.901	-13.980	-0.080
FeSO4+		2.693e-017	2.242e-017	-16.570	-16.649	-0.080
Fe(SO4)2-		2.885e-018	2.402e-018	-17.540	-17.619	-0.080
Fe+3		1.592e-018	4.173e-019	-17.798	-18.380	-0.581
FeCl+2		3.919e-020	1.882e-020	-19.407	-19.725	-0.318
FeCl2+		1.509e-022	1.256e-022	-21.821	-21.901	-0.080
FeHSO4+2		3.951e-023	1.898e-023	-22.403	-22.722	-0.318
Fe2(OH)2+4		3.667e-026	1.952e-027	-25.436	-26.709	-1.274
FeCl3		1.858e-026	1.876e-026	-25.731	-25.727	0.004
Fe3(OH)4+5		3.554e-034	3.636e-036	-33.449	-35.439	-1.990
H(0)	2.930e-020					
H2		1.465e-020	1.479e-020	-19.834	-19.830	0.004
K	9.738e-004					
K+		9.417e-004	7.775e-004	-3.026	-3.109	-0.083
KSO4-		3.215e-005	2.676e-005	-4.493	-4.572	-0.080
KOH		8.441e-012	8.521e-012	-11.074	-11.069	0.004
Mg	9.315e-003					
Mg+2		5.904e-003	2.998e-003	-2.229	-2.523	-0.294
MgSO4		3.411e-003	3.443e-003	-2.467	-2.463	0.004
MgOH+		4.133e-008	3.441e-008	-7.384	-7.463	-0.080
Na	2.659e-003					
Na+		2.595e-003	2.166e-003	-2.586	-2.664	-0.078
NaSO4-		6.387e-005	5.317e-005	-4.195	-4.274	-0.080
NaOH		4.480e-011	4.523e-011	-10.349	-10.345	0.004
O(0)	0.000e+000					
O2		0.000e+000	0.000e+000	-52.725	-52.720	0.004
Pb	2.418e-008					
PbSO4		1.293e-008	1.305e-008	-7.888	-7.884	0.004
Pb+2		9.864e-009	4.738e-009	-8.006	-8.324	-0.318
Pb(SO4)2-2		6.985e-010	3.355e-010	-9.156	-9.474	-0.318
PbOH+		3.508e-010	2.920e-010	-9.455	-9.535	-0.080
PbCl+		3.384e-010	2.817e-010	-9.471	-9.550	-0.080
PbCl2		6.607e-013	6.669e-013	-12.180	-12.176	0.004
Pb(OH)2		3.557e-013	3.591e-013	-12.449	-12.445	0.004
PbCl3-		9.504e-016	7.913e-016	-15.022	-15.102	-0.080
Pb2OH+3		1.612e-016	3.098e-017	-15.793	-16.509	-0.716
Pb(OH)3-		1.565e-017	1.303e-017	-16.805	-16.885	-0.080
PbCl4-2		1.178e-018	5.657e-019	-17.929	-18.247	-0.318
Pb(OH)4-2		1.964e-022	9.435e-023	-21.707	-22.025	-0.318
S(6)	1.512e-002					

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        SO4-2           1.004e-002  4.898e-003    -1.998     -2.310     -0.312
        MgSO4           3.411e-003  3.443e-003    -2.467     -2.463      0.004
        CaSO4           1.568e-003  1.583e-003    -2.805     -2.800      0.004
        NaSO4-          6.387e-005  5.317e-005    -4.195     -4.274     -0.080
        KSO4-           3.215e-005  2.676e-005    -4.493     -4.572     -0.080
        ZnSO4           8.124e-006  8.201e-006    -5.090     -5.086      0.004
        Zn(SO4)2-2      6.798e-007  3.265e-007    -6.168     -6.486     -0.318
        HSO4-           1.809e-007  1.506e-007    -6.743     -6.822     -0.080
        FeSO4           5.450e-008  5.502e-008    -7.264     -7.259      0.004
        PbSO4           1.293e-008  1.305e-008    -7.888     -7.884      0.004
        CdSO4           8.183e-009  8.260e-009    -8.087     -8.083      0.004
        CuSO4           6.243e-009  6.303e-009    -8.205     -8.200      0.004
        CaHSO4+         3.523e-009  2.933e-009    -8.453     -8.533     -0.080
        Cd(SO4)2-2      9.236e-010  4.437e-010    -9.035     -9.353     -0.318
        Pb(SO4)2-2      6.985e-010  3.355e-010    -9.156     -9.474     -0.318
        FeHSO4+         1.374e-013  1.144e-013   -12.862    -12.942     -0.080
        FeSO4+          2.693e-017  2.242e-017   -16.570    -16.649     -0.080
        Fe(SO4)2-       2.885e-018  2.402e-018   -17.540    -17.619     -0.080
        FeHSO4+2        3.951e-023  1.898e-023   -22.403    -22.722     -0.318
Zn              2.345e-005
        Zn+2            1.458e-005  7.142e-006    -4.836     -5.146     -0.310
        ZnSO4           8.124e-006  8.201e-006    -5.090     -5.086      0.004
        Zn(SO4)2-2      6.798e-007  3.265e-007    -6.168     -6.486     -0.318
        ZnCl+           3.449e-008  2.871e-008    -7.462     -7.542     -0.080
        ZnOH+           2.973e-008  2.475e-008    -7.527     -7.606     -0.080
        Zn(OH)2         8.898e-010  8.983e-010    -9.051     -9.047      0.004
        ZnCl2           4.448e-011  4.491e-011   -10.352    -10.348      0.004
        ZnCl3-          9.039e-014  7.526e-014   -13.044    -13.123     -0.080
        Zn(OH)3-        1.078e-014  8.978e-015   -13.967    -14.047     -0.080
        ZnCl4-2         1.173e-016  5.633e-017   -15.931    -16.249     -0.318
        Zn(OH)4-2       9.362e-021  4.497e-021   -20.029    -20.347     -0.318

------------------------------Saturation indices-------------------------------

        Phase               SI log IAP  log KT

        Anglesite        -2.84  -10.63   -7.79  PbSO4
        Anhydrite        -0.74   -5.10   -4.36  CaSO4
        Cd(OH)2          -8.88    4.77   13.65  Cd(OH)2
        CdSO4           -10.44  -10.54   -0.10  CdSO4
        Fe(OH)3(a)       -3.77    1.12    4.89  Fe(OH)3
        Goethite          2.12    1.12   -1.00  FeOOH
        Gypsum           -0.52   -5.10   -4.58  CaSO4:2H2O
        H2(g)           -16.68  -19.83   -3.15  H2
        H2O(g)           -1.51   -0.00    1.51  H2O
        Halite           -7.07   -5.49    1.58  NaCl
        Hematite          6.25    2.24   -4.01  Fe2O3
        Jarosite-K      -14.66  -23.87   -9.21  KFe3(SO4)2(OH)6
        Melanterite      -7.30   -9.51   -2.21  FeSO4:7H2O
        O2(g)           -49.76  -52.72   -2.96  O2
        Pb(OH)2          -3.47    4.68    8.15  Pb(OH)2
        Zn(OH)2(e)       -3.65    7.85   11.50  Zn(OH)2

Initial solution 4.   Rainwater

-----------------------------Solution composition------------------------------

        Elements           Molality       Moles

        Ca              2.500e-006  2.500e-006
        Cl              6.699e-006  6.699e-006
        K               1.499e-006  1.499e-006
        Mg              1.300e-006  1.300e-006
        Na              6.903e-006  6.903e-006
        S(6)            8.100e-006  8.100e-006
        Zn              1.530e-007  1.530e-007

----------------------------Description of solution----------------------------

                                       pH  =   4.590
                                       pe  =  10.150
                        Activity of water  =   1.000
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                             Ionic strength  =  4.455e-005
                         Mass of water (kg)  =  1.000e+000
                   Total alkalinity (eq/kg)  = -2.592e-005
                      Total carbon (mol/kg)  =  0.000e+000
                         Total CO2 (mol/kg)  =  0.000e+000
                        Temperature (deg C)  =  25.000
                    Electrical balance (eq)  =  1.933e-005
 Percent error, 100*(Cat-|An|)/(Cat+|An|)  =  29.71
                                 Iterations  =   3
                                    Total H  = 1.110125e+002
                                    Total O  = 5.550625e+001

----------------------------Distribution of species----------------------------

                                                   Log       Log       Log
    Species          Molality    Activity  Molality  Activity     Gamma

    H+             2.590e-005  2.570e-005    -4.587    -4.590    -0.003
    OH-            3.925e-010  3.895e-010    -9.406    -9.410    -0.003
    H2O            5.551e+001  1.000e+000     1.744    -0.000     0.000
Ca              2.500e-006
    Ca+2           2.496e-006  2.420e-006    -5.603    -5.616    -0.013
    CaSO4          3.780e-009  3.780e-009    -8.423    -8.423     0.000
    CaHSO4+        5.736e-013  5.691e-013   -12.241   -12.245    -0.003
    CaOH+          1.575e-014  1.563e-014   -13.803   -13.806    -0.003
Cl              6.699e-006
    Cl-            6.699e-006  6.647e-006    -5.174    -5.177    -0.003
    ZnCl+          2.669e-012  2.649e-012   -11.574   -11.577    -0.003
    ZnCl2          1.844e-017  1.844e-017   -16.734   -16.734     0.000
    ZnCl3-         1.386e-022  1.375e-022   -21.858   -21.862    -0.003
    ZnCl4-2        4.725e-028  4.581e-028   -27.326   -27.339    -0.013
H(0)            4.688e-033
    H2             2.344e-033  2.344e-033   -32.630   -32.630     0.000
K               1.499e-006
    K+             1.499e-006  1.487e-006    -5.824    -5.828    -0.003
    KSO4-          8.242e-011  8.178e-011   -10.084   -10.087    -0.003
    KOH            2.006e-016  2.006e-016   -15.698   -15.698     0.000
Mg              1.300e-006
    Mg+2           1.297e-006  1.258e-006    -5.887    -5.900    -0.013
    MgSO4          2.308e-009  2.308e-009    -8.637    -8.637     0.000
    MgOH+          1.791e-013  1.777e-013   -12.747   -12.750    -0.003
Na              6.903e-006
    Na+            6.902e-006  6.849e-006    -5.161    -5.164    -0.003
    NaSO4-         2.708e-010  2.687e-010    -9.567    -9.571    -0.003
    NaOH           1.760e-015  1.760e-015   -14.754   -14.754     0.000
O(0)            1.517e-027
    O2             7.586e-028  7.586e-028   -27.120   -27.120     0.000
S(6)            8.100e-006
    SO4-2          8.073e-006  7.827e-006    -5.093    -5.106    -0.013
    HSO4-          1.971e-008  1.956e-008    -7.705    -7.709    -0.003
    CaSO4          3.780e-009  3.780e-009    -8.423    -8.423     0.000
    MgSO4          2.308e-009  2.308e-009    -8.637    -8.637     0.000
    ZnSO4          2.716e-010  2.716e-010    -9.566    -9.566     0.000
    NaSO4-         2.708e-010  2.687e-010    -9.567    -9.571    -0.003
    KSO4-          8.242e-011  8.178e-011   -10.084   -10.087    -0.003
    CaHSO4+        5.736e-013  5.691e-013   -12.241   -12.245    -0.003
    Zn(SO4)2-2     1.783e-014  1.728e-014   -13.749   -13.762    -0.013
Zn              1.530e-007
    Zn+2           1.527e-007  1.480e-007    -6.816    -6.830    -0.013
    ZnSO4          2.716e-010  2.716e-010    -9.566    -9.566     0.000
    ZnOH+          6.364e-012  6.315e-012   -11.196   -11.200    -0.003
    ZnCl+          2.669e-012  2.649e-012   -11.574   -11.577    -0.003
    Zn(SO4)2-2     1.783e-014  1.728e-014   -13.749   -13.762    -0.013
    Zn(OH)2        2.821e-015  2.821e-015   -14.550   -14.550     0.000
    ZnCl2          1.844e-017  1.844e-017   -16.734   -16.734     0.000
    Zn(OH)3-       3.497e-022  3.470e-022   -21.456   -21.460    -0.003
    ZnCl3-         1.386e-022  1.375e-022   -21.858   -21.862    -0.003
    ZnCl4-2        4.725e-028  4.581e-028   -27.326   -27.339    -0.013
    Zn(OH)4-2      2.207e-030  2.140e-030   -29.656   -29.670    -0.013

------------------------------Saturation indices-------------------------------
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Phase	SI	log IAP	log KT	
Anhydrite	-6.36	-10.72	-4.36	CaSO4
Gypsum	-6.14	-10.72	-4.58	CaSO4:2H2O
H2(g)	-29.48	-32.63	-3.15	H2
H2O(g)	-1.51	-0.00	1.51	H2O
Halite	-11.92	-10.34	1.58	NaCl
O2(g)	-24.16	-27.12	-2.96	O2
Zn(OH)2(e)	-9.15	2.35	11.50	Zn(OH)2

Initial solution 5. Tailings Seepage

----------------------------Solution composition-----------------------------

Elements	Molality	Moles
Ca	1.024e-002	1.024e-002
Cd	7.216e-010	7.216e-010
Cl	7.463e-002	7.463e-002
Cu	2.776e-007	2.776e-007
Fe	5.718e-008	5.718e-008
K	7.700e-003	7.700e-003
Mg	4.462e-002	4.462e-002
Na	1.336e-001	1.336e-001
Pb	1.419e-009	1.419e-009
S(6)	6.532e-002	6.532e-002
Zn	5.071e-006	5.071e-006

----------------------------Description of solution----------------------------

pH	= 6.560
pe	= 1.690
Activity of water	= 0.995
Ionic strength	= 2.457e-001
Mass of water (kg)	= 1.000e+000
Total alkalinity (eq/kg)	= -4.947e-007
Total carbon (mol/kg)	= 0.000e+000
Total CO2 (mol/kg)	= 0.000e+000
Temperature (deg C)	= 25.000
Electrical balance (eq)	= 4.577e-002
Percent error, 100*(Cat-|An|)/(Cat+|An|)	= 12.94
Iterations	= 8
Total H	= 1.110124e+002
Total O	= 5.576752e+001

----------------------------Distribution of species----------------------------

Species	Molality	Activity	Log Molality	Log Activity	Log Gamma
H+	3.487e-007	2.754e-007	-6.458	-6.560	-0.102
OH-	5.236e-008	3.616e-008	-7.281	-7.442	-0.161
H2O	5.551e+001	9.948e-001	1.744	-0.002	0.000
Ca	1.024e-002				
Ca+2	6.543e-003	1.993e-003	-2.184	-2.700	-0.516
CaSO4	3.701e-003	3.916e-003	-2.432	-2.407	0.025
CaHSO4+	8.548e-009	6.319e-009	-8.068	-8.199	-0.131
CaOH+	1.616e-009	1.195e-009	-8.791	-8.923	-0.131
Cd	7.216e-010				
CdCl+	3.265e-010	2.414e-010	-9.486	-9.617	-0.131
Cd+2	1.629e-010	4.863e-011	-9.788	-10.313	-0.525
CdSO4	1.305e-010	1.381e-010	-9.884	-9.860	0.025
Cd(SO4)2-2	4.993e-011	1.491e-011	-10.302	-10.827	-0.525
CdCl2	4.942e-011	5.229e-011	-10.306	-10.282	0.025
CdCl3-	2.320e-012	1.715e-012	-11.635	-11.766	-0.131
CdOH+	1.976e-014	1.461e-014	-13.704	-13.835	-0.131
Cd(OH)2	2.678e-018	2.834e-018	-17.572	-17.548	0.025
Cd(OH)3-	1.553e-024	1.148e-024	-23.809	-23.940	-0.131
Cd(OH)4-2	1.238e-031	3.696e-032	-30.907	-31.432	-0.525
Cl	7.463e-002				
Cl-	7.463e-002	5.197e-002	-1.127	-1.284	-0.157
ZnCl+	1.453e-007	1.074e-007	-6.838	-6.969	-0.131

ZnCl2	5.523e-009	5.845e-009	-8.258	-8.233	0.025
FeCl+	1.111e-009	8.211e-010	-8.954	-9.086	-0.131
ZnCl3-	4.611e-010	3.408e-010	-9.336	-9.467	-0.131
CdCl+	3.265e-010	2.414e-010	-9.486	-9.617	-0.131
PbCl+	3.151e-010	2.329e-010	-9.502	-9.633	-0.131
CdCl2	4.942e-011	5.229e-011	-10.306	-10.282	0.025
ZnCl4-2	2.974e-011	8.878e-012	-10.527	-11.052	-0.525
PbCl2	1.813e-011	1.919e-011	-10.742	-10.717	0.025
CdCl3-	2.320e-012	1.715e-012	-11.635	-11.766	-0.131
PbCl3-	1.072e-012	7.921e-013	-11.970	-12.101	-0.131
PbCl4-2	6.600e-014	1.970e-014	-13.180	-13.705	-0.525
FeCl+2	2.814e-019	8.403e-020	-18.551	-19.076	-0.525
FeCl2+	2.639e-020	1.951e-020	-19.579	-19.710	-0.131
FeCl3	9.581e-023	1.014e-022	-22.019	-21.994	0.025
Cu(1)	2.077e-007				
Cu+	2.077e-007	1.374e-007	-6.683	-6.862	-0.179
Cu(2)	6.990e-008				
Cu+2	4.158e-008	1.282e-008	-7.381	-7.892	-0.511
CuSO4	2.436e-008	2.578e-008	-7.613	-7.589	0.025
Cu(OH)2	3.303e-009	3.495e-009	-8.481	-8.457	0.025
CuOH+	6.586e-010	4.631e-010	-9.181	-9.334	-0.153
Cu(OH)3-	1.029e-015	7.606e-016	-14.988	-15.119	-0.131
Cu(OH)4-2	1.836e-021	5.481e-022	-20.736	-21.261	-0.525
Fe(2)	5.718e-008				
Fe+2	3.711e-008	1.145e-008	-7.430	-7.941	-0.511
FeSO4	1.894e-008	2.004e-008	-7.723	-7.698	0.025
FeCl+	1.111e-009	8.211e-010	-8.954	-9.086	-0.131
FeOH+	1.768e-011	1.307e-011	-10.752	-10.884	-0.131
FeHSO4+	4.908e-014	3.628e-014	-13.309	-13.440	-0.131
Fe(3)	2.684e-012				
Fe(OH)2+	2.020e-012	1.493e-012	-11.695	-11.826	-0.131
Fe(OH)3	6.565e-013	6.947e-013	-12.183	-12.158	0.025
FeOH+2	4.181e-015	1.248e-015	-14.379	-14.904	-0.525
Fe(OH)4-	3.096e-015	2.288e-015	-14.509	-14.640	-0.131
FeSO4+	7.818e-018	5.779e-018	-17.107	-17.238	-0.131
Fe(SO4)2-	1.684e-018	1.245e-018	-17.774	-17.905	-0.131
Fe+3	4.472e-019	5.353e-020	-18.350	-19.271	-0.922
FeCl+2	2.814e-019	8.403e-020	-18.551	-19.076	-0.525
FeCl2+	2.639e-020	1.951e-020	-19.579	-19.710	-0.131
FeCl3	9.581e-023	1.014e-022	-22.019	-21.994	0.025
FeHSO4+2	1.428e-023	4.262e-024	-22.845	-23.370	-0.525
Fe2(OH)2+4	5.280e-027	4.195e-029	-26.277	-28.377	-2.100
Fe3(OH)4+5	2.500e-035	1.309e-038	-34.602	-37.883	-3.281
H(0)	4.231e-020				
H2	2.116e-020	2.239e-020	-19.675	-19.650	0.025
K	7.700e-003				
K+	7.229e-003	5.034e-003	-2.141	-2.298	-0.157
KSO4-	4.712e-004	3.483e-004	-3.327	-3.458	-0.131
KOH	5.958e-011	6.305e-011	-10.225	-10.200	0.025
Mg	4.462e-002				
Mg+2	2.600e-002	8.536e-003	-1.585	-2.069	-0.484
MgSO4	1.862e-002	1.970e-002	-1.730	-1.705	0.025
MgOH+	1.514e-007	1.119e-007	-6.820	-6.951	-0.131
Na	1.336e-001				
Na+	1.274e-001	9.346e-002	-0.895	-1.029	-0.134
NaSO4-	6.239e-003	4.612e-003	-2.205	-2.336	-0.131
NaOH	2.108e-009	2.230e-009	-8.676	-8.652	0.025
O(0)	0.000e+000				
O2	0.000e+000	0.000e+000	-53.109	-53.085	0.025
Pb	1.419e-009				
PbSO4	5.890e-010	6.233e-010	-9.230	-9.205	0.025
Pb+2	3.770e-010	1.126e-010	-9.424	-9.949	-0.525
PbCl+	3.151e-010	2.329e-010	-9.502	-9.633	-0.131
Pb(SO4)2-2	1.079e-010	3.220e-011	-9.967	-10.492	-0.525
PbCl2	1.813e-011	1.919e-011	-10.742	-10.717	0.025
PbOH+	1.072e-011	7.928e-012	-10.970	-11.101	-0.131
PbCl3-	1.072e-012	7.921e-013	-11.970	-12.101	-0.131
PbCl4-2	6.600e-014	1.970e-014	-13.180	-13.705	-0.525
Pb(OH)2	1.053e-014	1.114e-014	-13.978	-13.953	0.025
Pb(OH)3-	6.249e-019	4.619e-019	-18.204	-18.335	-0.131
Pb2OH+3	3.032e-019	1.998e-020	-18.518	-19.699	-1.181
Pb(OH)4-2	1.280e-023	3.822e-024	-22.893	-23.418	-0.525

```
S(6)            6.532e-002
    SO4-2            3.629e-002  9.846e-003    -1.440    -2.007    -0.567
    MgSO4            1.862e-002  1.970e-002    -1.730    -1.705     0.025
    NaSO4-           6.239e-003  4.612e-003    -2.205    -2.336    -0.131
    CaSO4            3.701e-003  3.916e-003    -2.432    -2.407     0.025
    KSO4-            4.712e-004  3.483e-004    -3.327    -3.458    -0.131
    ZnSO4            1.674e-006  1.772e-006    -5.776    -5.752     0.025
    Zn(SO4)2-2       4.749e-007  1.418e-007    -6.323    -6.848    -0.525
    HSO4-            3.567e-007  2.636e-007    -6.448    -6.579    -0.131
    CuSO4            2.436e-008  2.578e-008    -7.613    -7.589     0.025
    FeSO4            1.894e-008  2.004e-008    -7.723    -7.698     0.025
    CaHSO4+          8.548e-009  6.319e-009    -8.068    -8.199    -0.131
    PbSO4            5.890e-010  6.233e-010    -9.230    -9.205     0.025
    CdSO4            1.305e-010  1.381e-010    -9.884    -9.860     0.025
    Pb(SO4)2-2       1.079e-010  3.220e-011    -9.967   -10.492    -0.525
    Cd(SO4)2-2       4.993e-011  1.491e-011   -10.302   -10.827    -0.525
    FeHSO4+          4.908e-014  3.628e-014   -13.309   -13.440    -0.131
    FeSO4+           7.818e-018  5.779e-018   -17.107   -17.238    -0.131
    Fe(SO4)2-        1.684e-018  1.245e-018   -17.774   -17.905    -0.131
    FeHSO4+2         1.428e-023  4.262e-024   -22.845   -23.370    -0.525
Zn              5.071e-006
    Zn+2             2.766e-006  7.677e-007    -5.558    -6.115    -0.557
    ZnSO4            1.674e-006  1.772e-006    -5.776    -5.752     0.025
    Zn(SO4)2-2       4.749e-007  1.418e-007    -6.323    -6.848    -0.525
    ZnCl+            1.453e-007  1.074e-007    -6.838    -6.969    -0.131
    ZnCl2            5.523e-009  5.845e-009    -8.258    -8.233     0.025
    ZnOH+            4.113e-009  3.040e-009    -8.386    -8.517    -0.131
    ZnCl3-           4.611e-010  3.408e-010    -9.336    -9.467    -0.131
    Zn(OH)2          1.191e-010  1.261e-010    -9.924    -9.899     0.025
    ZnCl4-2          2.974e-011  8.878e-012   -10.527   -11.052    -0.525
    Zn(OH)3-         1.948e-015  1.440e-015   -14.710   -14.842    -0.131
    Zn(OH)4-2        2.761e-021  8.243e-022   -20.559   -21.084    -0.525

------------------------------Saturation indices-------------------------------

    Phase               SI log IAP  log KT

    Anglesite        -4.17  -11.96   -7.79  PbSO4
    Anhydrite        -0.35   -4.71   -4.36  CaSO4
    Cd(OH)2         -10.85    2.80   13.65  Cd(OH)2
    CdSO4           -12.22  -12.32   -0.10  CdSO4
    Fe(OH)3(a)       -4.49    0.40    4.89  Fe(OH)3
    Goethite          1.40    0.40   -1.00  FeOOH
    Gypsum           -0.13   -4.71   -4.58  CaSO4:2H2O
    H2(g)           -16.50  -19.65   -3.15  H2
    H2O(g)           -1.51   -0.00    1.51  H2O
    Halite           -3.90   -2.31    1.58  NaCl
    Hematite          4.82    0.81   -4.01  Fe2O3
    Jarosite-K      -15.57  -24.78   -9.21  KFe3(SO4)2(OH)6
    Melanterite      -7.75   -9.96   -2.21  FeSO4:7H2O
    O2(g)           -50.12  -53.08   -2.96  O2
    Pb(OH)2          -4.98    3.17    8.15  Pb(OH)2
    Zn(OH)2(e)       -4.50    7.00   11.50  Zn(OH)2

-----------------------------------------
Beginning of batch-reaction calculations.
-----------------------------------------

Reaction step 1.

Using mix 1.  Mixing of water in open pit - worst case Scenario 2

Mixture 1.   Mixing of water in open pit - worst case Scenario 2

      9.344e-001 Solution 1River water
      3.900e-003 Solution 2PAF Leachate
      3.530e-002 Solution 3NAF Leachate
      2.320e-002 Solution 4Rainwater
      3.100e-003 Solution 5Tailings Seepage

-----------------------------Solution composition------------------------------
```

Elements	Molality	Moles
Ca	1.373e-003	1.373e-003
Cd	3.530e-009	3.530e-009
Cl	6.989e-004	6.988e-004
Cu	2.200e-008	2.199e-008
Fe	1.893e-004	1.893e-004
K	1.591e-004	1.591e-004
Mg	2.695e-003	2.694e-003
Na	9.402e-004	9.402e-004
Pb	8.852e-009	8.851e-009
S	1.630e-003	1.630e-003
Zn	9.183e-006	9.182e-006

