A SOLID FOUNDATION FOR COLLABORATION

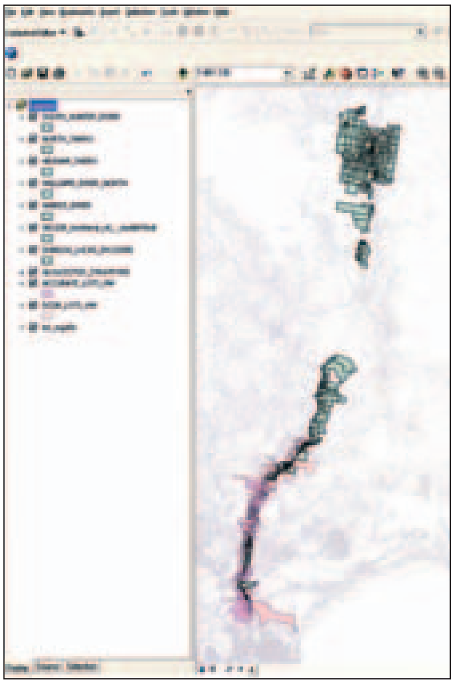
GIS PROVIDES THE BACKBONE FOR ACCURATE AND SEAMLESS DATA COLLECTION FOR 100-KILOMETER PIPELINE PROJECT IN NEW SOUTH WALES' HUNTER VALLEY

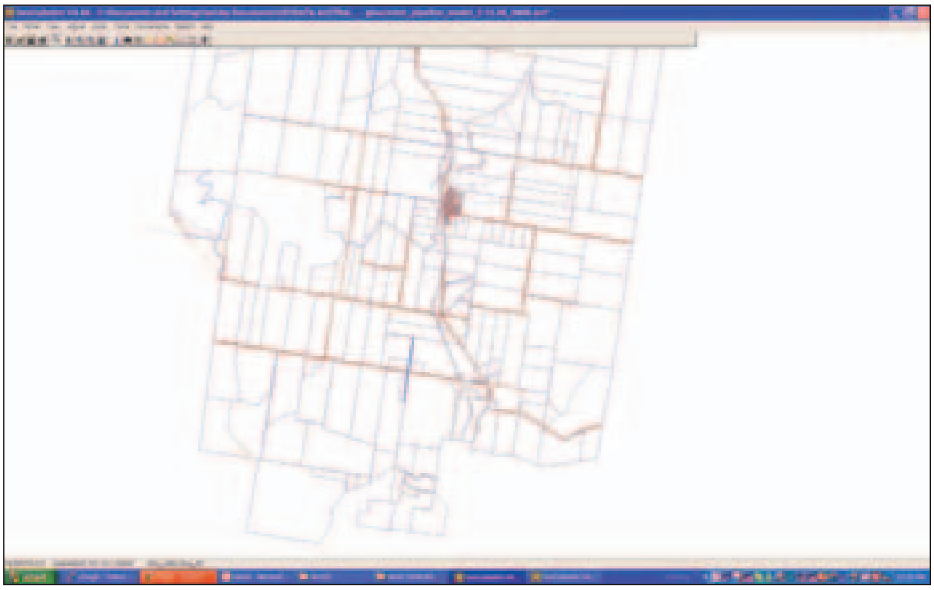
Collaboration is key in the modern world. Very seldom can projects be completed today without cooperation from several different organizations, especially in construction. Managing information and ensuring that data is accurate are paramount to keeping a project on track with respect to time and materials. This is especially true in Australia's Hunter Valley, a region in New South Wales (NSW) almost 200 miles north of Sydney, where construction of a 100-kilometer high-pressure pipeline to transport coal seam gas is under way.

Coal seam gas, also called coal bed methane, is a natural gas found in coal seams, or alongside coal in its natural fractures and cleats. The gas is recovered by drilling a borehole into the coal seam and fracturing it with high-pressure water and sand. The water is then pumped out, leaving the sand in the small fractures, which ensures the fractures remain open, allowing gas to flow from the coal seam to a well. This well is connected to a buried pipeline system that transports the gas and produced water to a central processing facility and eventually to market.

This particular pipeline, which is part of the Gloucester Coal Seam Gas Project, runs through a range of different types of land, creating a challenge for surveying and ground truthing. Wide-open rural, rural residential, and urban fringe areas serving the sixth-largest urban area in Australia were the canvas on which Calco Surveyors Pty. Ltd., Gloucester, NSW, and Geodata Australia Pty., Ltd., East Maitland, NSW, were to create a survey-accurate picture for the route of the pipeline.

This is a major economic centre for New South Wales, and the pipeline is expected to bring a green energy source to a region that currently imports 90 percent of its natural gas from other states—not a small project, considering the pipeline's route through diverse types of land in terms of both geography and ownership.





Comparison of the cadastral fabric after upgrading for the Hunter Valley pipeline route. The project benefitted by commencing with a survey accurate base cadastral fabric and council benefitted by the pipeline section being brought up to date with the significantly improved spatial precision (less than 100mm).]

The first step in the pipeline project was to create a cadastral database by seamlessly weaving together information for the full 100 kilometres of the project. A cadastral database serves as a foundation layer of spatial information, specified ownership, and the spatial extent of that ownership. This data is especially important for areas with critical locations, such as highway and railway crossings, the insides of power easements, and places where the pipeline route was adjacent to boundaries or within road reserves. The database was created not only for project design but also for easement negotiations.

