

## 2.2 Model Computation Review (Phase II)

The Model Input Review (Phase I) verified that all model inputs were correct and that GoldSim correctly sampled the probability distributions for uncertain (probabilistic) parameters. The Model Computation Review (Phase II), which will occur at the end of the Model Refinement Phase, will focus on the internal computations to provide a greater assurance that the GoldSim models function as defined in the work plans and data packages. The Model Computation Review described below will be applied separately to both the Mine Site and Plant Site models.

Given the scope and complexity of each model, it is not feasible to check ~~of all~~ of the internal calculations performed by the code. To be reasonably efficient, a three-step verification strategy is proposed for both hydrologic and chemical components of the model:

- Step 1.** Professional evaluation of calculated final values~~values~~results at all surface water and groundwater Evaluation Locations;
- Step 2.** Evaluation of system-wide water and chemical mass balances throughout the simulation period; and
- Step 3.** Independent verification of selected calculation pathways at selected time points during the simulation.

Step 1 will involve the use of professional judgment and project familiarity to screen results at all Evaluation Locations for evidence of unlikely values and improbable changes in values over time. This step will provide a time efficient way to screen the results of all major calculation pathways for potential problems before progressing to more detailed verification of results along specific calculation pathways.

Step 2 will utilize a system-wide mass balance analysis. After the establishment of system-wide control volumes, cumulative mass inflows and outflows to the control volumes will be reported over the course of a deterministic simulation along with current values of water and chemical mass storage elements contained within the control volumes. Evaluation of the resulting system-wide, cumulative mass balance will provide supporting evidence that all water and chemical mass is properly tracked by the model.

Step 3 will involve the verification of selected model outputs through independent calculation by the review team. Several representative hydrologic and chemical calculation pathways will be selected for review. All model-calculated results for each step along the selected pathways will be supplied by Barr to the review team for

**Comment [jrs1]:** isn't this the same as the Agency Comprehensive Review ?

**Comment [jrs2]:** isn't this the same as the Agency Comprehensive Review ?

**Comment [CDA3]:** System-wide seems to mean the model as a whole, but control volumes, being plural, seems to indicate smaller portions of the model will be checked for mass and water balance. The latter seems more appropriate and more possible.

**Comment [jrs4]:** who makes up the Review Team (assume ERM)

**Comment [jrs5]:** can these be selected now so that Barr can develop the required outputs ?

verification. The review team will evaluate a sufficient number of calculation pathways to provide a reasonable level of assurance that the overall model is performing as proposed. Emphasis will be placed on pathways providing the greatest chemical flux that ultimately reaches the Evaluation Locations where chemical concentrations are compared with Impact Criteria. For example, in the Plant Site model, emphasis will be placed on seepage and chemical concentrations emanating from the Tailings Basin and in downgradient groundwater flow paths that carry chemical mass to affected tributaries of the Embarrass River. If any calculation errors are identified through this process, the review team will document the issue for presentation to the model developer.

**Comment [jrs6]:** can this be determined now ?

**Comment [PJH7]:** This is the bulk of the Plant Site model. It would seem that the review process may indeed be checking the vast majority of the internal calculations. This is certainly possible but would be much more efficient if performed directly in GoldSim itself (i.e. without output to Excel).

The review team will also confirm that any model inputs that were either identified as incorrect through the Phase I review or have changed as a result of the Model Results Process are entered correctly.

### 2.2.1 Model Deliverables and Evaluation Process

Several deterministic runs of the GoldSim model will be required to generate the outputs necessary for Phase II evaluation. One model run will be based on mean values for input variables. The additional runs will utilize P95 and/or P05 values or minimums and/or maximums (where applicable) of selected input variables in order to test the model's logic algorithms for handling extreme values. For example, conditions may be simulated in one deterministic run to ensure that leach concentrations are controlled by concentration caps so that this aspect of the model algorithm can be evaluated.

**Comment [CDA8]:** Infinite distributions, i.e., log-normal, normal, etc, do not have maximum and/or minimum values. For these distributions percentile values must be specified for this evaluation.

**Comment [jrs9]:** can these be defined now ?

In addition to model outputs, the review team will require access to a complete copy of the GoldSim model to allow for calculation pathway tracing, model logic elucidation, and the ability to obtain additional specific values from model components as needed to complete the Phase II review. The input reporting functionality added to each GoldSim model during Phase I will be retained to provide the review team access to spreadsheet compilations of input values used in model calculations. Specific output requirements for each Phase II evaluation step are described in the following sections.

