Document 522
Post-Assessment Report

Chapter: Washington, DC Professionals
Country: Panama
Community: Hato Rincón
Project: CREER Energy and ICT Project

Prepared By:

September 20, 2015

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Post-Assessment Report Part 1 – Administrative Information

1.0 Contact Information *(correspondence regarding report reviews will be sent to the listed President, Project Leads, Mentors and Faculty Advisors)*

	Name	Email	Phone	Chapter Name or Organization Name
Project Leads				
President				
Responsible Engineer in Charge				
Traveling Mentor				
Additional Mentor				
Health and Safety Officer				
Assistant Health and Safety Officer				
Education Lead				
Planning, Monitoring, Evaluation and Learning (PMEL) Lead				
In-country Community Contact				
In-country NGO Contact				
In-country Local Government Contact				

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2.0 Travel History

Dates of Travel	Assessment or Implementation	Description of Trip
03/08/2014 – 03/16/2014	Assessment	EWB-DC's first assessment trip to Rincón established a partnership between the community and EWB. A thorough needs assessment was conducted and data was collected for the design of a civil structure in the community.
10/10/14 - 10/19/14	Assessment	A structural assessment was conducted to determine current construction methods and feasibility of using these methods with the CREER design.

3.0 Travel Team

Name	E-mail	Phone	Chapter	Student or Professional

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4.0 Health and Safety

4.1 Incident Reports

Did any health or safety incidents occur during this trip? ___Yes _X_No

If there were any health and safety incidents during the trip, check "Yes" and submit your completed 612 - Incident Report document as a separate attachment with this report. For further details, refer to this section in the 522 – Post-Assessment Report Instructions. If there were no incidents, check "No."

5.0 Planning, Monitoring, Evaluation and Learning

5.1 Canceled/Non-functioning Projects

Has the status of any of this program's past-implemented projects changed to Canceled or Non-functioning? ___Yes _X__No

5.2 If this was the <u>first assessment trip</u> for the program, is the 901 – Program Plan and Baseline Study included with this report?
___Yes ___No _X__Not the First Assessment trip

5.3 If this was <u>not the first assessment trip</u> for the program, is the 901B – Program Impact Monitoring Report included with this report?
_X__Yes ___No

5.4 Is the signed 902 - Project Partnership Agreement included as an appendix to this report? ___Yes _X__No (submitted for Assessment Trip 2 – October 2014)

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6.0 Budget

6.1 Project Budget

EWB-USA TRIP BUDGET

EWB-USA Chapter Name ::	DC Professionals
Project Name ::	CREER Panama
Type of Trip ::	

Trip Type: A= Assessment; I= Implementation; M= Monitoring + Evaluation
NOTE: The fees associated with each trip type will auto-populate the EWB-USA HQ section.

Lines with an asterisk are automatically calculated.

	A	
	BUDGET *(PRE-TRIP)*	**ACTUAL EXPENSES** *(POST-TRIP)*
DIRECT COSTS		
Travel + Logistics		
Airfare ($600 x 3 people)	$1,800	$2,767
Food + Lodging	$500	$500
In-country transportation	$255	$372
Sub-Total*	**$2,555**	**$3,639**
Labor		
In-Country Logistical Support	$40	$60
Local Skilled labor		
Sub-Total*	**$40**	**$60**
EWB-USA HQ (this section is auto-calculated based on trip type)		
Program Quality Assurance/Quality Control + Infrastructure*	$2,000	$2,000
Less EWB-USA HQ Subsidy*	$1,395	$1,395
Owed by Chapter Sub-Total*	**$605**	**$605**
Project Materials + Equipment (itemized, as appropriate)		
Multimeter	$100	$0
Solar Meter	$250	$0
Training Materials (posters, booklets, etc.)	$300	$0
Water flow meter	$80	$0
Topographical Survey (Rental)	$0	$0
Aggregate screens	$100	$25
Cell Repeater Rigging Equipment		$100
Fluorescent Light Bulbs		$30
Sub-Total*	**$830**	**$155**
Misc. (details required)		
First Aid Kit	$0	

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CPR training ($50 x 1)	$50	$50
Sub-Total*	**$50**	**$50**
TOTAL DIRECT COST*	**$4,080**	**$4,509**
IN-KIND CONTRIBUTIONS		
Community In-Kind Contributions to Project Costs		
Labor		
Materials		
Logistics		
Sub-Total*	**$0**	**$0**
TOTAL IN-KIND CONTRIBUTIONS*		
FUNDS RAISED		
Funds Raised for Project + Grants Received		
Cash from community (EWB-USA requires a minimum 5% contribution)		
Total $ in Project Fund at EWB-USA HQ	$3,682	
Total $ in Project Fund at University		
Total*	**$3,682**	
Funds Raised for Chapter		
Total $ in Chapter General Fund at EWB-USA HQ	$-447	
Total $ in Chapter General Fund at University		
Total*	**$-447**	

It should be noted that all in-country expenses (i.e. food, lodging, logistics, and in-country travel and supplies) are paid by donations from the travel team. These items are included in the budget to keep track of money spent on the project, but are handled as cash brought on the trip and do not pass through the account held with EWB-USA. The only purchases made through the account are airfare and insurance.

6.2 Professional Mentor Team Hours

Name(s) of Professional Mentor(s)	Pre-trip hours	During trip hours	Post-trip hours	Total Hours
1.	80	80	40	200
2.				

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7.0 Project Discipline(s): Check the specific project discipline(s) addressed in this report. Check all that apply.

Water Supply
____ Source Development
____ Water Storage
____ Water Distribution
____ Water Treatment
____ Water Pump

Sanitation
____ Latrine
____ Gray Water System
____ Black Water System

Structures
____ Bridge
__X__ Building

Civil Works
____ Roads
____ Drainage
____ Dams

Energy
____ Fuel
__X__ Electricity

Agriculture
____ Irrigation Pump
____ Irrigation Line
____ Water Storage
____ Soil Improvement
____ Fish Farm
____ Crop Processing Equipment

Information Systems
__X__ Computer Service

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8.0 Project Location

Latitude: N 8°28.992'
Longitude: W 81°47.649'

9.0 Project Snapshot for Publicity

9.1 Problem identification *(one sentence)*

Hato Rincón is an indigenous, rural community in Panama that has little access to information and communication, significantly limiting their economic opportunities and their children's educational outcomes.

9.2 Project goal *(maximum three sentences)*

The CREER Panama Project seeks to construct a building in Rincon that will house a library, computer center and a community center. The principal objective of the project is to increase access to information and provide the students with the educational tools that they need to succeed. The community members also plan to use the computers to document their indigenous language and culture, apply for government services and access better health care information, including telemedicine.

9.3 Project status *(maximum 100 words)*

The project is currently in the design phase for the structural and energy/ICT systems. The team plans to have an analysis of alternatives complete for both systems by the end of the year, with implementation starting in the summer of 2016.

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Post Assessment Report Part 2 – Technical Information

1.0 Executive Summary

The third assessment trip of the EWB-DC CREER Panama program took place between June 26th and July 5th, 2015. This trip was focused on the Energy and Information and Communication Technologies (ICT) project within the program, although some work was also done to confirm assumptions for the structural design of the Centro de Recursos Educativos en Rincón (CREER). The team was also requested to advise the community regarding their existing water system. The first assessment trip taken by the Program was focused on forming a relationship with the community and confirming the team's understanding of their needs and preferences. The second assessment trip was focused on gathering data related to the structural design of the CREER building. The Program now has all of the information and data necessary to proceed through design and has been working towards that goal, beginning with submittal of a 523 – Analysis of Alternatives report by the end of 2015.

The majority of the trip focused on energy and ICT objectives. This included investigating the existing solar panel systems, measuring the potential for a new solar panel system, and scouting the nearby stream for potential and feasibility of a micro hydro power system, all of which could generate electricity for the CREER. Regarding the ICT project, a proof of concept test was performed for a cell signal repeater and a laptop loaded with Rachel Pi educational software was loaned to the community to build a better understanding of their interests and usage patterns once the team returns to collect the laptop for analysis.
Several meetings were held during the team's trip, further strengthening ties with the community. Two of these meetings included representatives from two different programs within the Panamanian government, who had traveled out to Rincón for this purpose. The Office of Rural Electrification (OER) receives funding to extend the national electricity grid into rural areas, and the representatives indicated that Rincón is an excellent candidate although the timeline for construction would be at least a few years away. The other program that sent a representative to meet with the community is the National Secretary for Science, Technology, and Innovation (SENACYT). This organization is responsible for the extension of the information technology to rural and indigenous areas of Panama. This mostly manifests in Infoplazas, small computer centers with internet and other services, and maintained by trained staff. The possibility exists to establish the CREER as a rural Infoplaza.

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During this third assessment trip, design parameters and assumptions were confirmed for the structural design of the CREER building. These tests included a topographic survey, testing of concrete cylinders made by the community's method of mixing cement, soil testing, sieve analysis of the community's aggregate, and confirmation of the building architecture. These tests all resulted in confirmation of the team's previous data and assumptions, and will not result in significant changes to the current design idea and renderings.

The community's existing water system captures water from a spring up the mountain from Rincón and distributes it to several taps throughout the community, and has been in operation for several years. During a period in each of the past two years, the spring feeding the system has run nearly dry, leaving many without water. At the request of community leaders, the EWB-DC team investigated a potential new source of water that the community had proposed. The team was careful to advise the community without stepping into a position to be held liable for any design decisions. We will continue to monitor the situation and if the water shortages continues we will explore the possibility of expanding our program.

