# Online Interactive Reporting of Groundwater Monitoring and Remediation Progress at the Hanford Site, Washington – 16485

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## ABSTRACT

DOE annually publishes a groundwater monitoring report and separate groundwater remediation summary reports to comply with reporting and regulatory requirements for the Hanford Site, located in southeastern Washington State. The reports describe year-over-year groundwater monitoring and remediation progress. The annual groundwater monitoring report provides a summary of groundwater monitoring for chemical and radioactive liquid waste releases to the soil that contaminated groundwater from past operations at the site.

Content initially consisted of paper reports with static electronic copies available online. Based on an initiative from DOE to provide additional transparency of data and data interpretations presented in the reports, companion interactive versions of the reports were deployed online starting in 2012. The online version provides readers with map-based tools and links to supporting documents and reference materials; individual users can read the reports at their own personal level of expertise and interactively explore groundwater contaminant plume evolution, analytical data, site geology, and remediation system performance. An online user's guide and tutorials for each tool are also provided to assist the user with the overall application and individual tools. The online reports are available at: http://www.hanford.gov/page.cfm/SoilGroundwaterAnnualReports.

## INTRODUCTION

DOE annually publishes a groundwater monitoring report and separate groundwater remediation summary reports for the Hanford Site, located in southeastern Washington State (Figure 1). The reports provide the primary means to report monitoring results for *Resource Conservation and Recovery Act of 1976* (RCRA) units; for *Comprehensive Environmental Response, Compensation and Liability Act of 1980* (CERCLA) groundwater operable units (OUs); for State of Washington regulations; and for the *Atomic Energy Act of 1954* (AEA), as required by DOE orders; and to assess groundwater remediation activities.

The groundwater monitoring program at the Hanford site is an extensive program, collecting thousands of samples from hundreds of wells each year (Figures 2 and 3), and analyzing the samples for a variety of radionuclides and chemicals. In addition to monitoring wells, DOE monitors hundreds of sampling points near the

