Geographic Information System Tools for Management of US DOE Sites – 14125

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ABSTRACT

The US DOE Office of Legacy Management (LM) was created in December 2003 to primarily manage environmental activities, records, and information at US DOE closure sites. LM's environmental responsibilities have continued to increase and diversify as sites that have been remediated are transferred to LM for long-term surveillance and maintenance (LTS&M). LM currently conducts LTS&M activities at 89 sites in 29 states and territories in the United States to ensure the future protection of human health and the environment at these sites. With more than 6,000 local, regional, and national stakeholders, LM's success depends on effectively managing not only a diverse set of stakeholder relationships, but also relationships with regulators, local governments, communities, and tribal nations. LM fosters these relationships by using a number of Geographic Information System (GIS) tools to operate in an open and transparent way by sharing site-specific environmental information in a timely manner.

LM uses a variety of GIS tools in support of LTS&M activities at US DOE closure sites. These GIS applications provide access to data for external public viewing and for internal analysis and decision making.

LM uses a custom geospatial application called Geospatial Environmental Mapping System (GEMS) that draws validated information from a database of 4.7 million analytical results and 232,000 water level measurements for 58 LTS&M sites. These data were collected from transferred sites over a period of 40 years. The database is used to capture and store historical environmental information, such as analytical chemistry data, groundwater depths and elevations, well logs, well construction data, geo-referenced boundaries, site physical features, and sampling locations from LTS&M sites. Stakeholders, regulators, and project personnel can use this web-based application and data to display information in several forms, such as interactive tabular reports, graphs, geospatial displays, or with the data labeled or highlighted in map views.

GIS technology has advanced rapidly and has provided powerful tools to visually communicate massive amounts of technical information through the use of interactive maps. LM has embraced this technology in its commitment to ensure access to information about the sites it manages. Through the use of GIS technology, LM continues to develop interactive mapping tools that visually present site-specific well logs, photos, and monitoring data to end users in a geographic context.

Over the last year, LM has been migrating its GIS environment to ArcGIS 10.1 Desktop/Reader and ArcGIS Server. With these newer tools, LM can take advantage of

centralized management, better quality assurance and configuration management, and easier enterprise sharing of complex data and reporting. Both internal and external stakeholders can access up-to-date information through different web and desktop clients to help ensure the future protection of human health and the environment at LM sites. New functionality slated for the new environment is the ability to display real property interests on authoritative maps. Another project is used to facilitate discussions at stakeholder meetings concerning the Original Landfill at the Rocky Flats, Colorado, Site. The Uranium Leasing Program uses multiple interactive maps that assist in ongoing monitoring and oversight of leaseholders' activities. Production for the first phase of the upgraded and updated GEMS application was scheduled for December 2013. With this updated and modern infrastructure, LM will integrate additional layers, such as real property data and institutional controls.

INTRODUCTION

The US DOE Office of Legacy Management (LM) was created in December 2003 to primarily manage environmental activities, records, and information at US DOE closure sites. LM's environmental responsibilities continue to increase and diversify as remediated sites are transferred to LM for long-term surveillance and maintenance (LTS&M). LM currently conducts LTS&M activities at 89 sites in 29 states and territories in the United States to ensure the future protection of human health and the environment at these sites. With more than 6,000 local, regional, and national stakeholders, LM's success depends on effectively managing not only a diverse set of stakeholder relationships, but also relationships with regulators, local governments, communities, and tribal nations. LM fosters these relationships by using a number of Geographic Information System (GIS) tools to operate in an open and transparent way by sharing timely site-specific environmental information.

GIS technology has advanced rapidly and has provided powerful tools to visually communicate massive amounts of technical information through the use of interactive maps. LM has embraced this technology in its commitment to ensure access to information about the sites it manages. Through the use of GIS technology, LM continues to develop interactive mapping tools that visually present site-specific well logs, photos, and monitoring data to end users in a geographic context.

LM's New Interactive Mapping For The Public

Over the last year, LM has been migrating its GIS environment to ArcGIS 10.1 Desktop/Reader and ArcGIS Server. With these newer tools, LM can take advantage of centralized management, better quality assurance and configuration management, and easier enterprise sharing of complex data and reporting. Both internal and external stakeholders can access up-to-date information through different web and desktop clients to help ensure the future protection of human health and the environment at LM sites. In additional, LM has developed and enhanced a GIS-based custom interactive mapping application to give stakeholders, regulators, and the general public access to site-specific environmental information via the Internet. The Geospatial Environmental Mapping System (GEMS), a geospatial web-mapping application, combines the capabilities of GIS map services with customized reports based on validated information in the LM Environmental Services Database.

GEMS draws validated information from a database of 4.7 million analytical results and 232,000 water level measurements for 58 LTS&M sites. With the Advanced option selected, users are allowed to query a map (**Fig. 1**) by selecting an LM site from the drop-down menu. After selecting a site, users can query sample locations via the Environmental Data tab. Users have the option to either "draw" on the screen or, by selecting sample locations on the map, select specific criteria. Data are displayed on the map through a data table, a geospatial map display, a tabular report, a graph, and a map view (**Fig. 2**). In addition, users can view site photos by clicking on the camera icon. Clicking icons at sample location points will bring up information such as well logs, attributes of the location, and environmental sampling data (**Fig. 3**).

