CCN: 086547

Environmental
Restoration
Contractor

ERC Team

Meeting Minutes Cover Sheet

Please find attached the Open Meeting Minutes from the Groundwater/Vadose Zone Integration Project of February 5, 2001.

If you have any comments or changes to these minutes, please reply to this email and your comments will be incorporated into the next meeting minutes.

Environmental Restoration Contractor **ERC Team**

Meeting Minutes

CCN: 086547

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SUBJECT **GROUNDWATER/VADOSE ZONE INTEGRATION PROJECT MEETING - FEBRUARY 5, 2001**

TO Distribution

FROM Michael J. Graham, Groundwater/Vadose Zone Integration Project Manager

DATE February 12, 2001

ATTENDEES
See Attached List

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NEXT GW/VZ INTEGRATION PROJECT OPEN MEETING:

Next Meeting: Monday, March 5, 2001 – 1-3 p.m.
Location: Bechtel Hanford, Inc., Assembly Room (Badging Required)
Local Call-In Number: (509) 376-7411
Toll Free Call-In Number: (800) 664-0771

MEETING MINUTES:

A Groundwater/Vadose Zone (GW/VZ) Integration Project Open Meeting was held on February 5, 2001, in Richland, Washington, at the Bechtel Hanford, Inc. (BHI) Assembly Room.

PROJECT REPORT:

General Project Update (Michael Graham)

We have made a change in our principal liaison to the Integration Project Expert Panel (IPEP). Virginia Rohay is going to focus full time on carbon tetrachloride. Moses Jarayssi has agreed to step in as liaison to IPEP. This change is effective immediately. The Expert Panel has been informed and is supportive of the change.

Integration Project Expert Panel Update (Michael Graham)

The next IPEP meeting is at the end of April. We had discussions with Dr. Ed Berkey this week regarding the focus. The proposed focus of the agenda is around the work in the S-SX Tank Farm and related Science & Technology (S&T) efforts, as well as the efforts in inventory supporting that. Tony Knepp is putting together a report. The IPEP will work out the agenda and get back to us. We want to try to get some consensus from the regulators and the stakeholders as to what they want us to get from IPEP. Then, we can in turn provide some input to the IPEP on our recommendations for their focus.

We have been working on our responses to their report from the October IPEP meeting. We put all their recommendations into the database. A meeting with all parties was held along with the U.S. Department of Energy's Richland Operations Office (DOE-RL) to agree on who was going to take the action on the

responses. That report is due back at the end of February. The report is in the form of an Excel spreadsheet showing summaries of the recommendations, who holds the action and when it's due. We will share that when it's done. We have provided that kind of matrix to the IPEP in the past. They aren't particularly interested in point-by-point resolution. They are more interested in how their interaction has impacted the project and how we are implementing their ideas. They provide good recommendations. The IPEP was very specific in this report. A lot of the recommendations affect core projects. A lot of their recommendations have already been addressed.

River Protection Project Tank Farms Assessments Update (Tony Knepp)
We drilled to groundwater in the B-BX Tank Farm, just east of tank BX-102. The drilling went through an area of large metal-waste leaks. We hit perched water at about 15 - 25 feet above groundwater . Tritium readings were about 75,000 picocuries per liter (pCi/L), while uranium levels were 35,000 pCi/L. These measurements are typical of the groundwater in the area. There is another monitoring well about 200 feet away from this one. The Washington State Department of Ecology (Ecology) has approved our pulling the casing and decommissioning the well. That will be done in about three to four days. The work at BX-102 went well and was one of our lower-cost efforts. Two months from now, we plan to do the next well. That will complete the characterization we've committed to this year with Ecology.

QUESTION: Regarding the schedule for this campaign, when is that due to Ecology?

