



### PROJECT: A Mission to Provide Clean Water Turns into a Cadastral Adventure in the Jungles of Peru

PROJECT DATE: Ongoing

#### PROJECT HIGHLIGHTS

- USA surveyors help indigenous Peruvians determine village boundaries using Trimble technology
- Peruvian government acknowledges boundary lines, helps villagers prevent further encroachment
- High-powered Trimble Nomad handheld made for GPS data collection in harsh environments, such as under forest canopy

According to the World Health Organization, more than 1 billion people on Earth do not have access to safe drinking water. A group of surveyors and engineers from Colorado is working to make that number smaller, and in the process, clean up a boundary dispute.

Engineers Without Borders (EWB) is a non-profit humanitarian organization that partners with developing communities worldwide to improve their quality of life. In Fort Collins, Colorado, the local chapter of EWB "adopted" the Peruvian village of Santa Rosa de Dinamarca and offered assistance and expertise.

Santa Rosa de Dinamarca, home to about 750 families, lies in the flatlands of eastern Peru. While only about 40 km (24 mi) in a straight line from the provincial capital of Pucallpa, traveling to the village requires a six-hour boat trip on the Ucayali River.

Drinking water comes from a few wells, and many residents must carry it in buckets more than 1 km (0.6 mi) to their wood and thatch huts. Moreover, the wells are infested with e-coli bacteria due to the lack of sanitation systems, and as a result the villagers are constantly ill from drinking the contaminated water. Intermittent electricity comes from a 5Kw diesel-powered generator in the center of the village.

The EWB team developed plans to drill a new well, install solar-powered pumps and filters and provide a storage tank and water distribution system for the village. Surveyor John Von Nieda is one of a small team of EWB members who volunteered on the project. He enlisted the assistance of Bryan Baker from Frontier Precision, Inc., one of Trimble's largest and oldest MGIS and Survey dealers. Frontier Precision agreed to help sponsor the trip by providing all of the Trimble equipment and Bryan's time and expenses.

The team first visited the village in July 2007, when they planned to map the existing facilities and develop details for the water system. But the villagers had a new priority that radically changed the scope of the EWB visit.

Santa Rosa de Dinamarca is home to the indigenous Shipibo people, whose lands and culture are protected by the Peruvian government. While the ownership of their land is guaranteed, boundary lines exist only

on rudimentary maps and drawings. The Dinamarcans were concerned that non-Shipibo people from the north were encroaching into their land. When the Dinamarcans learned that the EWB team included surveyors, they asked them to solve the boundary issue.

"We were asked to establish the boundary for a 100 km<sup>2</sup> (38.6 mi<sup>2</sup>) parcel covered by thick jungle and swamps," said Von Nieda. "They handed us a tattered survey map from the 1991 government grant to the Shipibo that described the parcel. But getting that boundary tied to the ground was a major challenge."

A quick search of Google Maps showed that the Shapefiles received from the local government were outdated, and that the location of the Ucayali River had shifted significantly over the past 17 years. Because of this, the boundary maps and riparian boundary data were useless.

As a first step at obtaining spatially accurate boundary data, Von Nieda and Baker plotted the river's location using a Juno™ ST handheld GPS receiver on their river trip to the village. To mark the boundary on the ground, they relied on the Trimble GPS equipment, information from the local residents, and their own skill.

Von Nieda and Baker brought with them a multipurpose set of Trimble equipment. Baker's expertise with mapping and surveying hardware and software made it possible to easily assimilate the data from multiple hardware and software sources required for this project.

For GPS surveying, they had two Trimble R8 GPS receivers, a Trimble® TSC2® Controller and an array of batteries, poles and accessories. They also had a Nikon NPL-352 total station for use under jungle canopy. Baker added a Juno ST handheld for use in GIS mapping and data collection. Their modern equipment and laptop computers were enormously interesting to the locals; all work in the village was done with an audience of curious onlookers.

To begin their boundary work, the EWB surveyors set out into the jungle to locate the north boundary of the Shipibo land accompanied by two dozen machete-wielding villagers. Using the pocket-sized Juno ST handheld, the team navigated toward a point where they thought the northern boundary

## THE EQUIPMENT USED ON THIS PROJECT INCLUDES

- Juno ST handheld
- Trimble Nomad handheld
- GPS Pathfinder ProXH receiver
- Trimble R8 GPS receivers
- Trimble TSC2 Controller

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might be located. The villagers were very eager to blaze a trail along that line, but the team needed to collect more evidence and do additional research back in the states. They used the Juno handheld to map the locations of huts, trails, streams, and anything else that might be helpful in determining the boundary placement.

Once the EWB team finished their topo and planning surveys, they returned to the USA to begin processing the data they had collected. Over the winter, the surveyors completed extensive research and calculations, and returned to Peru in June 2008.

This time, the team was equipped with a high performance Trimble Nomad™ handheld field computer and GPS receiver, which is designed for use in harsh environments, such as under forest canopy, and a Trimble GPS Pathfinder ProXH™ receiver for advanced GPS positioning.

"This is by far the thickest, densest jungle environment I have ever seen, with canopy so thick it can feel like dusk in the middle of a clear, sunny day," said Baker. "For our second trip, it was clear that we were going to need the power and performance of the Trimble Nomad handheld and ProXH receiver."

Their first stop was in Pucallpa, where they met with national government officials to review Von Nieda's work. After detailed discussions, the officials accepted the minor boundary modifications and geodetic placement to coincide with the land title and agreed to send a representative to the village to inspect and approve the location on the ground. The officials were surprised by the extent of incursions into the land given to the Shipibo people, and promised to stop further encroachment.

To provide details on the encroachments, Baker conducted an aerial inventory of the area surrounding the village by using the Trimble Nomad handheld and GPS Pathfinder ProXH receiver. Working at an airfield near Pucallpa, he mounted digital still and video cameras to the side of a small airplane. He connected the cameras to his laptop computer and recorded the images coming from the cameras.

The pilot of the plane put the GPS coordinates for the boundary corners into the plane's GPS system, and using it to navigate the plane, the team flew along the Shipibo boundary collecting photos and video. After the flight, Baker correlated the images with positions from the Trimble GPS unit. The characteristics and locations of the encroachments were now documented. Finally, it was time to mark the boundary on the ground. The team loaded up



the boat and made the river trip to Santa Rosa de Dinamarca.

Again accompanied by an army of villagers with machetes, Von Nieda and Baker used the Trimble Nomad handheld and ProXH receiver to locate the boundary they had calculated over the winter. Using a base station running in a village just down the river, the postprocessed data from the GPS Pathfinder ProXH receiver was accurate within 30 centimeters.

The villagers installed monuments and blazed lines along the northern boundary. As promised, the government official visited the site to approve the monumentation. At last, the Shipibo communal lands were permanently marked on the ground.

Work continued on the original water system project as well. As an interim step, EWB delivered 300 bucket filtration systems to the village. While work on the boundary survey was underway, other EWB members installed the new filters and trained the villagers on their use.

There is more work to be done to ensure clean water in the village. Von Nieda is planning two more trips to the village with the goal of having the well, pump and storage tank operating by the end of 2009. The people of Santa Rosa de Dinamarca will soon have ample clean water to go with their secure, well-defined boundary.

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