

GIS APPLICATION USERS MANUAL
WYOMING SOURCE WATER PROTECTION PROJECT
REQUIRED SOFTWARE:
ESRI ARCGIS ARCVIEW 9.0

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Project #: 424-001

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1.0 INTRODUCTION

The Wyoming Department of Environmental Quality (DEQ) contracted and worked closely with Trihydro Corporation (Trihydro) and Lidstone and Associates, Inc. (Lidstone) to complete source water assessments for 389 public water supplies (PWSs)¹. Trihydro and Lidstone were selected because of their geologic experience, Geographic Information System (GIS) expertise, and their knowledge of many PWSs in Wyoming. PWS delineations were completed by the firm most familiar with the geology/hydrology of the area.

Water system susceptibility is related to three factors which were evaluated as part of this source water assessment. The first was the physical integrity of the well, intake, and conveyances. The second was the sensitivity of the land area through which potential contaminants may reach the well or intake, including the geologic, hydrologic, and land cover characteristics of the watershed, well location, or aquifer source area. The third was the nature of the potential contaminants. Potential contaminants include specific point sources and any land uses that may contribute contaminants to the water supply. For point sources, the type of potential contaminants, the location of the contaminant sources relative to the well or intake, and confirmation of a contaminant release were also considered.

Data used to quantitatively evaluate the susceptibility of each water source to potential contaminants were acquired from sources readily available for PWSs in Wyoming. The delineated source water areas, DEQ contaminant inventories, 1:500,000-scale land use maps compiled by the University of Wyoming, US Environmental Protection Agency (EPA) sanitary surveys, EPA's Safe Drinking Water Information System database, and DEQ and Wyoming State Engineer's Office (SEO) well or intake permits were used to determine the susceptibility of each PWS.

The project results included 389 individual PWS Susceptibility and a custom ArcGIS-based custom GIS application. The GIS application was developed within ArcView v9.0 and customized utilizing Visual Basic for Applications (VBA) programming. Additionally Crystal Reports v10 was utilized to create the individual susceptibility reports. The specific purpose of the application was to allow a user to add or update PWS well or intake information and then easily produce a final susceptibility report for the PWS. While Trihydro project staff were the initial users of the application while finalizing the project's 389 PWS reports, future users will include any individual or entity that wishes to update a previous report or develop a new one.

This user's manual was created to help a potential SWAP user create Source Water Assessment Reports for newly signed-up systems, as well as make modifications to existing systems. This manual contains instructions on adding or changing existing PWSs, as well as re-scoring the system to produce the susceptibility reports. The GIS application

¹ A complete discussion of this project and its results can be found in Trihydro's final project report to DEQ.

functionality is described along with instructions on using each tool to step through the susceptibility scoring process. This document does not include any information about creating source water delineations for new or modified PWSs. It is assumed that for new or modified systems, appropriate delineations will be provided to the Source Water Assessment and Protection (SWAP) program by the PWS or a qualified consultant.



2.0 DATA AND SYSTEM STRUCTURE

There are several components of the SWAP GIS application that require digital files to be stored in a specific location and structure in order to function properly through the susceptibility scoring process. The Microsoft Access database (**SWAP.mdb**) has been designed to hold the information for each PWS and well/intake. This data is used in the modeling process, as well as the scoring process. The GIS source water delineation files also require a specific structure. A **Delineations** directory stores PWS source water delineations, which are organized by PWS identification number. Each PWS has its own directory. Within a specific PWS directory, the next level of directories is organized by type such as **Groundwater**, **Surface Water**, **CFR**, and **GeoMapping**. Each of these directories holds delineation GIS shapefiles² defined in Lat/Long (Geographic NAD83) coordinates. Any changes or additions to this structure should mirror the data stored for previously completed delineations. The ArcView-based GIS application uses the **SWAP.mdb** database to store information and to hold the final scoring data. The GIS also uses the delineations to calculate the score by spatially joining it to the **Land Use**, **PSOC – points**, and **PSOC – lines** layers. Any changes made to this data structure should be made with care and with appropriate backups.

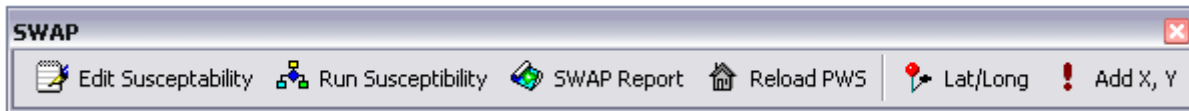
² Shapefile format is one of the native file formats of ArcGIS. A shapefile actually consists of 3-6 separate files (ex: *.shp, *.dbf, *.shx) that share a common prefix.

