SOCRATES

Suite of Comprehensive Rapid Analysis Tools for Environmental Sites

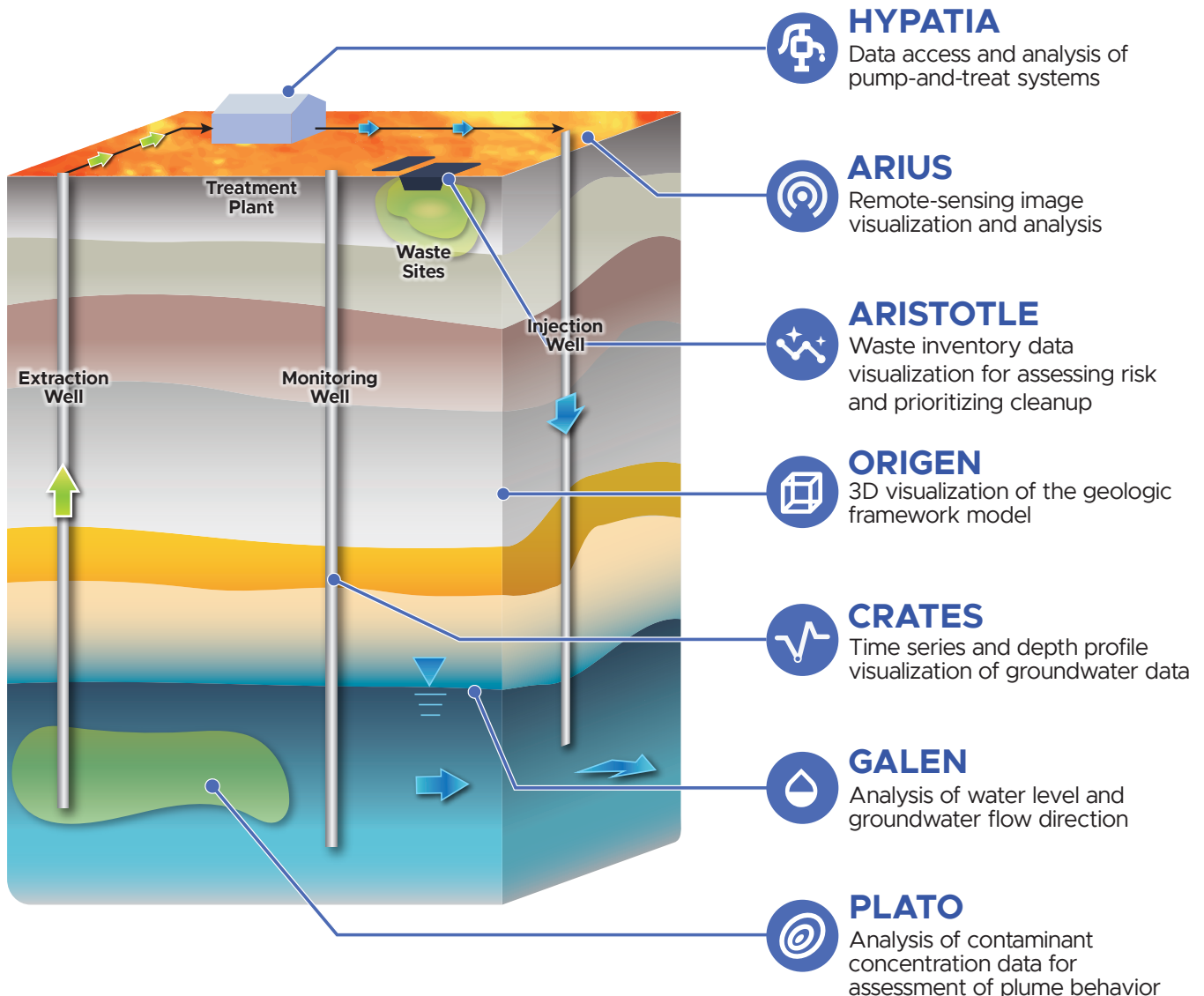**Pacific Northwest** NATIONAL LABORATORY

Web-based Tools to Support Remedy Decisions

SOCRATES is a suite of online tools that can be customized to provide rapid data analytics and visualization of environmental data. The tools support environmental management decisions associated with remedy selection, optimization, and exit strategies.

