DATASHED: AN ONLINE TOOL FOR PASSIVE TREATMENT SYSTEM MONITORING AND MAINTENANCE[1]

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Abstract: *Datashed* is a user-friendly, interactive, Geographic Information System (GIS)-enabled online database developed by Stream Restoration Incorporated to assist watershed groups, academic institutions, private industry and government agencies to monitor, operate, and maintain passive treatment systems. Using primarily open-source technology, *Datashed* provides a cost-effective and reliable solution to the management of data associated with environmental efforts. Specific, individualized functions can easily be added using common programming languages. One of these functions, called i-Map, is a GIS tool that spatially connects the data stored within *Datashed*. Both anonymous and authorized users can easily upload, download, and print data from any standards-compliant web browser without the use of additional plug-ins or software. *Datashed* is being used as a repository of information for over 230 passive treatment systems within the state of Pennsylvania. A "snapshot" of the current condition of these systems is underway by analyzing water samples from the raw untreated mine drainage, the final effluent of the passive system, and the influent and effluent of every alkalinity-generating component.

Additional Keywords: database, open source, internet, Geographic Information System (GIS), operation and maintenance, AMD, mine drainage, passive treatment system

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Introduction

For more than a decade, organizations have been installing passive systems to treat abandoned mine drainage throughout the Commonwealth of Pennsylvania. Through these activities, watersheds are being restored. According to an inventory of mine drainage treatment projects compiled by the Office of Surface Mining (OSM), over 280 systems exist within Pennsylvania (OSM, 2007). Many of these restoration projects, however, must be maintained properly in order to have a lasting impact. To prevent streams from reverting to their polluted condition, these projects must continue to function.

Volunteers, non-profit organizations, and government agencies have spent numerous hours collecting valuable water quality data in order to determine the effectiveness of these treatment systems. Dependent upon the organization, these data have a variety of end uses. Some groups enter the data into a computer database for use in reports, newsletters, etc. Other groups do not have a database and only keep paper records. Many times, government agencies store their data in proprietary databases behind firewalls for security. As a result, the availability of these data to the general public and to researchers is limited.

History

Stream Restoration Incorporated (SRI), a 501(c)(3) non-profit, has assisted numerous watershed groups throughout Pennsylvania with assessment, restoration, and protection projects. These efforts have included all necessary reports, studies, designs and construction oversight for the installation of over 30 passive treatment systems throughout Pennsylvania having a combined total of more than 200 components. With this experience, SRI understands the necessity of properly maintaining passive treatment systems and the need to make water quality data available to others.

In 2002, SRI began the development of the *Datashed* (www.datashed.org) web system to aid in the operation, maintenance, and monitoring of these passive systems. Work began on *Datashed* under a small United States Geologic Survey (USGS) grant to SRI to assist interns from Grove City College in monitoring passive treatment systems in the headwaters of the Slippery Rock Creek watershed. A small web development company, 241 Computer Services, offered to donate much of their time to create a simple interface for these interns to upload water quality data through the Internet and to provide downloadable information, such as schematics

and inspection sheets, on the passive treatment systems. As funding was not readily available for *Datashed*, work was completed in small increments over time. Additional partners who have contributed to *Datashed* since its inception include: Western Pennsylvania Coalition for Abandoned Mine Reclamation (WPCAMR), BioMost, Inc., PA Department of Environmental Protection (PA DEP), US Environmental Protection Agency, Greene County Watershed Alliance, Indiana County Conservation District, Eastern Pennsylvania Coalition for Abandoned Mine Reclamation (EPCAMR), Slippery Rock Watershed Coalition, and others. The pace of enhancements to *Datashed* has increased with contributions from these project partners.

Features

As funding was limited, SRI decided to use applicable Free and Open Source Software (FOSS) where available to reduce costs while increasing the longevity, security, reliability and stability of the web site. Using commercial software would have increased the cost by hundreds of thousands of dollars to meet the requirements. The FOSS alternatives have met these requirements and reduced initial and recurring maintenance costs of the project. The current configuration of *Datashed* uses PHP, MySQL, Mapserver, Apache, and MediaWiki as well as a host of open source functional libraries. *Datashed* can be viewed in most modern web browsers without the use of any additional plugins other than Adobe Acrobat Reader. *Datashed* currently offers the following capabilities:

- Instant, 24/7 access to important documents such as Operation & Maintenance Plans, inspection sheets, directions to project sites, topographic maps, and aerial photos
- Password-protected data submissions (i.e., field data)
- i-Map, an interactive GIS map depicting all known passive treatment systems at abandoned mine sites in Pennsylvania and other datasets
- Multi-parameter project searches
- Printable monitoring reports and predefined graphs
- Public access to *all* water sampling data
- Wiki

Downloads:

One of the primary functions of *Datashed* is to offer access to materials that will allow organizations, especially volunteer-based programs, to easily monitor their passive systems.

