Long-Term Surveillance and Maintenance Geospatial Environmental Mapping System

J. Appetta
U.S. Department of Energy Office of Legacy Management
626 Cochrans Mill Road, Mail Stop 920 L
Pittsburgh, PA 15236, USA

S. MacMillan, K. Miller, E. LaBonte
S.M. Stoller Corporation
2597 B¾ Road, Grand Junction, CO 81503, USA

ABSTRACT

For sites currently under the U.S. Department of Energy (DOE) Office of Legacy Management (LM) and for sites transitioning to LM, technical, operational, and environmental monitoring information continues to be of great interest to stakeholders. The Web-based Geospatial Environmental Mapping System (GEMS) developed by LM provides stakeholders, DOE, regulators, project staff, and the public with a user-friendly mechanism for retrieving geospatial and environmental monitoring information about the sites. This paper discusses GEMS and its use by LM stakeholders.

INTRODUCTION

As part of DOE's commitment to timely sharing of information with regulatory agencies and stakeholders, LM developed the GEMS Web application in 2002 to provide public access to environmental data collected at LM sites. GEMS is a robust, Web-based, interactive mapping environment tied to a database that contains years of environmental monitoring data. This information is available to anyone.

The functions of GEMS are based on comments from stakeholders and potential users of the application. The basic functions include commonly needed static features such as site boundary, surface features, topography, monitoring locations, and aerial photographs, and the commonly needed dynamic site features, such as contaminant plumes, site inspection photos, institutional controls, and sampling and analysis data.

Information needs and uses vary among users. GEMS meets most of the needs by featuring a well-designed user interface based on previously established information needs and an understanding of how geospatial and environmental data are used for long-term surveillance and maintenance of an LM site.

GENERAL DESCRIPTION

GEMS provides a graphical presentation of several types of environmental data. The primary data set is associated with monitoring wells located on and near the LM sites. In addition to the analytical data, the data set includes well construction information, well logs, completion zones, well status (abandoned or active), well classification, and water levels. Analytical data can be presented in tabular or graphical form and listed by analyte or location. Data can also be exported to a spreadsheet or text file. Other data sets include surface water sampling locations and analytical results, contaminant plume maps, site inspection photographs, survey control, and physical mapping features.