----------------------------Description of solution----------------------------

```
                                       pH  =   7.514      Charge balance
                                       pe  =   4.568      Adjusted to redox equilibrium
                        Activity of water  =   1.000
                           Ionic strength  =  1.055e-002
                       Mass of water (kg)  =  9.999e-001
                 Total alkalinity (eq/kg)  =  1.583e-004
                    Total carbon (mol/kg)  =  0.000e+000
                       Total CO2 (mol/kg)  =  0.000e+000
                      Temperature (deg C)  =  28.177
                  Electrical balance (eq)  =  5.329e-003
 Percent error, 100*(Cat-|An|)/(Cat+|An|)  =  46.48
                               Iterations  =   6
                                  Total H  = 1.110019e+002
                                  Total O  = 5.550772e+001
```

----------------------------Distribution of species----------------------------

	Species	Molality	Activity	Log Molality	Log Activity	Log Gamma
	OH-	4.609e-007	4.136e-007	-6.336	-6.383	-0.047
	H+	3.364e-008	3.065e-008	-7.473	-7.514	-0.040
	H2O	5.551e+001	9.999e-001	1.744	-0.000	0.000
Ca		1.373e-003				
	Ca+2	1.242e-003	8.239e-004	-2.906	-3.084	-0.178
	CaSO4	1.315e-004	1.318e-004	-3.881	-3.880	0.001
	CaOH+	4.959e-009	4.460e-009	-8.305	-8.351	-0.046
	CaHSO4+	2.741e-011	2.465e-011	-10.562	-10.608	-0.046
Cd		3.530e-009				
	Cd+2	2.947e-009	1.928e-009	-8.531	-8.715	-0.184
	CdSO4	4.401e-010	4.412e-010	-9.356	-9.355	0.001
	CdCl+	1.298e-010	1.167e-010	-9.887	-9.933	-0.046
	CdOH+	7.342e-012	6.603e-012	-11.134	-11.180	-0.046
	Cd(SO4)2-2	5.646e-012	3.693e-012	-11.248	-11.433	-0.184
	CdCl2	3.080e-013	3.088e-013	-12.511	-12.510	0.001
	Cd(OH)2	9.139e-015	9.161e-015	-14.039	-14.038	0.001
	CdCl3-	1.425e-016	1.282e-016	-15.846	-15.892	-0.046
	Cd(OH)3-	3.728e-020	3.353e-020	-19.429	-19.475	-0.046
	Cd(OH)4-2	1.490e-026	9.747e-027	-25.827	-26.011	-0.184
Cl		6.989e-004				
	Cl-	6.988e-004	6.273e-004	-3.156	-3.202	-0.047
	ZnCl+	1.120e-008	1.008e-008	-7.951	-7.997	-0.046
	FeCl+	2.261e-009	2.033e-009	-8.646	-8.692	-0.046
	CdCl+	1.298e-010	1.167e-010	-9.887	-9.933	-0.046
	PbCl+	9.795e-011	8.809e-011	-10.009	-10.055	-0.046
	ZnCl2	6.687e-012	6.703e-012	-11.175	-11.174	0.001
	CdCl2	3.080e-013	3.088e-013	-12.511	-12.510	0.001
	PbCl2	8.239e-014	8.259e-014	-13.084	-13.083	0.001
	ZnCl3-	5.346e-015	4.808e-015	-14.272	-14.318	-0.046
	FeCl+2	3.154e-016	2.063e-016	-15.501	-15.685	-0.184
	CdCl3-	1.425e-016	1.282e-016	-15.846	-15.892	-0.046
	PbCl3-	4.666e-017	4.196e-017	-16.331	-16.377	-0.046
	ZnCl4-2	2.369e-018	1.550e-018	-17.625	-17.810	-0.184
	FeCl2+	5.819e-019	5.233e-019	-18.235	-18.281	-0.046
	PbCl4-2	1.973e-020	1.291e-020	-19.705	-19.889	-0.184
	FeCl3	3.275e-023	3.283e-023	-22.485	-22.484	0.001

Cu(1)	1.484e-011				
Cu+	1.484e-011	1.327e-011	-10.829	-10.877	-0.048
Cu(2)	2.198e-008				
Cu(OH)2	2.015e-008	2.020e-008	-7.696	-7.695	0.001
Cu+2	1.359e-009	9.086e-010	-8.867	-9.042	-0.175
CuOH+	3.297e-010	2.963e-010	-9.482	-9.528	-0.046
CuSO4	1.472e-010	1.476e-010	-9.832	-9.831	0.001
Cu(OH)3-	4.413e-014	3.969e-014	-13.355	-13.401	-0.046
Cu(OH)4-2	3.948e-019	2.583e-019	-18.404	-18.588	-0.184
Fe(2)	3.892e-006				
Fe+2	3.513e-006	2.348e-006	-5.454	-5.629	-0.175
FeSO4	3.434e-007	3.442e-007	-6.464	-6.463	0.001
FeOH+	3.406e-008	3.063e-008	-7.468	-7.514	-0.046
FeCl+	2.261e-009	2.033e-009	-8.646	-8.692	-0.046
FeHSO4+	7.812e-014	7.025e-014	-13.107	-13.153	-0.046
Fe(HS)2	0.000e+000	0.000e+000	-144.862	-144.861	0.001
Fe(HS)3-	0.000e+000	0.000e+000	-216.868	-216.914	-0.046
Fe(3)	1.854e-004				
Fe(OH)3	1.461e-004	1.465e-004	-3.835	-3.834	0.001
Fe(OH)2+	3.380e-005	3.040e-005	-4.471	-4.517	-0.046
Fe(OH)4-	5.498e-006	4.944e-006	-5.260	-5.306	-0.046
FeOH+2	3.818e-009	2.498e-009	-8.418	-8.602	-0.184
FeSO4+	1.003e-013	9.019e-014	-12.999	-13.045	-0.046
Fe+3	2.274e-014	9.857e-015	-13.643	-14.006	-0.363
Fe(SO4)2-	1.729e-015	1.555e-015	-14.762	-14.808	-0.046
Fe2(OH)2+4	8.052e-016	1.475e-016	-15.094	-15.831	-0.737
FeCl+2	3.154e-016	2.063e-016	-15.501	-15.685	-0.184
Fe3(OH)4+5	9.940e-018	7.008e-019	-17.003	-18.154	-1.152
FeCl2+	5.819e-019	5.233e-019	-18.235	-18.281	-0.046
FeHSO4+2	1.132e-020	7.408e-021	-19.946	-20.130	-0.184
FeCl3	3.275e-023	3.283e-023	-22.485	-22.484	0.001
H(0)	9.396e-028				
H2	4.698e-028	4.709e-028	-27.328	-27.327	0.001
K	1.591e-004				
K+	1.582e-004	1.420e-004	-3.801	-3.848	-0.047
KSO4-	9.122e-007	8.204e-007	-6.040	-6.086	-0.046
KOH	1.602e-011	1.606e-011	-10.795	-10.794	0.001
Mg	2.695e-003				
Mg+2	2.380e-003	1.590e-003	-2.623	-2.799	-0.175
MgSO4	3.138e-004	3.146e-004	-3.503	-3.502	0.001
MgOH+	2.781e-007	2.501e-007	-6.556	-6.602	-0.046
Na	9.402e-004				
Na+	9.365e-004	8.433e-004	-3.028	-3.074	-0.046
NaSO4-	3.732e-006	3.356e-006	-5.428	-5.474	-0.046
NaOH	1.813e-010	1.817e-010	-9.742	-9.741	0.001
O(0)	3.877e-037				
O2	1.939e-037	1.943e-037	-36.713	-36.711	0.001
Pb	8.852e-009				
Pb+2	4.987e-009	3.263e-009	-8.302	-8.486	-0.184
PbOH+	2.307e-009	2.075e-009	-8.637	-8.683	-0.046
PbSO4	1.425e-009	1.428e-009	-8.846	-8.845	0.001
PbCl+	9.795e-011	8.809e-011	-10.009	-10.055	-0.046
Pb(OH)2	2.627e-011	2.633e-011	-10.581	-10.580	0.001
Pb(SO4)2-2	8.917e-012	5.833e-012	-11.050	-11.234	-0.184
PbCl2	8.239e-014	8.259e-014	-13.084	-13.083	0.001
Pb(OH)3-	1.096e-014	9.861e-015	-13.960	-14.006	-0.046
Pb2OH+3	3.937e-016	1.516e-016	-15.405	-15.819	-0.415
PbCl3-	4.666e-017	4.196e-017	-16.331	-16.377	-0.046
Pb(OH)4-2	1.126e-018	7.368e-019	-17.948	-18.133	-0.184
PbCl4-2	1.973e-020	1.291e-020	-19.705	-19.889	-0.184
S(-2)	0.000e+000				
HS-	0.000e+000	0.000e+000	-74.044	-74.091	-0.047
H2S	0.000e+000	0.000e+000	-74.704	-74.703	0.001
S-2	0.000e+000	0.000e+000	-79.222	-79.402	-0.180
Fe(HS)2	0.000e+000	0.000e+000	-144.862	-144.861	0.001
Fe(HS)3-	0.000e+000	0.000e+000	-216.868	-216.914	-0.046
S(6)	1.630e-003				
SO4-2	1.179e-003	7.784e-004	-2.928	-3.109	-0.180
MgSO4	3.138e-004	3.146e-004	-3.503	-3.502	0.001
CaSO4	1.315e-004	1.318e-004	-3.881	-3.880	0.001
NaSO4-	3.732e-006	3.356e-006	-5.428	-5.474	-0.046
ZnSO4	9.687e-007	9.711e-007	-6.014	-6.013	0.001

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     KSO4-            9.122e-007  8.204e-007    -6.040    -6.086    -0.046
     FeSO4            3.434e-007  3.442e-007    -6.464    -6.463     0.001
     Zn(SO4)2-2       9.167e-009  5.997e-009    -8.038    -8.222    -0.184
     HSO4-            2.767e-009  2.489e-009    -8.558    -8.604    -0.046
     PbSO4            1.425e-009  1.428e-009    -8.846    -8.845     0.001
     CdSO4            4.401e-010  4.412e-010    -9.356    -9.355     0.001
     CuSO4            1.472e-010  1.476e-010    -9.832    -9.831     0.001
     CaHSO4+          2.741e-011  2.465e-011   -10.562   -10.608    -0.046
     Pb(SO4)2-2       8.917e-012  5.833e-012   -11.050   -11.234    -0.184
     Cd(SO4)2-2       5.646e-012  3.693e-012   -11.248   -11.433    -0.184
     FeSO4+           1.003e-013  9.019e-014   -12.999   -13.045    -0.046
     FeHSO4+          7.812e-014  7.025e-014   -13.107   -13.153    -0.046
     Fe(SO4)2-        1.729e-015  1.555e-015   -14.762   -14.808    -0.046
     FeHSO4+2         1.132e-020  7.408e-021   -19.946   -20.130    -0.184
Zn               9.183e-006
     Zn+2             7.862e-006  5.195e-006    -5.104    -5.284    -0.180
     ZnSO4            9.687e-007  9.711e-007    -6.014    -6.013     0.001
     ZnOH+            2.622e-007  2.358e-007    -6.581    -6.627    -0.046
     Zn(OH)2          6.941e-008  6.957e-008    -7.159    -7.158     0.001
     ZnCl+            1.120e-008  1.008e-008    -7.951    -7.997    -0.046
     Zn(SO4)2-2       9.167e-009  5.997e-009    -8.038    -8.222    -0.184
     Zn(OH)3-         7.979e-012  7.176e-012   -11.098   -11.144    -0.046
     ZnCl2            6.687e-012  6.703e-012   -11.175   -11.174     0.001
     ZnCl3-           5.346e-015  4.808e-015   -14.272   -14.318    -0.046
     Zn(OH)4-2        5.671e-017  3.710e-017   -16.246   -16.431    -0.184
     ZnCl4-2          2.369e-018  1.550e-018   -17.625   -17.810    -0.184

------------------------------Saturation indices-------------------------------

     Phase               SI log IAP  log KT

     Anglesite        -3.82  -11.60   -7.77  PbSO4
     Anhydrite        -1.82   -6.19   -4.38  CaSO4
     Cd(OH)2          -7.34    6.31   13.65  Cd(OH)2
     CdSO4           -11.61  -11.82   -0.21  CdSO4
     Fe(OH)3(a)        3.64    8.53    4.89  Fe(OH)3
     FeS(ppt)        -68.29  -72.21   -3.92  FeS
     Goethite          9.65    8.53   -1.11  FeOOH
     Gypsum           -1.61   -6.19   -4.58  CaSO4:2H2O
     H2(g)           -24.16  -27.33   -3.16  H2
     H2O(g)           -1.43   -0.00    1.43  H2O
     H2S(g)          -73.67  -74.70   -1.03  H2S
     Halite           -7.87   -6.28    1.59  NaCl
     Hematite         21.31   17.07   -4.25  Fe2O3
     Jarosite-K        2.45   -7.00   -9.45  KFe3(SO4)2(OH)6
     Mackinawite     -67.56  -72.21   -4.65  FeS
     Melanterite      -6.57   -8.74   -2.17  FeSO4:7H2O
     O2(g)           -33.74  -36.71   -2.97  O2
     Pb(OH)2          -1.50    6.54    8.04  Pb(OH)2
     Pyrite         -111.26 -129.65  -18.39  FeS2
     Sphalerite      -60.31  -71.86  -11.55  ZnS
     Sulfur          -55.35  -50.54    4.81  S
     Zn(OH)2(e)       -1.76    9.74   11.50  Zn(OH)2

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End of simulation.
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Reading input data for simulation 3.
------------------------------------

     SOLUTION 1 River water
         temp      28.4
         pH        8.2
         pe        2.63
         redox     pe
         units     mg/l
         density   1
         S(6)      6.4
         Ca        48.7
         Cd        6e-005
```

```
    Cl        15.3
    Cu        0.001
    Fe        10
    K         4.2
    Mg        47
    Na        10.6
    Pb        0.00055
    Zn        0.0104
    water    1 # kg
SOLUTION 2 PAF Leachate
    temp      25
    pH        3.98
    pe        11.85
    redox     pe
    units     mg/l
    density   1
    Ca        358
    Cd        0.0631
    Cl        1
    Cu        0.058
    Fe        307
    K         4
    Mg        2560
    Na        6
    Pb        0.286
    S(6)      20000
    Zn        134
    water    1 # kg
SOLUTION 3 NAF Leachate
    temp      25
    pH        6.5
    pe        1.84
    redox     pe
    units     mg/l
    density   1
    Ca        193
    Cd        0.0025
    Cl        64
    Cu        0.005
    Fe        0.01
    K         38
    Mg        226
    Na        61
    Pb        0.005
    S(6)      1450
    Zn        1.53
    water    1 # kg
SOLUTION 4 Rainwater
    temp      25
    pH        4.59
    pe        10.15
    redox     pe
    units     mg/l
    density   1
    Ca        0.1002
    Cd        0
    Cl        0.2375
    Cu        0
    Fe        0
    K         0.0586
    Mg        0.0316
    Na        0.15869
    Pb        0
    S(6)      0.7781
    Zn        0.01
    water    1 # kg
SOLUTION 5 Tailings Seepage
    temp      25
    pH        6.56
    pe        1.69
    redox     pe
    units     mg/l
```

```
    density   1
    Ca        405
    Cd        0.00008
    Cl        2610
    Cu        0.0174
    Fe        0.00315
    K         297
    Mg        1070
    Na        3030
    Pb        0.00029
    S(6)      6190
    Zn        0.327
    water    1 # kg
MIX 1 Mixing of water in open pit - worst case Scenario 3
    1    0.9989
    2    0
    3    0
    4    0.0009
    5    0.0001
PRINT
    warnings               -1
SELECTED_OUTPUT
    file                  MRM2_Scenario3.txt
    totals                Ca  Cd  Cl  Cu  K  Mg  Mn
                           Na  Pb  S(-2)  Zn  S(6)  Al  Alkalinity
                           B  Ba  Br  C  C(4)  C(-4)  Cu(1)
                           Cu(2)  N  Mn(3)  Mn(2)  Li  Hfo_w  Hfo_s
                           H(0)  Fe(3)  Fe(2)  F  Fe  N(0)  N(3)
                           N(-3)  N(5)  O(0)  P  S  Si  Sr
                           X
    molalities            Ca+2  CaCO3  CaF+  CaH2PO4+
                           CaHCO3+  CaHPO4  CaHSO4+  CaOH+
                           CaPO4-  CaSO4  CaX2  Cd(CO3)2-2
                           Cd(OH)2  Cd(OH)3-  Cd(OH)4-2  Cd(SO4)2-2
                           Cd+2  CdCl+  CdCl2  CdCl3-
                           CdCO3  CdHCO3+  CdOH+  CdSO4
                           CdX2  Cl-  CO2  CO3-2
                           Cu(OH)2  Cu(OH)3-  Cu(OH)4-2  Cu+
                           Cu+2  CuOH+  CuSO4  CuX2
                           Fe(HS)2  Fe(HS)3-  Fe(OH)2+  FeH2PO4+
                           FeF3  FeF2+  FeF+2  FeF+
                           FeCO3  FeCl3  FeCl2+  FeCl+2
                           FeCl+  Fe3(OH)4+5  Fe2(OH)2+4  Fe+3
                           Fe+2  Fe(SO4)2-  Fe(OH)4-  Fe(OH)3
                           FeX2  FeSO4+  FeSO4  FeOH+2
                           FeOH+  FeHSO4+2  FeHSO4+  FeHPO4+
                           FeHPO4  FeHCO3+  FeH2PO4+2  H2S
                           HSO4-  HS-  K+  KHPO4-
                           KOH  KSO4-  KX  Mg+2
                           MgCO3  MgF+  MgH2PO4+  MgHCO3+
                           MgHPO4  MgOH+  MgPO4-  MgSO4
                           MgX2  Mn(NO3)2  Mn+2  Mn+3
                           MnCl+  MnCl2  MnCl3-  MnCO3
                           MnF+  MnHCO3+  MnOH+  MnSO4
                           MnX2  Na+  NaCO3-  NaF
                           NaHCO3  NaHPO4-  NaOH  NaSO4-
                           NaX  NH3  NH4+  NH4SO4-
                           NH4X  Pb(CO3)2-2  Pb(OH)2  Pb(OH)3-
                           Pb(OH)4-2  Pb(SO4)2-2  Pb+2  Pb2OH+3
                           PbCl+  PbCl2  PbCl3-  PbCl4-2
                           PbCO3  PbHCO3+  PbNO3+  PbOH+
                           PbSO4  PbX2  PO4-3  SO4-2
                           Zn(CO3)2-2  Zn(OH)2  Zn(OH)3-  Zn(OH)4-2
                           Zn(SO4)2-2  Zn+2  ZnCl+  ZnCl2
                           ZnCl3-  ZnCl4-2  ZnCO3  ZnHCO3+
                           ZnOH+  ZnSO4  ZnX2  Al(OH)2+
                           Al(OH)3  Al(OH)4-  Al(SO4)2-  Al+3
                           AlF+2  AlF2+  AlF3  AlF4-
                           AlF5-2  AlF6-3  AlHSO4+2  AlOH+2
                           AlOHX2  AlSO4+  AlX3  Ba+2
                           BaCO3  BaHCO3+  BaOH+  BaSO4
                           BaX2  BF(OH)3-  BF2(OH)2-  BF3OH-
```

```
                    BF4-  Br-  CH4  F-
                    H+  H2  H2BO3-  H2O
                    H2PO4-  H2SiO4-2  H3BO3  H3SiO4-
                    H4SiO4  HCO3-  HF  HF2-
                    Hfo_psi  Hfo_sO-  Hfo_sOCd+  Hfo_sOCu+
                    Hfo_sOFe+  Hfo_sOH  Hfo_sOH2+  Hfo_sOHBa+2
                    Hfo_sOHCa+2  Hfo_sOHSr+2  Hfo_sOMn+  Hfo_sOPb+
                    Hfo_sOZn+  Hfo_wF  Hfo_wH2BO3  Hfo_wH2PO4
                    Hfo_wHPO4-  Hfo_wO-  Hfo_wOBa+  Hfo_wOCa+
                    Hfo_wOCd+  Hfo_wOCu+  Hfo_wOFe+  Hfo_wOFeOH
                    Hfo_wOH  Hfo_wOH2+  Hfo_wOHF-  Hfo_wOHSO4-2
                    Hfo_wOMg+  Hfo_wOMn+  Hfo_wOPb+  Hfo_wOSr+
                    Hfo_wOSrOH  Hfo_wOZn+  Hfo_wPO4-2  Hfo_wSO4-
                    HPO4-2  Li+  LiOH  LiSO4-
                    LiX  N2  NO2-  NO3-
                    O2  OH-  S-2  SiF6-2
                    Sr+2  SrCO3  SrHCO3+  SrOH+
                    SrSO4  SrX2  X-
activities         Al(OH)2+  Al(OH)3  Al(OH)4-  Al(SO4)2-
                    Al+3  AlF+2  AlF2+  AlF3
                    AlF4-  AlF5-2  AlF6-3  AlHSO4+2
                    AlOH+2  AlOHX2  AlSO4+  AlX3
                    Ba+2  BaCO3  BaHCO3+  BaOH+
                    BaSO4  BaX2  BF(OH)3-  BF2(OH)2-
                    BF3OH-  BF4-  Br-  Ca+2
                    CaCO3  CaF+  CaH2PO4+  CaHCO3+
                    CaHPO4  CaHSO4+  CaOH+  CaPO4-
                    CaSO4  CaX2  Cd(CO3)2-2  Cd(OH)2
                    Cd(OH)3-  Cd(OH)4-2  Cd(SO4)2-2  Cd+2
                    CdCl+  CdCl2  CdCl3-  CdCO3
                    CdHCO3+  CdOH+  CdSO4  CdX2
                    CH4  Cl-  CO2  CO3-2
                    Cu(OH)2  Cu(OH)3-  Cu(OH)4-2  Cu+
                    Cu+2  CuOH+  CuSO4  CuX2
                    Fe(HS)2  Fe(HS)3-  Fe(OH)2+  F-
                    Fe(OH)3  Fe(OH)4-  Fe(SO4)2-  Fe+2
                    Fe+3  Fe2(OH)2+4  Fe3(OH)4+5  FeCl+
                    FeCl+2  FeCl2+  FeCl3  FeCO3
                    FeF+  FeF+2  FeF2+  FeF3
                    FeH2PO4+  FeH2PO4+2  FeHCO3+  FeHPO4
                    FeHPO4+  FeHSO4+  FeHSO4+2  FeOH+
                    FeOH+2  FeSO4  FeSO4+  FeX2
                    H+  H2  H2BO3-  H2O
                    H2PO4-  H2S  H2SiO4-2  H3BO3
                    H3SiO4-  H4SiO4  HCO3-  HF
                    HF2-  Hfo_psi  Hfo_sO-  Hfo_sOCd+
                    Hfo_sOCu+  Hfo_sOFe+  Hfo_sOH  Hfo_sOH2+
                    Hfo_sOHBa+2  Hfo_sOHCa+2  Hfo_sOHSr+2  Hfo_sOMn+
                    Hfo_sOPb+  Hfo_sOZn+  Hfo_wF  Hfo_wH2BO3
                    Hfo_wH2PO4  Hfo_wHPO4-  Hfo_wO-  Hfo_wOBa+
                    Hfo_wOCa+  Hfo_wOCd+  Hfo_wOCu+  Hfo_wOFe+
                    Hfo_wOFeOH  Hfo_wOH  Hfo_wOH2+  Hfo_wOHF-
                    Hfo_wOHSO4-2  Hfo_wOMg+  Hfo_wOMn+  Hfo_wOPb+
                    Hfo_wOSr+  Hfo_wOSrOH  Hfo_wOZn+  Hfo_wPO4-2
                    Hfo_wSO4-  HPO4-2  HS-  HSO4-
                    K+  KHPO4-  KOH  KSO4-
                    KX  Li+  LiOH  LiSO4-
                    LiX  Mg+2  MgCO3  MgF+
                    MgH2PO4+  MgHCO3+  MgHPO4  MgOH+
                    MgPO4-  MgSO4  MgX2  Mn(NO3)2
                    Mn+2  Mn+3  MnCl+  MnCl2
                    MnCl3-  MnCO3  MnF+  MnHCO3+
                    MnOH+  MnSO4  MnX2  N2
                    Na+  NaCO3-  NaF  NaHCO3
                    NaHPO4-  NaOH  NaSO4-  NaX
                    NH3  NH4+  NH4SO4-  NH4X
                    NO2-  NO3-  O2  OH-
                    Pb(CO3)2-2  Pb(OH)2  Pb(OH)3-  Pb(OH)4-2
                    Pb(SO4)2-2  Pb+2  Pb2OH+3  PbCl+
                    PbCl2  PbCl3-  PbCl4-2  PbCO3
                    PbHCO3+  PbNO3+  PbOH+  PbSO4
                    PbX2  PO4-3  S-2  SiF6-2
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                          SO4-2  Sr+2  SrCO3  SrHCO3+
                          SrOH+  SrSO4  SrX2  X-
                          Zn(CO3)2-2  Zn(OH)2  Zn(OH)3-  Zn(OH)4-2
                          Zn(SO4)2-2  Zn+2  ZnCl+  ZnCl2
                          ZnCl3-  ZnCl4-2  ZnCO3  ZnHCO3+
                          ZnOH+  ZnSO4  ZnX2
        equilibrium_phases   Al(OH)3(a)  Albite  Alunite  Anglesite
                          Anhydrite  Anorthite  Aragonite  Barite
                          Calcite  Ca-Montmorillonite  Cd(OH)2  CdSiO3
                          CdSO4  Celestite  Cerrusite  CH4(g)
                          Chalcedony  Hydroxyapatite  Hematite  Hausmannite
                          Halite  H2S(g)  H2O(g)  H2(g)
                          Gypsum  Goethite  Gibbsite  Fluorite
                          FeS(ppt)  Fe(OH)3(a)  Dolomite  CO2(g)
                          Chrysotile  Chlorite(14A)  Illite  Jarosite-K
                          Kaolinite  K-feldspar  K-mica  Mackinawite
                          Manganite  Melanterite  N2(g)  NH3(g)
                          O2(g)  Otavite  Pb(OH)2  Pyrite
                          Pyrochroite  Pyrolusite  Quartz  Rhodochrosite
                          Sepiolite  Sepiolite(d)  Siderite  SiO2(a)
                          Smithsonite  Sphalerite  Strontianite  Sulfur
                          Talc  Vivianite  Willemite  Witherite
                          Zn(OH)2(e)
        saturation_indices   Al(OH)3(a)  Zn(OH)2(e)  Witherite  Willemite
                          Vivianite  Talc  Sulfur  Strontianite
                          Sphalerite  Smithsonite  SiO2(a)  Siderite
                          Sepiolite(d)  Sepiolite  Rhodochrosite  Quartz
                          Pyrolusite  Pyrochroite  Pyrite  Pb(OH)2
                          Otavite  O2(g)  NH3(g)  N2(g)
                          Melanterite  Manganite  Mackinawite  K-mica
                          K-feldspar  Kaolinite  Jarosite-K  Illite
                          Hydroxyapatite  Hematite  Hausmannite  Halite
                          H2S(g)  H2O(g)  H2(g)  Gypsum
                          Goethite  Gibbsite  Fluorite  FeS(ppt)
                          Fe(OH)3(a)  Dolomite  CO2(g)  Chrysotile
                          Chlorite(14A)  Chalcedony  CH4(g)  Cerrusite
                          Celestite  CdSO4  CdSiO3  Cd(OH)2
                          Ca-Montmorillonite  Calcite  Barite  Aragonite
                          Anorthite  Anhydrite  Anglesite  Alunite
                          Albite
        gases               CH4(g)  CO2(g)  H2(g)  H2O(g)
                          H2S(g)  N2(g)  NH3(g)  O2(g)
        kinetic_reactants    Albite  Calcite  K-feldspar  Organic_C
                          Pyrite  Pyrolusite
    END
-------------------------------------------
Beginning of initial solution calculations.
-------------------------------------------

