Maintaining Water Rights in SDE Using ArcObjects

Robert Harmon, GISP
Oregon Water Resources Department

Abstract

The Oregon Water Resources Department (OWRD) has recently completed the migration of its water right feature data into ArcSDE from coverages. The whole process for creating and maintaining these data has been reinvented in ArcMap with a new suite of tools developed in VBA using ArcObjects. The presentation will review the migration path that OWRD took and cover, in more detail, the tool set that resulted. Plans for publishing our data on our web site (currently through ArcIMS) and distributing it will also be discussed.

Background

What's a water right?

Oregon's water laws are based on the principle of prior appropriation, used by most of the western states. This means the first person to obtain a water right on a stream, or from a well, is the last to be shut off in times of low stream flows.[1] "A water right is the legal authorization given by the state to a party to use a specific amount of public water in a specific way at a specific location for a specific purpose."[2]

A water right has two spatial components: a point where the water is diverted—the point of diversion (POD)—and the place where it is applied—the place of use (POU). Water rights can have more than one POD. A single POD can also serve more than one water right. POUs can be discontinuous, i.e., separated by roads or streams. POUs from different water rights can also overlap one another. This usually occurs in the event where a supplemental water right has been approved in an area where there already is another water right.

Water rights & GIS

The OWRD started digitizing water rights into ArcInfo coverages in 1989. An elaborate system was set up to link the geographic features (PODs & POUs) to more detailed attribute data in the agency's Water Right Information System (WRIS), which was maintained in INFO. For a variety of reasons the linkage between the data in the GIS and WRIS didn't always work and some features were left "link-less" (without attributes). Modeling for the potential overlap that can occur between POUs in the ArcInfo coverage model, pre-regions, was also burdensome and prone to error.

Redesign time

From 1998 through 2002 the OWRD Information Services team worked on a complete redesign of WRIS. This included porting the data from INFO into Informix and building a web interface for our customers inside and outside of the agency. A major component of this work was adding the ability to track a water right's "history". It is useful to staff

to be able to view information about a particular right at a particular stage in its "life". Within the database we refer to these as "snapshots". Hence, the snap(shot) id.

"New WRIS" was launched in November 2002 (Appendix, #4). With such a significant change in the water right attribute model the relationships to the GIS features simply broke. We were faced with the following options:

1. Continue to keep the GIS data in the coverage format and go through a complex process of recreating the old keys in the new system to maintain the existing links.
2. Or, redesign the water right GIS data in the geodatabase format and take advantage of its capability to model the spatial features to more closely match reality, at least the "reality" defined by WRIS.

In theory, the second option would provide a closer linkage to WRIS. We could even store our GIS data together with our attribute data!?

To make a long story very short we chose option two and spent the next two years migrating our data into personal geodatabases and eventually into SDE in Informix.

Entering & maintaining water right features

When the OWRD started compiling water right features into ArcInfo in 1990 it was soon realized that the task couldn't be accomplished with existing staff in a "reasonable" amount of time. By 1994 30% of the state's 200,000 water rights had been digitized. At that rate it would take at least another 10 years to complete the task (not including updates)! So, the agency went before the 1995 state legislature and was able to secure funding with which to hire a contractor to help complete the task more quickly.

The first pass through the state was completed in 2000 and an update process had already been established. With the economic recession of 2001 the water right mapping money was cut from our budget, as well as, funding for one (of four) GIS staff position, which had become vacant through attrition. We were able to continue water right mapping through funds secured from various contracts, albeit at a lower level.

In 2004 we decided to use our own data entry staff to do the mapping. This was due to the increasing costs of the contractor we had been using and loss of his more experienced personnel. We were also ready to leverage the efficiencies of the ArcGIS desktop and our new water right model. After much discussion we devised a plan to begin training data entry staff to map water rights in ArcMap in addition to the entry of attribute data that they were already entering into WRIS. Tools would be created in ArcMap to expedite the mapping and editing process and our mapping procedures revamped. The migration of our water right features from personal geodatabases into SDE was scheduled and completed later the same year. The tools were written, and revised, over the course of 2004 in VBA (Visual Basic for Applications) and ArcObjects within ArcMap 8.3.

