May 19, 2014

MEMORANDUM TO: Gregory F. Suber, Chief
Low-Level Waste Branch
Environmental Protection
and Performance Assessment Directorate
Division of Waste Management
and Environmental Protection

THRU: Christepher A. McKenney, Chief **/RA/**
Performance Assessment Branch
Environmental Protection
and Performance Assessment Directorate
Division of Waste Management
and Environmental Protection

FROM: Cynthia S. Barr, Sr. Systems Performance Analyst
Performance Assessment Branch
Environmental Protection
and Performance Assessment Directorate
Division of Waste Management
and Environmental Protection

SUBJECT: TECHNICAL REVIEW OF HYDROLOGICAL STUDIES AND DATA FOR IDAHO NATIONAL LABORATORY, IDAHO NUCLEAR TECHNOLOGY AND ENGINEERING CENTER, TANK FARM FACILITY (PROJECT NO. PROJ0735)

The U.S. Nuclear Regulatory Commission (NRC) staff has performed a technical review of the several documents prepared by the U.S. Department of Energy (DOE) and its contractors that provide information on the hydrological system at the Idaho National Laboratory (INL), Idaho Nuclear Technology and Engineering Center Tank Farm Facility (INTEC TFF) in Idaho Falls, Idaho. This technical review report supports Key Monitoring Area (KMA) 3, “Hydrological Uncertainties”, as detailed in the NRC staff’s plan for monitoring the INL INTEC TFF (Agencywide Documents Access and Management System (ADAMS) Accession No. ML070650222).

CONTACT: Cynthia Barr, FSME/DWMEP
(301) 415-4015

KMA 3, “Hydrological Uncertainties”, was developed by NRC staff to manage technical uncertainties identified in NRC staff’s Technical Evaluation Report for the INTEC TFF during the monitoring period. NRC staff has reviewed a number of hydrological studies and environmental monitoring reports, since it began monitoring the INTEC TFF in 2007. While review of this additional information has increased NRC staff’s understanding of the hydrological system at the INTEC TFF, the information has not fundamentally changed NRC staff’s understanding of the technical uncertainties, nor has it changed NRC staff’s Technical Evaluation Report conclusions. Therefore, NRC staff has decided to close KMA 3, “Hydrological Uncertainties”, at this time. This decision is based on (1) years of NRC review of DOE and DOE contractor prepared documents, including a supplemental, groundwater analysis that addresses technical concerns documented in NRC staff’s Technical Evaluation Report, and (2) results of NRC onsite observations related to INTEC TFF tank closure activities. Should technical issues arise in the future, NRC staff may reopen KMA 3, or create a new monitoring area. NRC staff will also continue to review environmental monitoring reports routinely under KMA 4 “Monitoring During Operations”, in conjunction with future onsite observation visits.

Enclosure:
Technical Review of Hydrological
Studies and Data at the INL INTEC TFF

KMA 3, “Hydrological Uncertainties”, was developed by NRC staff to manage technical uncertainties identified in NRC staff’s Technical Evaluation Report for the INTEC TFF during the monitoring period. NRC staff has reviewed a number of hydrological studies and environmental monitoring reports, since it began monitoring the INTEC TFF in 2007. While review of this additional information has increased NRC staff’s understanding of the hydrological system at the INTEC TFF, the information has not fundamentally changed NRC staff’s understanding of the technical uncertainties, nor has it changed NRC staff’s Technical Evaluation Report conclusions. Therefore, NRC staff has decided to close KMA 3, “Hydrological Uncertainties”, at this time. This decision is based on (1) years of NRC review of DOE and DOE contractor prepared documents, including a supplemental, groundwater analysis that addresses technical concerns documented in NRC staff’s Technical Evaluation Report, and (2) results of NRC onsite observations related to INTEC TFF tank closure activities. Should technical issues arise in the future, NRC staff may reopen KMA 3, or create a new monitoring area. NRC staff will also continue to review environmental monitoring reports routinely under KMA 4 “Monitoring During Operations”, in conjunction with future onsite observation visits.

Enclosure:
Technical Review of Hydrological
Studies and Data at the INL INTEC TFF

DISTRIBUTION: ASchwartzman MFerdas (Region I) MRoberts (Rgn I)
WIR Service List AMohseni

ML14113A278

OFC	DWMEP	DWMEP	DWMEP	DWMEP	DWMEP
NAME	CBarr	TMoon	MHeath	CMcKenney	CBarr
DATE	04/22/14	04/23/14	05/14/14	05/15/14	05/16/14

OFFICIAL RECORD COPY

Technical Review of Hydrological Studies and Data for the Idaho National Laboratory, Idaho Nuclear Technology and Engineering Center, Tank Farm Facility

Date: May 16, 2014

Reviewers:

Cynthia S. Barr, Senior Systems Performance Analyst, U.S. Nuclear Regulatory Commission

Background:

Since 2007, NRC staff has performed a number of technical review activities and onsite observation visits that address Key Monitoring Area (KMA) 3, "Hydrological Uncertainties", as detailed in the NRC staff's plan for monitoring the Idaho National Laboratory (INL), Idaho Nuclear Technology and Engineering Center, Tank Farm Facility (INTEC TFF) (NRC, 2006). A summary description of the KMA and related technical review activities and onsite observation visits is provided. KMA 3 reads as follows:

> *"Relevant recent and future monitoring data and modeling activities should continue to be evaluated to ensure that hydrological uncertainties that may significantly alter the conclusions in the PA and TER are addressed. If significant new information is found, this information should be evaluated against the PA and TER conclusions* (NRC, 2006)*."*

NRC staff developed KMA 3 to address a number of technical uncertainties associated with the United States Department of Energy's (DOE's) representation of the hydrological system at the INL INTEC TFF, as it impacts the level of natural system performance assumed in DOE's groundwater model[1]. These uncertainties include the following:

- Hydrogeologic Conceptual Model (HCM)—NRC staff's analysis of groundwater monitoring data revealed potential inconsistencies between the HCM implemented in DOE's groundwater model and field observations (e.g., potential differences in the degree of lateral transport observed in the unsaturated zone in DOE's groundwater model versus in reality). The assumed level of natural attenuation of radiological releases from the tank farm facility during transport through the vadose zone may lead to an underestimate of projected dose reported in DOE's Performance Assessment (DOE, 2003).

[1] NRC staff reference to "DOE's groundwater model" in this technical review report refers to the PORFLOW groundwater model used by DOE to project doses to a member of the public as documented in DOE's INTEC TFF Performance Assessment (DOE, 2003).

- Infiltration Rates—NRC staff noted that a higher assumed infiltration rate was used in the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) risk assessment model for the INTEC TFF (DOE, 2006a) compared to the value assumed in DOE's groundwater model (DOE, 2003). Higher assumed infiltration rates could lead to faster travel times, less decay, and less dilution in the Snake River Plain Aquifer.

- Big Lost River Seepage Rates—NRC staff evaluated Big Lost River seepage rates in DOE's groundwater model and concluded that the relatively high seepage rates used in the model may have unrealistically dispersed and diluted concentrations of radiological constituents in the unsaturated zone. Overly optimistic dispersion and dilution of INTEC TFF releases affect projected concentrations and dose for all constituents (i.e., lower assumed Big Lost River seepage rates could lead to higher projected concentrations and dose).

Based on its own calculations, NRC staff provided an easily defensible dilution factor for all constituents in its INTEC TFF technical evaluation report (NRC, 2006) based on Snake River Plain Aquifer dilution alone (i.e., no vadose zone attenuation was considered in this calculation). The NRC-calculated dilution factor was sufficient for DOE to demonstrate compliance with the performance objectives, provided the engineered system performs as well as assumed by DOE in its INTEC TFF performance assessment. The "conservative" dilution factor calculated by NRC is between 10 and 100 as illustrated in Figure 1 (see row labeled "Natural System (Saturated Zone)".

With respect to key radionuclides Technetium(Tc)-99 and Iodine(I)-129, NRC staff concluded (NRC, 2006) that credit from the engineered system is also needed to mitigate releases to levels that will meet the performance objectives (i.e., Snake River Plain Aquifer dilution alone, based on the "conservative" dilution factor calculated by NRC, is insufficient to ensure that Tc-99 and I-129 concentrations will be reduced to levels that will meet the performance objectives). If tank grout performance becomes an issue, additional credit for natural attenuation of Tc-99 and I-129 may be needed to demonstrate compliance with the performance objectives. However, natural attenuation of Tc-99 and I-129 in the subsurface is primarily limited to dilution and dispersion, as these two constituents are relatively non-sorbing in the subsurface at TFF and both of these constituents are long-lived, and are not expected to decay appreciably during transport through the environment. However, in the future, DOE could take credit for infiltration controls that would serve to increase dilution, if necessary, and if additional supporting information is provided.

With respect to key radionuclide Strontium(Sr)-90, NRC staff concluded (NRC, 2006) that while the hazard associated with Sr-90 is relatively high owing to its high specific activity (e.g., see Figure 1 row labeled "Minimum Total Barrier Performance Needed for Compliance"), the risk from Sr-90 could be eliminated entirely through either engineered or natural system performance (or both engineered and natural system performance) given its relatively short half-life and ability to decay during transport to the point of compliance[2].

---

[2] The point of compliance is located at the point of maximum exposure outside a 100 m buffer area surrounding the INTEC TFF.

A risk-significant inventory (i.e., total radionuclide activity) of Sr-90 is located outside of primary containment but within the concrete vaults that house Tanks WM-185 and WM-187[3]. NRC staff concluded that if the concrete vaults perform significantly worse than assumed in DOE's performance assessment model, then hydrological uncertainties associated with the transport of Sr-90 in the subsurface basalt and sedimentary interbeds will become more important given the total amount of credit needed to reduce the risk of this high specific activity radionuclide to acceptable levels. Sedimentary interbeds provide a significant barrier to mitigate the release of Sr-90 to the unsaturated zone. Sufficient information on sedimentary interbed sorption is available (laboratory and field-derived sorption coefficients have been developed for Sr-90 that can be used to model the transport of this constituent through sedimentary interbed materials). However, less information is available regarding the potential for infiltrating water to bypass relatively more sorbing sedimentary interbeds through relatively less sorptive, fractured basalt. As discussed in greater detail below, preferential flow through the vadose zone is thought to be an important mechanism for contaminant transport at the INTEC TFF.

Based on the preceding discussion, NRC staff concluded in its monitoring plan (NRC, 2007) that closure of KMA 2, related to cementitious material performance, and KMA 3, related to hydrological system performance and uncertainty, are intimately related as they are both important for assessing INTEC TFF risk. Therefore, NRC staff expects that the status of KMA 3 would be tied to the status of KMA 2. For example, if issues arise during evaluation of KMA 2 (e.g., the tank grout is not effective in promoting and maintaining low solubility of key radionuclides in a reducing environment, or the grouted tank and vault system is not effective as a hydraulic barrier limiting Sr-90 release), then additional credit from natural attenuation, evaluated under KMA 3, may be needed to demonstrate compliance. Therefore, NRC staff has been monitoring both grouting operations, and relevant groundwater modeling and monitoring activities performed at the INTEC TFF since NRC staff monitoring began in 2007. A summary of technical reviews and onsite observations reported in previous NRC staff Periodic Monitoring Compliance Reports (NRC, 2008; NRC, 2009; NRC, 2010a; NRC, 2011; and NRC, 2012) is provided in Appendix A. A summary of recent DOE groundwater monitoring reports reviewed by NRC staff in this report are provided in Appendix B.

[3] The Sr-90 inventory is located in sand pads that Tanks WM-185 and WM-187 rest on inside the concrete vaults that house those tanks.

Figure 1: Relative Hazards of and Barriers Mitigating the Risk of Key Radionuclides at the INTEC TFF. Image Credit: Table 14 of NRC (2006).