Initial solution 1.   River water

-----------------------------Solution composition------------------------------

    Elements           Molality       Moles

    Ca               1.215e-003  1.215e-003
    Cd               5.339e-010  5.339e-010
    Cl               4.316e-004  4.316e-004
    Cu               1.574e-008  1.574e-008
    Fe               1.791e-004  1.791e-004
    K                1.074e-004  1.074e-004
    Mg               1.933e-003  1.933e-003
    Na               4.611e-004  4.611e-004
    Pb               2.655e-009  2.655e-009
    S(6)             6.663e-005  6.663e-005
    Zn               1.591e-007  1.591e-007

----------------------------Description of solution----------------------------

                                     pH  =   8.200
                                     pe  =   2.630
                        Activity of water  =   1.000
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```
                         Ionic strength  =  6.879e-003
                     Mass of water (kg)  =  1.000e+000
               Total alkalinity (eq/kg)  =  1.996e-004
                  Total carbon (mol/kg)  =  0.000e+000
                     Total CO2 (mol/kg)  =  0.000e+000
                    Temperature (deg C)  =  28.400
                Electrical balance (eq)  =  6.283e-003
 Percent error, 100*(Cat-|An|)/(Cat+|An|)  =  84.94
                             Iterations  =   4
                                Total H  = 1.110130e+002
                                Total O  = 5.550704e+001

----------------------------Distribution of species----------------------------
```

Species		Molality	Activity	Log Molality	Log Activity	Log Gamma
	OH-	2.233e-006	2.043e-006	-5.651	-5.690	-0.039
	H+	6.825e-009	6.310e-009	-8.166	-8.200	-0.034
	H2O	5.551e+001	9.999e-001	1.744	-0.000	0.000
Ca	1.215e-003					
	Ca+2	1.209e-003	8.591e-004	-2.918	-3.066	-0.148
	CaSO4	6.060e-006	6.069e-006	-5.218	-5.217	0.001
	CaOH+	2.467e-008	2.260e-008	-7.608	-7.646	-0.038
	CaHSO4+	2.559e-013	2.344e-013	-12.592	-12.630	-0.038
Cd	5.339e-010					
	Cd+2	5.087e-010	3.579e-010	-9.294	-9.446	-0.153
	CdCl+	1.490e-011	1.365e-011	-10.827	-10.865	-0.038
	CdOH+	6.609e-012	6.053e-012	-11.180	-11.218	-0.038
	CdSO4	3.609e-012	3.615e-012	-11.443	-11.442	0.001
	Cd(OH)2	4.009e-014	4.015e-014	-13.397	-13.396	0.001
	CdCl2	2.271e-014	2.274e-014	-13.644	-13.643	0.001
	Cd(SO4)2-2	1.894e-015	1.332e-015	-14.723	-14.875	-0.153
	CdCl3-	6.507e-018	5.960e-018	-17.187	-17.225	-0.038
	Cd(OH)3-	7.795e-019	7.139e-019	-18.108	-18.146	-0.038
	Cd(OH)4-2	1.433e-024	1.008e-024	-23.844	-23.996	-0.153
Cl	4.316e-004					
	Cl-	4.316e-004	3.948e-004	-3.365	-3.404	-0.039
	FeCl+	9.966e-010	9.127e-010	-9.001	-9.040	-0.038
	ZnCl+	1.081e-010	9.898e-011	-9.966	-10.004	-0.038
	CdCl+	1.490e-011	1.365e-011	-10.827	-10.865	-0.038
	PbCl+	9.858e-012	9.029e-012	-11.006	-11.044	-0.038
	ZnCl2	4.141e-014	4.148e-014	-13.383	-13.382	0.001
	CdCl2	2.271e-014	2.274e-014	-13.644	-13.643	0.001
	PbCl2	5.298e-015	5.306e-015	-14.276	-14.275	0.001
	ZnCl3-	2.047e-017	1.875e-017	-16.689	-16.727	-0.038
	CdCl3-	6.507e-018	5.960e-018	-17.187	-17.225	-0.038
	PbCl3-	1.855e-018	1.699e-018	-17.732	-17.770	-0.038
	FeCl+2	1.546e-018	1.088e-018	-17.811	-17.963	-0.153
	ZnCl4-2	5.416e-021	3.810e-021	-20.266	-20.419	-0.153
	FeCl2+	1.883e-021	1.725e-021	-20.725	-20.763	-0.038
	PbCl4-2	4.683e-022	3.295e-022	-21.329	-21.482	-0.153
	FeCl3	6.800e-026	6.810e-026	-25.168	-25.167	0.001
Cu(1)	4.144e-011					
	Cu+	4.144e-011	3.781e-011	-10.383	-10.422	-0.040
Cu(2)	1.570e-008					
	Cu(OH)2	1.560e-008	1.563e-008	-7.807	-7.806	0.001
	CuOH+	5.155e-011	4.720e-011	-10.288	-10.326	-0.038
	Cu+2	4.169e-011	2.978e-011	-10.380	-10.526	-0.146
	CuSO4	2.132e-013	2.136e-013	-12.671	-12.670	0.001
	Cu(OH)3-	1.630e-013	1.492e-013	-12.788	-12.826	-0.038
	Cu(OH)4-2	6.708e-018	4.719e-018	-17.173	-17.326	-0.153
Fe(2)	2.474e-006					
	Fe+2	2.344e-006	1.675e-006	-5.630	-5.776	-0.146
	FeOH+	1.178e-007	1.079e-007	-6.929	-6.967	-0.038
	FeSO4	1.085e-008	1.087e-008	-7.965	-7.964	0.001
	FeCl+	9.966e-010	9.127e-010	-9.001	-9.040	-0.038
	FeHSO4+	4.989e-016	4.569e-016	-15.302	-15.340	-0.038
Fe(3)	1.766e-004					
	Fe(OH)3	1.439e-004	1.441e-004	-3.842	-3.841	0.001
	Fe(OH)4-	2.604e-005	2.385e-005	-4.584	-4.623	-0.038
	Fe(OH)2+	6.658e-006	6.098e-006	-5.177	-5.215	-0.038

	FeOH+2	1.454e-010	1.023e-010	-9.837	-9.990	-0.153
	Fe+3	1.663e-016	8.202e-017	-15.779	-16.086	-0.307
	FeSO4+	3.630e-017	3.324e-017	-16.440	-16.478	-0.038
	FeCl+2	1.546e-018	1.088e-018	-17.811	-17.963	-0.153
	Fe2(OH)2+4	1.001e-018	2.451e-019	-18.000	-18.611	-0.611
	Fe(SO4)2-	2.761e-020	2.528e-020	-19.559	-19.597	-0.038
	Fe3(OH)4+5	2.062e-021	2.290e-022	-20.686	-21.640	-0.954
	FeCl2+	1.883e-021	1.725e-021	-20.725	-20.763	-0.038
	FeHSO4+2	7.990e-025	5.621e-025	-24.097	-24.250	-0.153
	FeCl3	6.800e-026	6.810e-026	-25.168	-25.167	0.001
H(0)	2.991e-025					
	H2	1.495e-025	1.498e-025	-24.825	-24.825	0.001
K	1.074e-004					
	K+	1.074e-004	9.825e-005	-3.969	-4.008	-0.039
	KSO4-	2.742e-008	2.512e-008	-7.562	-7.600	-0.038
	KOH	5.390e-011	5.399e-011	-10.268	-10.268	0.001
Mg	1.933e-003					
	Mg+2	1.920e-003	1.371e-003	-2.717	-2.863	-0.146
	MgSO4	1.200e-005	1.202e-005	-4.921	-4.920	0.001
	MgOH+	1.167e-006	1.068e-006	-5.933	-5.971	-0.038
Na	4.611e-004					
	Na+	4.611e-004	4.226e-004	-3.336	-3.374	-0.038
	NaSO4-	8.107e-008	7.424e-008	-7.091	-7.129	-0.038
	NaOH	4.418e-010	4.425e-010	-9.355	-9.354	0.001
O(0)	0.000e+000					
	O2	0.000e+000	0.000e+000	-41.647	-41.646	0.001
Pb	2.655e-009					
	PbOH+	1.783e-009	1.633e-009	-8.749	-8.787	-0.038
	Pb+2	7.512e-010	5.285e-010	-9.124	-9.277	-0.153
	Pb(OH)2	1.005e-010	1.007e-010	-9.998	-9.997	0.001
	PbSO4	1.018e-011	1.020e-011	-10.992	-10.992	0.001
	PbCl+	9.858e-012	9.029e-012	-11.006	-11.044	-0.038
	Pb(OH)3-	2.000e-013	1.832e-013	-12.699	-12.737	-0.038
	PbCl2	5.298e-015	5.306e-015	-14.276	-14.275	0.001
	Pb(SO4)2-2	2.610e-015	1.836e-015	-14.583	-14.736	-0.153
	Pb(OH)4-2	9.454e-017	6.651e-017	-16.024	-16.177	-0.153
	Pb2OH+3	4.262e-017	1.932e-017	-16.370	-16.714	-0.344
	PbCl3-	1.855e-018	1.699e-018	-17.732	-17.770	-0.038
	PbCl4-2	4.683e-022	3.295e-022	-21.329	-21.482	-0.153
S(6)	6.663e-005					
	SO4-2	4.845e-005	3.431e-005	-4.315	-4.465	-0.150
	MgSO4	1.200e-005	1.202e-005	-4.921	-4.920	0.001
	CaSO4	6.060e-006	6.069e-006	-5.218	-5.217	0.001
	NaSO4-	8.107e-008	7.424e-008	-7.091	-7.129	-0.038
	KSO4-	2.742e-008	2.512e-008	-7.562	-7.600	-0.038
	FeSO4	1.085e-008	1.087e-008	-7.965	-7.964	0.001
	ZnSO4	6.618e-010	6.629e-010	-9.179	-9.179	0.001
	HSO4-	2.478e-011	2.269e-011	-10.606	-10.644	-0.038
	PbSO4	1.018e-011	1.020e-011	-10.992	-10.992	0.001
	CdSO4	3.609e-012	3.615e-012	-11.443	-11.442	0.001
	Zn(SO4)2-2	2.561e-013	1.801e-013	-12.592	-12.744	-0.153
	CaHSO4+	2.559e-013	2.344e-013	-12.592	-12.630	-0.038
	CuSO4	2.132e-013	2.136e-013	-12.671	-12.670	0.001
	Pb(SO4)2-2	2.610e-015	1.836e-015	-14.583	-14.736	-0.153
	Cd(SO4)2-2	1.894e-015	1.332e-015	-14.723	-14.875	-0.153
	FeHSO4+	4.989e-016	4.569e-016	-15.302	-15.340	-0.038
	FeSO4+	3.630e-017	3.324e-017	-16.440	-16.478	-0.038
	Fe(SO4)2-	2.761e-020	2.528e-020	-19.559	-19.597	-0.038
	FeHSO4+2	7.990e-025	5.621e-025	-24.097	-24.250	-0.153
Zn	1.591e-007					
	Zn+2	1.133e-007	8.030e-008	-6.946	-7.095	-0.150
	Zn(OH)2	2.535e-008	2.539e-008	-7.596	-7.595	0.001
	ZnOH+	1.966e-008	1.801e-008	-7.706	-7.745	-0.038
	ZnSO4	6.618e-010	6.629e-010	-9.179	-9.179	0.001
	ZnCl+	1.081e-010	9.898e-011	-9.966	-10.004	-0.038
	Zn(OH)3-	1.389e-011	1.272e-011	-10.857	-10.895	-0.038
	Zn(SO4)2-2	2.561e-013	1.801e-013	-12.592	-12.744	-0.153
	ZnCl2	4.141e-014	4.148e-014	-13.383	-13.382	0.001
	Zn(OH)4-2	4.543e-016	3.196e-016	-15.343	-15.495	-0.153
	ZnCl3-	2.047e-017	1.875e-017	-16.689	-16.727	-0.038
	ZnCl4-2	5.416e-021	3.810e-021	-20.266	-20.419	-0.153

```
------------------------------Saturation indices------------------------------

    Phase               SI  log IAP  log KT

    Anglesite        -5.97  -13.74   -7.77  PbSO4
    Anhydrite        -3.15   -7.53   -4.38  CaSO4
    Cd(OH)2          -6.70    6.95   13.65  Cd(OH)2
    CdSO4           -13.69  -13.91   -0.22  CdSO4
    Fe(OH)3(a)        3.62    8.51    4.89  Fe(OH)3
    Goethite          9.63    8.51   -1.12  FeOOH
    Gypsum           -2.95   -7.53   -4.58  CaSO4:2H2O
    H2(g)           -21.66  -24.82   -3.16  H2
    H2O(g)           -1.42   -0.00    1.42  H2O
    Halite           -8.37   -6.78    1.59  NaCl
    Hematite         21.29   17.03   -4.26  Fe2O3
    Jarosite-K       -2.53  -12.00   -9.47  KFe3(SO4)2(OH)6
    Melanterite      -8.07  -10.24   -2.17  FeSO4:7H2O
    O2(g)           -38.67  -41.65   -2.98  O2
    Pb(OH)2          -0.91    7.12    8.03  Pb(OH)2
    Zn(OH)2(e)       -2.20    9.30   11.50  Zn(OH)2

Initial solution 2.   PAF Leachate

----------------------------Solution composition-----------------------------

    Elements           Molality       Moles

    Ca               9.146e-003  9.146e-003
    Cd               5.748e-007  5.748e-007
    Cl               2.888e-005  2.888e-005
    Cu               9.346e-007  9.346e-007
    Fe               5.629e-003  5.629e-003
    K                1.047e-004  1.047e-004
    Mg               1.078e-001  1.078e-001
    Na               2.672e-004  2.672e-004
    Pb               1.413e-006  1.413e-006
    S(6)             2.132e-001  2.132e-001
    Zn               2.099e-003  2.099e-003

----------------------------Description of solution---------------------------

                                       pH  =   3.980
                                       pe  =  11.850
                        Activity of water  =   0.996
                           Ionic strength  =  3.474e-001
                       Mass of water (kg)  =  1.000e+000
                 Total alkalinity (eq/kg)  = -7.087e-003
                    Total carbon (mol/kg)  =  0.000e+000
                       Total CO2 (mol/kg)  =  0.000e+000
                      Temperature (deg C)  =  25.000
                  Electrical balance (eq)  = -1.748e-001
 Percent error, 100*(Cat-|An|)/(Cat+|An|)  = -50.44
                               Iterations  =  14
                                  Total H  = 1.110169e+002
                                  Total O  = 5.636285e+001

----------------------------Distribution of species---------------------------

                                                 Log       Log         Log
    Species            Molality    Activity  Molality  Activity     Gamma

    H+               1.347e-004  1.047e-004    -3.871    -3.980    -0.109
    OH-              1.437e-010  9.519e-011    -9.842   -10.021    -0.179
    H2O              5.551e+001  9.957e-001     1.744    -0.002     0.000
Ca              9.146e-003
    CaSO4            5.595e-003  6.061e-003    -2.252    -2.217     0.035
    Ca+2             3.546e-003  9.926e-004    -2.450    -3.003    -0.553
    CaHSO4+          5.083e-006  3.718e-006    -5.294    -5.430    -0.136
    CaOH+            2.141e-012  1.566e-012   -11.669   -11.805    -0.136
Cd              5.748e-007
    Cd(SO4)2-2       2.704e-007  7.742e-008    -6.568    -7.111    -0.543
    CdSO4            2.130e-007  2.308e-007    -6.672    -6.637     0.035
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	Cd+2	9.132e-008	2.615e-008	-7.039	-7.583	-0.543
	CdCl+	6.604e-011	4.831e-011	-10.180	-10.316	-0.136
	CdOH+	2.827e-014	2.068e-014	-13.549	-13.684	-0.136
	CdCl2	3.596e-015	3.896e-015	-14.444	-14.409	0.035
	CdCl3-	6.501e-020	4.756e-020	-19.187	-19.323	-0.136
	Cd(OH)2	9.748e-021	1.056e-020	-20.011	-19.976	0.035
	Cd(OH)3-	1.540e-029	1.127e-029	-28.812	-28.948	-0.136
	Cd(OH)4-2	3.335e-039	9.548e-040	-38.477	-39.020	-0.543
Cl	2.888e-005					
	Cl-	2.886e-005	1.935e-005	-4.540	-4.713	-0.174
	ZnCl+	8.825e-009	6.455e-009	-8.054	-8.190	-0.136
	FeCl+2	6.446e-009	1.846e-009	-8.191	-8.734	-0.543
	FeCl+	1.706e-009	1.248e-009	-8.768	-8.904	-0.136
	CdCl+	6.604e-011	4.831e-011	-10.180	-10.316	-0.136
	PbCl+	5.126e-011	3.750e-011	-10.290	-10.426	-0.136
	FeCl2+	2.180e-013	1.595e-013	-12.662	-12.797	-0.136
	ZnCl2	1.207e-013	1.308e-013	-12.918	-12.883	0.035
	CdCl2	3.596e-015	3.896e-015	-14.444	-14.409	0.035
	PbCl2	1.061e-015	1.150e-015	-14.974	-14.939	0.035
	ZnCl3-	3.881e-018	2.839e-018	-17.411	-17.547	-0.136
	FeCl3	2.848e-019	3.085e-019	-18.545	-18.511	0.035
	CdCl3-	6.501e-020	4.756e-020	-19.187	-19.323	-0.136
	PbCl3-	2.415e-020	1.767e-020	-19.617	-19.753	-0.136
	ZnCl4-2	9.613e-023	2.752e-023	-22.017	-22.560	-0.543
	PbCl4-2	5.714e-025	1.636e-025	-24.243	-24.786	-0.543
Cu(1)	1.179e-016					
	Cu+	1.179e-016	7.400e-017	-15.928	-16.131	-0.202
Cu(2)	9.346e-007					
	CuSO4	5.757e-007	6.237e-007	-6.240	-6.205	0.035
	Cu+2	3.588e-007	9.982e-008	-6.445	-7.001	-0.556
	CuOH+	1.401e-011	9.492e-012	-10.853	-11.023	-0.169
	Cu(OH)2	1.741e-013	1.886e-013	-12.759	-12.725	0.035
	Cu(OH)3-	1.477e-022	1.080e-022	-21.831	-21.966	-0.136
	Cu(OH)4-2	7.159e-031	2.050e-031	-30.145	-30.688	-0.543
Fe(2)	4.029e-004					
	FeSO4	2.347e-004	2.542e-004	-3.629	-3.595	0.035
	Fe+2	1.679e-004	4.672e-005	-3.775	-4.330	-0.556
	FeHSO4+	2.392e-007	1.750e-007	-6.621	-6.757	-0.136
	FeCl+	1.706e-009	1.248e-009	-8.768	-8.904	-0.136
	FeOH+	1.921e-010	1.405e-010	-9.717	-9.852	-0.136
Fe(3)	5.226e-003					
	FeSO4+	1.449e-003	1.060e-003	-2.839	-2.975	-0.136
	Fe(SO4)2-	9.700e-004	7.095e-004	-3.013	-3.149	-0.136
	Fe(OH)2+	8.348e-004	6.106e-004	-3.078	-3.214	-0.136
	FeOH+2	6.773e-004	1.939e-004	-3.169	-3.712	-0.543
	Fe3(OH)4+5	3.204e-004	1.291e-007	-3.494	-6.889	-3.395
	Fe2(OH)2+4	1.506e-004	1.012e-006	-3.822	-5.995	-2.173
	Fe+3	3.055e-005	3.159e-006	-4.515	-5.500	-0.985
	FeHSO4+2	1.038e-006	2.972e-007	-5.984	-6.527	-0.543
	Fe(OH)3	6.905e-007	7.480e-007	-6.161	-6.126	0.035
	FeCl+2	6.446e-009	1.846e-009	-8.191	-8.734	-0.543
	Fe(OH)4-	8.868e-012	6.487e-012	-11.052	-11.188	-0.136
	FeCl2+	2.180e-013	1.595e-013	-12.662	-12.797	-0.136
	FeCl3	2.848e-019	3.085e-019	-18.545	-18.511	0.035
H(0)	2.859e-035					
	H2	1.430e-035	1.549e-035	-34.845	-34.810	0.035
K	1.047e-004					
	K+	8.751e-005	5.865e-005	-4.058	-4.232	-0.174
	KSO4-	1.724e-005	1.261e-005	-4.763	-4.899	-0.136
	KOH	1.785e-015	1.934e-015	-14.748	-14.714	0.035
Mg	1.078e-001					
	MgSO4	7.230e-002	7.833e-002	-1.141	-1.106	0.035
	Mg+2	3.551e-002	1.092e-002	-1.450	-1.962	-0.512
	MgOH+	5.153e-010	3.770e-010	-9.288	-9.424	-0.136
Na	2.672e-004					
	Na+	2.322e-004	1.670e-004	-3.634	-3.777	-0.143
	NaSO4-	3.501e-005	2.561e-005	-4.456	-4.592	-0.136
	NaOH	9.685e-015	1.049e-014	-14.014	-13.979	0.035
O(0)	3.181e-023					
	O2	1.590e-023	1.723e-023	-22.798	-22.764	0.035
Pb	1.413e-006					
	PbSO4	7.734e-007	8.378e-007	-6.112	-6.077	0.035

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    Pb(SO4)2-2       4.699e-007  1.345e-007    -6.328    -6.871    -0.543
    Pb+2             1.700e-007  4.869e-008    -6.769    -7.313    -0.543
    PbCl+            5.126e-011  3.750e-011   -10.290   -10.426    -0.136
    PbOH+            1.234e-011  9.027e-012   -10.909   -11.044    -0.136
    PbCl2            1.061e-015  1.150e-015   -14.974   -14.939     0.035
    Pb2OH+3          1.641e-016  9.839e-018   -15.785   -17.007    -1.222
    Pb(OH)2          3.083e-017  3.339e-017   -16.511   -16.476     0.035
    PbCl3-           2.415e-020  1.767e-020   -19.617   -19.753    -0.136
    Pb(OH)3-         4.984e-024  3.646e-024   -23.302   -23.438    -0.136
    PbCl4-2          5.714e-025  1.636e-025   -24.243   -24.786    -0.543
    Pb(OH)4-2        2.774e-031  7.942e-032   -30.557   -31.100    -0.543
S(6)            2.132e-001
    SO4-2            1.288e-001  3.060e-002    -0.890    -1.514    -0.624
    MgSO4            7.230e-002  7.833e-002    -1.141    -1.106     0.035
    CaSO4            5.595e-003  6.061e-003    -2.252    -2.217     0.035
    FeSO4+           1.449e-003  1.060e-003    -2.839    -2.975    -0.136
    Fe(SO4)2-        9.700e-004  7.095e-004    -3.013    -3.149    -0.136
    ZnSO4            8.210e-004  8.893e-004    -3.086    -3.051     0.035
    Zn(SO4)2-2       7.726e-004  2.212e-004    -3.112    -3.655    -0.543
    HSO4-            4.259e-004  3.115e-004    -3.371    -3.506    -0.136
    FeSO4            2.347e-004  2.542e-004    -3.629    -3.595     0.035
    NaSO4-           3.501e-005  2.561e-005    -4.456    -4.592    -0.136
    KSO4-            1.724e-005  1.261e-005    -4.763    -4.899    -0.136
    CaHSO4+          5.083e-006  3.718e-006    -5.294    -5.430    -0.136
    FeHSO4+2         1.038e-006  2.972e-007    -5.984    -6.527    -0.543
    PbSO4            7.734e-007  8.378e-007    -6.112    -6.077     0.035
    CuSO4            5.757e-007  6.237e-007    -6.240    -6.205     0.035
    Pb(SO4)2-2       4.699e-007  1.345e-007    -6.328    -6.871    -0.543
    Cd(SO4)2-2       2.704e-007  7.742e-008    -6.568    -7.111    -0.543
    FeHSO4+          2.392e-007  1.750e-007    -6.621    -6.757    -0.136
    CdSO4            2.130e-007  2.308e-007    -6.672    -6.637     0.035
Zn              2.099e-003
    ZnSO4            8.210e-004  8.893e-004    -3.086    -3.051     0.035
    Zn(SO4)2-2       7.726e-004  2.212e-004    -3.112    -3.655    -0.543
    Zn+2             5.054e-004  1.240e-004    -3.296    -3.907    -0.610
    ZnCl+            8.825e-009  6.455e-009    -8.054    -8.190    -0.136
    ZnOH+            1.767e-009  1.293e-009    -8.753    -8.889    -0.136
    Zn(OH)2          1.303e-013  1.411e-013   -12.885   -12.850     0.035
    ZnCl2            1.207e-013  1.308e-013   -12.918   -12.883     0.035
    ZnCl3-           3.881e-018  2.839e-018   -17.411   -17.547    -0.136
    Zn(OH)3-         5.801e-021  4.243e-021   -20.237   -20.372    -0.136
    ZnCl4-2          9.613e-023  2.752e-023   -22.017   -22.560    -0.543
    Zn(OH)4-2        2.233e-029  6.395e-030   -28.651   -29.194    -0.543

------------------------------Saturation indices-------------------------------

    Phase               SI log IAP  log KT

    Anglesite        -1.04   -8.83   -7.79  PbSO4
    Anhydrite        -0.16   -4.52   -4.36  CaSO4
    Cd(OH)2         -13.28    0.37   13.65  Cd(OH)2
    CdSO4            -9.00   -9.10   -0.10  CdSO4
    Fe(OH)3(a)        1.54    6.43    4.89  Fe(OH)3
    Goethite          7.44    6.44   -1.00  FeOOH
    Gypsum            0.06   -4.52   -4.58  CaSO4:2H2O
    H2(g)           -31.66  -34.81   -3.15  H2
    H2O(g)           -1.51   -0.00    1.51  H2O
    Halite          -10.07   -8.49    1.58  NaCl
    Hematite         16.88   12.87   -4.01  Fe2O3
    Jarosite-K        9.32    0.11   -9.21  KFe3(SO4)2(OH)6
    Melanterite      -3.65   -5.86   -2.21  FeSO4:7H2O
    O2(g)           -19.80  -22.76   -2.96  O2
    Pb(OH)2          -7.51    0.64    8.15  Pb(OH)2
    Zn(OH)2(e)       -7.45    4.05   11.50  Zn(OH)2

