DOE/ORP-2005-01

Initial Single-Shell Tank System Performance Assessment Summary

Estimates of the Impacts to Human Health after Closure of Hanford's Radioactive Waste Tanks

CHG0607-08

Final decisions on the closure of tank farms at Hanford cannot be made until the completion of the Tank Closure and Waste Management Environmental Impact Statement scheduled for the year 2008.

Introduction

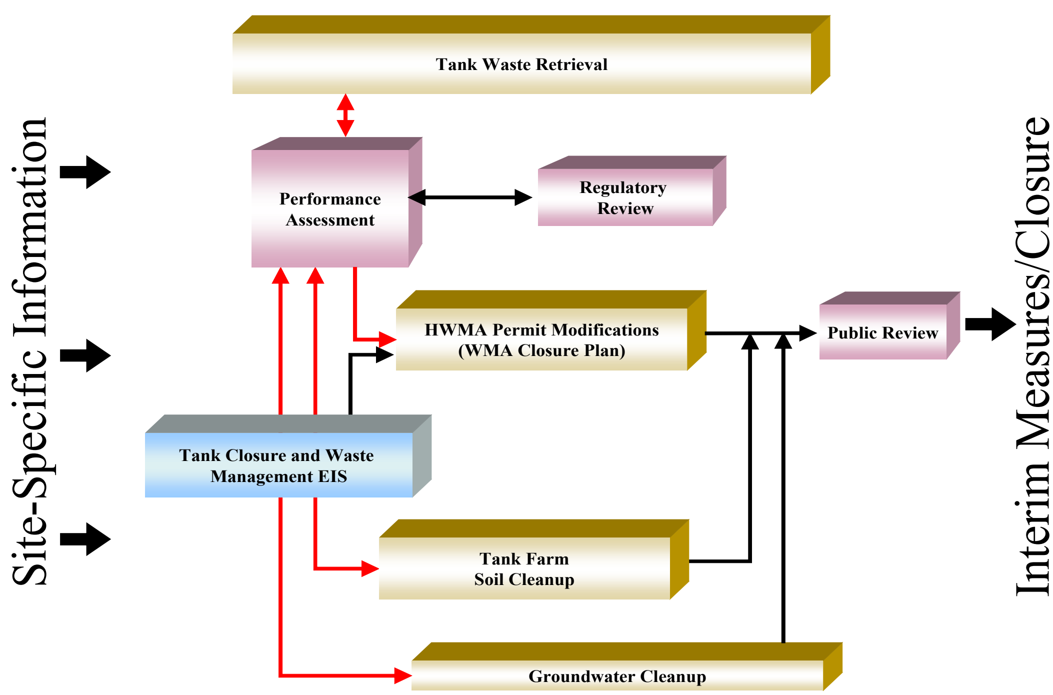
The Department of Energy Office of River Protection (DOE) has completed an initial evaluation of the potential risks to human health that may remain after retrieval of wastes from tank farms. The results have been documented in the "Initial Single-Shell Tank System Performance Assessment for the Hanford Site" DOE/ORP-2005-01 and can be found on the web at http://www.hanford.gov/orp/?page=14&parent=0 or in the approved reading rooms.

The SST PA evaluates radiological and chemical impacts associated with historical single-shell tank leaks and stabilized waste residuals remaining in tanks following the completion of the Tri-Party Agreement (TPA) retrieval activities. The document is considered a "living document" because it will be updated as more data become available, and will help guide the collection of future data for interim decision-making. It will also help guide the design of engineered portions of the tank waste retrieval and closure system.

Final closure of Hanford's tank farms will be implemented with regulatory approvals under the TPA and after completion of the Tank Closure and Waste Management Environmental Impact Statement (EIS) and its Record of Decision.

In order for the SST PA to proceed, a closure scenario had to be selected as a starting point. The chosen scenario, which is one scenario under analysis in the EIS, is landfill closure of the tank farms. This scenario involves removing as much waste as possible to meet TPA criteria, filling the tanks with grout or similar material to hold the residual waste in place, then building an earthen cap over the tanks to prevent moisture from penetrating and driving any escaping waste material to the ground water. The landfill scenario was chosen to facilitate analyses of data in the SST PA and is not prejudged as the final selected alternative in the EIS.

