# EWB-JSC Rwanda

# 507 - PROJECT DESIGN COMPENDIUM

*Prepared by:*
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Project Start Date: January 2006
Revision Date: June 2008

***Section A: Project Description***

[See EWB-CU, EWB-JSC June 2006 Rwanda Report]

***Section B: Pre-Assessment Report***

[See EWB-CU, EWB-JSC June 2006 Rwanda Report]

***Section C: Post-Assessment Summary***

[See EWB-CU, EWB-JSC June 2006 Rwanda Report]

***Section D: Pre-Implementation Report***

[See EWB-CU, EWB-JSC June 2006 Rwanda Report]

***Section E: Post-Implementation Report***

*Overview of trip*

In August 2007, EWB-JSC returned to the Kibuye region of Rwanda to install a water treatment system for the L'Esperance Children's Aid Orphanage. The four person team included project lead Evan Thomas, Christine Chang, Dan Garguilo, and Dean Muirhead. The team installed the second iteration of the Bring Your Own Water (BYOW) treatment system that had been implemented by EWB-CU at the Muramba Clinic in June 2006. The water treatment system was designed to provide clean drinking water for 100 orphans and supporting staff at the orphanage.

*Review of Community Interactions*

[See EWB-CU, EWB-JSC June 2006 Rwanda Report]

*Health Assessment*

[See EWB-CU, EWB-JSC June 2006 Rwanda Report]

*Engineering Designs Considered*

In June of 2006 a EWB-CU team installed the first BYOW treatment system at the Muramba Clinic in Rwanda. The concept of the BYOW system was to treat water from a variety of sources at its point of use in the community. The model fit well with how water is collected and transported in Rwanda—by use of widely available jerry cans.

This first BYOW treatment system utilized a settling tank, rapid sand filter, and ultraviolet light to treat the water. The first two stages of the system were designed to reduce water turbidity to a level compatible with the ultraviolet light, which is then responsible for the final sterilization stage of the treatment process. Details of the development and installation of this system in Muramba are available in the "Mugonero and Muramba, Rwanda: June 2006" report prepared by EWB-CU, EWB-JSC, and EWB-USA.

**BYOW-II Development**

EWB-JSC began work in the winter of 2006 on design improvements to the original BYOW treatment system, resulting in a BYOW-II prototype as show in Figure 3.2-1. Working in conjunction with EWB-CU team members, several areas of improvement to the original design were identified. Areas of focus included (1) the roughing filter, (2) plumbing size, design, and fitting selection, (3) UV sanitation box electrical system, and (4) long duration system testing.


**BYOW-II Prototype in Houston**

Roughing Filter

The original BYOW system design utilized an inclined tube settling tank to reduce large particulate concentration before sending water to the rapid sand filter. Major drawbacks of the tube filter design included the large amount of PVC tubes required to fill the drum, complexity of the internal plumbing, difficult installation due to the need to angle the drum, and decreased flow rate as the sediment accumulates.

The BYOW-II design replaces the tube settler with a roughing filter. The design uses the same 55 gallon drum and input bucket. Input water is directed to a PVC distribution arm (identical to the sand filter distribution arms) located 2/3 down the height of the drum. In lieu of filling the drum with PVC tubes it is filled with graded rock—ranging from 3-4 inch diameter stones on the bottom of the drum to 1 inch gravel on the top. The gravel provides sufficient surface area for particulate within the water to catch and form flocks, then settle to the bottom of the drum. This design also allows for level installation of the drum.

Plumbing and Fitting Upgrades

The original BYOW design utilized 1" diameter PVC throughout. The BYOW-II design utilizes 1 ½" PVC within all the drums to increase flow rate. The only exception to the 1 ½" size are the tubing feed lines between the roughing filter and sand filter, and through the UV light to the system outlet. The feed line between the roughing filter and sand filter was decreased to ¾" diameter tubing to limit flow rate into the sand filter and increase pressure head. This trade-off was determined via testing to produce the greatest net flow rate through the system, as the sand filter relies on pressure head to produce higher output flow rates.

