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September 26, 1994
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Mr. Andy Ledford
EG&G Rocky Flats, Inc.
Rocky Flats Environmental Technology Site
P.O. Box 464, Building 080
Golden, Colorado 80402-0464

Subject: MTS 343756 GG
OU4 Solar Ponds IM/IRA
Transmittal of Responses to the EPA/PRC Slurry Wall Comments

Dear Mr. Ledford:

Enclosed are responses to the EPA/PRC comments that were received on the document entitled "Evaluation of Specific Methods to Prevent Ground Water Contamination." ES will incorporate the comment responses as noted into the document, and re-issue the document as an Appendix in the Proposed IM/IRA-EA Decision Document.

Please call me at 764-8811 or pager 687-2551 if you have any questions.

Sincerely,

Philip A. Nixon
Project Manager: Solar Pond IM/IRA

cc:

| | | |
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**Responses to EPA/PRC Comments on the Slurry Wall**

Comment #1

Comment #1 is related to the evaluation of the slurry wall and trench system (collectively referred to as the vertical system) as a viable ground water control mechanism. The study did evaluate both the vertical system and the lateral (subdrain) system on the same basis. The evaluation criteria was cost, effectiveness, and potential risk for the design life span of 1,000 years. The purpose of the study was to investigate if a vertical system was better, based upon the evaluation criteria. This will mentioned in the report. Each bulleted item in comment #1 is responded to separately.

1st Bullet-Comment #1 Response-

The comment pertains to having both a slurry wall and a drainage trench on the upgradient south side of the SEPs to divert impinging ground water. The major overriding factor that was considered in the design process is that the system must function for 1,000 years. The probability that either system (trench or slurry wall) would fail is what needs to be considered. The likelihood that both would fail is much smaller. In essence, the collection trench serves as a "back-up system" (even though it is in front of the slurry wall), a ground water collector to satisfy the requests of CDPHE, and as a preventive to a hydraulic head build-up in front of the slurry wall. This will be clarified in the report. The factors that are addressed in the evaluation relate to the design criteria that were mutually agreed upon. It was agreed by the DOE, CDPHE, and EPA at the July 25, 1994 working group meeting that the following criteria would be established for the vertical system analysis.

a) The ground water control mechanism (in this case the upgradient vertical system) must prevent ground water from contacting the consolidated contaminated media beneath the protective cover for the 1,000-year system design life (restatement of the criteria for the functioning life for the system);

b) The ground water would have to be collected and removed from the area so that the ground water head build-up would not cause a failure of the control mechanism (both normal and abnormal precipitation events need to be considered);

c) Any mechanical device that was needed to remove ground water from the drainage system would not have to function for the 1,000-year time period because it will be assumed that the ground water at the Rocky Flats will be remediated (the drainage system still has to function in some other manner);

d) The upgradient ground water control mechanism needs to be tied into competent bedrock, estimated 20 to 30 feet (with limited site specific information on the spring ground water recharged mechanism for the alluvium, keying the control mechanism into competent bedrock adds to the factor safety and insures that the site is effectively dewatered);

e) The upgradient ground water control method must function to dewater the hillside under the same expected ground water rise (or impingement rate) that was used to design the subsurface drainage layer (horizontal system); and

f) The CDPHE requested the collection trench because they wanted to ensure that the ground water would be collected at the ITS.

The comment continues and is related to evaluating the slurry wall with an increased head. Although an estimate can be made of the worst case scenario for hydraulic head so that the performance objectives for the slurry wall can be analyzed, it would be beyond the scope of the agreed upon problem.