3.0 CUSTOM GIS APPLICATION

Final project deliverables include a customized ArcView-based GIS application to run the susceptibility score for each well and intake. This tool also produces and prints the final susceptibility reports and maps. To do this, Trihydro chose ESRI's ArcView 9.0 as the GIS software and created a set of custom tools for the DEQ. Additionally Crystal Reports v10 was utilized to create the final PWS reports.

The customized toolbar within the SWAP ArcView 9.0 application contains six customized tools specific for the SWAP project. These tools are designed to complete the editing and scoring of susceptibility data for each well or intake. Additionally, a report dialog has been developed for producing complete susceptibility reports, susceptibility summary reports, and well/intake information sheets. The fourth option from the reporting dialog will set up PWS maps for printing/plotting.

The toolbar shown below is the **SWAP Susceptibility** toolbar created within ArcView. Each tool is explained in detail in the following text. This toolbar is only available in the **SWAP.mxd** application. In conjunction with the toolbar, an initialize (*.ini) file is included in the same directory at the **SWAP.mxd** application. Always named the same prefix as its reference ArcView application (**SWAP.ini** in this case), this INI file contains information such as database paths and layout parameters. In the event that any of the data sources are renamed or moved to a different computer, a user may need to edit this INI file using a standard text editor.



APPLICATION OPENING:

Every time the **SWAP.mxd** application is opened, it connects to the project database (**SWAP.mdb** in this case) and creates a layer showing the PWS systems and locations.

3.1 ADDING OR MODIFYING PWS INFRASTRUCTURE

Adding information to the SWAP application should be done with great care. It is strongly recommended that before any data is modified that a complete project backup be performed.

3.1.1 SETTING UP A NEW PWS

This section details instructions to set up a new PWS for source water analysis. Two steps are required prior to susceptibility scoring. The first is entering the specific well and intake data into the **SWAP.mdb** database. The second is to import delineation and sanitary survey data into the GIS structure.

1. *In the Database:* Add the new record to the [**tblPWS Systems**] table in the **SWAP.mdb** database. Fill in the ID, PWS name, and other information available. ** If the PWS already exists in the table, proceed to Step 2.
2. *In the Database:* Add a new record for each well to the [**tblWells**] data. Required information includes *PWS Id*, *Well Id*, *latitude*, and *longitude*. These fields are necessary for the final susceptibility scoring to function properly. Fill in the columns with available data and groundwater modeling information for each well.
3. *GIS:* Place the Zone 1, 2, and 3 shapefiles from the delineation model into the appropriate directory under the **Delineations** directory. View the folder structure for other systems to ensure the names are correct on all directories and shapefiles. **The GIS assumes that input shapefiles are in Geographic NAD83 coordinates.
4. *GIS:* Open up the **SWAP.mxd** GIS project.
5. *GIS:* Use the **Edit Susceptibility** form to enter the sanitary survey information into the database. This will prepare the well for scoring. These tools are described further in the Susceptibility Scoring section of this document.
6. *GIS:* Run the **Scoring Susceptibility** form for each of the new wells.
7. *GIS:* Run the **SWAP Report** function to see the scoring results.

3.1.2 MODIFYING AN EXISTING PWS AND/OR WELL

Database: Update the record for each PWS that needs to be changed in the [**tblPWS Systems**] table in the **SWAP.mdb** database.

1. *Database:* Update the record for each well that needs to be changed in the [**tblWells**] table in the **SWAP.mdb** database.
2. *GIS:* If the delineations have changed, update the Zone 1, 2, or 3 in the appropriate **Delineations** directory. If no changes have been made to the delineations, proceed to the next step.
3. *GIS:* Open up the **SWAP.mxd** GIS project.



4. *GIS*: Use the **Edit Susceptibility** form to change any sanitary survey information in the database. This will prepare the well for scoring.
5. *GIS*: Run the **Scoring Susceptibility** form for each of the wells or intakes that had a data change.
6. *GIS*: Run the **SWAP Report** function to see the scoring results.

