CIMARRON CORPORATION

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October 26, 2006

Mr. Kenneth Kalman
Office of Nuclear Materials Safety & Safeguards
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Re: Docket No. 70-925; License No. SNM-928
Conceptual Site Model and Response to NRC Comments

Dear Mr. Kalman:

In August 2005, Cimarron Corporation (Cimarron) submitted *Site-Wide Groundwater Assessment Review* and *Refined Conceptual Site Model* to NRC. *Site-Wide Groundwater Assessment Review* demonstrated that Cimarron evaluated all potential sources of groundwater impact and delineated groundwater exceeding decommissioning criteria. *Refined Conceptual Site Model* presented a description of site geology, hydrogeology, and geochemistry, and described in detail areas in which remediation is needed, and provides the foundation for evaluation and design of groundwater remediation technologies. In October 2005, NRC, DEQ, and Cimarron representatives met to discuss these submittals and future plans for groundwater remediation. NRC formalized comments on the Conceptual Site Model in a February 2006 letter.

Cimarron encloses herein responses to NRC's comments and *Conceptual Site Model – (Revision 1)*. NRC's comments addressed not only the conceptual site model, but various aspects of groundwater remediation. NRC comments which address the conceptual site model are specifically addressed in these responses. Cimarron will shortly submit a license amendment request for groundwater remediation. NRC comments addressing the selection of a remedial technology were considered in Cimarron's evaluation, and those addressing implementation or post-remediation monitoring will be addressed in the work plan for groundwater remediation.

If you have any questions or comments, please contact me at (405) 775-5194.

Sincerely,

Jeff Lux
Project Manager

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RESPONSE TO NRC STAFF COMMENTS

Cimarron provides responses to NRC's review comments (Letter, K. Kalman, NRC to J. Lux, Tronox; 02/01/06) on the Refined Conceptual Site Model (CSM) dated August 2005, as well as "parking lot issues" derived from the October 5 and 6, 2005 meeting in this document only to the extent those comments relate to the CSM. The CSM was developed to provide a model of the site as it currently exists. The geological, hydrogeological, and geochemical characteristics of the site must be understood both to evaluate alternate remedial technologies as well as to prepare a remedial design. Some of NRC's comments relate to the remedial design rather than a conceptual understanding of the site. For example, General Comment #7, "Please discuss the need and value of future ground-water monitoring for the identified remedial options" does not address the CSM, but the remedial design. Cimarron therefore did not provide a definitive response to this comment. This and other comments not directly applicable to the CSM will be more fully addressed in the license amendment request for groundwater remediation.

General Comments:

Comment #1

Has Cimarron or its contractors developed numerical models (i.e., ground-water flow, transport, and/or geochemical simulation models) of the hydrogeologic system in Burial Area #1?

Response:

A numerical groundwater flow model has been developed to support evaluation of remedial alternatives in both the BA#1 Area and the Western Alluvial Area. The modeling is described in detail in the report entitled "Groundwater Flow Modeling Report, Cimarron Site", submitted as Attachment 2 to the Site Decommissioning Plan – Groundwater Decommissioning Amendment. The Refined Conceptual Site Model Report has been updated, incorporating findings from the modeling as appropriate.

Comment #2

If there are flow and/or transport models, please identify the estimated hydraulic and transport properties of the hydrogeologic units modeled for Burial Area #1, Western Upland Area, and Western Alluvial Area. Please include an estimate of the range of typical values and explain the technical bases and analysis procedures for its estimation.

Response:

Hydraulic conductivity data for the site are presented in the Conceptual Site Model Report. The Groundwater Flow Modeling Report provides a detailed discussion of the estimated range of aquifer characteristics, and those selected for the calibrated model. As described in the Groundwater Flow Modeling Report, the final values of hydraulic conductivity were based on both the available site-specific data and the model calibration process. Assigned values for porosity ranged from 10% to 30% for the various geologic materials; porosity is used in generating flow paths. Except for flow paths, no solute transport modeling was performed, so no values for retardation, dispersivity, and other transport properties were needed.

Comment #3

How was the geochemical data analyzed? Please discuss, in detail, your geochemical model(s) (e.g., MINTEQA and other software codes?) for this site.

Response:

Geochemical data was analyzed for two purposes: 1) to deduce the hydrochemical facies of site groundwater and 2) to assess the forms that uranium takes in groundwater. Stiff and Piper diagrams were generated from the data to evaluate groundwater types and to ascertain the relationships among the hydrochemical facies. A geochemical model, MINTEQA2, was used to evaluate the speciation of uranium in various groundwater samples at the site. Field water quality measurements, such as temperature, pH, dissolved oxygen, and oxidation/reduction potential (ORP), were also used in the evaluation of uranium speciation along with published information regarding uranium stability in natural water. A discussion of the MINTEQA2 model is included in the updated CSM.