ANSWER: There will be an internal borehole report. The B-BX area is wrapped up in the field investigation report that is due December 2002. The report on the S-SX Tank Farm is due January 2002 to Ecology. Six months after the B-BX Tank Farm report, the next report is due. First, there will be a borehole report, followed by a laboratory report. We are also processing all the spectral gamma data to create an inventory estimate. We will produce a graphic of the new conceptual model with geology and inventory estimates. The field investigation report will show how it all comes together. It is a good opportunity to pull all of this together and present it to IPEP.

The visualization represents all the work we've done and what it means. This pulls together the geology, the soils work, and the moisture work. The graphics are the key to the picture. We're about to have most of the S-SX Tank Farm work finished.

QUESTION: So, the report will be done by the beginning of April?

ANSWER: At least the graphical tables. It will probably be the end of May before all the words come together. We must submit the report to the Office of River Protection (ORP) at end of the fiscal year. We are trying to get it out as early as possible to facilitate the review.

MARK FRESHLEY: We have sent a number of samples to Pacific Northwest National Laboratory (PNNL) and other national labs to do studies beyond what Tony's team has done. They are analyzing samples in the lab and doing studies to explain the nature of the contaminants. We also have a team of modeling experts working on simulations to test some of the assumptions. We will be providing an appendix to that field investigation report.

We have been at this for less than three years. We've come a long way as a team and it will be good to demonstrate that.

National Vadose Zone Science & Technology Roadmap Workshop (Michael Graham)
The workshop is scheduled for April 9, 2001, in Richland, at Washington State University. This is an Idaho

National Engineering and Environmental Laboratory (INEEL) led effort. Shelley Cimon is the point of contact for this workshop. We are meeting in Salt Lake City, Utah, next Monday and Tuesday to assure that we're coordinated on this workshop and the work we've done here at Hanford. The focus of the workshop will be vadose zone issues. We will be looking at some of the long-term issues in the vadose zone. I will keep you informed. It will be out on the Hanford calendar once the agenda is set.

History Matching (Bob Bryce)
Over the past month, the System Assessment Capability (SAC) team has been putting together a paper on waste management, which will be out at the end of month. It's a high-level overview of what we've been doing in history matching. If you will look at figures in the handout, the first figure on second page shows the distribution of technetium-99. It matches pretty well with the records of Hanford. The model is actually producing numbers consistent with records on the site. The next figure is a representation of the situation at the 216-A8 crib. The figure shows a number of curves. The light curve represents simulated data. Things moved much deeper in the column than the data predicted. We expanded the area to two times the area of crib. That's the dark curve. It gives you an idea of the adjustments we're making to reflect what is actually in field.

We looked at two different time periods for the river. During one period, larger concentrations, particularly chromium and zinc, were put into the river. We plotted the particulate zinc being transported, the dissolved zinc, and the total of dissolved and particulate zinc. There are similar figures for chromium, tritium and uranium. The bottom graphs represent discharges from groundwater.

History matching is used to look at how well the models represent what we find in the field.

We finished up our work on the river last week. We will run an overall system looking at more mobile contaminants. The model represents the period from 1944 to 2000. We'll look at how well those match our field observations. We will then run an over all assessment in early April.

QUESTION: These records, are they through the reactive current?

ANSWER: The data plotted are measured values from the river during that period. There is not enough data from current times to run the model.

QUESTION: It's all direct coolant, not liquid disposal waste sites?

ANSWER: Right.

UPCOMING EVENTS (Michael Graham)
We are getting close to mid-year and we are cranking right along. Tony's team has made tremendous strides in the drilling operational activity.

QUESTION: Is the budget okay for this fiscal year?

ANSWER: The only area where we had some challenges with budgets is work in the 200 Area Assessment Project. Some field work was negotiated into the next fiscal year. And, there were a couple of minor things pushed out on SAC. All in all, though we're okay.

We do have a stretch goal – continuing investigation of 618-11. We found the efficiencies across Bechtel work here at Hanford, and our change board agreed to the work last Thursday. We had the kick-off

meeting last Thursday afternoon, and got the general scope and budget to move out. By end of year, we should have a good handle on tritium.

QUESTION: Did the five-year review actions cause some distress?

