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RE: Draft Montanore Project EIS – Review of the Hydrogeology and Water Resources Aspects of the Proposed Mining Project

Montanore Minerals Corp. (MMC) proposes to construct a copper and silver underground mine and associated facilities near the Cabinet Mountains Wilderness, in the Libby Creek drainage south of Libby MT. The proposed project is called the Montanore Project.

This DEIS review focuses on hydrology and water resource issues. This review has been prepared on behalf of Save our Cabinets and Earthworks.

Many hydrology and water resources issues are related meaning that many impacts depend on analyses of other things. The specific issues discussed include:

- Mine dewatering
- Overall Minesite hydrology
- Tailings impoundment hydrology and seepage
- Waste rock seepage
- Land application disposal (LAD) sites
- MPDES permit and outfalls
- Acid mine drainage – testing, prediction, and prevention

Summary of Major Conclusions

Water resources analysis of this mine, as should have been provided in this DEIS, depends on an accurate prediction of dewatering rates. This DEIS fails to provide one. The dewatering rate discussed in the DEIS is a moving target including 1200, 800, and 450 gpm. The DEIS predicted drawdown, the amount the water table drops due to dewatering the mine, with the 450 gpm estimate, the estimated long-term steady state dewatering rate. Assuming the long-term 450 gpm estimate is accurate and that 1200 gpm is a reasonable initial estimate, the project will discharge excess water to LADs initially and require make-up water in the long term. The DEIS fails to estimate how the dewatering rates will vary with time which makes the analysis of these different impacts extremely uncertain. The DEIS is technically insufficient because it bases all water-related impacts on guesswork, not a reasoned analysis. This review will discuss these specific water related impacts and provide a hard review of the technical documents supporting the DEIS. The following is a partial list of the major findings of the review.

- The mine dewatering rate estimate is not supported by the data or analysis presented in the DEIS or supporting documents.
- The analysis of drawdown due to the mine is based on an extreme simplification of the flow paths in the area. It is based on almost no data regarding the hydraulic properties of the rock. It is based on an oversimplification of the hydrogeology of the geologic formations. It is extremely uncertain and should not be given any weight in decision making.
- The analysis is based on an incorrect estimate of total recharge. There was no attempt made to distribute the recharge among watersheds, as is customary in such hydrogeology studies.
- The effects of dewatering on surface water resources, including lakes, streams, and springs, are based on a faulty conceptual model and oversimplification of the connections between surface water and groundwater.
- The conceptual model of flow does not explain the seasonal changes in groundwater levels or the movement of flow to the surface streams or springs.
- The tailings impoundments are designed to leak. The pumpback wells will not capture all of the seepage. Tailings seepage will discharge to Libby Creek, as planned, and to Little Cherry Creek (not included in the MPDES permit). It may discharge to Little Cherry Creek due to the increased head caused by the groundwater mound
- The DEIS does not consider the impacts of pumping from a well near Libby Creek which will be needed if the project needs make-up water.
- The DEIS fails to estimate the mound that will form under the impoundment and downgradient form the impoundment due to the seepage.
- The DEIS does not provide for proper monitoring of the seepage mound at either the tailings or the LAD sites.
- There is no analysis of seepage rates through the waste rock stockpiles or through the pads and other facilities to be constructed of waste rock.
- The analysis of acid mine drainage is based on far too few tests of actual Montanore ore or waste rock.
- The few acid/base tests completed show that Montanore is more likely than either Rock Creek or Troy to generate acid.
- The Troy Mine is not a good geochemical analogue for Montanore.
- The Libby Adit discharge water does not represent the range of potential acid mine drainage (AMD) that would occur from seepage through waste rock or the Montanore Mine shaft.
- Concentrations for MPDES discharge points are too low due to underestimates of seepage streams, overestimates of stream flow, and underestimates of parameter concentrations.

Mine Dewatering and Drawdown

Most of the drawdown and stream baseflow analysis depends on the conceptual flow models proposed for the Cabinet Mountain. The models must make hydrogeologic sense and be supported by observations or measured data, when possible. The agencies rejected the MMC conceptual model, therefore it will not be reviewed in detail. Prior to considering the uncertainties around the predicted mine dewatering rate, the agencies' conceptual model is reviewed.

Agency Conceptual Model

The key components of the agencies' model (DEIS, page 421) are that recharge occurs in the mountains, flows vertically downward to a water table aquifer at about 500 feet below ground surface. Some recharge is to perched aquifers which discharge to high elevation springs/streams. Fractures nearer the ground surface are larger than those at depth which impede the vertical flow and potentially cause the water table to slope toward the valleys and form springs/streams at about 5600 feet msl. They miss three important points.

- The recharge flows vertically downward through the larger fractures until it reaches the smaller fractures. Because the smaller fractures have lower permeability, the groundwater will "back-up" and form a water table. The limit for vertical flow rate is the decreasing permeability at depth. The mechanism for horizontal flow is not explained.
- Diffuse recharge will occur around the mountains wherever there are exposed fractures or shallow soils overlying the fractures.
- Recharge also occurs through stream bottoms and from the small perched aquifers. The agencies refer to perched aquifers, but these likely occur in larger fracture and small fault zones so that as a perched aquifer fills with water it not only discharges to the springs/streams but also through the bottom to the underlying fracture.

The agencies' model depends on the observation of groundwater levels at about 500 feet bgs, as observed during the exploration drilling (DEIS, page 421). But the agencies fail to consider four points about these observations:

- These are static water levels and may not represent the water table because a drill hole is a very large new "fracture" in the fracture zone. The bore hole would fill with water from the intersected fractures. Because of their low conductivity, as noted by the agencies, it could be days or weeks before water flowing to a large drill hole, relative to the fractures, actually fills with water. Essentially, the drill hole is a huge new pore space which needs to be filled with groundwater from the very small existing fractures intersected by the drill hole.
- The agencies should note at which level the drillers actually observed water entering the holes; this would shed some "light" on the previous bullet point.
- The water level in the fractures would depend on the measurement date because most recharge occurs during late spring/early summer. The recharge would will the fractures, possibly to the groundwater surface, which would drain slowly, as noted above, through the remainder of the year.
- Streams may be intermittent above 5600 ft amsl, if that is the elevation they become perennial. That is consistent with the previous bullet.

Neither conceptual model correctly accounts for Rock Lake or describes the Rock Lake Fault. Gurrieri (2001) indicates the shallow bedrock flow slowly seeps to the deeper bedrock; the connection is continuous if the deeper bedrock is less fractured which would cause it to have a much lower permeability. Faults, primarily the Rock Lake Fault, provide a conduit for flow to deeper levels.

Gurrieri describes the fault as the source of the baseflow to the stream that drains into Rock Lake Lake. The stream lies on gradient of saturated groundwater in the fault and the lake intercepts the flow through the fault, which provides the primary dry season inflow to the lake (it provides flow year-round). He described the faults as being 200 feet wide, based on the observed damage zone, by 70 feet deep, based on the depth of the lake. Gurrieri (2001) determined the groundwater inflow rate from the Rock Lake Fault as equaling 136,000 ft^3/d (1140 af/y) based on mass balance analysis. Over a 70 by 200 ft section and a 0.1 gradient based on the gradient between the lake and an upgradient spring, he used Darcy's Law to determine the conductivity is 116 ft/d ($3.5x10^{-2}$ cm/s).

Gurrieri notes a large spring located 850 feet below Rock Lake discharges from the fault, and that based on its relatively constant flow, there is a large residence time above it. "Spring 3R has a substantial perennial flow (100 gpm during the summer) and drains from the Rock Lake fault where it intersects a prominent northeast-trending joint set." (Gurrieri, 2001, page 16). By large residence time, considering the high conductivity, the fault likely is filled during snowmelt and drains to the spring and lake throughout the summer season.

The agencies' model must account for the variable water levels that would be expected in the bedrock and the structure of the fractures which would allow the groundwater to flow horizontally toward the streams. It also must address the role of faults, which may be a major conduit for recharge to reach deeper levels. It does not meet this requirement.

However, the agencies' conceptual model supports the fact that the shafts may significantly lower the water table and cause much more impact on surface waters than the agencies allow in the DEIS.

The dewatering rate is very uncertain.

The DEIS indicates that the groundwater model determined the rate would be 450 gpm, but this appears to be a long-term steady state flow (DEIS, page 429). It also states that MMC original estimate, from 1992, was 1200 gpm but that now Geomatrix (2007c) estimates 800 gpm. The DEIS notes that the drawdown area for 800 gpm is about twice that estimated for 450 gpm (*Id.*) The DEIS uses different flow rates and never really justifies any of them. This is an unacceptable level of uncertainty for a DEIS-level analysis.

