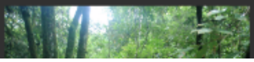
El Tigre Engineering

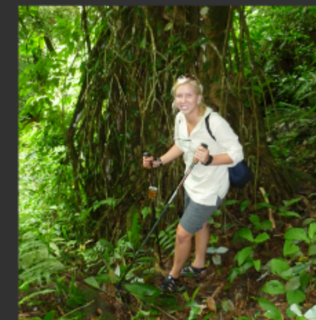
Jennifer Fuller
Grace Neuburg
Benjamin Coultes
Tristram Hokenson

Jennifer Fuller

Grace Neuburg

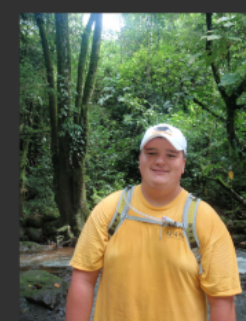


Jennifer Fuller

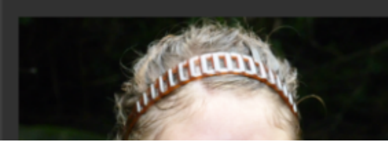


Grace Neuburg

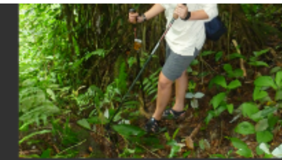
enjamin Coultes



ram Hokenson



Jennifer Fuller



Grace Neuburg

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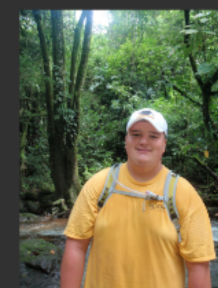


Tristram Hokenson

Grace Neuburg

Benjamin Coultes

Tristram Hokenson

Comarca Ngöbe-Buglé

Republic of Panama
International border
Provincial-level border
Comarca indígena
Provincial-level capital
0 25 50 75 100 kilometres
0 25 50 miles
Costa Rica
Bocas del Toro
Changuinola
Bocas del Toro
Río Changuinola
Laguna de Chiriquí
Golfo de los Mosquitos
Lago Gatún
Colón
Colón
Cativá
Río Indio
Panama Canal
El Porvenir
Caribbean Sea
Kuna Yala
Chilibre
Pacora
Río Chepo
Lago Bayano
Las Cumbres
Guadalupe
Tocumen
San Miguelito
Bay of Panama
Panamá
Veracruz
Panama City
Arraiján
La Chorrera
Chiriquí
La Concepción
David
Las Lomas
Pedregal
Puerto Armuelles
Ngöbe Buglé
Cerro Piedra
Quebrada Guabo
Veraguas
Coclé
Penonomé
Río Santa María
Pocrí
Aguadulce
Santiago de Veraguas
Río San Pablo
Golfo de Chiriquí
Chitré
Los Santos
Los Asientos
Herrera
Isla de Coiba
Pacific Ocean
Gulf of Panama
Isla del Rey
Archipiélago de las Perlas
Darién
La Palma
Río Chuqunaque
Río Balsas
Río Tuira
Emberá
Apartadó
Colombia
83°
81°
79°
77°
9°
7°

riquí
Concepción
vid
Las Lomas
egal
Ngöbe Buglé
Cerro Piedra
Quebrada
Guabo
Verag
Santiago
de Veraguas
Golfo de Chiriquí
Río
San Pablo

the communities

living



Jake

Peace Corps
Master's
International

&

Jed
aka El Tigre

...they have the most amazing views

our living

“To develop an economically and environmentally sustainable hydropower design to the communities of Mamey, Cerro Piedra, and Arena of the Comarca Ngöbe-Buglé, Panama to provide a better quality of life.”

