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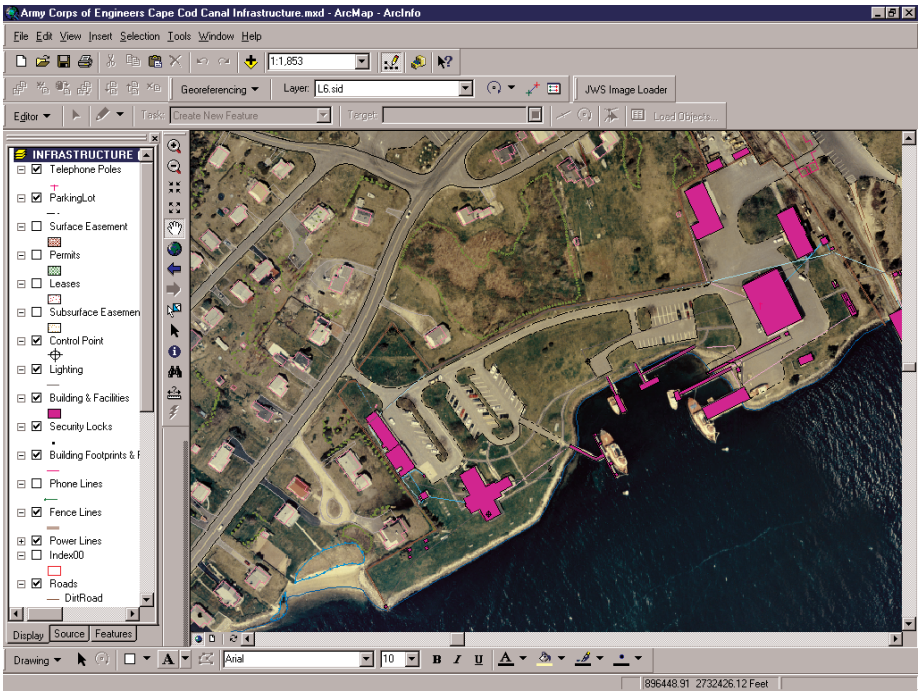
Experience in the Field

Army Corps of Engineers--Cape Cod Canal, Massachusetts

GIS DATABASE MIGRATION

In 2002, James W. Sewall Company performed a nine-month database migration project for the U.S. Army Corps of Engineers--Cape Cod Canal (CCC). To assist CCC personnel in maintaining and operating the 17.4-mile-long waterway system between Cape Cod Bay and Buzzards Bay, Sewall migrated landbase data, digital orthophotography, and infrastructure mapping from the existing ESRI ArcView 3.x system to ArcGIS Desktop. Based on the Geodatabase structure, the new system offers multi-user editing capabilities, wizard-driven menus, and high-quality cartographic functionality. Utilizing original engineering plans, Sewall also created a 3D GIS model of the Canal, developing custom dredging and volumetric analysis software tools. Used in conjunction with hydrographic surveys of the Canal bottom, the CCC is able to determine and track the amount and location of excess sand deposits for dredging operations.



Geodatabase elements overlaid on digital orthophotography for facilities and asset management.

Project Background. The CCC, a field office of the New England District of the Army Corps, has utilized ESRI products for the last ten years to assist with the maintenance and operation of the Canal. The original ArcView 3.x system, comprised of a landbase, digital orthophotography, and infrastructure mapping, was developed by Sewall to provide CCC personnel with a visual tool to monitor their facilities and assets.

For better system management and tighter security, the CCC initiated a migration project from the original system to ArcGIS Desktop, seeking to exploit the new functionality of ArcGIS and the Geodatabase structure. On this foundation, the CCC planned to create a GIS model of the waterway system, developing a process and specific tools to assist in the dredging of the Canal. Based on hydrographic surveys of the Canal bottom, dredging is periodically necessary to eliminate sand and other excess

material deposited due to the Canal's swift current. Previously, the CCC had used manual processes to determine the amount and location of material to dredge.