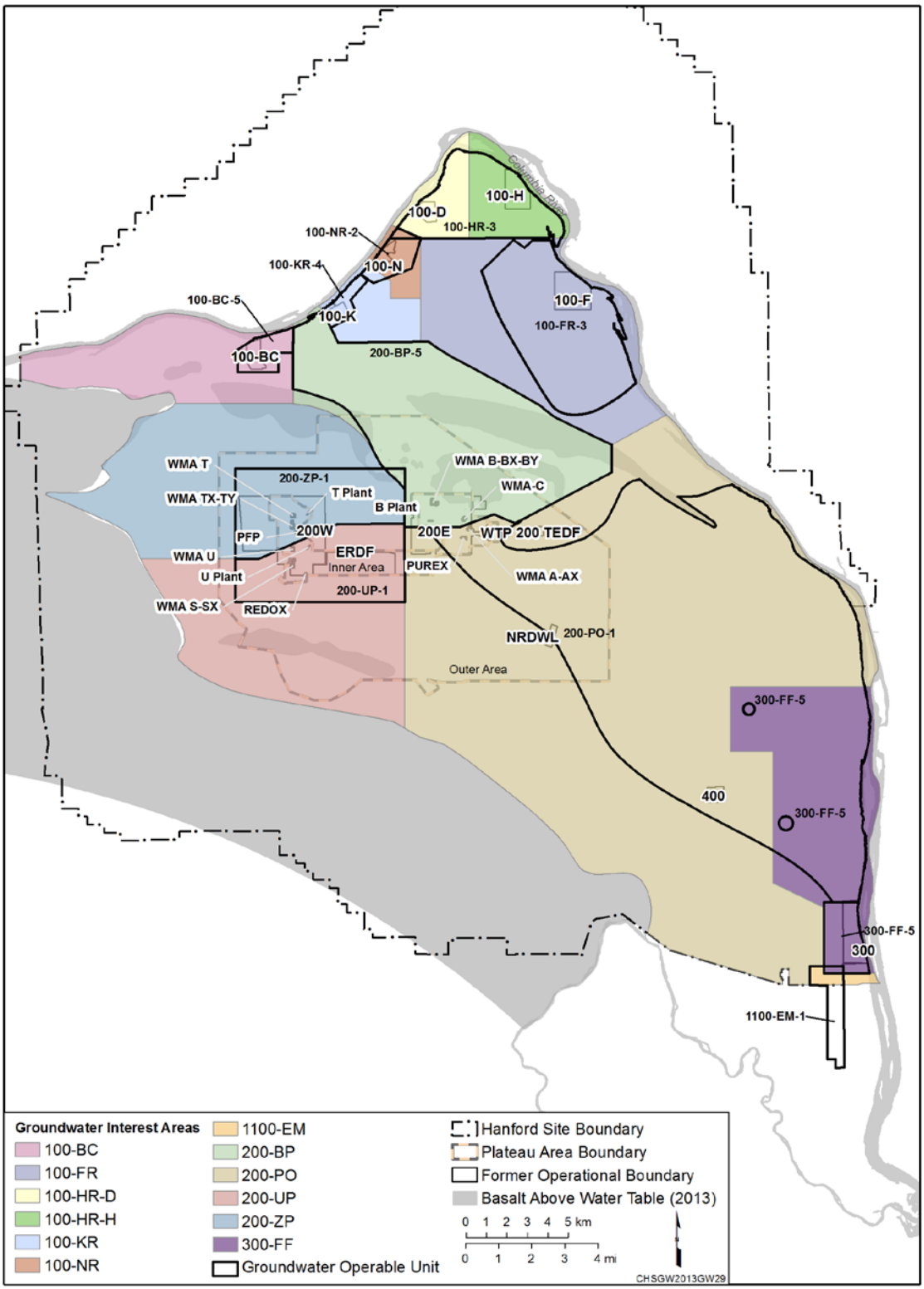


**Figure 1 – Regions of the Hanford Site**

Columbia River, known as aquifer sampling tubes, for general information about groundwater approaching the river. In order to address the groundwater contamination, interim groundwater treatment remedies are operating in several areas of the River Corridor including the 100-HR-3, 100-KR-4, and 100-NR-2 Groundwater Operable Units (OUs); and final and interim groundwater treatment remedies are operating in the 200-UP-1 and 200-ZP-1 OUs of the Central Plateau (Figure 1).

Groundwater analyses and monitoring activities are summarized in three monitoring reports annually. For 2014 groundwater monitoring and remediation activities these reports were the *Hanford Site Groundwater Monitoring Report for 2014* [1]; *Calendar Year 2014 Annual Summary Report for the 100-HR-3 and 100-KR-4 Pump and Treat Operations, and 100-NR-2 Groundwater Remediation* [2]; and *Calendar Year 2014 Annual Summary Report for the 200-ZP-1 and 200-UP-1 Operable Unit Pump and Treat Operations* [3].