#### Step 1: Professional evaluation of calculated final values at all Evaluation Locations

**Comment [jrs10]:** isn't this the same as the Agency Comprehensive Review ?

Step 1 of the Phase II evaluation will require Barr to deliver Excel-based, time-series output values for a series of mutually agreed upon elements in the model that represent Evaluation Locations along major calculation pathways. The review team will utilize professional judgment and simple calculations to assess the reasonableness of the reported mass flux and chemical concentrations over the course of the model

**Comment [jrs11]:** with who ? can this be done now ? Has the author looked at the current Excel results review tool ?

**Comment [PJH12]:** This is being provided already for the Mine Site as summary statistics of constituent concentration at all model evaluation locations. Are there other outputs that would be needed besides the type that has been provided in the model results review process?

simulation. If necessary, the review team may make additional requests for Barr to output other model values.

**Comment [jrs13]:** Hope this can be minimized

**Step 2: Evaluation of ~~system-wide~~ water and chemical mass balances throughout the simulation period**

For Step 2, the review team will work with Barr to define several control volumes within the model flow chart. Elements representing the flux of water and chemical mass into or out of each control volume will be identified along with all elements representing storage of water or chemical mass within the control volume. Barr will be requested to modify the GoldSim model so that it outputs relevant values from the identified elements into Excel-based time series output files. Output of inflows and outflows to the control volume will be on a cumulative basis. The resulting output files will be used to confirm that the following relationship is maintained throughout the simulation:

**Comment [jrs14]:** can this be done now ?

**Comment [CDA15]:** Will these be defined based on the results from Step 1? Or are these already defined?

$$initial\ mass + cumulative\ mass\ in - cumulative\ mass\ out = remaining\ mass$$

Output will be evaluated for several deterministic runs in order to confirm mass balance for mean and extreme input values. Graphical evaluation of the resulting mass balance totals will be used to ensure that all water and chemical mass is accounted for in the model.

**Comment [jrs16]:** can these be defined now ?

**Step 3: Independent verification of selected calculation pathways at selected time points during the simulation**

Using initial probabilistic model runs by Barr, the review team will first identify the primary solutes of concern at Evaluation Locations through comparison of statistically possible modeled concentrations to the corresponding impact criteria. Review efforts will then focus on calculation pathways for the solutes of concern. It is anticipated that three or four major pathways will be identified in each GoldSim model. In addition, tornado diagrams generated by GoldSim will identify the most sensitive model inputs and the corresponding calculation pathways impacted by these inputs.

Barr will be requested to add functionality to the model to export results for each element along the selected calculation pathways to Excel-based time-series spreadsheets for several deterministic runs of the model. The deterministic runs will be set up to test mean input values as well as extreme ranges of selected input parameters. For tracking chemical migration, this model export process will obtain the values for oxidation rates in mine waste (which is related closely to dissolution rates for most solutes) and the concentration caps (i.e., maximum dissolved concentrations of parameters in pore water) to ensure that the values for these critical parameters applied

**Comment [PJH17]:** The reasonableness of this request depends heavily on the length of the selected pathways. For loading from one stockpile to the river via groundwater there are literally hundreds of elements involved. Do the reviewers really want the results for every element exported?

**Comment [jrs18]:** how many runs ? what deterministic values ?

**Comment [jrs19]:** is this 'release' or 'oxidation' ?

in the model accurately match the values set in the input. Hydrologic input variables along the calculation pathway that are required to compute system flow rates (i.e., rainfall, evapotranspiration) will also need to be output to the Excel-based output files.

For each of the selected major pathways, the review team will perform independent calculations to track solutes of concern migration from its source to the Evaluation Location. The calculations will independently compute the mass flux along the pathway and compare this with mass flux simulated in the model. The independent evaluation will be based on a combination of time-step calculations that attempt to reproduce the model computations, average conditions over certain time intervals, and minimum/maximum calculations that attempt to bracket the model results.

### 2.2.2 Phase II Reporting

For each step in the evaluation, the review team will document any model outputs that are judged to be unreasonable or that contradict independent calculations performed by the team. Any discrepancies identified will be presented to Barr and to the Co-lead Agencies. ~~After Co-lead Agency review, the conflicting results will be presented to Barr and necessary revisions determined.~~ At the completion of the Phase II evaluation, a memo will be produced detailing any discrepancies or errors identified. Along with the memo, any independent calculations produced by the review team to check model function will be documented in calculation sheets. The team will develop several standard forms to provide hardcopy results from each step in the Phase II evaluation that can be reviewed by third parties. In many cases, the documented calculations will consist of Mathcad® worksheets that show the input values, equations used, and results/comparisons with the GoldSim outputs.

**Comment [jrs20]:** isn't this the same as the Agency Comprehensive Review ?

**Comment [TP21]:** There are many functions, particularly with the contaminant transport module which are not easy functions. There is a reason why the description of the inner-workings of the contaminant transport is written up in a separate, LARGE appendix. We are worried that, in particular with the direct transfer rates of mass and treatment rates, that the calculations will not be directly reproducible and the Co-Leads will get a report with all kinds of errors that shouldn't really be flagged as errors.

We would recommend that there be a check-back step to give Barr the opportunity to answer questions before "errors" are flagged.