Comment #4

Please discuss how the analytical results from your geochemical model(s) (or analyses) relate to solute transport modeling at this site. What are the major hydrochemical facies and what is the geochemical indicators for uranium mobility?

Response:

As discussed in the CSM, there are three major types of groundwater (hydrochemical facies) within the project areas based on the geochemical data. These include calcium bicarbonate water originating from Sandstone B, calcium sulfate water originating from Sandstone C, and magnesium bicarbonate water mainly associated with clayey soil. Mixing of these waters was evident in the floodplain alluvium. The Cimarron River is characteristically a sodium chloride type water and has not been identified in the project areas. Spatial distributions of the hydrochemical facies are presented in the CSM.

The mobility of uranium in groundwater is controlled by four factors including solution pH, ORP, water chemistry, and soil characteristics. These four factors determine the direction and extent of four basic chemical reactions that influence the transport of uranium: complexation, oxidation/reduction, adsorption/desorption, and precipitation/dissolution. Under the geochemical conditions (near neutral pH, positive ORP values, relatively high bicarbonate content) present at the Cimarron site, geochemical modeling indicated that the uranium exists in the site groundwater almost exclusively in the forms of uranyl carbonates ($UO_2(CO_3)_2^{-2}$ and $UO_2(CO_3)_3^{-4}$). These negatively charged species are stable in groundwater in the pH range between neutral and 9. In slightly acidic solution, adsorption of these species onto soil particles becomes increasingly important, thus reducing the uranium mobility.

Comment #5

If you have developed numerical models of Burial Area #1, Western Upland Area, and Western Alluvial Area, please discuss your model calibration procedures. If you have not developed numerical models for these areas, discuss what calibration procedures or approaches you would propose for future confirmation of conceptual and future numerical ground-water flow and transport models.

Response:

The Refined Conceptual Site Model Report (August 2005) was submitted prior to the development of any numerical groundwater models. A groundwater flow model was developed for the Burial Area #1 and Western Alluvial Area to facilitate the evaluation of remedial design options. The results are discussed in the Groundwater Flow Modeling Report for the Cimarron Site, and are briefly summarized in the updated CSM.

The groundwater flow model was calibrated to available groundwater elevation data using a trial-and-error process. The calibration was conducted by making adjustments primarily to the boundary *conditions and the hydraulic conductivities until the simulated groundwater elevations adequately matched observed groundwater elevations. In addition to comparing model predicted elevations to observed elevations, the calibration was also intended to capture gradients and flow directions such that simulated flow paths were congruent with inferred flow paths from concentration data (e.g., the shape of the uranium plume in the BA#1 Area).*

Incorporation of the Western Upland Area in the Western Alluvium numerical model would have unnecessarily increased the numerical complexity, due to the geometry of the escarpment and the contrasting geologic materials on either side of it. Instead a separate numerical model was developed to evaluate the flow to an interceptor trench proposed for this area.

MODFLOW was used to simulate the groundwater capture in an interceptor trench, in the same way a two-dimensional analytical model might be implemented. That is, it did not incorporate any geologic heterogeneities. The boundaries were selected only to approximate the gradients and elevations observed based on measured data; they themselves are not based on any measured data. No formal or rigorous calibration was completed. The purpose of using MODFLOW was to allow for some flexibility in simulating the placement both horizontally and vertically of the trench and to be able to use MODPATH to ensure that particles originating from BA #3 end up in the trench.

Comment #6

How do you integrate site hydrogeologic characterization and monitoring to identify and evaluate potential remediation options? How would numerical modeling using this information assist in the decision making?

Response:

The hydrogeologic characterization of groundwater conditions at the site (including monitoring data) served as the basis for the Conceptual Site Model. A conceptual model brings together available information to provide a comprehensive, integrated interpretation of conditions at a site. A conceptual site model is needed prior to evaluating remedial alternatives to address contaminated groundwater. The conceptual model for the Cimarron site was presented in the Refined Conceptual Site Model report (August 2005), and the report has been updated with current information, and in response to comments from the NRC.

Numerical modeling can support the evaluation of remedial alternatives in many different ways. Remedial alternatives that rely on hydraulic measures (pump-and-treat, cut-off walls, groundwater recharge and flushing, etc.) can all be modeled to develop a remedial design, to evaluate their effectiveness, and relative costs. Modeling can also be used to estimate clean-up timeframes. The specific potential uses of models are dependent on the objectives and types of remedial alternatives being considered.

Comment #7

Please discuss the need and value of future ground-water monitoring for the identified remedial options.