Table 14. Summary of NRC Staff Perspective on Credit for Engineered and Natural Barrier Performance*

	Tc-99	Sr-90	I-129
Minimum Total Barrier Performance Needed for Compliance†	4 orders of magnitude	9 orders of magnitude	3 orders of magnitude
Engineered Barrier (most effective of grouted tank, vault, or sand pad)	1 to 4 orders of magnitude	4 orders of magnitude‡	1 to 2 orders of magnitude
Natural System (Unsaturated Zone)		3 to 4 orders of magnitude§	
Natural System (Saturated Zone)‖	1 to 2 orders of magnitude	1 to 2 orders of magnitude	1 to 2 orders of magnitude

*This table presents NRC staff's perspective on the credit DOE Idaho can reasonably take for engineered and natural system performance in attenuating releases of Tc-99, Sr-90, and I-129, from the INTEC TFF, given the limitations in its groundwater model. Similar to Table 12, row 1 (highlighted in grey) provides a rough factor (within an order of magnitude) reduction necessary in the waste pore water concentration to achieve levels that will meet the 10 CFR 61.41 dose-based performance objective of 25 mrem/yr. Rows 2 through 4 provide a rough factor reduction in concentration and dose attributable to various barriers as indicated. Natural system performance (Rows 3 and 4) is calculated by NRC and is broken down into two components–unsaturated zone and saturated zone attenuation–this differs from Table 12 which presents DOE Idaho's credit for natural system performance based on its performance assessment modeling.

†Row 1 is based on the maximum, possible pore water concentration. The concentration used for this calculation is recognized as being very pessimistic because actual exposure to a receptor at the maximum concentration is virtually impossible.

‡The Sr-90 dose can be completely eliminated with more optimistic assumptions regarding barrier performance (e.g., if the tank vaults remain intact for a few hundred years, the short-lived radionuclides will decay to negligible levels).

§The factor reduction for Sr-90 represents NRC staff's perspective on an expected average (considers potential flow paths that may by-pass sedimentary interbeds) attenuation of Sr-90 in the subsurface from contact of contamination with basalts and sedimentary interbeds. This factor represents a reasonably conservative estimate based on NRC staff calculations and observed attenuation of SBW from historical releases.

‖Row 4 natural system concentration reduction factors for the saturated zone are based on NRC staff calculations of the expected dilution in the SRPA.

NRC Staff Evaluation:

Given uncertainty in the hydrological system at the INTEC TFF, NRC staff attempted to manage hydrological uncertainty with "conservative"[4] calculations in its Technical Evaluation Report (NRC, 2006). These calculations enabled NRC staff to reach conclusions regarding the ability of the disposal facility to meet the performance objectives for low-level waste disposal without the need for additional information from DOE prior to issuance of DOE's final waste determination for the INTEC TFF. NRC staff also created KMA 3 "Hydrological Uncertainties" in its INTEC TFF monitoring plan (NRC, 2007) to allow NRC staff to continue to evaluate key technical uncertainties important to assessing compliance with the performance objectives and to help ensure that its Technical Evaluation Report calculations were in fact "conservative". Because compliance with the performance objectives is also a function of engineered system performance, NRC staff has also monitored DOE disposal actions, such as tank grouting activities, to ensure that overall system performance is adequately constrained (see Appendix A for more information on previous technical reviews and onsite observations).

NRC staff focused on hydrological uncertainties during the monitoring period due to the importance of the vadose zone in mitigating releases from the disposal facility in DOE's groundwater model. For example, DOE indicated in a response to a follow-up Request for Additional Information (DOE, 2006b), that the large lateral extent of the modeled contaminant plume diverted laterally approximately 600 meters to the south of the Tank Farm Facility (see Figure 2 below) is due completely to the pressure gradient that results from the steady-state infiltration boundary condition for the Big Lost River. As documented in NRC staff's Technical Evaluation Report (NRC, 2006), DOE's response to NRC's inquiry regarding the cause of the large lateral spread (DOE, 2006b) appeared inconsistent with explanations provided in the actual Performance Assessment documentation (DOE, 2003)—DOE's Performance Assessment indicates that the numerical model predicts contaminant transport around the perched zones and through breaks in the sedimentary interbeds. In fact, the numerical model results show no perched zones along or near the flow path of the contaminant plume making the relevance of the statement regarding perched water in the Performance Assessment unclear. Additionally, there was no indication from the monitoring data that when Big Lost River flow did occur that contamination was deflected nearly half a mile laterally to the south of the TFF. Finally, DOE's groundwater model results provided in DOE (2006c) reveal very significant natural attenuation of releases from the disposal facility (i.e., concentrations are reduced approximately four orders of magnitude or a factor of 10,000 during transport through the vadose zone as shown in Figure 3 below [see, for example, difference in peak concentrations between zones 1 and 2 at the source and zone 4 at the vadose zone "spill-way"]). Due to the uncertainties in the hydrological system and the high level of performance of the vadose zone in DOE's performance assessment model, NRC staff advised DOE to consider new and significant information collected under the CERCLA program to determine the need for supplemental performance assessment modeling and/or updates to its performance assessment documentation.

[4] The term "conservative" is used by NRC staff to mean that the assumption (or set of assumptions) tends to lead to a higher projected dose compared to another assumption (or set of assumptions).

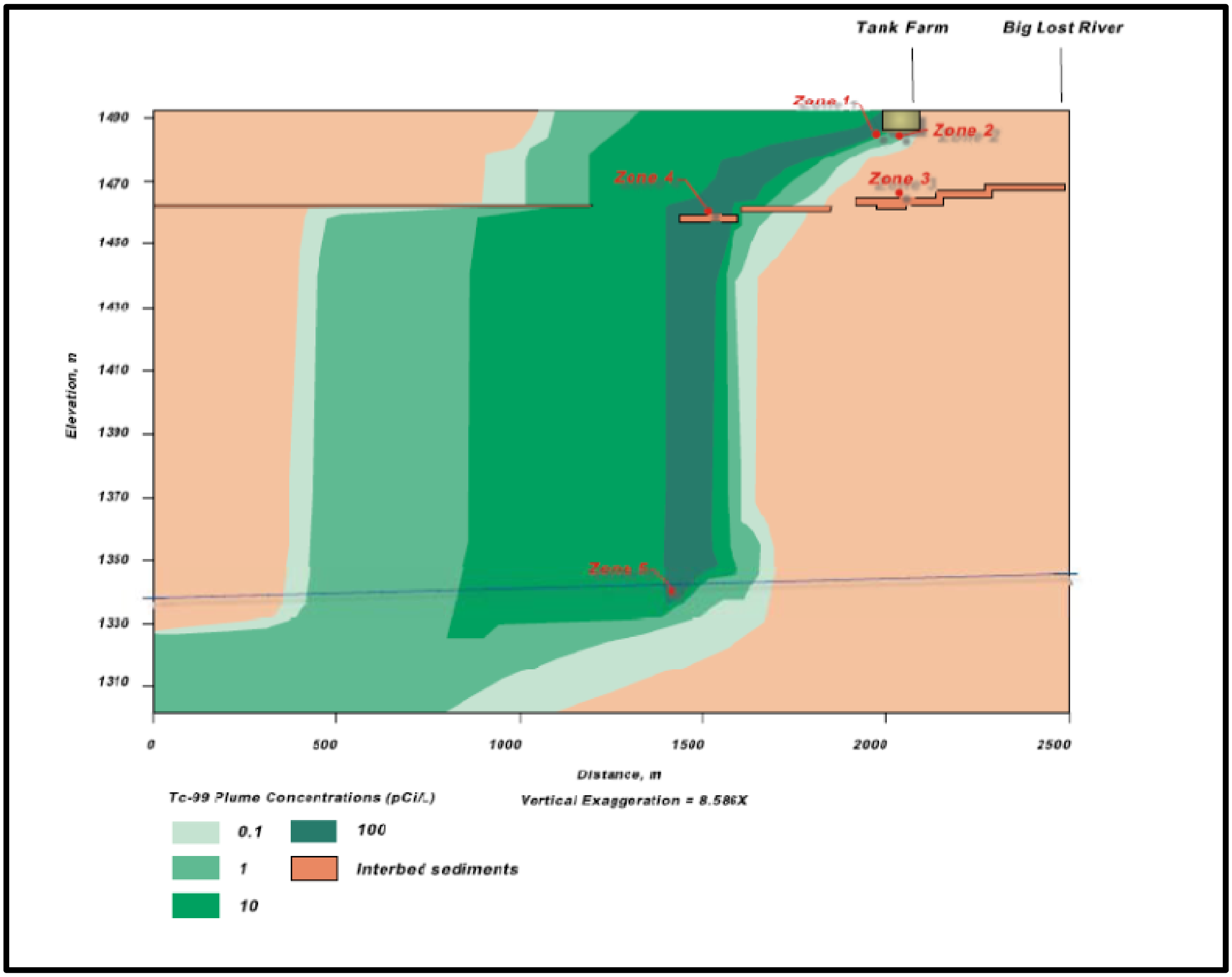

Figure 2: Technetium Plume Emanating from the INTEC TFF Diverted Laterally Approximately 600 m to the South. Locations Near the Source (Zones 1 and 2), at the Modeled "Spill-way" (Zone 4) and at the Water Table (Zone 5) are also Depicted. See Figure 3 Below for Technetium Concentrations at These Locations Through Time (DOE, 2006c).

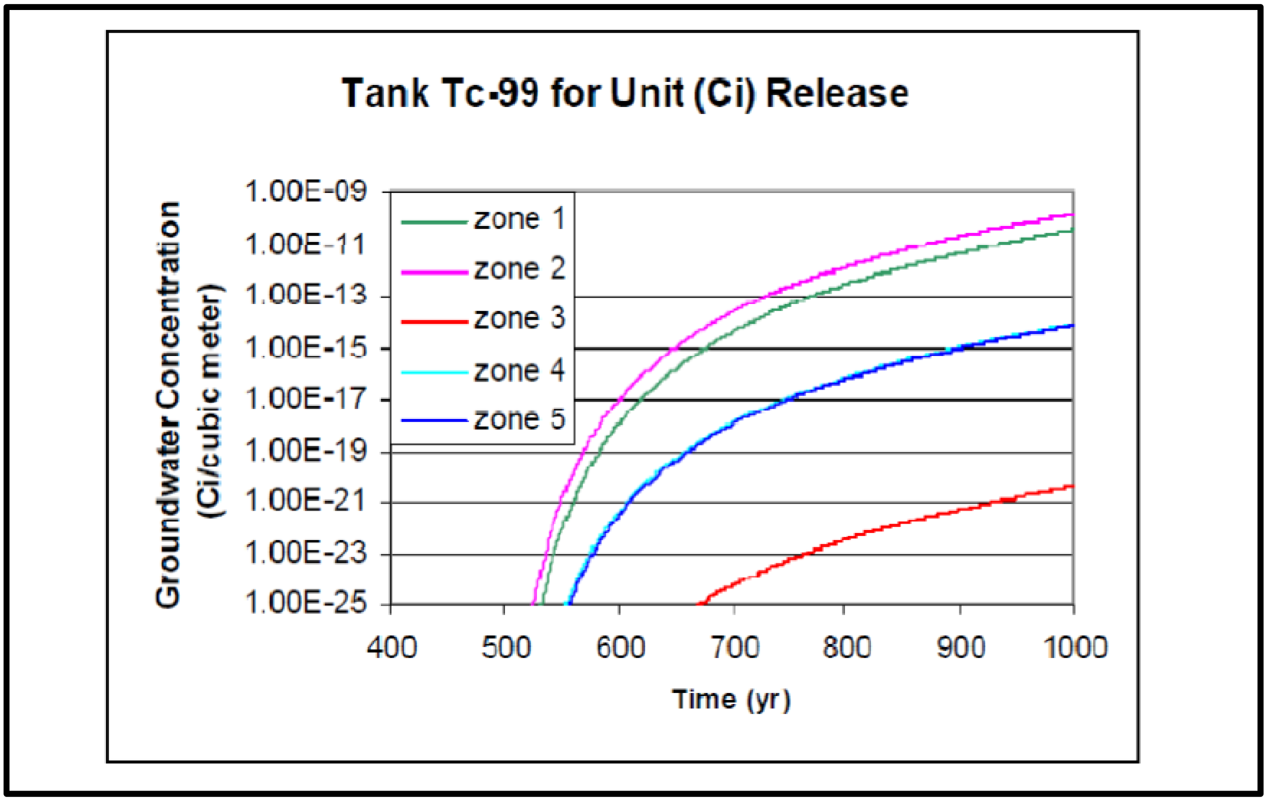

Figure 3: Technetium Concentrations at Zone Locations (see Figure 2 for Zone Locations) 1 through 5 Versus Time (DOE, 2006c).