2.0 Program Background

Hato Rincón is a remote community located in the Ngöbe-Buglé indigenous territory of Panama. Rincón lies in the center of the district of Jädeberi, about an eight hour drive from the capitol of Panama City. The residents of Rincón are primarily subsistence farmers and artisans, with a population of roughly 800. Rincón is the biggest community within Jädeberi and houses both primary and secondary schools for the region. Over the past decade the Community has been working with government ministries and non-governmental organizations (NGOs) to address their primary needs including improved water and sanitation, development of sustainable agriculture, access to educational opportunities through computers and the internet, access to electricity, improved healthcare services, and better housing.

The community of Rincón learned about EWB from Engineers Without Borders Washington DC Professional Chapter (EWB-DC) member who traveled to Rincón in 2011. With the help of and other volunteers the Community submitted a 501 New Project Application requesting engineering expertise from EWB-DC to assist with the implementation of basic infrastructure. The most desired potential improvement in the community that would complement on-going efforts by the Community and its partners, detailed in the Project Application Form 501, was the construction of a computer center. In June 2013, this project was approved by EWB-USA and subsequently the project was awarded to EWB-DC in August 2013.

Due to their isolation and lack of resources, Rincón has very limited educational opportunities. Students graduating from local schools who start high school outside this area have often never

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used a computer. They find themselves competing with students who have years of experience with computers and the internet, and often their success at the high school level and their chances of continuing to university are negatively impacted. For the communities in the area, access to information including national and international current events, modern science, best practices in sustainable development, and international funding sources and opportunities are restricted to what's aired on the radio. The Rincón community is further limited by the process of requesting government support for local projects, in that documents must be typed and printed. This requires a prohibitively expensive and time intensive trip to the nearest computer center (5 hour journey), as well as a working knowledge of computers. For this reason, Rincón has been working to realize their dream of a local computer center and library. Community members have already collected donations of books for the library.

The community is hard-working and very well organized. They have established various committees to implement development projects such as: construction of a water system, latrines, community farm, and fish ponds. Community members have elected committee for the computer literacy project, and continue to meet on a regular basis to discuss and support the project with local resources and knowledge including: labor, wood, sand, construction equipment, expertise in health, masonry, education, and the aid of local political figures. They are the perfect example of a community looking to achieve a higher standard of living.

The EWB-DC team has established the following goal and objectives, captured in our 901 and Logical Framework, for the program.

Overall Goal

- Improve access to information and communication, advance the educational outcome of students, and empower community members to use technology.

Specific Objectives

- Repair/implement/maintain the facilities and supporting infrastructure necessary to improve access to information.
- Train community members to use technology and other resources to attain higher economic output, preserve indigenous language and folklore, and integrate in day-day activities.
- Expand the community's organizational capacity and increase technical skills.

Our first assessment trip was carried out in March 2014, when the team established contacts and began a working relationship with the community, established contacts with in-Country NGOs,

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and began data collection efforts needed for alternative analysis and design of projects. A second assessment trip was taken in October 2014 when the team conducted a detailed analysis of the program's infrastructure needs, with a focus on structural needs. During this trip the team signed Partnership Agreements with the community and an NGO, Health Empowering Humanity (HEH). Alianza para la Conservación y el Desarrollo/Alliance for Conservation and Development (ACD) was originally identified as a partner by the community in their 501 application. The team has met with both ACD and HEH on separate assessment trips. While ACD is based in Panama, the team feels that HEH will be a better primary NGO partner because they have more in-depth knowledge into the specific community of Hato Rincón, as well as more frequent and depth contact with the community. For this reason, HEH has been the primary partner NGO since the second assessment trip in October 2.

As we undertook this review and addressed comments made by EWB staff after the second implementation trip, we recognized a third assessment trip was needed to gather additional data, particularly for our energy/information systems project, and to explore additional partnerships needed to ensure program success. The table below summarizes our contacts organizations involved with on-going activities in Rincón.

Organization[JC 2]	**Mission**	**Current Activities**	**Potential Participation**
Health Empowering Humanity (HEH) - NGO	Empower impoverished and marginalized communities to improve their own quality of life through access to quality basic medical care and community development, in accordance with fundamental human rights.	Works with the community in Hato Rincón to help them organize and self-advocate, liasing with external groups for assistance with development projects.	A Project Partnership Agreement was signed between EWB-DC, the community, and HEH. They are instrumental in coordinating with the community and assisting in EWB-DC's efforts on the ground.
Alianza para la Conservación y el Desarrollo en Panama (ACD) - NGO	To promote conservation and alternative development through empowerment of a more just and	Promotes conservation and alternative development projects throughout	ACD could provide assistance in transport logistics between Panama City and the community, as well

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	environmentally friendly Panamanian society.	the Ngobe-Bugle Comarca. No current activities in Rincón.	as help navigate any correspondence with commercial or governmental parties.
Secretaria Nacional de Ciencia, Tecnologia, e Innovacion (SENACYT) - Panamanian Government	Convert science and technology into tools for sustainable development in Panama.	SENACYT has a broad array of activities focused on promoting the sustainable use of science and technology in the indigenous areas of Panama.	Installation of an Infoplaza in Rincón, supplying computers, internet, and maintenance of these systems.
Oficina de Electrificacion Rural (OER) - Panamanian Government	Increase access to electricity in rural populations, wth the goal of reducing poverty and bettering the lives of the population, while increasing the efficiency of public and private resources used in the energy sector.	Extending the national electric grid into rural areas, including indigenous populations, that want electricity.	Grid extension into Rincón.

The main challenges we face included cost, complexity of the project, and need for training in the community. We also realized our program is somewhat unique in that it does not fit into just one EWB project categories. Currently we have two projects approved: construction of a center to house the computers and library (structural) and an energy/information systems (IT) project to provide the power necessary to run the Resource Center. Each of these will require several implementation trips and will likely overlap or "leapfrog" each other at times.

Our goal is to break the projects into work packages (small projects) that can be completed in one or two implementation trips that provide immediate benefit. For example repairing the existing solar power system would provide lighting in the classroom and power for computers they currently have. We envision implementation occurring over the next three years broken into three phases.

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- **Phase I** – Implementation of several "small projects" combined with training that are needed to prepare for the main construction effort.
- **Phase II** – Construction of the building and a new and expanded energy system. This will be when most of the construction occurs.
- **Phase III** – Implementation of a library and tech center. This involves furnishing the building, setting up computers, establish operations, and training.

We are now moving forward with both the alternatives analysis and preliminary design of each project. Sequencing of the projects is a major consideration and will presented in our 523, 524, and 525 documents. The following sections summarize the data collected on our recent trip.

3.0 Project Description

CREER - Centro de Recursos Educativos en Rincón (Educational Resource Center in Rincón) consists of a library and computer center with a meeting space for the community of Hato Rincón, Panama. The structure will be designed and constructed to meet the community's needs, while taking into account the local environmental and geotechnical factors. Alternative energy sources will be used as the community is not currently connected to Panama's electricity grid.
The CREER structure will be used for the following purposes:

1. Library – A small library will be established and maintained with books acquired by the community.
2. Computer Center – The center will provide the community with access to the internet and complement school education. The computers will be used not only for educational purposes, but also for communication and access to information such as improved health services.
3. Meeting space – Community members and community-based organizations will be able to meet at this center and use a projector for holding seminars.
4. Evening classes – Community members plan to conduct adult literacy classes for community members in the evening, making use of the lighting and infrastructure of the center.
5. Cultural Preservation – Rincón and the surrounding Ngobe communities are interested in using the computer technology to document the Ngobe language and culture. This will be done through audio and video recordings, as well as story-telling.
6. Telemedicine – Community members hope to use computer and the internet to access telemedicine services.

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4.0 Trip Description

EWB-DC'S third assessment trip to Rincón, Panama was conducted between June 26th and July 5th, 2015. Five members from the CREER team traveled on this trip: . This group consisted of engineering professionals. Figure 4.1 shows a schedule of activities that reflects the team's efforts while in the country of Panama and the community.

4.1 Friday, June 26th

The majority of the group flew from Baltimore, MD to the capitol of Panama, Panama City. One member flew from San Pedro Sula the same day and met up with the rest of the group at the hotel.

4.2 Saturday, June 27th

The group traveled by bus from Panama City to San Felix. From the San Felix bus terminal, the team traveled to Hato Rincón via one of the trucks that frequently travels between the two locations. Once in Rincón, they were met by , who both have previously lived in the community while working for HEH. After settling in and setting up camp, the team met with , members of HEH, and , members of the CREER committee, and planned the week's meetings and tasks.

4.3 Sunday June 28th

Upon the community's request, the team met with (also a general leader in the community) and leaders of the water committee to discuss current water shortage issues. led the team up the mountain to a new springbox the community had built so that EWB-DC could do a rough assessment of the situation. The team took notes on the springbox and further explored the area, as detailed in Section 3.4 below.

Heading back down to the community, the team split into smaller groups with members of the community and HEH as guides. This allowed the team to do a brief, qualitative assessment of the hydropower resources available, visit the existing water tank that had essentially run dry at the time of the trip, and also visit a potential new tank site while collecting cell signal data before reconvening at the camp in the community.

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4.4 Monday June 29th

The day begin with observing the procedure for concrete production. Two community members made two different types of concrete. One mixture used for slab, beams and columns and another for Concrete Masonry Unit (CMU) blocks. Four test cylinders were made from each mixture for a total of eight cylinders. These were brought back to Washington, D.C. for testing. A CMU block was also made so that the process could be observed. Additionally, . collected samples of the aggregate that the community uses to make cement.

Arrangements had been made to have a representative from the Office of Rural Electrification (OER) come to Rincón to meet with the community about the possibility of having the national electric grid extended to the area. ., went to Hato Chami to escort the representative, , up to Rincón. Engineer spoke with the community and our team regarding the cost, feasibility, and timeline for extending a power line from Hato Chami to Rincón. After the meeting with OER, the EWB-DC team met with the CREER committee members for a preliminary discussion of issues to bring up at the CREER-led community meeting to be held the following day. Issues included changes to the structural design of the building, potential for a cellular repeater installation, options for provide power to the CREER building, fundraising opportunities, and other logistics. Because of the heavy rain that day, the team was able to observe and identify potential drainage at the proposed building site. Later in the evening, used some tools on a nearby hill to characterize the cellular signal in the area. This gave the team an estimate of the tower location and signal strength.