To estimate it properly, the agencies should determine the rate and drawdown cone based on the calibrated parameters of the geologic material around the mine. This can be done within the model by using a head-dependent flux boundary to lower the water level to the level of the shaft. If the agencies had used the MODFLOW computer code, the DRAIN boundary could have been used to lower the water level to a set level to determine the required inflow (dewatering rate) and water level surface (Myers, 2006 and 2009).

The DEIS suggests the area of drawdown at steady state should approximate the area over which recharge equals the dewatering rates. If the groundwater table is initially flat, not the case here, these areas would exactly equal one another. With a steeply sloping surface, the area within the water surface that drains to the mine will equal the area within the groundwater divides, either natural or formed by pumping. As an approximation, based on DEIS Figure 73, the area within the 1-meter drawdown is about 9000 acres. If 450 gpm is the recharge within the area, it is just 0.08 feet/y, or less than 1 in/y. At 800 and 1200 gpm, the recharge would equal 1.7 and 2.6 in/y, respectively. These are extremely low recharge rates; even for just 32 in/y precipitation, as found at the lower elevations, a 10% recharge rate, as used in the groundwater model (ERO Resources, 2008) would be 3.2 in/y. For comparison, in the Great Basin the Maxey-Eakin recharge estimation procedure treats areas with over 20 in/y of precipitation as having a 25% recharge rate, or 5 inches for a 20 in/y precipitation. This suggests that the estimated dewatering rates are substantially too low.

Review of Geomatrix (2007c): Estimate of Inflow to the Adit

Geomatrix (2007c) uses two equations referenced to Goodman et al (1965) and Lei (1998) to estimate inflow to the shaft, but does not provide a full reference for either citation; their References section provides a web citation to reports that purportedly used these equations. Neither of the URLs still work as of May 1, 2009. Neither Goodman et al nor Lei are found as references in any standard hydrogeology textbook. Therefore, it is not possible to verify the equations or their development or efficacy for use in the way used here for this review.

Geomatrix (2007c) describes the Goodman et al equation as a steady state analytical solution, but the equation includes specific yield. Specific yield is a transient term and not used in a steady state flow solution. The equation is also dubious because it does not include diameter of the tunnel or any other way of estimating the perimeter of the tunnel through which groundwater would flow. Geomatrix (2007c) attempts to compensate by multiplying the estimate by 12 for the 12 panels; the “12 panels” are not explained so it is not clear what this attempts to do. Their assumptions become more confusing when they divide the estimate by 2 to account for the fact that only half of the rock will be removed. If the equation does not require an estimate of diameter, it seems unlikely that it matters that only half of the tunnel is excavated. Then reducing it by another 50% to account for drawdown; again this appears to be unreasonable because the operative gradient would be the difference between the water table and head at the tunnel divided by the distance from the tunnel to the point where there is little drawdown.

The hydraulic conductivity used for both equations was the matrix conductivity, $2.5x10^{-5}$ cm/s (0.07 ft/d). Gurrieri (2000) found a much higher fracture conductivity especially for the Rock Lake Fault System. Substituting into Goodman equation and assuming a head of 100 m, $Q= 0.707L(KH^3S/t)^{1/2} = .707*200/3.28*((3.5x10^{-2}*86400/100)100^3*.05/1825)^{1/2} =$ 1240 gpm for just the 200-foot thickness of the fault. This is not an alternative prediction but is merely a demonstration that the estimates in Geomatrix (2007c) may be inaccurate, are very uncertain, and likely underestimate the required dewatering.

The groundwater model incorrectly treated the bedrock aquifer as one geologic medium, homogenous and isotropic through the model domain. This yielded unrealistic and incorrect drawdown and baseflow-reduction predictions.

Homogenous means the properties are the same throughout the formation and isotropic means the properties do not vary by direction. As noted throughout the DEIS and accompanying documents, the bedrock is fractured with decreasing density with depth; this means the conductivity decreases with depth, except for fault zones (Gurrieri, 2001). The bedrock consists of many different formations, as seen in Figure 1, a factor which should be accounted for in the modeling. The formations that fold around the anticline (Figure 1) would have their primary conductivity in the vertical direction; if dewatering affects these formations, it could lower water levels under the mountain crest more than expected.

Treating fractured bedrock as a homogenous medium adds uncertainty to the predicted impacts of the dewatering (DEIS, page 429). Homogenous aquifer assumptions should cause the impacts to spread relatively uniformly in all directions, but structural control may allow drawdown to extend into surrounding watersheds, such as Poorman and W Fisher Creek, that the current analysis suggests will not be affected. Because of the failure to consider fractures and other structural control, the simplified analysis and reported drawdowns (DEIS, Figures 73-75) may be worse than useless, they may actually be harmful to the understanding of the potential impacts.

The mine and its drawdown will affect at least two fault systems, the Libby Lake and Rock Lake Faults. These should have been included in the conceptualization of the model. The speculative model testing of the effects of faults (ERO Resources, 2008) does not suffice for a proper conceptual model including the faults.

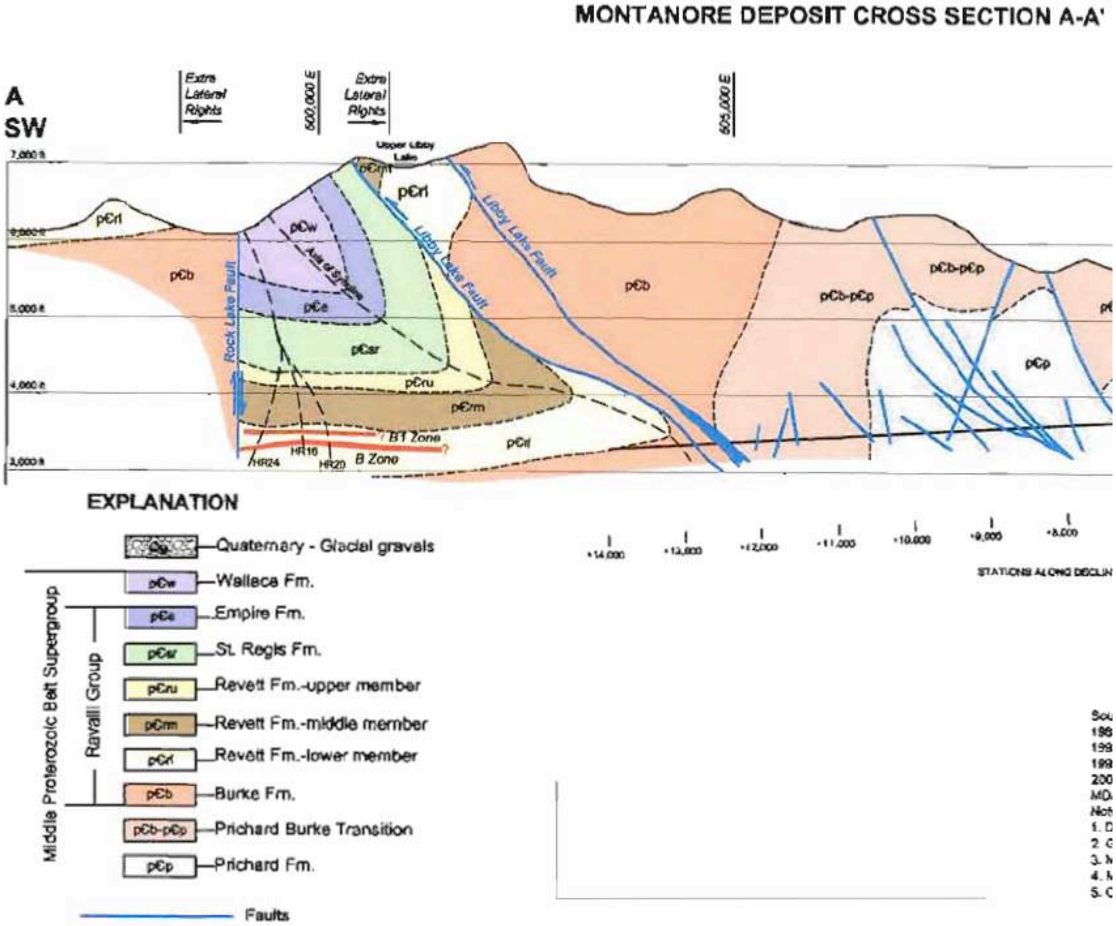

Figure 1: A portion of Figure 4 in Geomatrix (2006a).

