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Prepared for the U.S. Department of Energy
under Contract DE-AC05-76RL01830

Transfer of Physical and Hydraulic Properties Databases to the Hanford Environmental Information System - PNNL Remediation Decision Support Project, Task 1, Activity 6

ML Rockhold LA Middleton

March 2009

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Pacific Northwest National Laboratory
Richland, Washington 99352

Summary

The Remediation Decision Support (RDS) Project is managed by Pacific Northwest National Laboratory (PNNL) to support Hanford Site waste management and remedial action decisions by the U.S. Department of Energy and one of their current site contractors – CH2M-Hill Plateau Remediation Company (CHPRC). The objective of Task 1, Activity 6 of the RDS project is to compile all available physical and hydraulic property data for sediments from the Hanford Site, to port these data into the Hanford Environmental Information System (HEIS), and to make the data web-accessible to anyone on the Hanford Local Area Network via the so-called Virtual Library.[1] These physical and hydraulic property data are used to estimate parameters for analytical and numerical flow and transport models that are used for site risk assessments and evaluation of remedial action alternatives.

In past years efforts were made by RDS project staff to compile all available physical and hydraulic property data for Hanford sediments and to transfer these data into SoilVision®, a commercial geotechnical software package designed for storing, analyzing, and manipulating soils data. Although SoilVision® has proven to be useful, its access and use restrictions have been recognized as a limitation to the effective use of the physical and hydraulic property databases by the broader group of potential users involved in Hanford waste site issues. In order to make these data more widely available and useable, a decision was made to port them to HEIS and to make them web-accessible via a Virtual Library module.

In FY08 the original objectives of this activity on the RDS project were to: (1) ensure traceability and defensibility of all physical and hydraulic property data currently residing in the SoilVision® database maintained by PNNL, (2) transfer the physical and hydraulic property data from the Microsoft Access database files used by SoilVision® into HEIS, which is currently being maintained by CHRPC, (3) develop a Virtual Library module for accessing these data from HEIS, and (4) write a User's Manual for the Virtual Library module. The intent of these activities is to make the available physical and hydraulic property data more readily accessible and useable by technical staff and operable unit managers involved in waste site assessments and remedial action decisions for Hanford.

In FY08 communications were established between PNNL and staff from Fluor-Hanford Co. (who formerly managed HEIS) to outline the design of a Virtual Library module that could be used to access the physical and hydraulic property data that are to be transferred into HEIS. Data dictionaries used by SoilVision® were also provided to Fluor-Hanford personnel (who are now with CHPRC). During ongoing work to ensure traceability and defensibility of all physical and hydraulic property data that currently reside in the SoilVision® database, it was recognized that further work would be required in this effort before the data were actually ported into HEIS. Therefore work on the Virtual Library module development and an accompanying User's Guide was deferred until an unspecified later date.

In FY09 efforts have continued to verify the traceability and defensibility of the physical and hydraulic property datasets that are currently being maintained by PNNL. Although this is a work in progress, several of these datasets should be ready for transfer to HEIS in the very near future. This document outlines a plan for the migration of these datasets into HEIS.

[1] A Web-based graphical user interface that allows querying of HEIS databases, plotting, and data export.

Acknowledgments

The Hanford Vadose Zone Physical and Hydraulic Properties Database development was initiated by Gene Freeman (formerly with PNNL) and George Last (PNNL), who compiled historical data sets generated by various site contractors into a series of Excel spreadsheets. This work was continued by Andy Ward (PNNL) and Jason Keller (formerly with PNNL) who were responsible for generating some of the more recent data, and for porting historic data as well as some of the more recent data into SoilVision®. Data entry into SoilVision® has been performed by various PNNL staff and summer students.

Acronyms and Abbreviations

CHPRC	CH2M-Hill Plateau Remediation Company
HEIS	Hanford Environmental Information System

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1.0 Introduction

Over the more than 60 years of Hanford Site operations significant efforts have been made to measure the physical properties of sediments underlying the Hanford Site, such as grain-size distributions, bulk and particle densities, and porosities. During the past 30 years or so that effort has grown to include the measurement of hydraulic properties, which include saturated hydraulic conductivities, relative permeabilities for different fluid phases, and pressure-saturation data. Much of this effort is driven by the need to accurately estimate contaminant transport in the subsurface for the purpose of remedial investigations and site assessments.