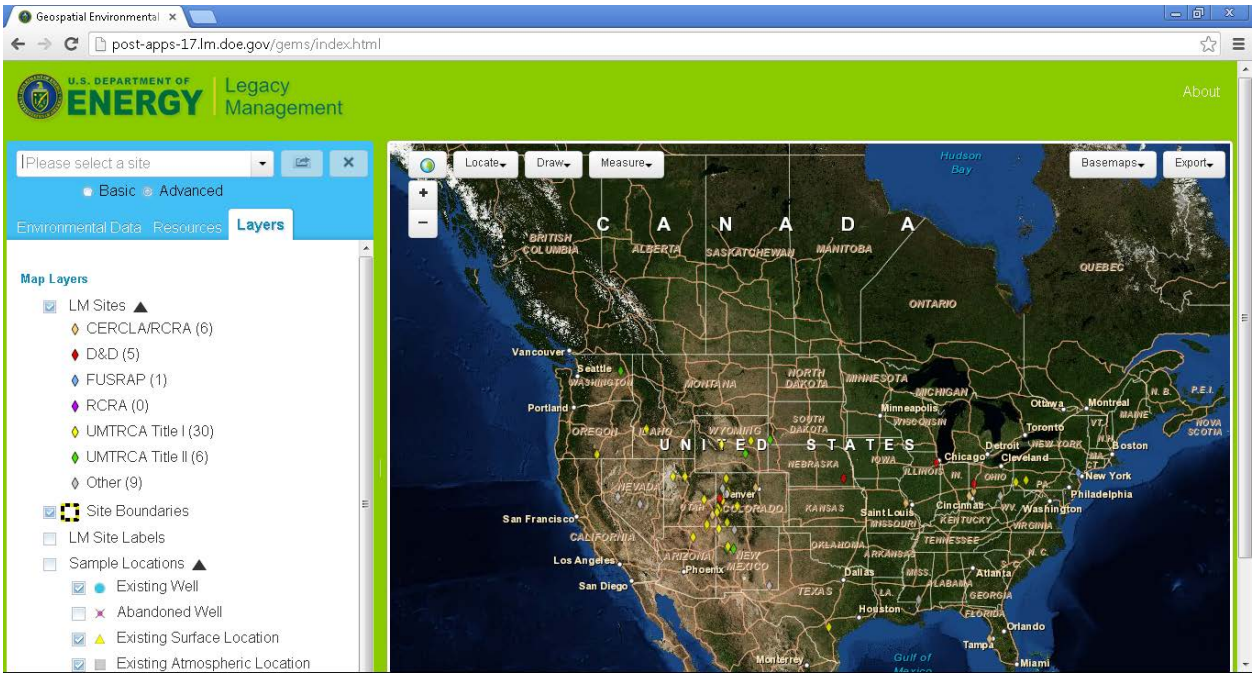

Fig. 1. Screenshot of the GEMS interactive map displaying all LM sites.

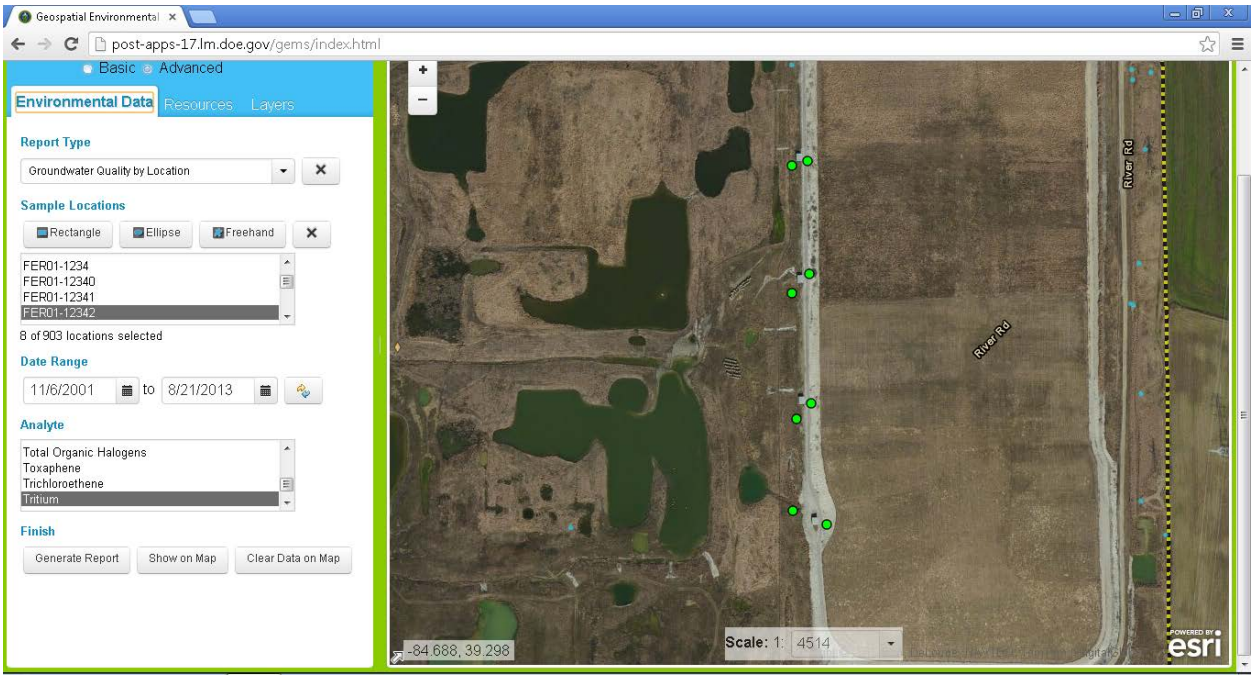

Fig. 2. Screenshot of the GEMS Environmental Data tab.