The model could have been improved by using better estimates of stream baseflow throughout the domain.

Calibration should have used better estimates of stream baseflow throughout the domain, irregardless of the agencies' claim that there are insufficient measurements at higher elevations on the stream to estimate baseflow (DEIS, page 430). The existing data reported in the Surface Water Hydrology section (DEIS, Tables 84 to 86, Figure 76) could be used in a regression analysis with the gaged data to estimate baseflow.

The model predictions are very inaccurate

The DEIS states there was a comparison of pre-mining, mining, and post-mining baseflows on four streams (DEIS, page 431). There should be a table in the document showing the measured baseflow, estimated 7Q10 values, the modeled pre-mine baseflow, the mining baseflow, and the post-mining baseflow. This would allow the public to compare the values. The table should also include the stream sections further upstream that have estimated baseflow from the regression as previously suggested.

The agencies analysis of many scenarios does not make up for the uncertainty in the conceptual flow model. Essentially, the agencies are numerically comparing different conceptual models, including those that include and do not include faults. That the results of the scenarios, different conceptualizations, do not differ substantially shows that they are either not correct or more likely too simply conceptualized.

Effects on baseflow are incorrectly considered. "The model results are also based on the assumption that the predicted base flow is representative of a typical precipitation year" (DEIS, page 431). This is relatively standard in that average recharge is used in steady state calibration; in this model, the recharge is based on an inaccurate calibration and cannot be assumed to resemble an "average" year. The very next sentence also differs from their apparent logic: "The agencies' numerical model predicted base flow values for the various model nodes that are comparable to the 7Q10 values calculated for several locations along various streams." (*Id.*) It is not possible for the model results to be "representative of a typical precipitation year" **AND** for the "predicted base flow … [to be] comparable to 7Q10 values" because the ten-year low flow does not result from a typical precipitation year.

For Libby and Ramsey Creek, the agencies compare the predicted baseflow changes to the variability in determining baseflow. The agencies suggest that dewatering will dry the upper reaches of the East Fork of Rock Creek so that inflow to Rock Lake will be decreased to zero during baseflow conditions (DEIS, page 432). However, the DEIS does not present any information to consider the importance of losing this inflow. The DEIS should discuss the reduction in stream flow both as a flow rate and percentage of inflow to the lake, the volume of the lake and the effect of losing this flow on its water balance.

The impact of baseflow reductions is important whether it dries a stream or not.

The DEIS improperly downplays the predicted decreases in baseflow by comparing, for example, a 10-percent flow reduction to the flow measurement precision. While a 10-percent baseflow reduction may be difficult for the casual observer to "see", the reduction is real; baseflow occurs year-round, even as snowmelt and rainfall runoff is a much larger portion of the flow for parts of the year. Drawdown will most apparently affect the upstream end of the streams where they become perennial (the DEIS notes the springs and streams from the 5400 to 5600 foot elevation). Lowering the water table and base flow will also lower the elevation that the streams become perennial. Effectively the project will shorten the perennial streams.

In addition, a decrease in baseflow that feeds an alpine lake will decrease the water volume available to the lake. The DEIS refers to a decrease in stream baseflow affecting late season flows to the lakes. This is correct, but the reduction will occur year round meaning that the residence time in the lakes will increase year-round.

The baseflow reductions due to drawdown may be much greater during drought years because the model does not consider the changing recharge rates. During a drought, the recharge is less, as is the baseflow. Project induced drawdown will also vary with time due to changing recharge. Therefore, the project drawdown will exacerbate drought conditions by decreasing the baseflow by a larger flow rate than during "normal" conditions. The project's effect on surface water flow may be most significant during drought conditions.

The agencies should prevent the impacts to East Fork Bull River.

The model suggests that during dry years, drawdown could prevent bedrock groundwater discharge to the upper reaches of the East Fork Bull River which could affect St. Paul Lake. The agencies acknowledge the seriousness of the changes in water balance on the river and lake, but downplay them due to the uncertainty in the model. Rather than downplaying the impacts, the industry should take steps to mitigate them, meaning preventing the impacts because the sites are within wilderness and there is no applicable physical mitigation (such as replacing the water).

Prevention is the only acceptable mitigation. The agencies should determine what level of mine development would not extend the drawdown into this watershed and require the mine stop at that point.

It is also unacceptable for discharge from the mine void to reach the EF Bull River after mine closure (DEIS, page 505, and ERO Resources, 2008, pages 12 and 20). The agencies should analyze alternatives to prevent this discharge. There can be no uncertainty in the analysis because there are no applications that could be implemented after impacts occur to mitigate them.

The DEIS fails to consider pumping of water from near Libby Creek.

The DEIS is incomplete because it does not include a detailed analysis of pumping process water from near Libby Creek, as proposed if the dewatering water is insufficient for processing.

> If total mine/adit inflow were not adequate to supply water for process purposes, MMC would likely install ground water wells for make-up water. **MMC has not identified specific well locations; the most likely location would be along a major drainage, such as Libby Creek**. The amount of make-up water required would depend primarily on mine inflows and precipitation at the impoundment site. MMC estimated 133 gpm would be needed on a steady-state basis if mine inflows were 800 gpm. If the numerical modeled inflows of 450 gpm were representative of actual inflows, 483 gpm of make-up water would be needed. Ground water withdrawals from Libby Creek alluvium would result in ground water level decreases near the pumping wells while the wells are in operation. (DEIS, page 432, emphasis added)

MMC appears to acknowledge that dewatering water will be insufficient for processing, but they have not even identified the locations for wells they know they will require. This renders the DEIS insufficient as a disclosure of environmental impacts document.

Dewatering the mine causes an unacceptable risk that the mountain lakes will be partially or totally drained.

The agencies' analysis somewhat concludes that there will be no effects on the high wilderness lakes. But their consultant's analysis throws huge uncertainty over that conclusion:

> In determining whether surface water would be affected by mine dewatering, another consideration is to what degree the hydrogeology of the area is heterogeneous versus homogeneous. The **agencies' numerical model assumed homogeneous conditions** because of the lack of specific data on this issue. If ground water flow is dominantly controlled by heterogeneous conditions, then potential impacts to surface water would be **focused along structural trends**, rather than being distributed evenly among all drainages. It is not possible to predict how this condition might affect creek base flow with the currently available data. (ERO Resources, 2008, page vi)

The agencies treat the fracture systems as homogeneous, but the reality is they are anything but homogeneous. If there are significant fracture systems responsible for most of the flow from shallow to deep bedrock, these systems may be at least intermittently saturated to the surface where they support lakes/streams. If the mine intercepts these fractures, it could drain them and lower the water table in the fractures. The conceptual model as discussed above supports the idea that the mine will drain or significantly lower the lakes' water level.

The Rock Lake Fault is an important example. If the dewatering pulls significantly from the water in that fault system, it could be like pulling the plug on Rock Lake.

The DEIS describes Rock Lake as transitioning from high inflow and short residence times in the spring to much less inflow, mostly just the groundwater inflow, and longer residence time. It does not provide a volume, but at 58 acres with a mean depth of 30 feet, the volume would be about 1740 af. Therefore, the groundwater baseflow calculated by Gurrieri would be about 66% of a total volume. For perspective, one lake volume would equal 2.47 feet of runoff from the surrounding 1.1 square mile watershed. At 4.5 feet of runoff (60 inches of precipitation minus 6 inches of recharge) from that watershed, the runoff volume would be about 3168 af/y and the residence time for just runoff would be 0.54 years. Adding the groundwater inflow (1140 af/y), total inflow would be about 4300 af/y and residence time about 0.4 years. Therefore, groundwater inflow is more than a quarter of the total inflow to the lake, and the DEIS overstates the difference in residence time from spring to late summer.

Considering that much of the outflow from the lake is also in the groundwater, lowering the groundwater level will both decrease the inflow and increase the outflow. Outflow increases because the gradient driving seepage from the lake will increase. If water levels in the fault zone drop far enough, below the bottom of the lake or just 70 feet, dewatering the Montanore mine will be equivalent to pulling the plug on the drain beneath Rock Lake; its level may drop substantially due to the water flowing into the fractures.

Review of ERO Resources (2008)

Much of the dewatering analysis relies on ERO Resources (2008). This section is a detailed review of that document, including the conceptual models (also reported in the DEIS), the groundwater model structure, the model calibration, and the predictive modeling. There may be some overlap with discussion from the DEIS. The section basically shows that the modeling does not help with the analysis presented in the DEIS.