Mission Statement

Hydropower System

Synonyms: hydroelectric power, hydraulic power, hydrokinetic power, water power

hydroelectric power

n, [hīdrō i'lektrik 'pouər]

a form of energy generated by the conversion of free-falling water to electricity;
the generation of electricity by using the motive power of water

Design

- dry season
- flashfloods
- remote location
- constructability
- material cost

Constraints

Objectives

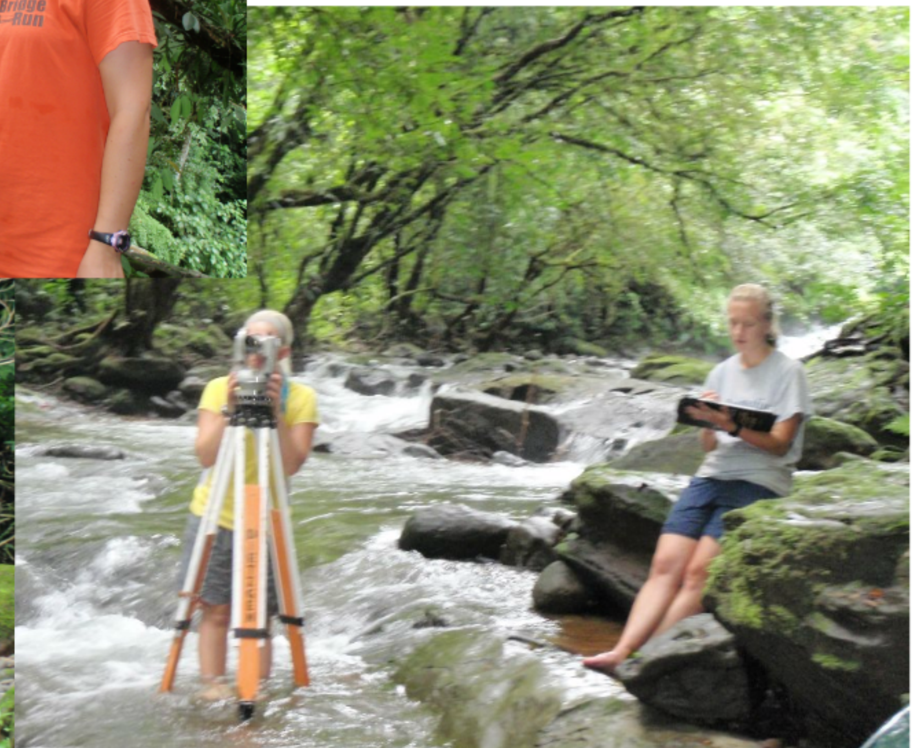
- produce power
- transmission / distribution system
- structural durability
- minimum maintenance
- low profile