4.5 Tuesday June 30th

The majority of the day was spent in a CREER committee-led community meeting. At the meeting, the community approved pursuing the extension of the power line through the OER program, approved proposed structural changes to the CREER building, discussed different window alternatives, learned about the cellular repeater, and were presented with a laptop containing the Rachel Pi system.

Following the meeting, worked with to do diagnostic testing of the solar system at the health center. also presented with an operations & maintenance manual for the system and completed a thorough analysis of the solar systems at the school. and did a topographical survey of the CREER site during this time. Later in the evening, the team temporarily set up the cellular repeater and tested the effectiveness on their personal phones, with some degree of success.

4.6 Wednesday July 1st

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Arrangements had been made for a representative from SENACYT to come to Rincón and meet with the community about the potential for building an Infoplaza on site. , went to Hato Chami to escort a representative from SENACYT, , back to Rincón. The EWB-DC team met with the Raul and discussed requirements SENACYT has for its computer program, as detailed in Section 3.3.3 below. A main takeaway from this meeting was that the internal computer room, within the CREER building, must allow the library administrator to see each of the computer screens, changing the layout of the floor plan, as described in section 5.1.3 below. Another key takeaway was that SENACYT will be providing a satellite uplink along with the computers. Unfortunately, it was also determined that the library administrator will not receive any compensation from SENACYT, as previously thought. Rather the administrator is trained by SENACYT and paid by the community.

took a trip to San Felix with to take notes on what is provided in the Infoplaza and do a survey of solar power system components in the hardware stores for cost and availability. The rest of the team met at the school with the Padres de Familias (PTA) and teachers to share the information garnered from the meeting with SENACYT and to brief on the current status of the solar panels.

Following the meeting, the team did a soil test at the proposed CREER site location, which involved taking a sample of the soil at the top layer of the ground, digging down four feet, and taking a sample from the bottom of the pit. The ground was much rockier than anticipated and the community pitched in to help dig. Soil samples were taken and analyzed as described in section 5.1.2 below. Lastly, the team characterized the potential for solar panels at the proposed CREER site using a Solar Pathfinder, as described in section 3.2.2.

as a guide and translator walked around the school grounds in the late afternoon to observe the exterior architectural and structural components of the school buildings. During this time structural and architectural components such as columns, beams, roofing material, windows, doors, etc. where measured for reference during the design phase. A conversations also occur with a teacher and community members with regards to how the structures were built, and what design flaws should be avoided if possible during the construction of CREER center.

4.7 Thursday July 2nd

left Rincón for Panama City in the morning. The rest of the team split up to various finish tasks throughout the day. focused on evaluating the solar power systems and restoring lighting to some of the classrooms. The rest of the team documented the buildings within the community, documented and took a GPS survey of the inlet infrastructure for the fish ponds, and prepped a site on a hill within the community for testing the cell signal repeater. Once

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, finished with the classrooms, the entire team, along with and , erected the repeater on a 20-foot pole, tested its effectiveness at amplifying cell signal over longer ranges (several hundred feet), and trouble-shooted a few issues.

While continued to work on the repeater, measured dimensions of the site of a future secondary school to be built for the community, as requested by the PTA. discovered the repeater had been burnt out for an unknown reason and the team took down the antenna. To finish the day, training in use of the donated computer and the team exchanged trip photos with .

4.8 Friday July 3rd

flew back to Washington. The team left Rincón and gathered price data of various building materials in hardware stores in San Felix before spending the night in the San Felix area.

4.9 Saturday July 4th

The team traveled back to Panama City from San Felix. met with and from Walter P. Moore to gain insight into structural engineering issues in Panama City and to being a relationship with engineers in country. flew back to .

4.10 Sunday July 5th

The rest of the team flew back to Washington.

5.0 Data Collection And Analysis

5.1 Structural Items

There were five primary objectives on this trip with regards to the structural portions of the project: taking an accurate Site Survey, observing existing soil conditions on site, obtaining a better understanding of typical architectural and structural practices in the area, ensure that our design was still in line with what the community had envisioned, test current concrete practice and observe what other materials are readily available in the area.

5.1.1 Site Survey

A site survey took place on June 30th, 2015 at the proposed CREER building site location in Hato Rincon. It was conducted with a transit, measuring rod, and engineering survey tape. The transit was set up at a single location and 35 elevation measurements were recorded relative to the transit, as shown in Appendix A. The site survey shows the distance and direction taken from magnetic north. The survey layout shows the location and the relative elevation from the lowest point during the survey taken as a datum. During the day before the site survey, it rained heavily

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throughout the day. Consequently, water flow through the community and adjacent ponding were recorded and mapped. This was not seen on previous trip implementations trips. Alternate drainage designs are being explored by our design team as we work through the alternative analysis. We want to ensure the footings and foundation are well drained and that ponding near the building will not occur. Care is being exercised to ensure that we do not simply divert the water creating problems elsewhere in the community.

5.1.2 Soil Testing

On July 1st, 2015 a test pit was dug under recommendations outlined in the Structural Guidelines section of Technical Guidelines Resource on the EWB website. The site of the test pit was done at the location where the transit readings were taken during the site survey. The hole was approximately 2 feet in diameter. A larger hole was considered, but ultimately not chosen in order to reduce potential hazards for school children playing in the area and to ease the concerns of the community. Soil sample 1 was taken at 4 inches below the surface. At this depth several pieces of plastic garbage and metallic objects where encountered. The EWB team hypothesized that this layer probably consists of runoff from up the road and/or back fill from prior construction jobs. At various depths throughout the excavation, several large rocks estimated to be from one foot to two feet in diameter, were encountered. After 90 minutes of digging, the hole reached a depth of 42 inches. Further excavation was terminated due to the extraneous effort to dig the remaining 6 inches of the test. At this depth soil sample 2 was taken. It should be noted that the soil samples taken did not account for the large quantity of gravel in the test pit. The gravel was removed from the test samples in an effort to prevent the mason jars from cracking during the shake portion of the soil test.

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Figure 5.1.2 – Soil Testing Hole

The soil samples were analyzed over the next 24 hour period and the composition can be found in Table 5.1.2. Additional information can be found in Appendix B. Comparing the findings from the soil sample tests and the high volume of gravel that was excluded, the soil was classified as *sandy gravel*, at a 42 inch depth and *silty gravel* at a 4 inch depth. Comparing this finding to Table 1806.2 Presumptive Load-Bearing. Values in the *International Building Code 2009* (IBC 2009), this would produce an allowable load of 3,000 psf and 2,000 psf. for footing design and slab design respectively. However, due to the precision of these tests compared to a standard sieve analysis, EWB-DC is selecting a more conservative bearing pressure. The design of the building will use bearing pressures of 2,000 psf. and 1,500 psf for footings and slabs respectively. During the construction phase another on site soil composition analysis will be conducted to ensure that the design assumptions have been met or exceeded. In accordance with the IBC 2009, in lieu of a more in-depth soil mechanics analysis, site class D will be used for seismic design. The team is comfortable with this assumption because when the gravel content is included into the overall soil content there is a much lower quantity of clay and organic matter, than the amounts that would have warranted the use of site class E or F.

Table 5.1.2 – Soil Composition

Soil Sample	Composition	Fine Gravel & Sand	Clay	Silt
1 (Top)	**Depth**	1 ¼”	5/16"	1/16"

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	Percent	77%	19%	4%
2 (Bottom)	**Depth**	1”	1/2”	1/8"
	Percent	62%	31%	8%

Members of the community noted the area of the building site, originally believed to be bedrock, probably consists of larger boulders roughly 2 -4 feet in diameter. This is typical of what is encountered elsewhere in the community. The community members who helped with the excavation explained that when obstacles of this nature can’t be removed simply by hand, they will typically take a sledge hammer and smash it into more manageable sizes. An additional method used by the community is to heated up the large rock with fire and then rapidly cool with water, making it easier to break up. Due to the amount of manual labor required for the soil testing, the design team is exploring different alternatives during the analysis and design phase of how and when to plan excavation. For example: A more appropriate plan may be to have the have the community excavate and level the site prior to the EWB’s arrival for the foundation construction implementation trip; allowing for the team to quickly adjust the grading if needed and start pouring concrete foundations and slabs. This also ensures community involvement.

5.1.3 Meeting with the Community Regarding Overall Building Layout

Two meetings were held between EWB-DC and the community of Rincon, to ensure that our plan was still on task with the vision and objectives of the community’s needs. The following topics were approved by the community during these meetings: use of glass block windows on the north and east walls of the building, glass sliding windows with steel security bars that allow air flow, an emergency egress door at the east face of the building, a gable roof style, a wall on the north side of the porch to block debris picked up by the wind during the windy season. See Figures 5.1.3A and 5.1.3B for CREER Center approved modifications. It should also be noted that although SENACYT hasn’t committed to helping the community, they require all computer screens to be visible at all times by the individuals in charge of the center. To accommodate this suggestion, several table configurations are being examined that will prevent theft of the computers, while allowing the computer lab’s monitor to have full view of all computers.