During the 2010 onsite observation, NRC staff was provided an opportunity to discuss groundwater monitoring issues identified during NRC staff's review of DOE's Performance Assessment (DOE, 2003) with DOE contractors working on related CERCLA projects. DOE contractor staff confirmed NRC staff's understanding of recent CERCLA monitoring results that indicate that only monitoring wells located very close to the Big Lost River, north the of the INTEC facility, show a water level response following rare occasions when Big Lost River flow occurs on site. DOE contractors indicated that Big Lost River flow is currently thought to have little impact on perched water further away from the river near INTEC facilities. The limited influence of the Big Lost River on perched water at the INTEC TFF based on current observations is contrary to conclusions drawn by DOE during development of its performance assessment models[5]. More recently, INL scientists have determined that anthropogenic sources of water to the INTEC subsurface and precipitation infiltration have a much larger effect

[5] It is important to note that the future influence of the Big Lost River on the INTEC TFF subsurface is uncertain. However, the NRC concern is that the INTEC TFF performance assessment model was calibrated with the thought that the Big Lost River contributed to perched water in the northern portion of the INTEC TFF, while the Big Lost River is now thought to have a much more modest influence on the hydrogeological system. Additionally, DOE provided follow-up information that indicated that the deflection of contaminant plumes due to Big Lost River seepage contributed to a large decrease in concentrations of radiological releases from the disposal facility in the INTEC TFF performance assessment model. Nonetheless, NRC staff recognizes that the future influence of the Big Lost River on radiological releases from the INTEC TFF facility is a function of many variables such as future human activities (e.g., diversion of water for irrigation) and climatic variability that are difficult to assess at this time, leading to significant uncertainty in the dose modeling projections. NRC staff attempted to manage this uncertainty with conservative assumptions in its Technical Evaluation Report (NRC, 2006).

on perched water at the INTEC TFF. DOE's assumption that Big Lost River seepage was a source of perched water observed in the northern portion of the INTEC may have negatively impacted the calibration process, as well as led to overly optimistic assumptions regarding vadose zone performance.

DOE contractors also presented data on perched and Snake River Plain Aquifer groundwater sampling at INTEC. Based on review of this data, NRC staff concludes that releases from TFF waste transfer system piping are proximal to the INTEC TFF and that limited lateral movement in the vadose zone, primarily to the southeast of the facility, has been observed (e.g., NRC, 2008; NRC, 2009; NRC, 2012). There is also evidence of rapid, preferential flow through a complex network of fractures, as significant radioactivity associated with the TFF waste transfer system releases has also been observed to the north of the facility, up-gradient of the direction of saturated groundwater flow (see [DOE, 2004] for more information about TFF releases and contaminant plumes). Infiltration associated with melting of accumulated snow in the spring has also been implicated with rapid transport of constituents through the subsurface at INL.

DOE's Performance Assessment (2003) documentation discusses different mechanisms for perched water formation, as well as differences in conceptual models for simulation of contaminant flow and transport in the subsurface at INL. For additional details, consult DOE (2003). Baker (2003) also recognizes two primary conceptual models for simulating solute transport: diffuse and preferential flow models. In the diffuse flow conceptual model, perched water zones accumulates until the head is sufficient to drive infiltration through the perching layer. In the preferential flow conceptual model, perched water moves laterally until a path around the perching layer is encountered. Perched zones are risk-significant because higher saturations lead to greater relative hydraulic conductivities. Preferential flow paths through fractured basalt are risk significant because they can lead to fast transport and bypassing of sedimentary interbed layers that have a higher sorption potential. Vadose Zone Research Park scientists concluded that perched water can persist for long periods of time, and that lateral transport can be substantial. This phenomenon is also true at the INTEC TFF; however, the influence of the Big Lost River on flow at the INTEC TFF appears to be less significant than simulated in the DOE INTEC TFF performance assessment modeling, while anthropogenic sources of water and precipitation infiltration appear to be more important to perched water formation. Precipitation infiltration can lead to greater releases from the INTEC TFF, while deflection of contaminant plumes due to the pressure gradient imposed by Big Lost River seepage appears to have decreased contaminant concentrations in DOE's groundwater model.

Scientists at the Vadose Zone Research Park also concluded that preferential flow dominates transport in the subsurface at INL. However, fracture networks within rock layers are difficult to characterize using traditional methods (Baker, 2006). As a result, current vadose zone transport models fail to capture the potential for rapid transport through fractured rock. Baker (2006) concludes that a better understanding of mechanisms contributing to the formation, longevity, and transport within perched water zones and a means to characterize and incorporate fracture networks into vadose zone transport models is needed to facilitate long-term stewardship of the site.

While DOE's performance assessment model attempts to simulate the presence of perched water and by-passing of contaminant plumes through breaks in sedimentary interbed materials, several limitations in DOE's conceptual model and PORFLOW model implementation are noted in NRC staff's Technical Evaluation Report (NRC, 2006) and summarized in this technical review report. Of potentially greater risk-significance, DOE's groundwater model simulated a high degree of lateral transport through the vadose zone at the INTEC TFF due to a pressure gradient resulting from application of a relatively high Big Lost River seepage rate as a boundary condition in DOE's groundwater model. While Big Lost River seepage was not assumed to increase releases from the TFF (releases from the TFF were independently modeled in a DUST-MS simulation using an infiltration rate of 4 cm/yr), the relatively high Big Lost River seepage boundary condition and resulting pressure gradient appears to have led to a very significant reduction in concentrations emanating from the TFF in DOE's performance assessment model due to dilution and dispersion. While the presence of perched water in the subsurface at the INTEC TFF may facilitate lateral transport and by-passing of sedimentary interbeds in the future, the HCM implemented by DOE in its performance assessment model is not supported by field observations, and the significant credit afforded by the vadose zone in DOE's model also appears to be unsupported.

In 2011, DOE contractors prepared a supplementary analysis to address NRC staff's key technical issues associated with DOE's groundwater model (Portage, 2011). In the supplementary analysis report, DOE indicates that the Big Lost River was thought to be a principal source of recharge to the shallow perched water beneath the northern part of INTEC based primarily on water level fluctuations in perched monitoring wells from Rodriguez et al. (1997). DOE acknowledged that more recent monitoring data demonstrates that the lateral influence of the river during flow events is much less pronounced. Therefore, DOE performed the additional analysis to investigate the impact of more vertical flow on projected doses to address NRC staff's concerns.

In lieu of the two-dimensional PORFLOW model used to simulate contaminant flow and transport in the vadose and saturated zones in DOE's INTEC TFF performance assessment, DOE elected to use the GWSCREEN code. The GWSCREEN code was also used in the INTEC TFF performance assessment to supplement PORFLOW model calculations for longer evaluation periods beyond 1,000 years (i.e., PORFLOW was only used for 1,000 year evaluations). Because DOE was attempting to simulate only one-dimensional, vertical flow in the unsaturated zone and one-dimensional horizontal flow in the saturated zone, the simpler one-dimensional GWSCREEN code could be used for this analysis. No significant changes to the source release modeling using the DUST-MS computer code were made.

DOE assumed that only interbed sediments control flow and transport in the unsaturated zone and that flow and transport through the basalts is instantaneous. Other key parameters are listed in Table 1. Results of the GWSCREEN calculations are presented in Table 2. It is interesting to note, that DOE simulations indicated that vadose zone dilution and dispersion could be rather significant (DOE, 2006c), while only a factor of two higher dose is realized with the alternative conceptual model. Presumably, dilution and dispersion in the vadose zone in DOE's performance assessment modeling is almost entirely offset by dilution and dispersion in the Snake River Plain Aquifer during transport to the 100 m well location in the supplemental analysis. Another possible explanation is that the unit Ci release in DOE's simulations (DOE, 2006c) exaggerated the level of attenuation in the vadose zone compared to a simulation in which Tc-99 and I-129 are released more slowly to the vadose zone. NRC staff noted in its 2011 technical review that it would be helpful for DOE to further explain the performance impact associated with the alternative conceptual model and any offsets between vadose and saturated zone dilution to further support the revised estimates. NRC staff also noted that key modeling parameters such as Darcy velocity, effective porosity, dispersivity, etc., should be fully supported and a sensitivity analysis conducted to study the impact of parameter uncertainty on dose predictions.

While changes to uncertain parameter values affecting the GWSCREEN modeled dilution such as infiltration rates, Aquifer Darcy velocity, dispersivity, and well screen thickness could lead to higher projected doses, NRC staff is confident that the safety margin is sufficient to ensure that the performance objective for protection of members of the public (10 CFR 61.41) can be met with selection of more conservative parameter values. Finally, NRC staff's review of recent monitoring reports in 2012 and 2013 (see Appendix B) reveals no new and significant information that would alter NRC staff's Technical Evaluation Report conclusions (NRC, 2006). Therefore, NRC staff continues to have reasonable assurance that the performance objectives in 10 CFR Part 61, Subpart C can be met. Furthermore, because no significant technical issues were identified under KMA 2 "Grout Formulation and Performance", during NRC staff's observation of INTEC TFF tank grouting in 2007 and 2008, NRC concludes that DOE has provided sufficient information for NRC staff to close KMA 3, "Hydrological Uncertainties" at this time. Should new and significant information become available in the future that challenges NRC staff TER conclusions in these areas, NRC staff may reopen KMA 3, or create a new monitoring area. NRC staff will also continue to review environmental monitoring reports routinely, in conjunction with future onsite observation visits. NRC staff expects to close KMA 2 "Grout Formulation and Performance" if no issues are identified during observation of final tank grouting activities for four remaining tanks at the INTEC TFF (Tanks WM-187 through WM-190).

Table 1: Key Parameters Used in the GWSCREEN Analysis

Parameter	Value	Units
Source length	15.24	m
Source width	1.0	m
Infiltration rate	0.041	m
Interbed thickness	17.6	m
Bulk density—unsaturated zone	1.9	g/cm^3
Water-filled porosity—unsaturated zone	0.3	
Receptor distance	100	m
Well screen thickness	15	m
Aquifer Darcy velocity	21.9	m/yr
Aquifer porosity	0.1	
Aquifer bulk density	1.9	g/cm^3
Longitudinal dispersivity	9	m
Transverse dispersivity	0.00001	m
I-129 interbed K_d	0.1	L/kg
I-129 aquifer K_d	0	L/kg
I-129 tank inventory	2.6E-03	Ci
Tc-99 interbed K_d	0.01	L/kg
Tc-99 aquifer K_d	1.0	L/kg
Tc-99 tank inventory	1	Ci

Table 2: GWSCREEN Analysis Results

	INTEC TFF PA		GWSCREEN Results	
Nuclide	**Time (yr)**	**Dose (mrem/yr)^**	**Time (yr)**	**Dose (mrem/yr)^**
I-129	890	0.77	1090	1.31
Tc-99	14,600	0.012*	14,770	0.023

^Multiple mrem/yr by 0.01 to convert to mSv/yr.
*The Tc-99 dose reported in the INTEC TFF performance assessment was in error (i.e., the DOE INTEC TFF performance assessment reported a dose for Tc-99 that was 10 times higher than the actual results). The error was corrected in this table.