2nd Bullet-Comment #1 Response-

This comment relates to the keying in the slurry wall into bedrock and determining the effectiveness of the slurry wall. Since the vast majority of the bedrock is claystone or siltstone, the term bedrock will treat the sandstone bedrock units as part of the alluvium (similar to UHSU connotations). It is true that the claystone/siltstone bedrock of OU4 have low hydraulic conductivity values (where there are no fractures). This statement is even true for the fine-grained sediments of the alluvium. However, fractures and coarse-grained sediments provide a more direct route for liquids to migrate. It is known (see the Phase I RFI/RI for OU4) that scoured into the surface of the bedrock are paleochannels and that there are fractures within the bedrock. Within most of these channels there are coarse-grained sediments that appear to act as one of the primary pathway to recharge the alluvium during the spring. The exact method of alluvium recharge is unknown. The conceptual model for spring recharge is that bedrock fractures, coarse-grained sediments incised into bedrock, coarse-grained sediments within the alluvium, and alluvium macropores all interact to recharge the alluvium. The head response seen in the monitoring wells is a result of interplay of these elements under what may be thought of as a "mounding aquifer condition". Mounding is a result of water entering a system faster than that system can transport it. For a "wetter response" (a response as a result of wetter climatic conditions), wells along North Walnut Creek were considered. Well B208589 is screened into the weathered bedrock and indicates a potential for hydrating the alluvium from low hydraulic conductivity materials. Assuming that this model is correct, then the slurry wall has to be extended to at least the top of the bedrock and possible deep enough to cut-off flow in the fractures. If the slurry wall does not extend into fractures, then there is a possibility that with sufficient hydraulic head and mounding type soil conditions that ground water could migrate beneath the protective cover within the 1,000-year period of performance. Without 100% effectiveness in separating the ground water system from the contaminated material beneath the protective cover, there could be leaching of contaminants. Within the report, the rational for extending the slurry wall into unfractured bedrock can be linked to the conceptual model developed in the Phase I RFI/RI. A slurry wall or trench drain could be very effective (if installed properly) under homogeneous alluvium material conditions with downward ground water gradient. However, under the heterogeneous conditions at OU4 the blanket drain will be easier to verify for conformance to design specifications.

The comment continues in reference to detecting fractures during trenching operations and not using a slurry wall if unfractured bedrock is required. Since anchoring the wall into unfractured bedrock is the premises for being guaranteed 100% effectiveness for 1,000 years, the depth extent of these fractures has to be at least estimated. It is correct that trenching operations can not be used to determine the depth of unfractured bedrock. Boreholes and geophysical methods both have technical limitations, therefore there is an unquantifiable risk associated with using a slurry wall. No report modification is necessary.

3rd Bullet-Comment #1 Response-

This comment is related to the amount of data required to determine the effectiveness of the slurry wall or the lateral drain and the schedule delay that would result. Demonstration that the slurry wall is 100% effective is the premise that needs to be addressed. This will be stated in the report as a risk factor. As stated above, the OU4 area is a complex hydrogeological site with a variety of factors that appear to be interrelated. In the OU4 Phase I RFI/RI sampling on a 30 foot basis was needed to characterize the configuration of the bedrock and identify a paleochannel (see wells 44893, 44993, 45093, 45293, and 45393). This level of detail investigation has not been done on the south side of the SEPs. As an alternative to drilling, this same channel and a weathered bedrock zone were identified with a refraction survey. There are no refraction lines on the south side of the SEPs. To complete a competent performance review of the slurry wall, a large amount of data would be required to fill certain data gaps and this process would have a schedule impact. The slurry wall was evaluated, based upon reasonable assumptions. PES/ES believes that for certain sites a slurry wall may be a preferred alternative but not for OU4 under the 1,000-year performance criteria. If the vertical system appeared to be a preferred system based upon the evaluation criteria then, exact data gaps would have been evaluated and the impact on the schedule estimated. DOE does not consider that the design schedule will have to be extended for the subsurface lateral drain design. The "modeling" and calculations for the subsurface lateral drain was performed as a function of the design process. Because necessary data exists for an analytical evaluation ("modeling")of the lateral drain no additional data is required. The final hydraulic calculations for the performance of the subsurface drain will be done as a function of the Title Design.

4th Bullet-Comment #1 Response-

This comment is related to the amount of wastes generated and the disposal of those wastes related to the installation of the slurry wall and trench system. Excluding the slurry component, the amount of material excavated to install the vertical system is approximately 8,000 cubic yards. Placing this under the protective cover raises the cover by about 6 inches. As for the displaced slurry, it should not be consolidated beneath the engineered cover unless it is solidified. Since there is an attempt to minimize the amount of free liquids and materials deposited beneath the engineered cover, these components are significant disadvantages to the vertical system. In the report, the mixing of clean soil with bentonite will be removed as a significant disadvantage to the vertical system but also the trade-offs of eliminating the drainage layer and replacing it with excavation wastes and slurry will be added.

5th Bullet-Comment #1 Response-

This comment is related to cost analysis/comparisons between the vertical and lateral systems. DOE considers that the upgradient collection trench is necessary to satisfy the concerns of the CDPHE. Therefore, the cost of this system will remain in the analysis. Since the cost of both the vertical and horizontal systems are essentially equal, the primary concerns are performance and risk issues. The system comparison basis will be mentioned in the report.