ANSWER: Yes. If you look at the five-year review, the majority of the issues are focused on groundwater.

Looking ahead, two weeks from now we have a holiday. The next Open Meeting will be March 5, 2001. The Oregon Hanford Waste board is meeting at the end of March. We are planning to send a couple of people to that. The National Academy of Sciences (NAS) has a meeting in Washington, DC, Mike Thompson, Tony Knepp and I are planning to go to that meeting. It's one last opportunity for them to ask us questions.

QUESTION: Is the Semi-Annual Report out yet?

ANSWER: No. We didn't get everything through the system before January 20, 2001. The new appointees aren't familiar with the information and are taking longer to get through it.

QUESTION: When do you expect it to be out?

ANSWER: I'd like to be able to say, but I just can't.

NOTES:
GW/VZ Web Site location: http://www.bhi-erc.com/vadose

If you have questions or comments, please contact Steve Sautter (509-372-9692) or Alison Kent (509-372-9192).

ATTACHMENTS:
1) History Matching Hand-out
2) GW/VZ Integration Project Four Month Look Ahead Calendar

ATTENDEES:
Bob Bryce – PNNL
Mark Freshley – PNNL
John Fruchter – PNNL
Michael Graham – BHI
Mary Harmon – DOE-HQ (by phone)
Kathy Huss – SAIC (by phone)
Moses Jarayssi - BHI
Alison Kent - BHI
Tony Knepp – CHG
Fred Mann – CHI
John Morse – DOE-RL
Gordon Rogers – HAB
Sue Safford – Oregon Office of Energy (by phone)
Steve Sautter – BHI
Stan Sobczyk – Nez Perce Tribe (by phone)
Bill Thackaberry – FH
Mike Thompson – DOE-RL
Rob Yasek - ORP

HISTORY MATCHING

History match efforts for the vadose zone, groundwater, river, and biota seek to use field observations to finalize conceptual models and model parameters. Each technical element, (i.e., vadose zone, groundwater), is being history matched independent of upstream and downstream models of the SAC. Each of these history match efforts, briefly described below, conducts simulations as a series of deterministic events.

Inventory. The inventory data used in the initial simulations were developed on a waste site basis. Release information, in the form of waste volume and concentration of contaminants in the waste volume, was developed for each waste site. All of the sites were added together to provide a Hanford combined release profile. This profile was generated on an annual basis. One of the history matching exercises was to evaluate how well the sum of inventory from all of the waste sites compared with independent estimates of the total inventory generated in Hanford Site production reactors.

Figure 1 displays a probability density function for the total technetium-99 produced on the Hanford Site. This density function of total production was generated using 100 stochastic realizations of waste disposition actions for each waste disposal site in the roll-up of Hanford Site inventory. Final disposition of this inventory would be partitioned into off-site disposal (high-level waste glass), liquid disposal (past and future) on-site, solid disposal on-site (exclusive of ILAW glass), and disposal of ILAW glass on-site. Table 1 provides average values from the 100 realizations of the inventory. Estimates of the total amount of technetium-99 produced on the Hanford Site have been developed in the past independent of this activity. The best estimate of total production of technetium-99 is 32,000 curies (14). The average values in Table 1 are consistent with this estimate. In addition, the probability plot shows that the roll-up of inventory is consistent with the best estimate being accurate to within 10 to 20%.

During the early years of Hanford Site operation, reprocessing of irradiated fuel was limited to the production of B, D, and F reactors. Total production and hence total processing was limited to these fuels and the bismuth-phosphate process that was run in T-Plant and B-Plant. The inventory of waste discharged and disposed to ground from these plants during this era represents a relatively small fraction (e.g., 3%) of the total Hanford Site inventory. This historical estimate matches well with the simulation estimates of about 4% of the technetium-99 inventory being released to the ground in the form of liquid releases during this period and shortly afterward during uranium recovery operations in the mid to late 1950s (8).