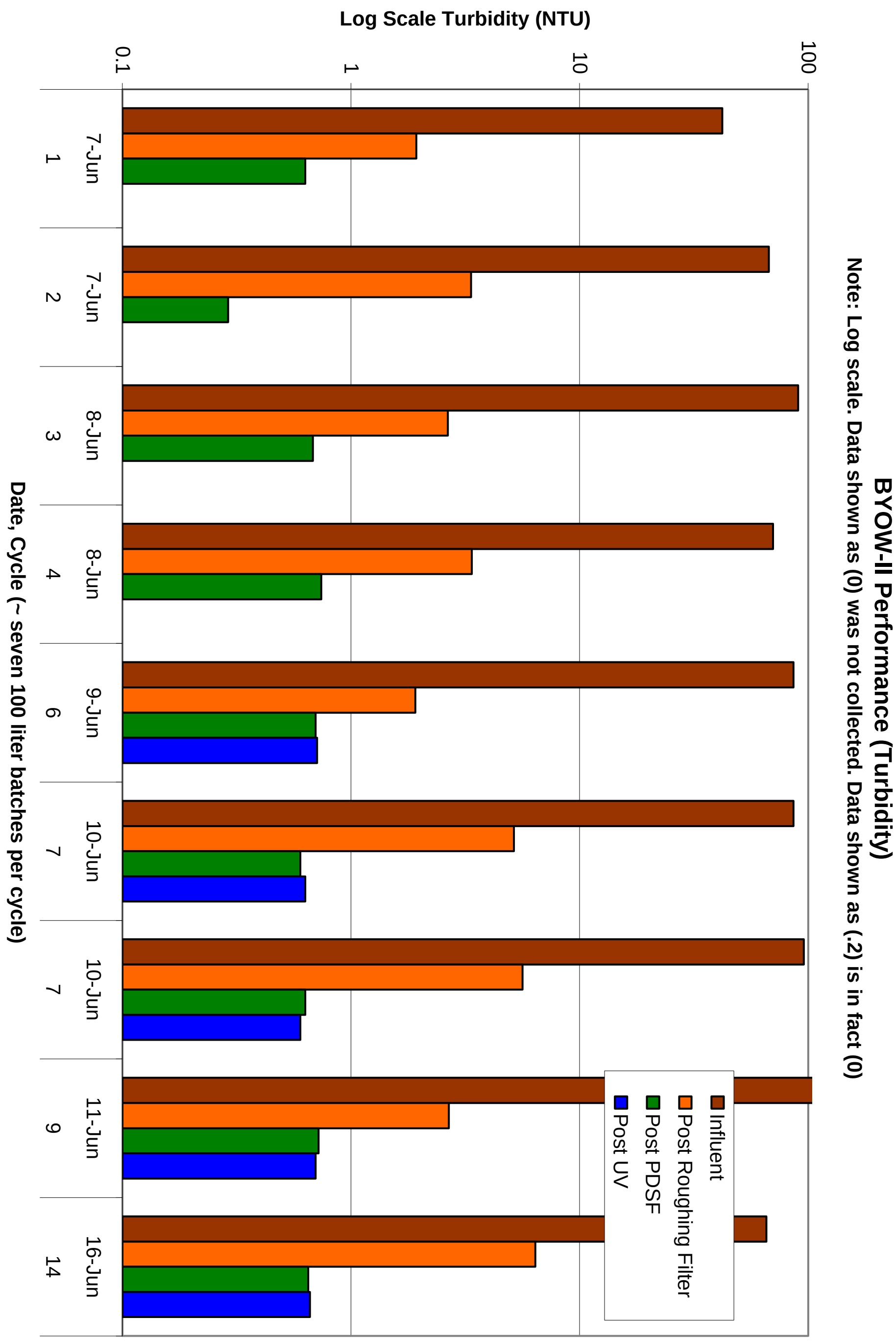
Another area of plumbing focus was on uniformity of design and ease of installation. Distribution arms within the rapid sand filter are consistent in design with the distribution arm in the roughing filter. Plumbing was refined to utilized minimum number of components and bends, while still including unions to allow for ease of removal for maintenance. Finally, the distribution arm hole sizes were opened to accommodate a higher flow rate and ensure adequate bed fluidization during backwashing.

Additionally, the plumbing was redesigned to eliminate the need for the siphon breaks, which we necessary in BYOW-I. After experimentation on the prototype, it was understood that if the plumbing was aligned with no local high areas, air would not become trapped in the system, and there would be no need to release such trapped air. Without the need for siphon break plumbing, this allowed the system to be much more streamlined, and easier to construct in the field.

The final plumbing improvement was to develop new bulkhead fittings for drum penetrations using commonly available materials. Bulkhead fittings are both costly and rarely available in the developing world, however they are critical to achieving a leak tight fit for tank penetrations. The new design utilizes widely available galvanized fittings, a homemade gasket, and a small piece of PVC.