Performance Assessment Provides Risk Information to Support the Closure Process



Why Do We Need a Performance Assessment Now?

The SST PA was developed and released to support Tank C-106 consultation requirements with the U.S. Nuclear Regulatory Commission as required by Appendix H of the TPA. Other uses of the SST PA analyses include supporting TPA tank waste retrieval activities, providing insights into possible tank farm interim measures and treatability studies, supporting residual waste determinations, and helping with the identification and prioritization of data needed to support tank farm cleanup actions.

A Impacts from Tank Waste Residuals are Below Regulatory Contamination Limits

It is anticipated that contaminant concentrations will be within drinking water standards at the Central Plateau Core Zone boundary and at the Columbia River (which is at least 6 miles from the tank farms), however, analyses to that effect will be included in the EIS and are not included in the SST PA. Impacts solely from TPA compliant tank residuals are shown in the SST PA to remain well below drinking water standards even 6000 years from now when groundwater concentrations from those sources are projected to peak. The SST PA only addresses contamination from past tank leaks and tank residuals. Releases from these and other Hanford sources will be evaluated in the EIS.

B Impacts from Past Leaks and Spills Peak Early and Decline with Time

The SST PA shows that past tank leaks have greater potential risk impacts through groundwater pathways than impacts resulting from post-retrieval tank residuals. For example, past leaks in all but one waste management area are projected to result in the groundwater directly beneath tank farms exceeding drinking water standards within the next 50 years -- this has already occurred at the S-SX tank farms and elevated levels below the T tank farm may be partially attributable to past tank farm leaks or spills. As a result, remedial technologies are being screened and evaluated for deployment in the deep vadose zone. In addition, institutional controls are anticipated to be used to prevent the use of groundwater in the vicinity of the tank farms for up to 300 years following closure.

Groundwater Impacts at the Waste Management Area Fenceline

			Maximum Contaminant Level [a]				Exposure Scenarios [b]		
			Beta-Photon	Tc-99	I-129	Cr	All-Pathways Farmer	Radiological ILCR Industrial	WAC 173-340 Hazard Index Method B
	Regulatory Limit		4 mrem/yr	900 pCi/L	1 pCi/L	0.10 mg/L	15 mrem	1.0E-4 to 1.0E-5	1.0
	WMA	Peak Year	TANK RESIDUALS						
A	S-SX	8191	◇ blue	◇ blue	◇ blue	◇ teal	◇ blue	◇ blue	◇ teal
	T	8191	◇ blue	◇ blue	◇ blue	◇ blue	◇ blue	◇ blue	◇ blue
	TX-TY	8191	◇ teal	◇ teal	◇ blue	◇ blue	◇ blue	◇ teal	◇ blue
	U	8191	◇ teal	◇ teal	◇ blue	◇ blue	◇ blue	◇ teal	◇ teal
	C	10461	◇ blue	◇ blue	◇ blue	◇ blue	◇ blue	◇ blue	◇ blue
	B-BX-BY	10461	◇ blue	◇ blue	◇ blue	◇ blue	◇ blue	◇ blue	◇ blue
	A-AX	10461	◇ blue	◇ blue	◇ blue	◇ blue	◇ blue	◇ blue	◇ teal
	WMA	Peak Year	PAST RELEASES						
B	S-SX*	2043	● red	● red	◇ teal	● red	◇ teal	● orange	● orange
	T	2043	● red	● red	◇ teal	● red	◇ teal	● orange	◇ teal
	TX-TY	2043	● red	● red	◇ teal	● orange	◇ blue	◇ teal	◇ teal
	U	2043	● red	● red	◇ blue	● orange	◇ blue	◇ teal	◇ teal
	C	2051	◇ teal	◇ teal	◇ blue	◇ teal	◇ blue	◇ teal	◇ teal
	B-BX-BY	2051	● red	● red	◇ blue	● orange	◇ blue	◇ teal	◇ teal
	A-AX	2051	● red	● red	◇ blue	● orange	◇ blue	◇ teal	◇ teal