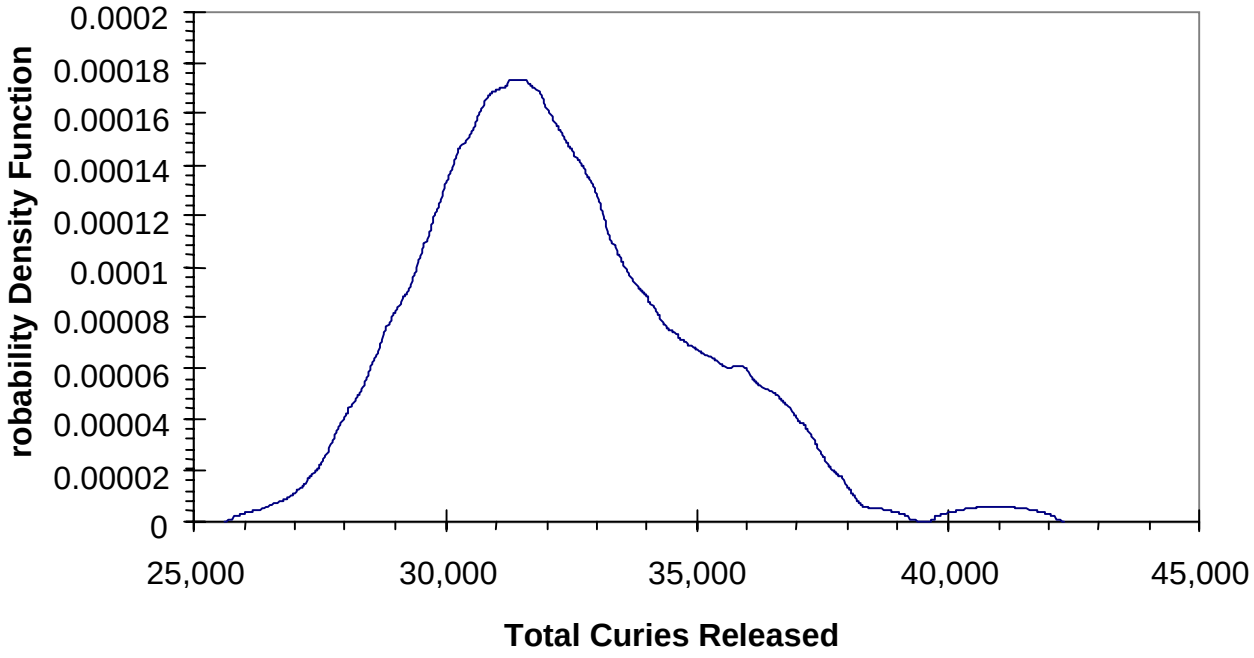

Figure 1. Stochastic estimate of the total technetium-99 produced at the Hanford Site.

Table I. Average Values from 100 Stochastic Realizations of Technetium-99 Inventory

Final Disposition	Average (Curies)	Average (Percent of Total)
Offsite Disposal	1099	3.4%
Liquid Releases Onsite	1284	4.0%
Solid Disposal Onsite	18955	58.6%
ILAW Glass Disposal Onsite	10993	34.0%
Total Produced at Hanford	32331	

This example shows that the technique of defining technetium-99 inventory at the Hanford Site on a waste-stream basis has the ability to match historical summary information. This approach, together with history matching to operational losses during specific operational eras, helps ensure that total inventory mass balance is achieved across the site.

Release. There is a complete absence of field data regarding the release of contaminants from waste disposal or discharge sites. Accordingly, history matching of release models is not achievable. During this phase of the history match effort, each of the release models was executed on the complete range of data available for the initial assessment. Thus, the release models were thoroughly verified on data sets relevant to Hanford Site wastes.

Vadose Zone. Vadose zone data sets are more abundant; however, they are few relative to the number of vadose zone contamination events at the Site, (e.g., ~1000). This is because few sites have undergone post-mortem excavation and evaluation, few sites outside the tank farms have been routinely dry-well logged to define moisture or contamination levels, and there is an absence of routine vadose zone monitoring data.