3.2 SUSCEPTIBILITY SCORING

3.2.1 EDITING EXISTING SCORING DATA

The [**Edit Susceptibility**] button will open the **Edit Susceptibility** form, which is shown below. This form is used in the entering and/or the editing of Sanitary Survey information for each well/intake.

3.3 PSOC LAYERS

3.3.1 MODIFYING PSOC LAYERS

PSOC features can be added, updated, or removed from the three PSOC layers by any competent GIS professional familiar with ArcView. No customized tools have been created to aid in this process however. Features are currently divided into separate GIS layers based on geometry (points, lines, and polygons). Great care should be taken to examine and understand the data structure and metadata before making any modifications. The custom GIS application's reporting tools expect this very specific data format and may fail if the [PSOC_NAME], [RELEASE], and [CONTRISK] fields are not fully and correctly populated. It is strongly recommended that before modifying any layers, backups be created.



Susceptibility Score

Select the Public Water Source: **6th Crossing Ranch RV Park & CG -- 5601487** Sort Order: **By Name**

Select the well to edit: **RANCH PRIM CAMP HANDPUMP WELL -- 5601487-102**

Well Source Sensitivity Score

Groundwater - Well Well Depth (ft) Bottom WBZ

1) Well is located in a(n): **UNCONFINED AQUIFER** **78** **78**

2) Confirmed Chemical Contaminant Detection: **YES**

Surface Water - Intake

1) Assume High Sensitivity for all surface water sources: **Score 5**

2) Confirmed Chemical Contaminant Detection:

Source Integrity Score

Groundwater - Well Integrity Date Completed: (MM/DD/YYYY)

Well Completion Date: **AFTER 1993** **5/11/2001**

Surface Seal Present? **YES** Annular Seal Present? **NO/UNKNOWN**

Wellhead Protected? **UNPROTECTED** Conveyance Structure Length? **SHORT**

Well Protected from Flooding? **YES** Risk of Conveyance Struct Damage? **LOW**

Surface Water - Intake Date Completed: (MM/DD/YYYY)

Intake Completion Date:

Intake Screened? Convey Struct Length?

Intake Inspected regularly? Risk of Convey Struct Damage?

Around Intake Restricted? Convey Open or Closed?

Close **Update**

* The Edit Susceptibility form has the **[Update]** button

1. Open the form.
2. Select the Public Water System in the PWS dropdown box. This dropdown box is sorted by PWS name. In order to resort by number, select **<By Number>** in the Sort Order dropdown box.
3. Select the well to edit from the Well dropdown box. This will load the form up with the well's information. If the dropdown/text boxes are empty, then there was no information entered for the well.
4. Use the dropdowns or text boxes to enter the sanitary survey information. The information in the dropdown boxes is very specific to the scoring process. The *Select the Well to Edit* input box on the form is automatically filled in with information from the SDWIS table located in the SWAP.mdb database.
5. After entering the information, click the **[Update]** button. This will write the data to the database.

NOTES: **If the **[Update]** button is not clicked, the data will NOT be saved to the database.

**If no data is entered in the dropdown boxes, the program will default to the highest possible scoring value.

3.3.2 TO RUN THE SUSCEPTIBILITY SCORE

In order to run the susceptibility scoring on a well or intake, the sanitary survey information must be entered into the database using the **Edit Susceptibility** form. Only after information is entered can the scoring process be run for each well/intake. The process behind the scoring application is included in the final SWAP report and in each PWS susceptibility report. Depending on the size of the delineations, the scoring process can take up to 10 minutes. This form will shut down after the scoring is complete.

Susceptibility Score ✖

Select the Public Water Source: Sort Order:

Select the well to edit:

Well Source Sensitivity Score

Groundwater - Well Well Depth (ft) Bottom WBZ

1) Well is located in a(n):

2) Confirmed Chemical Contaminant Detection:

Surface Water - Intake

1) Assume High Sensitivity for all surface water sources: Score 5

2) Confirmed Chemical Contaminant Detection:

Source Integrity Score

Groundwater - Well Integrity

Well Completion Date:

Surface Seal Present? Annular Seal Present?

Wellhead Protected? Conveyance Structure Length?

Well Protected from Flooding? Risk of Conveyance Struct Damage?

Surface Water - Intake

Intake Completion Date: Run Zone 3 Scoring

Intake Screened? Convey Struct Length?

Intake Inspected regularly? Risk of Convey Struct Damage?

Around Intake Restricted? Convey Open or Closed?

