FOREWORD

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Groundwater monitoring was reported in a variety of ways over the history of Hanford Site operations. While publically available descriptions of groundwater monitoring predated the 1980s, the "modern" annual groundwater monitoring report originated in 1996. Since then, the annual report evolved to reflect changes in regulations, the understanding of contaminants in Hanford groundwater, and refinements in the tools and methods used to evaluate data. Between 1996 and 2010, many of these changes were incremental, slowly shaping the content of the annual report without drastically changing its appearance. This report, Hanford Site Groundwater Monitoring for 2011, is a major advancement in the annual report's evolution. The changes in this year's report are needed to accomplish the following three objectives:

1. As DOE continues the cleanup process, the Hanford Site is transitioning from learning about the nature of groundwater contamination to making decision about the groundwater cleanup. To support this, changes must be made so the annual report can better report the effectiveness of cleanup activities.
2. Techniques and tools for studying very large environmental datasets are maturing. Many of these methods are now being implemented as process improvements with the goal of improving the timeliness, transparency, and technical integrity of scientific decisions.
3. In past years, the document has grown to more than 1,000 pages and several hundred figures. In many ways, this growth hampered the clarity of the report by introducing redundancy, or in some cases, inconsistency between sections. To correct this, scientists are improving clarity, consistency, and reducing redundancy in data presentation.

To meet these objectives, a number of changes were implemented in the annual report's presentation, as well as the underlying analyses and data evaluation. These changes are discussed throughout the report, but an overview of these improvements is presented below:

- **Focus on change** – To reduce redundancy and improve readability, report sections were focused on observing and explaining changes in the monitoring data. Effort is placed on communicating how contamination distribution has changed over the prior year, and what mechanisms are influencing its fate and transport.
- **Analysis and conclusions** – Additional emphasis was placed on drawing conclusions from data, rather than reporting it. Where data was found inconclusive, efforts are made to explain the uncertainty and provide recommendations to reduce uncertainty.
- **Reduce redundancy** – Rather than repeating information presented in other reports, information from those reports is presented in a summary fashion. For instance, only key data, findings, and conclusions from the pump-and-treat performance reports are presented in the annual report.
- **Report organization** – The annual report was reorganized to reflect regions (River Corridor and the Central Plateau) rather than each groundwater interest area to focus discussion and reduce repetitive text (for instance, reactor operations). Other changes to the report organization include efforts to eliminate broad background information. Background information essential to understanding groundwater contamination is still presented, but in some cases, it has been moved. For instance, a detailed discussion of Hanford geology and hydrogeology is now presented outside of the main report body (refer to Appendix E). The chapter on vadose zone activities was eliminated from this year's groundwater monitoring report. Discussion relevant

to groundwater monitoring was addressed as appropriate in each relevant section.
The performance of the vapor extraction system in 200 West was discussed in SGW-51807, *Performance Evaluation Report for Soil Vapor Extraction Operations at the 200-PW-1 Operable Unit Carbon Tetrachloride Site, Calendar Year 2011*.

- **Plume delineation and depiction** – In previous years, project scientists contoured the contaminant plumes in each groundwater interest area by hand. Given the refinement in computer interpolation algorithms and new data from remedial investigations currently underway, the 2011 contaminant plume maps were constructed by computers using quantile kriging. This method was used to increase the transparency and reproducibility in the findings of Hanford Site groundwater scientists. Computer interpolation also makes the data more widely available for evaluating the progress towards cleanup and provides another means of analysis. A discussion of this industry-standard approach is presented in Section 1.7.
All electronic input data files and resulting spatial data are available for electronic download. Substantial effort was placed on depicting plumes and improving the cartography in this annual report.

Some improvements made in the 2011annual report are incremental. Additional efforts are underway to develop techniques necessary to meet the objectives described above. These changes include the following:

- **Measuring cleanup performance** – As the Hanford Site moves from describing the extent of contamination to active cleanup, meaningful benchmarks for measuring cleanup progress must be developed. Cleanup metrics are still being evaluated and proposed; the table at the beginning of each section in this year's report begins the process by presenting basic measurements of the nature and extent of contamination and progress towards cleanup. Development of these metrics will continue as new data evaluation and reduction processes are implemented.
- **Aquifer Tubes** – Aquifer tubes are installed and monitored at many locations along the Columbia River shoreline. These tubes are monitored to collect data regarding groundwater contaminants in proximity to the river. Aquifer tube data is used to describe the nature and extent of contamination near the river, but uncertainty remains regarding the representativeness of these data. Recommendations are being made to address this question and describe the utility of monitoring data from aquifer tubes.

In the coming year, additional changes are anticipated to increase the timeliness and usefulness of the Hanford groundwater monitoring report. These changes will make it easier to explore and understand the analyses conducted as part of Hanford Site groundwater monitoring. Project scientists are working with communications specialists and experts in data visualization to implement these changes.