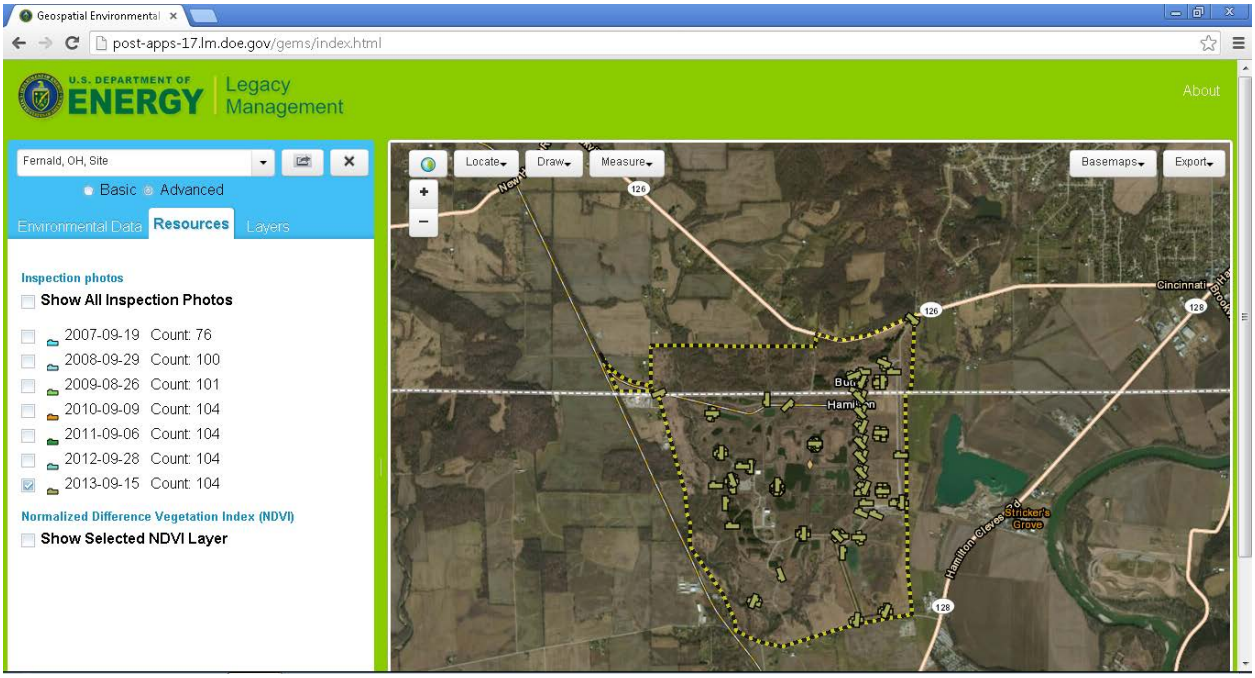

Fig. 3. Screenshot of the GEMS Resources tab.

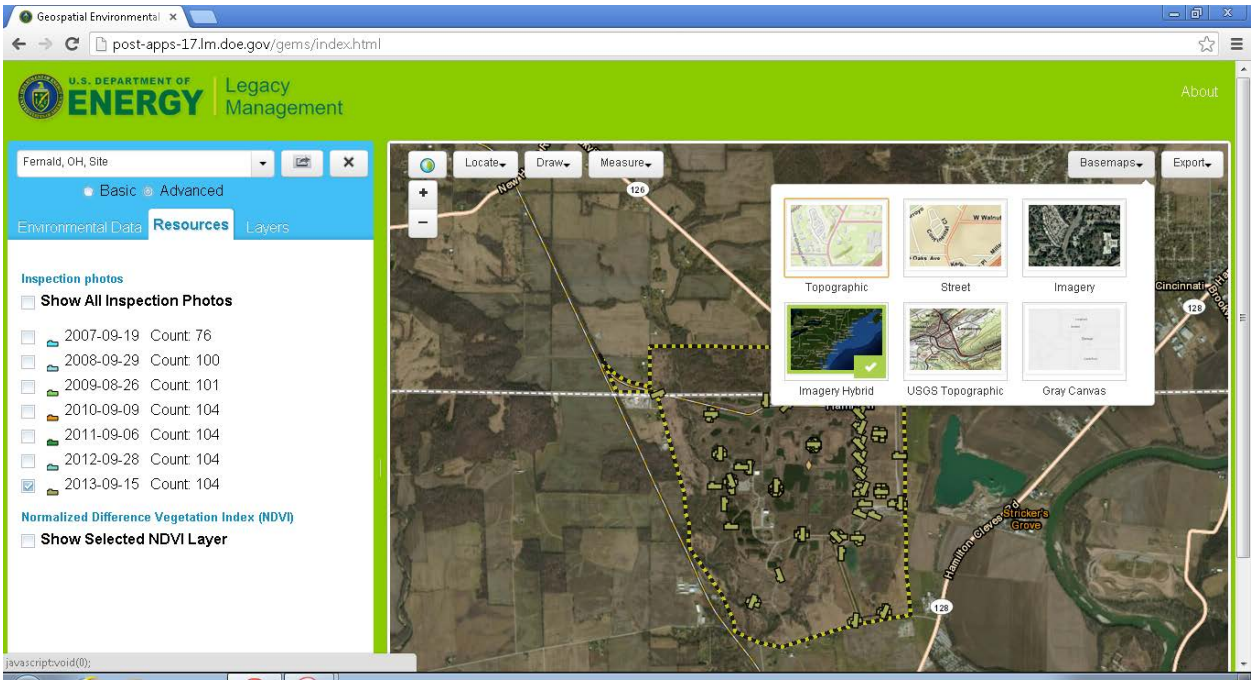

Fig. 4. Screenshot of the GEMS Basemaps tab.