Data for specific facilities that have undergone post-mortem studies or dry-well logging have been used to history match specific discharge events. In general, these efforts have been limited to sites that received a significant discharge volume or inventory or both, and as a result presented a case of interest or concern regarding the breakthrough of contamination to the aquifer or the development of a critical mass. Examples are plutonium cribs, 216-Z-1A and 216-Z-12, and the PUREX crib, 216-A-8. Results of the few vadose zone events history matched will be applied to broad classes of release, (i.e., adjustments made to history match a crib receiving a large discharge are applied to all cribs that received large discharges).

History matching was conducted for eight sites, including high volume cribs, low volume cribs, a high-level waste tank, a reverse well, and a pond. Simulations were also conducted using different column areas and for a number of contaminants ranging from highly mobile (e.g. technetium-99) to highly immobile (e.g. plutonium-239/240).

Figure 2 illustrates the simulation results for cesium-137 transport beneath the high volume 216-A-8 crib. The first simulation was conducted using the areal dimensions of the crib. The second simulation was conducted using twice the area, to help account for lateral spreading. Note that the second simulation produced a better fit with spectral-gamma logging data from a dry well located adjacent to the headend of the crib. Similar areal adjustments also appeared to work well for other high volume crib simulations. Thus, this general rule of doubling the area for high volume cribs will be applied to all high volume cribs.

Groundwater. History matching of the model of the unconfined aquifer is made possible by the abundance of water table observations for period of 1944 to present. This data set has been greatly improved over time by monitoring technology and numerous observation wells, and represents a transient long-term record that captures the water table response to discharges of cooling water, wastewater, and changes in surface infiltration. All water table elevation observations contribute to a single body of knowledge that applies to the aquifer.

Simulation of contaminant transport through the unconfined aquifer system at the Hanford Site has been performed using a relatively complex three-dimensional model composed of seven hydrogeologic units (3, 15). However, completing the stochastic simulations for SAC within a reasonable time required a faster model. The history matching process, therefore, involved two steps: 1) comparing historical plume movement to simulations with the full three-dimensional model and 2) comparing the full model results with simpler models including three-dimensional two-unit, three-dimensional one-unit, and two-dimensional models. For the three-dimensional cases, each unit is divided into several “transport layers” so that the contaminant is not spread over the entire unit thickness.