Physical and hydraulic properties are fundamental data for any type of quantitative analysis of contaminant transport and fate in the subsurface, including evaluation of risk associated with natural attenuation (no-action) or engineered remedial action alternatives at waste sites (e.g. biostimulation or In-Situ Redox Manipulation [ISRM] for chromium reduction, emplacement of surface infiltration barriers and soil dessication to minimize transport of technetium and other radionuclides, soil-vapor extraction for carbon tetrachloride removal, etc.). Therefore the Physical and Hydraulic Property Database and Interpretation activity of the RDS Project directly supports DOE's mission at the Hanford Site.

The efforts made to generate physical and hydraulic property data for Hanford sediments have resulted in the compilation of numerous data sets acquired by different contractors and individuals using different measurement methods, with data processing by different software, and with files stored in different locations. In order to more efficiently use the existing data, and to help reduce duplication of efforts, a process was initiated to compile into a single location the various Hanford sediment physical and hydraulic property datasets. A part of this effort is the transformation of the datasets into a form that allows the data to be presented and used in a consistent manner.

This document describes ongoing efforts to ensure traceability of these datasets and a plan for transfer of selected datasets to HEIS. This data transfer will be performed with guidance from the CHPRC Environmental Data Manager.

2.0 Physical and Hydraulic Properties Database

An overview of the database, its history of development, and a preliminary Virtual Library module development plan was presented by Rockhold (2008). The physical and hydraulic property data are currently managed using SoilVision® (http://www.soilvision.com/), a commercial geotechnical software package designed for storing and analyzing soils data. SoilVision® uses Microsoft Access database (*.mdb) files that allow for many different types of geotechnical data to be stored and cross-referenced, including physical (e.g. grain-size distribution data, bulk and particle density, porosity, etc.) and hydraulic properties (e.g. saturated hydraulic conductivity, water retention characteristics, relative permeability, etc.). These data and parameters derived from them are of great interest for vadose zone and groundwater modeling and risk assessment.

These data have generally been collected on a site-by-site or project-by-project basis. Figure 2.1 lists some of the sites or projects that are currently represented in the SoilVision® database files. The sites represented include the 300 Area (Schalla_1997_D.mdb), BC Cribs and Trenches (SVSoils_BCCrib_D.mdb), the ILAW site (SVSoils_ILAW_D.mdb), the Sisson & Lu Site (SVSoils_S&L_D.mdb), a clastic dike study site (SVSoils_VZTFFY03_D.mdb), and a compilation of data generated by the Westinghouse-Hanford Co. Geotechnical Engineering Lab (SVSoils_Freeman_D.mdb). The data in Schalla_1997_D.mdb represent data reported by Schalla et al. (1988), collected more than 20 years ago, that were previously available only in hardcopy. These and other historical data were entered by hand into Excel spreadsheets and/or into SoilVision®. The datasets also include grain-size distribution data for over 30,000 sediment samples collected during well drilling at Hanford from the historical ROCSAN[2] database (SV_Rocsan_1997_D.mdb), which are already accessible via the Virtual Library.

[2] Inclusion of *ROCSAN* data into SoilVision® was made to facilitate estimation of grain-size distribution metrics, such as the median diameter, d_{50}, that can be used for estimating other properties (Guber et al. 2006). Since this dataset is already available via the Virtual Library, these data and parameters derived from them will not be included in the initial database migration effort described herein.