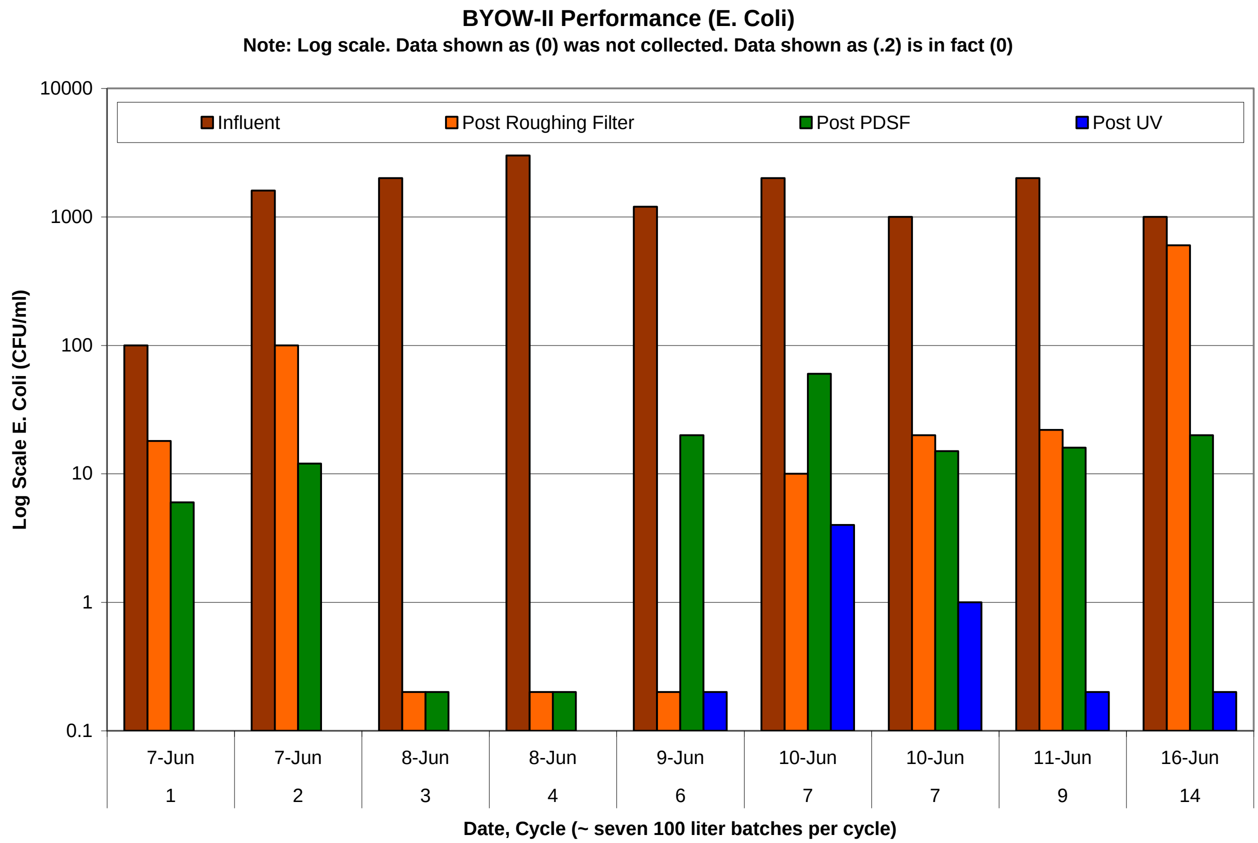
**BYOW-II Prototype Testing**

A long term test was conducted on the BYOW-II system using activated sludge, a by-product of wastewater treatment, as the primary contaminant in the influent water. Activated sludge is used because it is primarily bacteria flocs, and therefore the turbidity in the water tracks bacterial contamination well. This long term test involved an automated batch dosing system that diluted activated sludge with clean water and then pumped the mixture into the system at a rate of approximately seven liters per minute. Each batch was approximately 100 liters, and around seven batches were run per day separated by two hour intervals. In total, about 8,800 liters of wastewater at around 75 NTU (measured with a Hach 2100P Turbidimeter) were pumped into the BYOW-II system over ten days. The test was stopped when the effluent flowrate had reduced to about 1/3 liter per minute because of filter media fouling. Turbidity results for this test and E. Coli colony forming unit (CFU/ml) results (collected with 3M Petrifilm plates) are shown in Figures 3.2-2 and 3.2-3.




**BYOW-II Turbidity Reduction Performance**




**BYOW-II Bacteria Reduction Performance**

*Technical Description of Project*

The BYOW Treatment System combines several water treatment approaches. The first treatment step in the system is the gravel roughing filter. Incoming water enters the roughing filter from the bottom of the inclined drum and flows upward through gravel media with an average diameter of 1”. As the water travels through the gravel, gravity causes entrained sediment to sink downward below the distribution arms into a sediment catchment basin.

Next to this roughing filter is a backwash tank with a valve that automatically diverts a small portion of the input water and stores it for later backwash of the rapid sand filter. The bulk of the water is piped downhill, with the vertical drop of 10-15 vertical feet, providing pressure for the Plastic Drum Sand Filter (PDSF). The PSDF, a rapid sand filter, is built from a watertight UN standard 55 gallon drum with a removable lid. It is designed to operate under hydrostatic pressure to increase filtration speed. In this implementation, the PDSF operates at a maximum pressure of 14 feet of water (6 psi, 41 kPa).

Unfiltered water enters near the top of the filter drum and is distributed across the top of the media bed by perforated arms. The cross-shaped distribution arm is mounted on a PVC union fitting that allows the arm to swing upward and out of the way to facilitate maintenance access to the media bed.

Water is forced through the media by pressure from the column of water above it, removing particulates and bacteria. Because system pressurization is provided by each bucket of water added, the amount of treated water delivered to the user can be no greater than the amount introduced. Additionally, the water is provided within minutes, because the sand filter is already primed and pressurized with water added by previous users. The PDSF in the BYOW system differs from typical sand filters and borrows principles from both rapid and slow sand filter designs. The biggest departure from usual design is the minimal pretreatment before filtration. While typical filters have pretreatment processes or other types of influent control, the PDSF influent is quite variable with the only pretreatment process being the roughing filter. The predictable result of such a situation is that the filter will clog more rapidly and the effluent will be of lower quality then in a typical RSF (rapid sand filter) based plant.

During nominal operation, filtered water flows out of the PDSF into a solar powered electric UV reactor. The UV light deactivates much of the remaining bacteria in the water. The ultraviolet disinfection system utilizes a commercial-off-the-shelf disinfection unit and ballast, the R-Can Environmental Sterilight 12 or 20 liter per minute units. The system is stored in a waterproof, locked Zarges aluminum box. The necessary electrical and plumbing connections are also enclosed in the box. The system is operated by actuating an electrical timer switch on the side of the box. This switch turns on the UV system ballast, proving power to the light, while also actuating an electrical solenoid valve to allow the water flow to from the system. The UV system is powered by a 50 watt or 102 watt solar-panel power supply. The total draw of the disinfection system is approximately 25-40 watts. The PV installation was sized to provide power to the system for about 7 hours per day, or about 8,400 liters per day.