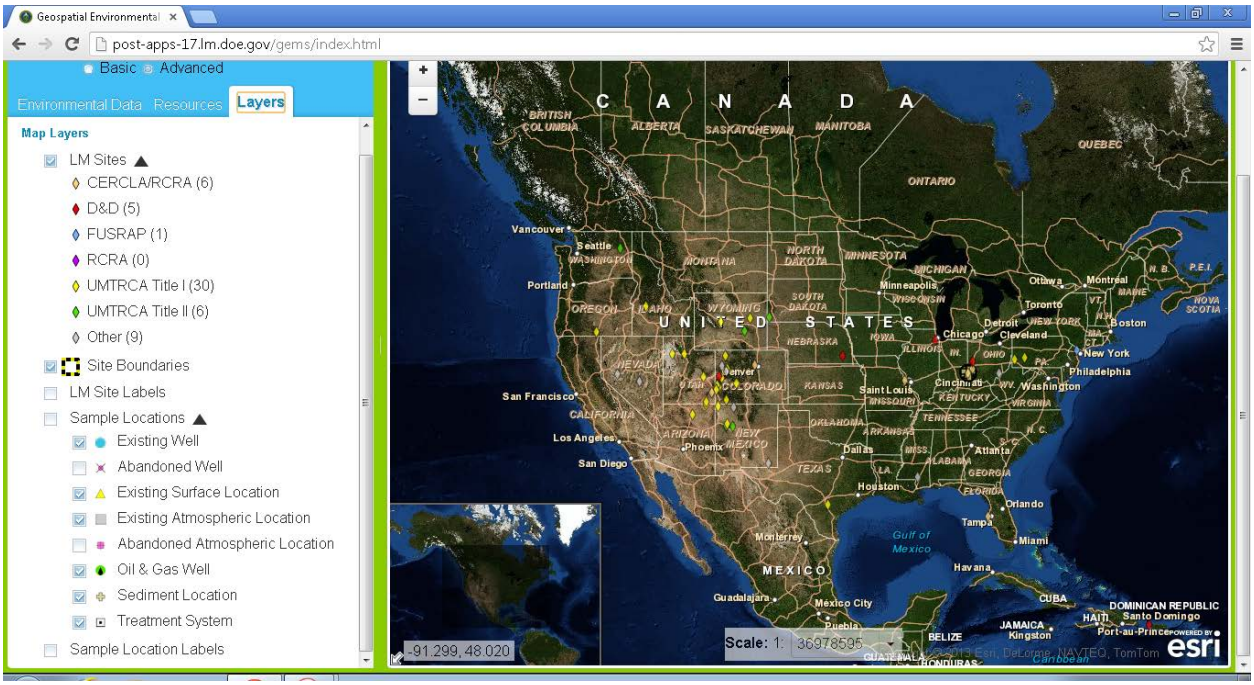

Fig. 5. Screenshot of the GEMS inset map.

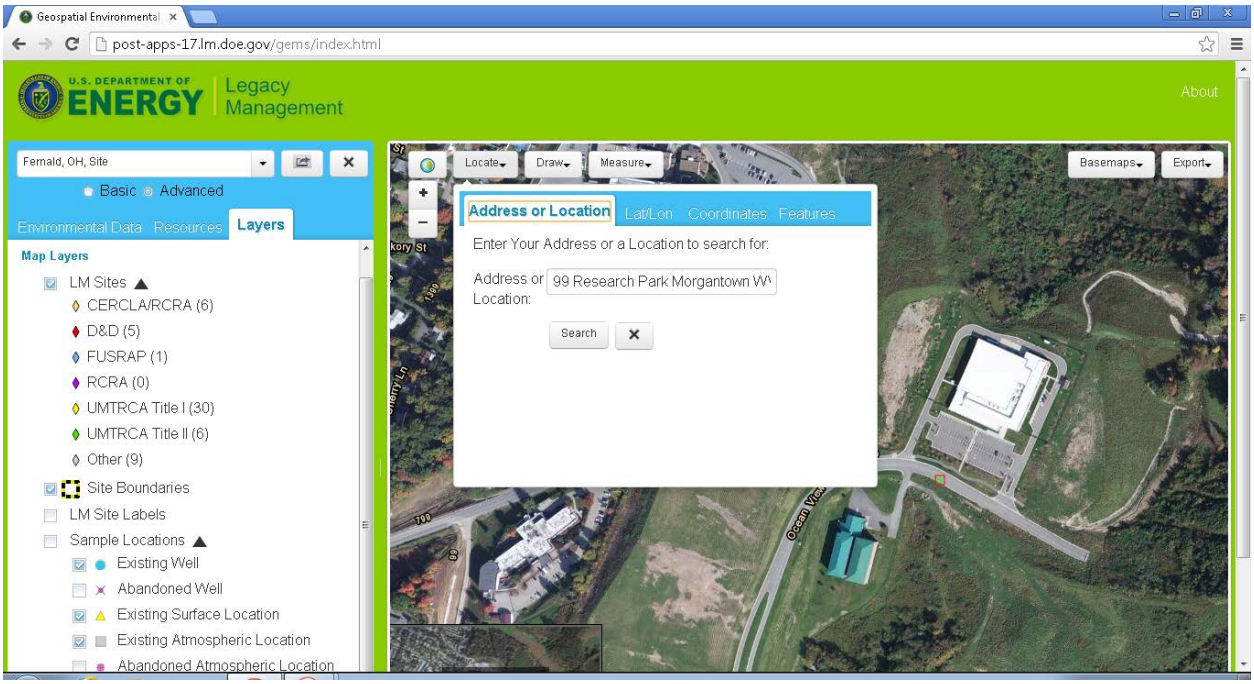

Fig. 6. Screenshot of the GEMS location of features dialogue box.