Teleconference or Meeting:

There were no teleconferences or meetings to support this technical review activity.

Follow-up Actions:

There are no follow-up actions associated with this technical review activity.

Open Issues:

There are no open issues associated with this technical review activity.

Conclusions:

KMA 3, "Hydrological Uncertainties", was developed by NRC staff to manage technical uncertainties identified in NRC staff's Technical Evaluation Report for the INTEC TFF during the monitoring period. NRC staff has reviewed a number of hydrological studies and environmental monitoring reports, since it began monitoring the INTEC TFF in 2007. While review of this additional information has increased NRC staff's understanding of the hydrological system at the INTEC TFF, the information has not fundamentally changed NRC staff's understanding of the technical uncertainties, nor has it changed NRC staff's Technical Evaluation Report conclusions. Therefore, NRC staff has decided to close KMA 3, "Hydrological Uncertainties", at this time. This decision is based on (1) years of NRC review of DOE and DOE contractor prepared documents, including a supplemental, groundwater analysis that addresses technical concerns documented in NRC staff's Technical Evaluation Report, and (2) results of NRC onsite observations related to INTEC TFF tank closure activities. Should technical issues arise in the future, NRC staff may reopen KMA 3, or create a new monitoring area. NRC staff will also continue to review environmental monitoring reports routinely under KMA 4 "Monitoring During Operations", in conjunction with future onsite observation visits.

Appendix A: Summary of Previous Technical Reviews Reviewed and Documented in Previous Periodic Monitoring Compliance Reports (NRC, 2008; NRC, 2009; NRC, 2010a; NRC, 2011; and NRC, 2012)

2007 Technical Review

Early on in the monitoring period, NRC staff reviewed a number of studies related to the hydrogeological system at INTEC. These documents included publications generated from research conducted at the Vadose Zone Research Park located just southwest of INTEC on the Big Lost River (e.g., see Baker, 2006). The Vadose Zone Research Park was the site of field-scale experiments used to study the movement of water and solutes through alluvium, sediment, and basalt between land surface and the underlying Snake River Plain Aquifer. Recharge sources at the Vadose Zone Research Park included two new percolation ponds, and the Big Lost River.

One goal of the research park was to improve the understanding of vadose zone processes that could be applied to the INL's environmental restoration, waste management and facility operations. Predicting fluid and contaminant transport in the vadose zone near INTEC at the INL is problematic due to the complex geology underlying the site. In 2002, DOE installed a system of monitoring instruments in boreholes around the perimeter of the newly constructed percolation ponds that extended to the Big Lost River. DOE studied important mechanisms, including hydraulic spreading, formation of perched water, fluid transport through fast pathways, extent of vertical and lateral infiltration, aquifer recharge, sorption capacity of porous media, and Big Lost River recharge to the vadose zone.

Data collected by DOE at the Vadose Zone Research Park indicates that perched water persists in the absence of local recharge, that water infiltration is complex and can reach large distances laterally and vertically in a non-sequential manner, and that flow paths are highly sensitive to discharge location and surface flux rates. The DOE Vadose Zone Research Park researchers studied the characteristics of perched zones, which may increase transport rates and lead to the by-passing of attenuating materials in the vadose zone, to better understand the effect of fracture flow and preferential pathways on solute flow and transport. These studies increased NRC staff's knowledge of the complex hydrogeological system at the INTEC TFF.

NRC staff also reviewed INTEC perched and saturated groundwater monitoring data conducted under the Comprehensive Environmental Response, Compensation, and Liabilities Act (CERCLA) program (Forbes, 2007). A Record of Decision for the Tank Farm Soil and INTEC Groundwater Operable Unit 3-14 was signed in May 2007 (DOE, 2007). Current risks associated with the tank farm soil and INTEC groundwater from previous releases include external exposure to soil contaminated with Cesium(Cs)-137 and ingestion of contaminated Snake River Plain Aquifer groundwater. The Snake River Plain Aquifer currently contains significant concentrations of Sr-90 and nitrate from previous injection well operations and Tc-99 resulting from tank farm releases (DOE, 2009a). DOE concluded that, if left unmitigated, perched water could become a source of groundwater contamination in the Snake River Plain Aquifer above certain CERCLA action levels (e.g., maximum contaminant levels) beyond 2095. CERCLA modeling also shows that with decreased infiltration in a 9.5-acre area surrounding the TFF, the Snake River Plain Aquifer could meet action levels by 2095. This 9.5-acre area is designated a recharge control zone under the selected remedy. Thus, remedial activities are focused on the control of recharge to the subsurface. Data collected under the CERCLA program are reviewed by NRC staff to provide insights on the complex hydrogeological system at the INTEC TFF.

Concentrations of Sr-90 and Tc-99 exceeded their respective drinking water standards (i.e., maximum contaminant level or MCLs) in one or more of the aquifer monitoring wells (see Figure A-1) at or near INTEC[6]. One aquifer well located southeast of INTEC showed an increase in Sr-90 from the previous year. Consistent with data collected in 2005, Tc-99 was detected above drinking water standards in two aquifer wells. The highest Tc-99 concentration of 80 Bq/L (2,150 pCi/L) was observed at a monitoring well located just north of the INTEC TFF. The second highest Tc-99 concentration of 46 Bq/L (1,240 pCi/L) was observed at a new aquifer well located just southeast of the tank farm. DOE has attributed detectable concentrations of Tc-99 to historical releases from the INTEC TFF. I-129 concentrations were below the MCL at all aquifer locations. None of the aquifer wells showed increases in I-129 concentration.

---

[6] NRC low-level waste regulations found in 10 CFR Part 61, Subpart C, do not provide concentration limits for radioactive constituents in groundwater. Comparisons to drinking water standards are made to provide a relative indication of the levels of contamination in the subsurface at INTEC from historical releases, and are not intended to imply that these standards are necessary to demonstrate compliance with criteria for non-high-level waste determinations. First, groundwater contamination from historical releases is not within the scope of non-high-level waste determinations. Second, drinking water standards established by the Environmental Protection Agency (EPA) consider only the drinking water pathway using a specific dose methodology described in EPA's regulations. Based on DOE's performance assessment results for the INTEC TFF, drinking water standards established by the EPA are generally more limiting than equivalent concentrations used to demonstrate compliance with the 10 CFR 61.41 performance objective related to protection of members of the public from releases of radioactivity from the disposal facility. For example, drinking water standards for beta/gamma emitters (with the exception of Sr-90 and H-3 that are specifically listed in EPA regulations) are based on an annual dose equivalent to the total body or any internal organ greater than 0.04 mSv/yr (4 mrem/yr) calculated on the basis of 2 L/d drinking water intake using the 168 hour data list in "Maximum Permissible Body Burdens and Maximum Permissible Concentrations of Radionuclides in Air and in Water for Occupational Exposure," National Bureau of Standards Handbook 69 as amended in August 1963. Using this method, the limit for Tc-99 is 33 Bq/L (900 pCi/L), and the limit for I-129 is 0.037 Bq/L (1 pCi/L). The EPA regulation, 40 CFR 141.66(d)(2), Table A, provides a specific limit for Sr-90 in the amount of 0.3 Bq/L (8 pCi/L). NRC staff calculated groundwater concentrations equivalent to a dose of 0.25 mSv/yr (25 mrem/yr) total effective dose equivalent to a member of the public using dose methodology assumptions reported in DOE's INTEC TFF Performance Assessment (DOE, 2003). Concentrations equivalent to 0.25 mSv/yr (25 mrem/yr) are 1.5 Bq/L (40 pCi/L) for Sr-90, 110 Bq/L (3000 pCi/L) for Tc-99 and 0.37 Bq/L (10 pCi/L) for I-129. These concentrations are 5, 3, and 10 times higher than the respective MCLs.

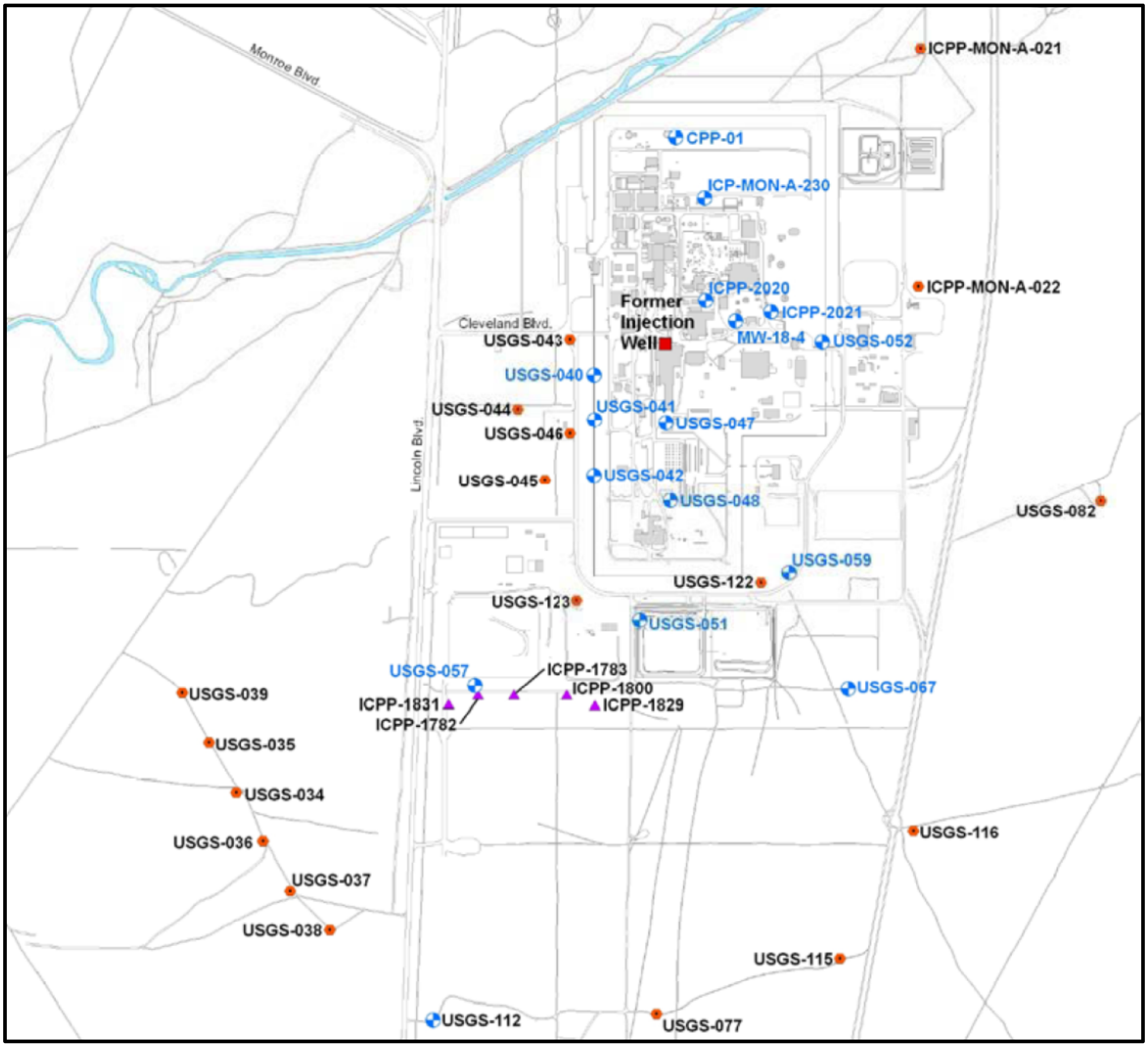

Figure A-1: Snake River Plain Aquifer Groundwater Monitoring Network (Blue Labeled Wells Sampled Every Year, Black Labeled Wells Sampled Only in Odd Numbered Years)