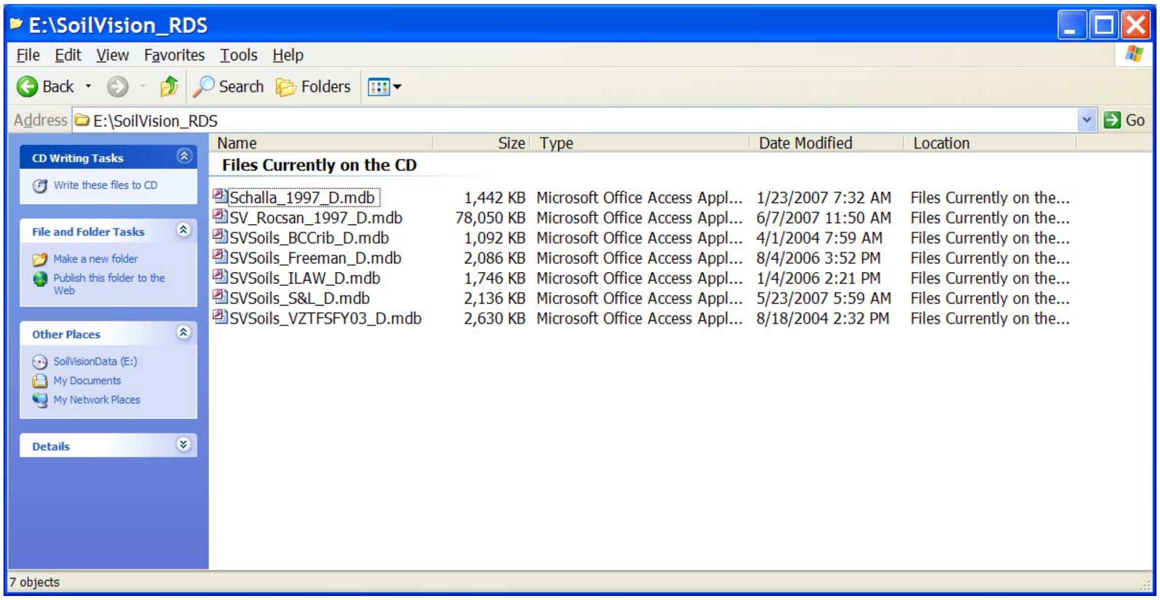

Figure 2.1. Hanford Site-Specific Soilvision® Databases

The database files shown in Figure 2.1 are currently static, but other similar database files are being actively developed on other projects for other sites at Hanford. These files are not under any formal configuration management at this time. Hence these database files should be considered informal. When these data or selected subsets are transferred into HEIS and made accessible via the Virtual Library, they will become "official" and will be placed under formal configuration management and control.

Additional data on physical and hydraulic properties for Hanford sediments are expected to be developed over time for different projects in support of various research activities and site-specific remedial investigations. A long-term strategic plan for continued improvement and updating of the physical and hydraulic properties database will be presented in a later report.

3.0 Data Traceability

As noted by Rockhold (2008), during FY08 it was determined that some of the *.mdb files depicted in Figure 2.1 did not have sufficient so-called “metadata” associated with them to allow for cross-checking of data entries with published documents, laboratory record books, and/or to spreadsheets from which the data were originally transferred. Therefore a process was initiated in FY08 to identify and to obtain the original data sources and to compare selected subsets of data in the *.mdb files to the data in the original data sources in order to establish their traceability and to verify consistency. Table 4.1 shows one example of the data cross-checking and verification process that is being performed. For the case shown in Table 4.1, most of the apparent discrepancies appear to be due to differences in the number of significant figures and/or to the units that have been used in SoilVision® versus the units that were used when the data were originally reported (μm versus mm).

Our intent is to initially transfer a smaller subset of the data that are currently in the SoilVision® database into HEIS, and to have these data made available via the Virtual Library. The data transferred to HEIS will be expanded over time as traceability checks are continued and the data are verified against the original data sources. New physical and hydraulic property data will also be added as more high-quality, well-documented, and fully traceable data are generated on other projects.

We intend to begin the process of data transfer to HEIS using the dataset contained in the file SVSoils_S&L_D.mdb. This dataset contains physical and hydraulic property data generated by the U.S. Salinity Laboratory in Riverside, California for samples from the so-called Sisson and Lu site, located in the 200 East Area of Hanford (Schaap et al. 2003). A progress report outlining the development and a completion schedule for migrating data to HEIS will be submitted to CHPRC in June 2009.

4.0 HEIS Database Migration Requirements

Environmental data currently contained in HEIS include chemical analysis data for water and sediment samples, grain-size distribution data, and various other types of data such as water levels in monitoring wells, 300 Area river stage elevations, etc. HEIS data are web-accessible via the Virtual Library for anyone who has access to the Hanford Local Area Network.