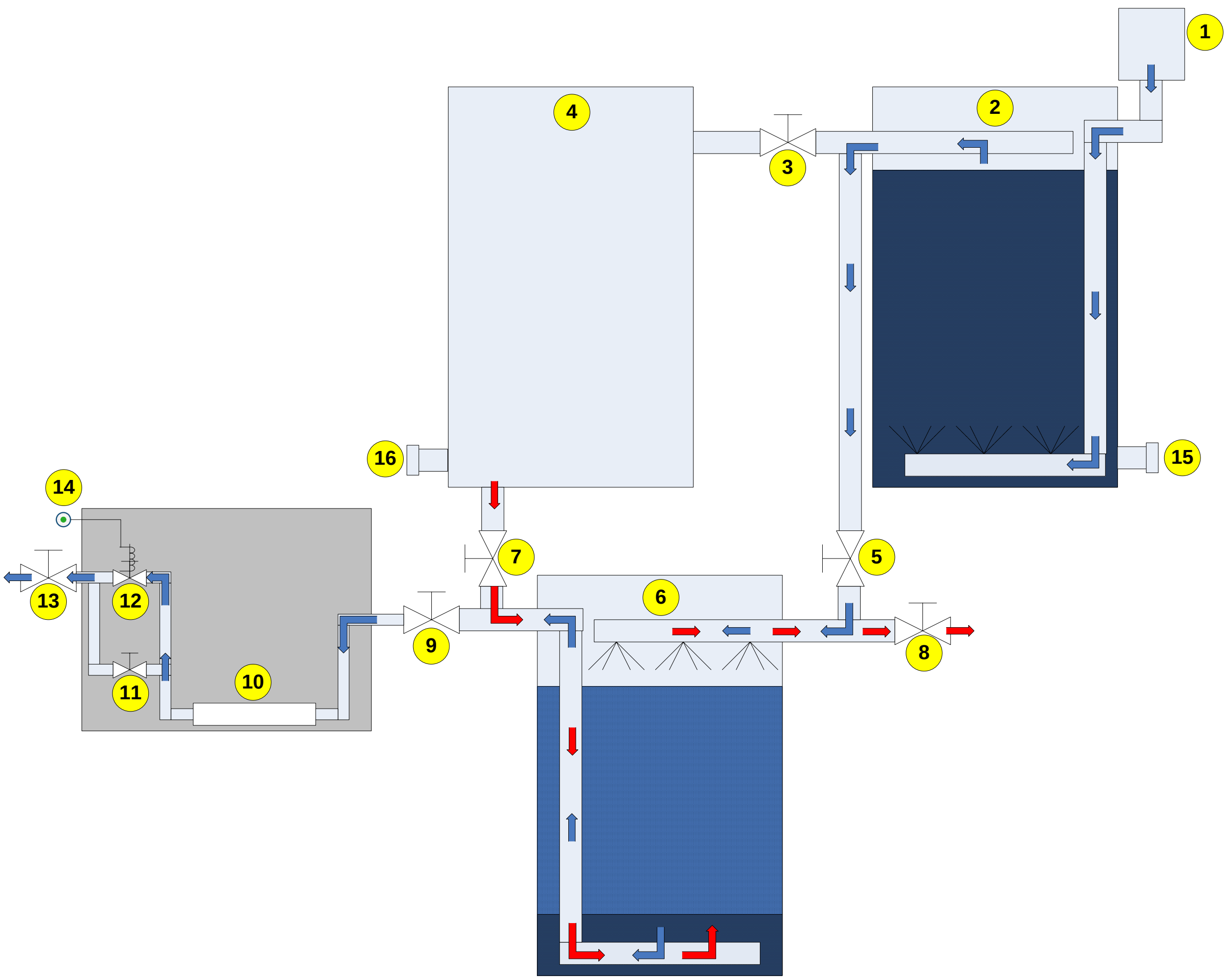
While the UV stage of the BYOW system is considerably higher technology than the PDSF and roughing filter, failure of the UV would not completely disable the BYOW system, as users would still receive filtered water better than the average input.

A schematic for the complete BYOW system is shown below. This figure shows the nominal flow path of the water under treatment, as well as the water used in backwash mode. The input bucket, roughing filter and backwash tank are located above the PDSF and UV components. One of the innovative aspects of this system that is noteworthy is that the energy required to drive the system both nominally and in backwash mode is provided by the sun, the user, and gravity. The cumulative result of all the aforementioned features is a system that can treat a five gallon bucket (about 20 liters) of water in about two minutes using solar and human power alone.

The BYOW-II filtration system consists of the following components, corresponding to the numbers in Figure 3.3-1.