To accomplish these tasks, the CCC contracted Sewall to assist with the Geodatabase design, interface ArcSDE and Oracle configuration, data migration, and development of custom dredging, volumetric analysis, and estimation tools. Sewall's shared history with the CCC and experience with ESRI products as an authorized ESRI software developer were essential criteria for selection as a vendor. On previous projects, Sewall provided the Canal with digital ortho-photography, digitally compiled photogrammetric and facility data in ESRI Coverage format, and a customized system using ArcView and ArcInfo.

To upgrade the CCC's GIS, the Sewall project team configured Oracle 8i Release 3, ArcSDE 8.1.2, and ArcGIS 8.1 on a Sun Solaris 8 machine. The Canal's Geodatabase was designed in Visio 2000 Enterprise Edition. Custom dredging tools for the Canal were programmed with ArcObjects, utilizing ESRI extensions Spatial Analyst and 3D Analyst, with ArcScene for viewing capabilities.

Data Migration. To exploit the advantages of the Geodatabase over the Coverage model and effect a smooth migration of data from one system to another, Sewall designed a Geodatabase that was structured similarly to the CCC's current Coverage model. Features, objects, relationships, and attributes were constructed to reflect the CCC's current schema. After completion of the Geodatabase design and testing, the project team migrated the CCC data from the legacy system to the Geodatabase.

The process of data migration and ArcGIS configuration involved six essential steps: loading the schema into the Geodatabase, loading the data, converting the data from Coverage to Geodatabase annotation, recreating layer symbology and ArcView 3.2 project files, and adding hyperlinks to features as necessary.

1. Using ESRI's case tools, the project team loaded the schema into Oracle. This process involved loading the schema into a Microsoft Repository database; the Case Schema Creation wizard was then used to load the schema into the Geodatabase. Connected with the Repository database, the wizard allowed the object model to be selected. After the object model was selected, the objects and features classes were loaded. The properties for each class were updated with a storage configuration keyword that the team generated for the SDE Geodatabase.

2. Using the Simple Data Loader in ArcCatalog, the team loaded the data from the current Coverage format. The simple data loader was used to import simple features and objects. For both, the target class was selected and the loader was activated to follow a step-by-step process. The only changes made during the process involved matching the correct source field with the correct target field.

3. To load Annotation Feature Classes, the data was converted from Coverage annotation to Geodatabase annotation using ArcMap. Because the annotation was non-feature-linked annotation, this process was relatively simple.

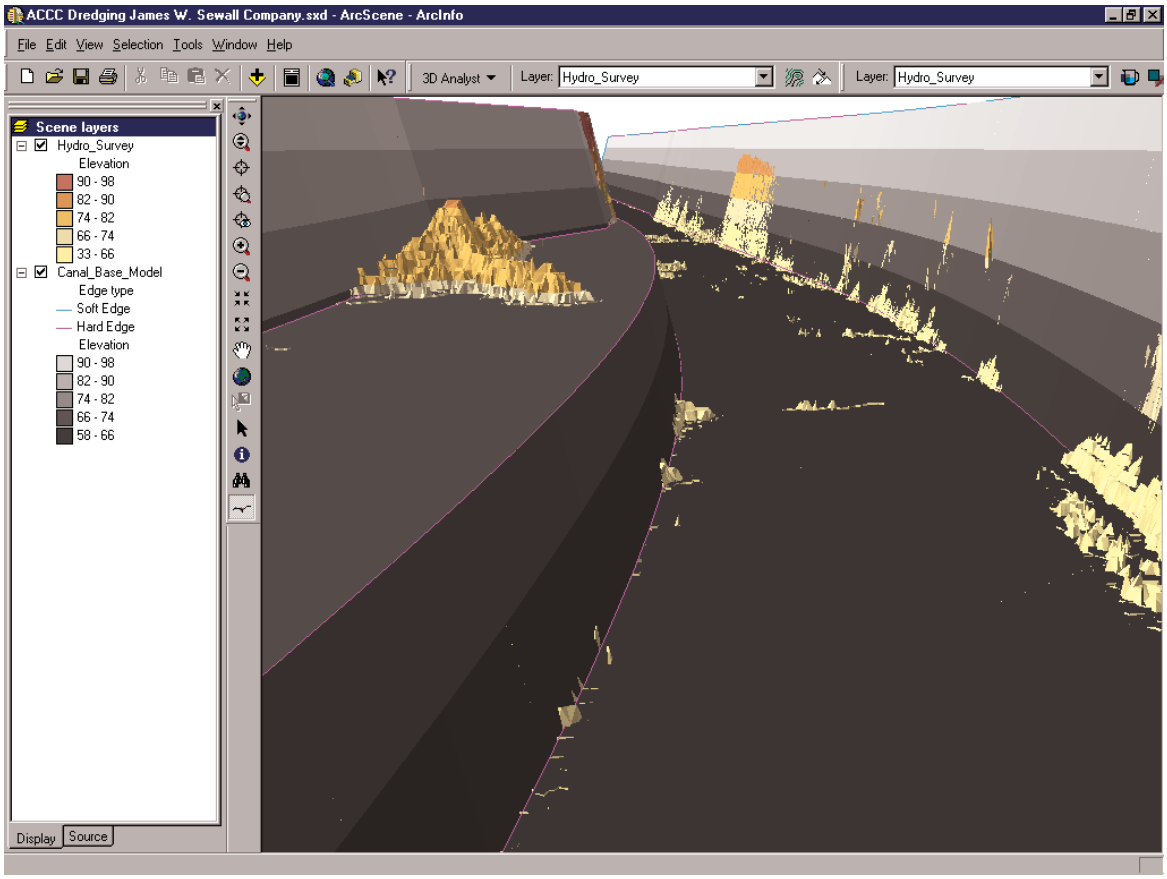
4. Layer symbology from ArcView 3.2 was recreated in ArcMap.