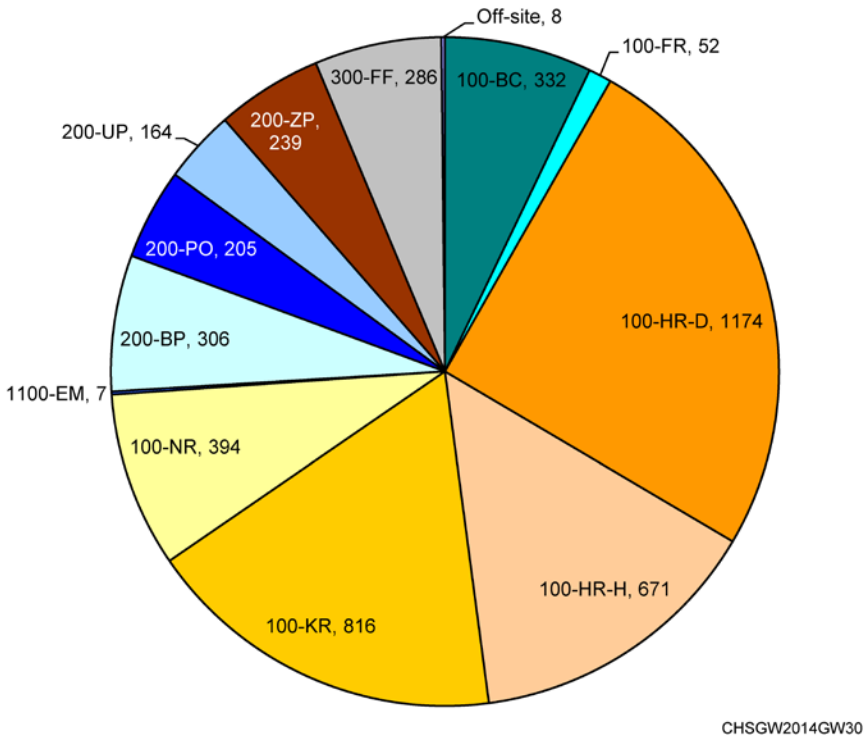


**Figure 2 – Sampling Trips in 2014 by Area**

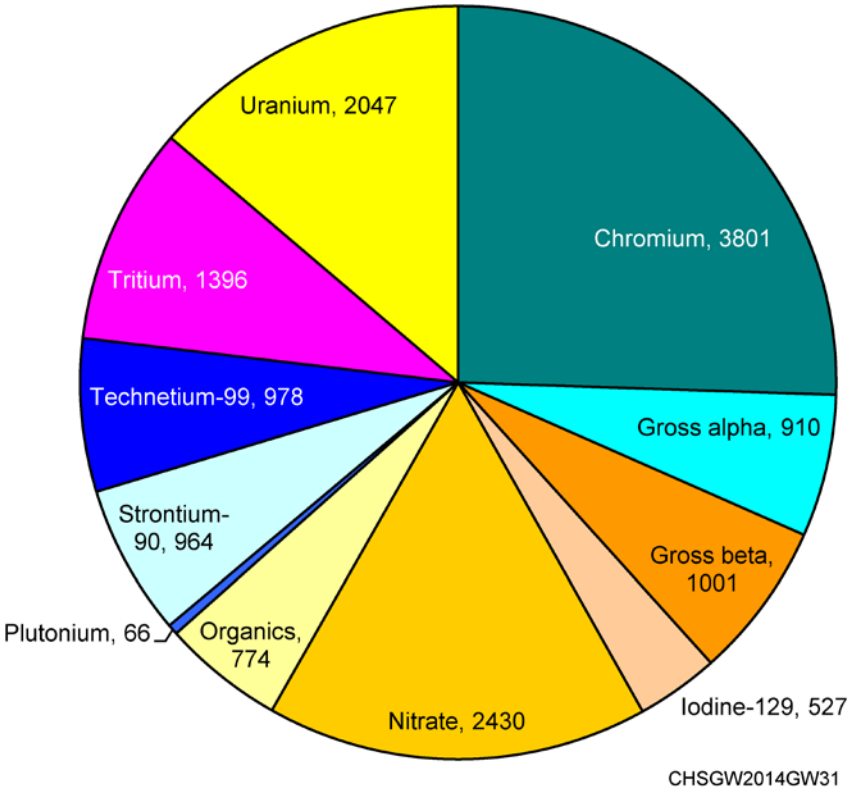


**Figure 3 – Number of Laboratory Analyses for Select Groundwater Contaminants, 2014**

## BACKGROUND

Prior to 2012, the annual reports were posted online as static read only files. Individuals interested in finding additional information related to interpretation of groundwater monitoring data, contaminant trends, or remediation progress would need to obtain and search through the references documented in the report, or specifically request the information if not available through the references. Based on a DOE initiative to make data and information more widely available and accessible for the Hanford Site to the public and stakeholders, DOE began developing online capabilities starting in 2012 using a web based application with a graphical user interface for groundwater reporting. As part of these efforts, the 2012 groundwater monitoring report (*Hanford Site Groundwater Monitoring Report for 2012 [4]*) was developed to support online report navigation and data exploration integrating multiple data sources. Online versions for the remedial action summary reports were implemented for calendar year 2013.