Current water right mapping process & OWRD ArcMap tools

Creating/editing a water right map
The process of creating, or editing, a water right feature in OWRD's GIS begins either when the data entry person has just finished entering the attribute information into WRIS and is ready to map the right, or is working from a list of rights to be added or updated in the GIS for a specific area.

The list, referred to as the "master index", is created when we are updating water right features in a specific area of the state because of agency or project priorities. The data entry person then opens ArcMap and starts the "WREdit" program (Figure 1, item #2). The WREdit menu appears (Figure 2) and the user enters the "snap id" (water right database id), picks the appropriate edit option, and clicks "Proceed". The program will attempt to grab the snap number from the Windows Clipboard buffer if the user copied it there from another application.

1. WR Link tool
2. WR Edit program
3. WR Audit program
4. Consistency report
5. POD Traverse
6. Poly-point tool
7. Locate BOR/BLM project reservoirs
8. Get DRG tool
9. Get DOQ tool
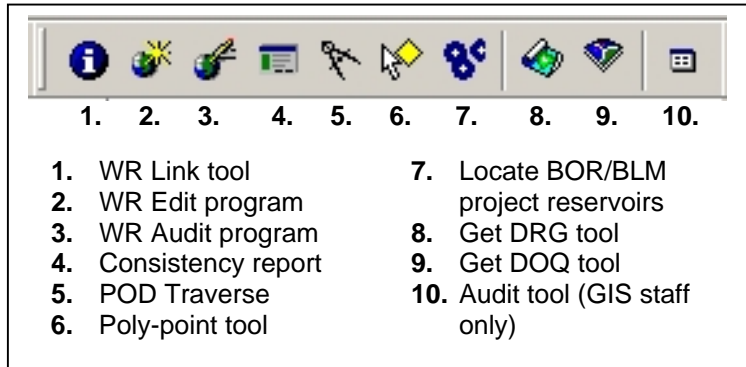10. Audit tool (GIS staff only)
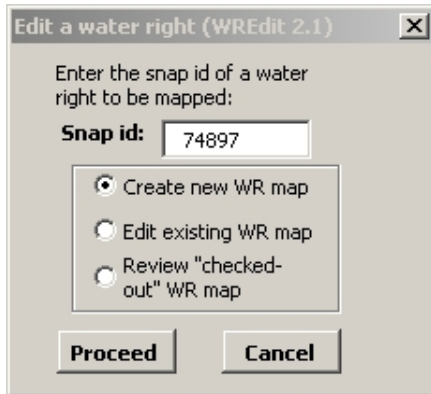
Figure 1. OWRD water right toolbar.

Figure 2. WREdit menu.

In the case of creating a new water right map, the program will copy a personal geodatabase (PGDB) template into the user's water right edit subdirectory and insert a new record in the "audit" table in SDE. The editor's user name, the snap id of the water right, the edit type ("new/existing"), and checkout date are recorded (Figure 3). The program will attempt to copy the features from the previous incarnation of the right, if it exists in the database. It can save the editor from recreating a lot of work. The process continues with the loading of base data used in the creation of water right features: public land survey data (township, range, section, and quarter-quarters, where they exist), tax lots, lakes and streams, roads, city limits, and the existing water rights themes (Figure 4). The program

Figure 3. Audit table.

finishes by retrieving the water right's POU location information from WRIS and zooming to the appropriate Public Land Survey section(s) (PLSS). A water right "proofing report" is also opened in a web browser window. The proofing report contains
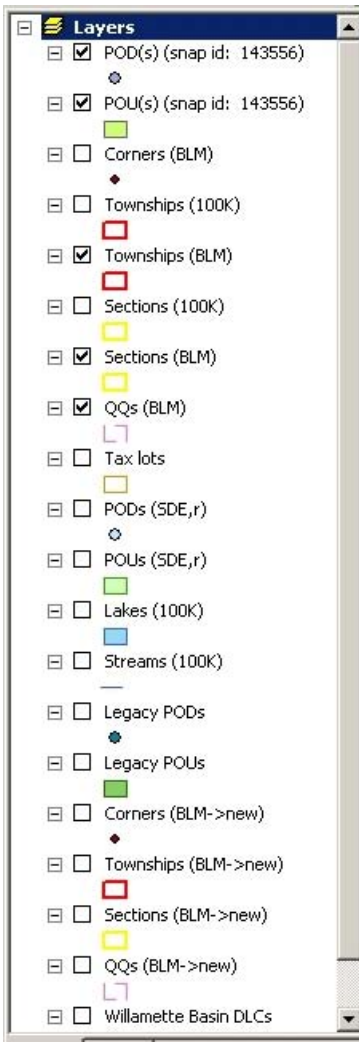
Figure 4. Water right map editing TOC in ArcMap.

pertinent information about the water right: a list of the PODs and POUs associated with the right and the database ids for each, and links to scanned documents from the water right file.