The Model Calibration Was Based on Little Data and Violated Many Hydrologic Principles

The agencies calibrated their model to gaging station flow data at the periphery of the model boundary (DEIS, page 430). This is an insufficient description to know exactly what it means, but presumably discharges from the model domain to the streams approximated the flow data. ERO Resources (2008) provided a little more detail. Over two phases they attempted to match four performance criteria (ERO Resources, 2008, page 8):

1. Simulate approximate elevation (and location) at which creeks draining the proposed mine area become perennial (within about 100 feet).
2. Simulate measured flow from two existing adits (within 10%).
3. Simulate measured base flows at existing gaging stations (within 50%).
4. Simulated heads must be consistent with bedrock head data. Depth to bedrock ground water exists in the area of the proposed Little Cherry Creek tailings impoundment and the proposed Rock Creek Mine. ERO reviewed the data and determined that the bedrock water levels are, in general, consistent with what would be predicted by the agency conceptual model. However, the water level data cannot be specifically compared to the numerical model-predicted ground water elevations because of the large contour interval (100 meters or about 300 feet) used in the model.

The performance criteria were restated as calibration targets (ERO Resources, 2008, page 8).

The first performance criterion is not sufficient because it ignores the dynamic equilibrium likely to be present in the model domain. Seasonal and annual recharge variation will cause the groundwater level to vary and cause the location of flow in the streams to vary. It is common to find some "average" value for use in this situation, but for this model a flow rate at some average discharge elevation would be much more appropriate.

The second criterion is adequate, but the means of modeling flow in the adits is dubious as discussed below. The third criterion, which allows simulated baseflow at specific points to vary by 50%, is hardly a criterion at all. By varying the recharge rate above the discharge point and the conductivity in the elements, it should be easy to obtain a 10% agreement. If the model code is too difficult to manipulate to achieve that criterion, they should use a different code.

The fourth criterion is also hardly a criterion. It is more important to match observed heads. Calibration usually involves changing the conductivity to minimize residuals between observed and simulated head values. Understanding there are no monitoring wells under the wilderness, it would be advisable to use the observed water levels in the original exploration wells, possibly adjusted for seasonal changes. Combined with the observation wells under the tailings impoundments, observed spring levels, and water balance criteria in 2 and 3, and starting with an improved implementation of the geologic formations discussed elsewhere, it would be possible to reach a decent calibration.

ERO Resources failed to comprehensively compare conceptual models.

The report discusses the use of "two simultaneous tracts" for calibration. Effectively, they are testing the model with and without the Rock Lake Fault, meaning there are two separate conceptual models. It is appropriate to consider alternative conceptual models, but this effort fails because there is really no objective comparison of the results. The discussion (ERO Resources, 2008, pages 9-11) is subjective. The continuing discussion of phase 2 modeling does nothing to improve confidence or add an objective comparison of the model results.

The model should have set recharge independent from the calibration.

Both phase 1 and 2 modeling describes changing the recharge as one means of meeting the performance criteria. This is inappropriate modeling strategy. A basic precept of hydrogeology is that inflow equals outflow, and in a mountain watershed, this means that recharge within a basin equals the baseflow discharge from the basin. In the Cabinet Mountains, recharge is the flow which reaches the bedrock below the "unconsolidated surficial deposits and weathered bedrock". This recharge then becomes baseflow, adding a relatively constant discharge into the streams which may be seen late during dry years. The modeler should have determined the recharge based on discharge (Cherkauer, 2005; Myers, 2009).

As shown in Table 2 (ERO Resources, 2008), the predicted baseflow rate totals 67.4 cfs for the six streams in the table and the measured baseflow rate is 116.2 cfs, assuming the mid-range of the adjusted low flow column. Given that the model underpredicts total baseflow by about 42%, ERO Resources obviously underestimated recharge input to the model. As noted above, recharge should have been set equal to the baseflow discharge to streams (Cherkauer, 2005; Myers, 2009). Recharge would have equaled 116.2 cfs and the conductivity could have been adjusted so that the distribution of flow among streams and adits would have resembled reality, similar to the method used by Myers (2009) on the Powder River basin.

ERO Resources (2008) notes that the model is extremely sensitive to "infiltration rates"; they judge that sensitivity by noting the large changes observed in flows from the adits. The observed sensitivity simply reflects the fact that outflow from the model equals inflow (recharge) and that increasing inflow increased the outflow; this sensitivity analysis is useless.

They attempted to argue that recharge into the model equals the baseflow, but the paragraph is nonsensical:

> In addition to using measured base flow from the periphery of the model domain (domain-wide water balance), the total model water balance water was reviewed to confirm that the model internally handles applied water appropriately. The net infiltration of precipitation and the rate of water leaving the model as base flow were both

> **257,124.133 cubic meters/sec**, which confirms that the model is correctly accounting for all water. (ERO Resources, 2008, page 14, emphasis added)

The highlighted flow rate equals more than 9,000,000 cfs, a rate about 35 times higher than the highest flow ever observed on the Colorado River; it is not likely that much flow is coming off the Cabinet Mountains.

The model, ABCFEM, is not designed to simulate a mine void. The methodology used herein does not accurately simulate flow around the mine.

The mine void in this 2-d model was set by lowering the ground surface to the level of the mine along a string of nodes (ERO Resources, 2008, pages 7 and A4). By using the "swamping" feature, the model removes water flowing to the mine void. Presumably the surrounding nodes remain at their pre-mining levels. This effectively creates a canyon above the mine, but for dewatering this may not be unreasonable. It is also necessary to "trick" the model during post-mining conditions by setting the conductivity within the mine void to a very high value (ERO Resources, 2008, page A4); because the model is two-dimensional, with effectively a single model layer representing the mine and bedrock above it, the high conductivity is set for the entire area between model nodes and not just the mine void.

The model is incorrect in how it simulates recovery, however, because it sets the nodes back at the topographic ground surface but simulates the void by "setting the hydraulic conductivity of the elements within the mine void to a high value" (*Id.*). Because there is just one model layer used to simulate the entire thickness (until a thin layer is added for simulating infiltration), this creates a high conductivity zone throughout the layer, not just at the void. This is not correct and represents an inability of the chosen model code to implement a conceptual model of flow to a mine void. This may also lead to the prediction that flow from the mine void will reach the EF Bull River even though the river is 3000 feet above the mine void.

The model code, MODFLOW, could be easily used to test the conceptual model as proposed for flow around the mine. A simple three-layer model could be used to set different parameter values for the void. The DRAIN boundary could be used to lower water levels to the bottom of the adits and void without effectively creating a canyon above these points.

Tailings Impoundment Hydrology

There are two locations considered for the disposal of tailings in the different alternatives. Alternative 2, the proposed action, is for disposal in Little Cherry Creek. The agencies' alternative 3 is for disposal near Poorman Creek.

The tailings impoundment is a significant problem for this mine development: it will bury wetlands and contaminate groundwater, for starters. Section A-A' (Geomatrix 2007a, Appendix B) through the Cherry Creek tailings site shows a reach about 3000 feet long that has a potentiometric surface above the ground surface. This artesian pressure corresponds with various springs which will be buried and permanently destroyed. The agencies **should not have allowed MMC to even consider building tailings at this location** because upwelling groundwater will affect the liner and the seepage collection system; the artesian pressure may affect the geotechnical stability of the proposed tailings impoundment. This section will outline the problems with the tailings proposals.

The DEIS predicts there will be at least 25 gpm of tailings water seeping to the groundwater and downgradient streams. This is an unacceptable degradation of groundwater.

The tailings impoundment for all alternatives is designed to discharge seepage to groundwater. The summary describes it well:

> The Little Cherry Creek Tailings Impoundment in Alternatives 2 and 4 is designed with an underdrain system to collect seepage from the tailings impoundment and divert intercepted water to a Seepage Collection Pond below the impoundment. A pumpback well system also would be necessary to **collect tailings seepage that reached underlying ground wate**r. Similar underdrain and pumpback well systems would be used at the Poorman Impoundment in Alternative 3. The tailings are expected to be placed in the impoundment with a high water content and as they consolidate, water would pool in low areas at the surface and would percolate downward. Most of the percolating water would be captured by the underdrain system, but **some would seep into the underlying fractured bedrock aquifer**. Tailings seepage not collected is expected to flow to ground water at a **maximum rate of 25 gpm**, slowly **decreasing to 5 gpm after operations cease**. The saturated zone beneath the impoundment would be able to accommodate the addition of 25 gpm from seepage and would respond with a **rising water table** (increasing the hydraulic gradient or slope of the water table) to convey the additional water from beneath the impoundment. Seepage from the tailings impoundment would enter the ground water system beneath the impoundment and be **intercepted by a pumpback well system**. (DEIS, page S-31, emphases added)

This description is wrong because supporting documents indicate the 25 gpm is seepage that passes the pumpback wells. Geomatrix (2007a) describes the 25 gpm as the seepage rate that passes the pumpback system. "Even though this impoundment would be constructed with an underdrain seepage collection and pump-back system, **some seepage** (approximately 25 gal/min calculated by Klohn Crippen (2005) for the operational period) **would exit the bottom of the impoundment and percolate to underlying groundwater**" (Geomatrix, 2007a, page 34, emphases added). The 25 gpm will pass the pumpback system and discharge to Libby Creek (Geomatrix, 2007a). This discharge will require a MPDES permit as analyzed by Geomatrix and discussed below.