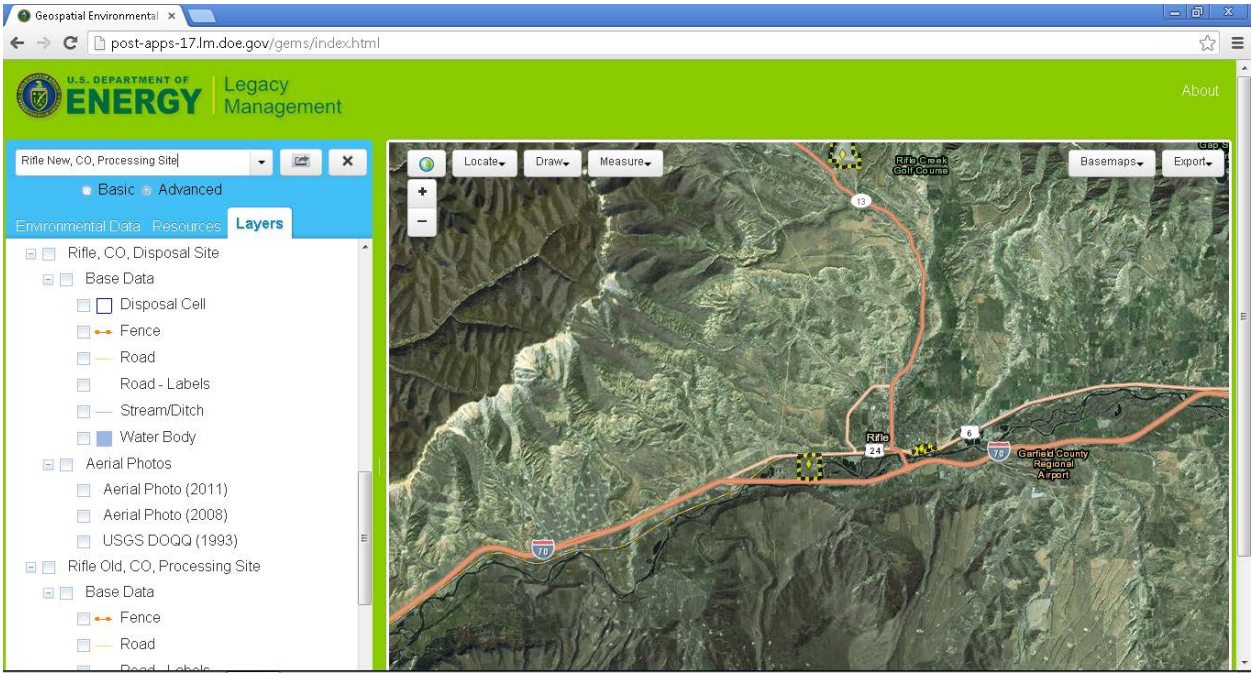

Fig. 7. Screenshot of the feature for viewing multiple LM sites.

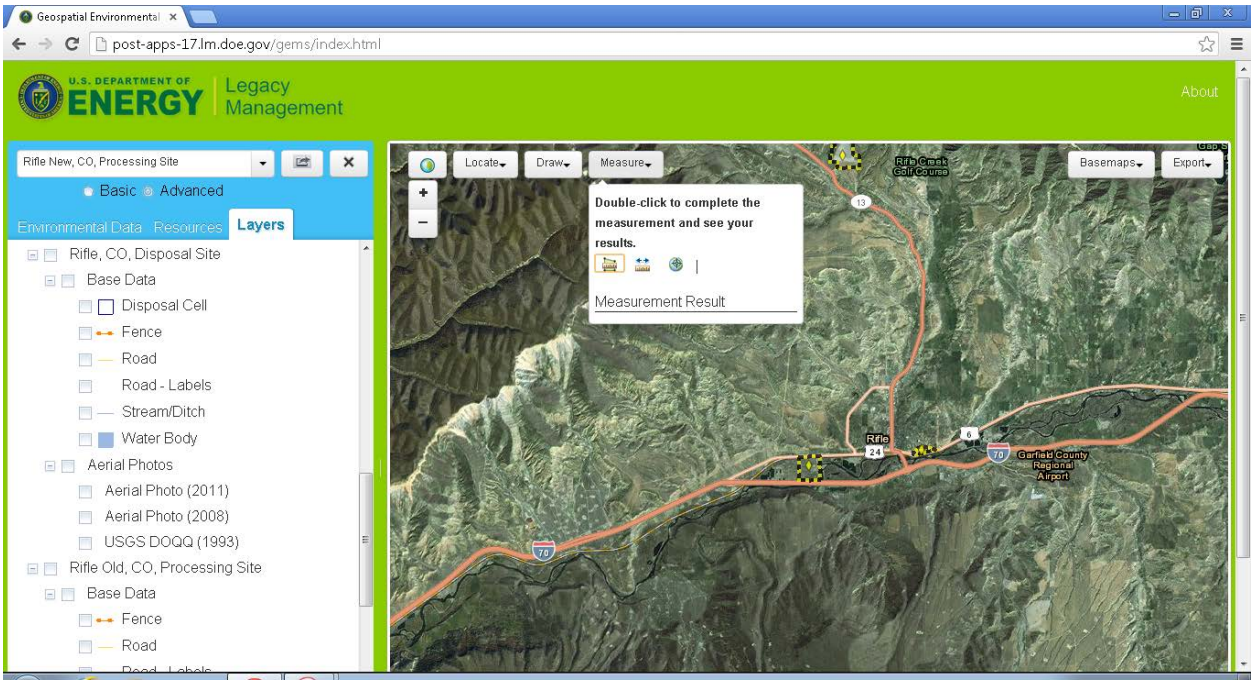

Fig. 8. Screenshot of the GEMS measurement features.