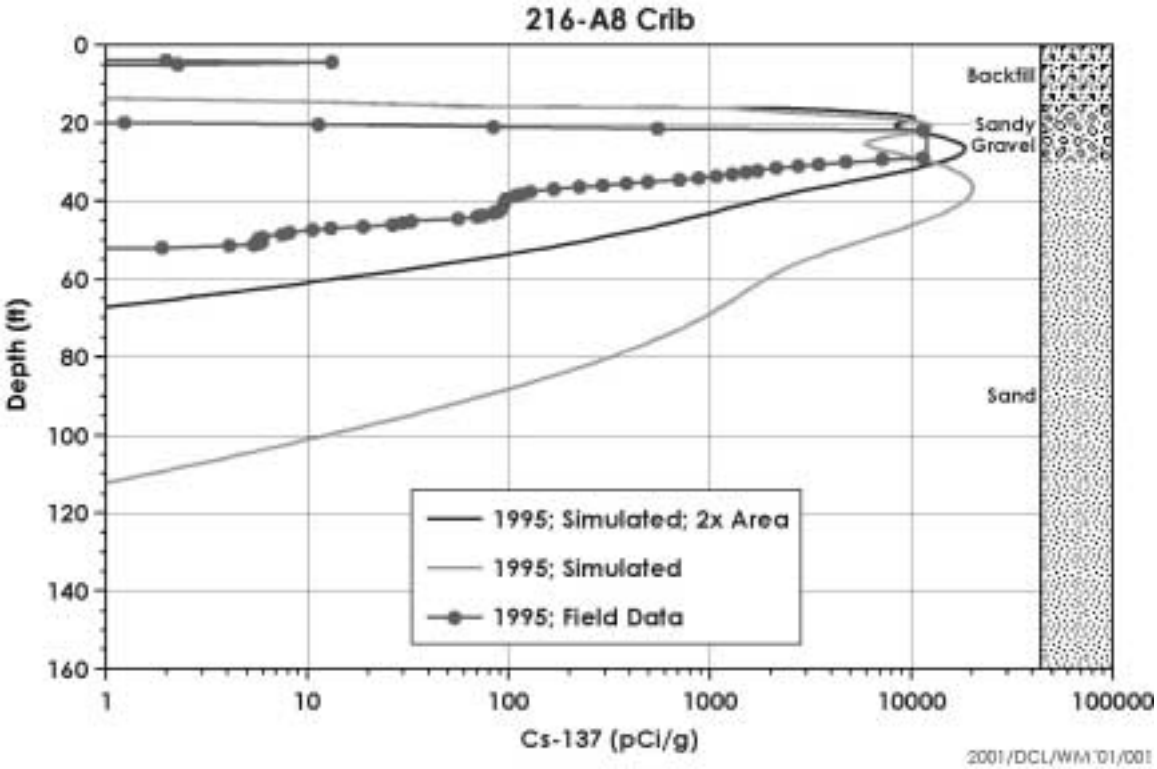

Figure 2. Plot of cesium-137 predictions for the 216-A-8 high volume crib.

An early tritium plume, which originated in the central Hanford Site and traveled approximately 20 km to the Columbia River, and a later tritium plume from the same area were used for the history matching exercise. The first plume resulted from wastewater discharged between 1955 and 1972. Unfortunately, because tritium was not routinely measured in wastewater or groundwater until about 1974, the source term and early movement of this plume are unknown. However, groundwater measurements taken in 1974 established an initial condition for simulation of this plume. Transport modeling was performed to predict the plume movement through 1998. Because of uncertainty in the plume thickness, five separate simulations were run with different initial vertical distributions of tritium. The case with tritium distributed over the upper 20 m of the aquifer, but not in mud-dominated sediments, gave the best results. The later tritium plume was discharged to the vadose zone during 1983 to 1987. Tritium source information is available for this plume, which was simulated from the source input to its 1998 distribution. Simulations with the simplified transport models are underway.

River. The Columbia River has a short-term response relative to the subsurface environment, especially to mobile contaminants that disperse in the river water and do not adsorb on sediment. Thus, short-term but relatively thorough field observations related to well quantified releases can yield sufficient data for limited history matching of transport events. Two such events have been used to perform history matching of the Columbia River model: reactor cooling water discharges during the reactor operation era, and releases from groundwater plumes in the recent past.

The River Flow and Transport Model, MASS2(16), provides the capability to calculate the flow, sediment transport, and contaminant transport in the Columbia River system. MASS2 is a two-dimensional depth-averaged model that simulates the lateral (bank-to-bank) variation of flow and contaminants. MASS2 includes the capability to simulate sediment transport, sediment-contaminant interaction (using Kds), sediment-sorbed contaminant transport, and contaminant transport within the riverbed sediment layer. The

simulated contaminant concentrations from the MASS2 model were compared to measurements for two separate time periods: 1964-1966 when radionuclides including chromium-51 and zinc-65 were directly discharged to the river from once-through cooled plutonium production reactors and 1992-1996 when contaminants including tritium and uranium enter the river from groundwater sources and upstream inputs. The results of these comparisons are shown in Figure 3. These results illustrate the ability of model predictions to lie within the range of field observations.

Biota. Ecological risk is being estimated using the ecological chemical exposure model, ECEM. The model was developed for the *Columbia River Comprehensive Impact Assessment* (CRCIA) and estimates ecological exposures from metals, organics, and/or radionuclides to 52 riparian and aquatic species. ECEM is based on a food-web architecture that has been developed for the Columbia River and associated riparian zone. Exposures are estimated through water (surface water and porewater), soil/sediment exposure and foods. The results of the model include: 1) for the riparian species, equilibrium doses for ingestion, inhalation, and dermal routes, total radiological dose (where appropriate), and tissue concentrations for terrestrial receptors; and 2) for the aquatic species, effective water concentration and equilibrium tissue.