Datashed provides downloadable operation and maintenance plans, site schematics, aerial photos, as-built drawings, etc. In addition, *Datashed* uses Bing Maps Web Services to allow users to view and print directions to the passive system based on their address.

Water Quality Data:

The data stored within *Datashed* can be viewed and downloaded from the web by any user in several different formats without the need of an account. The data are found by searching for the passive system or stream within a multi-parameter query or by searching i-Map (Fig. 1 and 3). Once the site is found, data can be viewed in dynamically-generated reports or downloaded as a CSV (comma separated value) file, which is easily opened in Excel, Access or other tools to allow further calculations and data manipulations.

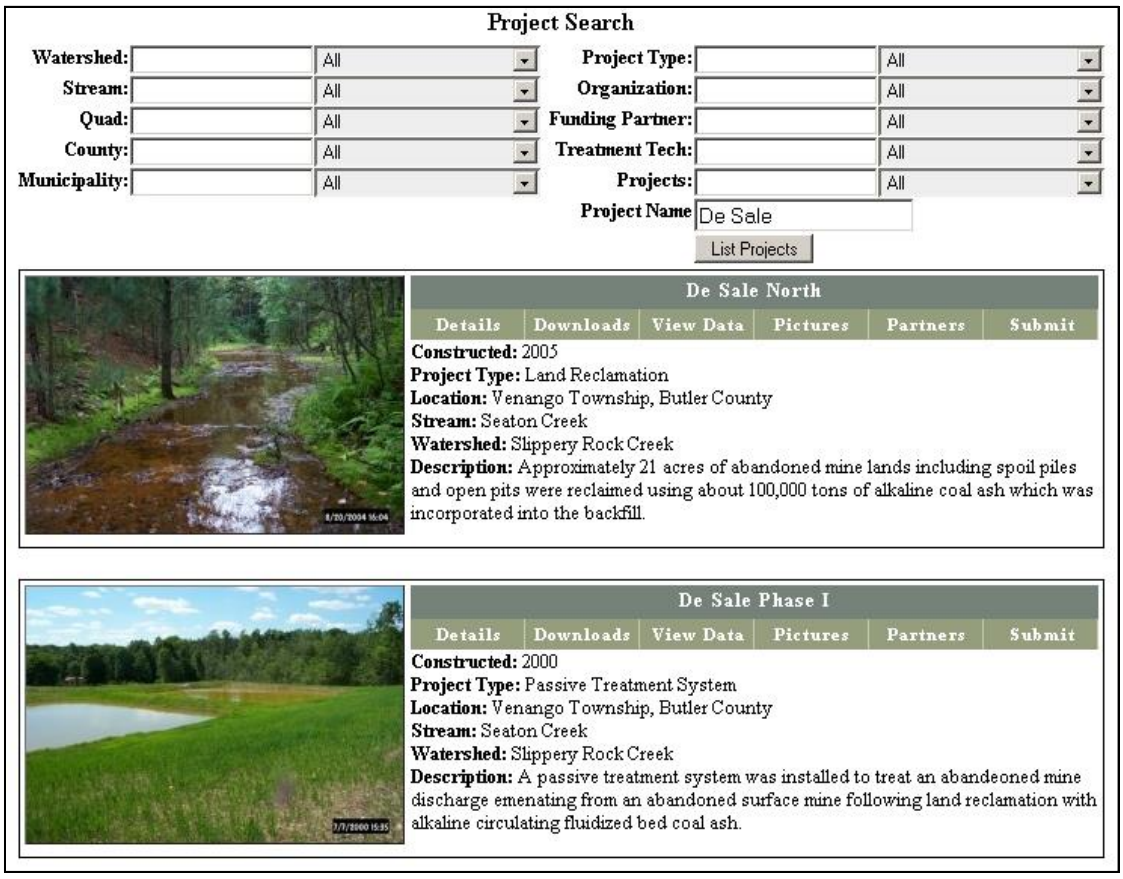

Figure 1: Project searches can be based on multiple parameters and by name.

No data may be uploaded to *Datashed* without first having an account. Passwords are available to any organization that would like to upload their data and access is given only to their projects. Users must type in their password before being able to access the data submission

interface. Passwords protect *Datashed* from potential vandalism and false data entries and provide a traceable path to the source of the data. A web-based tool has been developed to import large datasets in an electronic format. This tool assists in matching the fields within the organizations dataset to fields within *Datashed*. This tool also checks the data to ensure it is within appropriate ranges (e.g., pH is between 0 and 14). Once an organization has imported the historic dataset, the organization could continue to use the import tool or they could use an interface where they simply type the data into an online form. For organizations that would like a comprehensive assessment of their passive treatment system, operation and maintenance forms can be created. Information, such as erosion, berm stability, valve operability, etc., can be entered into an online form. In addition to water quality and operation and maintenance data, users may upload photos.