Treatment Plant

Waste Sites

Injection Well

Extraction Well

Monitoring Well

HYPATIA
Data access and analysis of pump-and-treat systems

ARIUS
Remote-sensing image visualization and analysis

ARISTOTLE
Waste inventory data visualization for assessing risk and prioritizing cleanup

ORIGEN
3D visualization of the geologic framework model

CRATES
Time series and depth profile visualization of groundwater data

GALEN
Analysis of water level and groundwater flow direction

PLATO
Analysis of contaminant concentration data for assessment of plume behavior

U.S. DEPARTMENT OF **ENERGY**

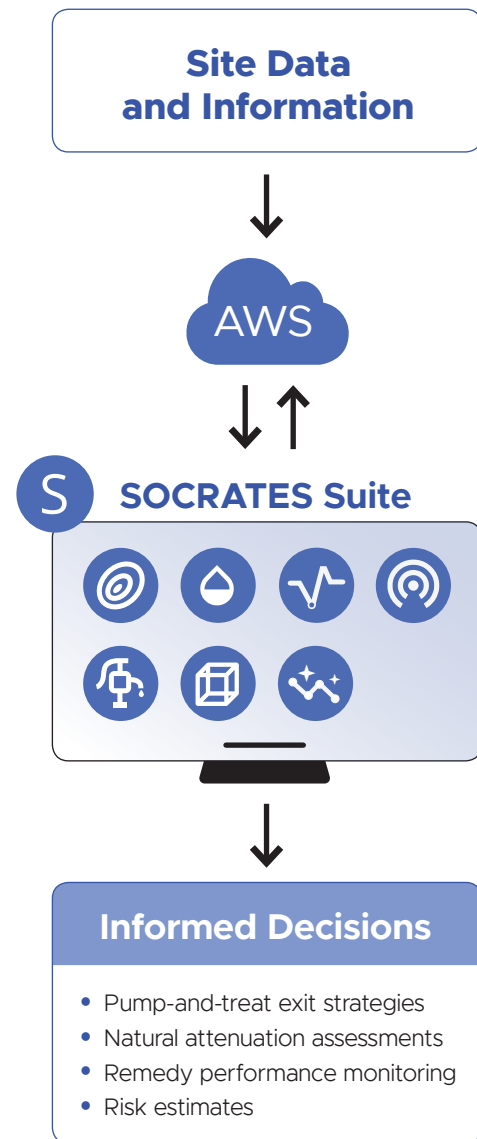# Capabilities

About SOCRATES

SOCRATES tools allow users to perform rapid visualization of data and data analytics that support environmental decisions. These tools bring together data from disparate databases to provide information at multiple levels of detail. They can be used to assess remedy performance, optimization, and endpoints, as well as support short- and long-term site management and monitoring decisions. Using the power of cloud-based computing, complex analyses involving calculations and graphics generation are completed in seconds, making traditional rote, time-consuming spreadsheet calculations obsolete.

Who can use SOCRATES?

Access to individual modules within SOCRATES is granted through a managed system, allowing the site to determine access permission. For example, modules that only visualize data may have unrestricted access (e.g., ARISTOTLE, CRATES, and ORIGEN), whereas modules that perform data analytics may be granted through a managed system (e.g., ARIUS, GALEN, HYPATIA, and PLATO).

What data are required for SOCRATES?

No specific requirements are associated with data types and formats needed for integration into a SOCRATES module. If databases are actively updated, data synchronization between the databases and SOCRATES can occur daily to keep data current. Satellite imagery updates occur as data become available.

Site Data and Information

AWS

S **SOCRATES Suite**

Informed Decisions

- Pump-and-treat exit strategies
- Natural attenuation assessments
- Remedy performance monitoring
- Risk estimates

Highlights

- Convenient access to environmental data and consistent, reproducible, and rapid analytics to support environmental decision-making

- Cloud computing for performing computationally intensive near-real-time analytics for big data (e.g., satellite and remotely sensed data)

- Implementation on Amazon Web Services for robust and reliable performance

- Integrated profile management system that supports workspace customization and streamlined web-based reporting and analysis

- Analytics to support remedy exit strategies, remedy optimization, and adaptive site management that are based on standard statistical methods and U.S. Environmental Protection Agency and U.S. Geological Survey guidance

- User dashboard that saves analyses and graphics and allows for sharing of active working sessions

- Developed under a program that is compliant with the American Society of Mechanical Engineers Nuclear Quality Assurance (NQA-1) standard

PLATO

PLATO (**PL**ume **A**nalysis **TO**ol) analyzes groundwater data to assess contaminant plume behavior, providing a consistent framework to quantify groundwater contaminant plume dynamics that support remedial decisions. PLATO implements data-driven, quantitative analyses based on standard statistical methods and published guidance from the U.S. Environmental Protection Agency and U.S. Geological Survey.

