

Territorial View

Field work with high resolution imagery

—by Jon Skiffington

Compressed satellite and aerial imagery is becoming increasingly important to companies whose operations occupy vast stretches of territory. Enbridge U.S. relies on a combination of georeferenced imagery and vector data to create the base maps its field crews use while building and maintaining the company's extensive network of crude oil, liquid petroleum, and natural gas pipelines in the United States. Technicians are deploying the latest geospatial technologies to manipulate the compressed image files so they can be accessed via the Internet and put into the hands of field crews.

Headquartered in Houston, Texas, Enbridge U.S. transports crude oil, liquid petroleum, and natural gas in the Midwest, Mid-Continent and Gulf Coast regions of the United States. The company also operates several midstream businesses concerned with the gathering, transmission, processing, treating and marketing natural gas.

MEETING CHALLENGES IN THE FIELD

Jason De Leon is a field designer in Enbridge's Pampa office outside Amarillo, Texas. Together with colleagues in two other nearby cities, De Leon creates imagery for field personnel working on a pipeline system covering 5,108 square miles in seven counties in the Texas Panhandle and western Oklahoma.

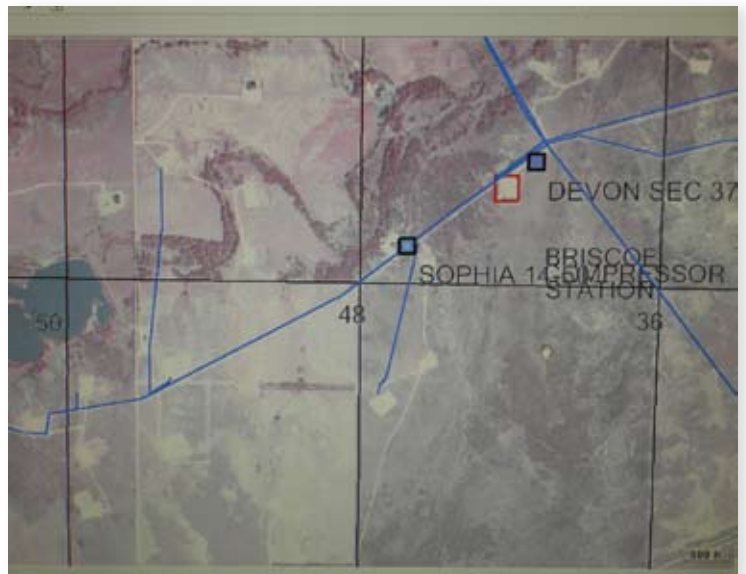
The pipeline is on private property; and right-of-way easements need to be leased or purchased from landowners for the sites where lines, meter stations, launchers and receivers, and other infrastructure are to be built. There are also compressor stations and gas plants where Enbridge employees process the natural gas. According to De Leon, "Construction is constant and can take place just about anywhere."

The field work involved in planning and performing these construction activities is now guided by imagery. A large repository of color and infrared aerial photography was purchased from the U.S. Department of Agriculture's National Agriculture Imagery Program (NAIP) and is managed by the Enbridge Houston office. The company also relies on the Texas Natural Resources Information System (www.tnris.org) for one-to-three-meter-resolution satellite imagery, which includes black-and-white, color, and infrared data sets.

"Our field crews used to navigate by paper maps in the field," says De Leon. "This was a slow and frustrating process." Often



the field people were given coordinates for their destinations, but they were not able to find those coordinates on the paper map. Also, the maps made by the Texas Department of Transportation did not necessarily show all the roads that we have up here. Crews spent a lot of time driving around in circles. One would get instructions such as, "Go to the windmill that's losing one of its blades and turn right, then turn left when you see three cows. That's how bad it was getting to be."



Not only field operators around Amarillo but users in the Houston office and other parts of Texas now access imagery on a shared network that De Leon maintains. Field crews using handheld GPS devices load the images into ArcPad mobile

Images illustrating the use of raster and vector data by Enbridge field crews to locate their work sites. This page, second image: An infrared aerial at 50% transparency combined with map data. The image on next page is an infrared aerial (set to 50% transparency) with GPS measurements identifying the beginning of the pipeline (marked by a red circle with a cross at the center)

mapping software from ESRI Inc. for navigation, GIS editing, and asset management purposes. With imagery loaded on handheld devices, personnel in the field can easily type in the coordinates of their destination and locate themselves via GPS readings. The handheld device pinpoints both their position and their destination on the image layer shown on the display screen. Instead of craning out of the windows to count cows and windmill blades, they can use the on-screen map to drive directly to the target location.

"Pipelines are also on the map," says De Leon, "with the imagery layer engaged you can see where the pipeline crosses a road. It takes our field operators less than a quarter of the time it used to take them to find a location. This is especially useful for new workers who might not know the area."