Below Regulatory Limit:
- ◇ blue — Well Below the Regulatory Limit (greater than 10 times)
- ◇ teal — Below the Regulatory Limit (less than 10 times)

Above Regulatory Limit:
- ● red — Well Above the Regulatory Limit (greater than 10 times)
- ● orange — Above the Regulatory Limit (less than 10 times)

[a] Evaluated from year 2000 to 12032.
[b] Evaluated from year 2332 to 12032.
ILCR = incremental lifetime cancer risk

Peak Year indicates the year that the highest concentration for Tc-99 and chromium arrive at the WMA fenceline

AIR Impacts will be Negligible

Impacts from the inhalation of any remaining volatile radionuclides remaining in the tank waste after closure is also negligible. Our analysis indicates that the major volatile radionuclides are tritium, carbon-14 and radon from decaying uranium. In no case is there expected to be sufficient quantity of these wastes to result in a situation where inhalation of air over the disposal site will adversely affect human health.

Air and Intruder Impacts in Year 2532

WMA	Intruder Impacts [a]					Air Impacts [b]	
	Worst Sources and Location	Reference Case		Sensitivity Cases		Dose from Tritium and Carbon-14	Radon Flux
		Well Driller	Rural Pasture	Suburban Gardener	Commercial Farm		
A-AX	AX-102 [c]	Well Below	Well Below	Above	Well Below	Well Below	Below
B-BX-BY	B-101 [d]	Well Below	Well Below	Below	Well Below	Well Below	Below
C	C-201 [c, d]	Well Below	Well Below	Below	Well Below	Well Below	Below
S-SX	SX-115 [c]	Well Below	Well Below	Above	Well Below	Below	Well Below
T	T-106 [c]	Well Below	Well Below	Below	Well Below	Well Below	Well Below
TX-TY	TX-118	Well Below	Well Below	Above	Well Below	Well Below	Well Below
U	U-106	Well Below	Well Below	Below	Well Below	Well Below	Well Below

Below Regulatory Limit:

Well Below the Regulatory Limit (greater than 10 times)

Below the Regulatory Limit (less than 10 times)

Above Regulatory:

Above the Regulatory Limit (less than 10 times)

[a] Performance objectives are 500 mrem for the well driller and 100 mrem/yr for chronic exposure scenarios

[b] Performance objective is 10 mrem/yr for air dose and 20 pCi/cm^2/s for radon flux

[c] Tank residual plus past release for intruder impacts

[d] Tank residual plus past release for air impacts

Limited Impacts from Human Intrusion Expected

Inadvertent intrusion into the closed and grouted tanks at the end of site controls will not cause significant impacts to human health either by exposure to the exhumed waste or by inhaling volatile radionuclides. To further examine the safety of the grouted tank residuals after closure, we examined the consequences of an unlikely but possible event: inadvertent intrusion by the public into the exhumed tank waste materials. This scenario requires disregard for all posted signs, engineered markers, destruction of the surface barriers, and disregard for the remains of the tank and its contents. Such an intrusion is assumed to occur 500 years after closure.

Special Features of the Performance Assessment

The Performance Assessment contains three special features:

- **Single analysis combines radiological and chemical impacts.**
- **An iterative process allows for new data and design changes.**
- **Reference case and uncertainty analyses help estimate the accuracy of impacts.**

Predicting the Future

Predicting future events always involves some level of uncertainty. Addressing uncertainty helps answer the question: "How believable is the result?" We directly address uncertainty in the Performance Assessment by examining the effects of each barrier and each parameter within the barrier on the performance of the closed system. Additionally, we study multiple scenarios that address the impacts of early barrier removal, errors in barrier construction, unexpected climate change and under performance on the closed system. The uncertainty analysis allows for prioritization of new data collection, changes in the proposed engineering system, and identifies features of the geologic system that must be carefully understood. Sources of uncertainty are divided into unknowns associated with such things as future societal actions or human behavior, physical engineering scenarios and parametric variability.