6th Bullet-Comment #1 Response-

This comment is related to the potential impacts on remedial ground water efforts caused by the vertical system. The apparent contradiction will be clarified by stating that the slurry wall system may have positive or negative impacts on future ground water remediation activities. To predict whether the impacts would be positive or negative, the upgradient hydrogeological conditions and the method of OU4 ground water remediation would be required for modeling. With Phase II investigation not yet started it is impossible to draw any meaningful conclusions regarding the potential impacts.

7th Bullet-Comment #1 Response-

This comment is related to the potential advantages of implementing a slurry wall. The potential for expanded capacity beneath the engineered cover or an increase in slope stability will be mentioned as advantages of the slurry wall. The actual increase in capacity under the protective cover is less than the 28 inches (drain thickness) by over 6 inches because of the addition of excavated materials that would be added beneath the cover due to trenching of the slurry wall and vertical drain. This information was provided in Advantage #2 for the Vertical Ground Water Control System, but it will be clarified that additional capacity may be available.

Comment #2 Response-

This comment is related to utilizing borehole logs adjacent to the SEPs to make a map of the top of bedrock. The map suggested has been made and is a part of the IM/IRA Environmental Assessment Decision Document-May 1994 (Phase I RFI/RI Report). It utilized borehole and geophysical data to generate a more complete configuration of the top of bedrock surface. The objective is not to key the slurry wall into bedrock but to key the wall and trench into competent bedrock for 100% effectiveness. What was apparent from the mapping task was that well control alone was insufficient to characterize the bedrock surface or determine the potential depth of weathering into the bedrock surface. Generating a bedrock surface map is insufficient in determining the depth of fractures that are (or could be with a wetter climate) actively transporting fluids. The report response will be incorporated into #3 Response.

Comment #3 Response-

This comment refers to utilizing the refraction profiles adjacent to the SEPs and not a line along the pediment slope (line 7)for determining the depth to competent bedrock. The conclusions reached during the interpretation of the refraction lines was that the western line was contaminated with noise and was unusable. The other lines (lines 1 and 3) did not fully discern the weathered bedrock zone. Comparing line 1 with well 2786 will indicate that weathering may exists down as deep as 120 feet and not just 20 feet. Line 7 is more suggestive of the depth of "active" weathering and undulations that may be encountered on the bedrock surface. Without additional geophysical and geological information, suggesting the bedrock surface is competent at 20 feet based solely on a velocity increase may very well be unsubstantiated especially in view of the fact that there is adjacent well data suggesting an alternative interpretation. Report will indicate that based upon the data information available, the most likely depth to ensure 100% effectiveness that the lower bedrock strata is sealed-off from the alluvium is approximately 35 feet for the southern side of the SEPs. The comment continues and is related to the slurry wall proposed at OU7. One can not comment on the effectiveness of an engineering design at OU7 without having the data available for analysis. Although, it is understood that the system does not have to be effective for 1,000 years.

Comment #4 Response-

This comment is related to the effectiveness and the ability to compare the two systems. The DOE considers that effectiveness for the two systems can not be evaluated under equivalent criteria because the systems are designed for different functions. The subsurface drain performs occasionally whereas the slurry wall would need to perform continuously. The most logical basis for judging the systems is cost, effectiveness, and risk potential. The vertical system was judged on the basis of these criteria to establish if it had sufficient merit for any additional feasibility investigations. Long term ground water flow modeling is required to demonstrate the effectiveness of the slurry wall. This can not be done without having a project cost and schedule impact. The effectiveness of the subsurface drain can be demonstrated by analytical hydraulic calculations. This can be performed without a cost or schedule impact. No particular report modification necessary because it will be taken care of by the response to Comment #1.

Also as a comment it is suggested that the ability of the subsurface drain to remove water is not discussed and Page 9 is referenced. On page 9 the document states " The slope of the drainage system would **conduct** intercepted ground water away from the engineered cover and discharge it to the north hillside. The system is depicted in Figure 3.1...." The text discusses/shows the performance of the lateral drain system to transfer water and the minimum hydraulic conductivity that is expected for only the gravel layer. Analytical calculations determined the proper thickness for the lateral drain subject to the ability to constructed the system and subject to the slope established by excavation. A computer model was not implemented because of the time constraint and possible lack of key input parameters. With a built-in safety factor of at least 5 for the lateral drain, the analytical approach is adequate to move forward with remediation processes and not be delayed with research into modeling approaches that may or may not describe the performance of the lateral system more appropriately. No report modification necessary.