Response:

As stated in the introduction, this question does not address the CSM, rather the remedial design. Cimarron therefore did not provide a definitive response to this comment; this comment will be more fully addressed in the license amendment request for groundwater remediation.

Comment #8

Please discuss your analysis of the temporal and spatial variability of the uranium plume concentrations in the monitoring wells for the August 2002, and August 2004, sampling campaigns at Burial Area #1.

Response:

Figures 4-11 and 4-12 in the Refined Conceptual Site Model Report (August 2005) present the uranium plume configurations in Burial Area #1 for the August 2004 and August 2002 sampling events, respectively. Based on these two data sets, the plume appears to have retained its basic configuration. However, some variations between the 2002 and 2004 plume are noted:

- *The highest detected uranium concentration has been reduced from 5039 pCi/L in 2002 to 4397 pCi/L in 2004 (TMW-09).*
- *The area containing groundwater above 2,000 pCi/L total uranium appears to have expanded.*
- *The leading edge of the plume appears to have shifted to the east and there is little migration to the north towards the Cimarron River.*

Based on data of only two sampling events, it is difficult to determine if the spatial variation of the plume is statistically significant.

General Comment #9

Please discuss your analysis of the historical seasonal variations in the water table elevations, total uranium concentrations, and geochemical constituents (e.g., major cations and anions dissolved in the ground water) at Burial Area #1, Western Upland Area, and Western Alluvial Area.

Discuss the hydrometeorological processes which control ground-water level (water table) fluctuations (e.g., significant recharge events and Cimarron River flooding). Please compare site ground-water elevation and quality data versus river stages and total uranium and geochemistry of the surface water in the Cimarron River

Response:

In general, the highest water levels are found in the spring, with the lowest in the fall. This pattern is typical in temperate areas where plant evapotranspiration intercepts much of the recharge to groundwater during the growing season, with a resulting lowering of groundwater levels. Water-level fluctuations in water wells with 10 years or more of records averaged about 3 feet on a seasonal basis. A detailed discussion of the variations in water level elevations in the three areas addressed the (Burial Area #1, Western Upland Area, and Western Alluvial Area) is provided in Section 3.2.1(Delineation of Water-bearing Units) of the CSM.

Groundwater in Sandstone A flows from the topographically higher areas to adjacent drainages and reflects local recharge from precipitation events. The drainages within the Cimarron Site receive flow from precipitation events and from groundwater base flow when groundwater levels are relatively high. Most of the drainages penetrate only the uppermost sandstone (Sandstone A in the Western Alluvial area, Sandstone B in the BA#1 area) and thus act as local drains for shallow groundwater during precipitation events. The alluvium of the Cimarron River floodplain drains to the river, except during extreme flood events when the long-term, stable gradient may be disrupted for a short duration and groundwater flow may be at least partially from the river towards the south.

Site-wide groundwater sampling for geochemical constituents (major cations and anions) took place only in August 2004. Since there was only one sample event, correlations between groundwater elevations and concentrations of geochemical parameters could not be determined.

Wells with the longest history of monitoring data for uranium in the BA#1 area were analyzed with respect to the relationships between water elevation and uranium concentrations. The review revealed no apparent correlations between the two parameters, suggesting that there is no evidence that the uranium groundwater concentrations are affected by water level fluctuation.

General Comment #10

Please discuss the sources and magnitude of uncertainties in the conceptual site model, estimated parameters and their affect on the uncertainty in the feasibility and effectiveness of potential remediation options.

Response:

The uncertainties in the conceptual model are associated with potential variations in some of the estimated hydrogeological and geochemical parameters observed at the site. Allowances for these uncertainties have been addressed by the evaluation of a range of values for these parameters as remedial alternatives were developed and evaluated.

Specific Comments

Comment #1

There are only three soil samples with plasticity data. Plasticity data may provide an indication of geochemical retardation potential. Are there any plasticity data for soil samples beyond the three identified in the soil mechanics report which may be useful in estimating Kd's?

Are there additional grain-size analyses for this area and for the Western Upland Area and Western Alluvial Area?

Additional information on available grain size and plasticity analyses could provide a much more detailed distribution of soil types and estimates of hydraulic conductivity and geochemical retardation. The underlining premise is that grain size and plasticity analyses can be used to condition the estimates of hydraulic conductivity and geochemical retardation.

Response:

Plasticity data was only obtained for those samples for which results were reported. Cimarron does not believe it is justifiable to use plasticity data to estimate Kd values. Consequently, Cimarron has conducted elution testing to directly obtain site-specific Kd values and leachability characteristics.