The EIS description is therefore wrong and the should be redone so that the public can understand that this proposal includes plans to discharge tailings seepage into the groundwater and then into Libby Creek.

It is unacceptable to allow this discharge for at least two reasons.

1. The seepage is untreated and even with the predicted water quality in the tails, there is a great deal of uncertainty around the final water quality. It would be almost impossible to mitigate the seepage if it has worse quality or causes greater impacts than expected.

2. The predicted seepage rate has a significant uncertainty around it as well. The seepage rate could be much more than 25 gpm; this would have significantly more impacts than MMC is currently planning and would be impossible to mitigate once they commence.

Tailings Seepage will cause significant groundwater mounding problems.

Seepage from the tailings impoundment may cause a significant groundwater mound beneath the impoundment. It is doubtful that the aquifer beneath the tailings impoundment can even accept 25 gpm of seepage from the tailings impoundment without mounding to levels above the ground surface because the current natural groundwater flux is only about 35 gpm (DEIS, page 435; Geomatrix, 2007a) and the planned seepage will exceed 25 gpm (because MMC has determined that 25 gpm is the flux that will pass the pumpback wells which are located downgradient of the TSF. This contrasts with the assurance provided in the quote cited above, which was not supported by analysis.

Geomatrix (2007a) estimated flux by assuming that the top 15 feet of the aquifer beneath the tailings impoundment with a valley width of 3000 feet transports groundwater. Their method was based on a MT DEQ methodology to be used for mixing calculations wherein just the top 15 feet would be available for the mixing; the 15-foot limit for dispersion is reasonable but the tailings seepage will form a mound on top of the existing groundwater table. There is no estimate of the tailings seepage that will form a mound under the TSF. Because it likely exceeds 25 gpm by a substantial amount, the mound under the TSF may rise into the bottom of the TSF. This could cause structural problems, piping, or preferential flow between the tails and the preexisting ground surface. Pumpback wells will not dissipate mounds under the impoundment because the wells will be downgradient of the impoundment.

The DEIS is also deficient in not considering the seasonal changes and potential seasonal impacts on the seepage. The existing groundwater levels fluctuate seasonally with recharge (Geomatrix, 2007a, Table 11). As shown in Table 11 (Geomatrix, 2007a), which provides a year's worth of water level data for the proposed tailings impoundment location, all of the wells fluctuate a few feet, but the best examples of the problem are wells LCM-10 and PLCM-6 (shallow). LCM-10 fluctuates from a water level of 5 feet bgs to about 14 feet bgs; PCLM-6 fluctuates from about 2 to 10 feet bgs. These are shallow wells (Geomatrix, 2007a, Table 10) which represent the water table onto which the seepage will mound. If there are seasonal changes in the tailings seepage, the mound could be larger also during the high recharge seasons. The DEIS has not analyzed these issues.

The DEIS fails to consider that the seepage will discharge to Little Cherry Creek.

Geomatrix (2007a, page 38) assumes that the flux beneath the tailings impoundment site will not discharge to Little Cherry Creek. They base this on synoptic streamflow measurements which show, during the baseflow period, steady flows along the creek. Because there appears to not be flow to Little Cherry Creek, they assume the flux is to Libby Creek. The synoptic measurements during wetter seasons (June 25-26) show a flow increase along Little Cherry Creek. This likely reflects the natural changes in water level mentioned above. The seepage will increase the magnitude of these water level changes. The assumption that seepage from the tailings impoundment will outfall only to Libby Creek is therefore wrong. The MPDES permit for outfall 06 must reflect discharge to Little Cherry Creek and the mixing analysis, as discussed below, must be adjusted accordingly.

The tailings seepage will contaminate groundwater.

Seepage from the tails to the groundwater will violate standards for manganese; Table 12 (Geomatrix, 2007a) shows that tailings seepage will have Mn concentration at 0.45 mg/l. Table 14 (Geomatrix, 2007a) reports that total arsenic concentration in Troy adit water is 0.027 mg/l, a value 2.7 times greater than the standard. This water will seep through the tails which probably explains why the operational tailings water at Troy has a similar As concentration (Table 17, Geomatrix, 2007a).

The DEIS must use total recoverable concentration, not dissolved, for metals and metalloids reaching surface waters.

The loading calculations performed by Geomatrix (2007a, Table 32) are incorrect because they utilize dissolved concentrations for metals when they should be using total recoverable concentrations. As shown in MT DEQ Circular 7:

> Standards for **metals (except aluminum) in surface water are based upon the analysis of samples following a "total recoverable**" digestion procedure (Section 9.4, "Methods of Analysis of Water and Wastes", 1983, Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency, EPA-600/4-79-020, or equivalent). Standards for alpha emitters, beta emitters and gamma emitters in surface waters are based upon the analysis of unfiltered samples and appropriate EPA approved analysis methods.
> Standards for **metals in ground water are based upon the dissolved portion** of the sample (after filtration through a 0.45 μm membrane filter, as specified in "Methods for Analysis of Water and Wastes" 1983, Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency, EPA-600/4-79-020, or equivalent). Standards for alpha emitters, beta emitters and gamma emitters in ground water are based upon the analysis of filtered samples and appropriate EPA approved analysis methods. (MT DEQ Circular 7, page 39, emphases added)

Dissolved values may be acceptable for calculating the allowable groundwater concentration at the end of the groundwater mixing zone, point LCTM-8 (Geomatrix, 2007a, pages 38, 90 and 91), but the important loading analysis is for groundwater discharge to surface water. Geomatrix (2007a) calculates the groundwater concentration by weighting 25 and 35 gpm, the seepage and natural groundwater flux, and their respective dissolved concentration. For the discharge to Libby Creek for compliance, the calculation should be made using total recoverable values for the 25 gpm.

The compliance point for groundwater monitoring below the tailings impoundment is arbitrarily located.

LCTM-8 is the apparent groundwater compliance point for tailings seepage; it lies at the downstream end of a 500-foot mixing zone. The DEIS should justify the choice of location along a transect at the chosen end of mixing. As noted, the mixing calculation is based on a 15-foot aquifer thickness, but there is also a significant channel along Little Cherry Creek. The conductivity could be much higher in this area. The DEIS should discuss whether the loading would be concentrated near the channel or away from the channel where the aquifer is thin. The agencies should require a series of compliance point wells across the prime transect of the flow; compliance should be based on each of the monitoring wells not exceeding standards.

The DEIS does not provide adequate specifications for seepage control and the pumpback systems.

The mining company has indicated they will install "seepage control measures, such as pump-back wells, if required to comply with applicable standards" (DEIS, page 52). The DEIS should state at this point what those applicable standards are and how the decision to install the seepage control measures will be made. This statement contradicts other statements in the MPDES permit application (Geomatrix, 2007a) which claims there WILL be a pumpback system. The DEIS discusses seepage as though the 25 gpm is what will occur after the seepage passes the pumpback wells.

The DEIS mentions the pumpback wells may not have to pump because of the artesian pressure in the aquifer beneath the tailings impoundment. The DEIS provides no analysis as to whether the tailings seepage will counter the upward flow from the artesian pressure. Without a liner under the tailings impoundment, the underdrain system may capture more natural groundwater than tailings seepage water. This could effectively increase the amount of seepage reporting to the seepage collection pond and ultimately being recycled into the impoundment. This is not a good plan because it increases the amount of groundwater contaminated by the tailings.

The seepage collection pond, downstream from the tailings impoundment, will have a liner designed to achieve permeability of 10^{-6} cm/s (DEIS, page 52). Neither the text nor cross-section (figure 9) shows the thickness of the liner. Without the thickness it is impossible to assess the efficacy or usefulness of the liner. Note that this permeability equals 0.0028 ft/d, which is not a very low value for a liner; at a gradient equal to 1.0, seepage will pass a 1 foot thick liner in less than a year.