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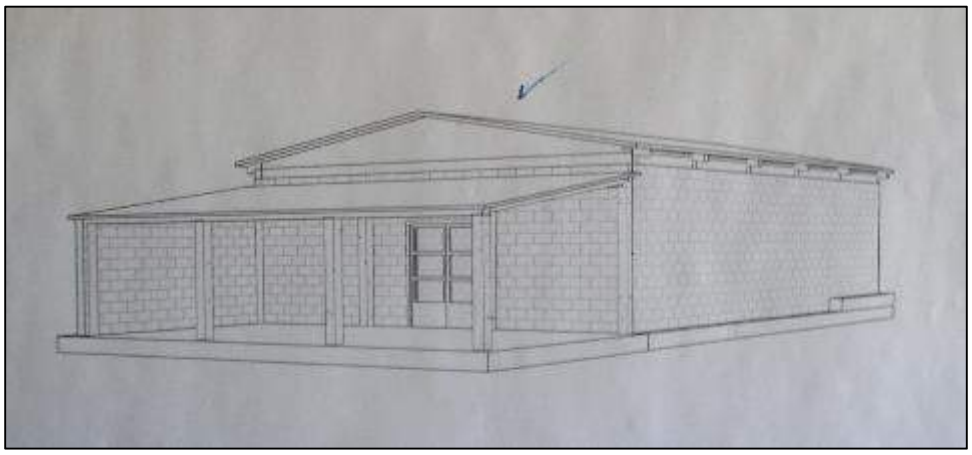

Figure 5.1.3A – CREER External Modifications

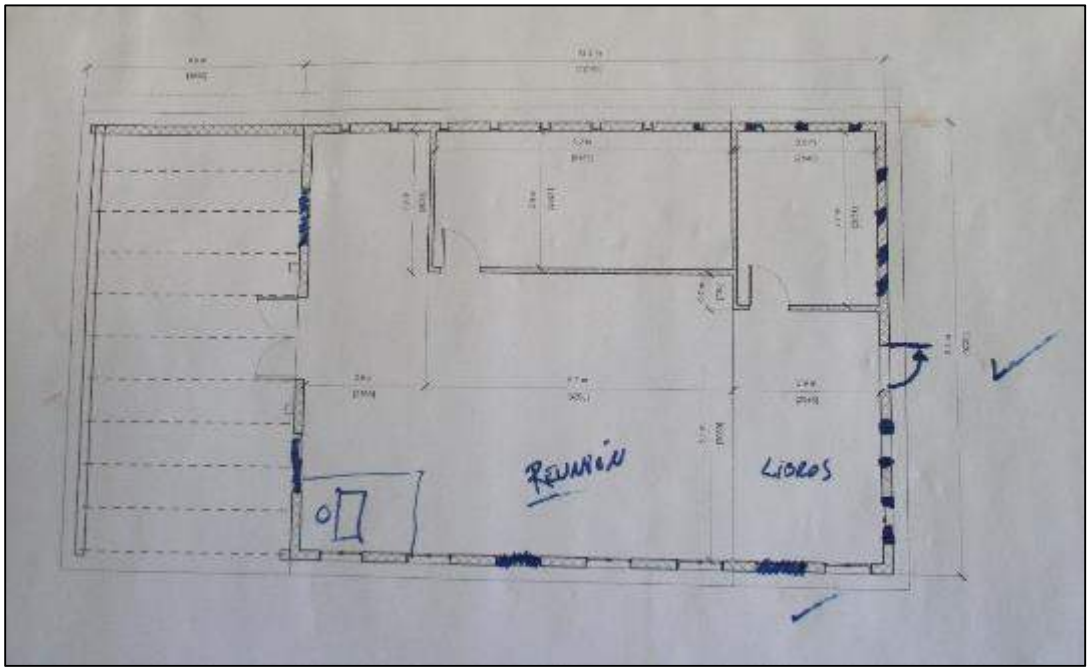

Figure 5.1.3B – CREER Internal Modifications

5.1.4 Existing Structure Survey

Several structures were thoroughly examined to gain better insight as to the materials and construction techniques leading to a building that is both structurally sound and economically feasible. These buildings included the health center and the school, which were built either by professional contractors, or the government. The school will be most similar to the structure type and design of the CREER Center. The school complex is split into several different buildings, with the newest structure built in 2009. The buildings were erected by the Panamanian Education Department. The buildings have gabled style roofs with metal deck roofing attached to cold form steel c-sections both by welded rebar and screws. Newer decking appeared to have an element

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resistive coating on it. The team was able to examine the sound proofing insulation that was installed after the last implementation trip. These were thin sheets of insulation and metal slipped under wire between the zinc roof and the cold form steel beams. This type of sound proofing insulation will be incorporated into our design. Having recently been outfitted with insulation between the roof decking and the rafters, the building has better sound damping during rain storms and acts to better insulate the rooms against the heat during the day. The walls of the building were constructed with CMU blocks plastered on either side to produce a smooth surface. Window opening used perforated CMUs to adhere to the desired window specifications. A porch is also typical at the front entrance of school buildings throughout Rincon and neighboring communities. These are constructed out of a metal deck canopy that continued down from the metal roof and extends to structural cast-in-place concrete columns that are assumed to be reinforced with rebar. The slab was a typical cast-in-place slab. The cast in place porch depth of the newest building was deeper to offset the elevation running alongside the building.

A more in-depth survey of the existing buildings within the community was conducted over the course of the assessment trip. Several structural elements that had previously been missed were observed on this trip to show signs of wear and tear. The majority of them were likely due to the uplift caused by wind loading. Figure 5.1.4A School Beam Cracking at Roof Beam portray cracking in cast in place (c.i.p.) beams stemming from the cold form steel roof support beams. The open air meeting building was observed to have a cold form steel girder truss reattached to a roof support beam with a cord on the windward side of the building where rust had caused the two elements to come apart. It was also typical to see large rocks roughly 1’-2’ in diameter or cmu blocks weighing the roof down to eliminate noise caused by deflection due to uplift on the roof. See Figure 5.1.4B Weighted Roof. The trip took place during the windy season, and the wind was observed to be calm at times with heavy sporadic gusts that were powerful enough to blow rocks up to 2”-3” off the central soccer field onto the top of the church in a lower lying area. The REP 2004 Reglamento Diseño Estructural Panama, the current building code in Panama based off ASCE7, requires a basic wind speed of either 140km/hr (87mph) or 115km/hr (72mph) for the pacific and Caribbean sides of the country respectively. Comparatively ASCE7-05 typically requires minimum basic wind speed of 90mph east of Mississippi, with up to a 150 mph basic wind speed along part of the Gulf Coast and Florida. Due to the aforementioned items, a more appropriate higher basic wind speed is being researched, with an emphasis on the effects from higher elevations with mountainous topography. Properly analyzing this structure with a higher wind speed will mitigate the risk of potential structural degradation over time.

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Figure 5.1.4A – School Beam Cracking at Roof Beam

Figure 5.1.4B – Weighted Roof

Cracking of concrete floor slabs was observed in several buildings ranging from hair line fractures to ¼" width. The church was one of the building that was erected by the community that appeared to adhere to a more ridge structural design than most. This building showed several

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structural problems unrelated to the effects of wind. The c.i.p. beam supporting the roof of the church exhibited cracking the entire depth of the beam. See Figure 5.1.4C Church Beam Cracking. These cracks are hypothesized to come from a poor concrete mix, poor construction implementation practices during the forming process, and/or wear and tear due to age. The door hinges of the church had come free from the CMU walls designed to hold them. See Figure 5.1.4D Church Door Separation.

Figure 5.1.4C – Church Beam Cracking

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Figure 5.1.4D – Church Door Cracking

5.1.5 Available Materials

Another hardware store other than the one previously visited on prior assessment trips in San Felix was assessed as an alternate spot to obtain building supplies from. A rough list of material costs and shipping costs from the hardware store is given in table 5.1.5. The contact information was also obtained from the steel manufacturer to verify steel material properties during the materials selection phase ( ). It should be noted that this list is not completely comprehensive of all misc. tools, and materials required for temporary construction purposes such as temporary forming and shoring.

Table 5.1.5 – Materials in San Felix Hardware Store

Item	Size/Quantity	Cost
Steel Grate	4'x8'	$22.50 per/unit
Cold Form Steel "C" Sections	3"x2"x20'	$12.00 per/unit
	4"x2"x20'	$14.00 per/unit
	6"x2"x20'	$22.00 per/unit
Zinc Roofing	42" width	$1.40 per/ft.
Painted Roofing	44" width	$2.25 per/ft.
Rectangular Tubing	2"x4"x⅛"x20'	$60.00 per/unit
	3"x3"x⅛"x20'	$50.00 per/unit

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	3"x3"x3/16"x20'	$70.00	per/unit
	4"x4"x⅛"X20'	$60.00	per/unit
	4"x4"x3/16"x20'	$85.00	per/unit
Circular Tubing	3"Dx20'	$53.00	per/unit
	4"Dx20'	$65.00	per/unit
Hot Rolled Steel Angles	1½"x1½"x1/16"x20'	$15.00	per/unit
	1½"x1½"x3/32"x20'	$20.00	per/unit
	1½"x1½"x⅛"x20'	$25.00	per/unit
	2"x2"x⅛"x20'	$20.00	per/unit
	2"x2"x3/16"x20'	$28.00	per/unit
Cement	42.5kg	$9.75	per/sack
Rebar	#3x30'	$3.50	per/unit
	#4x30'	$7.50	per/unit
	#5x30'	$12.00	per/unit
Transportation	30 sacks concrete	$75.00	per/trip

Concrete samples for both the CMU mix and the slab concrete mix were collected on the trip to better understand the mechanical properties exhibited by the concrete using local aggregate. Eight 4”D x 8”L cylinders were procured on site by the community using their typical methods. These were brought back to the United States for testing (four for grout and four for concrete). By testing the community’s design mix practices, there is now a degree of confidence that if a structural elements is accidental constructed using the local mixing methods at the very least the initial design assumptions will be met.