EPA. 2002. *Calculation and Use of First-Order Rate Constants for Monitored Natural Attenuation Studies.* EPA/540/S-02/500, U.S. Environmental Protection Agency, National Risk Management Research Laboratory, Cincinnati, Ohio.

EPA. 2013. *Guidance for Evaluating Completion of Groundwater Restoration Remedial Actions.* OSWER 9355.0-129, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, D.C.

Truex M.J., C.D. Johnson, D. Becker, M.H. Lee, and M.J. Nimmons. 2015. *Performance Assessment for Pump-and-Treat Closure or Transition.* PNNL-24696, Pacific Northwest National Laboratory, Richland, Washington.
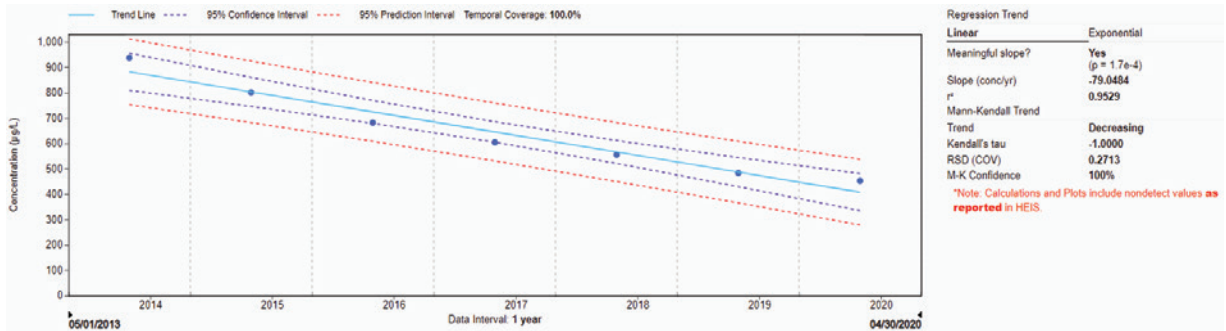
GALEN

GALEN (**G**roundwater **A**na**L**ytics for the **EN**vironment) can provide access to multiple sources of water level data through a single access portal. It includes tools for visualization and analysis of groundwater level and flow direction over time, key elements in supporting site characterization and enhancing remediation system design and performance monitoring.
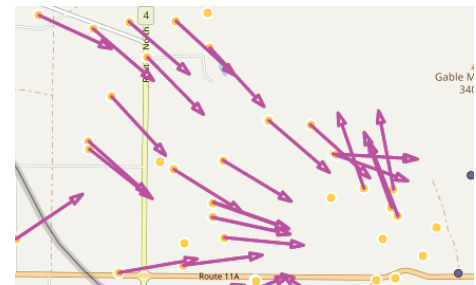

CRATES

CRATES (**C**harting, **R**eporting **A**nd **TE**mporal visualization**S**) is a plotting tool primarily used for visualizing groundwater concentration data. CRATES provides streamlined, quality-assured data visualization, enabling the user to easily identify well locations for plotting user-specified contaminants of concern, with export features for graphics and tabulated data.
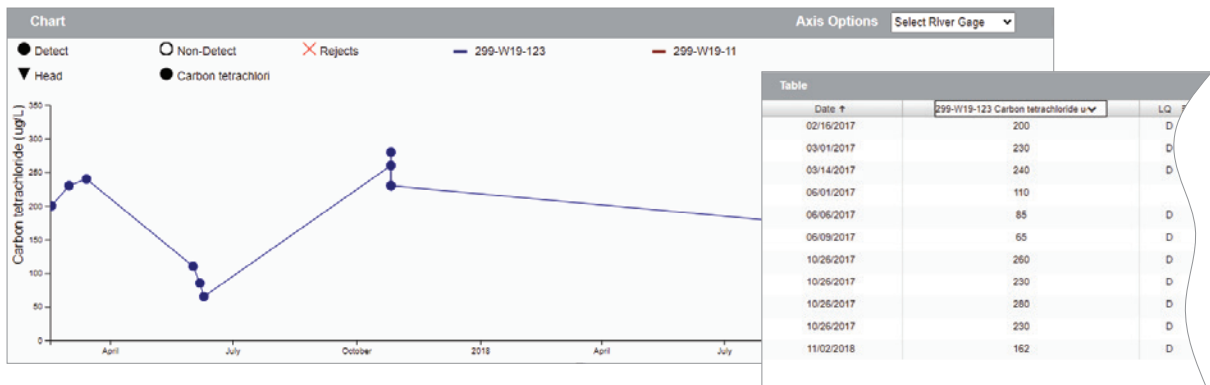
ORIGEN