Sustainable

Methods

&

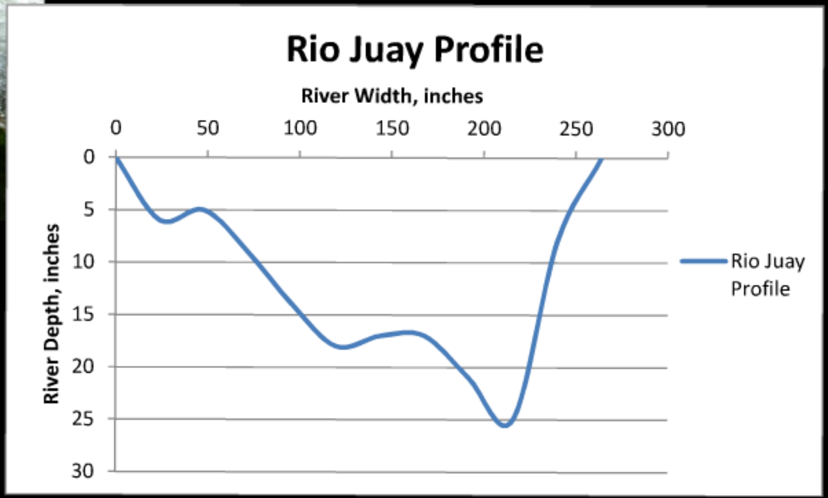
Procedures



surveying

measuring

river profiling



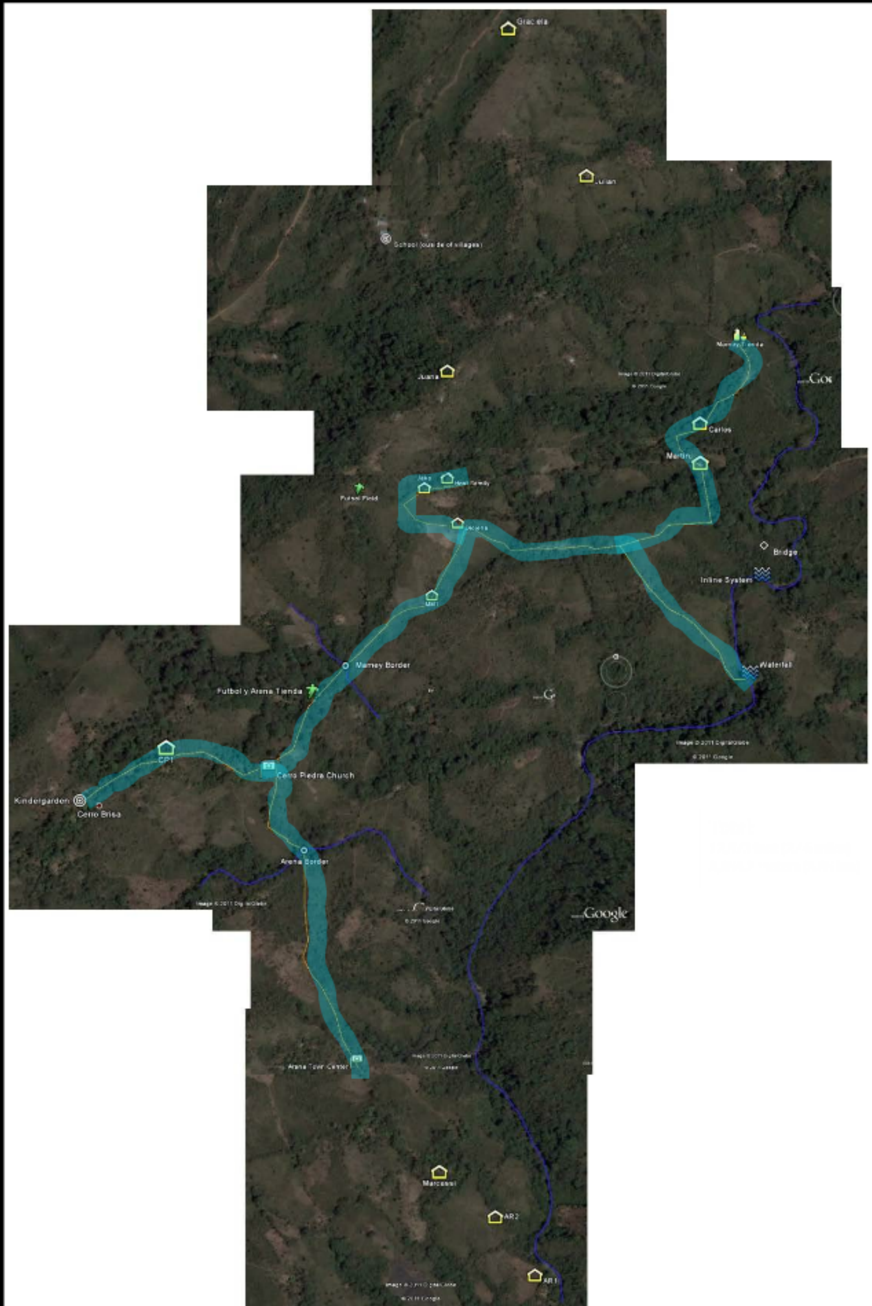
Float Method Data Upstream of Waterfall

Trial	Distance (ft)	Time (sec)	Velocity (ft/sec)
1	34	11.1	3.06
2	34	7.7	4.42
3	34	8.6	3.95
4	34	8.42	4.04
		Average	**4.14**