Table 4.1 shows an example of cross-checking of data entries in file SVSoils_S&L_D.mdb with data in Appendix A of Schaap et al. (2003). For this example, most of the apparent discrepancies are due to round-off, the number of significant digits, and/or units (mm versus µm) that were used when the data were entered into SoilVision® relative to what was used when the data were originally reported.

Table 4.1. Example of Cross-Checking of Data Entries

Ring ID # 1	Liner field designation S1-24		SoilVision counter # 144461313			
Sieve_No	graeParticle_Diameter (mm)	graePercent_Passing	Particle Size (µm)	% Passing	Size Match?	% Passing Match?
# 4	4.75	1			N-NO DATA	N-NO DATA
# 10	2	0.9564	2000	95.64	Y	Y
# 14	1.4	0.9246	1400	92.46	Y	Y
# 18	1	0.8896	1000	88.96	Y	Y
# 25	0.71	0.7895	700	78.95	N	Y
# 35	0.5	0.6438	500	64.38	Y	Y
# 45	0.355	0.4798	355	47.98	Y	Y
# 60	0.25	0.3801	250	38.01	Y	Y
# 80	0.18	0.3336	180	33.36	Y	Y
# 100	0.15	0.3103	147	31.03	ROUNDED	Y
# 140	0.106	0.2699	105	26.99	N	Y
# 170	0.09	0.2555	90	25.55	Y	Y
	grahParticle_Diameter	grahPercent_Passing				
	0.052	0.15	52.4	15	ROUNDED	Y
	0.043	0.125	43.01	12.5	ROUNDED	Y
	0.031	0.1	30.57	10	ROUNDED	Y
	0.022	0.075	21.73	7.5	ROUNDED	Y
	0.01	0.05	10.3	5	ROUNDED	Y
	0.004	0.05	4.26	5	ROUNDED	Y
	0.003	0.0375	2.66	3.75	ROUNDED	Y
	0.001	0.0375	1.41	3.75	ROUNDED	Y

HEIS data are organized in tables by sample number and results. Each sample is given a unique identification number from which different types of analytical results for a given sample can be cross-referenced. For routine sample collection activities that have been or will be performed by the site remediation contractor, HEIS numbers are prepared as part of the planning process and are assigned from an auto-generated list. For other projects, such as research projects performed by PNNL for the DOE-Office of Science, data may or may not have been incorporated into HEIS, depending on project objectives. Therefore research results exist for many samples, including physical and hydraulic properties that are not in HEIS. Before any of these sample results can be included in HEIS, sample numbers must be assigned and a minimum set of data requirements must be specified before the results can be loaded. The following information on the *minimum* data requirements needed to transfer data to HEIS was provided by JoAnne Rieger (CHPRC, March 27, 2009). This information will be developed for all samples with physical and hydraulic property data that are to be transferred into HEIS.

Table 4.2. Required Columns for Each Sample Media before Status can be Set to 'U' (Used), Permitting Analytical Result Records to be Loaded into HEIS

Note: Specific requirements for soil samples are highlighted in red.

MEDIA / COLUMN	AT	BI	ER	GPL	GW	MM	QC	SG	SO	SW	WS	WW
BIOTA_MEDIA	<null>	X	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
COLLECTION_PURPOSE	X^3	X^3	X^3	X^4	X^3	X^3		X^3	X^3	X^3	X	X
FIELD_QC_TYPE	<null>	<null>	<null>	<null>	<null>	<null>	X	<null>	<null>	<null>	<null>	<null>
FILTERED_FLAG	<null>	2	<null>	<null>	X	2		<null>	<null>	X	<null>	X
MEDIA	X	X	X	X	X	X	X	X	X	X	X	X
OWNER_ID	X	X	X	X	X	X	X	X	X	X	X	X
SAMP_DATE_TIME	X	X	X	X	X	X	X	X	X	X	X	X
SAMP_FROM		X	<null>	<null>		X	<null>	<null>		X	X	X
SAMP_INTERVAL_BOTTOM				X								
SAMP_ITEM	X	X	<null>	<null>	<null>	X	<null>	<null>			X	X
SAMP_MTHD				X			<null>					
SAMP_NUM	X	X	X	X	X	X	X	X	X	X	X	X
SAMP_SITE_ID	X	X	X	<null>	<null>	X^1		X^1	X^1	X	X	X
TOTAL_COUNTS	<null>	<null>	<null>	X	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
WATER_PRESENT	<null>	<null>	<null>	X	<null>	<null>	<null>	<null>	<null>	<null>	<null>	<null>
WELL_NAME	<null>	<null>	<null>	X	X	X^1		X^1	X^1	<null>	<null>	<null>