5. The ArcView 3.2 Project Files were recreated as ArcMap .mxd documents.

6. The project team added hyperlinks to appropriate features.

With the completion of this process, the CCC now stores and manages critical data in a centrally located commercial off-the-self database management system. Multiple CCC users can view, query, and edit data over a long period of time. Further, they can manage and edit the Geodatabase using standard ArcGIS tools (ArcCatalog, ArcMap, and ArcToolBox).

In addition to designing the Geodatabase, installing and configuring the software, and migrating the legacy data, the project team worked closely with the CCC to design a digitally automated dredging application for volumetric analysis.



ArcScene display of cut and fill analysis indicating amount and location of materials to be dredged. This display is a 3D intersection of two triangular irregular networks (TINs): a baseline datum from engineering drawings and a digital terrain model of real sounding points.

Application Development. To automate the current manual process of calculating dredge volumes, Sewall developed two custom tools, Fish Net Filter for creating Canal bottom contours and Cut Volume for dredging estimation and analysis. The Fish Net Filter was originally written for the CCC in 1995 in Avenue. For the updated process Sewall rewrote it in Visual Basic, using ESRI's ArcObjects.

When executed, the filter creates an even-spaced grid centered over the selected data set. Then it creates a new data set with the same fields as the original. The highest point in each grid cell is copied to the newly resampled data set. This smaller resampled data set makes some analysis functions more efficient without degrading the quality of the resulting information. The CCC uses these results to create Canal bottom contours. The original depth points are spaced about 1 foot apart.

For dredging estimation and analysis, the Cut Volume tool creates two triangular irregular networks (TINs)—digital terrain models based on a network of discrete triangles—then calculates the cut volume between them. Based on the 3D Canal design model, the first TIN is created from design elevation points at stations along the Canal and from breaklines for changes in slope. These two data sets contain attribute elevations for both the design bottom and the regulated design overdepth (2 feet lower).

The second TIN is a sounding model created from collected depth soundings that have been converted to elevations. The last steps were to convert both TINs to raster images and calculate the difference. The intermediate TINs were saved and can be loaded into ESRI's ArcScene for viewing.

PROJECT PROFILE

Services

ArcGIS database migration
User application development

Client

Army Corps of Engineers--Cape Cod Canal
Massachusetts

Size

17.4 miles

Systems used

ArcGIS 8.x, ArcSDE 8.x, ArcObjects, ArcScene
Oracle 8i
Visio 2000

Summary. For the CCC, maintenance and updating of Canal data are a critical part of an ongoing mission. The enhanced functionality of the Geodatabase model, ArcGIS Desktop, and custom dredging tools significantly increase the CCC's ability to optimize resources and manage navigation channel right-of-way operational activities.

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