The cylinders were tested on June 28th, 2015 and on August 4th, 2015 by ECS Mid-Atlantic. The results can be seen in Appendix C. Due to travel requirements, and availability of ECS Labs, the tests did not completely adhere to ACI standards, but are still an acceptable guideline for concrete design properties. After reviewing the results, it was determined that all slabs, reinforced concrete columns, and reinforced beams will be designed using a 2,000 psi strength concrete. Test samples for both structural concrete, and CMU blocks will be procured during construction and tested to ACI and/or other applicable standards. This will ensure the design assumptions have been met and the building is structurally sound, for human occupancy. These samples may be tested with the assistance of the structural engineers the team met with in Panama City at the end of the trip, as well as the Panamanian Academic institutes.

Two aggregate samples were also gathered from the community and run through a sieve analysis. The results can be found in Appendix C. By looking at the sieve analysis results and types of screens available in area the team is researching and developing a plan to teach the

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community how to effectively sort aggregate by size and remix the aggregate into improved portions that produce a higher strength. It should also be noted that the structural team is looking at options to account for the fact that some aggregate in the quarry while appearing to have desirable size and shape, were easily broken apart by hand. This could prove problematic and produce weak points within the concrete. The design team is currently researching methods to remove the weaker aggregate, while also looking into mix designs that are of better quality. Once the most practical methodology have been determined, it will be tested prior to any implementation trips. This will ensure the mix assumptions are correct, and that the implementation teams will be able to replicate the procedures and train the community in the field.

5.2 Energy Systems

Pre-trip estimates for electricity demand for the CREER have ranged from 7.5 kWh/day for a system employing laptops and efficient LED lighting to more than 25 kWh/day for a system using desktop computers and less efficient florescent lighting. In order to determine the best option for providing this electricity, the EWB team assessed the potential of the community's existing solar system, a new solar system, hydropower, and connection to Panama's national grid.

5.2.1 Work with existing solar system

The installed solar system in Hato Rincon consists of three systems detailed in Figure 5.2.1A. The community requested EWB evaluate the status of these systems. The first system we diagnosed consisted of a ground mounted 2' by 6' array of 12 50W panels connected by buried PVC conduit to a 45A charge controller, four 200AH 6V SLA batteries and a 600W inverter. The apparent loads were 6 luminaries for three classrooms and one external fixture. All fixtures were dual tube 2' T8 17W fixtures.

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Figure 5.2.1A – Existing Solar System

Upon our arrival at the school we requested access to the solar system so we could do an assessment and to provide a baseline to our proposed system in the CREER. The administrator reported that the system was non-functional, however the ministry of education had been notified of the problem and they expected someone to be sent out in less than 2 months. Never the less they agreed to allow us access to the system to do an evaluation.

The first system we evaluated was located in the south corner of a classroom. The battery box was covered with books and potentially flammable paper debris. The breaker enclosure was missing a cover and was left exposed 5’ above the classroom floor. The lid of the battery box showed signs of rust, although this could be attributed to the climate and normal wear and tear rather than excessive venting. The 200AH batteries in the vented box had approximately a quart of loose soil, which the teachers reported had been placed there by students. The charge controller was reading 99% state of charge and a battery was disconnected and the float voltage corroborated the charge controller. The inverter input terminals indicated the batteries were being charged by the panels and approximately 120V AC was present at the output of the inverter. As shown in Figure 5.2.1B, the breakers were exposed and the system load had been removed.

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Figure 5.2.1B – Existing Solar System Breakers

A 16 AWG zip-cord had been wired into the breaker outputs and wrapped around the conduit and strung across the ceiling. Additionally several of the switch plates had been removed and some of the switches for overhead lights were missing.

When the team inquired about the system modification, the educators reported the cord supplied power in their residences where they could charge 21 laptops every three days. There was also a LCD projector and printer that were loads on the system and in use. The teachers reported the LCD projector could run for 5 hours in the evening if the system was fully charged. The Epson Powerlite S17 projector they showed us has a power consumption of 283W. This suggests the system has a capacity of at least 1.4KWh when discharged over five hours. The neglecting charge and discharge efficiencies the total theoretical storage capacity of the batteries when new is 4.8KWh so it's plausible the system has retained at least a quarter of its original capacity. The teachers reported the tubes for the lights had gone bad and they were unable to find replacements and estimated the approximate cost at $2.00/Tube. Later investigation found this to be accurate at

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the closest hardware store. Several electronic ballasts were also found to be nonfunctional in the classrooms.

The second installed solar system at the school consisted of an identical configuration but with two additional batteries. This system served three classrooms in addition to a 10W DVD player and a 73W CRT television. This system's charge controller was not displaying any text, and the left control momentary control button was stuck in the activated position. The charger was missing two fuses which the educators removed from the functional system to demonstrate that the charger was operational. We observed the system did produce a charging voltage of 13.87V with a 14.1V PV array input voltage. The inverter failed to produce an AC output when the control switch was cycled. The most likely cause of an inverter failure coupled with blown fuses on the charge controller is reversal of the battery polarity.

The third existing solar system was located in the health center. With permission of the community the Health Administrator opened the clinic for our evaluation of the solar system. During the evaluation we were able to provide an introductory solar training to a local minister and mechanic who was interested in learning about PV diagnostics. The health center system consisted of two, twelve panel ground arrays feeding the same 45A charge controller and a bank of 6 batteries. The inverter failed to produce output after cycling system control several times and verifying input voltage. was also trained on evaluating PV panels and given a binder of product manuals for equipment that is part of the existing solar panel systems. EWB will continue to encourage 's interest in PV with the intention of developing local diagnostic, support and educational capability for the community.

5.2.2 Solar Pathfinder

A Solar Pathfinder device was used to map the available solar power potential around the proposed site of the CREER structure. In general, the site was found to have a wide solar window through most of the year, meaning that the sun would be directly hitting a solar panel placed there for the vast majority of the time between sunrise and sunset. This data was collected to quantify the amount of solar radiation that would reach a potential solar panel throughout the day. There seems to be sufficient potential collection to locate solar panels near the site so long as the panels are not placed near the trees at the southeast corner of the proposed CREER structure, although further analysis will need to be performed to determine the potential radiation at all points. An example calculation is included below.

Example: The potential is determined by surveying the radiation at grid points as established in figure 3.2.2A. This was done by taking a photo of the Solar Pathfinder after it has been leveled and directly oriented with a compass. At point B, for instance, the panels would be exposed to full sun by 7:30 AM and remain exposed until 4:45PM when the sun goes beneath the

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surrounding mountains for the entire year. Using the estimate tracings for position B, (Figure 3.2.2B) there is a potential of 94% of the solar radiation collection for the day. Using an estimated average annual sum of 1,600kWh/m^2 (Figure 3.2.2C), we can calculate the potential power at this point to be ~1,504kWh/m^2. This results in an average daily power collection of 4.12kWh/m^2.

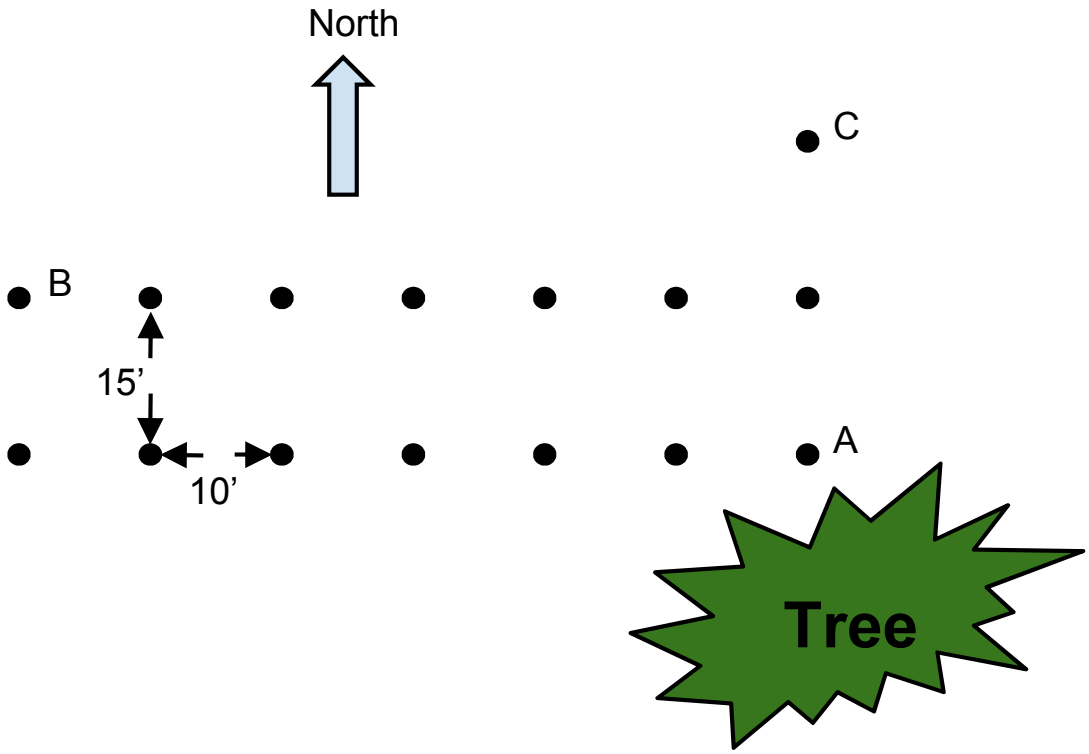

Figure 3.2.2A – Solar Pathfinder Data Collection Grid

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Figure 3.2.2B – Solar Pathfinder Device