The GEMS system consists of a single data source for environmental and related data, a Web-based Geographic Information System (GIS) interface with search/selection capabilities for sampling locations, and the application of dynamic mapping layers (Figure 1). Analytical and ad hoc reporting features provide data extraction files and image files linked to locations.
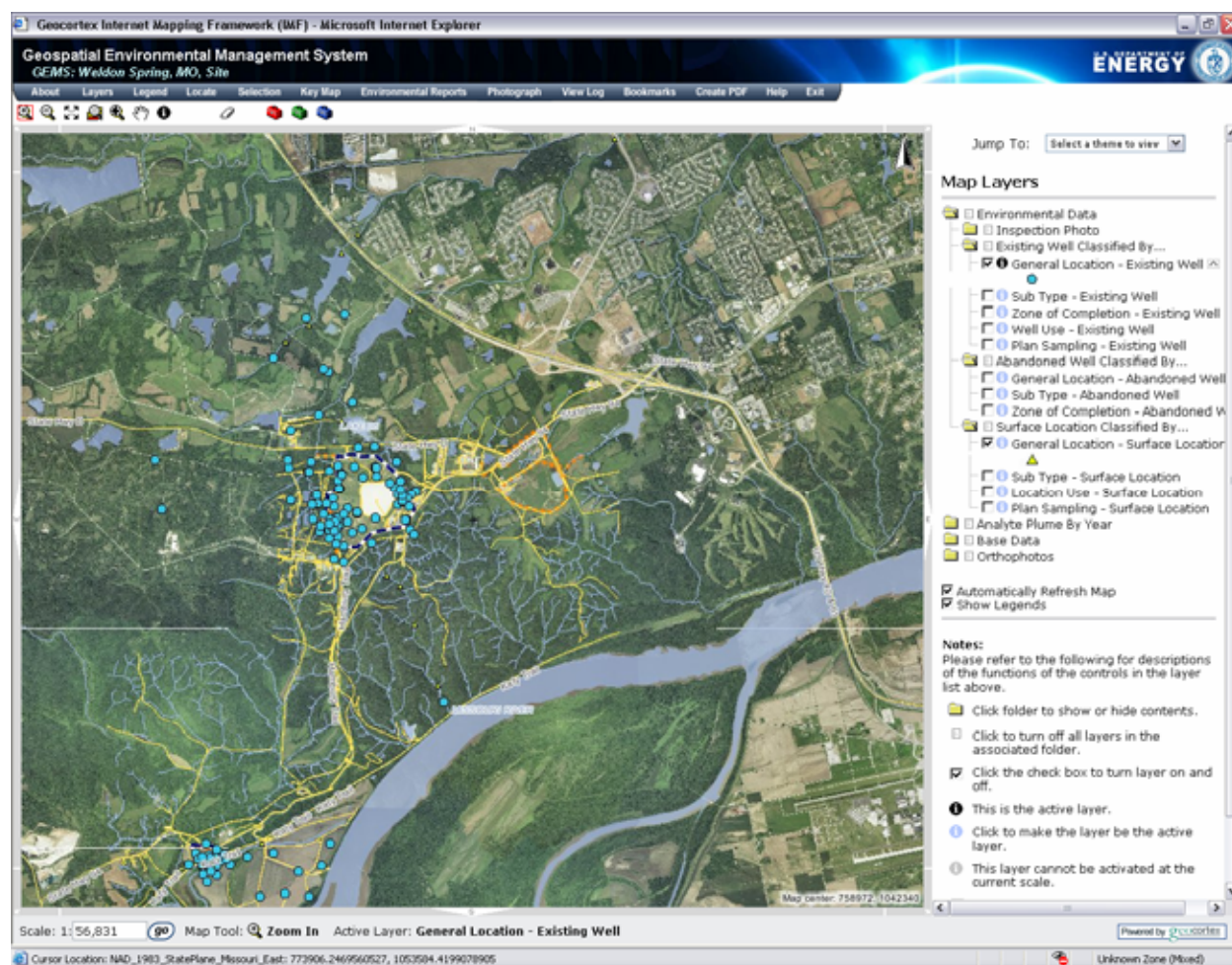

Figure 1. GEMS map layers

GEMS is an Internet Information Server (IIS) application running on Windows Server 2003. The core component of GEMS is a Java-based software application called the Geocortex Internet Mapping Framework (IMF). IMF is an Internet mapping solution that provides a consistent interface for ArcIMS-based spatial Web mapping from a variety of departments within LM. IMF is designed to get geospatial data from a existing ArcIMS map service and serve it to a Web browser, adding functionality that ArcIMS alone is not able to provide. Figure 2 shows the basic components of GEMS
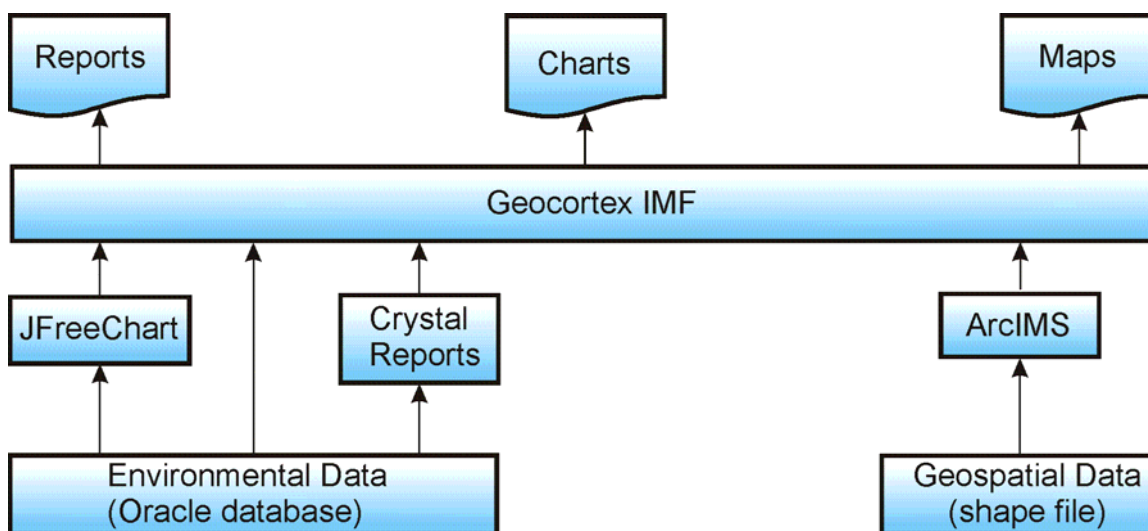