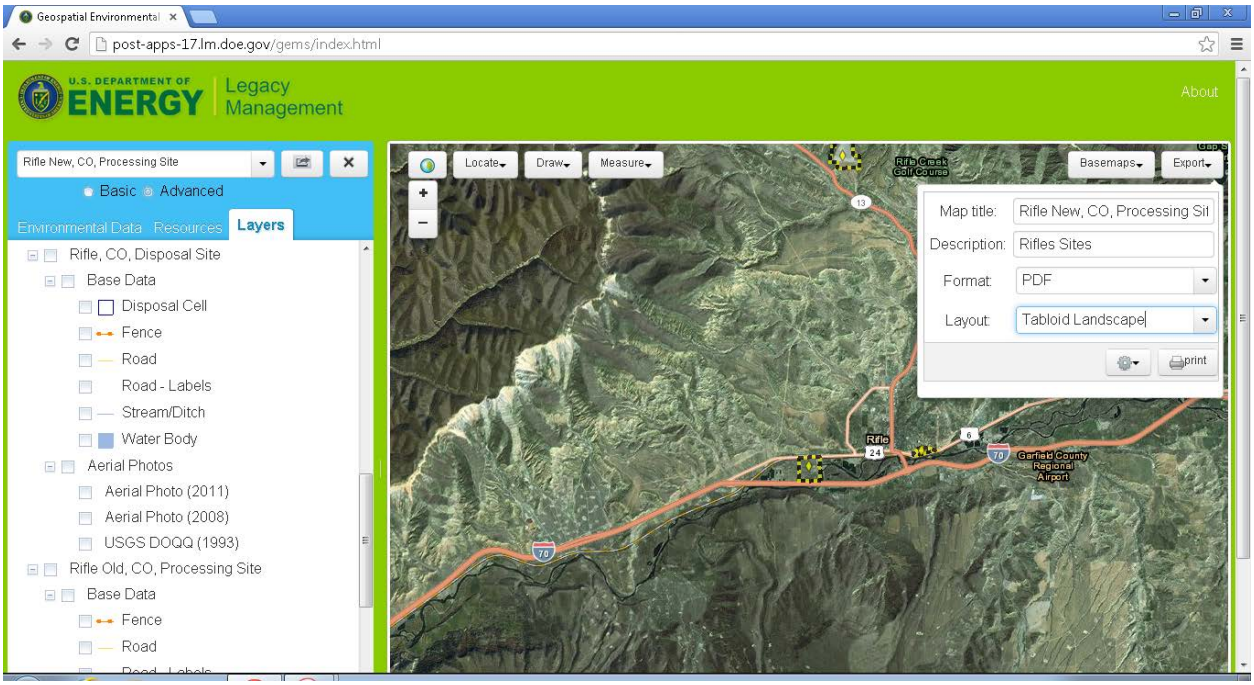

Fig. 9. Screenshot of the GEMS Export feature.

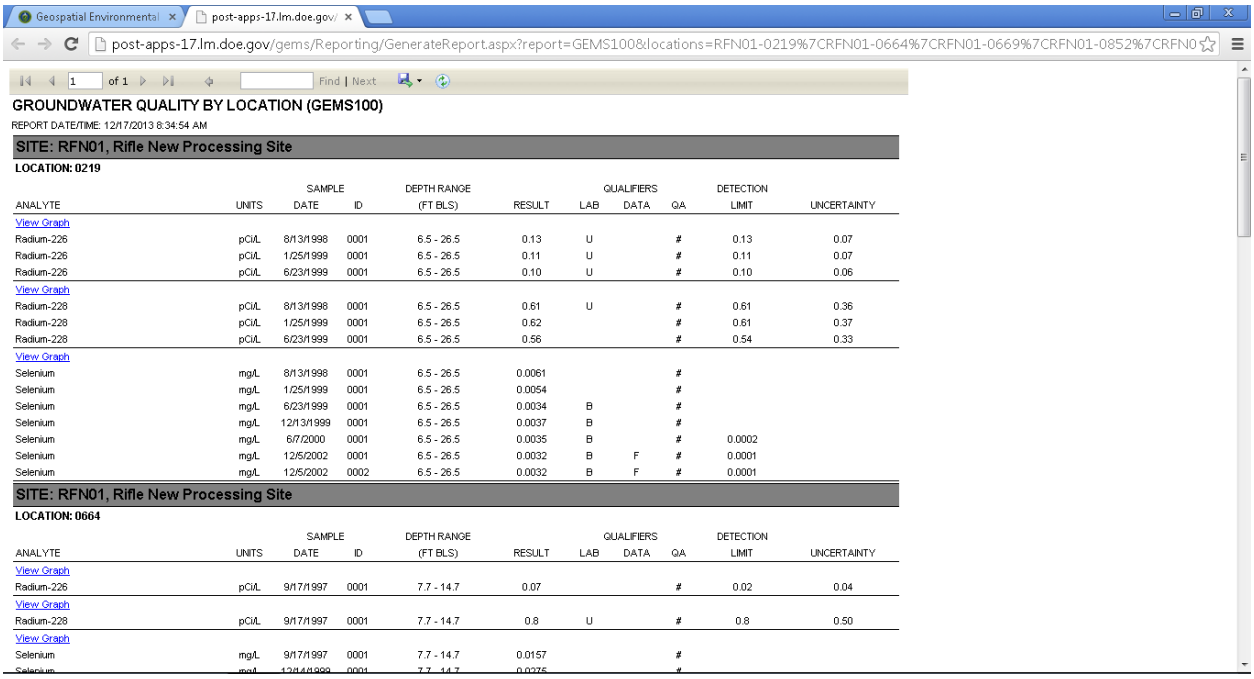

Fig. 10. Screenshot of the GEMS Reporting Window.

Interactive features of the GEMS application include:

- Advanced versus Basic User options
  - Advanced provides additional tabs and more site-specific data (Environmental Data and Resources tabs)
- Map Navigation Concepts
  - Click the Plus (+) and Minus (−) icons to zoom in or out by a factor of 4
  - Use the mouse wheel or left-click to zoom in or out by a factor of 4
  - Shift + click to drag a box around the area
  - Pan left and drag right
  - Pan left, right, up, and down with keyboard arrows
- Basemaps features (**Fig. 4**)
  - Topographic
  - Street
  - Imagery
  - Imagery Hybrid
  - US Geological Survey Topographic
  - Gray Canvas
- Inset map (**Fig. 5**)
  - Pan/hide overview map
- Locate features (**Fig. 6**)
  - Find an address
  - Locate based on latitude/longitude
  - Locate based on coordinates
  - Find features (by sample location or site name)

- View base data, such as fences, roads, and water bodies, for multiple LM sites (**Fig. 7**)

- Turn the following map information layers on and off:
  - Base data (site boundary, disposal cell, fences, roads, and water bodies)
  - Map backgrounds (topographic, aerial photo)

- Employ spatial tools (**Fig. 8**) to measure linear distance and surface area

- Query from the LM Environmental Database (**Fig. 2**, **Fig. 10**). Users can:
  - Filter information by location, date range, analyte, sample type, or geologic formation
  - View selection results through predefined types of sampling media, such as:
    - Groundwater quality
    - Groundwater levels
    - Surface water quality
    - Air particulate data
    - Sediment chemistry data
  - Apply reported data in many ways, such as:
    - Producing a graph to see trends
    - Exporting data to a spreadsheet
    - Posting data as labels on an interactive map
    - Displaying analyte concentration symbols on a map

- Edit, share, and export maps to PDF/PNG file formats (**Fig. 9**)

The format of the GEMS application is extensible. When newly remediated sites transfer to LM, a new webpage is added. The new site's webpage is created using GIS base data and map backgrounds and is linked to the site-specific environmental data that will have been migrated into the LM Environmental Database. New information categories can also be added to the existing application by creating GIS layers. For example, a prototype to communicate LTS&M institutional controls (ICs) to end users was developed on a GEMS webpage for the Weldon Spring, Missouri, Site.