Once the data has been uploaded to *Datashed*, the data can be viewed or downloaded as stated previously. In addition, dynamically-generated graphs are available (Fig. 2). These graphs use the most up-to-date information stored within *Datashed* at the moment they are generated. As new data is uploaded to *Datashed*, these graphs are updated to reflect these changes.

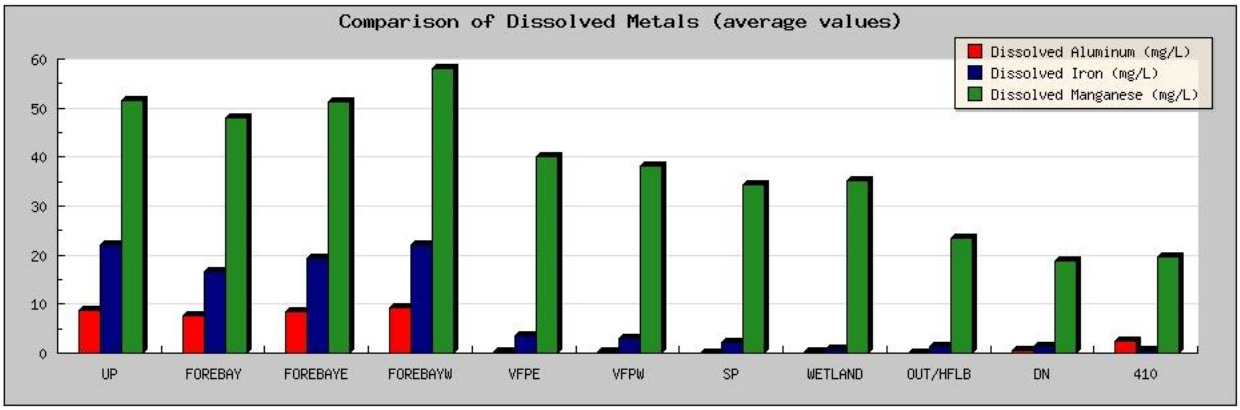

Figure 2: Example of a dynamically generated graph.

i-Map - Geographic Information System (GIS):

An innovative GIS application called i-Map has been developed to spatially connect the data stored in *Datashed*. The spatial component of *Datashed* is run utilizes MapServer, a robust, free and open source GIS software originally developed by the University of Minnesota ForNet project in cooperation with NASA and the Minnesota Department of Natural Resources (DNR)

(Regents of the University of Minnesota, 2009). A wide variety of government agencies, non-profit organizations, businesses, and academia are actively involved in using and developing this software such as the US Army Corp of Engineers, Minnesota DNR, US Department of Agriculture Forest Service, and Canada Center for Remote Sensing and Natural Resources Canada. A custom-designed JavaScript/HTML interface allows users to easily find sampling points and directs users to additional content on the site. Each passive system can be queried for average water quality data. Terrabytes of additional geographic data are made available using Web Mapping Services (WMS), such as NASA's Landsat 7 satellite and USGS topographic maps, and on-the-fly projections. Not only can i-Map serve as a WMS client, i-Map can provide spatial data to other internet and desktop applications. In addition, customized GIS maps can be generated from parameters stored within the database, such as the topographic maps found in the download section of *Datashed*.