Figure 2. CURRENT GEMS components

GEMS uses powerful tools built into the IMF software, including capabilities to create complex legends, PDF files, personal bookmarks, and also the capability to customize display data from a copy of LM's organization-wide environmental database. These data are used directly on the maps that the IMF creates (e.g., for creating graduated symbols) and are also used to generate reports (using Crystal Reports) and graphs (using JFreeChart).

IMF is platform independent and will run under a variety of Web servers and servlet engines on Windows, UNIX, or Linux servers. The Java object model and framework code are compatible with ArcIMS version 9.x and are upgraded as new versions of ArcIMS are released. IMF and GEMS run under Windows servers within the LM organization.

The IMF is deployed as an Application Service Provider model application and is installed on only one centralized server within the LM network, although its services are available to any group within the organization. This approach facilitates an infrastructure for application management, support, and maintenance.

LM stores and maintains environmental data for all LM sites in a centralized Oracle 9.2 database called SEEPro (Site Environmental Evaluation for Projects). This database serves the LM organization and is only available internally. An Oracle replication process called "materialized

views" replicates data maintained in SEEPro and stores it in the GEMS server, where it is available to users outside the LM organization. The materialized views in GEMS are "fast-refreshed," meaning that only data that have changed in the master database (SEEPro) are changed in GEMS on a daily basis. Using Oracle replication minimizes the need for continuously updating the GEMS data sets.

To generate a report, the user selects the type of report from several predefined report types, and then selects the locations to include, either by drawing a box around them on the map or by selecting them from a list. The user can then filter the results by parameters such as analyte, date range, and sample type. The IMF tries to help the user during the filter-building process by querying the database to identify any locations that do not have the kind of data the user is requesting. Once the report has the desired filtering in place, a text report is generated using Crystal Reports (Figure 3).

Figure 3. GEMS ground water quality by parameter report

Clicking the View Graph button will generate a graph of the report data (Figure 4).

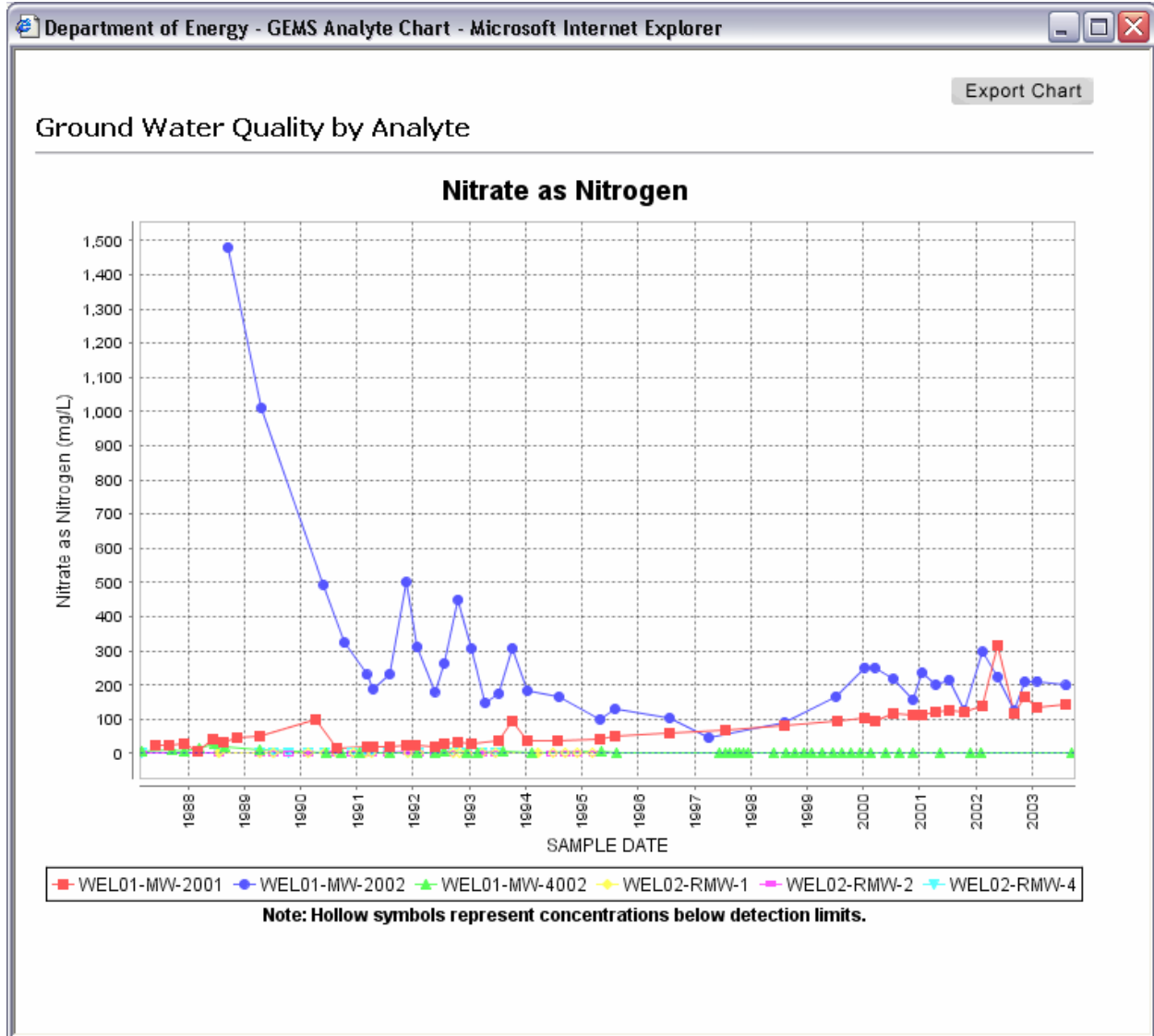Figure 4. GRAPH of GEMS ground water quality by analyte (parameter)