* The Run Susceptibility form has the **[Run Scoring]** button

1. Open the form by clicking on the [**Run Susceptibility**] button.
2. Select the Public Water System in the PWS dropdown box. This dropdown box is sorted by PWS name. In order to resort by number, select <**By Number**> in the Sort Order dropdown box.
3. Select the well to edit from the Well dropdown box. This will load the form up with the well's information. If the dropdown/text boxes are empty, then there was no information entered for the well.
4. Click the [**Run Scoring**] button to start the process.

NOTES ** To run Surface Water Zone 3, click on the <**Run Zone 3 Scoring**> checkbox. By default, only PSOCs within Zone 1 and Zone 2 will be scored on surface water delineations. Due to the large area that can be covered by the large surface water zone 3s, the process will capture many PSOCs that are not relevant to the scoring intake, as well as unnecessarily increasing computational processing time. The <**Run Zone 3 Scoring**> option is available specifically for the smaller surface water zone 3s. In the final project susceptibility reports, the project team scored the zone 3 delineations for all springs.

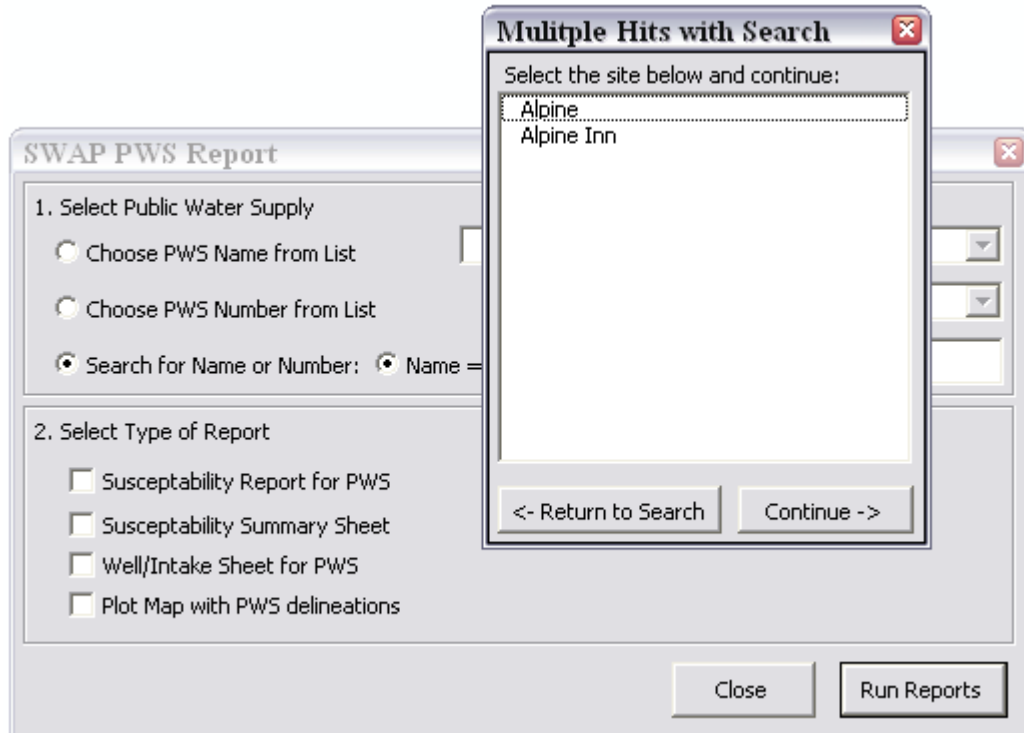
3.4 CREATING SOURCE WATER ASSESSMENT REPORTS

Four reports can be produced using the SWAP Report custom tool in the ArcView application. The user can produce the following reports: **Susceptibility Report**, a shorter **Susceptibility Summary Report**, full **Well/Intake Information Sheets**, and plot **Delineation Maps** for a PWS. Prior to running the reports, the scoring must be complete in order to produce the scoring tables. Prior to producing maps with this dialog, the delineations must be created and stored in the folder. The report dialog box is shown below. It has two dropdown boxes to easily provide access to any individual PWS. A search function is also included, which allows a user to search either by PWS name or number. Instructions are included below for running the reports.