The comment continues by assuming that the alluvium would act just as efficiently as the lateral drain on transferring water to the north hillside underneath the protective cover. It is expected that the natural discharge of ground water flow to the north hillside either as seeps or into the ITS would continue under "normal ground water flow conditions". This type of flow would be beneath the lateral drain. It is only under "extreme high water" conditions that the lateral drain needs to function. Presently, during extreme high water conditions ground water impinges upon the bottom of the SEPs. With the lateral drain this flow would be intercepted and controlled. The ground water conducted through the subsurface drain would also exit onto the hillside or into the ITS. The geometric mean hydraulic conductivity of only the coarse fraction of the alluvium is $5.8 \times 10^{-3}$ cm/sec while, the minimum expected hydraulic conductivity for the lateral drain is approximately 40 cm/sec. Based solely on hydraulic properties, the lateral drain in nearly 10,000 times better than the alluvium. The report will reference that this hydraulic conductivity difference and the slope of the drain will prevent any mounding of ground water that previously would have impinged upon material placed beneath the protective cover. The "day-lighting" of the subsurface drain is important and will be discussed in the report.

Comment #5 Response-

This comment is related to the analytical solution presented and the impact and usefulness that these solutions have on the evaluation processes. In comment #1 and #4 it has been assumed by the commentator that the alluvium can be just as effective in removing the ground water from beneath the protective cover and the effectiveness of the lateral drain has not been evaluated. These comments are in contradiction with the comments of #5 about the usefulness of the analytical calculations presented in the report. As discussed in the above response, the most logical basis that the systems can be judged on is cost, effectiveness, and risk potential. It can be analytically demonstrated that the lateral drain is effective. The vertical wall system can not be demonstrated fully because of the fractures within the bedrock have the potential to cause ground water to mound within the alluvium. A ground water flow model would be required to demonstrate the effectiveness of the slurry wall system. This modeling process could get quite complex (with or without the trench, density of bedrock fractures, depth of saturation used, type of soils used under the protective cover that causes the mounding, the interrelation with between macropores and the fine grain soils). The flow calculations in the report are associated with cost factors. Analytical or numerical calculations for the two drains can approximate of the amount of ground water captured and this amount of water has a cost associated with treatment/handling. The vagueness associated with the usefulness of these analytical solutions or the symbols will be clarified. For instance, Figure 3.1 is not labeled or referenced fully. It is the model for the EPA analytical equation used for determining the effectiveness of the lateral drain. This will be clarified as related to the decision-making process.

Comment #6 Response-

This comment is related to the well evaluation report for Rocky Flats (RFETS) and vertical gradients within the alluvium. Granted, the predominant ground water trend is in the downward direction. The model from OU4 RFI/RI program states that there may be a potential for the lower bedrock strata to locally recharge the alluvium. Unexplained by the "only downward gradient philosophy" is the gain in water by the alluvium with little areal infiltration noted. Reviewing the OU4 hydrographs also indicate a downward gradient, except for possibly well 46293 and B208589. Well 46293 was artesian in the spring of 1993 (mounding effect) and B208589 (a possible look-a-like for a wetter climate scenario) shows a recharge potential to the alluvium. Whether the "lower bedrock strata" are apart of the UHSU of the LHSU is unknown and is to be determined during the Phase II investigation. Any reference to the LHSU will be reworded to lower bedrock strata. The important part is that there is a potential for water movement between the lower bedrock strata and the alluvium and where exactly should the base of the slurry wall be set to be ensure 100% effectiveness for even wetter climatic conditions. (See also Comment #3 Response).

The second part of the comment is related to the infiltration calculations associated with well 41193 in the IM/IRA Decision Document. The observed response to the rainfall event and calculation of hydraulic conductivity was based upon the assumption that the rainfall event cause the movement. Two pages later (II.3-180) state that "Evidence of significant wetting front movement was not observed at any of the neutron probe monitoring locations." Being installed one month later than any significant precipitation event may have precluded any of these observations. Also within that document it is stated that the are several mechanisms that appear to recharge the alluvium (page II.3-178), one of which is flow through macropores. The macropore concept leads to the conclusions developed in Section II.6 (page II.6.6) which suggest that lower bedrock strata may account for some of the recharge. Since the hypothesis presented in this report is based upon these observations and conclusions developed in the IM/IRA Decision Document, no conclusions need to be reconsidered.

Comment #7 Response-

This comment is related to silt and clay particles that may clog the vertical drain because there is no known practical way to construct sand filter packs vertically. The subsurface lateral drain has a sand filter layer above and below the gravel to prevent clogging. The design was presented as Figure 3.1. The design will include a means to seal the upgradient end of the gravel layer. The important fact is the lateral drain does not have to work on a daily basis filtering particles unlike the vertical drain. The report will emphasize the functioning aspect of the lateral system.