The values provided by laboratories for grain size and plasticity analysis would give a false impression of accuracy in describing the distribution of soil types and hydraulic conductivity. Geotechnical analyses are only conducted on a subset of the soils obtained during drilling, providing data for a limited number of samples, even if taken from multiple borings. Lithologic descriptions provide a more reliable picture of the distribution of soil types than grain size or plasticity data, because lithologic logs are generated for all material recovered from every boring. Lithologic descriptions were included as an appendix to the January 2003 Burial Area #1 Groundwater Assessment Report.

Slug tests yield far superior estimates of hydraulic conductivity than grain size and plasticity analysis. Consequently, slug tests were performed on many of the wells installed in Burial Area #1, as reported in the January 2003 Burial Area #1 Groundwater Assessment Report.

Additionally, slug testing was performed in the Western Alluvium Area in 2006 to provide site specific conductivity data for this area.

Comment #2

Was the grain size analysis conducted by washing the samples through the #200 sieve? This information is very important since the fine particles may cling to the sand particles. The absence of washing may distort the particle size distribution by under reporting the "fine material" percentage which is thought to be the location for geochemical sorption sites.

Response:

According to representatives from Standard Testing (firm that completed the soil analyses), the grain size analysis did include a water wash to determine the washed loss for the #200 sieve.

Comment #3

What is the mineralogy of the sand, silt and clay particles? What implication does the mineralogy have on geochemical sorption and oxidation potential?

Response:

The mineralogy of the sand, silt, and clay particles was not determined for the alluvial sediments. However, the mineralogy of sandstone and mudstone of the Garber formation at or near the Cimarron site has been studied previously by Grant and USGS. These studies indicated that the sandstone and mudstone consist mainly of quartz, feldspars, and clay size particles with minor amount of calcite, dolomite, iron oxides or hydroxides, chlorite, and barite. The clay size particles comprised of kaolinite, smectite, illite, hematite, and goethite. Although the mineralogy of the alluvial sediments was not determined, their mineral compositions are expected to be similar to those of the bedrocks given the proximity of the unconsolidated soils in the floodplain and the weathered sandstone/mudstone. Different size fractions of the soils differ only in the proportion of each mineral that comprises each soil type.

The red or tan colored sediments in the floodplain indicate the presence of ferric iron oxides or hydroxides. The fine grained iron oxides or hydroxides are known to be adsorbents to uranium in slightly acidic water. As a result, the finer fractions of the soils (silt and clay) have greater tendency to adsorb uranium than the coarser fraction (mostly quartz and feldspars).

Comment #4

Is it possible that uranium which is possibly concentrated in the surficial soils of the partially saturated alluvial unit is being transported through the borehole annulus during infiltration and/or water table fluctuations? This local pathway should be explored to help explain some of the large values of total uranium concentrations in sands with little to no fine particles (e.g., SM).

Response:

Burial Area #1 - Final status survey measurements demonstrate that surficial soils are not contaminated. The source of uranium in this area was the now-excavated burial trenches overlying Sandstone B. Groundwater was impacted via migration of dissolved uranium from this source.

Cimarron is not aware of any source in surficial soils that could result in downward migration through the borehole annulus.

Western Alluvial Area – In this area, the final status survey measurements demonstrate that surficial soils are not contaminated. The historic pipeline leaks probably resulted in shallow subsurface soils (not surficial soils) becoming contaminated.

Monitoring wells are constructed to prevent downward migration through the annulus; the annulus is filled with a bentonite grout from the top of the screen to approximately three feet below grade. The top three feet is filled with concrete, which extends to a concrete apron at least three feet across at grade. As such, this pathway should be excluded as a possible source of contamination.

Comment #5

How often does the Cimarron river flood, and what is the duration and extent of the flooding? The flooding would influence the groundwater gradients and quality. Changes in the groundwater gradients would cause temporal variations in groundwater velocities, directions, and transport.

Response:

Cimarron concurs that changes in the groundwater gradients would cause temporal variations in groundwater velocities, directions, and transport. As the observed flooding during these periods is considered a transient event, and the floodwaters quickly recede, the periodic flooding in the Cimarron floodplain was not considered as part of the Conceptual Site Model.

Significant floods are relatively rare, therefore they have little long-term affect on plume migration and configuration, which is dominated by the groundwater system.

Comment #6

In Burial Area #1, the monitoring wells at the plume front have high total uranium concentrations. What are the plans for installing additional monitoring wells at the plume front? Will soil samples be collected for grain size analysis, plasticity analysis, and geochemical characterization?

Response:

The U concentrations at the leading edge of the plume in the BA#1 area are below the release criteria of 180 pCi/l, as documented in wells such as O2W45, O2W43, O2W44. As shown on Figures 4-11 and 4-12 in the Refined Conceptual Site Model Report (August 2005), the extent of the U above the release criteria is defined, so there are currently no plans to install additional wells in this area, nor to collect additional soil samples.