Initial solution 3.   NAF Leachate

-----------------------------Solution composition------------------------------

    Elements           Molality       Moles

    Ca               4.825e-003  4.825e-003
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```
     Cd                 2.229e-008  2.229e-008
     Cl                 1.809e-003  1.809e-003
     Cu                 7.884e-008  7.884e-008
     Fe                 1.794e-007  1.794e-007
     K                  9.738e-004  9.738e-004
     Mg                 9.315e-003  9.315e-003
     Na                 2.659e-003  2.659e-003
     Pb                 2.418e-008  2.418e-008
     S(6)               1.512e-002  1.512e-002
     Zn                 2.345e-005  2.345e-005

----------------------------Description of solution----------------------------

                                          pH  =   6.500
                                          pe  =   1.840
                           Activity of water  =   0.999
                              Ionic strength  =  4.115e-002
                          Mass of water (kg)  =  1.000e+000
                    Total alkalinity (eq/kg)  = -4.358e-007
                       Total carbon (mol/kg)  =  0.000e+000
                          Total CO2 (mol/kg)  =  0.000e+000
                         Temperature (deg C)  =  25.000
                     Electrical balance (eq)  = -9.827e-005
 Percent error, 100*(Cat-|An|)/(Cat+|An|)  =  -0.22
                                  Iterations  =   6
                                     Total H  = 1.110124e+002
                                     Total O  = 5.556672e+001

----------------------------Distribution of species----------------------------

                                                    Log       Log         Log
     Species             Molality    Activity  Molality  Activity       Gamma