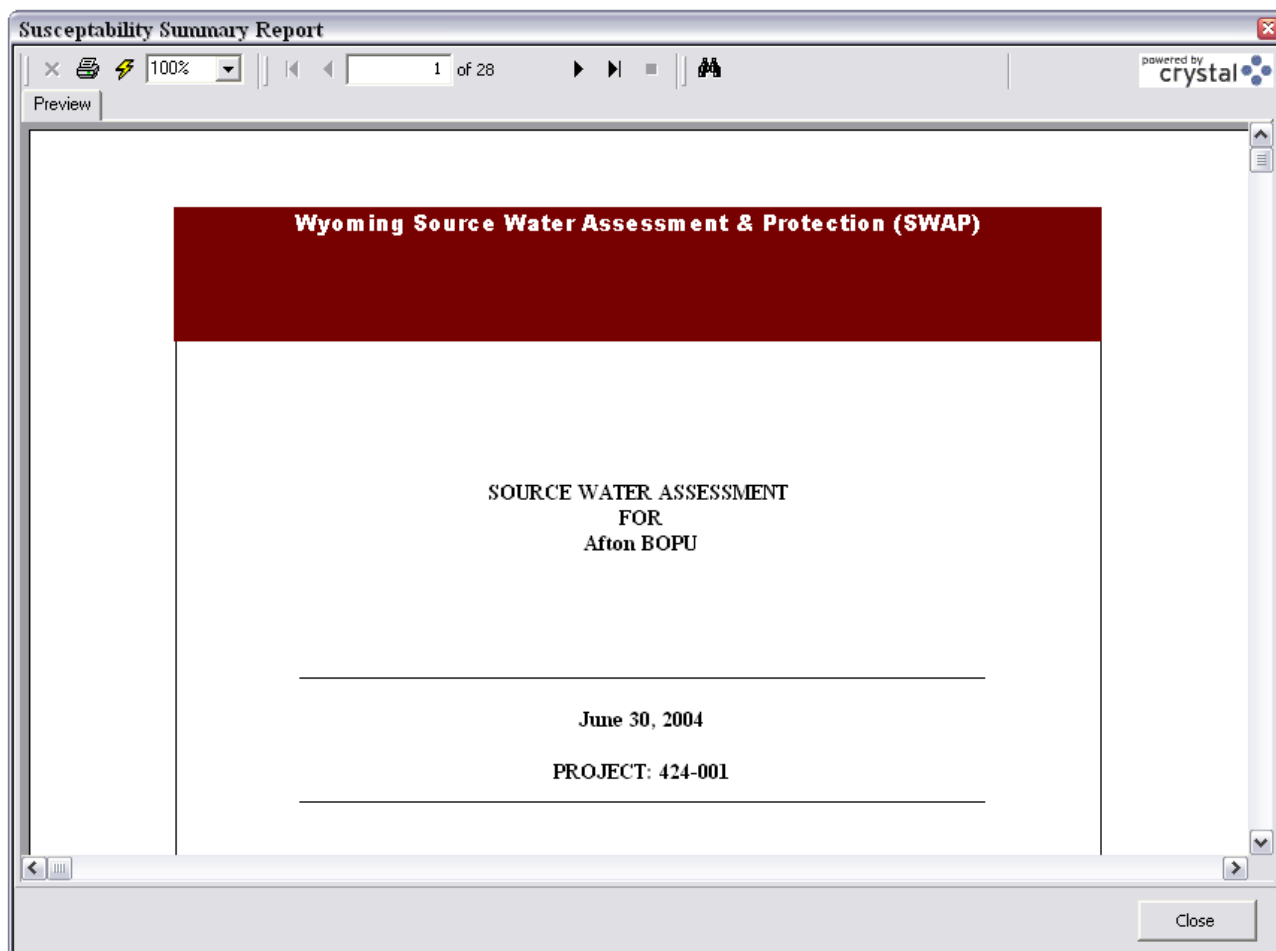
3.4.1 PRODUCING REPORTS

The following section details how to create the following reports:

- Susceptibility report
 - Susceptibility summary report
 - Well/intake information sheets
1. Open the SWAP report dialog box by clicking on the [SWAP Report] button.
 2. Select a PWS from the first dropdown to select by name. Use the second dropdown box to select a PWS by number.
 - a. To use the search option, first select the <Search for Name or Number> option, and then choose to search by either <Name> or <Number>. Next, enter the text or number for the search.
 - b. If one PWS is selected by the search criteria, it will automatically use that PWS. However, if there are multiple results, the Multiple Hits with Search dialog will appear.
 - c. If multiple results are retrieved, choose the correct PWS system and click <Continue>. If the correct results were not retrieved, click [Return to Search] to return to the SWAP Report dialog.