**BYOW System Components**

| | |
|---|---|
| 1. Input bucket | 9. UV box inlet valve |
| 2. Roughing filter | 10. UV light |
| 3. Backwash diversion valve | 11. UV box manual bypass valve |
| 4. Backwash tank | 12. UV box solenoid valve |
| 5. Rapid sand filter inlet valve | 13. UV box outlet valve |
| 6. Rapid sand filter | 14. System “On” button |
| 7. Backwash inlet valve | 15. Roughing filter drain |
| 8. Backwash outlet valve | 16. Backwash drain |




**BYOW system schematic showing nominal water flow path in blue and backwash flow path in red**

**Materials and Logistics**
The BYOW-II system was designed to use locally available materials as much as possible, however the UV sanitation box and associated electrical hardware must still be purchased and assembled in the US due to availability, cost, and time to assemble. While all parts of the plumbing system are available in Rwanda, a complete system was brought with the EWB-JSC team to ensure a working system could be installed during the short time the team had at the orphanage. The entire system, excluding the filter media, was checked as baggage for the flight to Rwanda. Coordination with the airlines resulted in a cost of only $150 for the overweight and oversized luggage.

*Budget and Funding*

**EWB-JSC Actual Expenditures for BYOW-II**

| **BYOW II Prototype Expenses** | **Price** |
|---|---|
| Drums (3 x 55 gal) | $150.00 |
| Plumbing | $1,027.38 |
| Sand | $45.36 |
| Sifting Screen | $132.84 |
| UV Box | $300.00 |
| UV Box Electronics | $179.51 |
| UV Bulb and Ballast (includes spares) | $374.00 |
| PV Panel | $150.00 |
| PV System Electronics | $250.00 |
| **Sub Total** | **$2,609.09** |
| | |
| **Tools & Test Equipment** | **Price** |
| 3M Petrifilm Plates (150 plates) | $323.24 |
| Sieve Set | $74.40 |
| Pumps (qty 3) | $87.73 |
| Misc. Tools | $272.61 |
| **Sub Total** | **$757.98** |
| | |
| **Implementation Trip** | **Price** |
| Airline Tickets (qty 4) | $8,479.24 |
| Travel Insurance (qty 5) | $382.00 |
| Food and Logding (5 ppl x 3 wks) | $1,259.77 |
| Logistics, Transportation, and Fuel | $2,377.29 |
| Cistern Construction and Materials | $1,150.00 |
| BYOW-II Supplies and Labor | $4,142.79 |
| BYOW-II Construction Management | $300.00 |
| Generator | $800.00 |
| **Sub Total** | **$18,891.09** |
| | |
| **Total Project Expense** | **$22,258.16** |

## Hours Worked on Project

| Names | # Weeks | Hours/Week | Trip Hours | Total Hours |
|---|---|---|---|---|
| Evan Thomas | 28 | 20 | 180 | 740 |
| Dan Garguilo | 28 | 10 | 180 | 460 |
| Christine Chang | 28 | 10 | 180 | 460 |
| Dean Muirhead | 28 | 10 | 180 | 460 |
| Tom Smith | 28 | 10 | | 280 |
| Mike Rouen | 28 | 10 | | 280 |
| John Muratore | 28 | 10 | | 280 |
| Katherine Hernandez | 14 | 10 | | 140 |
| | | | Total (est.) | 3100 |

*Donors and Funding for this trip*

| Donor Name | Type (company, foundation, Private, In Kind) | Where are the funds kept? (University, EWB, In Kind) | Amount |
|---|---|---|---|
| Pasadena Rotary | Foundation | EWB | $3000 |
| Space Center Rotary | Foundation | EWB | $2000 |
| West U Rotary | Foundation | EWB | $1500 |
| Jacobs Engineering | Company | EWB | $3000 |
| ASFE | Prof. Org. | EWB | $2775 |
| Private Donors | Private | EWB | $5000 |
| Fundraisers | Private | EWB | $3500 |
| Total Amount Raised: | | | $20,775 |

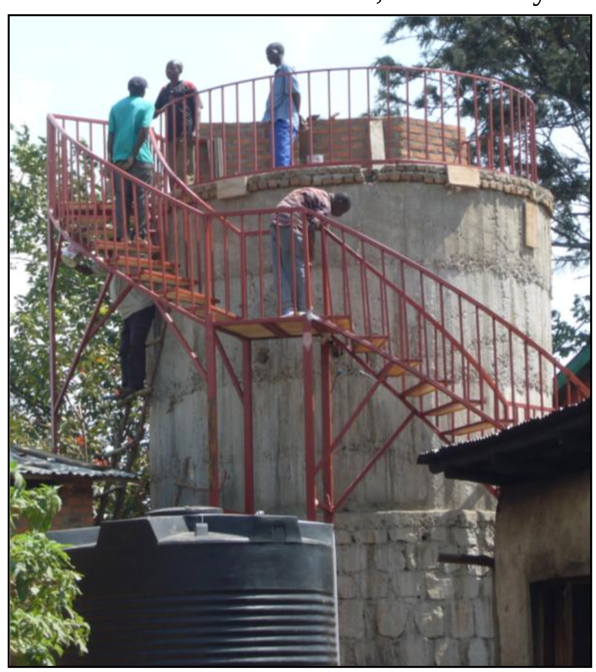
*Summary of Project Implementation*

**Labor**
Local, skilled labor was used as much as possible during BYOW-II construction to ensure timely completion of the installation. Laborers were contracted through the orphanage director and supervised by the orphanage maintenance director and our EWB-JSC construction foreman. These included general laborers and skilled masons. Additionally, a local welder and welding assistant were hired to construct the cistern staircase as detailed below.