The cadastral database was created using the Cadastral Editor feature inside the Survey Analyst extension of ESRI's ArcGIS geographic information system (GIS) software. The software follows the rules for creating a legal cadastre. Many times, historical survey records are of varying spatial quality. They do not easily translate to a geodetic spatial reference frame because monuments found on the ground have more legal weight than any written or electronic record in defining the spatial location of a cadastral boundary. Cadastral Editor facilitates the transition from a historical measurement survey system defining the cadastre to incorporating modern position-based survey systems, such as GPS, to define spatial locations.

Using a GIS to define cadastral features creates links to all descriptions and provides a data management tool effective for decision making on governance, social, environmental, and technical issues. Having surveyors accurately define the points and lines of the cadastre and document them based on a combination of survey rules, field measurements, and experience results in a real-world "fabric."

This fabric is constructed of a mesh of survey measurement geometry called a survey data model, which serves as the platform to create and efficiently manage an accurate geodetic cadastral database. The process replicates workflows adopted by surveyors to define cadastral boundaries.

Geodata used this process to create the cadastral fabric for the pipeline. The decision to collect survey-accurate data in one database that can be updated and retain historical information paid off from day one, as information could be updated, imported, created, and retained for seamless viewing and planning, no matter how many different lands the project crossed.

Surveying for the pipeline project began in Gloucester Shire, a rural area located in hilly terrain through which the first 10 kilometres of pipe runs. Geodata had created a cadastral fabric for the area back in 2004, finding that as it captured and converted historical and current parcels into the cadastral fabric, discrepancies of more than 100 meters were found.

When Geodata mapped the pipeline four years earlier, the existing database did not show boundaries of features where the pipeline crossed the main road and the railway line, since titles were up to 100 years old and there was no survey plan available. This time, using the cadastral fabric, a survey-accurate cadastre was created with two days of GPS fieldwork and approximately three days of office data management. The updated cadastral fabric was returned to the Glouster Shire Council free of charge.

Next, the pipeline runs through 40 kilometres of outlying rural areas, where the existing cadastral database was deemed suitable for the project. This database was migrated to the project cadastral fabric by Geodata by inverting the parcel coordinates to provide parcel dimensions for the cadastral fabric. While the inverting process does not provide true title dimensions as parcel attributes, such as in a correctly created cadastral fabric, the significant cost savings associated with the high precision of the inverted fabric more than compensates for accessing the data in this fashion.

In several locations, the pipeline passed close to boundaries, and the spatial precision was important. Small cadastral fabric models were built from survey plans at these locations, and several cadastral marks were located by GPS as control and for ground truthing, with a spatial precision of approximately 0.1 meter.

Fifty meters in, the pipeline route is adjacent to roads and electricity easements for 25 kilometres, so, again, spatial precision was important. A cadastral fabric needed to be created, since most plans were created pre-1900s and compiled with no survey information for boundary or road definition.

The fences bore little resemblance to the first field survey done for ground monuments. To rectify this, fence lines were located by GPS to provide survey definition of parcels and road reserves. The field data now provided a greater weight to boundary definition than the old plan data and was adopted for survey definition. Surveying this area took only two weeks of plan data entry and three days of GPS survey and provided 100–200 millimetres of precision.

The final 25 kilometres of pipeline runs through the operational area of the Hunter Water Corporation (HWC), a state-owned entity providing water and wastewater services for more than half a million people in the lower Hunter Valley. HWC had created a survey-accurate cadastral fabric providing information about where corporate assets are located, and this information is available commercially at a per-parcel rate. This data was used for 60 percent of the pipeline route in this section.

While the cadastral fabric is not commercially available, the cadastral layer provided in the asset zones has a spatial precision with less than 50 millimetres of discrepancy. It was purchased by the project and inverted to create a cadastral fabric.

Where HWC data didn't exist, cadastral models were created from survey plans. In one area of old plans where no survey marks existed, a GPS survey of fencing was required to provide a suitable spatial definition of the parcels affected by the pipeline. Creating this 25-kilometer section involved one person's efforts for two weeks for data input and one additional day for GPS fieldwork.

Collecting data for the project required seamlessly weaving data from many sources, including field survey, together for 100 kilometres of high pressure pipeline.

In some areas, fence lines were located by GPS to provide survey definition of parcels and road reserves where existing plans were pre 1900's and compiled with no survey information for boundary or road definition.

A small section of the pipeline route runs adjacent to electricity transmission lines under the jurisdiction of the local power utility, Energy Australia (EA). EA provided a small section of cadastral fabric showing the survey-accurate location of power line easements, which was imported into the project.

The final project involved fitting the surrounding surveyed land information to the spatially accurate pipeline corridor fabric, producing an extensive cadastral feature dataset for the project geodatabase.

Creating the pipeline cadastral fabric incorporated many separate cadastral databases, as well as land surveying in some cases for more accurate sections and ground truthing. The ability to import various data sources, including existing digital information and new survey data, into one seamless cadastral fabric greatly reduced the time and resources required. Using GIS to create survey-accurate detail for the length of the pipeline through the Hunter Valley was useful for not only the pipeline project but also the various local governments. Working together to update all 100 kilometres of the route allowed each jurisdiction to review the state of its data and update areas that required it, without duplicating resources or losing the rights to that data.

Article by Ian Harper, Geodata Australia Pty., Ltd., and Karen Richardson, ESRI staff writer.