The ORIGEN (**O**nline **R**etrieval **I**nterface for **GE**ologic **IN**formation) module is a viewer that provides access to site geology, with features to create cross sections and access information on stratigraphic thicknesses, water table elevation, and well construction information.
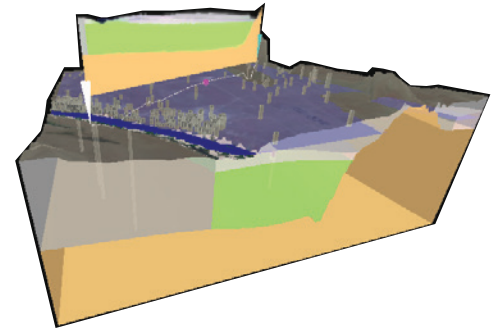

HYPATIA

HYPATIA (**HY**draulic **P**ump-**A**nd-**T**reat **I**nformation **A**nalytics) supports a data-driven management approach by providing data access and tools for analyzing pump-and-treat data, including extraction well and treatment plant chemistry and control system sensors that are often stored in separate databases. HYPATIA also provides methods for statistical analysis of time series data and includes calculated metrics, such as mass flow rate and injectivity for assessing P&T system performance.
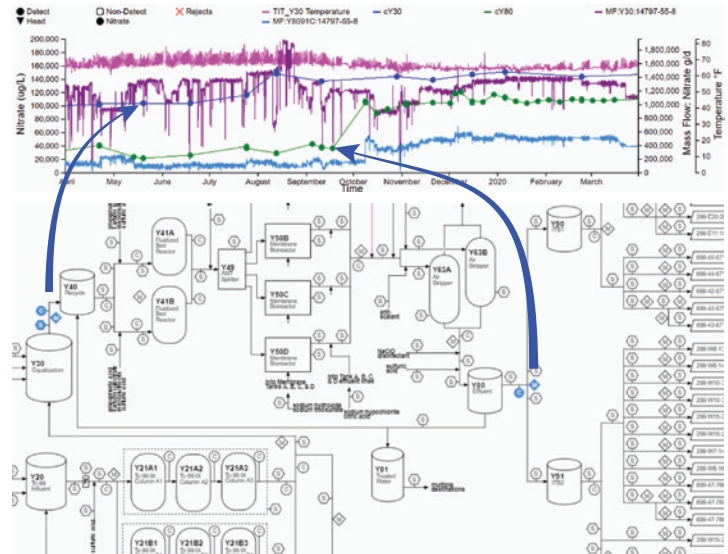
ARIUS Beta

The ARIUS (**A**dvanced **R**emote-sensing **I**mage **US**er interface) web-based application performs full end-to-end automated acquisition of remote-sensing datasets using a matrix of cloud-based technologies. The tool streamlines complex workflows and processes satellite data pertaining to variation in both ground surface elevation and ground surface temperatures. Both LiDAR (light detection and ranging) and SENTINEL-1 data are used to monitor surface displacement, whereas the Landsat 8 and 9 satellites are used to monitor surface temperatures as an indirect measure of groundwater and surface water interactions.
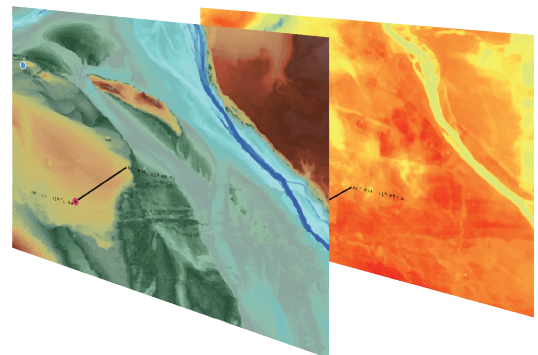
ARISTOTLE Beta

ARISTOTLE (**A**daptive **R**isk **I**nformed **S**ystem to **O**btain **T**he **L**ikely **E**ndstate) provides geospatial visualization of waste site inventory data from multiple data sources to help assess risk and prioritize remedy actions across spatial scales. Estimates of both chemical and radiological inventories from historical discharges are important for identifying risks of residual inventories of contaminants still present in the subsurface, and to qualitatively and quantitatively assess site cleanup priorities.