Comment #7

What are the performance indicators linking the groundwater monitoring to the formulation of the conceptual site model for groundwater flow and transport?

Response:

As stated in the introduction, this question does not address the CSM, rather the remedial design. Cimarron therefore did not provide a definitive response to this comment. This comment will be more fully addressed in the license amendment request for groundwater remediation.

Comment #8

What are the plans for monitoring groundwater, uranium, and other parameters in the unsaturated zone? Will soil water content, gradients, and soil water chemistry be monitored?

Response:

As stated in the introduction, this question does not address the CSM, rather the remedial design. Cimarron therefore did not provide a definitive response to this comment. This comment will be more fully addressed in the license amendment request for groundwater remediation.

Comment #9

What are the plans for calibrating or adjusting the site conceptual model using monitoring data? Will the calibration include different seasons and hydrologic conditions (e.g., flooding periods)?

Response:

The conceptual site model is not rigorously "calibrated" – formal calibration is a quantitative process, and the conceptual model is, by its nature, conceptual not numerical. However, conceptual models are typically refined and updated as new information becomes available, as described in Section 1.1 of the Refined Conceptual Site Model. For example, the conceptual model originally prepared in August 2005 has been updated based on information collected since that time. This new information is incorporated into the updated Conceptual Site Model Report.

Comment #10

What has been done to understand the possible leaching, mobilizing, and transport of total uranium from the unsaturated zone to the underlying water-table?

Response:

EPA's Soil Screening Guidance: User's Guide was utilized to evaluate the possible leaching, mobilizing, and transport of total uranium from the unsaturated zone to the underlying groundwater table. Using Equation 10 – (Soil Screening Level Partitioning Equation for Migration to Ground Water), it was determined that the soil leachate concentration after dilution will not exceed 153 μg/L., based on an initial soil concentration of 9 kg/mg Uranium, a distribution coefficient of 3.4 L/kg, water-filled soil porosity of 0.34 L/L, and a dry soil bulk density of 1.5Kg/L.

Comment #11

What is the concentration of total uranium in the unsaturated zone? Discuss its influence on the total uranium concentrations in the groundwater extracted from the monitoring wells.

Response:

Uranium concentrations for BA#1 soils in both the saturated and unsaturated zone are provided in the January 2003 Burial Area #1 Groundwater Assessment Report. Uranium concentrations in the unsaturated zone within or in the immediate vicinity of the historical footprints of the plume ranged between 1 and 32 pCi/g with an average concentration of 5.5 pCi/g. Sandy soils generally have a lower uranium concentration (<4 pCi/g) than clayey soils. If the clayey samples in the transitional zone and some samples from the former burial trenches are excluded from calculation, the average uranium concentration in the unsaturated soils decreased from 5.5 pCi/g to 3.8 pCi/g, which is considered within the background level. Although the background uranium concentration for the alluvial sediments was not available, uranium concentrations in the clayey soils that are apparently unaffected by the plume exhibited *an average concentration of 5 pCi/g. Therefore, with the exception of clayey samples inside the plume and some samples in the former burial trenches, uranium concentrations in the unsaturated zone are believed to be within the range of background values.*

The spatial distribution of uranium in groundwater and unsaturated soils indicate that the plume is largely unaffected by the uranium in unsaturated soils. Instead, the data suggest that the unsaturated soils may have been affected by the uranium plume at some points in the past. Elevated uranium concentrations in the transitional zone soils may have resulted from the adsorption of uranium originally present in groundwater. During a 5-year period from 1988 to 1993, the excavated former burial trenches were left open. Rainwater or surface runoff that accumulated in the open trenches may have increased the water elevation in the transitional zone to such an extent that soils currently in the unsaturated zone were actually in the saturated zone during that period of time. High groundwater levels resulted in soils at higher elevations being impacted by the moving uranium plume. This may be the reason that some shallow soils (not surficial soils) exhibited higher uranium concentrations than the saturated soil in the BA#1 transitional zone.

Parking Lot Issues

Comment #1

In the Western Alluvial Area near wells T-62 and T-64, (located at the base of the escarpment below the drainage of gully with groundwater seep 1206), is it feasible to perform a "pump and treat" remediation? Would a pilot study of a remediation procedure be feasible?

Response:

Extraction (i.e., pumping) with subsequent treatment is one of several remedial alternatives under consideration by Cimarron. Wells T-62 and T-64 are located near a "transition zone" containing lower permeability material. If excavation and pump and treat technologies are selected, these finer grained materials would likely be excavated.

Comment #2

For Burial Area #1, the plume's extended and narrow geometry might be explained by an advective-dispersive model. The Conceptual Site Model (CSM) should reflect this postulation and build on hydrologic and transport property estimation and needs. For example, what are the soil hydraulic and transport properties of alluvial materials and the importance of Kd's conditioned (or based) on particle size distributions and geochemical analyses?