KEY TERMINOLOGY

Analyte: An element, chemical compound, or radionuclide, that is undergoing analysis in a solid, liquid, or gaseous sample.

ArcIMS: An ESRI application for delivering dynamic maps, GIS data, and services via the Web.

Environmental Systems Research Institute (ESRI): Designs and develops GIS technology.

Geospatial: A term that describes the combining of spatial software and data analysis methods with terrestrial or geographic data sets. The term is often used in conjunction with Geographic Information Systems.

GIS (Geographic Information System): A visual, map-based software application that associates objects located geographically (a point feature such as a sample location, a line feature such as a river, and a polygon feature such as a building) with attributes describing that object. A GIS may also present several layers of objects, such as streets, buildings, and infrastructure.

Graduated Symbols: Different ranges for a specified variable (analyte result). This allows the user to get an idea about the magnitude of the variable based on the size of the symbol.

IMF (Geocortex Internet Mapping Framework): A Latitude Geographics Web-based mapping application.

IIS (Internet Information Server) Application: A logical collection of files and directories with a starting point, called the Web-root, mapped to a physical location. Each Web site is accessed through a domain name, or intranet server name, that is then mapped to the Web-root of the site, not the physical location.

Sampling Location: A location where environmental data were collected. In GEMS, sample locations are categorized into different GIS mapping layers to allow users easy access to environmental data associated with that category. Examples of sample location GIS mapping layers include existing wells, abandoned wells, surface locations, and atmospheric locations.

Web-based Application: A software application that can be viewed through a browser such as Microsoft Internet Explorer or Netscape Navigator.

CONCLUSION

By providing easy access to site environmental and GIS data, LM staff members are more efficient and better equipped to meet the needs of regulatory agencies, project staff, and the public. Since GEMS was deployed, stakeholders and users have noted its usefulness when retrieving environmental data and viewing geospatial attributes and layouts, and have provided feedback that resulted in further refinements. Personnel from sites transitioning into LM have also commented favorably on GEMS' functionality and have recommended additional features to be added. GEMS will continue to be updated to present new data sets and increased functionality to allow the user to evaluate data more effectively.

REFERENCES

http://www.geocortex.com, accessed January 4, 2006.

http://authors.aspalliance.com/PaulWilson/Articles/?id=16, accessed January 4, 2006.