GIS For LM Internal Use

When we were designing GEMS, our goal was to have only one system for both internal and external users. To accomplish this, the team developed a common structure for GIS Services that the application GEMS expects for both environments. This allows us to deploy to different ArcGIS servers with different GIS data while using these common GIS services. Using an established quality assurance process with LM site managers, only data that have been verified for release are made available. Next, we are planning to use ArcGIS Spatial Database Engine (SDE) versioning to enhance the process for moving from one GIS environment to another.

Benefits Of Latest ArcGIS Server

As mentioned, LM has completed the first phase of the migrated its GIS environment to the ArcGIS 10.1 server, which provides many benefits.

What Is The ArcGIS Server?

LM's rollout of the ArcGIS server allows us to manage geographic information from a centralized area. This also provides a single location to share our collection of geographic information with both internal and external users. The ArcGIS server provides the platform for sharing these GIS resources regardless of the user's location.

The ArcGIS server provides the mechanism to share our GIS resources across an enterprise or web. This provides LM with the advantage of sharing its data from a centrally managed location.

Next Steps

Now that LM has modernized the GIS environment, we plan to introduce new features based on provided user requirements. We plan to base our release on a 3-month software life-cycle. In conjunction, the team will continue to improve the GIS/CAD integration by using the centralized ArcGIS Service environment as a modernized configuration management and improved quality assurance tool.

USEFUL APPLICATIONS OF GIS TECHNOLOGY FOR ACCOMPLISHING LM'S MISSION

Institutional Controls

LM uses ICs to manage lands, facilities, materials, and resources under its jurisdiction. ICs are necessary to LM's mission to protect human health and the environment and are often required as part of the environmental remediation of a site when contamination is left in place. They may also be required as part of mandated cleanup actions. LM may decide to use ICs to supplement any of the following: active remediation, protection of the public and natural resources, physical security, or engineered remedies. US DOE divides ICs into three types: administrative (legal) controls, notices (methods of preserving risk and hazard information for current and future generations), and engineered controls (physical barriers or structural features). ICs can include multiple entities and overlapping geographic areas, making them difficult to grasp. Using GIS to display ICs provides a tool to help visualize and understand these complexities.

Real Property

LM is responsible for approximately 5,261 hectares (13,000 acres) of US DOE real property. As US DOE sites transition to LM, part of LM's mission is to transfer excess property and facilities to other parties for management and reuse. This entails working with other agencies and external organizations to transfer real property from US DOE. Negotiating and executing LM's real estate

instruments requires a clear understanding of each site's legal features such as covenants, easements, and deed restrictions. Part of this process also includes managing US Bureau of Land Management public-domain withdrawals and rights-of-way. Because the documentation associated with many of these instruments is complex, and because geographic areas can overlap, visualizing the instruments can be difficult. Properly configured GIS tools can eliminate this kind of confusion and expose issues or conflicts with real property instruments.

Rocky Flats, Colorado, Site Original Landfill

A project created for the Rocky Flats site Original Landfill (OLF) was used to give interactive presentations to the Rocky Flats Stewardship Council members. Instead of a display of paper drawings and posters, the site features were displayed interactively for the audience. The project showed current conditions of the OLF, including the original waste footprint, water diversion ditches, crack and sump repair locations, soil sample locations, settlement monument locations, inclinometers, seep locations, and RCRA sample wells (**Fig. 11**). Using aerial photography, LM documented changes in the OLF from 2004 to the present. These changes were easily viewed in GIS, and the ability to view the features interactively facilitated discussion and improved the audience's understanding of the site.

