TECHNOLOGY STATUS ASSESSMENT

For

GIS- and Web-based Water Resource Geospatial Infrastructure for Oil Shale Development

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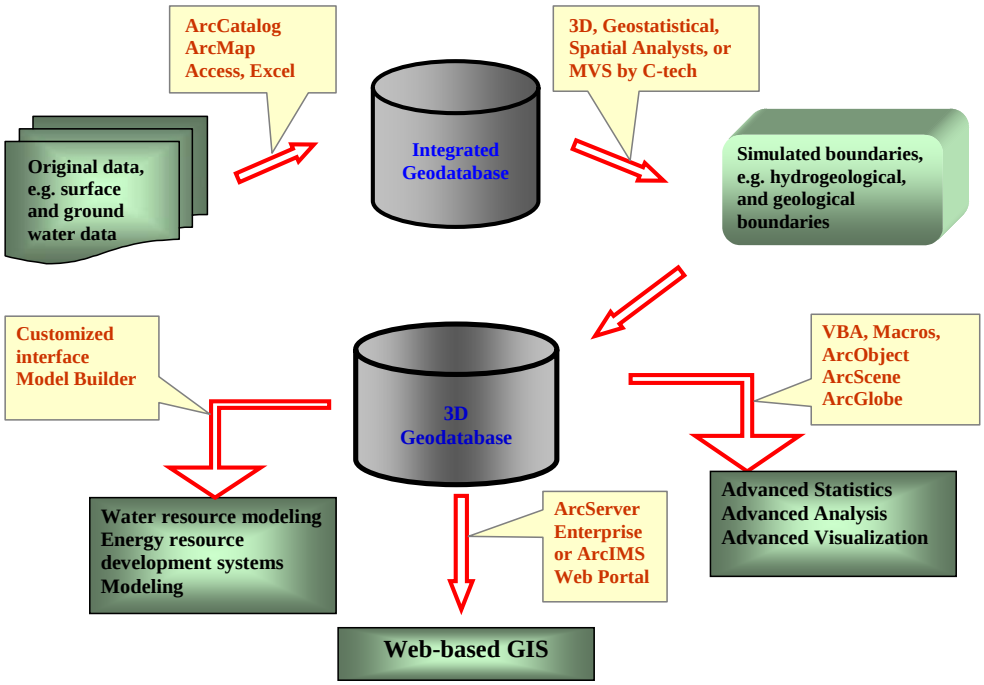

Prepared by
Colorado School of Mines
1516 Illinois St.
Golden, Colorado 80401

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Technology Status Assessment

DE-NT0006554:
GIS- and Web-based Water Resource Geospatial Infrastructure for Oil Shale Development

Performers:
Colorado School of Mines, Golden, CO
University of Texas at San Antonio, San Antonio, TX
Idaho National Laboratory, Idaho Falls, ID

1. Current State of Technology

Oil Shale deposits are found on all inhabited continents [1]. Large oil shale deposits are found throughout the Midwestern and Eastern United States; however, the deposits of the Green River Formation in northwestern Colorado, southwestern Wyoming, and northeastern Utah are most likely to be developed because of their richness, accessibility, and extensive prior characterization [1], [2], [3]. We propose to develop a Geographic Information Systems (GIS)-based regional/basin water resource geospatial infrastructure, a web-based data warehouse for oil shale related data, customized analytical toolsets and GIS models, and provide solutions to address water availability (quality and quantity) and environmental issues, such as surface and subsurface disturbance areas contributed by well pads, well roads, and pipelines, relating to potential development of oil shale resources in the Western U.S. [4].

One of the lessons learned from the Oil Shale Environmental Task Force (OSETF), active from 1978 to 1984, was that test data collected at the site-scale are not comparable with each other, and the "big picture" is not considered in most circumstances [5]. This situation remains true to some extent more than two decades after the OSETF studies. The environmental issues surrounding potential development of oil shale resources in the Western U.S. must be evaluated in concert with the ongoing and future development of all natural resources region-wide. Thus, strategies to manage the environmental aspects of air, water, solid waste, and carbon should be addressed on a regional basis. Collecting regional "baseline" data is the foundation of addressing issues on a regional basis [5].

The current methods used in collecting and storing oil shale related data overwhelm our current ability to make these valuable data resources easily available to a wide spectrum of data consumers, such as scientific researchers at one extreme and policy-makers or the public at the other end of the consumer spectrum. Despite different levels of technical knowledge, these data consumers face similar problems, such as how to locate, assemble, and integrate heterogeneous domain-specific data into a format that meets their needs. For the technically savvy data consumer, this task is possible today, but often only with significant and time-consuming manual effort that could be better spent on data analysis. However, the typical data consumer usually only possesses some, if any, of the knowledge necessary to even locate rele-

vant data, let alone convert and integrate it into a useful product. The ability to view products based on multiple heterogeneous datasets in a new and novel manner is often the key to enhancing the global knowledge base, such as scientific understanding. However, this opportunity is frequently unavailable to data consumers, due either to insufficient data access resources, or to time constraints.