1. Select one or more of the report types by clicking on the checkbox next to the report type. At least one report type must be chosen before continuing.
2. Click [**Run Reports**] button to run the reports. An example of the report dialog box is below.
3. From the **SWAP PWS Report** dialog box, a report can be viewed and/or printed.
4. Close the Report dialog box by clicking on the [**Close**] button. This will allow the program to run the next report selected.

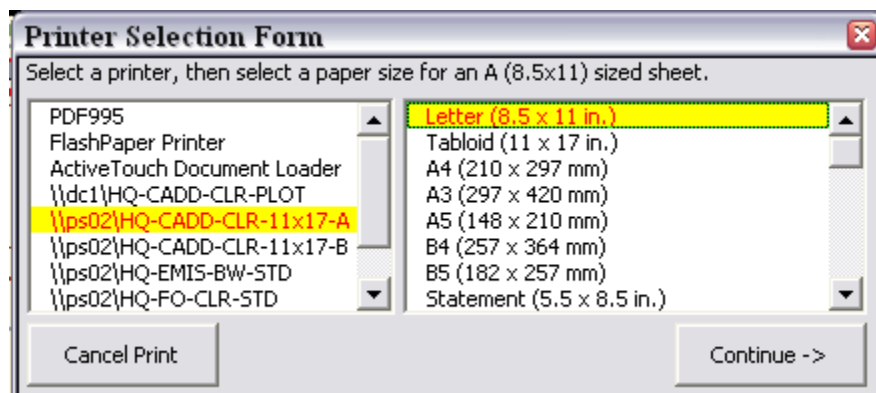


3.4.2 DELINEATION MAPS:

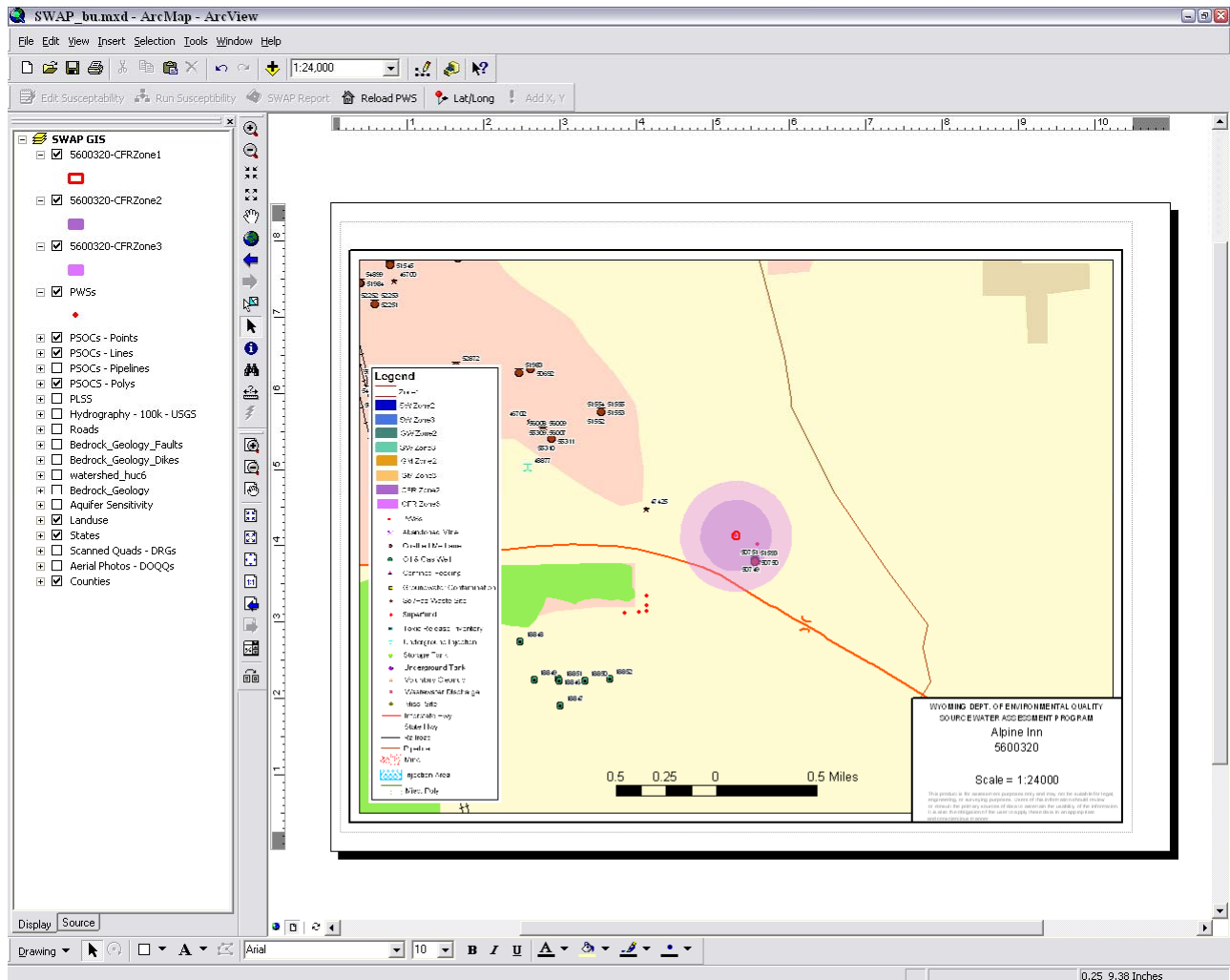
The fourth report option is to **<Plot PWS with Delineation>**. This option will create and format the map layout for the user, including the loading of the appropriate delineations. Before the mapping option can format the layout, the user must choose the appropriate printer for the map. The Printer Dialog box shows all available printers and paper sizes for the individual printers available on the local computer.