**Location**
The primary driver when considering placement of the BYOW-II system is elevation change. A minimum 12 foot height difference between the sand filter and both the roughing filter and backwash drum is required to maintain adequate flow rate during operation, and adequate filter bed fluidization while backwashing. A partially constructed cistern at the orphanage proved to be the ideal location to install the system.

**Cistern Construction**
The cistern at the orphanage was constructed by the German NGO that runs the orphanage under the supervision of their engineers. The intended use was to act as a holding tank for water pumped from a stream downhill from the orphanage, however the project has not yet been completed. The cistern design was robust, however it lacked a roof which would be needed to support the roughing filter and backwash drum.

EWB-JSC commissioned our Rwanda construction foreman to inspect the cistern and develop a roof design to adequately support the BYOW-II system. A design using structurally reinforced concrete was submitted to EWB-JSC, reviewed by our structural engineers, and determined to be more than adequate to support our anticipated loads. Construction commenced prior to the EWB-JSC team departure to allow for adequate drying time of the concrete roof. Inspections once the team arrived confirmed sound construction.



**Cistern Staircase**
A staircase was required to access the cistern roof. A design was developed using structural steel tubing for the frame and wooden slats for the steps. The staircase, which includes two landings, was anchored with cement footings. All materials

were purchased in Kigali upon arrival in Rwanda, and a welder was hired from the town of Kibuye once the EWB-JSC team arrived at the orphanage. Once the metal frame was constructed, the metal was finished with gap filler and painted to ensure corrosion resistance. The steps were provided by carpenters from the local wood shop at the Mugonero hospital. To ensure safety while on the cistern roof, a railing was also constructed of the same structural steel tubing with slat spacing small enough to preclude users from squeezing though.

**Masonry**

Masonry housings were built around all three drums to protect them from the elements, keep out light to prohibit algae growth, and reduce the risk of outside interference. The rapid sand filter

masonry housing at the base of the cistern was also required to elevate the rapid sand filter drum to decrease the pressure head. During installation it was determined that the cistern height produced too much pressure head for the drum lids to withstand. Elevating the sand filter by 1 meter alleviated this problem. The final piece of masonry constructed was a pedestal for the UV box.

**Rapid Sand Filter**

The rapid sand filter was constructed inside one of the 55 gallon drums brought with the EWB-JSC team. Plumbing fittings, which had been measured and cut prior to leaving Houston, were assembled and glued. The BYOW-II control valves, external to the sand filter plumbing, were secured within the masonry housing for protection. A drain line was routed from the sand filter drain hole.

Sand for the filter was obtained locally. The first step in preparing the sand for use was sifting it through a metal screen, brought with the EWB-JSC team, to obtain the desired particle size and uniformity. The sand then had to be thoroughly washed before it was ready for use. This was accomplished by placing a few handfuls of sand in a bucket and performing 20-30 rinses with clean water. Rinse water was available due to recent rains filling up the EWB-CU installed rainwater catchment systems. Before the clean sand was added to the drum, 6 inches of clean, ½ inch diameter gravel was added to prevent the sand from clogging the distribution holes.

**Roughing Filter**

The roughing filter was constructed in a similar manner as the rapid sand filter. The filter inlet was plumbed to a metal bucket serving as the system inlet for dirty water. The plumbing penetration to the metal bucket was done using a bulkhead fitting, then the base of the bucket was filled with cement to form a smooth, level surface so that the bucket would not retain any standing water.

The roughing filter media consisted of graded rock found locally at the orphanage. Rock was collected and washed by hand before adding to the assembled drum.

**Backwash Drum**
The backwash drum contains no internal plumbing, and consists only of inlet, outlet, and drain fittings. Both the backwash outlet and the roughing filter outlet lines were routed together though a 110 mm diameter PVC pipe to the rapid sand filter valve box.

**UV Sanitation Box**
The UV sanitation box was assembled in Houston prior to departure. A masonry pedestal was built to support and anchor the box. A ¾" hose runs from the sand filter outlet valve to the UV box inlet. Inside the box water is directed through the UV light and out to a solenoid valve. The solenoid valve is actuated by an external button on the front of the box which triggers a 60 second timer when pressed. The timer actuates an electro-mechanical relay to open the solenoid valve allowing water to leave the box through an outlet valve. The box contains a normally-closed bypass valve should any part of the electronic system fail.

**PV Power System**
The UV light is powered by a 50 watt photovoltaic panel that was installed on the roof of the orphanage director's building. Power feeds were directed to a charge controller located inside the building. From the charge controller, lines are run through a GFCI to a battery pack, and also to an inverter where the DC power is converted to 120 VAC power and routed externally, dropped below grade, and through conduit to the UV box.

**BYOW-III Prototype Construction**
One of the team goals while in Rwanda was to construct a sample PDSF using locally purchased materials. The purpose was to validate that the design can be replicated easily and at reasonable cost. Numerous hardware stores were visited while in the capital city to average fitting cost and validate availability.