## DESCRIPTION

Production and publication of the online reports occurs in five (5) main steps. The first step involves developing the report content itself, which includes text describing the current year's results and changes in conditions from the previous year. Maps and technical figures include groundwater plume maps, time series plots

of contaminant concentrations and plume areas, and maps of well locations. Plume maps are developed using geostatistical methods (e.g., [5]) for eleven contaminants that have well defined extents and include chemicals (carbon tetrachloride, cyanide, hexavalent chromium, nitrate, trichloroethene, and uranium) and radionuclides (C-14, I-129, Sr-90, Tc-99, and tritium). Meanwhile, the online tools and interfaces are concurrently developed and/or upgraded as a series of JavaScript libraries. This architecture was chosen to emphasize client-side processing, minimizing the strain placed on the production server, and mitigating the vulnerability to cyber-attack.

The content is then assembled into a preliminary draft, which is reviewed by both the DOE and regulators (Step 2). Once the review is complete, the report is assembled into the online version (Step 3). During Step 3, final content is converted into a series of hypertext markup language (HTML) files and portable document format (PDF) files, and data supporting the online reporting tools (e.g., groundwater contaminant data, geology, and well data) is loaded into a geospatial database and placed on a test server. Finally, the software framework developed in Step 1 is deployed and connects the (static) text to the (dynamic) data.

The online report is then tested and reviewed (Step 4) in two phases: first, project staff review the content, functionality, and data sources to ensure content accuracy and data integrity; and second, site computer security staff reviews the entire online product. Finally, once the report passes testing and meets site software requirements, it is deployed on a secure, public-facing production server (Step 5).

## DISCUSSION

The publicly available reports are accessed through a DOE homepage that contains links to all available online reports. The reports are designed so that a user can navigate to content directly based on their level of interest and expertise. The annual groundwater monitoring reports consist of a layout that includes a navigation area on the left-hand side of the screen (left pane), a content section in the center portion of the screen (center pane), and data exploration tools on right-hand portion of the screen (right pane) (Figure 4). This design maximizes readability and supports a broad set of screen resolutions.

The report navigator (left-hand pane) includes links to a series of online video tutorials that provide instructions for viewing the report and using the tools. The links also include a table of contents for direct access to specific parts of the report, static (pdf) copies of report chapters, and previous reports. The main portion (center pane) of the screen displays report content, which the viewer can navigate with a mouse, touchpad, or keyboard. Readers have the option of changing the font size, expanding the viewer to fill the entire screen, and “popping-out” individual figures or mapping tools as separate windows; this optimizes readability, since one can view text and dynamic content side-by-side. Links to interactive tools are available in the right pane including a plume tool, charting tool, and cross-section tool.


**Figure 4 - Layout of the Online Hanford Site Groundwater Report**

The two online groundwater remediation summary reports are formatted similarly to the annual groundwater report using a three-framed approach. For the remediation summary reports, the frames are displayed differently since those reports are much more data-oriented. In those reports, content is displayed in the left-hand pane, maps and data are accessed through the center pane, and the right-hand pane allows access to data exploration tools and legend for the center mapping pane (Figure 5). The table of contents is available at the top of the page. The remediation summary reports include the same tools as the groundwater summary report, a tool summarizing the analysis of the protection of the Columbia River (River Projection Tool), and a tool to view groundwater extraction and injection rates, and contaminant mass removal for site pump-and-treat systems.

Additional functionality available to all three online reports includes the ability for user to open and close both the left and right panes so that only the report content (groundwater report) or mapping window (remediation summary reports) is displayed, download individual sections of each report in pdf format, and access to multiple base map layers including aerial photography, streets, and topography.