LEGEND:

X = The field must have a valid value.

<null> = The field must be null.

1 = SAMP_SITE_ID OR WELL_NAME, but not both.

2 = FILTERED_FLAG may be specified if Sample MATRIX is "WATER" or "OTHER LIQUID"

3 = SAMP_INTERVAL_BOTTOM (and units) required if COLLECTION_PURPOSE is "Vertical Profile".

4 = COLLECTION_PURPOSE is always "VP"

Empty = The field may have a validated value, but a value is not required.

Media/Column abbreviations are as follows: AT = atmospheric (air monitoring), BI = biota, ER = external radiation, GPL = geophysical logging, GW = ground-water, MM = miscellaneous material, QC = quality control (field), SG = soil gas, SO = soil, SW = surface water, WS = waste solid, WW = waste water

4.1 Data Requirements

In most cases, for physical and hydraulic property data, the appropriate COLLECTION_PURPOSE to use would be VP (Vertical Profile). A definition of that collection purpose is given below. As noted in the legend, SAMP_INTERVAL_BOTTOM and units will also be required for this COLLECTION_PURPOSE; SAMP_INTERVAL_TOP is not required but you can provide it if you want it in the database.

4.1.1 COLLECTION_PURPOSE

A code that identifies the primary reason the sample was collected. Valid values for this code are:

Code	Translation
C	Characterization
IH	Industrial Hygiene
IP	In Process
PE	Performance Evaluation
R	Routine (i.e., repetitive)
RC	Radiological Control
S	Special Studies
T	Transportation
TS	Time Series - To be used for time series sampling where the well is pumped for a long period of time and samples are collected at different times to see how the chemistry is changing.
VAR	Variance (Remediation)
VER	Verification (Remediation)
VP	Vertical Profile - To be used for samples collected at different depths in a well or at depths in the aquifer different from the depth of the completed well (e.g., samples collected during well drilling or abandonment). Examples include: • Samples collected during well drilling. • Samples collected using a multi-level sampling device.
WM	Waste Management

Entries into this field are validated against codes in the HEIS VALID_CODES table where the VALID_FIELD_NAME is 'COLLECTION_PURPOSE'.

4.1.2 SAMP_INTERVAL_BOTTOM

Normally the vertical distance from the land surface to the bottom of the sample, but in the case of sloping or spiraling boreholes this is the distance measured along the path of the hole. If the SAMP_INTERVAL_BOTTOM is not null then valid units must be entered into the SAMP_INTERVAL_UNITS column. If only one sample interval is provided then it is stored in the SAMP_INTERVAL_BOTTOM, and the SAMP_INTERVAL_TOP field is left empty.

4.1.3 SAMP_INTERVAL_TOP

Normally the vertical distance from the land surface to the top of the sample, but in the case of sloping or spiraling boreholes this is the distance measured along the path of the hole. If the SAMP_INTERVAL_TOP is not null then the SAMP_INTERVAL_BOTTOM cannot be null and valid units of length (distance) must be entered into the SAMP_INTERVAL_UNITS column.

4.1.4 SAMP_INTERVAL_UNITS

The units of length used to measure the SAMP_INTERVAL_TOP and SAMP_INTERVAL_BOTTOM. If the sample interval bottom is specified then the SAMP_INTERVAL_UNITS field must contain a valid code. The units codes are stored in the HEIS VALID_CODES table where the VALID_FIELD_NAME is 'DISTANCE_UNITS'. These codes are defined as:

Code	Translation
cm	Centimeter
ft	Foot
in	Inch
m	Meter

Sample top and bottom intervals with any of these units of length are standardized to meters in the STD_SAMP_INTV_TOP, STD_SAMP_INTV_BOT, and STD_SAMP_INTV_UNITS fields, described below.