1. Open the SWAP report dialog box by clicking on the **[SWAP Report]** button.
2. Select a PWS from the first dropdown to select by name. Use the second dropdown box to select a PWS by number.

- a. To use the search option, first select the <Search for Name or Number> option and then choose to search by either <Name> or <Number>. Next, enter the text or number for the search.
 - b. If one PWS is selected by the search criteria, it will automatically use that PWS. However, if there are multiple results, the **Multiple Hits with Search** dialog will appear.
 - c. If multiple results. Choose the correct PWS system and click [**Continue**]. If these are not the results sought, click [**Return to Search**] to return to the **SWAP PWS Report** dialog.
3. Select the <Plot PWS with Delineations> option by clicking on the checkbox next to the report type. At least one report type must be chosen before continuing.
 4. Click [**Run Reports**] button to run the reports. An example of the report dialog box is below.
 5. The **Printer Selection Form** dialog will show up. Please choose the appropriate printer and paper size. The paper size is listed on the form above the listboxes. *Only the printers available on the local computer are visible in the printer list box.



6. Click [**Continue**] after selecting the printer and paper size.
7. Under the File menu, choose [**Print**]. (The map can be adjusted if the basic layout is not ideal. Please refer to the ArcMap's online help option for more details.)
8. Below is an example of the map layout view with a formatted A sized (letter) map.