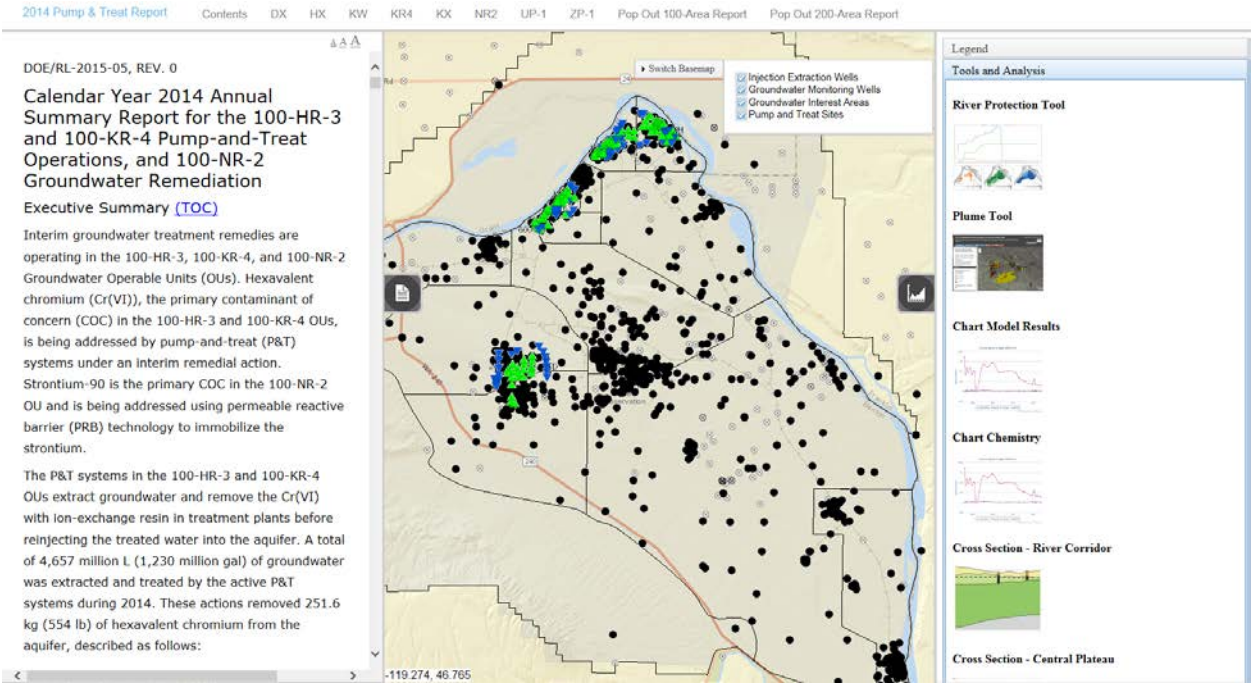


**Figure 5 – Layout of the Online Hanford Site Groundwater Remediation Summary Reports**

## INTERACTIVE TOOLS

The interactive tools available in the right pane provide graphical interface for accessing and viewing groundwater monitoring data and geology. The plume tool allows a user to investigate the data sources behind current-year plume estimates and view changes in plume extents over time (Figure 6). The charting tool provides geographical interface to select contaminant trends for wells (Figure 7). Contaminant trends can be selected for multiple constituents for a single well, or single constituent for multiple wells.

The cross-section tools provide graphical view of geology cross section for a selected polyline traversing selected wells (Figure 8). The tool provides a graphical chart showing changes in geology and well screen information along the selected cross section. Separate cross section tools are provided for the Hanford River Corridor and the Central Plateau.

All displays from the interactive tools can be downloaded and saved as an image file. These tools provide users access to information not previously available in the static annual reports for improving transparency and communication of groundwater monitoring data and interpretation.