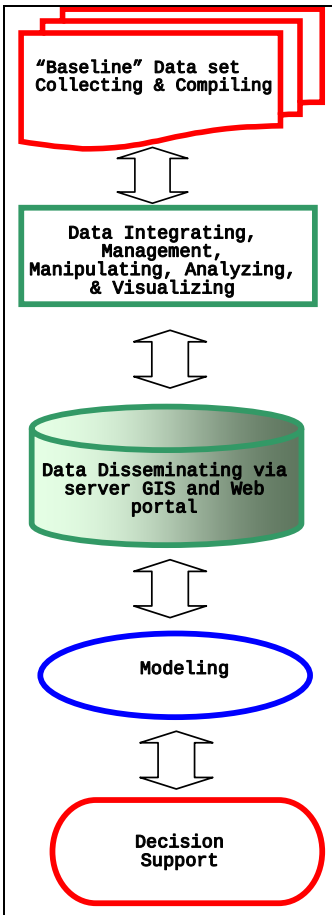
2. Development Strategies

The Green River formation in the Western U. S. has been divided into several distinct geological basins – Piceance, Uinta, Green River, and Washakie Basins. The richest and most thoroughly explored deposits occur in the Piceance basin of northwestern Colorado. We will collect regional surface water and groundwater "baseline" data sets, develop a GIS- and web-based water resource geospatial infrastructure, and provide GIS-solutions to environmental issues, such as surface and subsurface disturbance areas contributed by -well pads, roads, and pipelines.

We will also develop customized GIS-models and Graphical User Interfaces (GUIs) for the models to carry out surface water and groundwater analytical modeling in the Piceance basin. These models will be used to support prediction and decision making for oil shale development, but also be versatile so that they are useful in other regions. Figure 1 shows the framework of the proposed water management solutions relating to oil shale development.

We aim to address three major problems. The first one is to develop a GIS-based water resource geospatial infrastructure which contains regional surface water and groundwater data sets, customized GIS tools and models for data storing, managing, manipulating, modeling, and visualizing. The second one is to improve the information dissemination and utilization through web GIS and web portal. The third one is to provide water management solutions relating to oil shale development through surface water and groundwater modeling, using the data in the GIS-based water resource geospatial infrastructure.

The ultimate goal of this proposed project is to develop a water resource geospatial infrastructure (including data, toolsets, analytical models and GUIs), to provide water management solutions to facilitate decision making for potential oil shale resource development in the Western U. S., and to facilitate environmental impact studies (EIS), and cost estimation under different scenarios.



Collecting and compiling regional surface water and groundwater data (on quality and quantity) from various available sources into integrated relational geodatabases, initially for the Piceance Basin. Geologic maps (e.g., of the Green River Formation), surficial material maps, land use/land status maps and transportation network will also be collected.

Integrating the data collected into an ArcGIS geodatabase. Data will be managed using ArcCatalog, analyzed using ArcMap, and visualized using ArcMap, ArcScene and ArcGlobe. Customized analytical tools will be developed using VBA macros and ArcObjects. GIS analytical models will be built using ArcGIS ModelBuilder.

The derived data will be store in 3D geodatabase. Both geodatabases and the developed customized tools will be stored on a GIS server. These products will be available to end users via web GIS and web portal.

Modeling of surface water and ground water to understand and predict the environmental impacts and water availability under different oil shale development scenarios. Development of GUI between the GIS platform and models

Simplified decision-aiding models that evaluate the output of potential development options or evaluate integrated impacts to the total system will be developed to test the growing GIS-based system. The development of the entire water information system will help decision makers go through available information in a time efficient manner, so they will have more time to focus on resource management issues.

Figure 1: Unified Framework for GIS- and Web-based Water Resource Geospatial Infrastructure

3. Future

Two of the greatest challenges to advancing scientific discovery and industry development are to collect data efficiently, and to share that data among the scientific and public communities. At the core of this project are research into, and the development of, tools that meet these challenges. The proposed study will first enhance the effectiveness of existing oil shale data use. Secondly, the efforts will facilitate communication among industry, state and Federal regulators, and other stakeholders, and provide a "baseline" data set for a data gathering and regional systems modeling effort. Modeling can be used to help determine the costs and benefits of various resource development scenarios and potential cumulative impacts. These efforts will also facilitate data standardization, so that analysis conducted by different institutions will be comparable, and act as an aggregator of data and a developer of "bigger picture" regional/basin level assessments. The new toolsets developed in this project will make a previously rich, dispersed and diverse dataset available and immediately useful, benefiting the public and policy-makers and encouraging further new scientific discovery and industry development.

The performers will submit the periodic, topical, and final reports in accordance with the "Federal Assistance Reporting Checklist" and the instructions accompanying the checklist. Other deliverables shall include: all input data sets, GIS products, databases, and models developed shall be delivered to DOE upon request.

4. References

[1] The Office of Technology Assessment Materials Program staff, An Assessment of Oil Shale Technology, Volume I, June 1980

[2] Geology and Resources of Some World Oil-Shale Deposits (USGS Scientific Investigations Report 2005–5294)

[3] Draft OSTS PEIS, Appendix A: Oil Shale Development Background and Technology Overview (December 2007)

[4] Wood, T., Dammer, A., Wilson, C., Parker, J., Skaggs, R., and Stovall, T. An Overview of the Water Management Cross-Cut Plan for Commercialization of America's Unconventional Fuels, In J. Boak and H. Whitehead, eds. Proceedings of the 27th Oil Shale Symposium, Colorado Energy Research Institute Document 2008-1, Colorado School of Mines. Golden CO USA (CD-ROM) 2008.

[5] U.S. Department of Energy, National Energy Technology Laboratory *2007 Oil Shale Environmental Issues and Needs Workshop*, October 18, 2007, Colorado School of Mines, Golden, Colorado, March 2008.