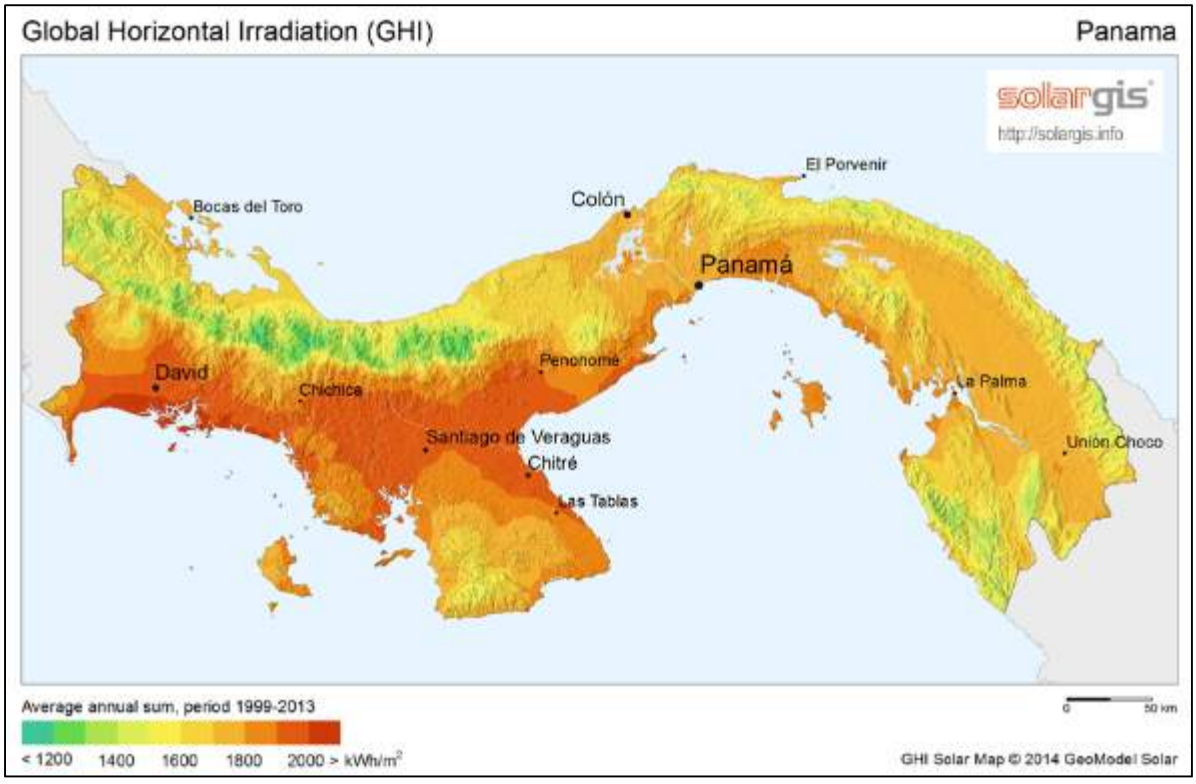

Figure 3.2.2C – Solar Radiation Data for Panama

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5.2.3 Hydropower Potential Observations

Micro-hydropower is a potentially viable option for the CREER, but a number of community questions need to be addressed before a decision to install a system.

In addition to electricity demand for the CREER center, the visit also revealed significant household electricity demand in the community. There were a handful of houses with small (10-50 W) solar panels that are used for lighting, cell phone charging, and in at least one case, a television. However, most of the community relies on flashlights for night time lighting. In a discussion about the potential for hydropower, one of the community leaders indicated that the community would like to use hydro not only for the CREER, but also for households in the community. It is not clear how many households might be candidates for power, but he indicated that there were as many as 350 families in the general vicinity of Rincon.

Rincon is situated beside a stream with significant hydraulic head. At the community's request, on June 28 the team hiked to the upper limits of the stream to view another source of potable water and, according to GPS measurements, gained 1700 feet of elevation and a distance of about 1.5 miles. The stream also has a significant flow rate. During a February, 2014, visit, the EWB team estimated flow rates to exceed 120 gpm using a bucket test method. During the most recent visit, it was estimated that the stream was, in fact, flowing at approximately 470 gpm through culverts where it crosses the road adjacent to the community. Furthermore, according to members of the community, this more recent flow rate was very low as it had been on the February, 2014 trip - the result of lower rainfall in both 2014 and 2015. Based on topographic maps (Google) and the team visit, it appears a hydropower facility could easily capture 100 meters of hydraulic head. Assuming a flow rate of 330 gpm could be exploited (70% of the current "minimum" flow), the estimated hydropower available at this site could exceed 200 kWh/day.

Challenges

- Terrain: The team did not survey specific hydropower sites or potential penstock routes. It was clear on inspection of the stream, however, that a major part of installing a hydropower system would be clearing a route for the penstock, as the stream traverses steep and rugged terrain. The community has already installed a existing 2-inch line that draws water out of the stream to feed community fish ponds. This system, however, consists of PVC line strung through the forest, without burial, and with portions left unsupported. While it functions, there are several leaks, and the line will likely continue to degrade over time. A much more robust installation, including trenching and burial of the line, would be needed to install a viable hydropower system for the community.
- Matching Resource to Demand: A single small DC hydropower turbine, with a capacity of less than 1 kW, might be adequate to meet the needs of CREER, but given the work

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required to clear and trench a penstock, as well as the community's interest in household electricity, it would probably make better sense to install a significantly larger hydropower turbine (up to 10 kW) to serve the needs of both CREER and the broader community. This would require work well beyond the scope of CREER, however, including installing distribution lines and service drops for multiple households.

- Allocating the Resource: A related challenge is how the community would allocate the use of this hydro resource among its residents. A 10 kW system, for example, might be adequate to provide service for CREER, the school, the health center, and perhaps 35 households (assuming 1 kW each for CREER, school, and health center, and 200 W per household). How would the community allocate power if 50, or 100 households wanted to tap into the resource? In addition, how would use of the hydropower affect other uses of the stream? Will there be enough residual flow for bathing, washing, and to provide water for the fish ponds?

It seems, therefore, that to exploit its hydropower efficiently, the community would not only need to establish a mechanism to pay the capital costs and operating expenses, but also a system that protects the interests of everyone in the community with respect to its hydro resource.

5.2.4 Grid extension meeting and observations

The most significant development on the power question came from a June 29 visit by Ing. , from Panama's Office of Rural Electrification (OER), a visit that was organized by the EWB team and HEH. During a meeting with the community, said that Hato Rincon was a good candidate for grid extension from the closest connection at Hato Chami, some 6 kilometers away by road. He noted that OER typically required 10 potential households to be connected for each kilometer of extension, which Hato Rincon can easily able to meet. He added that the presence of a school and a health clinic in the community made Rincon an ever better candidate. According to , a rough estimate of cost to extend the lines to Rincon is $180-200,000 for the 6 kilometers of line. In addition, the investment would include large outdoor lamps on some posts, transformers, and meters. indicated that a basic package for residential consumers would include 4 light fixtures with bulbs, and 3 electrical outlets, and typically cost $5-7/month for the residents. A grid extension to the center of the community could make electricity available to all customers within 300 meters of the line.

cautioned that the government's budget for grid extension for all of Panama was only $3 million and had already been committed for 2015 and 2016, but encouraged the community to take the legal steps necessary to formally petition OER for an extension of the grid. To start the process, the community organization, in this case possibly the CREER committee, must send Mr. , Executive Director of the OER, a formal application, including a list of potential beneficiaries and details on the services and infrastructure already present in the

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community (e.g., health center, school, corregiduría (local office)). In addition, the community needs to identify a person in charge of the project. Once the request is sent, Ing. will begin visiting each of the homes to verify information and measure the distance between the road and the houses. He will then be responsible for making the official request (public tender) with all elements necessary for the project. added that the school and health center would need to apply separately through their own ministries to get electricity connections. Ortega urged the community to ask the Deputy (Diputado), , to obtain money for this project as soon as possible. Other options include contacting the Mayor, Corregidor, etc. In a community meeting on July 1, the community voted overwhelmingly to pursue grid connection, and community leaders took advantage of a visit by Panama's First Lady to Hato Chami on July 2, to present their case in person.

5.3 Information and Communication Systems

5.3.1 Cell signal analysis and repeater testing

Data Collection

The collection of cellular signal strength in the community had two main objectives. First, the cell base stations serving the community needed to be identified so that directional antennas on the proof of concept prototype could be correctly pointed. Second, the cell signal strength and topography would validate a signal propagation model which would identify the most suitable location for a repeater. This model will be used to develop RF link budgets which will guide the repeater system. Basic data collection was performed with a COTS Samsung S5 phone running a simple application to collect signal strength and GPS location. The data collection system was tested before the trip and after arriving in Panama City. Because the United States uses different cellular band and standard then Panama the additional step of testing in country was critical. Had primary data collection system failed the backup plan was to use a RTL-SDR software defined radio hardware and GNURadio to directly measure the signal without demodulation. However, upon arriving in Panama City the data collection application was able to report on signal strength and identify the location of several towers along the highway. The accuracy of the tower location data embedded in the signal was visually verified versus the GPS location reported.

Actual data collection started in San Felix 20km from the community and data was sampled continuously by the phone as the team traveled around the community. Figure 5.3.1A shows the aggregate data collected during the sampling signal levels indicating '-1' indicate no usable signal.