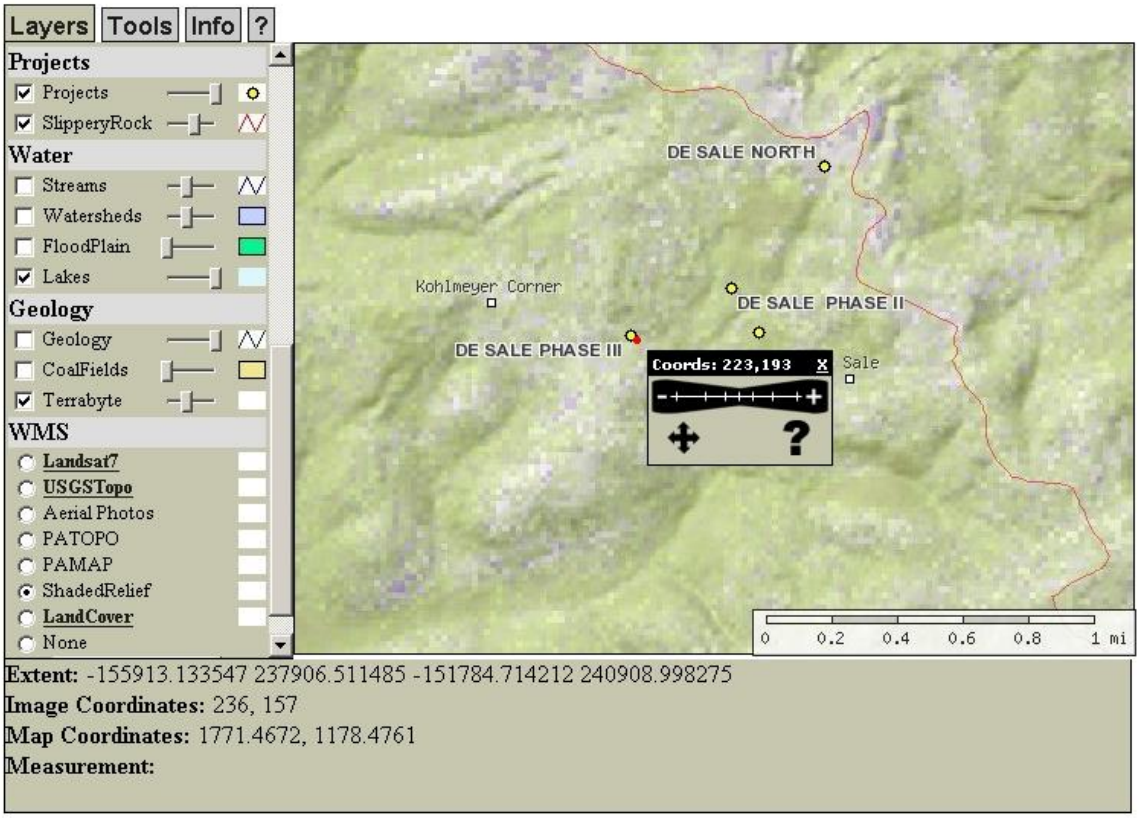

Figure 3: Screenshot of i-Map, the GIS component of *Datashed*.

FACTS:

Funding AMD Chemistry for Treatment Systems (FACTS) is a program of WPCAMR offering funding for chemical analyses to watershed organizations in Pennsylvania. In cooperation with WPCAMR, many new features have been incorporated to *Datashed* to create a powerful data management system and repository for data collected for the FACTS program. FACTS standardizes the process of establishing a sampling schedule and coordinates the analysis of water samples with the watershed organization and participating laboratories. Email "triggers" are sent to the appropriate organization to alert them of upcoming sampling events.

Wiki:

A wiki is a collection of web pages that is edited by users. *Datashed* uses wikis in several different ways. Administrators of *Datashed* are capable of adding and modifying content within the Help pages without having to learn HTML or other programming languages, which also prevents accidents with the code. In addition, any organization using *Datashed* can use the Community Wiki to generate content that may be useful to other organizations, such as instructions on how to use different types of field sampling equipment.

Snapshot

In order to assess the condition of over 230 of the 280 passive treatment systems in the Commonwealth of Pennsylvania, a partnership effort was organized to conduct two water quality "snapshots" of all the publicly-funded passive treatment systems located within the state. This snapshot consists of collecting water samples for laboratory analysis as well as measuring selected field parameters. The samples have been collected for the raw untreated mine drainage, the final effluent of the passive system, and the influent and effluent of every alkalinity-generating component, such as anoxic limestone drains (ALDs), vertical flow ponds (VFPs), etc. The first snapshot took place in the fall 2009, while the second snapshot is planned to take place in early spring (March and April 2010) to represent both low flow and high flow conditions. Approximately 50 systems were not sampled due to a variety of issues, such as the discharge was not flowing, the discharge was bypassing the treatment system, and the landowners have denied access. The monitoring has been completed by a team consisting of individuals from PA DEP's Bureau of Abandoned Mine Reclamation (BAMR), Stream Team, PA Senior Environmental Corps, Mill Creek Coalition, Babbs Creek Watershed Association, Broadtop Township, and Stream Restoration Incorporated. Data from the snapshot will be made publicly available via

Datashed. These data complements the information provided within the website to provide an accurate account of the location, components, and current condition of these treatment systems. Once the data are posted, *Datashed* will become an invaluable tool for research.

Conclusion

It is the goal of SRI for local groups to be actively involved in the operation, maintenance, and monitoring of treatment systems. *Datashed* has begun to help us achieve this goal. Although a work in progress, many features are currently available to store and distribute data on passive systems. Additional features are being added to meet the needs of the project partners. Below is a list of a few of the more prominent feature requests:

1. Tutorials on using *Datashed*.
2. Allow the user to define custom graphs and reports based on date, location, etc.
3. Modeling of passive treatment systems to determine the effectiveness of the system and when maintenance may be needed.
4. Management interface to add, modify, transfer, or delete data.
5. Develop online tools to calculate flows (multiple methods) and loading, unit conversions (ex. gallons to liters), etc.
6. Create a process to incorporate PA DEP data on a regular interval from their database management system.

Please send us any comments or suggestions to make the site even better! Anyone interested in opening an account on *Datashed* can email us at sri@streamrestorationinc.org.

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