The tailings impoundment will be a permanent source of contamination to the groundwater and Libby Creek.

The DEIS also plans for 5 gpm to seep to the groundwater after operations cease. This means there will be a continuous source of contaminants into perpetuity. This also means there will also be a substantial amount of water captured by the underdrain system after operations cease. The agencies do not have a plan for handling this continuing seepage in perpetuity.

There is insufficient data provided to consider the alternative 3 tailings impoundment.

The DEIS provides almost no site specific data or analysis for alternative 3. The brief discussion (DEIS section 3.10.4.3.2) indicates the Poorman tailings impoundment will not cover a creek and the groundwater beneath the impoundment will not have a deep channel through which to flow (as at the Little Cherry site). It also notes that it will be more difficult to control the seepage if that becomes important.

The DEIS fails by not estimating the seepage from the Poorman tailings impoundment or determine groundwater concentrations near the site; the source of the concentrations shown in Table 82 is not provided and should therefore not be considered useful. The values in Table 82 cannot be evaluated. The DEIS is deficient from the perspective of considering a viable alternative because the potential alternative has very little site-specific data.

Alternative 3 may avoid some of the problems with surface water diversions expected in the proposed action, but there is insufficient data and analysis with which to make a final judgment.

Water Use and Management

Dewatering is the source of most of the process water, the details of which are discussed elsewhere in this review. This section considers the use of water onsite and the disposal of excess water.

MMC expects that dewatering will provide 800 gpm in steady state flow which will be used at the mill; this differs from the amount use to predict drawdown. If the dewatering rate is actually 1200 gpm, they will dispose of 267 gpm at the LAD sites; it is not 400 gpm because 800 gpm is not enough for the mill and MMC will use make-up water if 800 gpm is the produced rate. Table 8 (DEIS) shows that the mill inflow will be 2323 gpm with more than half coming from water stored in the tailings impoundment. This means that a lot of water is needed to initial the mill process. While the mine is under construction, before the mill starts processing ore, MMC will store water behind the starter dam in tailings impoundment.

Water Disposal

MMC currently disposes of water from the Libby Adit through three outfalls (MPDES Permit 0030279). Outfalls 001, 002, and 003 are a percolation pond, leach field, and direct discharge to Libby Creek, respectively. It appears that these outfalls will continue to be used only during construction and that the proposed LAD sites, outfalls 004 and 005 will be used after the pipeline from the Libby Adit to the sites can be constructed. “During construction, mine and adit water from the Libby Adit could be discharged via the existing outfalls 001, 002, and 003 or LAD Area 1. MMC plans to install a pipeline from the Libby Adit area to the LAD Areas” (DEIS, page 61). The DEIS should verify whether the existing outfalls will be abandoned.

MMC proposes three additional disposal outflows. Outfalls 004 and 005 would be for two land application disposal areas (LADs). Outfall 006 would be for seepage from the tailings impoundment. There are two additional outfalls, one for waste rock seepage and the other for surface water runoff from the portal site. The mixing analysis for the outfalls is considered below.

Land Application Disposal

The DEIS calculated the natural flux through the saturated groundwater beneath the LAD areas to equal 141 gpm. It was based on flow through a cross-section beneath the LAD; adding flow from the LAD will increase the area of this cross-section by mounding. The agency noted that the conductivity must be too high because 141 gpm would require a recharge rate equal to 53% of the annual precipitation (DEIS, page 438). The DEIS does not indicate the area over which the recharge would occur, so it is hard to interpret what this means. However, if the precipitation is 32 in/y (DEIS, page 229, for the tailings area), a 53% recharge efficiency is 1.41 ft/y of recharge which would require about 160 acres of recharge area. Appendix G, under LAD Application Rates, confirms that they are considering an LAD area of 200 acres. This ignores any groundwater flowing under the LAD from upgradient of the facility. Groundwater flow through a cross-section under the LAD would include the recharge occurring in the drainage basin flowing to that cross-section, therefore calculations of recharge based on the area of the LAD are meaningless.

Geomatrix (2008b) essentially repeats this argument only increasing the cross-sectional area through which the groundwater will flow and is also not useful.

This is a fatal flaw in the analysis which indicates the analysis is not considering the appropriate recharge area; during wet years this could be a major problem because there will be much more natural recharge and the cross-sectional area will increase. That means the groundwater level will be much closer to the ground surface and there will be no place to put the infiltrating water from the LAD site. The remainder of the LAD water balance analysis is based on this flawed logic and is essentially meaningless.

Surface and Groundwater Monitoring

The description of monitoring plans in the DEIS is very scattered and difficult to follow. Table 4, the description of mine alternatives, states that for alternative 2, there will be "Detailed monitoring around proposed project facilities". Alternatives 3 and 4 will have that detailed monitoring plus "Additional monitoring in East Fork Rock Creek, East Fork Bull River, Rock Lake, and Libby Lakes, Analyze additional parameters, such as chlorophyll *a* and acrylamide. Install an array of small-diameter boreholes from, and continuous recording pressure transducers within the mine and adits as construction progressed."

They will also monitor "ground water dependent ecosystems" in alternatives 3 and 4, but not alternative 2. This monitoring includes the completion of a "comprehensive ground water-dependent ecosystem inventory an area overlying the proposed underground mine, focusing on areas below about 5,600 feet", measurement of the "flow of any spring overlying the proposed mine" in early June and between mid-August and mid-September", and a "vegetation survey at each identified spring or seep" including trigger species to monitor effects (DEIS, Table 4). The table does not specify the frequency at which these inventories will be completed.

Tailings Impoundment

Tailing impoundments, in all alternatives, will be monitored with one upgradient well and six downgradient wells. All wells will have shallow and deep completions, for the alluvium and the bedrock and be monitored monthly. There should be an additional upgradient well. For the Little Cherry Creek site, there should be a well in the deep channel and a well in the shallower terrace area away from the deep channel. Also, the pumpback wells should be sampled monthly for water quality only. This would help to determine the efficiencies of the pumpback wells.

Several piezometers should be installed through the tailings to beneath the seepage trenches. These would be monitored for level only, but with continuous level recorders. This would be important for determining whether the mound was imposing on the bottom of the impoundment.

LAD Areas

The plan is for one monitoring well, with shallow and deep completions, downgradient of the LAD sites. Because of the width of the sites and the importance of determining whether the mound is reaching the ground surface, there should be three monitoring wells with similar completions. In addition to the proposed monthly water quality samples, the water level should be monitored with continuous recorders to provide real time data for management of the sites.

Mine Shaft and Adit Sampling

A major concern of this project is that dewatering of the shafts and declines will drain surface water resources, primarily Rock Lake, in and near the Cabinet Mountains Wilderness. Because of the wilderness designation, it is not possible to construct monitoring wells within the wilderness. For all alternatives, there will be a shallow and deep monitoring well near Rock Lake. The basic problem is that once dewatering affects these wells, it will be too late because for the fractures under the lake to be dewatered so that the well detects the drawdown, the lake will be draining into the fractures.

There really is no suitable monitoring that will enable mitigation which will protect the surface water resources. Once the effects are observed, it will be too late.

For alternative 3, Appendix C proposes that there will be multiple piezometers installed near the Libby adit as it is extended for evaluation purposes. Because dewatering will be commenced before the piezometers are installed, the value of the piezometers as currently proposed is questionable. They will be perpendicular to the adit. The value of the piezometers could be increased if they were installed from the end of the existing adit. MMC should drill and install piezometers at multiple points adjacent to and in front of the current end of the adit. Presumably, there has been little current drawdown caused by the Libby Adit more than a few tenths of a mile in front of the adit. Adding piezometers to these points now would allow the changes in water pressure as the adit is extended to be evaluated. This would provide invaluable information that could be used to predict what will occur under full development. The agencies should require this type of evaluation prior to allowing any mine development.

Waste Rock Seepage, Discharge, and Geochemistry

During construction and operations, waste rock will apparently be moved all over the site, including stockpiles at the Ramsey Plant or LAD 1 site, tailings impoundment construction, or in mined-out parts of the mine (DEIS, page 48). There will be no permanent waste rock dumps (*Id.*), although acid-producing waste rock may be isolated within the tailing impoundments. This section considers the acid mine drainage (AMD) characteristics of the ore and waste as presented in the DEIS and Environmine (2007).