Parametric variability refers to the range of possible values an important variable might likely assume. Societal actions include expected future land use. Conceptualizations refer to such features as the assumed presence of a clastic dike or the projected long-term durability of a surface barrier. Parametric uncertainty includes such factors as the range of soil distribution coefficients used in transport calculations.

As we progress toward single-shell tank farm waste retrieval and closure, we expect to firm up many uncertainties. For example, when we measure the amount of residual waste left in each tank at the end of closure, we will be able to change what are now estimates into precise measurements.

However, we expect that some features of the single-shell tank farm waste retrieval and closure system, such as the parameters used to estimate moisture movement through the soil, will always contain some uncertainty. Because of this, we have included a detailed uncertainty analysis in the Performance Assessment.

Results of the Performance Assessment uncertainty analysis indicate that at the time of closure, there will likely remain a range of a factor of 10 (plus or minus) in estimates of the closed single-shell tank farm performance.

The Performance Assessment contains a detailed uncertainty analysis because some aspects of the single-shell tank farm system will always contain some uncertainty.

Uncertainty is the level of variability and lack of knowledge incorporated into a prediction of a future condition.

Did You Know...

Regulatory contamination limits are numerical values developed by regulatory agencies such as the U.S. Environmental Protection Agency and the Washington State Department of Ecology. These values tell us whether or not the groundwater is safe. We use regulatory contamination limits in the Performance Assessment to demonstrate the level of protection provided by a set of assumptions used to estimate the performance of the single-shell tank farm system. Regulatory contamination limits are set up to protect the most susceptible element of the population exposed to a contaminant.

Performance Assessment Results Support the Following Actions

First and foremost, tank waste retrieval and stabilization protects future generations from the waste materials left behind in the tanks based on our assumptions of a closed system.

While tank farm waste retrieval is moving forward, short-term surface barriers designed to temporarily reduce infiltration should be installed over known large tank leaks. This can be done without impeding the tank waste retrieval process. The analysis shows that reducing the amount of water infiltrating the tank farm will significantly decrease the peak groundwater impact from past leaks over what it would be without the surface barrier. This type of temporary measure will not prevent contamination from exceeding groundwater contamination limits, but it will reduce the magnitude of the groundwater impact.