UN standard 55-gallon drums proved to be difficult to find, however a 38-gallon variety with a sealing lid was readily available. The difference in height would require a sand level closer to the top of the drum, and the smaller diameter would pose no functional problem as system flow rate is tied closer to sand depth, particulate accumulation, and pressure head. The practical issue with the smaller diameter meant there was less room to install the 1 ½" (50 mm) diameter PVC fittings. The distribution arm was simplified to fit within the smaller diameter drum, and was also changed to remove all crosses as these proved to be a very rare and expensive item. Total cost of plumbing supplies, including the drum, was found to be approximately $100 as shown in Table 4.0-1.

**Cost of PDSF Materials (RWF/USD)**

| Description | Quantity | Cost/Unit | Total Cost |
|---|---|---|---|
| 38-gallon drum | 1 | 17,000 ($31.19) | 17,000 ($31.19) |
| 50 mm dia. tee | 6 | 2,000 ($3.67) | 2,000 ($22.02) |
| 50 mm dia. elbow | 2 | 1,500 ($2.75) | 3,000 ($5.50) |
| 50 mm dia. threaded adapter | 3 | 1,500 ($2.75) | 4,500 ($8.25) |
| 50 mm dia. end caps | 8 | 2,000 ($3.67) | 16,000 ($29.36) |
| 50 mm dia. union | 2 | 4,000 ($7.34) | 8,000 ($14.68) |
| 50 mm dia. PVC pipe (6 m) | 1 | 4,500 ($8.26) | 4,500 ($8.26) |
| | | Total: | 55,000 ($100.92) |

***Section E: EWB-JSC August 2008 Rwanda Project Plans***

The Engineers Without Borders-JSC chapter of Engineers Without Borders-USA has been working in Rwanda since 2005 on water treatment, water provisioning, and energy provisioning appropriate technologies in the Mugonero, Rwanda region. For the 2007-2008 cycle, EWB-JSC partnered with the Manna Energy Foundation to expand the impact of clean water projects in Rwanda. At the request of the Government of Rwanda and the UNDP, Manna and EWB-JSC intend to develop in-line filtration systems for Rwanda's secondary schools.

In support of this venture, EWB-JSC received a matching grant from Rotary International that explicitly funds a water treatment system for the Mugonero Secondary School, installed by EWB-JSC and owned and operated by Manna. However, EWB-JSC must first prototype this system in partnership with Manna, and assess the Mugonero Secondary School for installation. Additionally, EWB-JSC will install prototype solar fruit dryers at the Mugonero Orphanage.

Therefore, the plan for this project is as follows:

August 2008: Prototype of in-line filtration system at Kigali factory site in partnership with Manna

Assessment of Mugonero Secondary School for filtration system installation

Installation of prototype solar fruit dryer at Mugonero Orphanage

January 2009: Installation of in-line filtration system at Mugonero Secondary School by EWB-JSC, owned and maintained by Manna Energy Foundation with permission of funders

| **Item** | **Estimated Cost** | **Funding Source** |
|---|---|---|
| Davis and Shirtliff FC310, FC210D filter bodies | $4,000.00 | Rotary Matching Grant - repaid to EWB-JSC |
| UV disinfection system | $3,500.00 | Rotary Matching Grant - repaid to EWB-JSC |
| Travel - Dan Garguilo | $2,500.00 | EWB-JSC |
| Travel - Angie Franzke | $2,500.00 | EWB-JSC |
| Travel - Jack Bacon | $2,500.00 | EWB-JSC |
| Travel - Chris Craw | $2,500.00 | EWB-JSC |
| Rwanda travel and logistics | $3,000.00 | Rotary Matching Grant |
| Solar Fruit Dryer Prototype | $3,000.00 | EWB-JSC |
| **EWB-JSC Total:** | **$23,500.00** | |
| **Difference:** | **-$2,925.00** | |

| | |
|---|---|
| Rotary Matching Grant - intended for Mugonero Secondary School water treatment system installation by EWB-JSC, owned and maintained by Manna Energy Foundation | $10,575.00 |

| | |
|---|---|
| EWB-JSC donations - Rwanda water only | $3,500.00 |
| EWB-JSC donations - general Rwanda | $6,500.00 |
| **Total** | **$20,575.00** |

***Section B: Pre-Assessment Report [August 2008]***

*Review these checklists prior to filling out this section:*

- *TAC & Travel page for when to submit your documents.*
- *806-807 - Logistical Checklist Prior to Travel*
- *505 – Site Assessment Checklist*

*Travel Team*

Please fill out the following table

| EWB-USA Travel Member | E-mail | Phone | Chapter | Student/ Professional |
|---|---|---|---|---|
| Evan Thomas | evan.a.thomas@nasa.gov | 303-550-4671 | JSC | Pro |
| Dan Garguilo | daniel.p.garguilo@nasa.gov | 832-628-5148 | JSC | Pro |
| Jack Bacon | john.bacon-1@nasa.gov | 281-814-8665 | JSC | Pro |
| Chris Craw | christopher.l.craw@nasa.gov | 281-483-3051 | JSC | Pro |
| Dean Muirhead | dean.muirhead-1@nasa.gov | 281-483-3070 | JSC | Pro |

*Objectives of Site Assessment Trip*

- Describe the Overall Project Objective: The Engineers Without Borders-JSC chapter of Engineers Without Borders-USA has been working in Rwanda since 2005 on water treatment, water provisioning, and energy provisioning appropriate technologies in the Mugonero, Rwanda region. For the 2007-2008 cycle, EWB-JSC has partnered with the Manna Energy Foundation to expand the impact of clean water projects in Rwanda. At the request of the Government of Rwanda and the UNDP, Manna and EWB-JSC intend to develop in-line filtration systems for Rwanda's secondary schools.