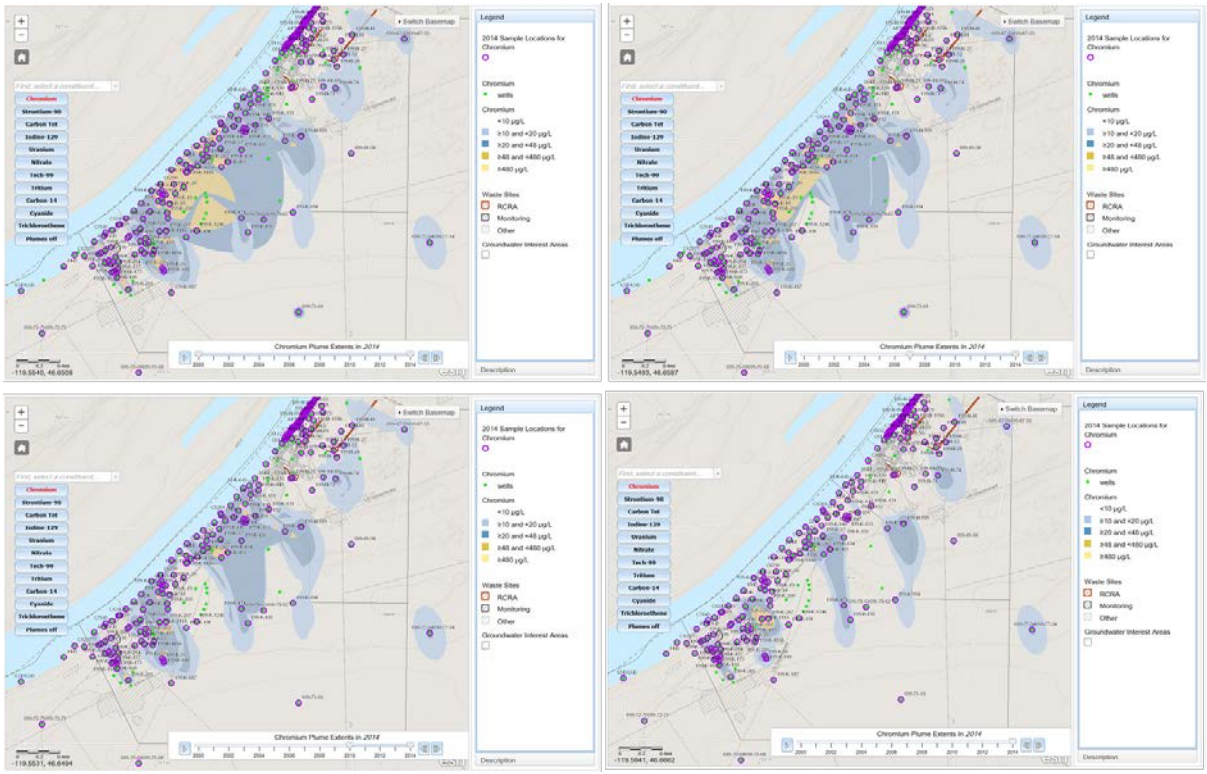

**Figure 6 – Example Screen Shots from Plume Tool Depicting Decreasing Plume Area Over Time**


**Figure 7 – Example Screen Shots from Charting Tool**

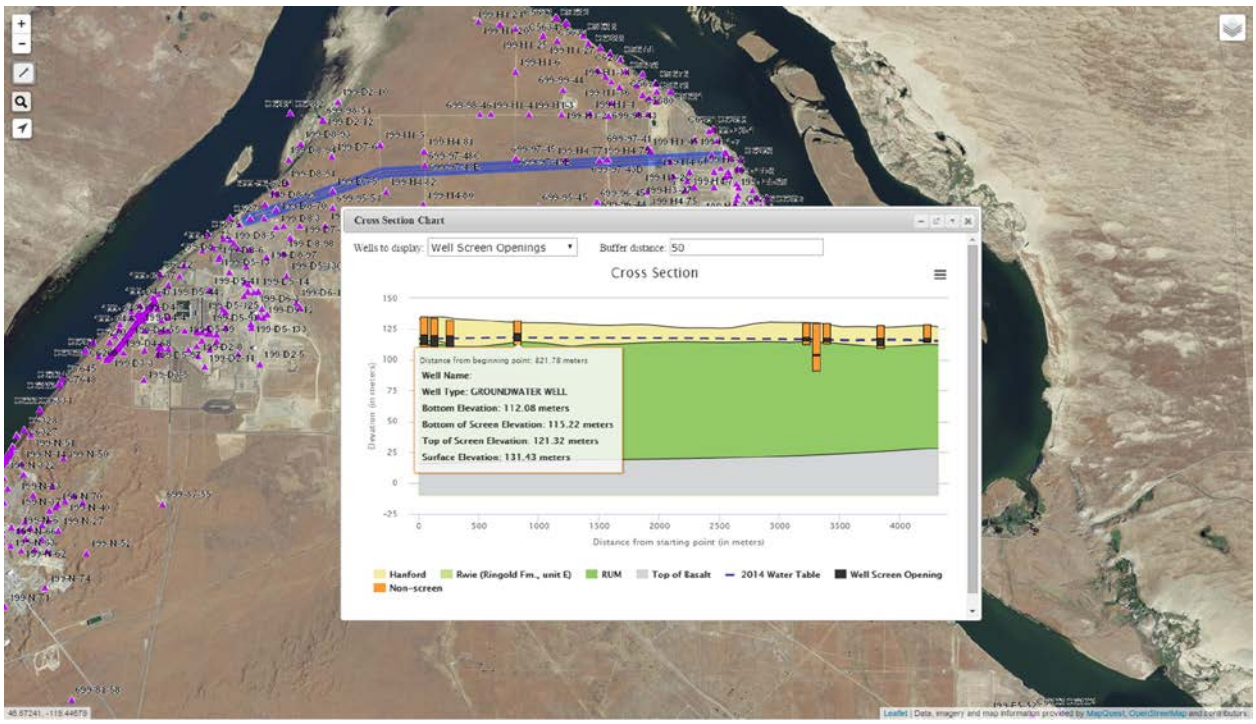


**Figure 8 – Example Screen Shots from Cross Section Tool**

## CONCLUSIONS

Starting for the 2012 calendar year reporting cycle, DOE has successfully implemented online annual groundwater reporting for the Hanford Site. The reports are readily accessible on a variety of electronic devices (e.g., laptop computers, tablets, and smart phones) on any operating system supporting a JavaScript-enabled web browser, and anywhere that an internet connection is available.

The reports have been well received by DOE, the regulatory community, and stakeholders for several key reasons: first, the online tools provide readily available access to site data through easy to use tools; second, the interactive report allows the users to focus on specific areas of interest at the site through online report navigation; and third, the online reports can be used to answer questions from the public, thus saving DOE and regulators time and effort when responding to requests for groundwater information. The online reports are available at: http://www.hanford.gov/page.cfm/SoilGroundwaterAnnualReports.

## REFERENCES

[1] DOE/RL-2015-07. Hanford Site Groundwater Monitoring Report for 2014. U.S. Department of Energy, Richland Operations Office, 2015.

[2] DOE/RL-2015-05. Calendar Year 2014 Annual Summary Report for the 100-HR-3 and 100-KR-4 Pump and Treat Operations, and 100-NR-2 Groundwater.

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[4] DOE/RL-2013-22. Hanford Site Groundwater Monitoring Report for 2012. U.S. Department of Energy, Richland Operations Office, 2013.
Remediation. U.S. Department of Energy, Richland Operations Office, 2015.

[5] ECF-HANFORD-15-0003. Calculation and Depiction of Groundwater Contamination for the Calendar Year 2014 (CY2014) Hanford Site Groundwater Monitoring Report. CH2M Hill Plateau Remediation Company, Richland, Washington, 2015.