The Montanore Ore has a substantial chance of generating acid.

Montanore ore has a much greater chance of generating acid than does Rock Creek or Troy (Table 74, DEIS). Based on 35 samples, the ABA is -4, which is closer to the acid producing end of the range than is either Rock Creek (5.1) or Troy (7.6). The NP/AP ratio indicates the ore would produce acid, averaging 0.8 (which is less than the 1:1 ratio which would indicate acid producing capacity equalizes the neutralizing capacity, at least for static testing).

DEIS Figure 62 shows clearly that the ore is net acid producing, but the DEIS claims this is due to the "conservative assumption" that all sulfide is acid-producing (DEIS, page 378). The DEIS misses the fact that neutralizing minerals must also be available if the acid generation is to be prevented. As noted by (Drever, 1997, page 308): "[o]ne limitation of this approach [the static tests] is that it is based on total amounts of sulfur and carbonate without any consideration of relative rates of reaction or physical location in the rock."

The DEIS correctly states that: '[t]he net generation of acid from a rock or waste rock facility is related more to the reactivity of sulfide and neutralizing minerals than the total concentrations", but then indicates that "static tests may overpredict potential for acid generation" (DEIS, page 374). "The pH decrease associated with ARD occurs if acidity is produced at a faster rate than alkalinity or when neutralizing minerals are consumed by excess acid. The development of acid drainage is time-dependent and, at some sites, may form after many years of slow depletion in available alkalinity or slowly increasing sulfide oxidation" (*Id.*). The conclusion that kinetic tests are necessary is correct, but the DEIS then relies on one test completed in 1992 (DEIS, page 379). In a mine in which 10s of millions of tons of ore will be mined, one sample would represent hardly any of it. As noted by Drever (1997, page 308), "both sulfides and carbonates are typically heterogeneously distributed … and a large number of analyses may be required to characterize the rock adequately." One test does not represent the ore body.

Additionally, that one humidity cell, in 1992, was not run for long enough to reach a conclusion regarding the long-term productions of acid, as the DEIS suggested is necessary. Many mines have run these tests for much longer than 12 weeks, as reported in the DEIS; these include the Mount Hope, Round Mountain, and Phoenix mines in Nevada for which the tests were run for longer than one year[1]

The DEIS inappropriately dismisses the potential for AMD from the tailings impoundment

The DEIS notes that the chemistry of the tailings may be more influenced by the process activities than by the amounts of sulfide in the ore (DEIS, page 380). However, based on the potential for ore to produce acid, it is not appropriate to dismiss it in the tailings as the DEIS apparently does. For example, the DEIS bases the analysis on one test from 1992 (DEIS, page 381). The DEIS claims that most sulfides are removed during processing, resulting in sulfide concentrations less than 0.1%; it dismisses this proportion as too little to produce acid. This is not correct because the test mixes the tailings so that the sulfide is well distributed into a homogeneous mixture. In a tailings impoundment, there will certainly be areas with much higher sulfide concentrations – these will produce acid over the long term.

Waste rock from both primary formations have the potential to generate AMD

The ABA test results for each type of waste lie in the "uncertain" range (DEIS, pages 383-4). Because of this uncertainty, the two kinetic tests performed on Prichard formation rock are grossly insufficient, especially since those results are uncertain. The DEIS is wrong to conclude these tests do not support acid generation from this formation because in the previous paragraph it noted the wide range in ABP values and one test producing more acidity than alkalinity at the end of the 20-week test. This is exactly the reason that longer tests are necessary; there is no confidence in the conclusion of the DEIS for the Prichard formation[2].

The Libby adit flow is not a useful analog because it is a mixture of flow entering the adit from many fracture zones. The DEIS should use water samples collected from each fracture zone to assess the variability in water chemistry rather than reporting an average.

Figures 65 and 66 compare the waste rock from the Libby adit to waste rock at Rock Creek and Troy; these figures show conclusively that the Libby adit waste rock has much higher potential to produce acid than the other two sites. A large proportion of samples, especially of the Prichard formation, plot above the 1:1 line showing that much of the rock may produce acid. Much of the lower Revett formation waste rock discussed in the DEIS (pages 384-6) show that this waste rock is uncertain with regard to acid production as well.

The DEIS primary reference regarding waste rock, Environmine (2007), also supports the idea that the waste rock could produce acid because it acknowledges the sulfide deposits within the halo surrounding the ore are acid-producing.

> Although they do not occur in any significant quantities within the ore itself, galena, pyrite, and pyrrhotite are potentially significant to the environmental chemistry of the

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[1] EPA, 2009. Emigrant Project Revised Draft Environmental Impact Statement (EIS), Elko County, Nevada (CEQ#20080468). March 23, 2009. This comment letter lists the three mines mentioned and notes that the 20 weeks used at the Emigrant Springs Project is grossly insufficient.

[2] See note 2.

> waste rock to be mined from the lower Revett Formation. Limited drilling data suggest that the thickness of these halo zones varies across the mine area, and across the Belt basin (Boleneus, 2005). The relative tonnage of these lithologies that would be produced as waste, and the relative area that would be exposed underground, would need to be further defined during completion of the Libby and Ramsey adits, along with development of underground work stations. (Enviromine, 2007, page 7)

In summary, there is just not sufficient data to make conclusions regarding acid mine drainage at this mine. The DEIS should be redone with many additional kinetic tests considered. If alternative 3 is chosen, the reconnaissance work should include many additional ABA and kinetic tests.

The ABA and kinetic tests for ore and waste rock do not adequately consider the actual seepage through the stockpiles.

As noted, far too few tests were performed. Because of the uncertain results of these tests, the mine will produce acid depending on the site specific aspects of the facilities. Preferential flow paths will develop which could bypass the mixing of rock which is assumed by the mining company. Fractures and finger flow are two forms of preferential flow.

The plans for managing potentially acid generating waste rock are grossly insufficient and will allow degradation of the waters of Montana.

There should be an estimate of how much neutralizing material is necessary to counter the AMD and how much is available. Without these estimates, even the best management plan can not be depended on to actually decrease the AMD. It also seems unlikely that isolation will occur in a plan that does not include permanent waste rock dumps, as most of the waste rock will be stockpiled only temporarily.

One of the MPDES outfall points includes waste rock seepage and runoff from the stockpile at LAD site 1.

> The EPA has established Effluent Limitations Guidelines (ELGs) applicable to mines that produce copper and silver and mills that use the froth-flotation process for the beneficiation of copper and silver (40 CFR 440.100). The following discharges subject to the ELGs would include, but not be limited to: mine and adit drainage, tailings impoundment seepage, tailings impoundment dam runoff, runoff and **seepage for waste rock stockpiles**, runoff from facilities constructed of waste rock if subjected to precipitation, and runoff of excess water from LAD Areas 1 and 2. The discharges would be regulated at an outfall in a MPDES permit. (DEIS, page 61, bold emphasis added)
>
> **Infiltration and/or runoff from stormwater on the waste rock stockpile at LAD Area 1 is subject to MPDES permitting requirements.** MMC proposes to collect LAD Area 1 surface water runoff in an unlined ditch extending northward along NFS road #4781 and routed into an unlined sediment retention pond (Figure 7). A second unlined ditch and pond are proposed for runoff from LAD Area 2….

> The **Waste Rock Stockpile at LAD Area 1** would be a staging area for temporary and intermittent placement of waste rock during construction of the tailings impoundment dams. In addition, MMC anticipates minimal to no surface water discharges from LAD Area ponds due to the design capacity (10-year/24-hour storm event). (DEIS, page 62)

The mine therefore plans to discharge waste rock seepage through its MPDES outfalls. There will also be seepage through the pads, constructed of waste rock, at the Ramsey Plant site (Geomatrix, 2007, page 90; DEIS , page 62). The DEIS does not estimate the seepage rate through the waste rock, therefore there is insufficient information to permit it.

The plan for the LAD Area ponds to be designed for the 10-year return interval storm event virtually guarantees the design capacity will be exceeded once or more during the project life of 16 years (DEIS, page S-9).

Predictions of Surface Water Quality

The DEIS lists the sources of discharges (DEIS, page 501) and notes that all, excepting storm runoff, are discharges to groundwater. The DEIS does not include the 25 gpm tailings seepage in that list, as it should. The list includes water from the tailings impoundment treated at the LAD areas, but that does not include the tailings seepage. Geomatrix (2007c, Figure 17) shows tailings seepage, therefore the DEIS should be corrected. The DEIS also acknowledges that the tailings seepage will degrade surface water: “Seepage from the tailings impoundment would have to be captured prior to entering the creek to avoid water quality exceedences in former Little Cherry Creek” (DEIS, page 503). The discussion in the remainder of the DEIS indicates that they will NOT capture the tailings seepage, therefore this statement acknowledges the project, at least as proposed (alternative 2), will degrade surface water.