     H+                 3.669e-007  3.162e-007    -6.435    -6.500      -0.065
     OH-                3.837e-008  3.164e-008    -7.416    -7.500      -0.084
     H2O                5.551e+001  9.995e-001     1.744    -0.000       0.000
Ca                4.825e-003
     Ca+2               3.257e-003  1.620e-003    -2.487    -2.790      -0.303
     CaSO4              1.568e-003  1.583e-003    -2.805    -2.800       0.004
     CaHSO4+            3.523e-009  2.933e-009    -8.453    -8.533      -0.080
     CaOH+              1.021e-009  8.498e-010    -8.991    -9.071      -0.080
Cd                2.229e-008
     Cd+2               1.217e-008  5.847e-009    -7.915    -8.233      -0.318
     CdSO4              8.183e-009  8.260e-009    -8.087    -8.083       0.004
     CdCl+              1.002e-009  8.340e-010    -8.999    -9.079      -0.080
     Cd(SO4)2-2         9.236e-010  4.437e-010    -9.035    -9.353      -0.318
     CdCl2              5.144e-012  5.193e-012   -11.289   -11.285       0.004
     CdOH+              1.846e-012  1.537e-012   -11.734   -11.813      -0.080
     CdCl3-             5.878e-015  4.894e-015   -14.231   -14.310      -0.080
     Cd(OH)2            2.585e-016  2.609e-016   -15.588   -15.583       0.004
     Cd(OH)3-           1.111e-022  9.253e-023   -21.954   -22.034      -0.080
     Cd(OH)4-2          5.426e-030  2.607e-030   -29.266   -29.584      -0.318
Cl                1.809e-003
     Cl-                1.809e-003  1.494e-003    -2.743    -2.826      -0.083
     ZnCl+              3.449e-008  2.871e-008    -7.462    -7.542      -0.080
     CdCl+              1.002e-009  8.340e-010    -8.999    -9.079      -0.080
     PbCl+              3.384e-010  2.817e-010    -9.471    -9.550      -0.080
     FeCl+              1.564e-010  1.302e-010    -9.806    -9.885      -0.080
     ZnCl2              4.448e-011  4.491e-011   -10.352   -10.348       0.004
     CdCl2              5.144e-012  5.193e-012   -11.289   -11.285       0.004
     PbCl2              6.607e-013  6.669e-013   -12.180   -12.176       0.004
     ZnCl3-             9.039e-014  7.526e-014   -13.044   -13.123      -0.080
     CdCl3-             5.878e-015  4.894e-015   -14.231   -14.310      -0.080
     PbCl3-             9.504e-016  7.913e-016   -15.022   -15.102      -0.080
     ZnCl4-2            1.173e-016  5.633e-017   -15.931   -16.249      -0.318
     PbCl4-2            1.178e-018  5.657e-019   -17.929   -18.247      -0.318
     FeCl+2             3.919e-020  1.882e-020   -19.407   -19.725      -0.318
     FeCl2+             1.509e-022  1.256e-022   -21.821   -21.901      -0.080
     FeCl3              1.858e-026  1.876e-026   -25.731   -25.727       0.004
Cu(1)             5.862e-008
     Cu+                5.862e-008  4.780e-008    -7.232    -7.321      -0.089
Cu(2)             2.022e-008
```

	Cu+2	1.244e-008	6.302e-009	-7.905	-8.201	-0.295
	CuSO4	6.243e-009	6.303e-009	-8.205	-8.200	0.004
	Cu(OH)2	1.303e-009	1.315e-009	-8.885	-8.881	0.004
	CuOH+	2.403e-010	1.992e-010	-9.619	-9.701	-0.082
	Cu(OH)3-	3.009e-016	2.505e-016	-15.522	-15.601	-0.080
	Cu(OH)4-2	3.289e-022	1.580e-022	-21.483	-21.801	-0.318
Fe(2)		1.794e-007				
	Fe+2	1.247e-007	6.317e-008	-6.904	-7.200	-0.295
	FeSO4	5.450e-008	5.502e-008	-7.264	-7.259	0.004
	FeCl+	1.564e-010	1.302e-010	-9.806	-9.885	-0.080
	FeOH+	7.584e-011	6.314e-011	-10.120	-10.200	-0.080
	FeHSO4+	1.374e-013	1.144e-013	-12.862	-12.942	-0.080
Fe(3)		1.433e-011				
	Fe(OH)2+	1.071e-011	8.914e-012	-10.970	-11.050	-0.080
	Fe(OH)3	3.595e-012	3.629e-012	-11.444	-11.440	0.004
	FeOH+2	1.773e-014	8.517e-015	-13.751	-14.070	-0.318
	Fe(OH)4-	1.257e-014	1.046e-014	-13.901	-13.980	-0.080
	FeSO4+	2.693e-017	2.242e-017	-16.570	-16.649	-0.080
	Fe(SO4)2-	2.885e-018	2.402e-018	-17.540	-17.619	-0.080
	Fe+3	1.592e-018	4.173e-019	-17.798	-18.380	-0.581
	FeCl+2	3.919e-020	1.882e-020	-19.407	-19.725	-0.318
	FeCl2+	1.509e-022	1.256e-022	-21.821	-21.901	-0.080
	FeHSO4+2	3.951e-023	1.898e-023	-22.403	-22.722	-0.318
	Fe2(OH)2+4	3.667e-026	1.952e-027	-25.436	-26.709	-1.274
	FeCl3	1.858e-026	1.876e-026	-25.731	-25.727	0.004
	Fe3(OH)4+5	3.554e-034	3.636e-036	-33.449	-35.439	-1.990
H(0)		2.930e-020				
	H2	1.465e-020	1.479e-020	-19.834	-19.830	0.004
K		9.738e-004				
	K+	9.417e-004	7.775e-004	-3.026	-3.109	-0.083
	KSO4-	3.215e-005	2.676e-005	-4.493	-4.572	-0.080
	KOH	8.441e-012	8.521e-012	-11.074	-11.069	0.004
Mg		9.315e-003				
	Mg+2	5.904e-003	2.998e-003	-2.229	-2.523	-0.294
	MgSO4	3.411e-003	3.443e-003	-2.467	-2.463	0.004
	MgOH+	4.133e-008	3.441e-008	-7.384	-7.463	-0.080
Na		2.659e-003				
	Na+	2.595e-003	2.166e-003	-2.586	-2.664	-0.078
	NaSO4-	6.387e-005	5.317e-005	-4.195	-4.274	-0.080
	NaOH	4.480e-011	4.523e-011	-10.349	-10.345	0.004
O(0)		0.000e+000				
	O2	0.000e+000	0.000e+000	-52.725	-52.720	0.004
Pb		2.418e-008				
	PbSO4	1.293e-008	1.305e-008	-7.888	-7.884	0.004
	Pb+2	9.864e-009	4.738e-009	-8.006	-8.324	-0.318
	Pb(SO4)2-2	6.985e-010	3.355e-010	-9.156	-9.474	-0.318
	PbOH+	3.508e-010	2.920e-010	-9.455	-9.535	-0.080
	PbCl+	3.384e-010	2.817e-010	-9.471	-9.550	-0.080
	PbCl2	6.607e-013	6.669e-013	-12.180	-12.176	0.004
	Pb(OH)2	3.557e-013	3.591e-013	-12.449	-12.445	0.004
	PbCl3-	9.504e-016	7.913e-016	-15.022	-15.102	-0.080
	Pb2OH+3	1.612e-016	3.098e-017	-15.793	-16.509	-0.716
	Pb(OH)3-	1.565e-017	1.303e-017	-16.805	-16.885	-0.080
	PbCl4-2	1.178e-018	5.657e-019	-17.929	-18.247	-0.318
	Pb(OH)4-2	1.964e-022	9.435e-023	-21.707	-22.025	-0.318
S(6)		1.512e-002				
	SO4-2	1.004e-002	4.898e-003	-1.998	-2.310	-0.312
	MgSO4	3.411e-003	3.443e-003	-2.467	-2.463	0.004
	CaSO4	1.568e-003	1.583e-003	-2.805	-2.800	0.004
	NaSO4-	6.387e-005	5.317e-005	-4.195	-4.274	-0.080
	KSO4-	3.215e-005	2.676e-005	-4.493	-4.572	-0.080
	ZnSO4	8.124e-006	8.201e-006	-5.090	-5.086	0.004
	Zn(SO4)2-2	6.798e-007	3.265e-007	-6.168	-6.486	-0.318
	HSO4-	1.809e-007	1.506e-007	-6.743	-6.822	-0.080
	FeSO4	5.450e-008	5.502e-008	-7.264	-7.259	0.004
	PbSO4	1.293e-008	1.305e-008	-7.888	-7.884	0.004
	CdSO4	8.183e-009	8.260e-009	-8.087	-8.083	0.004
	CuSO4	6.243e-009	6.303e-009	-8.205	-8.200	0.004
	CaHSO4+	3.523e-009	2.933e-009	-8.453	-8.533	-0.080
	Cd(SO4)2-2	9.236e-010	4.437e-010	-9.035	-9.353	-0.318
	Pb(SO4)2-2	6.985e-010	3.355e-010	-9.156	-9.474	-0.318
	FeHSO4+	1.374e-013	1.144e-013	-12.862	-12.942	-0.080

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    FeSO4+           2.693e-017  2.242e-017   -16.570   -16.649    -0.080
    Fe(SO4)2-        2.885e-018  2.402e-018   -17.540   -17.619    -0.080
    FeHSO4+2         3.951e-023  1.898e-023   -22.403   -22.722    -0.318
Zn                2.345e-005
    Zn+2             1.458e-005  7.142e-006    -4.836    -5.146    -0.310
    ZnSO4            8.124e-006  8.201e-006    -5.090    -5.086     0.004
    Zn(SO4)2-2       6.798e-007  3.265e-007    -6.168    -6.486    -0.318
    ZnCl+            3.449e-008  2.871e-008    -7.462    -7.542    -0.080
    ZnOH+            2.973e-008  2.475e-008    -7.527    -7.606    -0.080
    Zn(OH)2          8.898e-010  8.983e-010    -9.051    -9.047     0.004
    ZnCl2            4.448e-011  4.491e-011   -10.352   -10.348     0.004
    ZnCl3-           9.039e-014  7.526e-014   -13.044   -13.123    -0.080
    Zn(OH)3-         1.078e-014  8.978e-015   -13.967   -14.047    -0.080
    ZnCl4-2          1.173e-016  5.633e-017   -15.931   -16.249    -0.318
    Zn(OH)4-2        9.362e-021  4.497e-021   -20.029   -20.347    -0.318

------------------------------Saturation indices-------------------------------

    Phase               SI  log IAP   log KT

    Anglesite        -2.84  -10.63   -7.79  PbSO4
    Anhydrite        -0.74   -5.10   -4.36  CaSO4
    Cd(OH)2          -8.88    4.77   13.65  Cd(OH)2
    CdSO4           -10.44  -10.54   -0.10  CdSO4
    Fe(OH)3(a)       -3.77    1.12    4.89  Fe(OH)3
    Goethite          2.12    1.12   -1.00  FeOOH
    Gypsum           -0.52   -5.10   -4.58  CaSO4:2H2O
    H2(g)           -16.68  -19.83   -3.15  H2
    H2O(g)           -1.51   -0.00    1.51  H2O
    Halite           -7.07   -5.49    1.58  NaCl
    Hematite          6.25    2.24   -4.01  Fe2O3
    Jarosite-K      -14.66  -23.87   -9.21  KFe3(SO4)2(OH)6
    Melanterite      -7.30   -9.51   -2.21  FeSO4:7H2O
    O2(g)           -49.76  -52.72   -2.96  O2
    Pb(OH)2          -3.47    4.68    8.15  Pb(OH)2
    Zn(OH)2(e)       -3.65    7.85   11.50  Zn(OH)2

Initial solution 4.   Rainwater

-----------------------------Solution composition------------------------------

    Elements           Molality       Moles

    Ca               2.500e-006  2.500e-006
    Cl               6.699e-006  6.699e-006
    K                1.499e-006  1.499e-006
    Mg               1.300e-006  1.300e-006
    Na               6.903e-006  6.903e-006
    S(6)             8.100e-006  8.100e-006
    Zn               1.530e-007  1.530e-007

----------------------------Description of solution----------------------------

                                       pH  =   4.590
                                       pe  =  10.150
                        Activity of water  =   1.000
                           Ionic strength  =  4.455e-005
                       Mass of water (kg)  =  1.000e+000
                 Total alkalinity (eq/kg)  = -2.592e-005
                    Total carbon (mol/kg)  =  0.000e+000
                       Total CO2 (mol/kg)  =  0.000e+000
                      Temperature (deg C)  =  25.000
                  Electrical balance (eq)  =  1.933e-005
 Percent error, 100*(Cat-|An|)/(Cat+|An|)  =  29.71
                               Iterations  =   3
                                  Total H  = 1.110125e+002
                                  Total O  = 5.550625e+001

----------------------------Distribution of species----------------------------

                                                Log       Log         Log
    Species            Molality    Activity  Molality  Activity     Gamma
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```
     H+                  2.590e-005  2.570e-005    -4.587    -4.590    -0.003
     OH-                 3.925e-010  3.895e-010    -9.406    -9.410    -0.003
     H2O                 5.551e+001  1.000e+000     1.744    -0.000     0.000
Ca                2.500e-006
     Ca+2                2.496e-006  2.420e-006    -5.603    -5.616    -0.013
     CaSO4               3.780e-009  3.780e-009    -8.423    -8.423     0.000
     CaHSO4+             5.736e-013  5.691e-013   -12.241   -12.245    -0.003
     CaOH+               1.575e-014  1.563e-014   -13.803   -13.806    -0.003
Cl                6.699e-006
     Cl-                 6.699e-006  6.647e-006    -5.174    -5.177    -0.003
     ZnCl+               2.669e-012  2.649e-012   -11.574   -11.577    -0.003
     ZnCl2               1.844e-017  1.844e-017   -16.734   -16.734     0.000
     ZnCl3-              1.386e-022  1.375e-022   -21.858   -21.862    -0.003
     ZnCl4-2             4.725e-028  4.581e-028   -27.326   -27.339    -0.013
H(0)              4.688e-033
     H2                  2.344e-033  2.344e-033   -32.630   -32.630     0.000
K                 1.499e-006
     K+                  1.499e-006  1.487e-006    -5.824    -5.828    -0.003
     KSO4-               8.242e-011  8.178e-011   -10.084   -10.087    -0.003
     KOH                 2.006e-016  2.006e-016   -15.698   -15.698     0.000
Mg                1.300e-006
     Mg+2                1.297e-006  1.258e-006    -5.887    -5.900    -0.013
     MgSO4               2.308e-009  2.308e-009    -8.637    -8.637     0.000
     MgOH+               1.791e-013  1.777e-013   -12.747   -12.750    -0.003
Na                6.903e-006
     Na+                 6.902e-006  6.849e-006    -5.161    -5.164    -0.003
     NaSO4-              2.708e-010  2.687e-010    -9.567    -9.571    -0.003
     NaOH                1.760e-015  1.760e-015   -14.754   -14.754     0.000
O(0)              1.517e-027
     O2                  7.586e-028  7.586e-028   -27.120   -27.120     0.000
S(6)              8.100e-006
     SO4-2               8.073e-006  7.827e-006    -5.093    -5.106    -0.013
     HSO4-               1.971e-008  1.956e-008    -7.705    -7.709    -0.003
     CaSO4               3.780e-009  3.780e-009    -8.423    -8.423     0.000
     MgSO4               2.308e-009  2.308e-009    -8.637    -8.637     0.000
     ZnSO4               2.716e-010  2.716e-010    -9.566    -9.566     0.000
     NaSO4-              2.708e-010  2.687e-010    -9.567    -9.571    -0.003
     KSO4-               8.242e-011  8.178e-011   -10.084   -10.087    -0.003
     CaHSO4+             5.736e-013  5.691e-013   -12.241   -12.245    -0.003
     Zn(SO4)2-2          1.783e-014  1.728e-014   -13.749   -13.762    -0.013
Zn                1.530e-007
     Zn+2                1.527e-007  1.480e-007    -6.816    -6.830    -0.013
     ZnSO4               2.716e-010  2.716e-010    -9.566    -9.566     0.000
     ZnOH+               6.364e-012  6.315e-012   -11.196   -11.200    -0.003
     ZnCl+               2.669e-012  2.649e-012   -11.574   -11.577    -0.003
     Zn(SO4)2-2          1.783e-014  1.728e-014   -13.749   -13.762    -0.013
     Zn(OH)2             2.821e-015  2.821e-015   -14.550   -14.550     0.000
     ZnCl2               1.844e-017  1.844e-017   -16.734   -16.734     0.000
     Zn(OH)3-            3.497e-022  3.470e-022   -21.456   -21.460    -0.003
     ZnCl3-              1.386e-022  1.375e-022   -21.858   -21.862    -0.003
     ZnCl4-2             4.725e-028  4.581e-028   -27.326   -27.339    -0.013
     Zn(OH)4-2           2.207e-030  2.140e-030   -29.656   -29.670    -0.013

------------------------------Saturation indices-------------------------------

     Phase               SI log IAP  log KT

     Anhydrite        -6.36  -10.72   -4.36  CaSO4
     Gypsum           -6.14  -10.72   -4.58  CaSO4:2H2O
     H2(g)           -29.48  -32.63   -3.15  H2
     H2O(g)           -1.51   -0.00    1.51  H2O
     Halite          -11.92  -10.34    1.58  NaCl
     O2(g)           -24.16  -27.12   -2.96  O2
     Zn(OH)2(e)       -9.15    2.35   11.50  Zn(OH)2

Initial solution 5.   Tailings Seepage

-----------------------------Solution composition------------------------------

     Elements           Molality       Moles
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```
     Ca                 1.024e-002  1.024e-002
     Cd                 7.216e-010  7.216e-010
     Cl                 7.463e-002  7.463e-002
     Cu                 2.776e-007  2.776e-007
     Fe                 5.718e-008  5.718e-008
     K                  7.700e-003  7.700e-003
     Mg                 4.462e-002  4.462e-002
     Na                 1.336e-001  1.336e-001
     Pb                 1.419e-009  1.419e-009
     S(6)               6.532e-002  6.532e-002
     Zn                 5.071e-006  5.071e-006

----------------------------Description of solution----------------------------

                                       pH  =   6.560
                                       pe  =   1.690
                       Activity of water  =   0.995
                          Ionic strength  =  2.457e-001
                      Mass of water (kg)  =  1.000e+000
                Total alkalinity (eq/kg)  = -4.947e-007
                   Total carbon (mol/kg)  =  0.000e+000
                      Total CO2 (mol/kg)  =  0.000e+000
                     Temperature (deg C)  =  25.000
                 Electrical balance (eq)  =  4.577e-002
 Percent error, 100*(Cat-|An|)/(Cat+|An|)  =  12.94
                              Iterations  =   8
                                 Total H  = 1.110124e+002
                                 Total O  = 5.576752e+001

----------------------------Distribution of species----------------------------

                                                    Log       Log         Log
     Species            Molality    Activity   Molality  Activity       Gamma

     H+                 3.487e-007  2.754e-007    -6.458    -6.560      -0.102
     OH-                5.236e-008  3.616e-008    -7.281    -7.442      -0.161
     H2O                5.551e+001  9.948e-001     1.744    -0.002       0.000
Ca                1.024e-002
     Ca+2               6.543e-003  1.993e-003    -2.184    -2.700      -0.516
     CaSO4              3.701e-003  3.916e-003    -2.432    -2.407       0.025
     CaHSO4+            8.548e-009  6.319e-009    -8.068    -8.199      -0.131
     CaOH+              1.616e-009  1.195e-009    -8.791    -8.923      -0.131
Cd                7.216e-010
     CdCl+              3.265e-010  2.414e-010    -9.486    -9.617      -0.131
     Cd+2               1.629e-010  4.863e-011    -9.788   -10.313      -0.525
     CdSO4              1.305e-010  1.381e-010    -9.884    -9.860       0.025
     Cd(SO4)2-2         4.993e-011  1.491e-011   -10.302   -10.827      -0.525
     CdCl2              4.942e-011  5.229e-011   -10.306   -10.282       0.025
     CdCl3-             2.320e-012  1.715e-012   -11.635   -11.766      -0.131
     CdOH+              1.976e-014  1.461e-014   -13.704   -13.835      -0.131
     Cd(OH)2            2.678e-018  2.834e-018   -17.572   -17.548       0.025
     Cd(OH)3-           1.553e-024  1.148e-024   -23.809   -23.940      -0.131
     Cd(OH)4-2          1.238e-031  3.696e-032   -30.907   -31.432      -0.525
Cl                7.463e-002
     Cl-                7.463e-002  5.197e-002    -1.127    -1.284      -0.157
     ZnCl+              1.453e-007  1.074e-007    -6.838    -6.969      -0.131
     ZnCl2              5.523e-009  5.845e-009    -8.258    -8.233       0.025
     FeCl+              1.111e-009  8.211e-010    -8.954    -9.086      -0.131
     ZnCl3-             4.611e-010  3.408e-010    -9.336    -9.467      -0.131
     CdCl+              3.265e-010  2.414e-010    -9.486    -9.617      -0.131
     PbCl+              3.151e-010  2.329e-010    -9.502    -9.633      -0.131
     CdCl2              4.942e-011  5.229e-011   -10.306   -10.282       0.025
     ZnCl4-2            2.974e-011  8.878e-012   -10.527   -11.052      -0.525
     PbCl2              1.813e-011  1.919e-011   -10.742   -10.717       0.025
     CdCl3-             2.320e-012  1.715e-012   -11.635   -11.766      -0.131
     PbCl3-             1.072e-012  7.921e-013   -11.970   -12.101      -0.131
     PbCl4-2            6.600e-014  1.970e-014   -13.180   -13.705      -0.525
     FeCl+2             2.814e-019  8.403e-020   -18.551   -19.076      -0.525
     FeCl2+             2.639e-020  1.951e-020   -19.579   -19.710      -0.131
     FeCl3              9.581e-023  1.014e-022   -22.019   -21.994       0.025
Cu(1)             2.077e-007
     Cu+                2.077e-007  1.374e-007    -6.683    -6.862      -0.179
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Cu(2)           6.990e-008
     Cu+2             4.158e-008  1.282e-008    -7.381     -7.892     -0.511
     CuSO4            2.436e-008  2.578e-008    -7.613     -7.589      0.025
     Cu(OH)2          3.303e-009  3.495e-009    -8.481     -8.457      0.025
     CuOH+            6.586e-010  4.631e-010    -9.181     -9.334     -0.153
     Cu(OH)3-         1.029e-015  7.606e-016   -14.988    -15.119     -0.131
     Cu(OH)4-2        1.836e-021  5.481e-022   -20.736    -21.261     -0.525
Fe(2)           5.718e-008
     Fe+2             3.711e-008  1.145e-008    -7.430     -7.941     -0.511
     FeSO4            1.894e-008  2.004e-008    -7.723     -7.698      0.025
     FeCl+            1.111e-009  8.211e-010    -8.954     -9.086     -0.131
     FeOH+            1.768e-011  1.307e-011   -10.752    -10.884     -0.131
     FeHSO4+          4.908e-014  3.628e-014   -13.309    -13.440     -0.131
Fe(3)           2.684e-012
     Fe(OH)2+         2.020e-012  1.493e-012   -11.695    -11.826     -0.131
     Fe(OH)3          6.565e-013  6.947e-013   -12.183    -12.158      0.025
     FeOH+2           4.181e-015  1.248e-015   -14.379    -14.904     -0.525
     Fe(OH)4-         3.096e-015  2.288e-015   -14.509    -14.640     -0.131
     FeSO4+           7.818e-018  5.779e-018   -17.107    -17.238     -0.131
     Fe(SO4)2-        1.684e-018  1.245e-018   -17.774    -17.905     -0.131
     Fe+3             4.472e-019  5.353e-020   -18.350    -19.271     -0.922
     FeCl+2           2.814e-019  8.403e-020   -18.551    -19.076     -0.525
     FeCl2+           2.639e-020  1.951e-020   -19.579    -19.710     -0.131
     FeCl3            9.581e-023  1.014e-022   -22.019    -21.994      0.025
     FeHSO4+2         1.428e-023  4.262e-024   -22.845    -23.370     -0.525
     Fe2(OH)2+4       5.280e-027  4.195e-029   -26.277    -28.377     -2.100
     Fe3(OH)4+5       2.500e-035  1.309e-038   -34.602    -37.883     -3.281
H(0)            4.231e-020
     H2               2.116e-020  2.239e-020   -19.675    -19.650      0.025
K               7.700e-003
     K+               7.229e-003  5.034e-003    -2.141     -2.298     -0.157
     KSO4-            4.712e-004  3.483e-004    -3.327     -3.458     -0.131
     KOH              5.958e-011  6.305e-011   -10.225    -10.200      0.025
Mg              4.462e-002
     Mg+2             2.600e-002  8.536e-003    -1.585     -2.069     -0.484
     MgSO4            1.862e-002  1.970e-002    -1.730     -1.705      0.025
     MgOH+            1.514e-007  1.119e-007    -6.820     -6.951     -0.131
Na              1.336e-001
     Na+              1.274e-001  9.346e-002    -0.895     -1.029     -0.134
     NaSO4-           6.239e-003  4.612e-003    -2.205     -2.336     -0.131
     NaOH             2.108e-009  2.230e-009    -8.676     -8.652      0.025
O(0)            0.000e+000
     O2               0.000e+000  0.000e+000   -53.109    -53.085      0.025
Pb              1.419e-009
     PbSO4            5.890e-010  6.233e-010    -9.230     -9.205      0.025
     Pb+2             3.770e-010  1.126e-010    -9.424     -9.949     -0.525
     PbCl+            3.151e-010  2.329e-010    -9.502     -9.633     -0.131
     Pb(SO4)2-2       1.079e-010  3.220e-011    -9.967    -10.492     -0.525
     PbCl2            1.813e-011  1.919e-011   -10.742    -10.717      0.025
     PbOH+            1.072e-011  7.928e-012   -10.970    -11.101     -0.131
     PbCl3-           1.072e-012  7.921e-013   -11.970    -12.101     -0.131
     PbCl4-2          6.600e-014  1.970e-014   -13.180    -13.705     -0.525
     Pb(OH)2          1.053e-014  1.114e-014   -13.978    -13.953      0.025
     Pb(OH)3-         6.249e-019  4.619e-019   -18.204    -18.335     -0.131
     Pb2OH+3          3.032e-019  1.998e-020   -18.518    -19.699     -1.181
     Pb(OH)4-2        1.280e-023  3.822e-024   -22.893    -23.418     -0.525
S(6)            6.532e-002
     SO4-2            3.629e-002  9.846e-003    -1.440     -2.007     -0.567
     MgSO4            1.862e-002  1.970e-002    -1.730     -1.705      0.025
     NaSO4-           6.239e-003  4.612e-003    -2.205     -2.336     -0.131
     CaSO4            3.701e-003  3.916e-003    -2.432     -2.407      0.025
     KSO4-            4.712e-004  3.483e-004    -3.327     -3.458     -0.131
     ZnSO4            1.674e-006  1.772e-006    -5.776     -5.752      0.025
     Zn(SO4)2-2       4.749e-007  1.418e-007    -6.323     -6.848     -0.525
     HSO4-            3.567e-007  2.636e-007    -6.448     -6.579     -0.131
     CuSO4            2.436e-008  2.578e-008    -7.613     -7.589      0.025
     FeSO4            1.894e-008  2.004e-008    -7.723     -7.698      0.025
     CaHSO4+          8.548e-009  6.319e-009    -8.068     -8.199     -0.131
     PbSO4            5.890e-010  6.233e-010    -9.230     -9.205      0.025
     CdSO4            1.305e-010  1.381e-010    -9.884     -9.860      0.025
     Pb(SO4)2-2       1.079e-010  3.220e-011    -9.967    -10.492     -0.525
     Cd(SO4)2-2       4.993e-011  1.491e-011   -10.302    -10.827     -0.525
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    FeHSO4+          4.908e-014  3.628e-014   -13.309   -13.440    -0.131
    FeSO4+           7.818e-018  5.779e-018   -17.107   -17.238    -0.131
    Fe(SO4)2-        1.684e-018  1.245e-018   -17.774   -17.905    -0.131
    FeHSO4+2         1.428e-023  4.262e-024   -22.845   -23.370    -0.525
Zn              5.071e-006
    Zn+2             2.766e-006  7.677e-007    -5.558    -6.115    -0.557
    ZnSO4            1.674e-006  1.772e-006    -5.776    -5.752     0.025
    Zn(SO4)2-2       4.749e-007  1.418e-007    -6.323    -6.848    -0.525
    ZnCl+            1.453e-007  1.074e-007    -6.838    -6.969    -0.131
    ZnCl2            5.523e-009  5.845e-009    -8.258    -8.233     0.025
    ZnOH+            4.113e-009  3.040e-009    -8.386    -8.517    -0.131
    ZnCl3-           4.611e-010  3.408e-010    -9.336    -9.467    -0.131
    Zn(OH)2          1.191e-010  1.261e-010    -9.924    -9.899     0.025
    ZnCl4-2          2.974e-011  8.878e-012   -10.527   -11.052    -0.525
    Zn(OH)3-         1.948e-015  1.440e-015   -14.710   -14.842    -0.131
    Zn(OH)4-2        2.761e-021  8.243e-022   -20.559   -21.084    -0.525

------------------------------Saturation indices-------------------------------

    Phase               SI  log IAP   log KT

    Anglesite        -4.17  -11.96   -7.79  PbSO4
    Anhydrite        -0.35   -4.71   -4.36  CaSO4
    Cd(OH)2         -10.85    2.80   13.65  Cd(OH)2
    CdSO4           -12.22  -12.32   -0.10  CdSO4
    Fe(OH)3(a)       -4.49    0.40    4.89  Fe(OH)3
    Goethite          1.40    0.40   -1.00  FeOOH
    Gypsum           -0.13   -4.71   -4.58  CaSO4:2H2O
    H2(g)           -16.50  -19.65   -3.15  H2
    H2O(g)           -1.51   -0.00    1.51  H2O
    Halite           -3.90   -2.31    1.58  NaCl
    Hematite          4.82    0.81   -4.01  Fe2O3
    Jarosite-K      -15.57  -24.78   -9.21  KFe3(SO4)2(OH)6
    Melanterite      -7.75   -9.96   -2.21  FeSO4:7H2O
    O2(g)           -50.12  -53.08   -2.96  O2
    Pb(OH)2          -4.98    3.17    8.15  Pb(OH)2
    Zn(OH)2(e)       -4.50    7.00   11.50  Zn(OH)2

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Beginning of batch-reaction calculations.
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Reaction step 1.

Using mix 1. Mixing of water in open pit - worst case Scenario 3

Mixture 1.   Mixing of water in open pit - worst case Scenario 3

     9.989e-001 Solution 1River water
     0.000e+000 Solution 2PAF Leachate
     0.000e+000 Solution 3NAF Leachate
     9.000e-004 Solution 4Rainwater
     1.000e-004 Solution 5Tailings Seepage

-----------------------------Solution composition------------------------------

    Elements           Molality       Moles

    Ca               1.215e-003  1.215e-003
    Cd               5.334e-010  5.334e-010
    Cl               4.387e-004  4.386e-004
    Cu               1.575e-008  1.575e-008
    Fe               1.789e-004  1.789e-004
    K                1.081e-004  1.081e-004
    Mg               1.936e-003  1.936e-003
    Na               4.740e-004  4.740e-004
    Pb               2.652e-009  2.652e-009
    S                7.311e-005  7.310e-005
    Zn               1.596e-007  1.596e-007

----------------------------Description of solution----------------------------
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                                     pH  =   8.200      Charge balance
                                     pe  =   2.632      Adjusted to redox equilibrium
                      Activity of water  =   1.000
                         Ionic strength  =  6.900e-003
                     Mass of water (kg)  =  9.999e-001
               Total alkalinity (eq/kg)  =  1.994e-004
                  Total carbon (mol/kg)  =  0.000e+000
                     Total CO2 (mol/kg)  =  0.000e+000
                    Temperature (deg C)  =  28.397
                Electrical balance (eq)  =  6.281e-003
 Percent error, 100*(Cat-|An|)/(Cat+|An|)  =  84.56
                             Iterations  =   3
                                Total H  = 1.110019e+002
                                Total O  = 5.550151e+001

----------------------------Distribution of species----------------------------

                                                  Log       Log        Log
    Species             Molality    Activity  Molality  Activity      Gamma

    OH-               2.231e-006  2.041e-006    -5.651    -5.690     -0.039
    H+                6.831e-009  6.314e-009    -8.166    -8.200     -0.034
    H2O               5.551e+001  9.999e-001     1.744    -0.000      0.000
Ca              1.215e-003
    Ca+2              1.208e-003  8.582e-004    -2.918    -3.066     -0.149
    CaSO4             6.639e-006  6.649e-006    -5.178    -5.177      0.001
    CaOH+             2.463e-008  2.255e-008    -7.609    -7.647     -0.038
    CaHSO4+           2.806e-013  2.570e-013   -12.552   -12.590     -0.038
Cd              5.334e-010
    Cd+2              5.077e-010  3.570e-010    -9.294    -9.447     -0.153
    CdCl+             1.511e-011  1.383e-011   -10.821   -10.859     -0.038
    CdOH+             6.588e-012  6.033e-012   -11.181   -11.219     -0.038
    CdSO4             3.949e-012  3.955e-012   -11.404   -11.403      0.001
    Cd(OH)2           3.993e-014  4.000e-014   -13.399   -13.398      0.001
    CdCl2             2.339e-014  2.343e-014   -13.631   -13.630      0.001
    Cd(SO4)2-2        2.274e-015  1.599e-015   -14.643   -14.796     -0.153
    CdCl3-            6.812e-018  6.238e-018   -17.167   -17.205     -0.038
    Cd(OH)3-          7.761e-019  7.107e-019   -18.110   -18.148     -0.038
    Cd(OH)4-2         1.426e-024  1.003e-024   -23.846   -23.999     -0.153
Cl              4.387e-004
    Cl-               4.387e-004  4.012e-004    -3.358    -3.397     -0.039
    FeCl+             1.011e-009  9.258e-010    -8.995    -9.033     -0.038
    ZnCl+             1.101e-010  1.008e-010    -9.958    -9.996     -0.038
    CdCl+             1.511e-011  1.383e-011   -10.821   -10.859     -0.038
    PbCl+             1.001e-011  9.164e-012   -11.000   -11.038     -0.038
    ZnCl2             4.287e-014  4.294e-014   -13.368   -13.367      0.001
    CdCl2             2.339e-014  2.343e-014   -13.631   -13.630      0.001
    PbCl2             5.464e-015  5.473e-015   -14.262   -14.262      0.001
    ZnCl3-            2.154e-017  1.972e-017   -16.667   -16.705     -0.038
    CdCl3-            6.812e-018  6.238e-018   -17.167   -17.205     -0.038
    PbCl3-            1.945e-018  1.781e-018   -17.711   -17.749     -0.038
    FeCl+2            1.575e-018  1.107e-018   -17.803   -17.956     -0.153
    ZnCl4-2           5.792e-021  4.073e-021   -20.237   -20.390     -0.153
    FeCl2+            1.948e-021  1.784e-021   -20.710   -20.749     -0.038
    PbCl4-2           4.991e-022  3.509e-022   -21.302   -21.455     -0.153
    FeCl3             7.147e-026  7.159e-026   -25.146   -25.145      0.001
Cu(1)           4.138e-011
    Cu+               4.138e-011  3.775e-011   -10.383   -10.423     -0.040
Cu(2)           1.571e-008
    Cu(OH)2           1.562e-008  1.564e-008    -7.806    -7.806      0.001
    CuOH+             5.164e-011  4.727e-011   -10.287   -10.325     -0.038
    Cu+2              4.180e-011  2.985e-011   -10.379   -10.525     -0.146
    CuSO4             2.344e-013  2.347e-013   -12.630   -12.629      0.001
    Cu(OH)3-          1.630e-013  1.492e-013   -12.788   -12.826     -0.038
    Cu(OH)4-2         6.706e-018  4.716e-018   -17.174   -17.326     -0.153
Fe(2)           2.471e-006
    Fe+2              2.341e-006  1.672e-006    -5.631    -5.777     -0.146
    FeOH+             1.175e-007  1.076e-007    -6.930    -6.968     -0.038
    FeSO4             1.188e-008  1.190e-008    -7.925    -7.925      0.001
    FeCl+             1.011e-009  9.258e-010    -8.995    -9.033     -0.038
    FeHSO4+           5.466e-016  5.005e-016   -15.262   -15.301     -0.038
    Fe(HS)2           0.000e+000  0.000e+000  -129.069  -129.068      0.001
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    Fe(HS)3-         0.000e+000  0.000e+000  -193.114  -193.152    -0.038
Fe(3)           1.764e-004
    Fe(OH)3          1.438e-004  1.440e-004    -3.842    -3.842     0.001
    Fe(OH)4-         2.600e-005  2.380e-005    -4.585    -4.623    -0.038
    Fe(OH)2+         6.659e-006  6.098e-006    -5.177    -5.215    -0.038
    FeOH+2           1.456e-010  1.024e-010    -9.837    -9.990    -0.153
    Fe+3             1.668e-016  8.216e-017   -15.778   -16.085    -0.307
    FeSO4+           3.988e-017  3.652e-017   -16.399   -16.437    -0.038
    FeCl+2           1.575e-018  1.107e-018   -17.803   -17.956    -0.153
    Fe2(OH)2+4       1.004e-018  2.455e-019   -17.998   -18.610    -0.612
    Fe(SO4)2-        3.327e-020  3.047e-020   -19.478   -19.516    -0.038
    Fe3(OH)4+5       2.072e-021  2.295e-022   -20.684   -21.639    -0.956
    FeCl2+           1.948e-021  1.784e-021   -20.710   -20.749    -0.038
    FeHSO4+2         8.788e-025  6.180e-025   -24.056   -24.209    -0.153
    FeCl3            7.147e-026  7.159e-026   -25.146   -25.145     0.001
H(0)            2.973e-025
    H2               1.487e-025  1.489e-025   -24.828   -24.827     0.001
K               1.081e-004
    K+               1.081e-004  9.884e-005    -3.966    -4.005    -0.039
    KSO4-            3.026e-008  2.771e-008    -7.519    -7.557    -0.038
    KOH              5.419e-011  5.427e-011   -10.266   -10.265     0.001
Mg              1.936e-003
    Mg+2             1.922e-003  1.371e-003    -2.716    -2.863    -0.147
    MgSO4            1.317e-005  1.319e-005    -4.880    -4.880     0.001
    MgOH+            1.166e-006  1.068e-006    -5.933    -5.972    -0.038
Na              4.740e-004
    Na+              4.740e-004  4.344e-004    -3.324    -3.362    -0.038
    NaSO4-           9.140e-008  8.370e-008    -7.039    -7.077    -0.038
    NaOH             4.538e-010  4.545e-010    -9.343    -9.342     0.001
O(0)            0.000e+000
    O2               0.000e+000  0.000e+000   -41.643   -41.642     0.001
Pb              2.652e-009
    PbOH+            1.780e-009  1.630e-009    -8.750    -8.788    -0.038
    Pb+2             7.507e-010  5.279e-010    -9.125    -9.277    -0.153
    Pb(OH)2          1.003e-010  1.004e-010    -9.999    -9.998     0.001
    PbSO4            1.115e-011  1.117e-011   -10.953   -10.952     0.001
    PbCl+            1.001e-011  9.164e-012   -11.000   -11.038    -0.038
    Pb(OH)3-         1.994e-013  1.826e-013   -12.700   -12.738    -0.038
    PbCl2            5.464e-015  5.473e-015   -14.262   -14.262     0.001
    Pb(SO4)2-2       3.138e-015  2.207e-015   -14.503   -14.656    -0.153
    Pb(OH)4-2        9.421e-017  6.625e-017   -16.026   -16.179    -0.153
    Pb2OH+3          4.254e-017  1.926e-017   -16.371   -16.715    -0.344
    PbCl3-           1.945e-018  1.781e-018   -17.711   -17.749    -0.038
    PbCl4-2          4.991e-022  3.509e-022   -21.302   -21.455    -0.153
S(-2)           0.000e+000
    HS-              0.000e+000  0.000e+000   -66.082   -66.121    -0.039
    H2S              0.000e+000  0.000e+000   -67.422   -67.422     0.001
    S-2              0.000e+000  0.000e+000   -70.589   -70.739    -0.150
    Fe(HS)2          0.000e+000  0.000e+000  -129.069  -129.068     0.001
    Fe(HS)3-         0.000e+000  0.000e+000  -193.114  -193.152    -0.038
S(6)            7.311e-005
    SO4-2            5.316e-005  3.763e-005    -4.274    -4.424    -0.150
    MgSO4            1.317e-005  1.319e-005    -4.880    -4.880     0.001
    CaSO4            6.639e-006  6.649e-006    -5.178    -5.177     0.001
    NaSO4-           9.140e-008  8.370e-008    -7.039    -7.077    -0.038
    KSO4-            3.026e-008  2.771e-008    -7.519    -7.557    -0.038
    FeSO4            1.188e-008  1.190e-008    -7.925    -7.925     0.001
    ZnSO4            7.278e-010  7.289e-010    -9.138    -9.137     0.001
    HSO4-            2.720e-011  2.491e-011   -10.565   -10.604    -0.038
    PbSO4            1.115e-011  1.117e-011   -10.953   -10.952     0.001
    CdSO4            3.949e-012  3.955e-012   -11.404   -11.403     0.001
    Zn(SO4)2-2       3.090e-013  2.173e-013   -12.510   -12.663    -0.153
    CaHSO4+          2.806e-013  2.570e-013   -12.552   -12.590    -0.038
    CuSO4            2.344e-013  2.347e-013   -12.630   -12.629     0.001
    Pb(SO4)2-2       3.138e-015  2.207e-015   -14.503   -14.656    -0.153
    Cd(SO4)2-2       2.274e-015  1.599e-015   -14.643   -14.796    -0.153
    FeHSO4+          5.466e-016  5.005e-016   -15.262   -15.301    -0.038
    FeSO4+           3.988e-017  3.652e-017   -16.399   -16.437    -0.038
    Fe(SO4)2-        3.327e-020  3.047e-020   -19.478   -19.516    -0.038
    FeHSO4+2         8.788e-025  6.180e-025   -24.056   -24.209    -0.153
Zn              1.596e-007
    Zn+2             1.137e-007  8.052e-008    -6.944    -7.094    -0.150
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    Zn(OH)2          2.538e-008  2.542e-008    -7.595    -7.595     0.001
    ZnOH+            1.970e-008  1.804e-008    -7.706    -7.744    -0.038
    ZnSO4            7.278e-010  7.289e-010    -9.138    -9.137     0.001
    ZnCl+            1.101e-010  1.008e-010    -9.958    -9.996    -0.038
    Zn(OH)3-         1.390e-011  1.273e-011   -10.857   -10.895    -0.038
    Zn(SO4)2-2       3.090e-013  2.173e-013   -12.510   -12.663    -0.153
    ZnCl2            4.287e-014  4.294e-014   -13.368   -13.367     0.001
    Zn(OH)4-2        4.544e-016  3.195e-016   -15.343   -15.495    -0.153
    ZnCl3-           2.154e-017  1.972e-017   -16.667   -16.705    -0.038
    ZnCl4-2          5.792e-021  4.073e-021   -20.237   -20.390    -0.153

------------------------------Saturation indices-------------------------------

    Phase               SI  log IAP  log KT

    Anglesite        -5.93  -13.70   -7.77  PbSO4
    Anhydrite        -3.11   -7.49   -4.38  CaSO4
    Cd(OH)2          -6.70    6.95   13.65  Cd(OH)2
    CdSO4           -13.65  -13.87   -0.22  CdSO4
    Fe(OH)3(a)        3.62    8.51    4.89  Fe(OH)3
    FeS(ppt)        -59.78  -63.70   -3.92  FeS
    Goethite          9.63    8.51   -1.12  FeOOH
    Gypsum           -2.91   -7.49   -4.58  CaSO4:2H2O
    H2(g)           -21.66  -24.83   -3.16  H2
    H2O(g)           -1.42   -0.00    1.42  H2O
    H2S(g)          -66.39  -67.42   -1.03  H2S
    Halite           -8.35   -6.76    1.59  NaCl
    Hematite         21.29   17.03   -4.26  Fe2O3
    Jarosite-K       -2.44  -11.91   -9.47  KFe3(SO4)2(OH)6
    Mackinawite     -59.05  -63.70   -4.65  FeS
    Melanterite      -8.03  -10.20   -2.17  FeSO4:7H2O
    O2(g)           -38.67  -41.64   -2.98  O2
    Pb(OH)2          -0.91    7.12    8.03  Pb(OH)2
    Pyrite          -97.97 -116.36  -18.39  FeS2
    Sphalerite      -53.47  -65.02  -11.55  ZnS
    Sulfur          -50.56  -45.76    4.80  S
    Zn(OH)2(e)       -2.19    9.31   11.50  Zn(OH)2

------------------
End of simulation.
------------------

------------------------------------
Reading input data for simulation 4.
------------------------------------

    SOLUTION 1 River water
        temp      28.4
        pH        8.2
        pe        2.63
        redox     pe
        units     mg/l
        density   1
        S(6)      6.4
        Ca        48.7
        Cd        6e-005
        Cl        15.3
        Cu        0.001
        Fe        10
        K         4.2
        Mg        47
        Na        10.6
        Pb        0.00055
        Zn        0.0104
        water    1 # kg
    SOLUTION 2 PAF Leachate
        temp      25
        pH        3.98
        pe        11.85
        redox     pe
        units     mg/l
        density   1
```

```
    Ca        358
    Cd        0.0631
    Cl        1
    Cu        0.058
    Fe        307
    K         4
    Mg        2560
    Na        6
    Pb        0.286
    S(6)      20000
    Zn        134
    water    1 # kg
SOLUTION 3 NAF Leachate
    temp      25
    pH        6.5
    pe        1.84
    redox     pe
    units     mg/l
    density   1
    Ca        193
    Cd        0.0025
    Cl        64
    Cu        0.005
    Fe        0.01
    K         38
    Mg        226
    Na        61
    Pb        0.005
    S(6)      1450
    Zn        1.53
    water    1 # kg
SOLUTION 4 Rainwater
    temp      25
    pH        4.59
    pe        10.15
    redox     pe
    units     mg/l
    density   1
    Ca        0.1002
    Cd        0
    Cl        0.2375
    Cu        0
    Fe        0
    K         0.0586
    Mg        0.0316
    Na        0.15869
    Pb        0
    S(6)      0.7781
    Zn        0.01
    water    1 # kg
SOLUTION 5 Tailings Seepage
    temp      25
    pH        6.56
    pe        1.69
    redox     pe
    units     mg/l
    density   1
    Ca        405
    Cd        0.00008
    Cl        2610
    Cu        0.0174
    Fe        0.00315
    K         297
    Mg        1070
    Na        3030
    Pb        0.00029
    S(6)      6190
    Zn        0.327
    water    1 # kg
MIX 1 Mixing of water in open pit - worst case Scenario 4
    1    0.9940
    2    0
```

```
    3    0.0004
    4    0.0049
    5    0.0006
PRINT
    warnings                 -1
SELECTED_OUTPUT
    file                    MRM2_Scenario4.txt
    totals                  Ca  Cd  Cl  Cu  K  Mg  Mn
                             Na  Pb  S(-2)  Zn  S(6)  Al  Alkalinity
                             B  Ba  Br  C  C(4)  C(-4)  Cu(1)
                             Cu(2)  N  Mn(3)  Mn(2)  Li  Hfo_w  Hfo_s
                             H(0)  Fe(3)  Fe(2)  F  Fe  N(0)  N(3)
                             N(-3)  N(5)  O(0)  P  S  Si  Sr
                             X
    molalities              Ca+2  CaCO3  CaF+  CaH2PO4+
                             CaHCO3+  CaHPO4  CaHSO4+  CaOH+
                             CaPO4-  CaSO4  CaX2  Cd(CO3)2-2
                             Cd(OH)2  Cd(OH)3-  Cd(OH)4-2  Cd(SO4)2-2
                             Cd+2  CdCl+  CdCl2  CdCl3-
                             CdCO3  CdHCO3+  CdOH+  CdSO4
                             CdX2  Cl-  CO2  CO3-2
                             Cu(OH)2  Cu(OH)3-  Cu(OH)4-2  Cu+
                             Cu+2  CuOH+  CuSO4  CuX2
                             Fe(HS)2  Fe(HS)3-  Fe(OH)2+  FeH2PO4+
                             FeF3  FeF2+  FeF+2  FeF+
                             FeCO3  FeCl3  FeCl2+  FeCl+2
                             FeCl+  Fe3(OH)4+5  Fe2(OH)2+4  Fe+3
                             Fe+2  Fe(SO4)2-  Fe(OH)4-  Fe(OH)3
                             FeX2  FeSO4+  FeSO4  FeOH+2
                             FeOH+  FeHSO4+2  FeHSO4+  FeHPO4+
                             FeHPO4  FeHCO3+  FeH2PO4+2  H2S
                             HSO4-  HS-  K+  KHPO4-
                             KOH  KSO4-  KX  Mg+2
                             MgCO3  MgF+  MgH2PO4+  MgHCO3+
                             MgHPO4  MgOH+  MgPO4-  MgSO4
                             MgX2  Mn(NO3)2  Mn+2  Mn+3
                             MnCl+  MnCl2  MnCl3-  MnCO3
                             MnF+  MnHCO3+  MnOH+  MnSO4
                             MnX2  Na+  NaCO3-  NaF
                             NaHCO3  NaHPO4-  NaOH  NaSO4-
                             NaX  NH3  NH4+  NH4SO4-
                             NH4X  Pb(CO3)2-2  Pb(OH)2  Pb(OH)3-
                             Pb(OH)4-2  Pb(SO4)2-2  Pb+2  Pb2OH+3
                             PbCl+  PbCl2  PbCl3-  PbCl4-2
                             PbCO3  PbHCO3+  PbNO3+  PbOH+
                             PbSO4  PbX2  PO4-3  SO4-2
                             Zn(CO3)2-2  Zn(OH)2  Zn(OH)3-  Zn(OH)4-2
                             Zn(SO4)2-2  Zn+2  ZnCl+  ZnCl2
                             ZnCl3-  ZnCl4-2  ZnCO3  ZnHCO3+
                             ZnOH+  ZnSO4  ZnX2  Al(OH)2+
                             Al(OH)3  Al(OH)4-  Al(SO4)2-  Al+3
                             AlF+2  AlF2+  AlF3  AlF4-
                             AlF5-2  AlF6-3  AlHSO4+2  AlOH+2
                             AlOHX2  AlSO4+  AlX3  Ba+2
                             BaCO3  BaHCO3+  BaOH+  BaSO4
                             BaX2  BF(OH)3-  BF2(OH)2-  BF3OH-
                             BF4-  Br-  CH4  F-
                             H+  H2  H2BO3-  H2O
                             H2PO4-  H2SiO4-2  H3BO3  H3SiO4-
                             H4SiO4  HCO3-  HF  HF2-
                             Hfo_psi  Hfo_sO-  Hfo_sOCd+  Hfo_sOCu+
                             Hfo_sOFe+  Hfo_sOH  Hfo_sOH2+  Hfo_sOHBa+2
                             Hfo_sOHCa+2  Hfo_sOHSr+2  Hfo_sOMn+  Hfo_sOPb+
                             Hfo_sOZn+  Hfo_wF  Hfo_wH2BO3  Hfo_wH2PO4
                             Hfo_wHPO4-  Hfo_wO-  Hfo_wOBa+  Hfo_wOCa+
                             Hfo_wOCd+  Hfo_wOCu+  Hfo_wOFe+  Hfo_wOFeOH
                             Hfo_wOH  Hfo_wOH2+  Hfo_wOHF-  Hfo_wOHSO4-2
                             Hfo_wOMg+  Hfo_wOMn+  Hfo_wOPb+  Hfo_wOSr+
                             Hfo_wOSrOH  Hfo_wOZn+  Hfo_wPO4-2  Hfo_wSO4-
                             HPO4-2  Li+  LiOH  LiSO4-
                             LiX  N2  NO2-  NO3-
                             O2  OH-  S-2  SiF6-2
```

```
                         Sr+2  SrCO3  SrHCO3+  SrOH+
                         SrSO4  SrX2  X-
activities              Al(OH)2+  Al(OH)3  Al(OH)4-  Al(SO4)2-
                         Al+3  AlF+2  AlF2+  AlF3
                         AlF4-  AlF5-2  AlF6-3  AlHSO4+2
                         AlOH+2  AlOHX2  AlSO4+  AlX3
                         Ba+2  BaCO3  BaHCO3+  BaOH+
                         BaSO4  BaX2  BF(OH)3-  BF2(OH)2-
                         BF3OH-  BF4-  Br-  Ca+2
                         CaCO3  CaF+  CaH2PO4+  CaHCO3+
                         CaHPO4  CaHSO4+  CaOH+  CaPO4-
                         CaSO4  CaX2  Cd(CO3)2-2  Cd(OH)2
                         Cd(OH)3-  Cd(OH)4-2  Cd(SO4)2-2  Cd+2
                         CdCl+  CdCl2  CdCl3-  CdCO3
                         CdHCO3+  CdOH+  CdSO4  CdX2
                         CH4  Cl-  CO2  CO3-2
                         Cu(OH)2  Cu(OH)3-  Cu(OH)4-2  Cu+
                         Cu+2  CuOH+  CuSO4  CuX2
                         Fe(HS)2  Fe(HS)3-  Fe(OH)2+  F-
                         Fe(OH)3  Fe(OH)4-  Fe(SO4)2-  Fe+2
                         Fe+3  Fe2(OH)2+4  Fe3(OH)4+5  FeCl+
                         FeCl+2  FeCl2+  FeCl3  FeCO3
                         FeF+  FeF+2  FeF2+  FeF3
                         FeH2PO4+  FeH2PO4+2  FeHCO3+  FeHPO4
                         FeHPO4+  FeHSO4+  FeHSO4+2  FeOH+
                         FeOH+2  FeSO4  FeSO4+  FeX2
                         H+  H2  H2BO3-  H2O
                         H2PO4-  H2S  H2SiO4-2  H3BO3
                         H3SiO4-  H4SiO4  HCO3-  HF
                         HF2-  Hfo_psi  Hfo_sO-  Hfo_sOCd+
                         Hfo_sOCu+  Hfo_sOFe+  Hfo_sOH  Hfo_sOH2+
                         Hfo_sOHBa+2  Hfo_sOHCa+2  Hfo_sOHSr+2  Hfo_sOMn+
                         Hfo_sOPb+  Hfo_sOZn+  Hfo_wF  Hfo_wH2BO3
                         Hfo_wH2PO4  Hfo_wHPO4-  Hfo_wO-  Hfo_wOBa+
                         Hfo_wOCa+  Hfo_wOCd+  Hfo_wOCu+  Hfo_wOFe+
                         Hfo_wOFeOH  Hfo_wOH  Hfo_wOH2+  Hfo_wOHF-
                         Hfo_wOHSO4-2  Hfo_wOMg+  Hfo_wOMn+  Hfo_wOPb+
                         Hfo_wOSr+  Hfo_wOSrOH  Hfo_wOZn+  Hfo_wPO4-2
                         Hfo_wSO4-  HPO4-2  HS-  HSO4-
                         K+  KHPO4-  KOH  KSO4-
                         KX  Li+  LiOH  LiSO4-
                         LiX  Mg+2  MgCO3  MgF+
                         MgH2PO4+  MgHCO3+  MgHPO4  MgOH+
                         MgPO4-  MgSO4  MgX2  Mn(NO3)2
                         Mn+2  Mn+3  MnCl+  MnCl2
                         MnCl3-  MnCO3  MnF+  MnHCO3+
                         MnOH+  MnSO4  MnX2  N2
                         Na+  NaCO3-  NaF  NaHCO3
                         NaHPO4-  NaOH  NaSO4-  NaX
                         NH3  NH4+  NH4SO4-  NH4X
                         NO2-  NO3-  O2  OH-
                         Pb(CO3)2-2  Pb(OH)2  Pb(OH)3-  Pb(OH)4-2
                         Pb(SO4)2-2  Pb+2  Pb2OH+3  PbCl+
                         PbCl2  PbCl3-  PbCl4-2  PbCO3
                         PbHCO3+  PbNO3+  PbOH+  PbSO4
                         PbX2  PO4-3  S-2  SiF6-2
                         SO4-2  Sr+2  SrCO3  SrHCO3+
                         SrOH+  SrSO4  SrX2  X-
                         Zn(CO3)2-2  Zn(OH)2  Zn(OH)3-  Zn(OH)4-2
                         Zn(SO4)2-2  Zn+2  ZnCl+  ZnCl2
                         ZnCl3-  ZnCl4-2  ZnCO3  ZnHCO3+
                         ZnOH+  ZnSO4  ZnX2
equilibrium_phases      Al(OH)3(a)  Albite  Alunite  Anglesite
                         Anhydrite  Anorthite  Aragonite  Barite
                         Calcite  Ca-Montmorillonite  Cd(OH)2  CdSiO3
                         CdSO4  Celestite  Cerrusite  CH4(g)
                         Chalcedony  Hydroxyapatite  Hematite  Hausmannite
                         Halite  H2S(g)  H2O(g)  H2(g)
                         Gypsum  Goethite  Gibbsite  Fluorite
                         FeS(ppt)  Fe(OH)3(a)  Dolomite  CO2(g)
                         Chrysotile  Chlorite(14A)  Illite  Jarosite-K
                         Kaolinite  K-feldspar  K-mica  Mackinawite
```

```
                              Manganite  Melanterite  N2(g)  NH3(g)
                              O2(g)  Otavite  Pb(OH)2  Pyrite
                              Pyrochroite  Pyrolusite  Quartz  Rhodochrosite
                              Sepiolite  Sepiolite(d)  Siderite  SiO2(a)
                              Smithsonite  Sphalerite  Strontianite  Sulfur
                              Talc  Vivianite  Willemite  Witherite
                              Zn(OH)2(e)
        saturation_indices   Al(OH)3(a)  Zn(OH)2(e)  Witherite  Willemite
                              Vivianite  Talc  Sulfur  Strontianite
                              Sphalerite  Smithsonite  SiO2(a)  Siderite
                              Sepiolite(d)  Sepiolite  Rhodochrosite  Quartz
                              Pyrolusite  Pyrochroite  Pyrite  Pb(OH)2
                              Otavite  O2(g)  NH3(g)  N2(g)
                              Melanterite  Manganite  Mackinawite  K-mica
                              K-feldspar  Kaolinite  Jarosite-K  Illite
                              Hydroxyapatite  Hematite  Hausmannite  Halite
                              H2S(g)  H2O(g)  H2(g)  Gypsum
                              Goethite  Gibbsite  Fluorite  FeS(ppt)
                              Fe(OH)3(a)  Dolomite  CO2(g)  Chrysotile
                              Chlorite(14A)  Chalcedony  CH4(g)  Cerrusite
                              Celestite  CdSO4  CdSiO3  Cd(OH)2
                              Ca-Montmorillonite  Calcite  Barite  Aragonite
                              Anorthite  Anhydrite  Anglesite  Alunite
                              Albite
        gases                CH4(g)  CO2(g)  H2(g)  H2O(g)
                              H2S(g)  N2(g)  NH3(g)  O2(g)
        kinetic_reactants    Albite  Calcite  K-feldspar  Organic_C
                              Pyrite  Pyrolusite
    END
-------------------------------------------
Beginning of initial solution calculations.
-------------------------------------------

Initial solution 1.   River water

-----------------------------Solution composition------------------------------

    Elements           Molality       Moles

    Ca              1.215e-003  1.215e-003
    Cd              5.339e-010  5.339e-010
    Cl              4.316e-004  4.316e-004
    Cu              1.574e-008  1.574e-008
    Fe              1.791e-004  1.791e-004
    K               1.074e-004  1.074e-004
    Mg              1.933e-003  1.933e-003
    Na              4.611e-004  4.611e-004
    Pb              2.655e-009  2.655e-009
    S(6)            6.663e-005  6.663e-005
    Zn              1.591e-007  1.591e-007

----------------------------Description of solution----------------------------

                                       pH  =   8.200
                                       pe  =   2.630
                        Activity of water  =   1.000
                           Ionic strength  =  6.879e-003
                       Mass of water (kg)  =  1.000e+000
                 Total alkalinity (eq/kg)  =  1.996e-004
                    Total carbon (mol/kg)  =  0.000e+000
                       Total CO2 (mol/kg)  =  0.000e+000
                      Temperature (deg C)  =  28.400
                  Electrical balance (eq)  =  6.283e-003
 Percent error, 100*(Cat-|An|)/(Cat+|An|)  =  84.94
                               Iterations  =   4
                                  Total H  = 1.110130e+002
                                  Total O  = 5.550704e+001

----------------------------Distribution of species----------------------------

                                               Log       Log         Log
    Species            Molality    Activity  Molality  Activity     Gamma
```