In order to ensure that ECEM best represents the ecosystem in the SAC study area, ECEM output was calibrated to historic biological monitoring data from the Hanford Site. The source of this historical data was the Hanford Environmental Information System (HEIS). Some of the programs that store data in the HEIS are PNNL's Groundwater Monitoring Program, PNNL's Surface Environmental Surveillance Project (SESP), and the Environmental Restoration Contractor's CERCLA remedial investigation/feasibility study programs. Many special studies also place their data in HEIS.

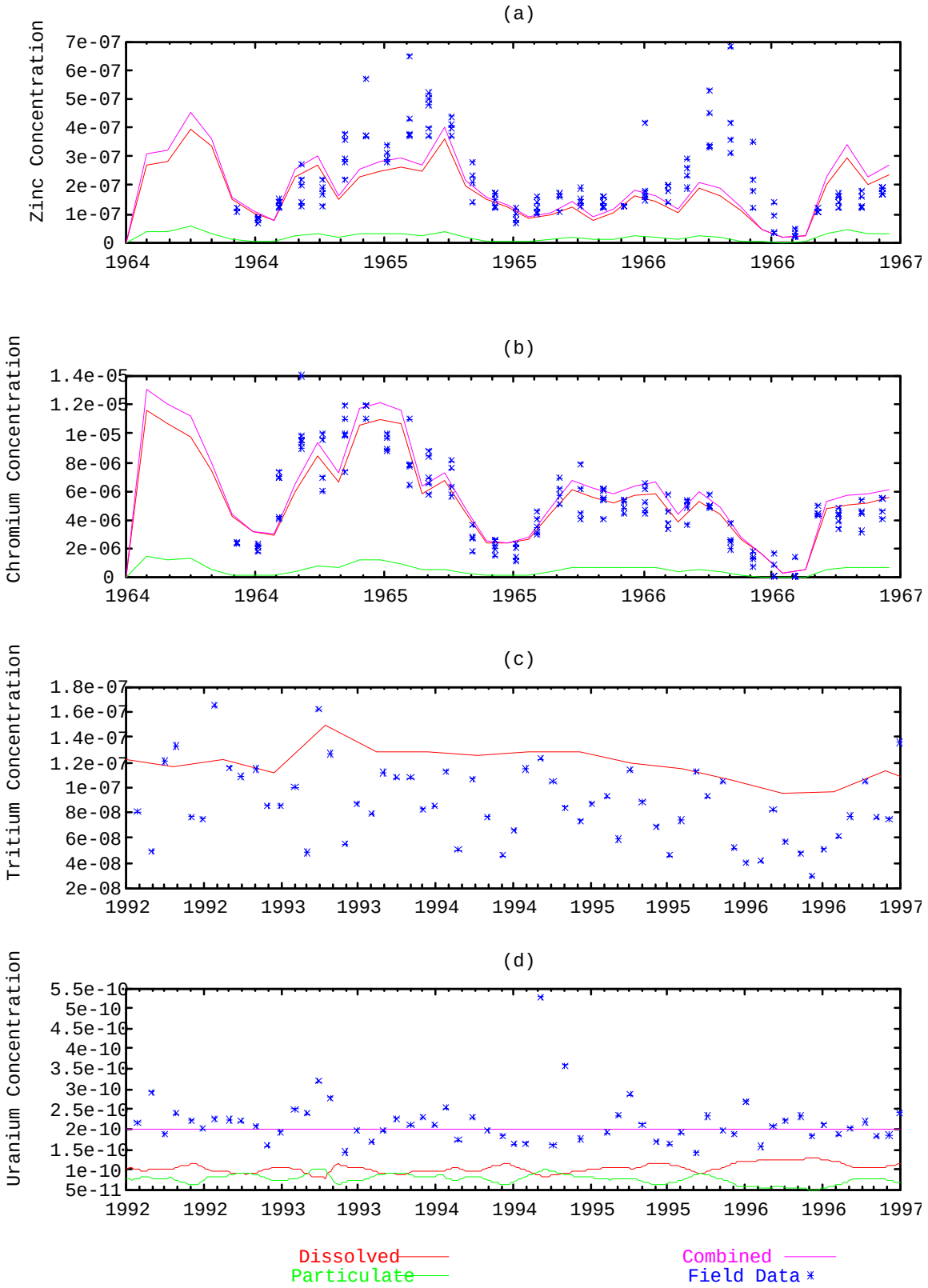

Figure 3. Comparison of simulated and measured concentrations (Ci/m^3) for a) zinc-65, b) chromium-51, c) tritium, and d) uranium at the Richland Pump House.

Biological data were available for seven of the SAC contaminants of interest (i.e., cesium-137, inorganic metallic chromium, plutonium-239/240, strontium-90, technitiumm-99, tritium, and uranium-238). No data were available for carbon tetrachloride and iodine-129. These data were further reduced to those aquatic and terrestrial species (periphyton, phytoplankton, marcophytes, aquatic insects, riparian vegetation, fish, birds, mammals) that could be reasonably matched to the SAC species of interest based on similar taxonomy and lifestyle attributes.

The historic biota averages were then compared to average body burdens (chromium [mg/kg]) and average radiation doses (radionuclides [pCi/kg]) generated by contaminant, species and river segment by ECEM. The comparison was made by calculating the quotient of ECEM and historic biota averages. Positive quotients expressed an overestimation by ECEM of the historic biota averages. Negative quotients expressed an underestimation by