New Mexico Coal Mine Reclamation and Abandoned Mine Land Programs, Mining & Minerals Division, Apply Updated GPS Units to Project Workflows.

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A Geographic Information System (GIS) is a critical component to all project activities performed by the New Mexico Coal Mine Reclamation (CMRP) and Abandoned Mine Land (AMLP) Programs, Mining & Minerals Division. Activities can include planning, reconnaissance, inventory, reclamation and safeguarding construction, monitoring, and oversight and inspection activities. Sources of the GIS data often come from mining operators, agency collaborators, contractors, or from our own staff. Over the years, much of the inventory work collected by AMLP have been with the use of global positioning systems (GPS) such as Trimble Geo Explorer XT and XH conjointly with Terrasync and Pathfinder Office software. These mapping grade units yielded on average 2-3 foot accuracies, post-processed. Difficulties associated with the older units involved their limited ability to use uploaded GIS data, limited space for background images, and slow redraw times. The CMRP staff has long used Garmin eTrex units and PDA devices running ArcPad as part of the inspections at active coal mines. Both programs benefited from GPS unit upgrades and ArcPad licenses provided by TIPS. The option to use Esri ArcPad on mobile units was needed to better integrate data collection with our geodatabase. Upgraded GPS units were needed for many projects requiring more accuracy. TIPS provided the AMLP with a Topcon GRS-1 and CMRP with a Trimble Juno SD unit.

Figure 1. Steven Lucero, NM CMRP Reclamation Inspector, using his Trimble Juno SB to delineate and comment on highwalls and reclamation status.

Figure 2. Back at the office, a look at the Juno unit loaded with digital basemaps provided by the mine operator and GPS inspection locations.

The New Mexico Coal Mine Reclamation Program staff now uses the Trimble Juno SB unit with Esri ArcPad software as a regulatory tool to ensure compliance with the New Mexico Surface Mining Act and the associated individual mine permits. During monthly mine inspections, state inspectors quickly and accurately identify and plot compliance points and areas using the Trimble Juno. Mine maps and multiple GIS layers are loaded into the handheld unit which then can be referenced throughout these

inspections. The identification of areas such as archaeological sites, wildlife buffer zones, surface water management structures and land ownership information is easily achieved with this device. Given the large aerial extent of these coal mines, this unit has been valuable in assisting state inspectors and mine operators identify permit areas for compliance.

The Juno SD collection accuracy is about 2-4 meters horizontal accuracy (median post-processing) based on our field use. It's light and easy to carry. Screen brightness is decent but one needs to completely shade the display or point into direct sunlight. The memory card allows for lots of space for background images. Overall, it is a nice upgrade to our GPS collection tools.

The Topcon GRS-1 handheld with optional 2 meter pole and 4 inch external antenna is used to collect data on several AMLP pre-construction projects. Topcon, with the aid of ArcGIS, is used to calculate areas of work, borrow area locations, and distances of access roads. The Spencer Mine project map (Figure 4) illustrates features collected with Topcon as well as features digitized in ArcGIS ArcMap. The set of features were then uploaded into the Topcon unit for use in the field.

Figure 3. James J. Smith, P.E. and Environmental Engineer for NM AMLP and CMRP, is shown operating a Topcon GRS-1 mounted on a pole with the external antenna.

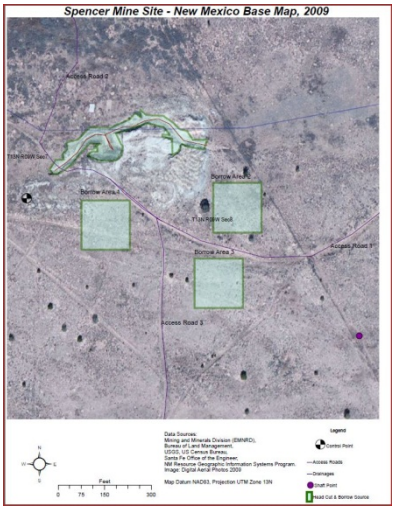

Figure 4. Map of Spencer Mine created by James J. Smith, P.E., in 2009 as part of planning for AMLP construction work.

The strengths of the Topcon include easy GPS collection, user friendly navigation, and a bright screen that can be read in direct sunlight. One of the project engineers was impressed with the ease of collecting points, after satellite signals received, by simply pressing the enter button. The point geometry and coordinates are readily stored and viewed when finished. Attribute collection is limited, however, without ArcPad installed. There is a Topcon equivalent to a data dictionary (Terrasync) but it is difficult to modify. Compared to user experience with Trimble Geo Explorer XH, the unit was not as user-friendly.

The navigation feature is quick and accurate. The user can create coordinates from the desktop and transfer them to the unit or select a previously stored point on the unit as a guide for navigation. Esri shapefiles can also be imported and used as new locations. The most impressive characteristic is the external antenna that boosts the unit's real-time field collection to two-inch horizontal accuracy in less than 30 seconds. Vertical accuracy has been tested to be within a foot and a half.

Both the Juno and Topcon have built in cameras, which is handy. Topcon picture quality was good however the picture taking process was too slow, involving many steps. Juno picture taking would freeze the operating system if not used properly. Photos and photo points created within ArcPad result in a more stable experience. Juno picture quality is harder to adjust. Overall, we found it better to create photos and associated coordinates with a separate GPS enabled camera.

Figure 5. An AMLP geomorphic project site, Swastika Mine, where land cover samples were collected with GPS units for a remote sensing classification analysis prior to construction. Map created in 2011 by Linda DeLay, GIS Specialist.

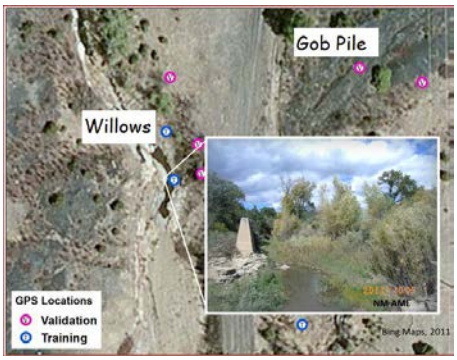

Figure 6. Close-up locations of GPS collections used to train and validate classes of land cover used in creating a map from satellite imagery. Linda DeLay, GIS Specialist collected data with both the Juno and a higher grade Trimble GeoXH unit.

TIPS has also aided our CMRP and AMLP programs by supplying satellite images of several NM active coal mines and an AML geomorphic reclamation site for use in remotely sensed vegetation monitoring methodology studies. These studies are currently in progress. The Juno unit with ArcPad was initially used to collect field training data. This data is used as input into a supervised classification to help create vegetation and land cover maps. The Topcon was taken in the field also for training set collection and was by far superior in terms of location accuracy. Collection in ArcPad can be accomplished with both a tap to a GPS icon and by digitizing with stylus over background images. Ultimately, we decided to assign the Juno SD unit to CMRP inspection staff and purchase a Trimble Geo Explorer Series 6000 for greater accuracy. This GeoEx 6000 utilizes ArcPad 10 and GPScorrect extension to collect features. We use the OSMRE licensed Pathfinder Office 5.3 with GPScorrect to differentially correct the GPS collections. Horizontal accuracies of 3-6 feet have been achieved, though we have not yet given the unit a proper evaluation.

Both the CMRP and AMLP are very happy with the GPS units supplied by TIPS and continue to use them in our projects. We have also been utilizing the TIPS GPS and ArcPad training courses to improve our operation of the devices and project applications.