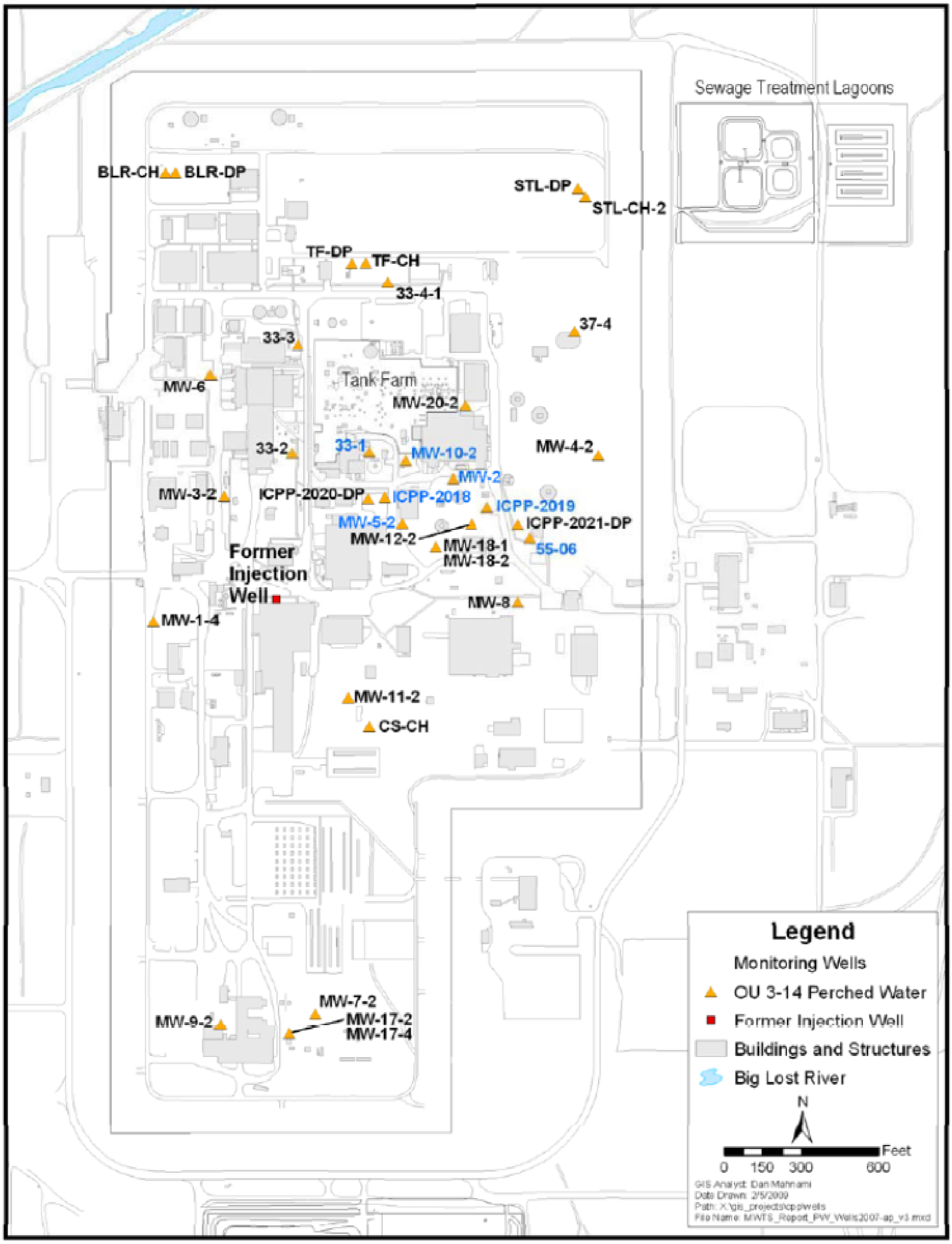

Figure A-2: Perched Water Monitoring (Blue Labeled Wells Sampled Every Year, Black Labeled Wells Sampled Only In Odd Numbered Years)

DOE perched water monitoring data from historical releases indicate that Sr-90 was the principal radionuclide detected in shallow perched water at INTEC (Forbes, 2007). Perched water wells (see Figure A-2) located at and southeast of the INTEC TFF exhibited the highest levels of Sr-90 contamination. The maximum Sr-90 activity concentration observed in perched water in 2006 was 7290 Bq/L (197,000 pCi/L). Consistent with recent detections in 2005, Cesium (Cs)-137 was detected at a lower concentration in one shallow perched water well located at the INTEC TFF. Cs-137 is less mobile than Tc-99, I-129, and Sr-90. Thus, this constituent was not detected in INTEC groundwater until 2005, long after Tc-99, I-129, and Sr-90 were detected in monitoring wells at INTEC. NRC staff reviews data on Cs-137 and other less mobile radionuclides for discernible trends and to gather information regarding the attenuation of these constituents in the subsurface at INTEC to compare against DOE performance assessment assumptions. The highest levels of Tc-99 in shallow perched water were observed in monitoring wells located southeast of the INTEC TFF at levels lower than the drinking water standards. I-129 was detected in only one perched water well located south of the INTEC TFF at a concentration of 0.2 Bq/L (5 pCi/L), higher than reported in 2005, and the highest concentration reported in any well in recent years. I-129 concentration trends were either relatively constant or slowly declining over time at all other locations.

The Big Lost River flowed past INTEC from April 16, 2006 until July 3, 2006. The effect on perched water levels was observed only at monitoring wells located closest to the river (within 150 m [500 feet]). Little or no water level response was observed in wells located further from the river. A combination of precipitation infiltration (rainfall and snowmelt), and discharges or leaks of water from facility pipelines appears to account for continued recharge of the perched water beneath the northern part of INTEC (Forbes, 2007). The extent of shallow perched water beneath the northern portion of INTEC expanded eastward during 2005-2006, primarily due to an increase in on-site precipitation infiltration.

NRC staff also conducted two onsite observations in 2007. During the first onsite observation, NRC staff evaluated the implementation of the quality assurance program and reviewed the records pertaining to tank grouting operations. NRC staff also observed and reviewed data collected to assess consistency with assumptions made in the waste determination. The observation determined that the quality assurance program of DOE and its contractor, CH2M-WG Idaho, LLC (CWI), is being implemented effectively. NRC staff also determined CWI has a robust program for verifying that the grout components conform to applicable ASTM standards and that the final grout formulations are consistent with the design specifications assumed in the waste determination. NRC requested additional information regarding (i) the qualifications required of vendors to be on DOE's "approved vendors" list and (ii) the minimum cure time between grout pours. NRC staff also recommended that DOE provide documentation to demonstrate that the high water to cement ratio used in grouting tanks WM-104, WM- 105, and WM-106 will not adversely impact the expected performance of the grout. NRC recommended that DOE document deviations from its final waste determination and performance assessment and assess the risk significance of these deviations.

On the second onsite observation, NRC staff reviewed records and observed ongoing tank grouting operations at the INTEC TFF. NRC determined that the DOE and CWI quality assurance program pertaining to tank grouting, grout formulation, and placement is being implemented effectively. NRC reviewed the documents DOE provided in response to an NRC request made during its April 2007 onsite observation visit. NRC closed the issues from the April 2007 observation report as it has determined that satisfactory information had been received.

For the issue on the qualification for vendors on the approved vendor list, DOE supplied information on the quality assurance program of its vendor, Valley Ready Mix, which ensures the grout materials it supplies to CWI meet DOE specifications, in terms of constituent formulation and standard grout characteristics. NRC recommended that if specific characteristics of the grout material, which are not part of the standard grout characteristics, such as the sulfide level of the slag, are being relied on for performance, specific requirements for testing should be added to the quality assurance programs.

DOE provided adequate information for NRC to close the issue on the minimum cure time for the grout lifts. NRC is recommending that DOE remain cognizant of the potential for crack formation, which may be more of an issue at other sites which have not used very conservative assumptions for concrete degradation. The third issue addressed the water to cement ratio used in three of the small tanks, as compared to the water to cement ratio assumed in the waste determination. NRC determined that, based on the small radionuclide inventory in the 113.6 m3 (30,000 gal) tanks, the high water to cement ratio of the grout used in three of the four 113.6 m3 (30,000 gal) tanks poses a low risk of significantly increasing the dose to the general population.

2008 Technical Review (NRC, 2008)

In 2008, NRC staff reviewed groundwater monitoring data collected from the previous year. Consistent with previous data, concentrations of Sr-90 and Tc-99 from historical releases exceeded their respective drinking water standards in two or more of the aquifer monitoring wells (see Figure A-1) at or near INTEC. At least one aquifer monitoring wells located southeast of INTEC showed an increase in Sr-90 from the previous year. Consistent with previous data, Tc-99 was detected at concentrations above drinking water standards in two aquifer wells. The highest Tc-99 concentration of 61 Bq/L (1650 pCi/L) was observed at a monitoring well located just north of the INTEC TFF. The second highest Tc-99 of 46 Bq/L (1230 pCi/L) was observed at a monitoring well located just southeast of the tank farm. I-129 concentrations were below drinking water standards at all aquifer locations. None of the aquifer wells showed increases in I-129 concentration.

DOE perched water monitoring data from historical releases indicates that Sr-90 is the principal radionuclide detected in shallow perched water at the INTEC (Forbes, 2008). Perched water wells (see Figure A-2) located at and southeast of the INTEC TFF exhibited the highest levels of Sr-90 contamination. The maximum Sr-90 activity concentration observed in perched water in 2007 was 5880 Bq/L (159,000 pCi/L). Although Cs-137 was detected in one shallow perched water well located at the INTEC TFF the previous two years (2005 and 2006), this perched well was dry in CY2007 and therefore could not be sampled. Consistent with previous data, the highest well concentrations of Tc-99 in shallow perched water were observed in monitoring wells located southeast of the INTEC TFF, but at levels lower than drinking water standards. I-129 was not detected in any perched water well in CY2007.

NRC staff also conducted one onsite observation in 2008 to monitor ancillary equipment grouting. NRC staff did not observe any problems with the grouting of the ancillary equipment at the INTEC TFF and the staff determined that this program is being conducted in a manner that ensures the grout specifications meet those that were assumed in DOE's final waste determination.

2009 Technical Review (NRC, 2009)

DOE developed a Tank Farm Soil and INTEC Groundwater Remedial Design/Remedial Work Plan (DOE, 2008), and Long-Term Monitoring Plan (DOE, 2009a) that calls for annual reporting of groundwater monitoring results at the INTEC TFF. As part of its technical review activities for 2009, NRC staff reviewed the 2008 annual report (DOE, 2009b) describing maintenance, inspection, and other activities performed to address contaminated soils and groundwater at INTEC. Activities reported in the annual report include inspections, monitoring, radiological surveys, and maintenance of various water management and infiltration control measures implemented at INTEC (e.g., storm water collection ditches, evaporation pond, culverts, and infiltration barriers). Despite efforts to identify and control anthropogenic sources, evaluation of perched water levels indicates that unknown sources of water from operations may continue to recharge the subsurface at INTEC. Potential sources will continue to be investigated. While trend data show the potential for above-average snowfall accumulation and associated melting and infiltration to increase perched water levels at INTEC in the short-term (e.g., higher than average snowfall and infiltration in the winter of 2007-2008), a longer term general decline in shallow perched water volumes over the period from 2006 through 2008 has been observed.