Predictions of water quality are for points along Libby Creek, Ramsey Creek, Poorman Creek, and Little Cherry Creek (Table 1). These currently have very good water quality, so it takes very little discharge to “degrade” their water quality.

Table 1 allows a side-by-side comparison of the predicted water quality at three sites for alternatives 2 and 3. Although there are many reasons discussed below as to why these estimates are too low, the table shows clearly that alternative 3 will degrade the surrounding streams the least. This is probably due to the tailings not being located in Little Cherry Creek and to the use of denser tailings resulting in less seepage and less tailings water being applied for LAD.

Geomatrix (2007a) presents the mixing calculations for each monitoring point along the streams. The basic calculations appear to have been done correctly. The accuracy of the predictions depends on the seepage rates, seepage water quality predictions, and the predicted flow rates in the receiving waters.

Table 1: Comparison of predicted concentrations for alternatives 2 and 3 for three monitoring points. Data from Tables in the DEIS.

Site	RA-600		PM-1200		LB-1000	
Alternative	2	3	2	3	2	3
During Construction						
TDS	30	42	33	40	45	44
NH3, as N	0.59	0.95	0.45	0.69	0.24	0.36
NO3	1.42	0.28	1.06	0.21	0.52	0.13
TIN	2.01	1.23	1.51	0.9	0.76	0.48
Antimony	0.003	0.003	0.003	0.003	0.004	0.004
Cu	0.001	0.001	0.001	0.001	0.001	0.001
Fe	0.05	0.05	0.05	0.05	0.04	0.05
Mn	0.02	0.02	0.02	0.02	0.02	0.02
Zn	0.02	0.02	0.02	0.05	0.02	0.02
During Mining						
TDS	29	40	32	38	39	46
NH3, as N	0.41	0.36	0.32	0.47	0.19	0.24
NO3	0.97	0.15	0.73	0.16	0.39	0.1
TIN	1.38	0.5	1.05	0.63	0.58	0.34
Antimony	0.003	0.003	0.003	0.003	0.004	0.004
Cu	0.001	0.001	0.001	0.001	0.001	0.001
Fe	0.05	0.05	0.05	0.05	0.05	0.05
Mn	0.02	0.02	0.02	0.02	0.02	0.02
Zn	0.02	0.02	0.02	0.02	0.02	0.02
Post Mining						
TDS	34	48	36	45	39	48
NH3, as N	0.45	0.7	0.34	0.52	0.21	0.27
NO3	0.93	0.2	0.7	0.15	0.4	0.1
TIN	1.38	0.91	1.04	0.67	0.61	0.36
Antimony	0.003	0.004	0.003	0.003	0.004	0.004
Cu	0.001	0.002	0.001	0.001	0.001	0.001
Fe	0.05	0.05	0.05	0.05	0.05	0.05
Mn	0.07	0.11	0.06	0.08	0.04	0.05
Zn	0.02	0.02	0.02	0.02	0.02	0.02
TIN: Total nitrogen, NO3: nitrate, TDS: Total dissolved solids						

Seepage Rates

The DEIS expects the tailings impoundment to seep tails water past the drains and pumpback wells at rates up to 25 gpm (Geomatrix, 2007a; Klohn Crippen, 2004). However, the design presented in the 1992 EIS called for seepage to equal 400 gpm. Klohn Crippen (2004) designed an underdrain system to reduce the seepage. As discussed above, the liner does not extend under the entire impoundment. The agencies must provide better justify the low seepage rates because the seepage water quality is poor and a small difference in the seepage, as compared to the 1992 value, would result in large differences in the loading to Libby Creek.

The amount of water to be applied at the LAD sites is truly a moving target that depends on the dewatering rate, the uncertainties of the different estimates were discussed above.

Tailings Seepage Quality

The seepage water quality predictions have generally been based on values from the Libby adit and observed at the Troy Mine. An error is that Geomatrix (2007a) uses dissolved values where total recoverable values should be used. As noted above in the section "Tailings Impoundment Hydrology", total recoverable values should be used for surface water; this applies for situations where groundwater discharges to surface water.

Chemistry resulting from recent analyses of tailings seepage at Troy may not represent that to be expected at Montanore because those tails have been drying for at least 13 years; prior to using any recent chemistry from Troy tailings (Geomatrix 2007, page 47), the agencies must consider how that chemistry may have changed.

Concentrations are based on an artificially low nitrate and ammonia concentration from several sources. Geomatrix (2007a) justifies using a lower concentration for nitrate and ammonia than was used in the 1992 EIS because they claim Montanore will handle the explosives better. "Management of explosives and use of emulsions would reduce nitrate concentrations expected during construction and operation of the Montanore Mine by Mines Management" (Geomatrix 2007a, page 49). The basic claim is that they would use emulsions rather than the basic dry fuel/nitrate mix which would reduce the residual nitrate pollution. Based upon this speculation, they have chosen to reduce the nitrate concentrations from adits, mine workings, and tailings impoundments to 15 and 25 mg/l from 23.5 and 40.7 mg/l used in the 1992 EIS, respectively, for construction and operations. Ammonia has been reduced to 5 and 10 mg/l from 15.7 and 26.9 mg/l, respectively. This Montanore DEIS has inappropriately assumed away from 36 to 68 percent of the nitrate and ammonia loading with this unjustified speculation.

Predicted Stream Flows

The stream flows used for mixing analysis correspond to the 10-year 7-day low flow and the average annual flow. The 10-year 7-day low flow is the average flow that occurs for 7 consecutive days with a 10-year return interval for recurrence. On average, an average 7-day flow will be less than this value only once every ten years; in any given year, the probability the 7-day flow will be less than this value is 0.1. The values presented in Geomatrix (2007a) were originally determined for the 1992 EIS. Geomatrix (2007a) does not explain how the values were determined or present the data used to determine them. However, they present a table with the Q_{7D10Y} flow along with the observed low flows (Geomatrix, 2007a, Table 25) which shows how the low flows are grossly overestimated for Poorman Creek and Libby Creek.

The agencies allowed a mixing analysis based on too much flow at the stream monitoring points. The Q_{7D10Y} flows, reduced by an additional 25%, for stations PM-1000, LB-2000, LB-1000, and LB-800 are 440, 3000, 2300, and 2100 gpm, respectively, but the observed low flow for the 1988 to 2006 period is 320, 2600, 1300, and 1300 gpm for those stations. Geomatrix reduced the 1992 EIS Q_{7D10Y} flows by 25% to "account for some uncertainty and to be conservative" (Geomatrix, 2007a, Table 25), but a comparison of the flows to the observed low flows indicates they are probably still too high. They do not explain the frequency of the flow measurements used to determine the low flow and the time period exceeds 10 years (1988 to 2006), but the magnitude of the difference is too large to ignore or to suggest that it just represents a low point in the Q_{7D10Y} flow. These streams would experience baseflow for a significant time period – that is why low flow analyses use periods longer than an observed nadir in the flow – therefore it is likely the low flows are part of a much longer period[3]. Because they are so much less than the design flows, they indicate that the mixing analysis is based on flows that are too high and therefore allow for too much dilution.

The analysis also shows the importance of considering seepage to Little Cherry Creek. Geomatrix's Table 25 shows the low flow in that creek is 70 gpm which is less than a quarter that in Poorman Creek and a small fraction of that in Libby Creek, the stream which Geomatrix assumes will receive tailings seepage. As discussed above on page 16, the tailings seepage could mound and cause discharge to Little Cherry Creek. If all or part of the tailings seepage reaches Little Cherry Creek, because of its small flow rate, it could potentially be highly degraded.

Summary for MPDES Outfalls

The tailings seepage is underestimated. The LAD application rate is highly uncertain. The analysis uses incorrect As concentration for tailings seepage to surface water. Predicted nitrate and ammonia concentrations for all sources of water are artificially lowered. The stream flow rates are grossly underestimated. All of these factors result in the concentrations predicted for discharges of groundwater to surface water to be much too low.

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[3] It is possible the lowest flow occurred due to an ice jam or similar infrequent event not ordinarily considered as the cause of low flows. If that is the case, the agencies should not use the flow to compare with the longer duration low flow used for mixing analysis because the low flow, in that case, would be irrelevant to the analysis.

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