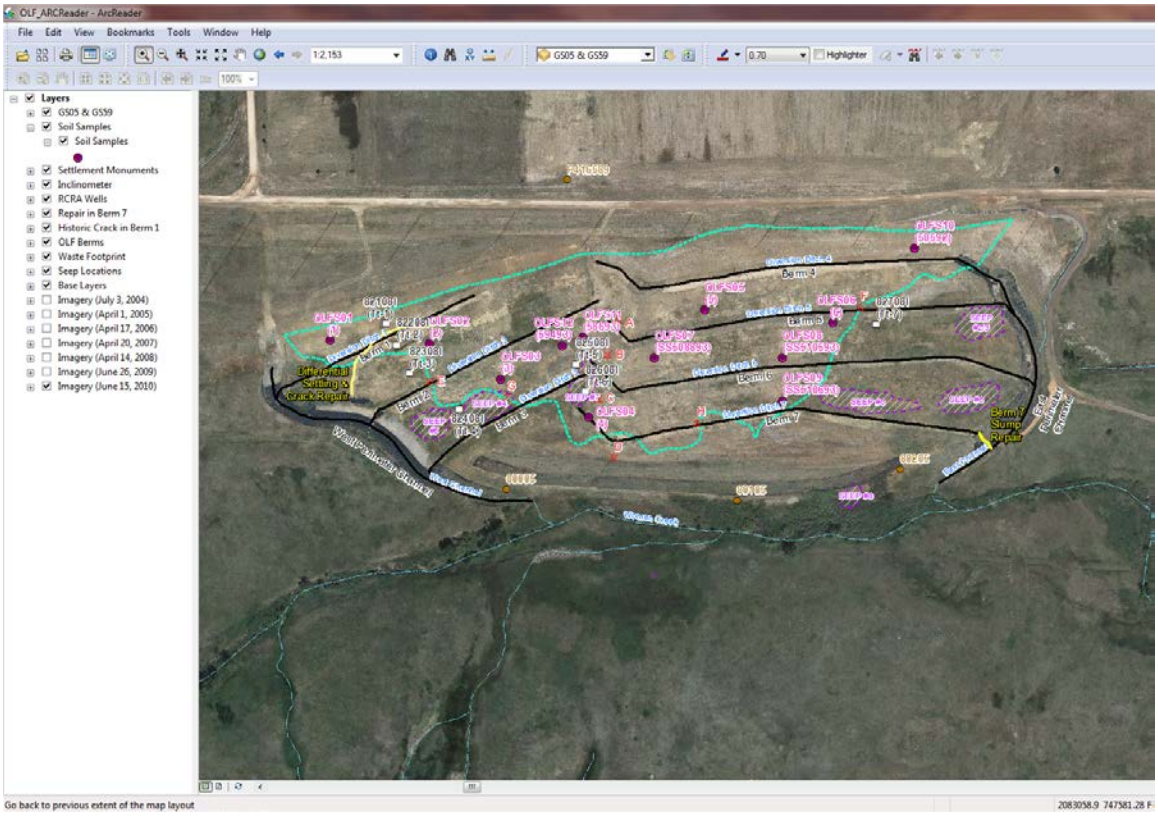

Fig. 11. Screenshot of the Rocky Flats site Original Landfill stakeholder presentation.

Uranium Leasing Program

LM's Uranium Leasing Program also employs GIS tools. Currently, LM administers 31 lease tracts, all located within the Uravan Mineral Belt in southwestern Colorado. Administration of these tracts includes ongoing monitoring and oversight of the leaseholders' mineral extraction activities and annual inspections to identify and correct safety hazards or other environmental compliance issues. During an inspection, a GPS is used to collect data associated with the monitoring and oversight activities.

The Uranium Leasing Program uses several published interactive maps that give employees access to GIS and GPS data. These interactive maps eliminate the need to plot new maps every time new data are added to the geodatabase. The Uranium Leasing Program currently uses four projects:

- Field map
  - Displays all existing features from the Uranium Leasing Program geodatabase
  - Used to review data and create printed maps (**Fig. 6**)
- GPS map
  - Displays all GPS data-collection events
- Leaseholder mine workings
  - Displays all features received from the leaseholders that have been loaded into the geodatabase
  - Used to track the data-loading progress
- Weed map
  - Displays all existing noxious weed locations that have been identified and collected by GPS and loaded into the geodatabase

These projects give non-GIS users access to the map features and their attribute data. The user can determine when the data were collected and if they need to be updated. Users can quickly print maps on their own. It also allows users to easily share data with leaseholders.

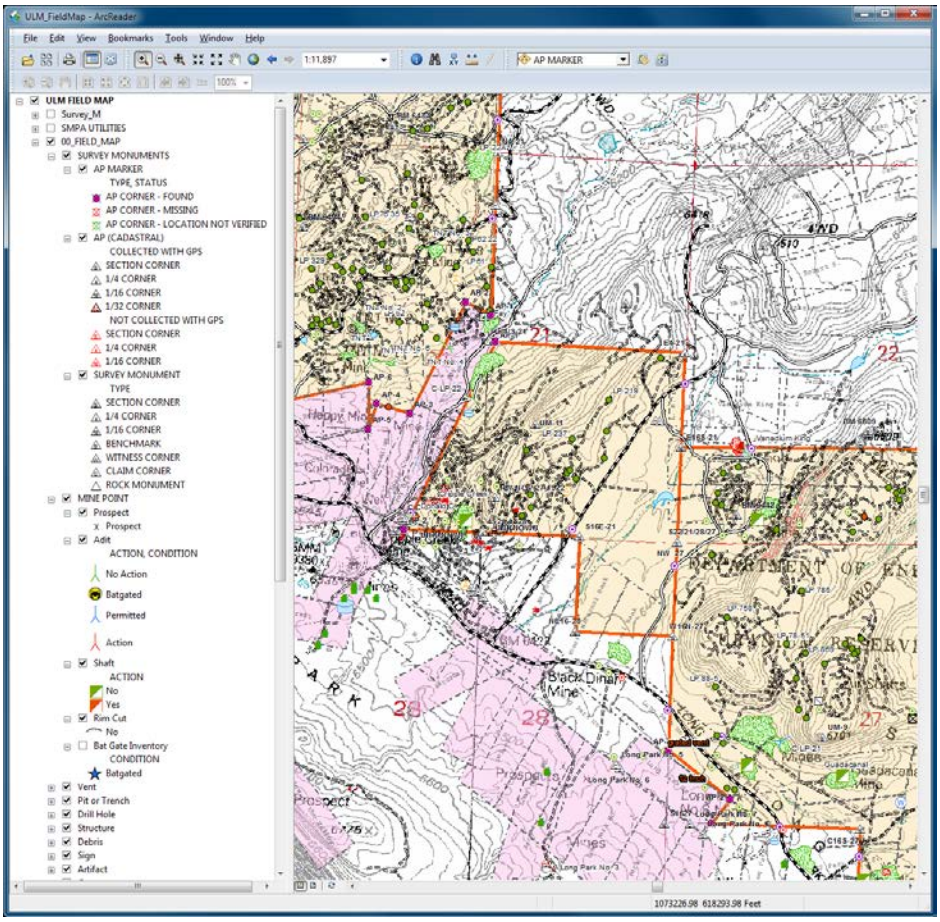

Fig. 12. Screenshot of the Uranium Leasing Program field map.

CONCLUSIONS

The role of GIS in LM's mission continues to grow and diversify. Enhancements are ongoing in both in the GIS data and the applications that allow users access to the data. For instance, the migration of the LM GIS data to the ArcGIS server provides easier access for both internal and external GIS functionality and allows data to be deployed from a central environment. This in turn provides browser-based end-user access both internally and externally. In conjunction, the team will continue to improve existing GIS/CAD work processes using the centralized ArcGIS Service environment for modernized configuration management and improved quality assurance.

As GIS technology advances, LM continues to expand its use of GIS tools to help manage US DOE closure sites, support decision making, promote community and interagency relationships, and protect human health and the environment.