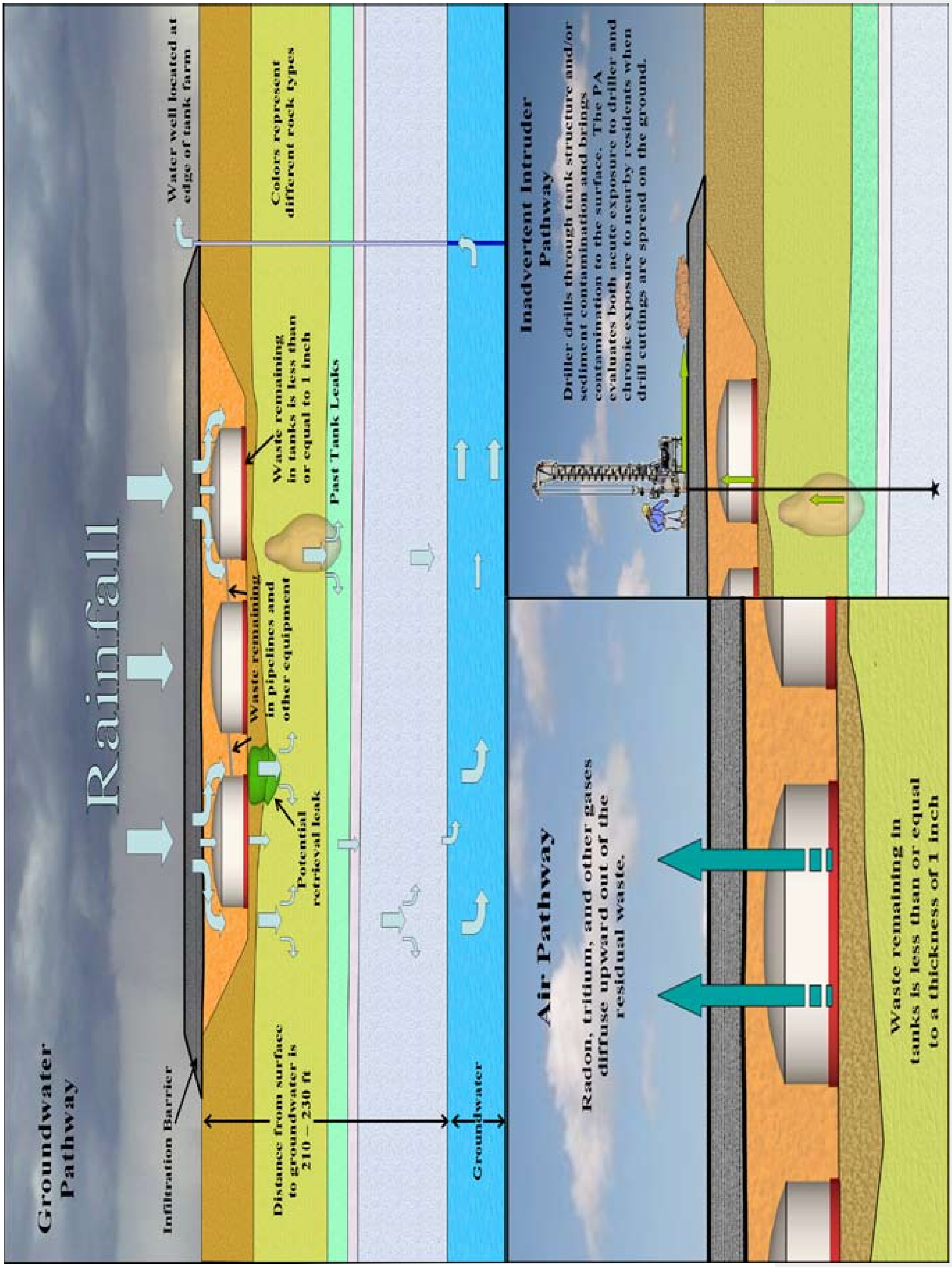
Finally, the Performance Assessment shows that we need to evaluate the effectiveness of deep soil cleanup measures to ensure that final tank farm closure protects the environment and the public.

Did You Know...

Actions that limit access to the final closed single-shell tank farms are called institutional controls. These controls can be either active or passive. Active institutional controls include security guards, access badges and other controls that prevent would-be intruders from accessing the tank farms. Passive controls include communication techniques, such as widely distributed records, and monuments that sustain knowledge about tank farms for many generations into the future. Institutional controls are commonly used at radioactive waste sites that have been stabilized and closed with some remaining waste in place. The controls are used to both maintain any engineered barriers to the waste and to warn against any inadvertent intrusion.

The Performance Assessment will Evolve as Tank Retrieval Continues

The Performance Assessment analysis will be repeated and improved as new data are collected and design changes occur. Because the closure process for single-shell tank farms is complex, it is important that an assessment of the performance of the closed single-shell tank system be iterative to allow for new information and ideas. This process allows for the refinement of key components and safety features as technology improves. As understanding progresses, changes to the final closure design will lead to a system that protects future generations as much as possible.


Groundwater Pathway
Rainfall
Infiltration Barrier
Water well located at edge of tank farm
Colors represent different rock types
Distance from surface to groundwater is 210 – 230 ft
Potential retrieval leak
Waste remaining in pipelines and other equipment
Waste remaining in tanks is less than or equal to 1 inch
Past Tank Leaks
Groundwater
Air Pathway
Radon, tritium, and other gases diffuse upward out of the residual waste.
Waste remaining in tanks is less than or equal to a thickness of 1 inch
Inadvertent Intruder Pathway
Driller drills through tank structure and/or sediment contamination and brings contamination to the surface. The PA evaluates both acute exposure to driller and chronic exposure to nearby residents when drill cuttings are spread on the ground.