2010 Technical Review (NRC, 2010a)

In 2010, NRC staff reviewed DOE's annual report for FY2009 (DOE, 2010a). DOE's annual monitoring report describes various activities designed to control infiltration including inspection activities, remedial actions (e.g., laying down asphalt over decommissioned areas, constructing and lining ditches), identification of anthropogenic sources of water, plugging abandoned wells, etc. Section 5 of the annual monitoring report describes long-term monitoring activities.

Consistent with previous data, the highest Tc-99 concentrations were associated with monitoring well ICPP-MON-A-230 (82 Bq/L or 2,220 pCi/L) located near the INTEC Tank Farm and the second-highest Tc-99 concentrations were measured at aquifer well ICPP-2021 (46 Bq/L or 1,240 pCi/L), located southeast of the Tank Farm (see Figure A-1 for well locations). These two wells were the only wells to exceed the Tc-99 MCL of 33 Bq/L (900 pCi/L). ICPP-2020 was the only well that showed a significantly higher Tc-99 level (14 Bq/L or 382 pCi/L) compared to what was reported in previous years (e.g., 8 Bq/L or 215 pCi/L in FY 2007). All other wells showed stable or declining trends.

Consistent with previous data, very high Sr-90 levels (>370 Bq/L or >10,000 pCi/L) were observed in the northern shallow perched water across INTEC. The highest Sr-90 concentrations were observed in wells (see Figure A-2) southeast of the Tank Farm. The maximum Sr-90 concentration detected was 4810 Bq/L (130,000 pCi/L) at monitoring well ICPP-2018. At most well locations, Sr-90 concentrations were similar to those observed during the previous year, but are approximately half those reported in the same wells during the mid-1990s due to decay and transport. Gross beta activity was detected at nearly all perched water sampling locations with the highest gross beta level occurring at well ICPP-2018 (11,500 Bq/L or 311,000 pCi/L) consistent with the Sr-90 data.

Detectable gross alpha activity was reported at nearly all perched water sampling locations. The highest gross alpha activity was measured at well 33-2 at a value of 0.74 Bq/L (20.1 pCi/L). However, the gross alpha activity reported in a duplicate sample from the same well was only 0.21 Bq/L (5.75 pCi/L). No plutonium isotopes were detected in either sample from well 33-2 and uranium concentrations, although slightly elevated, could not account for all the alpha activity detected in this well. The high concentrations were thought to potentially be attributable to laboratory error given the results of the duplicate sample. NRC staff indicated that it would continue to evaluate gross alpha measurements in this and other nearby wells to ensure that no new alpha emitting radionuclides that are not currently being targeted for sampling are identified.

The lateral extent of the northern shallow perched water was mapped in the FY 2009 report. Shallow perched water wells MW-8, MW-11-2, MW-12-2, and MW-18-2 were essentially dry (<0.15 m or <0.5 ft of water) during the monitoring period. The Big Lost River flowed past INTEC between June 18 and July 4, 2009. However, only one monitoring well (Well BLR-CH) showed a significant water-level response to the river flow event. Well BLR-CH is the well closest to the river (i.e., 150 m or 500 ft from the river channel). After a 4-day time lag following the onset of flow in the river, the perched water level in Well BLR-CH rose 7 m (22 ft) over 16 days. This is essentially the same water-level response observed in the past at this well location. No other wells showed any response to flow changes in the river.

During the onsite observation conducted in August 2010 (NRC, 2010b), NRC staff listened to presentations and participated in discussions with DOE and contractor staff regarding ongoing remedial and groundwater monitoring activities performed under the CERCLA program at the INTEC TFF as described in the preceding paragraphs. Prior to the onsite observation, NRC staff also met with officials from the State of Idaho's Department of Environmental Quality (Idaho DEQ) to discuss its oversight of the site, specifically its environmental monitoring program. NRC staff reviewed environmental monitoring reports generated by Idaho DEQ under KMA 4, related to protection of individuals during operations. DOE also indicated that it was in the process of completing a check-list[7] to determine the need for an update to the INTEC TFF Performance Assessment (DOE, 2003). NRC staff indicated the following:

1. The INTEC TFF Performance Assessment documentation (DOE, 2003) should reflect the results of simulations performed and additional documentation generated during the National Defense Authorization Act Section 3116 consultation process to answer NRC staff inquiry regarding the cause and performance impact of the significant lateral spread of the contaminant plume emanating from the TFF to the south (e.g., caused by pressure gradient from BLR seepage and resulted in up to a factor of 10,000 decrease in contaminant concentrations emanating from the tank farm facility for relatively mobile [non-sorbing] constituents such as Tc-99 and I-129).

2. DOE should consider (in its decision to update the INTEC TFF performance assessment model) recent data collected under the CERCLA program that appears to be inconsistent with the DOE performance assessment modeling results with respect to the impact of Big Lost River flow on contaminant fate and transport at the INTEC TFF.

Following the onsite observation, DOE completed an annual review checklist to ensure that conclusions reached in the waste determination remain technically sound and based upon current information. The annual review checklist process indicated that the modeling approach and assumptions of DOE's performance assessment should be assessed because recent CERCLA monitoring showed anthropogenic sources are the predominant recharge source rather than the Big Lost River. DOE conducted additional analysis for comparison to the INTEC

[7] Later during the August 2012 onsite observation, DOE provided NRC staff with a copy of the "Compliance and Monitoring Plan for Performing Grouting at the INTEC Tank Farm Facility Closure Project" (DOE, 2010b). This plan contains a check-list in Appendix D that indicates that types of triggers that might warrant further evaluation.

TFF performance assessment results to investigate the potential doses for more vertical movement of water due to the decreased influence of the Big Lost River at the TFF. NRC staff reviewed the analysis as discussed in the "*2011 Technical Review*" section.

2011 Technical Review (NRC, 2011)

In 2011, NRC staff reviewed DOE's 2010 annual report (DOE, 2011a) describing maintenance, inspection, and other activities performed to address contaminated soils and groundwater at INTEC. DOE's annual reports are not intended to interpret data, form conclusions, or determine the effectiveness of the selected remedy; these topics are the subject of DOE's 5-year review of the effectiveness of its CERCLA response actions. A 5-year review was recently completed and documented in a January 2011 report (DOE, 2011b). This report is discussed further below.

DOE's 2010 annual monitoring report (DOE, 2011a) describes various activities designed to control infiltration including inspection activities, remedial actions (e.g., laying down asphalt over decommissioned areas; constructing and lining ditches), identification of anthropogenic sources of water, plugging abandoned wells, etc. Section 5 of DOE's annual monitoring report describes long-term monitoring activities that are of particular interest to NRC staff in its review of KMA 3. During the FY2010 reporting period DOE conducted groundwater sampling at 14 Snake River Plain Aquifer wells[8] and five additional wells sampled as part of the Idaho CERCLA Disposal Facility monitoring program[9]. The operating unit monitoring plan requires sampling of 15 aquifer wells (see Figure A-1) during the even years. One well, USGS-57, was not sampled in FY2010 because of an inoperable submersible pump at the time of the sampling event. Perched water samples were collected from six perched wells: 55-06, ICPP-2018, ICPP-2019, MW-2, MW-5-2, MW-10-2 (see Figure A-2). Well 33-1 was not sampled because the well contained insufficient water for sampling. Well MW-10-2 only had enough water for a partial suite of analyses.

Consistent with previous data, the highest Tc-99 concentrations from the April 2010 sampling event were associated with monitoring well ICPP-MON-A-230 (71 Bq/L or 1,930 pCi/L) located near the INTEC Tank Farm and the second-highest Tc-99 concentrations were measured at aquifer well ICPP-2021 (50 Bq/L or 1,340 pCi/L), located southeast of the TFF. These two wells were the only wells to exceed the Tc-99 MCL[10] of 33 Bq/L (900 pCi/L). All wells show stable or declining trends.

Consistent with previous data, very high Sr-90 levels (>370 Bq/L or >10,000 pCi/L) were observed in the northern shallow perched water across INTEC. The highest Sr-90 concentrations were observed in wells southeast of the TFF. The maximum Sr-90 concentration detected was 5,700 Bq/L (154,000 pCi/L) at monitoring well ICPP-2018. At most well locations, Sr-90 concentrations were similar to those observed during the previous year, but are approximately half those reported in the same wells during the mid-1990s due to decay and transport. Gross beta activity was detected at nearly all perched water sampling locations with the highest gross beta level occurring at well ICPP-2018 (12,000 Bq/L or 326,000 pCi/L)

[8] SRPA wells CPP-01, ICPP-2020, ICPP-2021, ICPP-MON-A-1230, MW-18-4, USGS-040, USGS-41, USGS-42, USGS-47, USGS-48, USGS-51, USGS-52, USGS-59, USGS-067 were sampled in the April 2010 event.

[9] Wells ICPP-1782, ICPP-1783, ICPP-1800, ICPP-1829, and ICPP-1831 were sampled in the April 2010 event.

[10] Note that NRC does not use MCLs or maximum contaminant levels to determine compliance with performance objectives in 10 CFR Part 61, Subpart C. MCLs are standards used by the Environmental Protection Agency in the CERCLA program and are provided for information only.

consistent with the Sr-90 data. Sr-90 was detected in 13 of 14 Snake River Plain Aquifer wells with samples from seven of the wells exceeding the Sr-90 MCL of 0.3 Bq/L (8 pCi/L). The highest measurement of Sr-90 in the aquifer was 1 Bq/L (24.8 pCi/L) at well USGS-47 located down gradient of the former INTEC injection well. All wells showed similar or slightly lower Sr-90 levels compared to the previous reporting period.

Although U-234 and U-238 were present at background levels, no detectable gross alpha levels were reported for any perched water sampling locations. The apparent discrepancy between uranium and gross alpha measurements may be explained by the lower detection limit for U isotopes compared to gross alpha of 0.02 Bq/L (0.5 pCi/L) and 0.15 Bq/L (4 pCi/L), respectively. Analysis revealed no detectable levels of Pu in the vadose zone and aquifer wells.

The lateral extent of the northern shallow perched water was also mapped in the FY 2010 report. Changes in water levels at several wells could be attributable to contributions from or elimination of anthropogenic sources of water. The Big Lost River is another potential source that can impact perched water levels at INTEC and flowed past INTEC between June 9 and 14 and between June 17, 2010 and 20, 2010. Similar to previous observations, only one monitoring well (Well BLR-CH) showed a significant water-level response to the river flow event. Well BLR-CH is the well closest to the river (i.e., 152 m [500 ft] from the river channel). After a 4-day time lag following the onset of flow in the river, the perched water level in Well BLR-CH rose 3 m (10 ft) over 15 days. This is similar to the water-level response observed in the past at this well location. No other wells showed any response to flow changes in the river.

DOE also conducts a 5-year review of CERCLA response actions. The 5-year review was conducted for the INTEC and documented in a report issued in January 2011 (DOE, 2011b). With respect to perched water and groundwater, DOE concludes that the CERCLA response actions are functioning as intended and that previous exposure assessment assumptions remain valid. Since the 2007 Record of Decision, DOE indicates that significant progress has been made towards reducing precipitation infiltration and anthropogenic recharge at INTEC. Plans to install a low permeability cover over the tank farm and surrounding area will proceed as facilities are decommissioned. Although remedial activities are not yet complete and their ultimate effectiveness cannot be assessed at this time, DOE concludes that indications are favorable that the desired effect of these remedies will be achieved.