  In support of this venture, EWB-JSC received a matching grant from Rotary International that explicitly funds a water treatment system for the Mugonero Secondary School, installed by EWB-JSC and owned and operated by Manna. However, EWB-JSC must first prototype this system in partnership with Manna, and assess the Mugonero Secondary School for installation.

  Additionally, EWB-JSC will continue our work at the Mugonero Orphanage by installing a prototype solar fruit dryer. The goal of the fruit dryer project is to help make the orphanage economically self-sustainable by drying and packaging fruit for foreign export and sale.

- Site Assessment Data Needs: A standard water quality assessment at the Mugonero Seconday School (turbidity, total coli forms, fecal coli forms, pH) will be performed, in addition to measuring pressure head and flow rate of the piped water supply. Other relevant data to be collected will include developing a basic map of the school and the water distribution network. This data, in addition to consulting with the school headmaster, will be used to finalize the design and layout of the school water treatment system.

A prototype solar fruit dryer will be built to demonstrate capabilities. Data needs for the fruit dryer project will include:

- quantities and types of fruit to be dried
- desired drying time
- scale of the operation
- sanitation and hygiene practices
- packaging integration

***Equipment***

- List all relevant equipment that will be brought to the country for this project, E.g. if this is a water project, what water testing equipment will be brought?
    - *3M Petri film enumeration plates for total coli forms and fecal coli forms*
    - *Hach 5100P Turbidimeter*
    - *Hach pH meter*
    - *Hach portable incubator*
    - *Garmin portable GPS units*
    - *Digital cameras*
    - *Miscellaneous tools*

***Accommodations***

- Provide a short point to point list with dates & transportation, and lodging

| | |
|---|---|
| Dates of Travel | August 9-24, 2008 |
| Transportation | 8/9/08: Depart Houston (air)<br>8/11/08: Arrive Kigali<br>8/16/08: Depart for Mugonero (rented truck/driver)<br>8/22/08: Return to Kigli (rented truck/driver)<br>8/23/08: Jack, Chris, and Dean return to Houston (air)<br>8/30/08: Dan and Evan return to Houston (air) |
| Lodging | Kigali: Hotel Impala (www.impalaHotel.rw), 570180, 08304866<br>Mugonero: L'Esperance Orphanage |

- On-the ground Contact Phone # for the travel team:

| | | |
|---|---|---|
| EWB – Rwanda Project Cell Phone | 00 250 08440607 | |
| Peter Muligo – USAID | 00 250 08683263 | jmuligo@usaid.gov |
| George Learned – US Embassy | ConsularKigali@state.gov<br>Avenue de la Révolution<br>**Tel**: (250) 505601, 505602, 505603 **Extension**: 3241 | LearnedG@state.gov |

| | | |
|---|---|---|
| Dr. Jean Damascene Ntawukuliryayo<br>Minister of Health | 00 250 08301612 | ntdamas@yahoo.fr |
| Kamali Kalisa<br>Mugonero Hospital Administrator | | Kamali.kalisa@yahoo.fr |
| Sister Donota<br>Headmistress, Muramba College | | uwimanimpayedon@yahoo.fr |
| Jean Pierre Habanabakize | | jeanpierre_habanabakize@yahoo.com |
| Jean Paul Eyadema | | eyademapaul@yahoo.com |
| Victor Monroy<br>Director, L'Esperance Children's Aid Orphanage | 0025008545731 | Lesperancerwanda@aol.com |
| Violette Uwamutara<br>First Secretary Rwandan Embassy | 250.08.641745<br>250.08.613.211 | vuwamuta@yahoo.com |
| Ambassador Zac Nsenga, Rwandan Embassy | 202.232.2882 | zacnsenga@hotmail.com |

*Budget*

| **Item** | **Estimated Cost** | **Funding Source** |
|---|---|---|
| Davis and Shirtliff FC310, FC210D filter bodies | $4,000.00 | Rotary Matching Grant - repaid to EWB-JSC |
| UV disinfection system | $3,500.00 | Rotary Matching Grant - repaid to EWB-JSC |
| Travel - Dan Garguilo | $2,500.00 | EWB-JSC |
| Travel - Angie Franzke | $2,500.00 | EWB-JSC |
| Travel - Jack Bacon | $2,500.00 | EWB-JSC |
| Travel - Chris Craw | $2,500.00 | EWB-JSC |
| Rwanda travel and logistics | $3,000.00 | Rotary Matching Grant |
| Solar Fruit Dryer Prototype | $3,000.00 | EWB-JSC |
| **EWB-JSC Total:** | **$23,500.00** | |
| **Difference:** | **-$2,925.00** | |

| | |
|---|---|
| Rotary Matching Grant - intended for Mugonero Secondary School water treatment system installation by EWB-JSC, owned and maintained by Manna Energy Foundation | $10,575.00 |
| EWB-JSC donations - Rwanda water only | $3,500.00 |
| EWB-JSC donations - general Rwanda | $6,500.00 |
| **Total** | **$20,575.00** |