When the user is editing an existing right in the database, the program will go through a similar process as laid out for a new right. The only difference is that the program will bring in any existing geometry for features associated with the right, not it predecessor.

The "review" option is for an editor who is returning to a right to make more edits. This usually occurs after another data entry staff person has audited the right and identified that more work is required to complete the mapping. The program does not attempt to extract any data from SDE or make any entries in the audit table. It will load the "common" base data (Figure 4), zoom to the extent of the right in question, and open a proofing report.

Other edit tools
Six other tools have been created to assist with the process of editing a water right:

"Get DRG"/"Get DOQ". The "Get D*" tools (Figure 1, items #8 & 9, respectively) simply retrieves a DRG (USGS Digital Raster Graphic, a.k.a., a scanned 7.5' quad map) or DOQ (1994 or 2000 USGS Digital
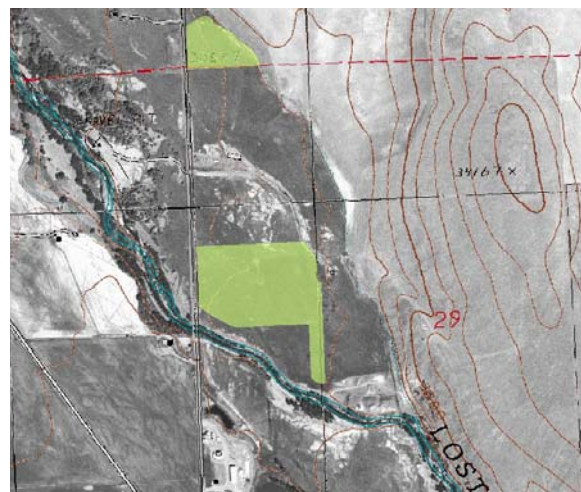

Figure 5. DRG displayed over a DOQ.

Orthophotoquad, a.k.a., an aerial photo) for the area on the map display where the user clicks his or her mouse. The program identifies the quadrangle under the cursor by loading a 1:24,000-scale quad theme (if it's not already in the TOC) and retrieving the "Ohio code" from the attribute table. It then goes out to a network drive where we keep the image files and brings them into the map document. In the case of DRGs the program will "turn off" most of the colors in the image colormap in order to "see through" the map to underlying themes such as a DOQ (Figure 5). When acquiring a DOQ, a click with the left mouse button will bring in a DOQ from our 2000 collection, or a click with the right button will get the DOQ from the 1994 data set.

"POD Traverse". Often, on water right source maps, the position of the point of diversion is identified with respect to a known Public Land Survey corner. This is

Figure 6. POD Traverse measured distance menu.

commonly expressed in one of two methods. The first method is a measured distance north, east, south, and/or west from the initial point, such as, "1233 feet north & 2520 feet east from the southwest corner of section 29." The user would select the "POD traverse" tool (Figure 1, #5) click on the southwest corner of section 29 and a menu would appear prompting them for the distance north and east to enter (Figure 6). A POD point is then placed at the specified offset from the PLSS
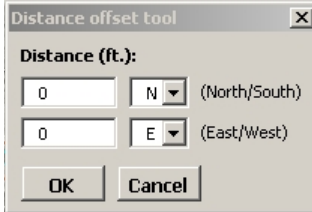
corner and an attribute window appears. The user's initials, current date, and a remark are already populated.

Figure 7. POD Traverse bearing & distance menu.