Response:

The configuration of the U plume in the BA#1 Area does appear to be best explained by advective and dispersive transport. This hypothesis has been incorporated into the updated Conceptual Site Model Report. An evaluation of partitioning (Kd's) has also been performed, and is included in the updated report.

Comment #3

What are the potentiometric surfaces in the mudstone? How do mudstones relate to creation of perched water systems? How does groundwater in the mudstones relate to the groundwater flow directions and velocities within the adjoining sandstone hydrogeologic units?

Response:

There are no site-specific data on the potentiometric surfaces within the mudstones at the site, as no wells have been installed in these units. Due to the lower permeability of the mudstone relative to the sandstones, groundwater will tend to perch in the sandstone overlying these units. This is why groundwater in Sandstone A generally yields a higher potentionmetric surface than groundwater in Sandstone B. In the BA#1 Area, there is no evidence of perching. The presence of the mudstones between the water-bearing units restricts vertical movement of groundwater in preference to horizontal flow. This is most readily apparent in the seeps along the escarpment bounding the Western Upland Area. The horizontal flow of water in Sandstone A causes groundwater to discharge at the seeps in preference to migrating vertically downward to Sandstone B. Vertical hydraulic conductivities across units are expected to be significantly smaller than horizontal conductivities within water-bearing units. Gradients and flow directions within these lower permeability units are expected to be predominantly vertical.

Comment #4

Can groundwater monitoring data be used to estimate time-varying hydraulic gradients? Provide hydraulic conductivities estimates and groundwater flow velocities for Sandstones A, B, and C. How do these flow velocities vary with recharge in the gullies draining the uplands, and with recharge in the alluvial areas?

Response:

Estimated groundwater velocities for the three sandstone units and the alluvium have been added to the updated Conceptual Site Model Report. Hydraulic gradients could be calculated for any time period where groundwater level data are available. These values could also be used to estimate groundwater velocities.

Comment #5

What is the vertical groundwater flow in the two mudstones? How does it affect the contaminant plumes in Burial Area #1 and Western Alluvial and Upland Areas?

After reviewing the chemistry of Cimarron River water and the chemistry of groundwater in the alluvial flood plain, what insights can be drawn as to areas influenced by episodic flooding by the river, as opposed to the active upward groundwater flow from Sandstone C? What can be determined as to spatial and temporal horizontal groundwater flow and vertical groundwater flow in the alluvial materials in the vicinity of Burial Area #1?

Response:

The hydraulic gradient in the mudstones is expected to be vertical, and vertically downward in the BA#1 and Western Upland Areas. The low permeability of the mudstones restricts vertical flow and forces horizontal flow in the water bearing units, and this would restrict the migration of uranium-impacted groundwater to the water bearing units overlying the mudstones.

In the alluvium in the BA#1 Area, the hydraulic gradient is not expected to change significantly over time, except when the Cimarron River is at flood stage. The high permeability of the alluvial materials and the location of the River as a discharge point will tend to create a stable system. When the river is at flood stage, however, gradients are likely to be changed. However, these changes are short-term phenomena and are unlikely to have a significant impact on contaminant migration in the long-term.

This position is supported by the Stiff and Piper Diagram data presented in Section 4.3 (Area-Specific Geochemical Considerations) in the Updated CSM.

Comment #6

After reviewing the chemistry of the Cimarron River water and the chemistry of groundwater in the alluvial floodplain, what insights can be drawn as to areas influenced by episodic flooding by the river, as opposed to the active upward groundwater flow from Sandstone C? What can be determined as to spatial and temporal horizontal groundwater flow and vertical groundwater flow in the alluvial materials in the vicinity of Burial Area #1?

Response:

Based on the Stiff diagrams presented on Figure 4.7 and the Piper diagrams presented in Figure 4.8, the episodic flooding of the Cimarron River had little influence on the geochemistry of the alluvial floodplain as compared to the influence of the active upward flow from Sandstone C.

Comment #7

How can recharge and local water table fluctuations (and at time perched water tables) caused by the reservoirs, discharge in the 1206 groundwater seep area, and gullies draining to Burial Area 1 affect contaminant transport? How can this information be brought into the CSM?

Response:

The reservoirs have no impact on contaminant transport, as the water level in the reservoirs is nearly constant. Similarly, the short-term presence of run-off in the gullies may cause short-term, transient changes in hydraulic gradients, but that is reflected in the plume distribution as observed today. These transitory changes are reflected in the groundwater flow model.

Comment #8

How will the upward ground-water flow in Sandstone C impact the selection and design of remediation approaches?