Float Method

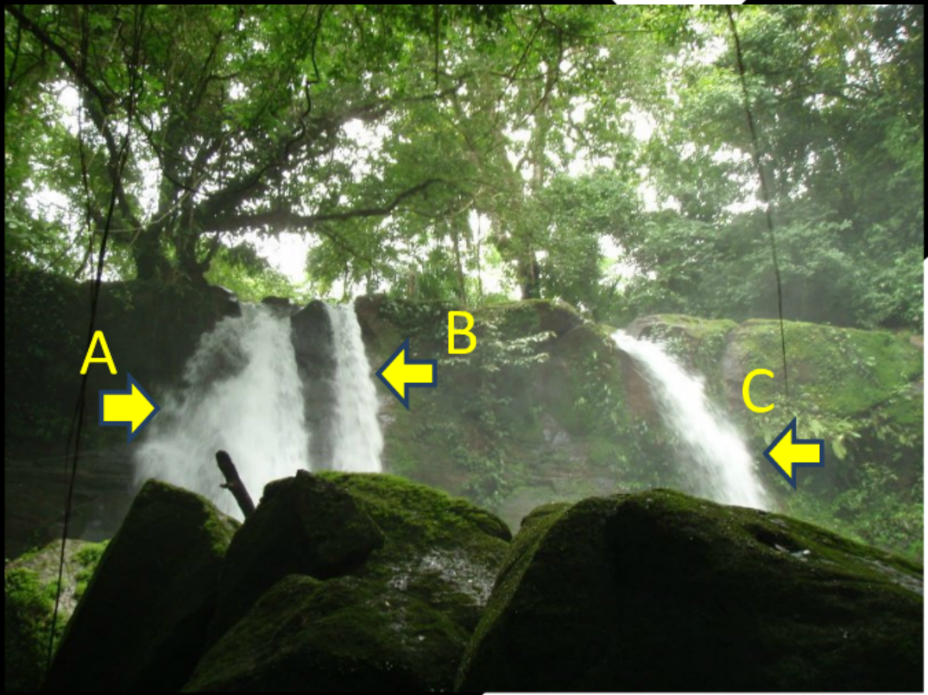
Global Positioning System

Google Earth