	OH-	2.233e-006	2.043e-006	-5.651	-5.690	-0.039
	H+	6.825e-009	6.310e-009	-8.166	-8.200	-0.034
	H2O	5.551e+001	9.999e-001	1.744	-0.000	0.000
Ca		1.215e-003				
	Ca+2	1.209e-003	8.591e-004	-2.918	-3.066	-0.148
	CaSO4	6.060e-006	6.069e-006	-5.218	-5.217	0.001
	CaOH+	2.467e-008	2.260e-008	-7.608	-7.646	-0.038
	CaHSO4+	2.559e-013	2.344e-013	-12.592	-12.630	-0.038
Cd		5.339e-010				
	Cd+2	5.087e-010	3.579e-010	-9.294	-9.446	-0.153
	CdCl+	1.490e-011	1.365e-011	-10.827	-10.865	-0.038
	CdOH+	6.609e-012	6.053e-012	-11.180	-11.218	-0.038
	CdSO4	3.609e-012	3.615e-012	-11.443	-11.442	0.001
	Cd(OH)2	4.009e-014	4.015e-014	-13.397	-13.396	0.001
	CdCl2	2.271e-014	2.274e-014	-13.644	-13.643	0.001
	Cd(SO4)2-2	1.894e-015	1.332e-015	-14.723	-14.875	-0.153
	CdCl3-	6.507e-018	5.960e-018	-17.187	-17.225	-0.038
	Cd(OH)3-	7.795e-019	7.139e-019	-18.108	-18.146	-0.038
	Cd(OH)4-2	1.433e-024	1.008e-024	-23.844	-23.996	-0.153
Cl		4.316e-004				
	Cl-	4.316e-004	3.948e-004	-3.365	-3.404	-0.039
	FeCl+	9.966e-010	9.127e-010	-9.001	-9.040	-0.038
	ZnCl+	1.081e-010	9.898e-011	-9.966	-10.004	-0.038
	CdCl+	1.490e-011	1.365e-011	-10.827	-10.865	-0.038
	PbCl+	9.858e-012	9.029e-012	-11.006	-11.044	-0.038
	ZnCl2	4.141e-014	4.148e-014	-13.383	-13.382	0.001
	CdCl2	2.271e-014	2.274e-014	-13.644	-13.643	0.001
	PbCl2	5.298e-015	5.306e-015	-14.276	-14.275	0.001
	ZnCl3-	2.047e-017	1.875e-017	-16.689	-16.727	-0.038
	CdCl3-	6.507e-018	5.960e-018	-17.187	-17.225	-0.038
	PbCl3-	1.855e-018	1.699e-018	-17.732	-17.770	-0.038
	FeCl+2	1.546e-018	1.088e-018	-17.811	-17.963	-0.153
	ZnCl4-2	5.416e-021	3.810e-021	-20.266	-20.419	-0.153
	FeCl2+	1.883e-021	1.725e-021	-20.725	-20.763	-0.038
	PbCl4-2	4.683e-022	3.295e-022	-21.329	-21.482	-0.153
	FeCl3	6.800e-026	6.810e-026	-25.168	-25.167	0.001
Cu(1)		4.144e-011				
	Cu+	4.144e-011	3.781e-011	-10.383	-10.422	-0.040
Cu(2)		1.570e-008				
	Cu(OH)2	1.560e-008	1.563e-008	-7.807	-7.806	0.001
	CuOH+	5.155e-011	4.720e-011	-10.288	-10.326	-0.038
	Cu+2	4.169e-011	2.978e-011	-10.380	-10.526	-0.146
	CuSO4	2.132e-013	2.136e-013	-12.671	-12.670	0.001
	Cu(OH)3-	1.630e-013	1.492e-013	-12.788	-12.826	-0.038
	Cu(OH)4-2	6.708e-018	4.719e-018	-17.173	-17.326	-0.153
Fe(2)		2.474e-006				
	Fe+2	2.344e-006	1.675e-006	-5.630	-5.776	-0.146
	FeOH+	1.178e-007	1.079e-007	-6.929	-6.967	-0.038
	FeSO4	1.085e-008	1.087e-008	-7.965	-7.964	0.001
	FeCl+	9.966e-010	9.127e-010	-9.001	-9.040	-0.038
	FeHSO4+	4.989e-016	4.569e-016	-15.302	-15.340	-0.038
Fe(3)		1.766e-004				
	Fe(OH)3	1.439e-004	1.441e-004	-3.842	-3.841	0.001
	Fe(OH)4-	2.604e-005	2.385e-005	-4.584	-4.623	-0.038
	Fe(OH)2+	6.658e-006	6.098e-006	-5.177	-5.215	-0.038
	FeOH+2	1.454e-010	1.023e-010	-9.837	-9.990	-0.153
	Fe+3	1.663e-016	8.202e-017	-15.779	-16.086	-0.307
	FeSO4+	3.630e-017	3.324e-017	-16.440	-16.478	-0.038
	FeCl+2	1.546e-018	1.088e-018	-17.811	-17.963	-0.153
	Fe2(OH)2+4	1.001e-018	2.451e-019	-18.000	-18.611	-0.611
	Fe(SO4)2-	2.761e-020	2.528e-020	-19.559	-19.597	-0.038
	Fe3(OH)4+5	2.062e-021	2.290e-022	-20.686	-21.640	-0.954
	FeCl2+	1.883e-021	1.725e-021	-20.725	-20.763	-0.038
	FeHSO4+2	7.990e-025	5.621e-025	-24.097	-24.250	-0.153
	FeCl3	6.800e-026	6.810e-026	-25.168	-25.167	0.001
H(0)		2.991e-025				
	H2	1.495e-025	1.498e-025	-24.825	-24.825	0.001
K		1.074e-004				
	K+	1.074e-004	9.825e-005	-3.969	-4.008	-0.039
	KSO4-	2.742e-008	2.512e-008	-7.562	-7.600	-0.038
	KOH	5.390e-011	5.399e-011	-10.268	-10.268	0.001

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Mg              1.933e-003
     Mg+2             1.920e-003  1.371e-003    -2.717    -2.863    -0.146
     MgSO4            1.200e-005  1.202e-005    -4.921    -4.920     0.001
     MgOH+            1.167e-006  1.068e-006    -5.933    -5.971    -0.038
Na              4.611e-004
     Na+              4.611e-004  4.226e-004    -3.336    -3.374    -0.038
     NaSO4-           8.107e-008  7.424e-008    -7.091    -7.129    -0.038
     NaOH             4.418e-010  4.425e-010    -9.355    -9.354     0.001
O(0)            0.000e+000
     O2               0.000e+000  0.000e+000   -41.647   -41.646     0.001
Pb              2.655e-009
     PbOH+            1.783e-009  1.633e-009    -8.749    -8.787    -0.038
     Pb+2             7.512e-010  5.285e-010    -9.124    -9.277    -0.153
     Pb(OH)2          1.005e-010  1.007e-010    -9.998    -9.997     0.001
     PbSO4            1.018e-011  1.020e-011   -10.992   -10.992     0.001
     PbCl+            9.858e-012  9.029e-012   -11.006   -11.044    -0.038
     Pb(OH)3-         2.000e-013  1.832e-013   -12.699   -12.737    -0.038
     PbCl2            5.298e-015  5.306e-015   -14.276   -14.275     0.001
     Pb(SO4)2-2       2.610e-015  1.836e-015   -14.583   -14.736    -0.153
     Pb(OH)4-2        9.454e-017  6.651e-017   -16.024   -16.177    -0.153
     Pb2OH+3          4.262e-017  1.932e-017   -16.370   -16.714    -0.344
     PbCl3-           1.855e-018  1.699e-018   -17.732   -17.770    -0.038
     PbCl4-2          4.683e-022  3.295e-022   -21.329   -21.482    -0.153
S(6)            6.663e-005
     SO4-2            4.845e-005  3.431e-005    -4.315    -4.465    -0.150
     MgSO4            1.200e-005  1.202e-005    -4.921    -4.920     0.001
     CaSO4            6.060e-006  6.069e-006    -5.218    -5.217     0.001
     NaSO4-           8.107e-008  7.424e-008    -7.091    -7.129    -0.038
     KSO4-            2.742e-008  2.512e-008    -7.562    -7.600    -0.038
     FeSO4            1.085e-008  1.087e-008    -7.965    -7.964     0.001
     ZnSO4            6.618e-010  6.629e-010    -9.179    -9.179     0.001
     HSO4-            2.478e-011  2.269e-011   -10.606   -10.644    -0.038
     PbSO4            1.018e-011  1.020e-011   -10.992   -10.992     0.001
     CdSO4            3.609e-012  3.615e-012   -11.443   -11.442     0.001
     Zn(SO4)2-2       2.561e-013  1.801e-013   -12.592   -12.744    -0.153
     CaHSO4+          2.559e-013  2.344e-013   -12.592   -12.630    -0.038
     CuSO4            2.132e-013  2.136e-013   -12.671   -12.670     0.001
     Pb(SO4)2-2       2.610e-015  1.836e-015   -14.583   -14.736    -0.153
     Cd(SO4)2-2       1.894e-015  1.332e-015   -14.723   -14.875    -0.153
     FeHSO4+          4.989e-016  4.569e-016   -15.302   -15.340    -0.038
     FeSO4+           3.630e-017  3.324e-017   -16.440   -16.478    -0.038
     Fe(SO4)2-        2.761e-020  2.528e-020   -19.559   -19.597    -0.038
     FeHSO4+2         7.990e-025  5.621e-025   -24.097   -24.250    -0.153
Zn              1.591e-007
     Zn+2             1.133e-007  8.030e-008    -6.946    -7.095    -0.150
     Zn(OH)2          2.535e-008  2.539e-008    -7.596    -7.595     0.001
     ZnOH+            1.966e-008  1.801e-008    -7.706    -7.745    -0.038
     ZnSO4            6.618e-010  6.629e-010    -9.179    -9.179     0.001
     ZnCl+            1.081e-010  9.898e-011    -9.966   -10.004    -0.038
     Zn(OH)3-         1.389e-011  1.272e-011   -10.857   -10.895    -0.038
     Zn(SO4)2-2       2.561e-013  1.801e-013   -12.592   -12.744    -0.153
     ZnCl2            4.141e-014  4.148e-014   -13.383   -13.382     0.001
     Zn(OH)4-2        4.543e-016  3.196e-016   -15.343   -15.495    -0.153
     ZnCl3-           2.047e-017  1.875e-017   -16.689   -16.727    -0.038
     ZnCl4-2          5.416e-021  3.810e-021   -20.266   -20.419    -0.153

------------------------------Saturation indices-------------------------------

     Phase               SI log IAP  log KT

     Anglesite        -5.97  -13.74   -7.77  PbSO4
     Anhydrite        -3.15   -7.53   -4.38  CaSO4
     Cd(OH)2          -6.70    6.95   13.65  Cd(OH)2
     CdSO4           -13.69  -13.91   -0.22  CdSO4
     Fe(OH)3(a)        3.62    8.51    4.89  Fe(OH)3
     Goethite          9.63    8.51   -1.12  FeOOH
     Gypsum           -2.95   -7.53   -4.58  CaSO4:2H2O
     H2(g)           -21.66  -24.82   -3.16  H2
     H2O(g)           -1.42   -0.00    1.42  H2O
     Halite           -8.37   -6.78    1.59  NaCl
     Hematite         21.29   17.03   -4.26  Fe2O3
     Jarosite-K       -2.53  -12.00   -9.47  KFe3(SO4)2(OH)6
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    Melanterite      -8.07  -10.24   -2.17  FeSO4:7H2O
    O2(g)           -38.67  -41.65   -2.98  O2
    Pb(OH)2          -0.91    7.12    8.03  Pb(OH)2
    Zn(OH)2(e)       -2.20    9.30   11.50  Zn(OH)2

Initial solution 2.   PAF Leachate

-----------------------------Solution composition------------------------------

    Elements           Molality       Moles

    Ca                9.146e-003  9.146e-003
    Cd                5.748e-007  5.748e-007
    Cl                2.888e-005  2.888e-005
    Cu                9.346e-007  9.346e-007
    Fe                5.629e-003  5.629e-003
    K                 1.047e-004  1.047e-004
    Mg                1.078e-001  1.078e-001
    Na                2.672e-004  2.672e-004
    Pb                1.413e-006  1.413e-006
    S(6)              2.132e-001  2.132e-001
    Zn                2.099e-003  2.099e-003

----------------------------Description of solution----------------------------

                                       pH  =   3.980
                                       pe  =  11.850
                        Activity of water  =   0.996
                           Ionic strength  =  3.474e-001
                       Mass of water (kg)  =  1.000e+000
                 Total alkalinity (eq/kg)  = -7.087e-003
                    Total carbon (mol/kg)  =  0.000e+000
                       Total CO2 (mol/kg)  =  0.000e+000
                      Temperature (deg C)  =  25.000
                  Electrical balance (eq)  = -1.748e-001
 Percent error, 100*(Cat-|An|)/(Cat+|An|)  = -50.44
                               Iterations  =  14
                                  Total H  = 1.110169e+002
                                  Total O  = 5.636285e+001

----------------------------Distribution of species----------------------------

                                                    Log       Log         Log
    Species            Molality    Activity  Molality  Activity       Gamma

    H+                1.347e-004  1.047e-004    -3.871    -3.980      -0.109
    OH-               1.437e-010  9.519e-011    -9.842   -10.021      -0.179
    H2O               5.551e+001  9.957e-001     1.744    -0.002       0.000
Ca              9.146e-003
    CaSO4             5.595e-003  6.061e-003    -2.252    -2.217       0.035
    Ca+2              3.546e-003  9.926e-004    -2.450    -3.003      -0.553
    CaHSO4+           5.083e-006  3.718e-006    -5.294    -5.430      -0.136
    CaOH+             2.141e-012  1.566e-012   -11.669   -11.805      -0.136
Cd              5.748e-007
    Cd(SO4)2-2        2.704e-007  7.742e-008    -6.568    -7.111      -0.543
    CdSO4             2.130e-007  2.308e-007    -6.672    -6.637       0.035
    Cd+2              9.132e-008  2.615e-008    -7.039    -7.583      -0.543
    CdCl+             6.604e-011  4.831e-011   -10.180   -10.316      -0.136
    CdOH+             2.827e-014  2.068e-014   -13.549   -13.684      -0.136
    CdCl2             3.596e-015  3.896e-015   -14.444   -14.409       0.035
    CdCl3-            6.501e-020  4.756e-020   -19.187   -19.323      -0.136
    Cd(OH)2           9.748e-021  1.056e-020   -20.011   -19.976       0.035
    Cd(OH)3-          1.540e-029  1.127e-029   -28.812   -28.948      -0.136
    Cd(OH)4-2         3.335e-039  9.548e-040   -38.477   -39.020      -0.543
Cl              2.888e-005
    Cl-               2.886e-005  1.935e-005    -4.540    -4.713      -0.174
    ZnCl+             8.825e-009  6.455e-009    -8.054    -8.190      -0.136
    FeCl+2            6.446e-009  1.846e-009    -8.191    -8.734      -0.543
    FeCl+             1.706e-009  1.248e-009    -8.768    -8.904      -0.136
    CdCl+             6.604e-011  4.831e-011   -10.180   -10.316      -0.136
    PbCl+             5.126e-011  3.750e-011   -10.290   -10.426      -0.136
    FeCl2+            2.180e-013  1.595e-013   -12.662   -12.797      -0.136
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ZnCl2	1.207e-013	1.308e-013	-12.918	-12.883	0.035
CdCl2	3.596e-015	3.896e-015	-14.444	-14.409	0.035
PbCl2	1.061e-015	1.150e-015	-14.974	-14.939	0.035
ZnCl3-	3.881e-018	2.839e-018	-17.411	-17.547	-0.136
FeCl3	2.848e-019	3.085e-019	-18.545	-18.511	0.035
CdCl3-	6.501e-020	4.756e-020	-19.187	-19.323	-0.136
PbCl3-	2.415e-020	1.767e-020	-19.617	-19.753	-0.136
ZnCl4-2	9.613e-023	2.752e-023	-22.017	-22.560	-0.543
PbCl4-2	5.714e-025	1.636e-025	-24.243	-24.786	-0.543
Cu(1)	1.179e-016				
Cu+	1.179e-016	7.400e-017	-15.928	-16.131	-0.202
Cu(2)	9.346e-007				
CuSO4	5.757e-007	6.237e-007	-6.240	-6.205	0.035
Cu+2	3.588e-007	9.982e-008	-6.445	-7.001	-0.556
CuOH+	1.401e-011	9.492e-012	-10.853	-11.023	-0.169
Cu(OH)2	1.741e-013	1.886e-013	-12.759	-12.725	0.035
Cu(OH)3-	1.477e-022	1.080e-022	-21.831	-21.966	-0.136
Cu(OH)4-2	7.159e-031	2.050e-031	-30.145	-30.688	-0.543
Fe(2)	4.029e-004				
FeSO4	2.347e-004	2.542e-004	-3.629	-3.595	0.035
Fe+2	1.679e-004	4.672e-005	-3.775	-4.330	-0.556
FeHSO4+	2.392e-007	1.750e-007	-6.621	-6.757	-0.136
FeCl+	1.706e-009	1.248e-009	-8.768	-8.904	-0.136
FeOH+	1.921e-010	1.405e-010	-9.717	-9.852	-0.136
Fe(3)	5.226e-003				
FeSO4+	1.449e-003	1.060e-003	-2.839	-2.975	-0.136
Fe(SO4)2-	9.700e-004	7.095e-004	-3.013	-3.149	-0.136
Fe(OH)2+	8.348e-004	6.106e-004	-3.078	-3.214	-0.136
FeOH+2	6.773e-004	1.939e-004	-3.169	-3.712	-0.543
Fe3(OH)4+5	3.204e-004	1.291e-007	-3.494	-6.889	-3.395
Fe2(OH)2+4	1.506e-004	1.012e-006	-3.822	-5.995	-2.173
Fe+3	3.055e-005	3.159e-006	-4.515	-5.500	-0.985
FeHSO4+2	1.038e-006	2.972e-007	-5.984	-6.527	-0.543
Fe(OH)3	6.905e-007	7.480e-007	-6.161	-6.126	0.035
FeCl+2	6.446e-009	1.846e-009	-8.191	-8.734	-0.543
Fe(OH)4-	8.868e-012	6.487e-012	-11.052	-11.188	-0.136
FeCl2+	2.180e-013	1.595e-013	-12.662	-12.797	-0.136
FeCl3	2.848e-019	3.085e-019	-18.545	-18.511	0.035
H(0)	2.859e-035				
H2	1.430e-035	1.549e-035	-34.845	-34.810	0.035
K	1.047e-004				
K+	8.751e-005	5.865e-005	-4.058	-4.232	-0.174
KSO4-	1.724e-005	1.261e-005	-4.763	-4.899	-0.136
KOH	1.785e-015	1.934e-015	-14.748	-14.714	0.035
Mg	1.078e-001				
MgSO4	7.230e-002	7.833e-002	-1.141	-1.106	0.035
Mg+2	3.551e-002	1.092e-002	-1.450	-1.962	-0.512
MgOH+	5.153e-010	3.770e-010	-9.288	-9.424	-0.136
Na	2.672e-004				
Na+	2.322e-004	1.670e-004	-3.634	-3.777	-0.143
NaSO4-	3.501e-005	2.561e-005	-4.456	-4.592	-0.136
NaOH	9.685e-015	1.049e-014	-14.014	-13.979	0.035
O(0)	3.181e-023				
O2	1.590e-023	1.723e-023	-22.798	-22.764	0.035
Pb	1.413e-006				
PbSO4	7.734e-007	8.378e-007	-6.112	-6.077	0.035
Pb(SO4)2-2	4.699e-007	1.345e-007	-6.328	-6.871	-0.543
Pb+2	1.700e-007	4.869e-008	-6.769	-7.313	-0.543
PbCl+	5.126e-011	3.750e-011	-10.290	-10.426	-0.136
PbOH+	1.234e-011	9.027e-012	-10.909	-11.044	-0.136
PbCl2	1.061e-015	1.150e-015	-14.974	-14.939	0.035
Pb2OH+3	1.641e-016	9.839e-018	-15.785	-17.007	-1.222
Pb(OH)2	3.083e-017	3.339e-017	-16.511	-16.476	0.035
PbCl3-	2.415e-020	1.767e-020	-19.617	-19.753	-0.136
Pb(OH)3-	4.984e-024	3.646e-024	-23.302	-23.438	-0.136
PbCl4-2	5.714e-025	1.636e-025	-24.243	-24.786	-0.543
Pb(OH)4-2	2.774e-031	7.942e-032	-30.557	-31.100	-0.543
S(6)	2.132e-001				
SO4-2	1.288e-001	3.060e-002	-0.890	-1.514	-0.624
MgSO4	7.230e-002	7.833e-002	-1.141	-1.106	0.035
CaSO4	5.595e-003	6.061e-003	-2.252	-2.217	0.035
FeSO4+	1.449e-003	1.060e-003	-2.839	-2.975	-0.136