Response:

Upward flow from Sandstone C and underlying units is discussed in the updated Conceptual Site Model Report and is incorporated into the groundwater flow model (Groundwater Flow Modeling Report). Remedial selection and design considerations are not included in the updated Conceptual Site Model.

Comment #9

Can the relative ages of ground water in the upland, transitional zone, and alluvium units be used to understand the dynamics of groundwater recharge, groundwater flow, and groundwater transport variabilities (e.g., determining O16/O18 rations of the groundwater sources)?

Response:

The dynamics of groundwater recharge, groundwater flow, and groundwater transport were evaluated during the development of the numerical flow models and the results are incorporated into the groundwater flow model (Groundwater Flow Modeling Report).

Comment #10

What are the sources of contaminants for the Western Alluvial Area, particularly in the 1206 seep gully? How can the elevated uranium concentrations in Wells T-62 and T-64 be explained? Would a monitoring well between Seep 1206 and Wells T-62 and T-64 help to identify sources and transport dynamics?

Response:

There are two potential sources for the contaminants in the Western Alluvial Area- Burial Area #3 and the pipeline corridor that extends from the historic locations of the lagoons to the alluvium. Cimarron installed two monitoring wells designated as MWWA03 and MWWA09 in February 2006 at locations that were located up-gradient (south) of wells T-62 and T-64 in the drainage from the 1206 seep. One of these wells is located in the drainage way through which the pipeline ran and the other was is located in the drainage way into which BA#3 discharges. Both wells detected uranium at concentrations exceeding the license criteria, so both the leaking pipeline and the BA#3 Area contributed to uranium observed in the Western Transition Zone.

Comment #11

To develop confidence and knowledge of the CSM, additional sampling events that target geochemistry/chemistry analytes using selected monitoring wells would be beneficial. This is particularly true for the "clay unit" and alluvium in the Burial Area #1 upland, transitional area, and flood plain. One sampling event does not adequately address the temporal patterns due to recharge and flow dynamics.

Response:

As part of a remediation system performance monitoring program, groundwater samples may be collected from selected wells and analyzed for selected geochemical parameters to allow for an evaluation of the groundwater remediation performance. The specifics of this program will be dependant upon the remedial technology selected.

Comment #12

Trend analysis for total uranium in the groundwater would help to understand the uranium plumes' behavior and the geometries and groundwater transport conditions for remediation. For example, how much uranium is in the groundwater as opposed to the porous media?

Response:

There were only two site-wide sample collection events in the BA#1 Area: August 2002 and September 2004. Based on the two sample events, trend analysis could not be performed. However, there are seven wells (TMW-13, 02W04, 02W07, 02W08, 02W19, 02W43, and 02W62) in the northern portion of the plume that have more than four quarters' data available. For those wells the Mann-Kendall statistics was calculated to evaluate whether the concentration fluctuation was random or directional. The analysis indicated that except one well (02W19) which showed an upward trend, there is no clear trend associated with the data in other wells, suggesting the concentration variations in those wells are random. Trend analysis for the entire plume would require the collection of several additional samples from numerous wells over time. Neither ENSR nor ARCADIS believe this information is needed for the development of a remedial design regardless of which remedial technology is selected.

The relative proportion of uranium mass in groundwater and in the porous media depends on three aquifer properties: soil bulk density, porosity, and distribution coefficient (Kd). If the bulk density is 1.7 *and porosity 0.25, it would require a Kd value of 0.15 to have uranium mass equally distributed between soil and groundwater. If the Kd is greater than 0.15, there would be more uranium in porous media than in groundwater. Because the uranium Kd values are greater than 0.3 at the Cimarron site, more uranium mass is expected in soils than in groundwater.*

Comment #13

Can further sampling and characterization of radionuclides and groundwater dynamics particularly the geochemistry of the porous media and groundwater, be used to better understand the transport and remediation approaches (e.g., "pump and treat") in the Western Pipeline Corridor?

Response:

As stated in the introduction, this question does not address the CSM, rather the remedial design. Cimarron therefore did not provide a definitive response to this comment; this comment will be more fully addressed in the license amendment request for groundwater remediation.

Comment #14

Nitrate and fluoride concentrations appear high in some areas. How do these areas compare to possible sources and contaminant releases for radionuclides discussed in the CSM?

Response:

A discussion of the occurrence of nitrate and fluoride has been included in the updated CSM report. Neither of these constituents is elevated in the BA#1 Area. Therefore, they are unrelated to potential releases from this area. A direct comparison between the occurrence of nitrate and fluoride with radionuclides does not seem useful, as elevated nitrate and fluoride concentrations in groundwater have been observed in locations where there is no exceedance of the site specific uranium criteria. Further information on nitrate and fluoride distribution in groundwater is included in the updated CSM report.