An infrastructure data layer is also loaded on the handheld mapping device, and the first thing crews usually do upon arriving on scene to perform their work is verify the accuracy of this layer. Enbridge typically records the location of the facilities in an ArcGIS data layer as vector overlays or shapefiles. The easiest way to verify that the vectors are in the right location and are accurately configured is to inspect them on-site; then one can overlay the vectors of raster aerial images on the screen of a handheld mapping device. If the vectors don't line up with the actual pipeline assets in the imagery, the vectors can be edited on-screen with mobile mapping software.

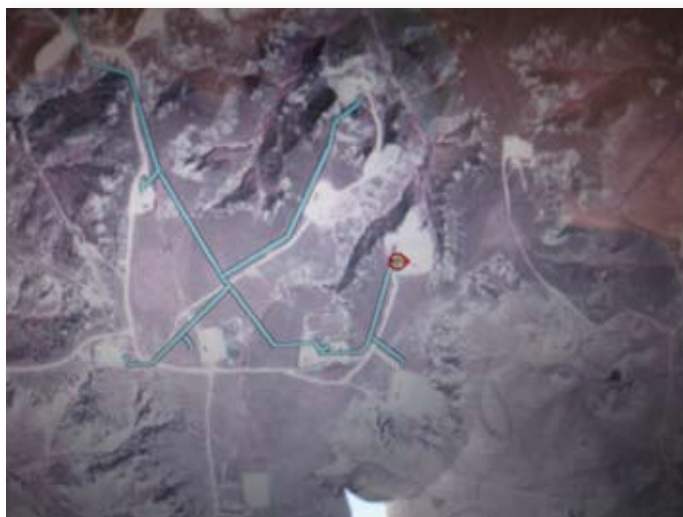
When Enbridge started using ArcPad a couple of years ago it ran into a major obstacle: the software can't reproject compressed image files. Reprojection is translating the coordinates and other georeferencing information accompanying the image from one coordinate reference system—also called a spatial reference system—to another.

Vectors are created in their local map projection, State Plane NAD 83 Texas North Feet, which won't align with the WGS 84 coordinate system that nearly all aerial photography in Texas is delivered in. Reprojecting the imagery ensures that the vectors and imagery overlay properly for accurate editing, according to De Leon.

WORKING WITH COMPRESSED IMAGES

De Leon says his office spent weeks looking at various solutions available for working with compressed imagery, and the only one he received positive feedback was GeoExpress, an image manipulation and compression software package from LizardTech of Seattle. This was a logical choice for dealing with compressed image files since LizardTech had developed the MrSID compression format used throughout the geospatial industry to shrink huge raster image files to manageable sizes.

Besides the basic function of encoding imagery to the standard compressed format, GeoExpress also performs image processing or "manipulation" tasks on the compressed images, including reprojection, cropping, area-of-interest encoding, and color balancing. For De Leon's workflow, these other functions all play an important roles in



getting imagery from a variety of sources ready for use by Enbridge field crews and offices.

"By reprojecting this imagery with ArcPad, we've saved literally tens of thousands of dollars over what it would have cost to have each county separately reprojected by a contractor," said De Leon. They also save money by using it to crop mosaics so that the black zones along the edges of mosaicked images are reduced or even removed. This helps make maps more readable, just like adjusting color, for instance.

"If there is a canyon that we have to go through," said De Leon, "adjusting the color just a little will make the image show up better." "Or maybe there's a lake or private property that we have to go around, or any other obstacle of geographic nature. We could run into serious problems if we don't accurately account for anything that might be in the way of the pipeline."

Combining maps with aerial imagery represents a huge advantage over analog maps which do not always clearly represent geographic features. Digital maps make it possible to apply color contrast or balance colors in an aerial image, and so enhance the features of interest—the added boon is that the enhancements can be done in real time.

"The use of color in GIS mapping is becoming a big thing," said De Leon. Some workers may find it difficult to read maps in a single color, or in infrared; De Leon can alter the color value, remove one color, or convert the image and save it as a grey scale, should workers in the field need an alternative selection.

Using image compression and manipulation software costs Enbridge a fraction of what it would cost to outsource reprojection, cropping, and color balancing. But De Leon is most enthusiastic about the time it saves field operators.

"Delivering all the map data they need for a job into the palm of their hands, so to speak, saves field operators, measurement technicians, and engineers hours and hours on the road. And, as the saying goes, time is money. The faster we can get work done, the better off our company will be," said De Leon, adding that each crew saves about an hour a week in driving time thanks to the improved navigation.

The accuracy of its reprojected images is so high that Enbridge has created a set of new road maps covering the areas through which the Texas Panhandle pipeline runs. The company has provided the maps to local emergency response officials so that their drivers can find the quickest route to Enbridge facilities in the event of an emergency.