The second method is expressed as a bearing and distance, such as "north 47° 10' 49" east, 1854.62 feet from the southwest corner of section 13." After selecting the tool, the user *right-clicks* on the starting point and enters the appropriate information (Figure 7).
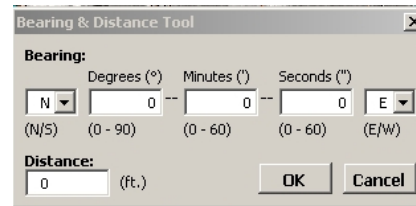
"Poly-point". Some water right files do not contain maps or enough information for adequately locating POU, or POD, features in the GIS. This is especially true of older rights. Historically, the OWRD GIS group did not map these features. Instead, a record would be added to an "unmapped" features table. In an attempt to put the water right feature *somewhere* in the neighborhood of its intended location we created a tool for mapping the POU with a unique (60' by 80' diamond) shape that shouldn't be confused with a *real* POU—the poly-point (Figure 8). Both the POU and POD feature classes also have a "feature quality code" that includes a code for "unmapped features."
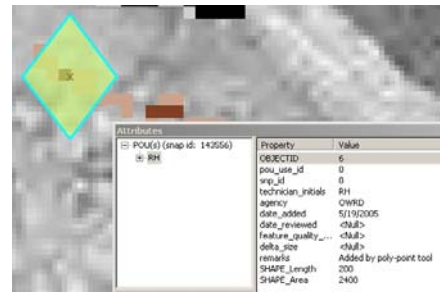

Figure 8. Poly-point tool result.

"Locate BOR/BLM project reservoirs". This tool is for those situations where a water right draws from one or more U.S. Bureau of Reclamation (BOR) or U.S. Bureau of Land Management (BLM) reservoirs. The associated file does not always specify which reservoirs these are so the tool assists the data entry technician in the search. The technician picks the tool and clicks on the stream closest to the water right. The program selects and zooms out to the

Figure 9. BOR/BLM project reservoir tool result.

project reservoirs that are on the tributaries to the stream (Figure 9). It also places a red graphic "X" on the spot that the user initially clicked. From here the user can place PODs on the contributing BOR or BLM reservoirs upstream from the water right.

"Consistency report". When the editor is finished digitizing the features for a particular right they run this tool which checks the feature attributes against WRIS. It verifies the number of features and that their key identifiers are consistent with what is stored in WRIS for the right in question. If there are any inconsistencies they are listed and flagged with an asterisk in a text report (Figure 10). It also verifies the PLS location of the PODs (to the section) and some of the feature-level metadata such as the technician's initials, agency, and date.

Figure 10. Consistency report.

Auditing a water right map

After a data entry person has completed editing a water right another technician audits their work before the features from the personal geodatabase are committed to SDE. The program, "WRAudit," has been created, similar to WREdit, which sets up the ArcMap environment for the auditor. When the program is launched (Figure 11), the auditor enters the snap id of the water right and presses the "OK" button. The program checks the audit table in SDE to verify that the right has been checked out for editing and *not* already committed back to SDE. Edit information from the audit table is displayed in the WRAudit window which remains on the screen until the auditor closes it. The auditor also has the option to display a proofing report if they desire. After the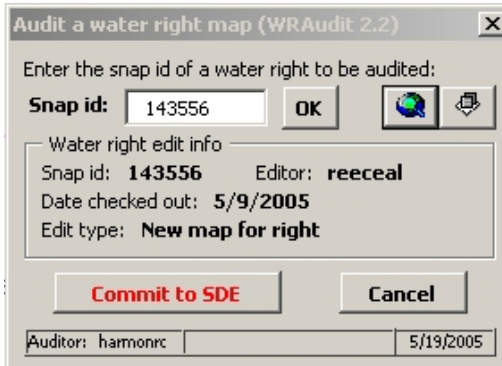 data have been loaded into ArcMap and reviewed they can be committed back to SDE with the "Commit" button. If existing data is being replaced than the program informs the auditor before proceeding further. A status bar at the bottom of the WRAudit screen displays the progress of the commit process.

Figure 11. WRAudit program.

After a successful commit, the program compacts the water right PGDB and attempts to move it from the editor's subdirectory into an "archives" directory. Sometimes this doesn't work programmatically because a lock file remains. In this case, the program informs the user by displaying the full path name of the file to be moved and its intended destination.

Accessing Oregon water right information

Data download

Currently, all of the OWRD water right GIS data is available for download as a single PGDB file zipped together with a user guide (PDF). Six tables of fundamental water right attribute data from WRIS are also included in the PGDB with relationship classes linking them to the POD and POU feature classes. The user guide covers all of this and provides some examples on their use.