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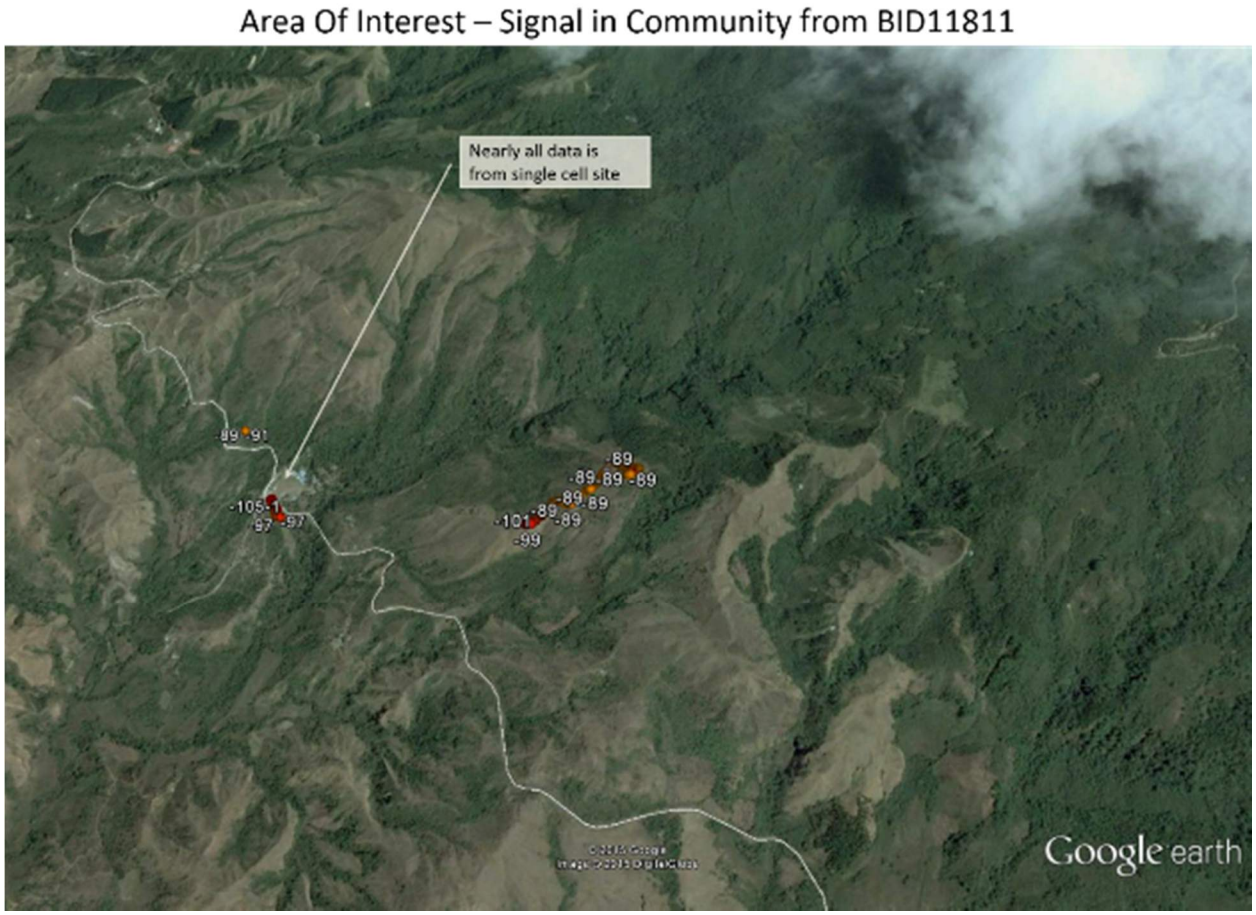

Figure 5.3.1A – Cell Signal Data Collection

Cellular basestations were detected as far as Costa Rica 128km from Hato Rincon. Additional information about all data collected while in the community can be found in Appendix D. Again, -1 represents an unusable signal while the signal strength in dBm is indicated with the marker name if acquisition was successful. When the data from each cell site is turned off in succession it becomes clear cellular coverage of the Rincon community is from a single Site in Las Lajas near the coast 32 Km away. Three factors contribute to this fact. One, the majority of the population density is along the coast consequently most of the cell service serves this area. Two, cellular coverage is more expensive to provide in mountainous areas and requires greater site density this provides a greater disincentive to serve these communities. Finally, radio waves at these frequencies show little refraction, high path loss and poor non-line of site propagation phenomena so although the area extends closer to the community the slant angle from the Rincon community to these sites travels though several mountains. These intermediate mountains cast a radio coverage 'shadow' on these sites from the community, as shown in Figure 5.3.1B The simulated coverage area of the site providing the community with service was modeled with a Longley-Rice propagation model at 850MHz (see Appendix D) and good correlation can be seen

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between the areas there signal was measured and where coverage was predicted. This allows the team to move forward with system design with high confidence the overall design will satisfy the requirements.

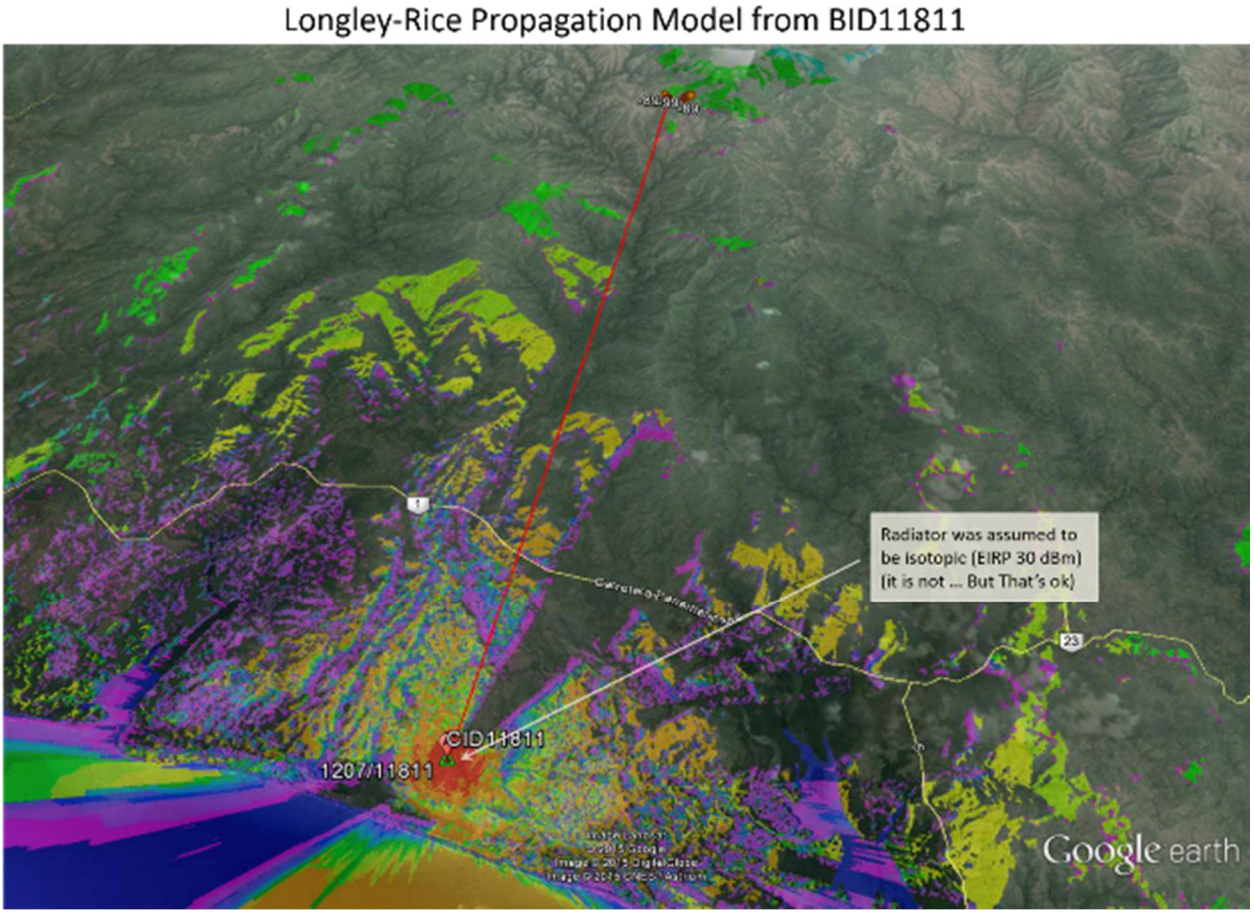

Figure 5.3.1B – Elevation Model

Community approval

The community approval of the cellular repeater project was conducted during a general Community Meeting in the Rincon health center on 6/30/2015 where all interested members of the community were welcome. We presented the community with the background behind the CREER center internet access alternatives search and how this grew into the potential for a separate project. We detailed the potential for the project to serve the health center, school and CREER grounds with internet access. We then detailed basic system components their purpose and initial and maintenance items and costs. The community was very interested in the project going forward and was willing to provide 5% of the estimated $800 material cost of the project.

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Proof-of-concept Repeater Testing

A small portable repeater system was constructed as proof of concept for the project to verify operational feasibility of the design to achieve the technical goals with the conditions at the site. This consisted of a SLA power source and a 65dB, 850MHz repeater (mounted in a Pelican Case) and two small Yagi antennas. This was mounted on a 10' locally sourced mast and guyed to 16" rebar stakes. The repeater immediately provided full signal to several members' cellphones however due to the inability to sufficiently separate the antennas and/or control gain of the system, the system was too prone to oscillations to provide stable service. The system was able to verify the feasibility of the site for the repeater however it highlighted the need for careful system design to deliver the minimum gain needed to meet the community's requirements.

5.3.2 Rachel Pi training

In order to determine the baseline level of computer knowledge within the community, we provided the RACHEL package on a laptop that was left with the community until the next EWB-DC trip when it will be collected by the team for analysis. The "Remote Area Community Hotspots for Education and Learning,"(R.A.C.H.E.L.) allows the user offline access a variety of locally stored archives including WIKIpedia, KHAN academy and Project Gutenberg, as well as providing access to word processing and spreadsheet applications. RACHEL is a custom Linux system image that is loadable on a single board computer or laptop. In our case because the community had very limited access to laptops or tablets the system was loaded on a donated Dell Latitude D630 Laptop and booted directly, although the system can also be configured to be accessible via wifi as a server. In order for the system to be used immediately, internet access was not needed however a stable and reliable power source is required for the laptop. The existing solar ground arrays at the health center provided ample power to charge the laptop with a small inverter that was attached to the DC load output of the existing 45A charge controller. This provides some utility for the existing solar systems that, as a result of damaged load inverters, are otherwise at risk for further damage and degradation.