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         Fe(SO4)2-         9.700e-004  7.095e-004    -3.013    -3.149    -0.136
         ZnSO4             8.210e-004  8.893e-004    -3.086    -3.051     0.035
         Zn(SO4)2-2        7.726e-004  2.212e-004    -3.112    -3.655    -0.543
         HSO4-             4.259e-004  3.115e-004    -3.371    -3.506    -0.136
         FeSO4             2.347e-004  2.542e-004    -3.629    -3.595     0.035
         NaSO4-            3.501e-005  2.561e-005    -4.456    -4.592    -0.136
         KSO4-             1.724e-005  1.261e-005    -4.763    -4.899    -0.136
         CaHSO4+           5.083e-006  3.718e-006    -5.294    -5.430    -0.136
         FeHSO4+2          1.038e-006  2.972e-007    -5.984    -6.527    -0.543
         PbSO4             7.734e-007  8.378e-007    -6.112    -6.077     0.035
         CuSO4             5.757e-007  6.237e-007    -6.240    -6.205     0.035
         Pb(SO4)2-2        4.699e-007  1.345e-007    -6.328    -6.871    -0.543
         Cd(SO4)2-2        2.704e-007  7.742e-008    -6.568    -7.111    -0.543
         FeHSO4+           2.392e-007  1.750e-007    -6.621    -6.757    -0.136
         CdSO4             2.130e-007  2.308e-007    -6.672    -6.637     0.035
Zn              2.099e-003
         ZnSO4             8.210e-004  8.893e-004    -3.086    -3.051     0.035
         Zn(SO4)2-2        7.726e-004  2.212e-004    -3.112    -3.655    -0.543
         Zn+2              5.054e-004  1.240e-004    -3.296    -3.907    -0.610
         ZnCl+             8.825e-009  6.455e-009    -8.054    -8.190    -0.136
         ZnOH+             1.767e-009  1.293e-009    -8.753    -8.889    -0.136
         Zn(OH)2           1.303e-013  1.411e-013   -12.885   -12.850     0.035
         ZnCl2             1.207e-013  1.308e-013   -12.918   -12.883     0.035
         ZnCl3-            3.881e-018  2.839e-018   -17.411   -17.547    -0.136
         Zn(OH)3-          5.801e-021  4.243e-021   -20.237   -20.372    -0.136
         ZnCl4-2           9.613e-023  2.752e-023   -22.017   -22.560    -0.543
         Zn(OH)4-2         2.233e-029  6.395e-030   -28.651   -29.194    -0.543

------------------------------Saturation indices-------------------------------

         Phase                SI log IAP  log KT

         Anglesite         -1.04   -8.83   -7.79  PbSO4
         Anhydrite         -0.16   -4.52   -4.36  CaSO4
         Cd(OH)2          -13.28    0.37   13.65  Cd(OH)2
         CdSO4             -9.00   -9.10   -0.10  CdSO4
         Fe(OH)3(a)         1.54    6.43    4.89  Fe(OH)3
         Goethite           7.44    6.44   -1.00  FeOOH
         Gypsum             0.06   -4.52   -4.58  CaSO4:2H2O
         H2(g)            -31.66  -34.81   -3.15  H2
         H2O(g)            -1.51   -0.00    1.51  H2O
         Halite           -10.07   -8.49    1.58  NaCl
         Hematite          16.88   12.87   -4.01  Fe2O3
         Jarosite-K         9.32    0.11   -9.21  KFe3(SO4)2(OH)6
         Melanterite       -3.65   -5.86   -2.21  FeSO4:7H2O
         O2(g)            -19.80  -22.76   -2.96  O2
         Pb(OH)2           -7.51    0.64    8.15  Pb(OH)2
         Zn(OH)2(e)        -7.45    4.05   11.50  Zn(OH)2

Initial solution 3.    NAF Leachate

-----------------------------Solution composition------------------------------

         Elements           Molality       Moles

         Ca                4.825e-003  4.825e-003
         Cd                2.229e-008  2.229e-008
         Cl                1.809e-003  1.809e-003
         Cu                7.884e-008  7.884e-008
         Fe                1.794e-007  1.794e-007
         K                 9.738e-004  9.738e-004
         Mg                9.315e-003  9.315e-003
         Na                2.659e-003  2.659e-003
         Pb                2.418e-008  2.418e-008
         S(6)              1.512e-002  1.512e-002
         Zn                2.345e-005  2.345e-005

----------------------------Description of solution----------------------------

                                       pH  =   6.500
                                       pe  =   1.840
                        Activity of water  =   0.999
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                       Ionic strength  =  4.115e-002
                     Mass of water (kg)  =  1.000e+000
               Total alkalinity (eq/kg)  = -4.358e-007
                  Total carbon (mol/kg)  =  0.000e+000
                     Total CO2 (mol/kg)  =  0.000e+000
                    Temperature (deg C)  =  25.000
                Electrical balance (eq)  = -9.827e-005
 Percent error, 100*(Cat-|An|)/(Cat+|An|)  =  -0.22
                             Iterations  =   6
                                Total H  = 1.110124e+002
                                Total O  = 5.556672e+001
```

----------------------------Distribution of species----------------------------

Species		Molality	Activity	Log Molality	Log Activity	Log Gamma
H+		3.669e-007	3.162e-007	-6.435	-6.500	-0.065
OH-		3.837e-008	3.164e-008	-7.416	-7.500	-0.084
H2O		5.551e+001	9.995e-001	1.744	-0.000	0.000
Ca	4.825e-003					
Ca+2		3.257e-003	1.620e-003	-2.487	-2.790	-0.303
CaSO4		1.568e-003	1.583e-003	-2.805	-2.800	0.004
CaHSO4+		3.523e-009	2.933e-009	-8.453	-8.533	-0.080
CaOH+		1.021e-009	8.498e-010	-8.991	-9.071	-0.080
Cd	2.229e-008					
Cd+2		1.217e-008	5.847e-009	-7.915	-8.233	-0.318
CdSO4		8.183e-009	8.260e-009	-8.087	-8.083	0.004
CdCl+		1.002e-009	8.340e-010	-8.999	-9.079	-0.080
Cd(SO4)2-2		9.236e-010	4.437e-010	-9.035	-9.353	-0.318
CdCl2		5.144e-012	5.193e-012	-11.289	-11.285	0.004
CdOH+		1.846e-012	1.537e-012	-11.734	-11.813	-0.080
CdCl3-		5.878e-015	4.894e-015	-14.231	-14.310	-0.080
Cd(OH)2		2.585e-016	2.609e-016	-15.588	-15.583	0.004
Cd(OH)3-		1.111e-022	9.253e-023	-21.954	-22.034	-0.080
Cd(OH)4-2		5.426e-030	2.607e-030	-29.266	-29.584	-0.318
Cl	1.809e-003					
Cl-		1.809e-003	1.494e-003	-2.743	-2.826	-0.083
ZnCl+		3.449e-008	2.871e-008	-7.462	-7.542	-0.080
CdCl+		1.002e-009	8.340e-010	-8.999	-9.079	-0.080
PbCl+		3.384e-010	2.817e-010	-9.471	-9.550	-0.080
FeCl+		1.564e-010	1.302e-010	-9.806	-9.885	-0.080
ZnCl2		4.448e-011	4.491e-011	-10.352	-10.348	0.004
CdCl2		5.144e-012	5.193e-012	-11.289	-11.285	0.004
PbCl2		6.607e-013	6.669e-013	-12.180	-12.176	0.004
ZnCl3-		9.039e-014	7.526e-014	-13.044	-13.123	-0.080
CdCl3-		5.878e-015	4.894e-015	-14.231	-14.310	-0.080
PbCl3-		9.504e-016	7.913e-016	-15.022	-15.102	-0.080
ZnCl4-2		1.173e-016	5.633e-017	-15.931	-16.249	-0.318
PbCl4-2		1.178e-018	5.657e-019	-17.929	-18.247	-0.318
FeCl+2		3.919e-020	1.882e-020	-19.407	-19.725	-0.318
FeCl2+		1.509e-022	1.256e-022	-21.821	-21.901	-0.080
FeCl3		1.858e-026	1.876e-026	-25.731	-25.727	0.004
Cu(1)	5.862e-008					
Cu+		5.862e-008	4.780e-008	-7.232	-7.321	-0.089
Cu(2)	2.022e-008					
Cu+2		1.244e-008	6.302e-009	-7.905	-8.201	-0.295
CuSO4		6.243e-009	6.303e-009	-8.205	-8.200	0.004
Cu(OH)2		1.303e-009	1.315e-009	-8.885	-8.881	0.004
CuOH+		2.403e-010	1.992e-010	-9.619	-9.701	-0.082
Cu(OH)3-		3.009e-016	2.505e-016	-15.522	-15.601	-0.080
Cu(OH)4-2		3.289e-022	1.580e-022	-21.483	-21.801	-0.318
Fe(2)	1.794e-007					
Fe+2		1.247e-007	6.317e-008	-6.904	-7.200	-0.295
FeSO4		5.450e-008	5.502e-008	-7.264	-7.259	0.004
FeCl+		1.564e-010	1.302e-010	-9.806	-9.885	-0.080
FeOH+		7.584e-011	6.314e-011	-10.120	-10.200	-0.080
FeHSO4+		1.374e-013	1.144e-013	-12.862	-12.942	-0.080
Fe(3)	1.433e-011					
Fe(OH)2+		1.071e-011	8.914e-012	-10.970	-11.050	-0.080
Fe(OH)3		3.595e-012	3.629e-012	-11.444	-11.440	0.004
FeOH+2		1.773e-014	8.517e-015	-13.751	-14.070	-0.318

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      Fe(OH)4-           1.257e-014  1.046e-014   -13.901   -13.980    -0.080
      FeSO4+             2.693e-017  2.242e-017   -16.570   -16.649    -0.080
      Fe(SO4)2-          2.885e-018  2.402e-018   -17.540   -17.619    -0.080
      Fe+3               1.592e-018  4.173e-019   -17.798   -18.380    -0.581
      FeCl+2             3.919e-020  1.882e-020   -19.407   -19.725    -0.318
      FeCl2+             1.509e-022  1.256e-022   -21.821   -21.901    -0.080
      FeHSO4+2           3.951e-023  1.898e-023   -22.403   -22.722    -0.318
      Fe2(OH)2+4         3.667e-026  1.952e-027   -25.436   -26.709    -1.274
      FeCl3              1.858e-026  1.876e-026   -25.731   -25.727     0.004
      Fe3(OH)4+5         3.554e-034  3.636e-036   -33.449   -35.439    -1.990
H(0)                2.930e-020
      H2                 1.465e-020  1.479e-020   -19.834   -19.830     0.004
K                   9.738e-004
      K+                 9.417e-004  7.775e-004    -3.026    -3.109    -0.083
      KSO4-              3.215e-005  2.676e-005    -4.493    -4.572    -0.080
      KOH                8.441e-012  8.521e-012   -11.074   -11.069     0.004
Mg                  9.315e-003
      Mg+2               5.904e-003  2.998e-003    -2.229    -2.523    -0.294
      MgSO4              3.411e-003  3.443e-003    -2.467    -2.463     0.004
      MgOH+              4.133e-008  3.441e-008    -7.384    -7.463    -0.080
Na                  2.659e-003
      Na+                2.595e-003  2.166e-003    -2.586    -2.664    -0.078
      NaSO4-             6.387e-005  5.317e-005    -4.195    -4.274    -0.080
      NaOH               4.480e-011  4.523e-011   -10.349   -10.345     0.004
O(0)                0.000e+000
      O2                 0.000e+000  0.000e+000   -52.725   -52.720     0.004
Pb                  2.418e-008
      PbSO4              1.293e-008  1.305e-008    -7.888    -7.884     0.004
      Pb+2               9.864e-009  4.738e-009    -8.006    -8.324    -0.318
      Pb(SO4)2-2         6.985e-010  3.355e-010    -9.156    -9.474    -0.318
      PbOH+              3.508e-010  2.920e-010    -9.455    -9.535    -0.080
      PbCl+              3.384e-010  2.817e-010    -9.471    -9.550    -0.080
      PbCl2              6.607e-013  6.669e-013   -12.180   -12.176     0.004
      Pb(OH)2            3.557e-013  3.591e-013   -12.449   -12.445     0.004
      PbCl3-             9.504e-016  7.913e-016   -15.022   -15.102    -0.080
      Pb2OH+3            1.612e-016  3.098e-017   -15.793   -16.509    -0.716
      Pb(OH)3-           1.565e-017  1.303e-017   -16.805   -16.885    -0.080
      PbCl4-2            1.178e-018  5.657e-019   -17.929   -18.247    -0.318
      Pb(OH)4-2          1.964e-022  9.435e-023   -21.707   -22.025    -0.318
S(6)                1.512e-002
      SO4-2              1.004e-002  4.898e-003    -1.998    -2.310    -0.312
      MgSO4              3.411e-003  3.443e-003    -2.467    -2.463     0.004
      CaSO4              1.568e-003  1.583e-003    -2.805    -2.800     0.004
      NaSO4-             6.387e-005  5.317e-005    -4.195    -4.274    -0.080
      KSO4-              3.215e-005  2.676e-005    -4.493    -4.572    -0.080
      ZnSO4              8.124e-006  8.201e-006    -5.090    -5.086     0.004
      Zn(SO4)2-2         6.798e-007  3.265e-007    -6.168    -6.486    -0.318
      HSO4-              1.809e-007  1.506e-007    -6.743    -6.822    -0.080
      FeSO4              5.450e-008  5.502e-008    -7.264    -7.259     0.004
      PbSO4              1.293e-008  1.305e-008    -7.888    -7.884     0.004
      CdSO4              8.183e-009  8.260e-009    -8.087    -8.083     0.004
      CuSO4              6.243e-009  6.303e-009    -8.205    -8.200     0.004
      CaHSO4+            3.523e-009  2.933e-009    -8.453    -8.533    -0.080
      Cd(SO4)2-2         9.236e-010  4.437e-010    -9.035    -9.353    -0.318
      Pb(SO4)2-2         6.985e-010  3.355e-010    -9.156    -9.474    -0.318
      FeHSO4+            1.374e-013  1.144e-013   -12.862   -12.942    -0.080
      FeSO4+             2.693e-017  2.242e-017   -16.570   -16.649    -0.080
      Fe(SO4)2-          2.885e-018  2.402e-018   -17.540   -17.619    -0.080
      FeHSO4+2           3.951e-023  1.898e-023   -22.403   -22.722    -0.318
Zn                  2.345e-005
      Zn+2               1.458e-005  7.142e-006    -4.836    -5.146    -0.310
      ZnSO4              8.124e-006  8.201e-006    -5.090    -5.086     0.004
      Zn(SO4)2-2         6.798e-007  3.265e-007    -6.168    -6.486    -0.318
      ZnCl+              3.449e-008  2.871e-008    -7.462    -7.542    -0.080
      ZnOH+              2.973e-008  2.475e-008    -7.527    -7.606    -0.080
      Zn(OH)2            8.898e-010  8.983e-010    -9.051    -9.047     0.004
      ZnCl2              4.448e-011  4.491e-011   -10.352   -10.348     0.004
      ZnCl3-             9.039e-014  7.526e-014   -13.044   -13.123    -0.080
      Zn(OH)3-           1.078e-014  8.978e-015   -13.967   -14.047    -0.080
      ZnCl4-2            1.173e-016  5.633e-017   -15.931   -16.249    -0.318
      Zn(OH)4-2          9.362e-021  4.497e-021   -20.029   -20.347    -0.318
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```
------------------------------Saturation indices------------------------------

    Phase               SI  log IAP  log KT

    Anglesite        -2.84  -10.63   -7.79  PbSO4
    Anhydrite        -0.74   -5.10   -4.36  CaSO4
    Cd(OH)2          -8.88    4.77   13.65  Cd(OH)2
    CdSO4           -10.44  -10.54   -0.10  CdSO4
    Fe(OH)3(a)       -3.77    1.12    4.89  Fe(OH)3
    Goethite          2.12    1.12   -1.00  FeOOH
    Gypsum           -0.52   -5.10   -4.58  CaSO4:2H2O
    H2(g)           -16.68  -19.83   -3.15  H2
    H2O(g)           -1.51   -0.00    1.51  H2O
    Halite           -7.07   -5.49    1.58  NaCl
    Hematite          6.25    2.24   -4.01  Fe2O3
    Jarosite-K      -14.66  -23.87   -9.21  KFe3(SO4)2(OH)6
    Melanterite      -7.30   -9.51   -2.21  FeSO4:7H2O
    O2(g)           -49.76  -52.72   -2.96  O2
    Pb(OH)2          -3.47    4.68    8.15  Pb(OH)2
    Zn(OH)2(e)       -3.65    7.85   11.50  Zn(OH)2

Initial solution 4.   Rainwater

-----------------------------Solution composition-----------------------------

    Elements           Molality       Moles

    Ca               2.500e-006  2.500e-006
    Cl               6.699e-006  6.699e-006
    K                1.499e-006  1.499e-006
    Mg               1.300e-006  1.300e-006
    Na               6.903e-006  6.903e-006
    S(6)             8.100e-006  8.100e-006
    Zn               1.530e-007  1.530e-007

----------------------------Description of solution----------------------------

                                       pH  =   4.590
                                       pe  =  10.150
                        Activity of water  =   1.000
                           Ionic strength  =  4.455e-005
                       Mass of water (kg)  =  1.000e+000
                 Total alkalinity (eq/kg)  = -2.592e-005
                    Total carbon (mol/kg)  =  0.000e+000
                       Total CO2 (mol/kg)  =  0.000e+000
                      Temperature (deg C)  =  25.000
                  Electrical balance (eq)  =  1.933e-005
 Percent error, 100*(Cat-|An|)/(Cat+|An|)  =  29.71
                               Iterations  =   3
                                  Total H  = 1.110125e+002
                                  Total O  = 5.550625e+001

----------------------------Distribution of species----------------------------

                                               Log       Log         Log
    Species            Molality    Activity  Molality  Activity     Gamma

    H+               2.590e-005  2.570e-005    -4.587    -4.590    -0.003
    OH-              3.925e-010  3.895e-010    -9.406    -9.410    -0.003
    H2O              5.551e+001  1.000e+000     1.744    -0.000     0.000
Ca              2.500e-006
    Ca+2             2.496e-006  2.420e-006    -5.603    -5.616    -0.013
    CaSO4            3.780e-009  3.780e-009    -8.423    -8.423     0.000
    CaHSO4+          5.736e-013  5.691e-013   -12.241   -12.245    -0.003
    CaOH+            1.575e-014  1.563e-014   -13.803   -13.806    -0.003
Cl              6.699e-006
    Cl-              6.699e-006  6.647e-006    -5.174    -5.177    -0.003
    ZnCl+            2.669e-012  2.649e-012   -11.574   -11.577    -0.003
    ZnCl2            1.844e-017  1.844e-017   -16.734   -16.734     0.000
    ZnCl3-           1.386e-022  1.375e-022   -21.858   -21.862    -0.003
    ZnCl4-2          4.725e-028  4.581e-028   -27.326   -27.339    -0.013
H(0)            4.688e-033
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     H2                 2.344e-033  2.344e-033   -32.630   -32.630     0.000
K               1.499e-006
     K+                 1.499e-006  1.487e-006    -5.824    -5.828    -0.003
     KSO4-              8.242e-011  8.178e-011   -10.084   -10.087    -0.003
     KOH                2.006e-016  2.006e-016   -15.698   -15.698     0.000
Mg              1.300e-006
     Mg+2               1.297e-006  1.258e-006    -5.887    -5.900    -0.013
     MgSO4              2.308e-009  2.308e-009    -8.637    -8.637     0.000
     MgOH+              1.791e-013  1.777e-013   -12.747   -12.750    -0.003
Na              6.903e-006
     Na+                6.902e-006  6.849e-006    -5.161    -5.164    -0.003
     NaSO4-             2.708e-010  2.687e-010    -9.567    -9.571    -0.003
     NaOH               1.760e-015  1.760e-015   -14.754   -14.754     0.000
O(0)            1.517e-027
     O2                 7.586e-028  7.586e-028   -27.120   -27.120     0.000
S(6)            8.100e-006
     SO4-2              8.073e-006  7.827e-006    -5.093    -5.106    -0.013
     HSO4-              1.971e-008  1.956e-008    -7.705    -7.709    -0.003
     CaSO4              3.780e-009  3.780e-009    -8.423    -8.423     0.000
     MgSO4              2.308e-009  2.308e-009    -8.637    -8.637     0.000
     ZnSO4              2.716e-010  2.716e-010    -9.566    -9.566     0.000
     NaSO4-             2.708e-010  2.687e-010    -9.567    -9.571    -0.003
     KSO4-              8.242e-011  8.178e-011   -10.084   -10.087    -0.003
     CaHSO4+            5.736e-013  5.691e-013   -12.241   -12.245    -0.003
     Zn(SO4)2-2         1.783e-014  1.728e-014   -13.749   -13.762    -0.013
Zn              1.530e-007
     Zn+2               1.527e-007  1.480e-007    -6.816    -6.830    -0.013
     ZnSO4              2.716e-010  2.716e-010    -9.566    -9.566     0.000
     ZnOH+              6.364e-012  6.315e-012   -11.196   -11.200    -0.003
     ZnCl+              2.669e-012  2.649e-012   -11.574   -11.577    -0.003
     Zn(SO4)2-2         1.783e-014  1.728e-014   -13.749   -13.762    -0.013
     Zn(OH)2            2.821e-015  2.821e-015   -14.550   -14.550     0.000
     ZnCl2              1.844e-017  1.844e-017   -16.734   -16.734     0.000
     Zn(OH)3-           3.497e-022  3.470e-022   -21.456   -21.460    -0.003
     ZnCl3-             1.386e-022  1.375e-022   -21.858   -21.862    -0.003
     ZnCl4-2            4.725e-028  4.581e-028   -27.326   -27.339    -0.013
     Zn(OH)4-2          2.207e-030  2.140e-030   -29.656   -29.670    -0.013

------------------------------Saturation indices-------------------------------

     Phase               SI log IAP  log KT

     Anhydrite        -6.36  -10.72   -4.36  CaSO4
     Gypsum           -6.14  -10.72   -4.58  CaSO4:2H2O
     H2(g)           -29.48  -32.63   -3.15  H2
     H2O(g)           -1.51   -0.00    1.51  H2O
     Halite          -11.92  -10.34    1.58  NaCl
     O2(g)           -24.16  -27.12   -2.96  O2
     Zn(OH)2(e)       -9.15    2.35   11.50  Zn(OH)2

Initial solution 5.   Tailings Seepage

-----------------------------Solution composition------------------------------

     Elements           Molality       Moles

     Ca                 1.024e-002  1.024e-002
     Cd                 7.216e-010  7.216e-010
     Cl                 7.463e-002  7.463e-002
     Cu                 2.776e-007  2.776e-007
     Fe                 5.718e-008  5.718e-008
     K                  7.700e-003  7.700e-003
     Mg                 4.462e-002  4.462e-002
     Na                 1.336e-001  1.336e-001
     Pb                 1.419e-009  1.419e-009
     S(6)               6.532e-002  6.532e-002
     Zn                 5.071e-006  5.071e-006

----------------------------Description of solution----------------------------

                                       pH  =   6.560
                                       pe  =   1.690
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                  Activity of water  =   0.995
                     Ionic strength  =  2.457e-001
                 Mass of water (kg)  =  1.000e+000
           Total alkalinity (eq/kg)  = -4.947e-007
              Total carbon (mol/kg)  =  0.000e+000
                 Total CO2 (mol/kg)  =  0.000e+000
                Temperature (deg C)  =  25.000
            Electrical balance (eq)  =  4.577e-002
Percent error, 100*(Cat-|An|)/(Cat+|An|)  =  12.94
                         Iterations  =   8
                            Total H  = 1.110124e+002
                            Total O  = 5.576752e+001
```