Interactive Mapper

The OWRD "Interactive Mapper" was launched in January 2000. It provides a set of commonly used base themes, water rights, and a "drill-down" tool for the water right application review team to use to answer most of the questions on their checklist. The program also includes a statewide image catalog of the DRGs and 1994 orthophotoquads. Other agency databases are linked to the mapper, notably our library of scanned documents—well logs, water right certificates—and other large databases. This has helped to expand the use of the application well beyond the water rights group. Now, data searches that had previously been restricted to text queries can start with a map. For example, when a user zooms down to a public land survey section a query of the section theme will produce a link to our well log database for the area. Or, the user may query our water availability unit theme and produce a report, on-the-fly, from that model. We also linked our peak flow estimation program to the site.

Future plans

The OWRD IS group has a lot on tap for the remainder of 2005: migration from Informix to Oracle 10g, upgrading from ArcGIS 8.3 to 9.1, and migrating *and* upgrading the Interactive Mapper ArcIMS site from version 3.1 on a Windows server to 9.x on Linux.

The Informix to Oracle migration will occur first to be followed closely by the ArcGIS upgrade. We've stayed with 8.3 because ArcGIS won't work with a 64-bit instance of Informix, the version that WRIS resides in. In the meantime, we maintain our SDE instance in 32-bit Informix on an unsupported platform. Once Oracle is up and running we will install SDE and start the ArcGIS migration to 9.1. WRIS will be migrated later.

We've been running ArcIMS 3.1 on a dual-processor Pentium 4 (1.2 GHz) Windows 2000 computer for the past 3 years. With the upgrades that we've made to our water right data and ArcGIS we decided that it's time to upgrade our ArcIMS hardware and software, *and* connect it to "live" GIS data in SDE. This project will get underway following the Oracle migration and ArcGIS upgrade.

Keeping up with water right mapping is always a challenge. Getting to the point to where we have a current set of features is crucial to our success. We will be exploring ways to incorporate our field units into the editing process as one way to achieve that goal. It increases the number of people working with the data and leverages local knowledge. There are two ways to participate in the editing: with remote installations of

ArcGIS desktop and the OWRD water right editing tools, or providing the ability to login through a central instance of ArcMap through a terminal service such as Cytrix.

Both options require more research on our part. We are already exploring rewriting our ArcMap tool set in C# (.NET) to make it easier to distribute. Our WRIS entry application, and several other tools for accessing WRIS, is written in C#. By migrating our ArcGIS tools into C# we're hoping it will be easier to integrate them with the WRIS tool set in the future.

Appendix

Oregon water resources links
1. Oregon Water Resources Department: http://www.wrd.state.or.us/

2. OWRD water right GIS data & users guide: http://www.wrd.state.or.us/OWRD/MAPS/index.shtml - Water_Right_Data_GIS_Themes

3. OWRD Interactive Mapper: http://map.wrd.state.or.us/apps/wr/wr_mapping/

4. OWRD Water Rights Information System (WRIS): http://www.wrd.state.or.us/OWRD/WR/wris.shtml

5. OWRD water right GIS procedures: http://map.wrd.state.or.us/apps/wr/wr_mapping/owrdprocedures.pdf

6. OWRD, *Water Rights in Oregon* (referred to as the *Aqua Book*): http://www1.wrd.state.or.us/pdfs/aquabook.pdf

7. Oregon State University Press, *Waters of Oregon*: http://oregonstate.edu/dept/press/u-w/WatersOR.htm

End notes
[1] OWRD web page (*Appendix*, #1), "Water Management" link
[2] Bastasch, 1998, p. 48.

References
Bastasch, Rick. 1998. *Waters of Oregon: A Source Book on Oregon's Water and Water Management*. Corvallis, OR: Oregon State University Press. (publisher's web site in the *Appendix*, #7)

Oregon Water Resources Dept. 2004. *Water Rights in Oregon: An Introduction to Oregon's Water Laws and Water Rights System*. Salem, OR: Oregon Water Resources Department. (PDF of the booklet on the OWRD web site; URL in the *Appendix*, #6)

Author Information
Robert Harmon, GISP
GIS Coordinator
Oregon Water Resources Dept.
725 Summer St. NE, Suite A
Salem, OR 97301-1271
Voice: 503-986-0866
FAX: 503-986-0902
Email: robert.c.harmon@wrd.state.or.us