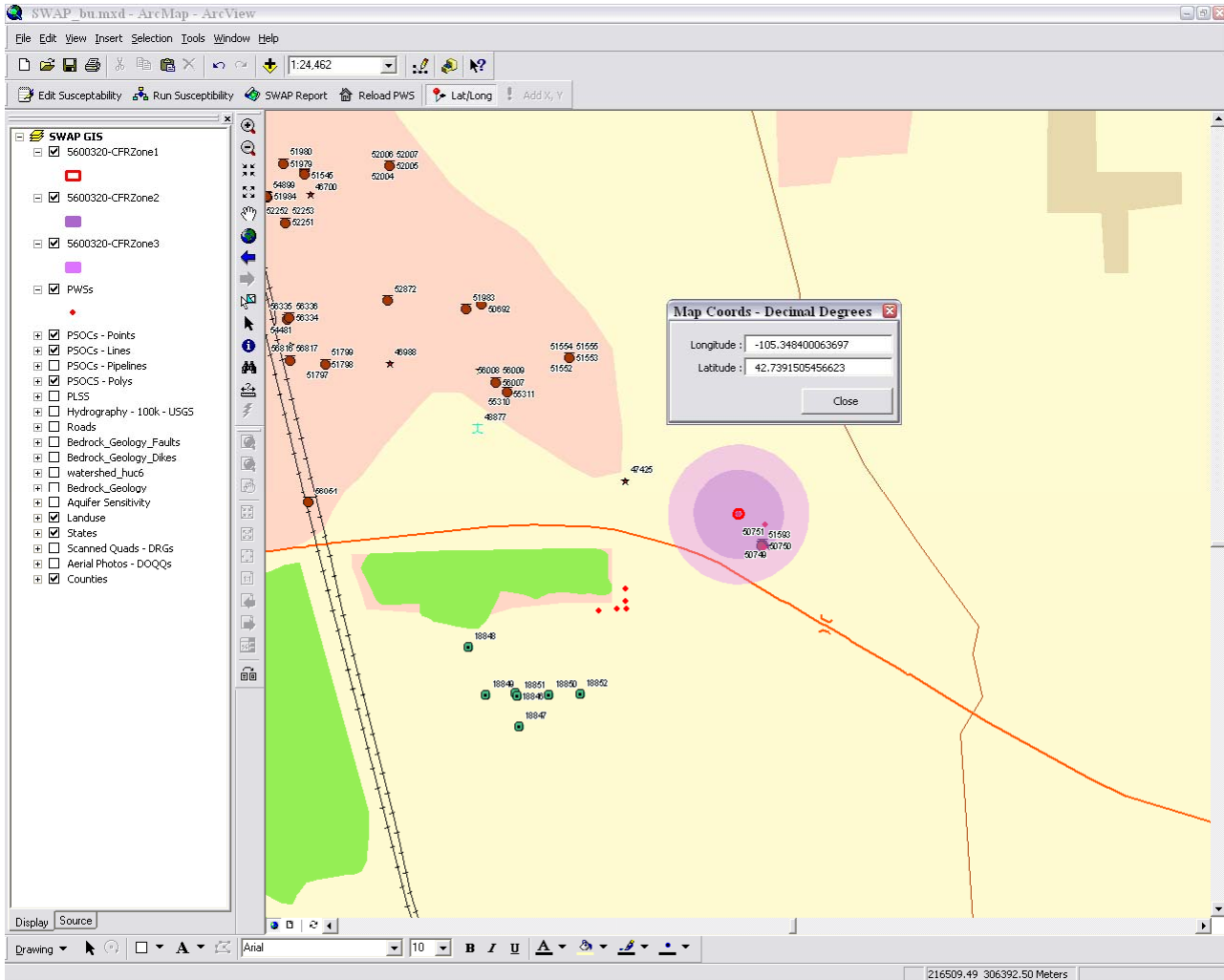
3.5 OTHER CUSTOM GIS TOOLS

3.5.1 RELOADING PWS POINTS

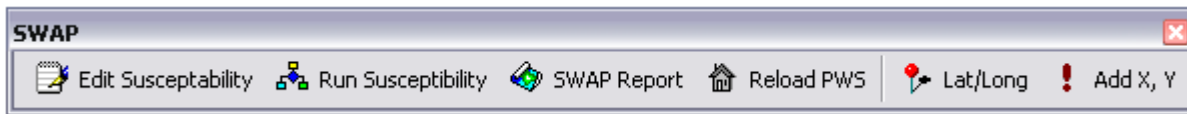
The **[Reload PWS]** button is used to recreate the PWS layer in the GIS interface. In the case where a well location has been updated in the database by changing the latitude and longitude values, this button will reload the latest coordinates and replace the PWS layer with the updated well locations. It reads the well/intake coordinates from the database and creates a new layer then loads it into the map. This button is primarily used to move well locations. To get the latitude and longitude coordinates for a location, the user can use the **[Lat/Long]** tool.

3.5.2 GETTING COORDINATES

If a well location needs to be moved, the coordinates need to be updated in the SWAP project database. To get the latitude and longitude coordinates from the map, use the **[Lat/Long]** button. After clicking on the **[Lat/Long]** button, click inside the map. The **Map Coords** dialog (shown below) will appear with the latitude and longitude coordinates of the point where clicked. The coordinates can then be copied and pasted from this dialog box.



3.5.3 ADDING X, Y COORDINATES TO AN ATTRIBUTE TABLE



The last button was rarely used within the application; however, it was developed for this project and can be a useful tool. This tool will add X, Y coordinates to any point or polygon layer's attribute table. It will add two fields and calculate the coordinates for each feature and write them in the new fields. This tool was used to get all of the well/intake coordinates and updating the database with the new locations for many wells.