----------------------------Distribution of species----------------------------

Species	Molality	Activity	Log Molality	Log Activity	Log Gamma
H+	3.487e-007	2.754e-007	-6.458	-6.560	-0.102
OH-	5.236e-008	3.616e-008	-7.281	-7.442	-0.161
H2O	5.551e+001	9.948e-001	1.744	-0.002	0.000
Ca	1.024e-002				
Ca+2	6.543e-003	1.993e-003	-2.184	-2.700	-0.516
CaSO4	3.701e-003	3.916e-003	-2.432	-2.407	0.025
CaHSO4+	8.548e-009	6.319e-009	-8.068	-8.199	-0.131
CaOH+	1.616e-009	1.195e-009	-8.791	-8.923	-0.131
Cd	7.216e-010				
CdCl+	3.265e-010	2.414e-010	-9.486	-9.617	-0.131
Cd+2	1.629e-010	4.863e-011	-9.788	-10.313	-0.525
CdSO4	1.305e-010	1.381e-010	-9.884	-9.860	0.025
Cd(SO4)2-2	4.993e-011	1.491e-011	-10.302	-10.827	-0.525
CdCl2	4.942e-011	5.229e-011	-10.306	-10.282	0.025
CdCl3-	2.320e-012	1.715e-012	-11.635	-11.766	-0.131
CdOH+	1.976e-014	1.461e-014	-13.704	-13.835	-0.131
Cd(OH)2	2.678e-018	2.834e-018	-17.572	-17.548	0.025
Cd(OH)3-	1.553e-024	1.148e-024	-23.809	-23.940	-0.131
Cd(OH)4-2	1.238e-031	3.696e-032	-30.907	-31.432	-0.525
Cl	7.463e-002				
Cl-	7.463e-002	5.197e-002	-1.127	-1.284	-0.157
ZnCl+	1.453e-007	1.074e-007	-6.838	-6.969	-0.131
ZnCl2	5.523e-009	5.845e-009	-8.258	-8.233	0.025
FeCl+	1.111e-009	8.211e-010	-8.954	-9.086	-0.131
ZnCl3-	4.611e-010	3.408e-010	-9.336	-9.467	-0.131
CdCl+	3.265e-010	2.414e-010	-9.486	-9.617	-0.131
PbCl+	3.151e-010	2.329e-010	-9.502	-9.633	-0.131
CdCl2	4.942e-011	5.229e-011	-10.306	-10.282	0.025
ZnCl4-2	2.974e-011	8.878e-012	-10.527	-11.052	-0.525
PbCl2	1.813e-011	1.919e-011	-10.742	-10.717	0.025
CdCl3-	2.320e-012	1.715e-012	-11.635	-11.766	-0.131
PbCl3-	1.072e-012	7.921e-013	-11.970	-12.101	-0.131
PbCl4-2	6.600e-014	1.970e-014	-13.180	-13.705	-0.525
FeCl+2	2.814e-019	8.403e-020	-18.551	-19.076	-0.525
FeCl2+	2.639e-020	1.951e-020	-19.579	-19.710	-0.131
FeCl3	9.581e-023	1.014e-022	-22.019	-21.994	0.025
Cu(1)	2.077e-007				
Cu+	2.077e-007	1.374e-007	-6.683	-6.862	-0.179
Cu(2)	6.990e-008				
Cu+2	4.158e-008	1.282e-008	-7.381	-7.892	-0.511
CuSO4	2.436e-008	2.578e-008	-7.613	-7.589	0.025
Cu(OH)2	3.303e-009	3.495e-009	-8.481	-8.457	0.025
CuOH+	6.586e-010	4.631e-010	-9.181	-9.334	-0.153
Cu(OH)3-	1.029e-015	7.606e-016	-14.988	-15.119	-0.131
Cu(OH)4-2	1.836e-021	5.481e-022	-20.736	-21.261	-0.525
Fe(2)	5.718e-008				
Fe+2	3.711e-008	1.145e-008	-7.430	-7.941	-0.511
FeSO4	1.894e-008	2.004e-008	-7.723	-7.698	0.025
FeCl+	1.111e-009	8.211e-010	-8.954	-9.086	-0.131
FeOH+	1.768e-011	1.307e-011	-10.752	-10.884	-0.131
FeHSO4+	4.908e-014	3.628e-014	-13.309	-13.440	-0.131
Fe(3)	2.684e-012				
Fe(OH)2+	2.020e-012	1.493e-012	-11.695	-11.826	-0.131
Fe(OH)3	6.565e-013	6.947e-013	-12.183	-12.158	0.025

	FeOH+2	4.181e-015	1.248e-015	-14.379	-14.904	-0.525
	Fe(OH)4-	3.096e-015	2.288e-015	-14.509	-14.640	-0.131
	FeSO4+	7.818e-018	5.779e-018	-17.107	-17.238	-0.131
	Fe(SO4)2-	1.684e-018	1.245e-018	-17.774	-17.905	-0.131
	Fe+3	4.472e-019	5.353e-020	-18.350	-19.271	-0.922
	FeCl+2	2.814e-019	8.403e-020	-18.551	-19.076	-0.525
	FeCl2+	2.639e-020	1.951e-020	-19.579	-19.710	-0.131
	FeCl3	9.581e-023	1.014e-022	-22.019	-21.994	0.025
	FeHSO4+2	1.428e-023	4.262e-024	-22.845	-23.370	-0.525
	Fe2(OH)2+4	5.280e-027	4.195e-029	-26.277	-28.377	-2.100
	Fe3(OH)4+5	2.500e-035	1.309e-038	-34.602	-37.883	-3.281
H(0)	4.231e-020					
	H2	2.116e-020	2.239e-020	-19.675	-19.650	0.025
K	7.700e-003					
	K+	7.229e-003	5.034e-003	-2.141	-2.298	-0.157
	KSO4-	4.712e-004	3.483e-004	-3.327	-3.458	-0.131
	KOH	5.958e-011	6.305e-011	-10.225	-10.200	0.025
Mg	4.462e-002					
	Mg+2	2.600e-002	8.536e-003	-1.585	-2.069	-0.484
	MgSO4	1.862e-002	1.970e-002	-1.730	-1.705	0.025
	MgOH+	1.514e-007	1.119e-007	-6.820	-6.951	-0.131
Na	1.336e-001					
	Na+	1.274e-001	9.346e-002	-0.895	-1.029	-0.134
	NaSO4-	6.239e-003	4.612e-003	-2.205	-2.336	-0.131
	NaOH	2.108e-009	2.230e-009	-8.676	-8.652	0.025
O(0)	0.000e+000					
	O2	0.000e+000	0.000e+000	-53.109	-53.085	0.025
Pb	1.419e-009					
	PbSO4	5.890e-010	6.233e-010	-9.230	-9.205	0.025
	Pb+2	3.770e-010	1.126e-010	-9.424	-9.949	-0.525
	PbCl+	3.151e-010	2.329e-010	-9.502	-9.633	-0.131
	Pb(SO4)2-2	1.079e-010	3.220e-011	-9.967	-10.492	-0.525
	PbCl2	1.813e-011	1.919e-011	-10.742	-10.717	0.025
	PbOH+	1.072e-011	7.928e-012	-10.970	-11.101	-0.131
	PbCl3-	1.072e-012	7.921e-013	-11.970	-12.101	-0.131
	PbCl4-2	6.600e-014	1.970e-014	-13.180	-13.705	-0.525
	Pb(OH)2	1.053e-014	1.114e-014	-13.978	-13.953	0.025
	Pb(OH)3-	6.249e-019	4.619e-019	-18.204	-18.335	-0.131
	Pb2OH+3	3.032e-019	1.998e-020	-18.518	-19.699	-1.181
	Pb(OH)4-2	1.280e-023	3.822e-024	-22.893	-23.418	-0.525
S(6)	6.532e-002					
	SO4-2	3.629e-002	9.846e-003	-1.440	-2.007	-0.567
	MgSO4	1.862e-002	1.970e-002	-1.730	-1.705	0.025
	NaSO4-	6.239e-003	4.612e-003	-2.205	-2.336	-0.131
	CaSO4	3.701e-003	3.916e-003	-2.432	-2.407	0.025
	KSO4-	4.712e-004	3.483e-004	-3.327	-3.458	-0.131
	ZnSO4	1.674e-006	1.772e-006	-5.776	-5.752	0.025
	Zn(SO4)2-2	4.749e-007	1.418e-007	-6.323	-6.848	-0.525
	HSO4-	3.567e-007	2.636e-007	-6.448	-6.579	-0.131
	CuSO4	2.436e-008	2.578e-008	-7.613	-7.589	0.025
	FeSO4	1.894e-008	2.004e-008	-7.723	-7.698	0.025
	CaHSO4+	8.548e-009	6.319e-009	-8.068	-8.199	-0.131
	PbSO4	5.890e-010	6.233e-010	-9.230	-9.205	0.025
	CdSO4	1.305e-010	1.381e-010	-9.884	-9.860	0.025
	Pb(SO4)2-2	1.079e-010	3.220e-011	-9.967	-10.492	-0.525
	Cd(SO4)2-2	4.993e-011	1.491e-011	-10.302	-10.827	-0.525
	FeHSO4+	4.908e-014	3.628e-014	-13.309	-13.440	-0.131
	FeSO4+	7.818e-018	5.779e-018	-17.107	-17.238	-0.131
	Fe(SO4)2-	1.684e-018	1.245e-018	-17.774	-17.905	-0.131
	FeHSO4+2	1.428e-023	4.262e-024	-22.845	-23.370	-0.525
Zn	5.071e-006					
	Zn+2	2.766e-006	7.677e-007	-5.558	-6.115	-0.557
	ZnSO4	1.674e-006	1.772e-006	-5.776	-5.752	0.025
	Zn(SO4)2-2	4.749e-007	1.418e-007	-6.323	-6.848	-0.525
	ZnCl+	1.453e-007	1.074e-007	-6.838	-6.969	-0.131
	ZnCl2	5.523e-009	5.845e-009	-8.258	-8.233	0.025
	ZnOH+	4.113e-009	3.040e-009	-8.386	-8.517	-0.131
	ZnCl3-	4.611e-010	3.408e-010	-9.336	-9.467	-0.131
	Zn(OH)2	1.191e-010	1.261e-010	-9.924	-9.899	0.025
	ZnCl4-2	2.974e-011	8.878e-012	-10.527	-11.052	-0.525
	Zn(OH)3-	1.948e-015	1.440e-015	-14.710	-14.842	-0.131
	Zn(OH)4-2	2.761e-021	8.243e-022	-20.559	-21.084	-0.525

```
------------------------------Saturation indices-------------------------------

    Phase               SI log IAP  log KT

    Anglesite        -4.17  -11.96   -7.79  PbSO4
    Anhydrite        -0.35   -4.71   -4.36  CaSO4
    Cd(OH)2         -10.85    2.80   13.65  Cd(OH)2
    CdSO4           -12.22  -12.32   -0.10  CdSO4
    Fe(OH)3(a)       -4.49    0.40    4.89  Fe(OH)3
    Goethite          1.40    0.40   -1.00  FeOOH
    Gypsum           -0.13   -4.71   -4.58  CaSO4:2H2O
    H2(g)           -16.50  -19.65   -3.15  H2
    H2O(g)           -1.51   -0.00    1.51  H2O
    Halite           -3.90   -2.31    1.58  NaCl
    Hematite          4.82    0.81   -4.01  Fe2O3
    Jarosite-K      -15.57  -24.78   -9.21  KFe3(SO4)2(OH)6
    Melanterite      -7.75   -9.96   -2.21  FeSO4:7H2O
    O2(g)           -50.12  -53.08   -2.96  O2
    Pb(OH)2          -4.98    3.17    8.15  Pb(OH)2
    Zn(OH)2(e)       -4.50    7.00   11.50  Zn(OH)2

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Beginning of batch-reaction calculations.
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Reaction step 1.

Using mix 1.  Mixing of water in open pit - worst case Scenario 4

Mixture 1.   Mixing of water in open pit - worst case Scenario 4

     9.940e-001 Solution 1River water
     0.000e+000 Solution 2PAF Leachate
     4.000e-004 Solution 3NAF Leachate
     4.900e-003 Solution 4Rainwater
     6.000e-004 Solution 5Tailings Seepage

-----------------------------Solution composition------------------------------

    Elements           Molality       Moles

    Ca               1.216e-003  1.216e-003
    Cd               5.401e-010  5.400e-010
    Cl               4.746e-004  4.746e-004
    Cu               1.584e-008  1.584e-008
    Fe               1.780e-004  1.780e-004
    K                1.118e-004  1.118e-004
    Mg               1.953e-003  1.952e-003
    Na               5.397e-004  5.396e-004
    Pb               2.650e-009  2.650e-009
    S                1.115e-004  1.115e-004
    Zn               1.714e-007  1.713e-007

----------------------------Description of solution----------------------------

                                       pH  =   8.198      Charge balance
                                       pe  =   2.640      Adjusted to redox equilibrium
                        Activity of water  =   1.000
                           Ionic strength  =  7.023e-003
                       Mass of water (kg)  =  9.999e-001
                 Total alkalinity (eq/kg)  =  1.983e-004
                    Total carbon (mol/kg)  =  0.000e+000
                       Total CO2 (mol/kg)  =  0.000e+000
                      Temperature (deg C)  =  28.380
                  Electrical balance (eq)  =  6.273e-003
 Percent error, 100*(Cat-|An|)/(Cat+|An|)  =  82.51
                               Iterations  =   4
                                  Total H  = 1.110019e+002
                                  Total O  = 5.550166e+001

----------------------------Distribution of species----------------------------
```

	Species	Molality	Activity	Log Molality	Log Activity	Log Gamma
	OH-	2.223e-006	2.031e-006	-5.653	-5.692	-0.039
	H+	6.858e-009	6.336e-009	-8.164	-8.198	-0.034
	H2O	5.551e+001	9.999e-001	1.744	-0.000	0.000
Ca		1.216e-003				
	Ca+2	1.206e-003	8.543e-004	-2.919	-3.068	-0.150
	CaSO4	1.006e-005	1.008e-005	-4.997	-4.997	0.001
	CaOH+	2.445e-008	2.237e-008	-7.612	-7.650	-0.039
	CaHSO4+	4.269e-013	3.906e-013	-12.370	-12.408	-0.039
Cd		5.401e-010				
	Cd+2	5.110e-010	3.583e-010	-9.292	-9.446	-0.154
	CdCl+	1.640e-011	1.501e-011	-10.785	-10.824	-0.039
	CdOH+	6.586e-012	6.027e-012	-11.181	-11.220	-0.039
	CdSO4	6.033e-012	6.043e-012	-11.219	-11.219	0.001
	Cd(OH)2	3.980e-014	3.987e-014	-13.400	-13.399	0.001
	CdCl2	2.744e-014	2.748e-014	-13.562	-13.561	0.001
	Cd(SO4)2-2	5.304e-015	3.720e-015	-14.275	-14.430	-0.154
	CdCl3-	8.644e-018	7.910e-018	-17.063	-17.102	-0.039
	Cd(OH)3-	7.714e-019	7.059e-019	-18.113	-18.151	-0.039
	Cd(OH)4-2	1.416e-024	9.929e-025	-23.849	-24.003	-0.154
Cl		4.746e-004				
	Cl-	4.746e-004	4.338e-004	-3.324	-3.363	-0.039
	FeCl+	1.083e-009	9.915e-010	-8.965	-9.004	-0.039
	ZnCl+	1.275e-010	1.166e-010	-9.895	-9.933	-0.039
	CdCl+	1.640e-011	1.501e-011	-10.785	-10.824	-0.039
	PbCl+	1.080e-011	9.883e-012	-10.967	-11.005	-0.039
	ZnCl2	5.361e-014	5.370e-014	-13.271	-13.270	0.001
	CdCl2	2.744e-014	2.748e-014	-13.562	-13.561	0.001
	PbCl2	6.373e-015	6.383e-015	-14.196	-14.195	0.001
	ZnCl3-	2.914e-017	2.667e-017	-16.536	-16.574	-0.039
	CdCl3-	8.644e-018	7.910e-018	-17.063	-17.102	-0.039
	PbCl3-	2.454e-018	2.245e-018	-17.610	-17.649	-0.039
	FeCl+2	1.720e-018	1.206e-018	-17.764	-17.919	-0.154
	ZnCl4-2	8.489e-021	5.953e-021	-20.071	-20.225	-0.154
	FeCl2+	2.298e-021	2.103e-021	-20.639	-20.677	-0.039
	PbCl4-2	6.822e-022	4.784e-022	-21.166	-21.320	-0.154
	FeCl3	9.106e-026	9.121e-026	-25.041	-25.040	0.001
Cu(1)		4.117e-011				
	Cu+	4.117e-011	3.753e-011	-10.385	-10.426	-0.040
Cu(2)		1.580e-008				
	Cu(OH)2	1.571e-008	1.573e-008	-7.804	-7.803	0.001
	CuOH+	5.216e-011	4.772e-011	-10.283	-10.321	-0.039
	Cu+2	4.245e-011	3.023e-011	-10.372	-10.519	-0.147
	CuSO4	3.614e-013	3.619e-013	-12.442	-12.441	0.001
	Cu(OH)3-	1.635e-013	1.496e-013	-12.786	-12.825	-0.039
	Cu(OH)4-2	6.718e-018	4.711e-018	-17.173	-17.327	-0.154
Fe(2)		2.460e-006				
	Fe+2	2.325e-006	1.656e-006	-5.634	-5.781	-0.147
	FeOH+	1.159e-007	1.061e-007	-6.936	-6.974	-0.039
	FeSO4	1.790e-008	1.793e-008	-7.747	-7.746	0.001
	FeCl+	1.083e-009	9.915e-010	-8.965	-9.004	-0.039
	FeHSO4+	8.273e-016	7.571e-016	-15.082	-15.121	-0.039
	Fe(HS)2	0.000e+000	0.000e+000	-128.805	-128.805	0.001
	Fe(HS)3-	0.000e+000	0.000e+000	-192.716	-192.754	-0.039
Fe(3)		1.756e-004				
	Fe(OH)3	1.431e-004	1.434e-004	-3.844	-3.844	0.001
	Fe(OH)4-	2.579e-005	2.360e-005	-4.589	-4.627	-0.039
	Fe(OH)2+	6.661e-006	6.095e-006	-5.176	-5.215	-0.039
	FeOH+2	1.465e-010	1.027e-010	-9.834	-9.988	-0.154
	Fe+3	1.690e-016	8.283e-017	-15.772	-16.082	-0.310
	FeSO4+	6.123e-017	5.603e-017	-16.213	-16.252	-0.039
	FeCl+2	1.720e-018	1.206e-018	-17.764	-17.919	-0.154
	Fe2(OH)2+4	1.024e-018	2.475e-019	-17.990	-18.606	-0.617
	Fe(SO4)2-	7.775e-020	7.115e-020	-19.109	-19.148	-0.039
	FeCl2+	2.298e-021	2.103e-021	-20.639	-20.677	-0.039
	Fe3(OH)4+5	2.128e-021	2.315e-022	-20.672	-21.635	-0.963
	FeHSO4+2	1.357e-024	9.513e-025	-23.868	-24.022	-0.154
	FeCl3	9.106e-026	9.121e-026	-25.041	-25.040	0.001
H(0)		2.885e-025				

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     H2                1.443e-025  1.445e-025   -24.841   -24.840     0.001
K               1.118e-004
     K+                1.118e-004  1.022e-004    -3.952    -3.991    -0.039
     KSO4-             4.764e-008  4.359e-008    -7.322    -7.361    -0.039
     KOH               5.581e-011  5.590e-011   -10.253   -10.253     0.001
Mg              1.953e-003
     Mg+2              1.931e-003  1.374e-003    -2.714    -2.862    -0.148
     MgSO4             2.009e-005  2.012e-005    -4.697    -4.696     0.001
     MgOH+             1.164e-006  1.065e-006    -5.934    -5.973    -0.039
Na              5.397e-004
     Na+               5.395e-004  4.942e-004    -3.268    -3.306    -0.038
     NaSO4-            1.584e-007  1.449e-007    -6.800    -6.839    -0.039
     NaOH              5.144e-010  5.153e-010    -9.289    -9.288     0.001
O(0)            0.000e+000
     O2                0.000e+000  0.000e+000   -41.622   -41.621     0.001
Pb              2.650e-009
     PbOH+             1.771e-009  1.621e-009    -8.752    -8.790    -0.039
     Pb+2              7.512e-010  5.268e-010    -9.124    -9.278    -0.154
     Pb(OH)2           9.936e-011  9.952e-011   -10.003   -10.002     0.001
     PbSO4             1.694e-011  1.697e-011   -10.771   -10.770     0.001
     PbCl+             1.080e-011  9.883e-012   -10.967   -11.005    -0.039
     Pb(OH)3-          1.971e-013  1.803e-013   -12.705   -12.744    -0.039
     Pb(SO4)2-2        7.277e-015  5.103e-015   -14.138   -14.292    -0.154
     PbCl2             6.373e-015  6.383e-015   -14.196   -14.195     0.001
     Pb(OH)4-2         9.298e-017  6.520e-017   -16.032   -16.186    -0.154
     Pb2OH+3           4.248e-017  1.911e-017   -16.372   -16.719    -0.347
     PbCl3-            2.454e-018  2.245e-018   -17.610   -17.649    -0.039
     PbCl4-2           6.822e-022  4.784e-022   -21.166   -21.320    -0.154
S(-2)           0.000e+000
     HS-               0.000e+000  0.000e+000   -65.948   -65.987    -0.039
     H2S               0.000e+000  0.000e+000   -67.287   -67.286     0.001
     S-2               0.000e+000  0.000e+000   -70.456   -70.607    -0.151
     Fe(HS)2           0.000e+000  0.000e+000  -128.805  -128.805     0.001
     Fe(HS)3-          0.000e+000  0.000e+000  -192.716  -192.754    -0.039
S(6)            1.115e-004
     SO4-2             8.116e-005  5.729e-005    -4.091    -4.242    -0.151
     MgSO4             2.009e-005  2.012e-005    -4.697    -4.696     0.001
     CaSO4             1.006e-005  1.008e-005    -4.997    -4.997     0.001
     NaSO4-            1.584e-007  1.449e-007    -6.800    -6.839    -0.039
     KSO4-             4.764e-008  4.359e-008    -7.322    -7.361    -0.039
     FeSO4             1.790e-008  1.793e-008    -7.747    -7.746     0.001
     ZnSO4             1.186e-009  1.188e-009    -8.926    -8.925     0.001
     HSO4-             4.156e-011  3.803e-011   -10.381   -10.420    -0.039
     PbSO4             1.694e-011  1.697e-011   -10.771   -10.770     0.001
     CdSO4             6.033e-012  6.043e-012   -11.219   -11.219     0.001
     Zn(SO4)2-2        7.689e-013  5.392e-013   -12.114   -12.268    -0.154
     CaHSO4+           4.269e-013  3.906e-013   -12.370   -12.408    -0.039
     CuSO4             3.614e-013  3.619e-013   -12.442   -12.441     0.001
     Pb(SO4)2-2        7.277e-015  5.103e-015   -14.138   -14.292    -0.154
     Cd(SO4)2-2        5.304e-015  3.720e-015   -14.275   -14.430    -0.154
     FeHSO4+           8.273e-016  7.571e-016   -15.082   -15.121    -0.039
     FeSO4+            6.123e-017  5.603e-017   -16.213   -16.252    -0.039
     Fe(SO4)2-         7.775e-020  7.115e-020   -19.109   -19.148    -0.039
     FeHSO4+2          1.357e-024  9.513e-025   -23.868   -24.022    -0.154
Zn              1.714e-007
     Zn+2              1.220e-007  8.621e-008    -6.914    -7.064    -0.151
     Zn(OH)2           2.699e-008  2.703e-008    -7.569    -7.568     0.001
     ZnOH+             2.101e-008  1.922e-008    -7.678    -7.716    -0.039
     ZnSO4             1.186e-009  1.188e-009    -8.926    -8.925     0.001
     ZnCl+             1.275e-010  1.166e-010    -9.895    -9.933    -0.039
     Zn(OH)3-          1.474e-011  1.349e-011   -10.831   -10.870    -0.039
     Zn(SO4)2-2        7.689e-013  5.392e-013   -12.114   -12.268    -0.154
     ZnCl2             5.361e-014  5.370e-014   -13.271   -13.270     0.001
     Zn(OH)4-2         4.812e-016  3.374e-016   -15.318   -15.472    -0.154
     ZnCl3-            2.914e-017  2.667e-017   -16.536   -16.574    -0.039
     ZnCl4-2           8.489e-021  5.953e-021   -20.071   -20.225    -0.154

------------------------------Saturation indices-------------------------------

     Phase               SI log IAP  log KT

     Anglesite        -5.75  -13.52   -7.77  PbSO4
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    Anhydrite         -2.93   -7.31   -4.38  CaSO4
    Cd(OH)2           -6.70    6.95   13.65  Cd(OH)2
    CdSO4            -13.47  -13.69   -0.22  CdSO4
    Fe(OH)3(a)         3.62    8.51    4.89  Fe(OH)3
    FeS(ppt)         -59.65  -63.57   -3.92  FeS
    Goethite           9.63    8.51   -1.12  FeOOH
    Gypsum            -2.73   -7.31   -4.58  CaSO4:2H2O
    H2(g)            -21.68  -24.84   -3.16  H2
    H2O(g)            -1.42   -0.00    1.42  H2O
    H2S(g)           -66.25  -67.29   -1.03  H2S
    Halite            -8.26   -6.67    1.59  NaCl
    Hematite          21.29   17.03   -4.26  Fe2O3
    Jarosite-K        -2.06  -11.53   -9.47  KFe3(SO4)2(OH)6
    Mackinawite      -58.92  -63.57   -4.65  FeS
    Melanterite       -7.85  -10.02   -2.17  FeSO4:7H2O
    O2(g)            -38.65  -41.62   -2.98  O2
    Pb(OH)2           -0.92    7.12    8.04  Pb(OH)2
    Pyrite           -97.69 -116.08  -18.39  FeS2
    Sphalerite       -53.30  -64.85  -11.55  ZnS
    Sulfur           -50.41  -45.61    4.80  S
    Zn(OH)2(e)        -2.17    9.33   11.50  Zn(OH)2

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End of simulation.
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Reading input data for simulation 5.
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End of run.
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