In addition to providing the community with immediate access to information, one of their main goals, our project team chose to provide this RACHEL package in order to acclimatize and train the community to use and care for computers. Since the CREER structure will house a computer center this is a critical step for the team. This training involves computer hardware, computer software, computer maintenance, general care, and sharing the resource throughout the community.

The RACHEL laptop was assigned to a sub-committee that will be overseen by two other sub-committees to ensure the system is shared amongst all who desire access. During the proceeding of the meeting questions were raised by some community members who were unsure of the utility of a computer. We were able to demonstrate to the community the usefulness of the system by asking them to "name any topic they were interested in learning about." The topics of

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agriculture and handicraft were selected by members and the Wikipedia pages read aloud to the group. The response from the meeting members was immediate and dramatic as the capacity of the system to deliver information on topics of specific interest to the community became apparent to them. Before leaving, we provided a training to demonstrate how to turn the computer on, check and charge the battery, perform basic functions, and access the pre-installed material. During the process we noted concerns from the committee and recorded several areas of potential improvement which we will evaluate and implement on the next Assessment Trip. When we return, we will evaluate the community's use of the hardware and software, as well as any unforeseen events that may affect its use.

5.3.3 SENACYT meeting and observations

Another significant meeting, organized by EWB and our NGO partner, was a visit by Ing. , of SENACYT, on July 1. SENACYT is the Panamanian Government agency that provides equipment for computer centers - "Info Plazas" - around the country. advised that for a typical "Info-Plaza" electricity demand would come from computers, lighting and a combination printer/copier/scanner. The centers are normally open 40 hours during the week and 5 hours on the weekend, so he advised using 50 hours/week as a basis for demand. For communities that are linked to the grid, SENACYT provides regular desktop computers, but uses laptops for systems that are off the grid. promised to email more information on the electrical usage of the agency's equipment to the EWB team.

also told the community that it would need to take certain steps to make an "Info Plaza" a possibility. In order to enter into a formal agreement with SENACYT, the community will need to create a formal legal entity (personalidad juridica). Additionally, the community would also need to designate and provide compensation for an individual to work as the center coordinator. For its part, SENACYT would provide the equipment, pay for satellite communication services for the internet, and service and maintain the equipment. indicated that keeping dust and dirt out of the center was important, but acknowledged that in communities without air conditioning, it was difficult to do so. He also provided the EWB team with design elements needed for the center.

5.4 Water System Investigation

Upon the EWB team's arrival, the community advised that the water system in the community was not working. The current system consists of a spring box, a pipeline with two in-line cloth filters that leads to a storage tank, and a distribution to a few community taps. The system has been in operation for a number of years and seems to be well maintained by the community. At the time of the EWB team's arrival, the community believed that the spring had run dry based on searching the pipelines for leaks and observing the flow rate into the spring box and storage tank. They had also closed the distribution system off from the storage tank to allow the tank to fill for

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several days and found the amount of stored water to be extremely low compared to what they would see under normal flow conditions.

The spring flow rate has been alarmingly low for periods of each of the last two dry seasons. For as long as the community can remember this has never happened; the spring has never run so dry that it affected the flow rate seen at the taps of the water system. As such, the community asked the EWB team to help them with measurements for a proposed new system, namely the distance of pipe required for a new system. The proposed new system would capture water from a spring box much higher up the mountains that is currently still flowing strong. The community has already built a concrete spring box to capture the water, but it needs some repair. This spring box would feed the same storage tank that is currently in use, so the community only needs to repair the higher spring box and connect it to the existing storage tank.

The EWB team hiked to the higher spring box with (a community member active in the PTA and eager to help and learn from the team) and carried a GPS transmitter to determine the length of pipe needed and the elevation of the spring. While at the higher spring box, they marked a GPS waypoint, noted the concrete repairs that would be required for the spring to function, and also found that the box was capturing water that was flowing over ground. The EWB team uncovered the spring as it exited rock and the community members present were excited to see that they could build a spring box to capture water straight from the source.

On the way back to Rincon, the EWB team hiked to the existing storage tank and marked a GPS point to determine distance and elevation from the existing tank to the higher spring box. Once returned to the US, the EWB team determined that the length of pipe required to connect the higher spring box to the existing tank is about 8,000 feet and the elevation difference is about 2,000 feet. With this much elevation difference, connecting the higher spring box directly to the existing tank with PVC pipe (the community's intended material) would likely result in pipes bursting near the tank due to excessive pressure caused by such high hydraulic head.

With this information, the EWB team advised the community of the distance of pipe needed and also the elevation and associated danger of directly connecting the spring box to the existing storage tank. They informed the community that their proposed system could work, but that break-pressure tanks or a similar device would be required along the pipeline from the spring box to the tank. The EWB team was careful to advise that this was a possible solution, but that they couldn't give any more information without taking on a separate project through EWB-USA. While the EWB-DC CREER Panama Program team does not have the resources to take on another project, they are discussing the possibility of partnering with a local student chapter that would take on the project as their own under the supervision of the CREER Panama Program.

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This process will be coordinated with the community through HEH, who will help the community to understand the potential impacts and logistics of this arrangement if they decided to move forward with a new 501 application.

6.0 Photo Documentation

Photo documentation can be found in section 5.0 – Data Collection and Analysis and in the Appendices.

7.0 Lessons Learned

Health and Safety – During the trip, the community's water system had run dry. The team had to go to the stream for drinking water and bathing. On future trips, teams should be prepared for this as well as have a redundant water filtration device.

Health and Safety – Several team members fell ill during the trip with vomiting and diarrhea. This was likely viral as it also caused fever and passed within 24-48 hours. However, teams in the future should be prepared with medicine for sour stomach, travelers' diarrhea, etc.

8.0 Project Status

Assessment Continues	Design	Cancelled
	X	

9.0 Project Monitoring

9.1 Project Status Table

Project Type	**Project Discipline**	**Date of Completion** (mm/dd/yy)	**Functionality** (enter one range per project)			**Periodic Maintenance** (yes or no)	**Community Capacity** (yes or no)
			0-50%	50-75%	75-100%		
Energy	Electricity						
Information Systems	Computer Service						

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9.2 **Project Functionality Indicators** (Include **3** per Project Type)

Project Type	**Project Functionality Indicator** (select from Document 906)	**Monitoring Result**
Energy	Number (or percentage) of community members satisfied with the project	
	Percentage of time the electrical system is being used for the intended use	0%
	Average kW of electricity provided per day	0 kW
Information Systems		

9.3 **Periodic Maintenance Indicators** (Include **3** per Project Type)

Project Type	**Periodic Maintenance Indicator** (select from Document 906)	**Monitoring Result**
Energy	Level of cleanliness of solar panels, hydropower penstock, etc.	N/A
	Observed evidence of routine maintenance on the system done accurately without EWB-USA	N/A
	Number of days without electricity per year	365 days

9.4 **Community Capacity Indicators** (Include **3** per Project Type)

Project Type	**Community Capacity Indicator** (select from Document 906)	**Monitoring Result**
Energy	Chapter observed community	N/A

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	members training others	
	Balance available in maintenance fund	N/A
	Community completed major repairs to the system accurately without EWB-USA	N/A

9.5 Additional Information

10.0 Professional Mentor Assessment

10.1 Professional Mentor Name and Role

is a an RF engineer with 10 years of professional experience and also the Professional Mentor for the Energy and ICT Systems project within the CREER Panama program.

10.2 Professional Mentor Assessment

This report was formulated by the travel team according to their area of expertise and in country experience. Each member provided input with all members reviewing each other's work to provide perspective and facilitate broader accessibility.

During the trip members expanded the relationship with our in country NGO Health Empowering Humanity and established direct contracts in SENACYT and OER as well as better exploring the alternatives for internet access and structural materials and methods. The OER contract enabled the community and HEH to advocate directly to the first lady of Panama and get a verbal acknowledgement of their needs. This may have significant impact on the project as direct electrification provides the lowest initial and ongoing cost to the community. Although electrification is by no means assured during the timeframe of the project the group should focus their efforts on supplying an alternative or supplementary system that can either provide a holdover capability or be expanded if needed.

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In general the greatest risk from a programmatic standpoint is raising funding sufficient to accomplish the goals of the Phase I work projects while building funds for the later phases. Ironically resources are split between the necessities of meeting potential donors' expectations which competes with engineering work necessary to meet community needs. Part of addressing this issue may be looking at travel overhead and costing the Phase I proposals in total costs including travel. In country EWB time being delivered to an engineering task should be considered at a rate that takes into account the total cost including the social and community engagement necessities. I think the group needs to take a pragmatic look at the number of hours they can commit to a task in a day in context of the culture and social expectations. If the last team was only able to deliver 4 hours a day of a particular task item due to competing demands it's likely the next team will as well and the hourly travel overhead should reflect this. These cost can then be used to accurately stage the Phase one work projects.

The relationship EWB forms during the assessment trips clarifies a relationship of trust between the community and EWB DC that needs to be carefully preserved and stewarded throughout the project. It's for this reason we must set expectations very clearly, and carefully choose the implementation sequencing to simultaneously maintain financial solvency and community accountability. The team has chosen to break the project into work packages that can provide the community immediate utility while advancing the main construction effort. By phasing the construction in this way I think the team has stuck a balance between the immediate needs of the community, the ability of our group to raise capital and the timeliness of the construction schedule.

10.3 **Professional Mentor Affirmation**

As an ongoing professional mentor, acknowledges his involvement in the trip preparation and accepts responsibility for the course that the Energy and ICT project is taking. acknowledges his involvement in reviewing this post-assessment report and his approval for the course of this project and the overall CREER Panama program.

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