4.1.5 MEDIA

The media for all sediment samples will be SO (soil). The MEDIA code categorizes samples into logical types. These codes and their translations are:

Code	Translation
AT	Atmospheric (Air Monitoring)
BI	Biota
ER	External Radiation
GPL	Geophysical Logging
GW	Ground-water
MM	Miscellaneous Material
QC	Quality Control (Field)
SG	Soil Gas
SO	Soil
SW	Surface Water
WS	Waste Solid
WW	Waste Water

Entries into this field are validated against codes in the HEIS VALID_CODES table where the VALID_FIELD_NAME is 'MEDIA'.

4.1.6 OWNER_ID

The OWNER_ID for sample data provided by PNNL will be PNLWELL. The OWNER_ID field identifies the Hanford contractor that owns the sample record and is responsible for the sample and its attributes. It is used to control the modification/deletion of sample records and the insertion/modification/deletion of their analytical result records. The database administrator controls user privileges to sample records based on the OWNER_ID of the sample records.

Valid OWNER_ID codes are validated against codes in the VALID_CODES table where the VALID_FIELD_NAME is 'OWNER_ID'. These codes and their translations are:

OWNER_ID	Contractor/Project
CENTPLAT	Central Plateau Remediation Project Company (CHPRC)
FHAS	Fluor Hanford Analytical Services
HEISPROD	River Corridor Contractor (Washington Closure Hanford)
LPCS	Liquid Processing and Capsule Storage (Fluor Hanford)
PNLGW	PNNL Groundwater
PNLWELL	PNNL Lithology
SESPMNT	SESP Maintenance (PNNL)
SESPSPEC	SESP Special Analysis (PNNL)
TFVADZNP	Tank Farm Vadose Zone Project
TRANSWMH	Samples records from the Liquid Effluent Monitoring Information System (LEMIS) database.

4.1.7 SAMP_DATE_TIME

The date and local time that the sample was collected. This field is also used for the ending sample date/time if a SAMP_DATE_TIME_ON is specified.

4.1.8 SAMP_NUM

Each sample must have a SAMP_NUM. These are auto-generated from HEIS, after the number of samples in a given batch that to be loaded is provided to CHPRC staff in charge of loading data into HEIS. The SAMP_NUM is comprised of uppercase letters and numbers and may be generated by a HEIS algorithm or specified by the project that is responsible for the sample. HEIS-generated sample numbers are six characters in length, begin with a consonant, end with a number (0 - 9), and disallow "A", "E", "I", "O", "U", "G", "Q", "S", and "Z".

4.1.9 WELL_NAME

All samples must have either a SAMP_SITE_ID or a WELL_NAME, but NOT both. Samples from boreholes associated with wells must also have a WELL_NAME. WELL_ID is acceptable, even preferred; CHPRC staff responsible for loading data into HEIS can translate it to a WELL_NAME.

A WELL_NAME is the name of the well or borehole from which the sample was collected. This field is appropriate for samples with media values of 'GW', 'SO', and 'MM'. Entries into this field are validated with WELL_NAMEs in the Well table.

5.0 Discussion

The previous section outlines the requirements needed for migration of physical and hydraulic property data from the Microsoft Access database (*.mdb) files used by SoilVision® into HEIS. Discussions were initiated in FY08 with Fluor-Hanford Co. staff on how these data would be reformatted into HEIS-compatible tables. This will likely involve the development of a “loader” program that directly accesses the *.mdb files, and that adds any additional required data fields. In previous discussions, it was decided that this data loader program would be developed by a third party under subcontract to Fluor-Hanford. Now that the HEIS maintenance contract resides with CHPRC, this data loading issue will have to be revisited. Therefore some of the details regarding the specific mechanisms by which these data will actually be transferred into HEIS still need to be resolved. These issues will be taken up and resolved with the CHPRC Environmental Data Manager in the coming months.

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