Comment #15

Compare the significance of longitudinal dispersion to diffusion in understanding the contaminant plume's geometry and behavior in Burial Area #1.

Response:

With the exception of a few very rare circumstances, diffusion is not an important transport mechanism in migration of contaminants in groundwater systems. As stated in Freeze and Cherry (Groundwater, 1979), "...diffusion is a relatively slow process. In zones of active groundwater flow its effects are usually masked by the effects of the bulk water movement. In low-permeability deposits such as clay or shale, in which the groundwater velocities are small, diffusion over periods of geologic time can, however, have a strong influence on the spatial distribution of dissolved constituents." The migration at the Cimarron site is not on the scale of geologic time. The primary mechanisms of transport are advective transport (with the groundwater flow), and dispersion (spreading during transport). Discussion of the advection and dispersion processes in the BA#1 Area has been added to the updated Conceptual Site Model Report in Section 5.1.2.

Comment #16

Evaluate the Cimarron River stage when the five trenches in Burial Area #1 were open, uncovered, during remediation.

Response:

There have been 5 recorded flood stage events affecting the Cimarron floodplain at BA #1 Area since the decommissioning activitie0s were undertaken. They were:

Date	***Status of BA#1 Area Burial Trenches***
October 4, 1986	*Open*
May 10, 1993	*Open*
March 16-19, 1998	*Closed*
November 1, 1998	*Closed*
March 23, 2000	*Closed*

The trenches in the BA#1 Area were excavated to depths of 7 to 8 feet during the period from 1986 to 1988. As such, the trenches were open during the flood stage event that occurred on October 6, 1986. It is estimated that the flood stage conditions persisted for an estimated 3-4 days in duration (flood waters only reached the far northern fringes of the trenched areas). Following a survey in 1991, the trenches were excavated an additional four feet in depth and an additional 14,000 cubic feet of impacted soil was removed. The four trenches were released in 1992 for backfilling by the NRC per License Amendment #9. The BA #1 Area trenches were subsequently backfilled with clean soil in 1993 and closed, after having remained opened for the time period from 1988 to 1993. As the trenches were in the process of being backfilled during the period of March through July of 1993, it is possible that they were still open during the May 10, 1993 flood stage event.

Because the flooding events in the Cimarron floodplain were transient and of short duration (typically less than a few days), it is unlikely that these events had much impact on the concentration of uranium observed in groundwater in the BA #1 Area. Based on observations from onsite personnel, it should be noted that flood waters never actually reached the open trenches, rather they were filled with surface run-off from site precipitation. Consequently, the run on of surface water from precipitation events would be expected have more influence on the groundwater regime than the infrequent flood events.

Comment #17

Why not discuss the impact of the Plutonium Pond, Plutonium Emergency Pond, and Uranium Emergency Pond on the CSM?

Response:

These ponds were identified as potential sources of impact to groundwater in the August 2005 Site-Wide Groundwater Assessment Review. Groundwater downgradient from these potential sources was sampled, and the results were discussed in that report. These areas, as well as those downgradient from them, are identified on Plate 2 of that report as Phase IIIa areas, meaning neither further monitorimg or remediation would be required for these areas. Because the August 2005 Refined Conceptual Site Model (CSM) was generated to provide a foundation for groundwater remediation in impacted areas, these areas unimpacted areas were not addressed specifically in the Refined CSM.

Comment #18

Do we need a groundwater monitoring well or wells in the drainage area near seep 1206?

Response:

Cimarron has installed two monitoring wells designated as MWWA03 and MWWA09 in February 2006 at locations that were located up-gradient (south) of wells T-62 and T-64 in the drainage from the 1206 seep. This information is included in Section 4.4.4 (Western Alluvial Area) of the updated Conceptual Site Model.

Comment #19

Evaluate the recharge in the gullies draining the seep 1206 area and Burial Area #1.

Response:

The groundwater recharge in these areas (portion of rainfall that reaches groundwater) would typically be similar to the surrounding areas. However, at times there is standing water or flow in the drainage ways. When groundwater levels are high, groundwater discharges to the drainages. After storms, surface water runoff is channeled to the drainages, and under these circumstances, the water in the drainages may serve as additional recharge to groundwater. The updated Conceptual Site Model has been modified to include further discussion on the hydrologic role of the drainage ways.

Comment #20

What is the groundwater transport mechanism in the Western Alluvium?

Response:

The primary mechanisms of chemical transport in the Western Alluvium area are advection and dispersion. However, the current distribution of U in groundwater is not entirely due to transport, but also to leaks from the former pipeline. The discussion in the updated Conceptual Model Report has been modified to clarify this understanding.