the ECEM of the historic biota averages. Quotients of 0.0 $\pm$ 15 were considered acceptable. For contaminants and species with a quotient greater or less than $\pm$ 15, the most sensitive ECEM parameter values (bioconcentration factors, chemical assimilation efficiencies/ingestion absorption factors, depuration rates, and soil/plant transfer factors) were increased or decreased accordingly. ECEM was subsequently re-run with the new parameter values and the resulting quotients were re-calculated. The new quotients were compared with the previous quotients to determine which parameter values still needed to be increased or decreased. This process was repeated until the majority of the quotients fell within the range of acceptance.

CCN: 086547

GW/VZ INTEGRATION PROJECT

FEBRUARY 5, 2001 – MAY 21, 2001

FOUR MONTH LOOK AHEAD CALENDAR

February 5	GW/VZ Project Open Meeting BHI Assembly Room – 1-3 p.m. (Contact: Steve Sautter)
February 19	**CANCELLED DUE TO PRESIDENTS DAY HOLIDAY GW/VZ Project Open Meeting BHI Assembly Room – 1-3 p.m. (Contact: Steve Sautter)
March 5	GW/VZ Project Open Meeting BHI Assembly Room – 1-3 p.m. (Contact: Steve Sautter)
March 19	GW/VZ Project Open Meeting BHI Assembly Room – 1-3 p.m. (Contact: Steve Sautter)
March 27-28	Oregon Hanford Waste Board (Mission, OR)
April 2	GW/VZ Project Open Meeting BHI Assembly Room – 1-3 p.m. (Contact: Steve Sautter)
April 5-6	HAB (Red Lion Inn, Richland, WA)
April 16	GW/VZ Project Open Meeting BHI Assembly Room – 1-3 p.m. (Contact: Steve Sautter)
April 25-27	IPEP Meeting (BHI Assembly Room, Richland, WA)
May 7	GW/VZ Project Open Meeting BHI Assembly Room – 1-3 p.m. (Contact: Steve Sautter)
May 21	GW/VZ Project Open Meeting BHI Assembly Room – 1-3 p.m. (Contact: Steve Sautter)