During FY2010, DOE contractors also performed a modeling analysis that addressed an NRC staff technical concern made during NRC's 2010 onsite observation. NRC staff encouraged DOE to consider (in its performance assessment maintenance review) recent data collected under the CERCLA program that appears to be inconsistent with the DOE INTEC TFF performance assessment modeling results with respect to the impact of Big Lost River flow on contaminant fate and transport at the INTEC TFF. Recent observations of limited perched water level response in vadose zone wells following Big Lost River flow and other investigations indicate that anthropogenic sources of water associated with INTEC operations, rather than Big Lost River seepage, are a more significant source of perched water currently observed at INTEC TFF. Ultimately, DOE determined that this issue was significant enough to include in its performance assessment maintenance checklist and performed additional modeling to determine the potential dose impact of more vertical movement of water in the vadose zone at the INTEC TFF compared to the significant lateral spread and dilution of TFF releases that occurs in the vadose zone in DOE's INTEC TFF performance assessment model.

NRC staff reviewed DOE's modeling analysis (Portage, 2011) that showed while the doses would increase by roughly a factor of two, performance objectives could still be met. DOE's analysis was conducted using the DUST-MS code originally used to develop a source term in the INTEC TFF Performance Assessment (DOE, 2003). The source term was used as input to the GWSCREEN simulations that were used to simulate vadose and saturated zone transport. Because flow through the TFF vadose zone was assumed to be vertical in this alternative conceptual model (along with 1-D flow in the saturated zone), a multi-dimensional PORFLOW model was not needed to perform the groundwater simulations. NRC staff noted that, in general, the supplemental analysis appears to be technically sound. However, NRC staff also noted, that DOE's PORFLOW simulations used to prepare the INTEC TFF PA indicated that vadose zone dilution would be rather significant (i.e., concentrations released from the tanks would be thousands to tens of thousands times less during transport through the vadose zone). Presumably, dilution and dispersion in the vadose zone in the PA modeling was almost entirely offset by dilution and dispersion in the Snake River Plain Aquifer during transport to the 100 m well location in the supplemental analysis. NRC staff noted in its 2011 technical review that it would be helpful for DOE to further explain the performance impact associated with the alternative conceptual model and any offsets between vadose and saturated zone dilution to further support the revised estimates. NRC staff also noted that key modeling parameters such as Darcy velocity, effective porosity, dispersivity, etc., should be fully supported and a sensitivity analysis conducted to study the impact of parameter uncertainty on dose predictions.

Appendix B: Summary of Recent Groundwater Monitoring Reports Not Previously Reviewed or Documented

Documents Reviewed:

DOE, 2012a, “Fiscal Year 2011 Annual Operations and Maintenance Report for Operable Unit 3-14, Tank Farm Soil and INTEC Groundwater”, DOE/ID-11462, Revision 0, DOE Idaho, Idaho Falls, Idaho, July 2012.

DOE, 2013, “Fiscal Year 2012 Annual Operations and Maintenance Report for Operable Unit 3-14, Tank Farm Soil and INTEC Groundwater”, DOE/ID-11476, Rev. 0, DOE Idaho, Idaho Falls, Idaho, June 2013.

2011 Annual Report

During the FY2011 reporting period (April 2011), groundwater samples were collected from 18 of 19 Snake River Plain Aquifer monitoring wells (DOE, 2012a) targeted for sampling in odd years per the Operable Unit 3-14 Long-Term Monitoring Plan (DOE, 2012b), as well as 5 additional aquifer wells sampled as part of the Idaho CERCLA Disposal Facility monitoring program (see Figure A-1). One well, USGS-40, was not sampled.

Sr-90 was detected in 14 of 18 Snake River Plain Aquifer groundwater wells with 9 of the 14 Sr-90 detections above the MCL of 0.3 Bq/L (8 pCi/L). Consistent with previous years, the highest concentration of Sr-90 occurred in Well USGS-47 (see Figure A-1) at a value of 0.8 Bq/L (21 pCi/L), a little lower than previous years. Sr-90 at well USGS-47 is thought to be associated with the former waste injection well and attributable to desorption and/or drain out of Sr-90 from perched water.

Tc-99 was detected at 17 of 18 Snake River Plain Aquifer wells sampled, with two well concentrations measured at levels above the MCL of 33 Bq/L (900 pCi/L). The highest well concentration of 39 Bq/L (1250 pCi/L) occurred at ICPP-2021 located to the southeast of the tank farm. The other well with a sampled groundwater concentration above the MCL occurred at ICPP-MON-A-230, north of the tank farm, at a value of 35 Bq/L (940 pCi/L), although the Tc-99 concentration in this well was significantly lower than in previous years. Tc-99 detected in the two highest Snake River Plain Aquifer wells is associated with historical releases from the tank farm facility. I-129 was detected at a minority of wells and all detections were below the MCL of 0.04 Bq/L (1 pCi/L). The highest concentration was detected at well USGS-67 at a value of 0.02 Bq/L (0.5 pCi/L). I-129 concentrations have been generally declining since the highest detections were measured in the 1980s and 1990s.

Perched water samples were obtained from 22 wells (see Figure A-2); however, insufficient water was collected from some wells to perform a full suite of laboratory analyses. Sr-90 was detected in most wells, with 11 wells above the MCL of 0.3 Bq/L (8 pCi/L). The highest well concentration was observed at ICPP-2018 at a value of 4500 Bq/L (121,000 pCi/L). Well concentrations were similar to previous measurements but significantly lower than those observed at the same wells in the mid 1990s, given Sr-90’s half-life of 30 years[11]. Tc-99 was detected in most perched wells but none above MCLs. Perched wells observe a declining trend in Tc-99 concentrations due to dispersion and dilution or drain out of Tc-99 from the perched zone. I-129 detections have been observed in perched wells but only one well has I-129 above the MCL.

---

[11] Only one-half of Sr-90 remains after every 30 years, or only approximately 10 percent after 100 years.

The extent of perched water was also mapped in the FY2011 report. Consistent with past measurements, several shallow perched water wells MW-8, MW-11-2, MW-12-2, and MW-18-2 were essentially dry. Notable changes in perched water levels include the following:

1. Well 33-2 has historically had one of the highest perched water levels at INTEC; however, this well declined 2.4 m (8 ft) between the summer of 2010 and January 2011, when the well went dry for the first time since 2003. Then, the water level suddenly began rising and increased 2.4 m (8 foot) beginning in February through March 2011. The cause of the abrupt rise and fall of the water level was not confirmed.

2. The Big Lost River flowed past INTEC between June 25 and July 13, 2011, with only monitoring well BLR-CH (see Figure A-1), closest to the river, showing any significant water-level response, similar to past observations. A 8 m (24 ft) water level rise in Well BLR-CH occurred over 2 weeks with a 4 day lag time between the river flow event and water level rise.

3. Well MW-5-2 showed a sharp water-level rise beginning in late December 2010, possibly related to steam condensate discharged to an active shallow injection well, and then a sharp water-level decline beginning in July 2011 and continuing through the end of September 2011.

Progress has been made to reduce perched water recharge; however, DOE expects perched water to persist as long as INTEC is an operational, industrial facility with pressurized underground water pipelines periodically developing leaks.

With regard to tensiometer measurements, the largest change was associated with the Big Lost River set at the 40 m (132 ft) depth beginning in late June 2011 in response to Big Lost River flow. By September 2011, water potentials in the BLR-CH tensiometer had returned to values similar to those observed before the river flow event. At the central well set, the 85 m (280 ft) depth tensiometer began rising sharply in mid-April 2011 possibly due to a large underground water leak from a buried raw water pipeline. At the sewage treatment lagoon well set, the 32 m (104 ft) tensiometer showed a wetting pulse during February to March 2011 likely due to infiltration of melt water. Finally, at the tank farm set, the 36 m (118 ft) tensiometer showed a wetting pulse beginning in late July 2011 following Big Lost River Flow that began on June 25, 2011.

2012 Annual Report

During the FY2012 reporting period (March 2012), groundwater samples were collected from all 14 Snake River Plain Aquifer monitoring wells (DOE, 2013) targeted for sampling in even years per the Operable Unit 3-14 Long-Term Monitoring Plan (DOE, 2012b), as well as 5 additional aquifer wells sampled as part of the Idaho CERCLA Disposal Facility monitoring program.

Sr-90 was detected in 12 of 14 Snake River Plain Aquifer groundwater wells with 7 of the 12 Sr-90 detections above the MCL of 0.3 Bq/L (8 pCi/L). Consistent with previous years, the highest concentration of Sr-90 occurred in Well USGS-47 (see Figure A-1) at a value of 0.5 Bq/L (17 pCi/L), a little lower than previous years. Sr-90 at well USGS-47 is thought to be associated with the former waste injection well and attributable to desorption and/or drain out of Sr-90 from perched water. Figure A-1 shows the location of Snake River Plain Aquifer wells.

Tc-99 was detected at nearly all of the Snake River Plain Aquifer wells sampled, with two well concentrations measured at levels above the MCL of 33 Bq/L (900 pCi/L). The highest well concentration of 45 Bq/L (1,450 pCi/L) occurred at ICPP-MON-A located to the north of the tank farm. The other well with a sampled groundwater concentration above the MCL occurred at ICPP-2021, southeast of the tank farm, at a value of 33 Bq/L (1070 pCi/L). Tc-99 detected in the two highest Snake River Plain Aquifer wells is associated with historical releases from the tank farm facility. Figure B-1 provides Tc-99 concentration trends at select Snake River Plain Aquifer wells. I-129 concentrations were below reporting levels in all sampled wells. The highest concentration was detected at well USGS-67 at a value of 0.02 Bq/L (0.5 pCi/L). I-129 concentrations have been generally declining since the highest detections were measured in the 1980s and 1990s.

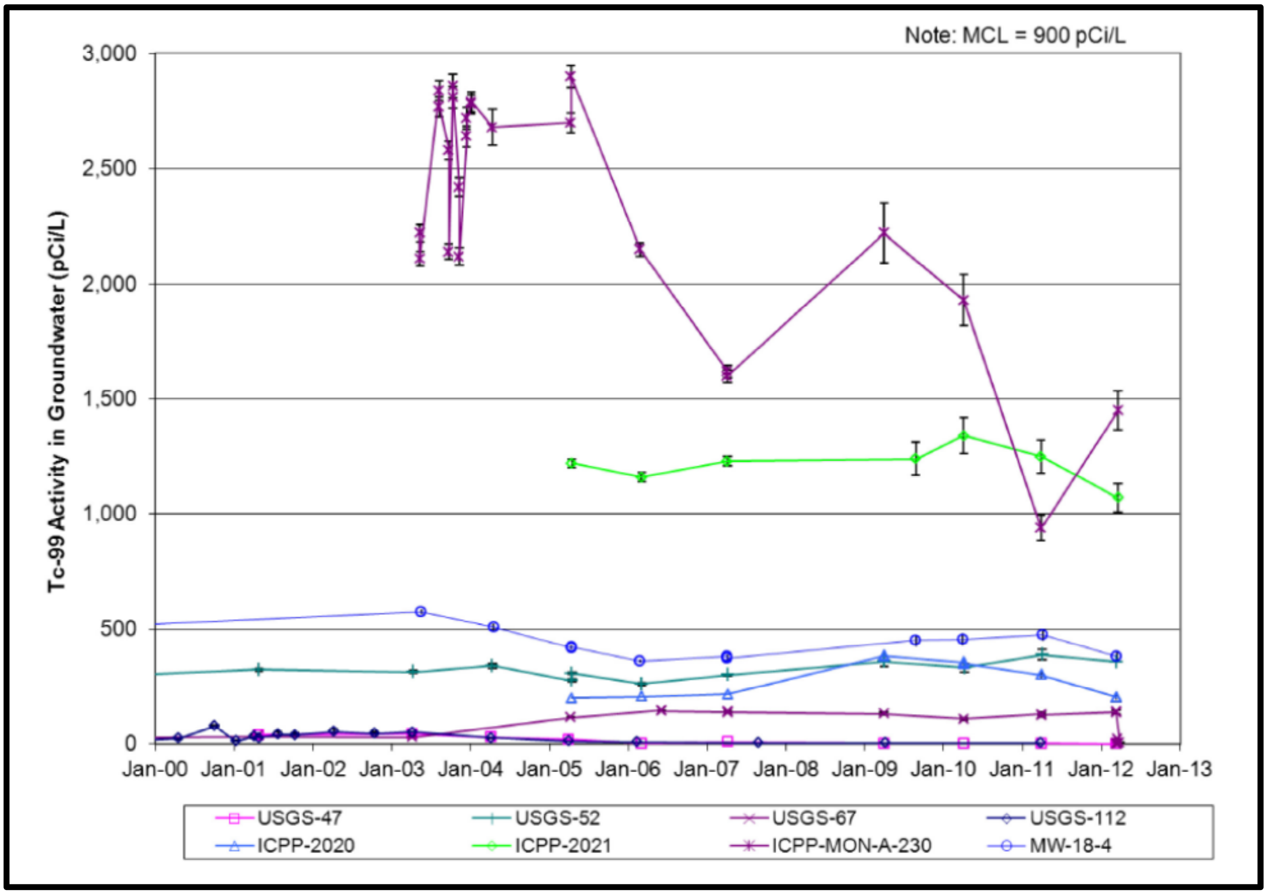

Figure B-1: Tc-99 Concentration Trends for Selected Snake River Plain Aquifer Wells. Image Credit: Figure A-10 (DOE, 2013).

Perched water samples were obtained from 6 wells (see Figure A-2). One well, 33-1, had insufficient water for sampling, and well MW-10-2 had insufficient water collected to perform a full suite of laboratory analyses. Sr-90 was detected at all sampled wells, and all wells sampled were above the MCL of 0.3 Bq/L (8 pCi/L). The highest well concentration was observed at ICPP-2018 at a value of 4740 Bq/L (153,000 pCi/L). Well concentrations were similar to previous measurements but significantly lower than those observed at the same wells in the mid 1990s, given Sr-90's half-life of 30 years. Tc-99 was detected in most perched wells but none above MCLs. Perched wells observe a declining trend in Tc-99 concentrations due to dispersion and dilution or drain out of Tc-99 from the perched zone. I-129 was not detected in any perched well sampled in 2012. In general, I-129 has been steadily declining over the past several years.

The extent of perched water was also mapped in the FY2012 report. Consistent with past measurements, several shallow perched water wells MW-8, MW-11-2, MW-12-2, and MW-18-2 were essentially dry. Notable changes in perched water levels include the following:

1. Beginning in January 2012, water levels in MW-6 and 33-3 rose sharply as a result of a nearby potable water leak. The 7.6 million L (2 million gal) leak began on January 5, 2012, and caused a 4.5 m (15 ft) rise in the water level in MW-6 and a 2 m (7 ft) rise in the water level in MW-33. A sharp decline in the water levels occurred beginning on May 19, after the leak was eliminated on May 17, 2012. The water levels declined to nearly pre-leak levels by the end of June 2012.

2. Except for Wells MW-6 and 33-3 that were impacted by the potable water leak, perched water levels declined in most of the remaining wells during FY2012. Wells 33-2, ICPP-2018, 33-4-1, and 37-4 went dry during the reporting period, with the latter two wells going dry for the first time since they were installed in the 1990s.

A rare Big Lost River winter flow occurred from November 2011 to February 2012 leading to the greatest rise in water potential in a well set near the Big Lost River at the 40 m (132 ft) level, beginning in late November. By July 2012, water potentials at the BLR-CH tensiometer had returned to pre-event values. Also noteworthy, at the sewage treatment lagoon well set, the tensiometer at 104 ft showed a wetting pulse during November 2011 to March 2012 that may be the result of infiltration of melt water into the vadose zone.

Appendix C: References

Baker, K., et al., “Conceptual Models of Flow through a Heterogeneous, Layered Vadose Zone under a Percolation Pond,” INEEL/EXT-04-01679, Idaho National Engineering and Environmental Laboratory, Bechtel BWXT Idaho, LLC, February 2004.

Baker, K., “Idaho National Laboratory Vadose Zone Research Park Geohydrological Monitoring Results,” INL/EXT-05-01044, Idaho National Laboratory, Geosciences Department, Idaho Falls, Idaho, January 2006.

DOE, 2003, “Performance Assessment for the Tank Farm Facility at the Idaho National Engineering and Environmental Laboratory,” DOE/ID–10966, Rev. 1, (Errata December 2, 2003), DOE Idaho, Idaho Falls, Idaho, 2003.

DOE, 2004, “Evaluation of Tc-99 in Groundwater at INTEC: Summary of Phase 1 Results,” ICP/EXT–04-244, Rev. 0, DOE Idaho, Idaho Falls, Idaho, September 2004.

DOE, 2006a, “Operable Unit 3-14 Tank Farm Soil and Groundwater Remedial Investigation/ Baseline Risk Assessment,” DOE/NE–ID–11227, Rev. 0, DOE Idaho, Idaho Falls, Idaho, April 2006.

DOE, 2006b, “Follow-up Item from June 1 and 20, 2006, Meetings with DOE on INL TFF Waste Determination (Related to the large lateral extent of the contaminant plume),” DOE Idaho, Idaho Falls, Idaho, 2006.

DOE, 2006c, “Follow-up Item from June 1 and 20, 2006, Meetings with DOE on INL TFF Waste Determination (Providing center-line plume concentrations),” DOE Idaho, Idaho Falls, Idaho, 2006.

DOE, 2008, “Operable Unit 3-14, Tank Soil and INTEC Groundwater Remedial Design/ Remedial Action Work Plan,” DOE/ID-11333 Rev. 0, DOE Idaho, Idaho Falls, Idaho, June 2008.

DOE, 2007, “Record of Decision for Tank Farm Soil and Idaho Nuclear Technology and Engineering Center Groundwater, Operable Unit 3-14,” DOE/ID–11296, Rev. 0., DOE Idaho, Idaho Falls, Idaho, May 2007.

DOE, 2009a, “Operable Unit 3-14, Tank Farm Soil and INTEC Groundwater Long-Term Monitoring Plan,” DOE/ID-11334, Rev. 0, DOE Idaho, Idaho Falls, Idaho, May 2009.

DOE, 2009b, “2008 Annual Report for Operable Unit 3-14, Tank Farm Soil and INTEC Groundwater,” DOE/ID-11395, Revision 0, DOE Idaho, Idaho Falls, Idaho, June 2009.

DOE, 2010a. “Fiscal Year 2009 Annual Report for Operable Unit 3-14, Tank Farm Soil and INTEC Groundwater,” DOE/ID-11419, Revision 0, DOE Idaho, Idaho Falls, Idaho, April 2010.

DOE, 2010b. “Compliance and Monitoring Plan for Performing Grouting at the INTEC Tank Farm Facility Closure Project.” PLN-2309, Revision 3, DOE Idaho, Idaho Falls, Idaho, October 2010.

DOE, 2011a, “Fiscal Year 2010 Annual Operations and Maintenance Report for Operable Unit 3-14, Tank Farm Soil and INTEC Groundwater,” DOE/ID-11442, Rev. 0, DOE Idaho, Idaho Falls, Idaho, August 2011.

DOE, 2011b, “Five-Year Review of CERCLA Response Actions at the Idaho National Laboratory Site—Fiscal Years 2005-2009,” DOE/ID-11429, Rev. 0, DOE Idaho, Idaho Falls, ID, January 2011.

DOE, 2012a, “Fiscal Year 2011 Annual Operations and Maintenance Report for Operable Unit 3-14, Tank Farm Soil and INTEC Groundwater”, DOE/ID-11462, Revision 0, DOE Idaho, Idaho Falls, Idaho, July 2012.

DOE, 2012b, “Operable Unit 3-14, Tank Farm Soil and INTEC Groundwater Long-Term Monitoring Plan,” DOE/ID-11334, Rev. 2, DOE Idaho, Idaho Falls, Idaho, April 2012.

DOE, 2013, “Fiscal Year 2012 Annual Operations and Maintenance Report for Operable Unit 3-14, Tank Farm Soil and INTEC Groundwater”, DOE/ID-11476, Rev. 0, DOE Idaho, Idaho Falls, Idaho, June 2013.

Forbes, J.R., and L.S. Cahn, “Monitoring Report/Decision Summary for Operable Unit 3-13, Group 4, Perched Water,” DOE/ID-11326, Revision 0, Project No. 24668, DOE Idaho, Idaho Falls, Idaho, October 2007.

Forbes, J.R., and S.L. Ansley, 2008, “INTEC Groundwater Monitoring Report (2007)”, DOE/ID-11356, Revision 1, DOE Idaho, Idaho Falls, Idaho, June 2008.

NRC, 2006, “Nuclear Regulatory Commission Technical Evaluation Report for the U.S. Department of Energy Idaho National Laboratory Site Draft Section 3116 Waste Determination for Idaho Nuclear Technology and Engineering Center Tank Farm Facility,” ML062490142, NRC, Washington, DC, October 2006.

NRC, 2007, “Nuclear Regulatory Commission Plan for Monitoring the Disposal Actions Taken by the U.S. Department of Energy at the Idaho National Laboratory Idaho Nuclear Technology and Engineering Center Tank Farm Facility in Accordance with the National Defense Authorization Act for Fiscal Year 2005.” ML070650222, NRC, Washington, DC, April 2007.

NRC, 2008. “NRC Periodic Compliance Monitoring Report for U.S. Department of Energy Non-High-Level Waste Disposal Actions—Annual Report for Calendar Year 2007,” NUREG-1911, ML082280145, NRC, Washington, DC, August 2008.

NRC, 2009, “NRC Periodic Compliance Monitoring Report for U.S. Department of Energy Non-High-Level Waste Disposal Actions—Annual Report for Calendar Year 2008,” NUREG-1911, Revision 1, ML091400501, NRC, Washington, DC, May 2009.

NRC, 2010a, “NRC Periodic Compliance Monitoring Report for U.S. Department of Energy Non-High-Level Waste Disposal Actions—Annual Report for Calendar Year 2009,” NUREG-1911, Revision 2, ML101950385, NRC, Washington, DC, June 2010.

NRC, 2010b, “Nuclear Regulatory Commission August 10, 2010 Onsite Observation Report for the Idaho National Laboratory Idaho Nuclear Technology and Engineering Center Tank Farm Facility,” ML102770022, NRC, Washington, DC, October 2010.

NRC, 2011, “NRC Periodic Compliance Monitoring Report for U.S. Department of Energy Non-High-Level Waste Disposal Actions—Annual Report for Calendar Year 2010,” NUREG-1911, Revision 3, ML111890412, NRC, Washington, DC, February 2012.

NRC, 2012, “NRC Periodic Compliance Monitoring Report for U.S. Department of Energy Non-High-Level Waste Disposal Actions—Annual Report for Calendar Year 2011,” NUREG-1911, Revision 4, ML12234A576, NRC, Washington, DC, August 2012.

Portage, 2011, “Tank Farm Performance Assessment—GWSCREEN Modeling to Evaluate the Reduced Impact of the Big Lost River on Perched Water,” Prepared for CH2M-WG Idaho, LLC, Contract DE-AC07-05ID14516500116.32 by Portage, Inc., Idaho Falls, ID, August 2011.

Rodriguez, R.R., et al., “Comprehensive RI/FS for the Idaho Chemical Processing Plant OU 3-13 at the INEEL—Part A, RI/BRA Report (Final)”, DOE/ID-10534, DOE Idaho, Idaho Falls, Idaho, November.