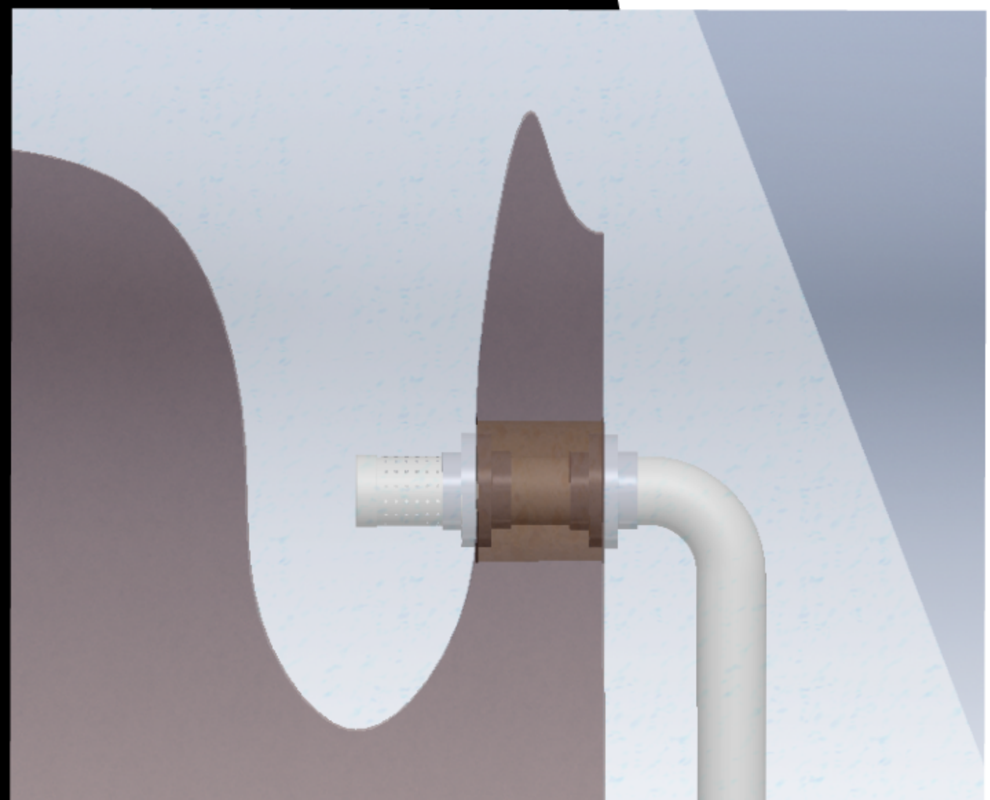


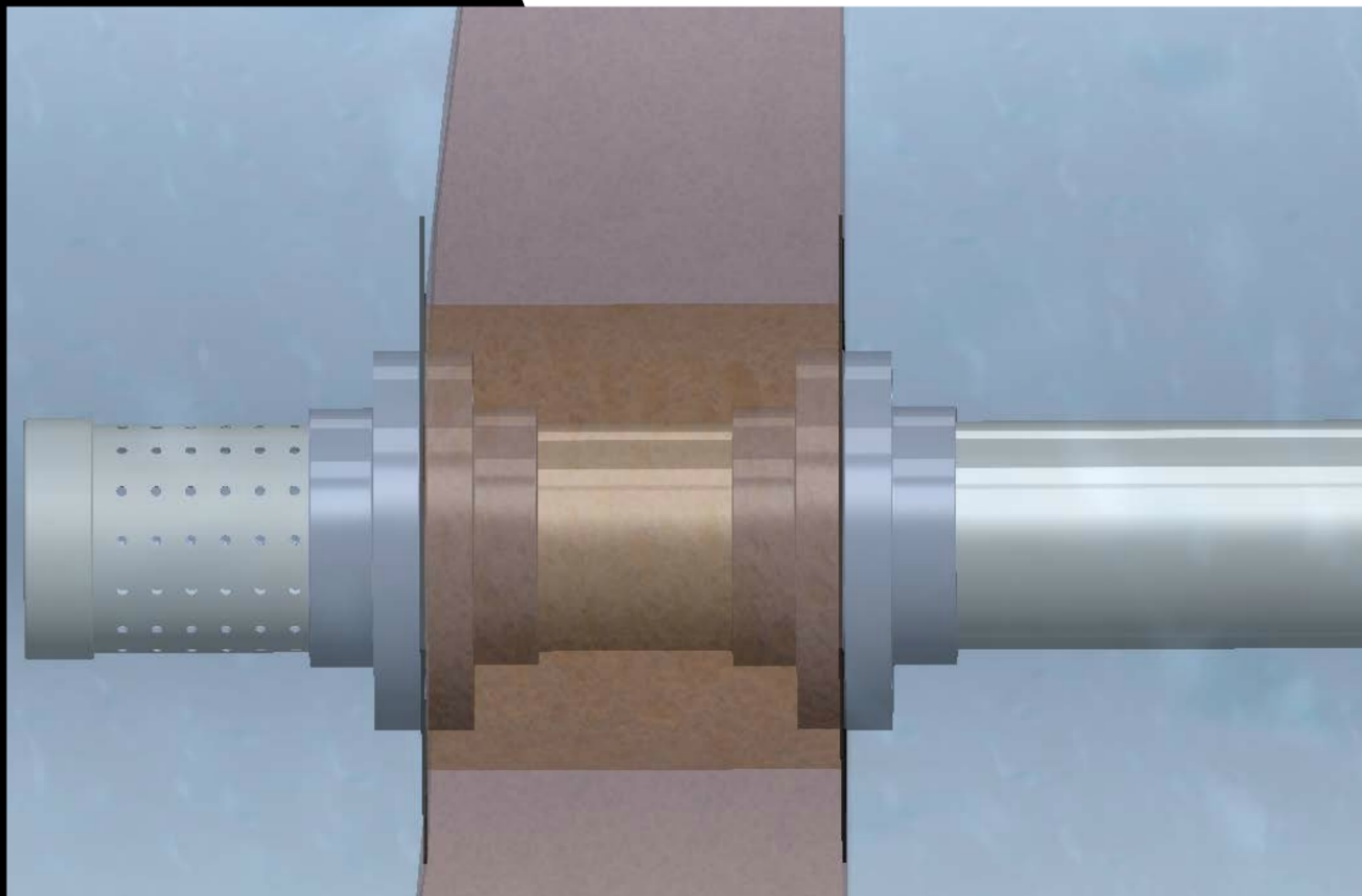
Design and Analysis

the waterfall

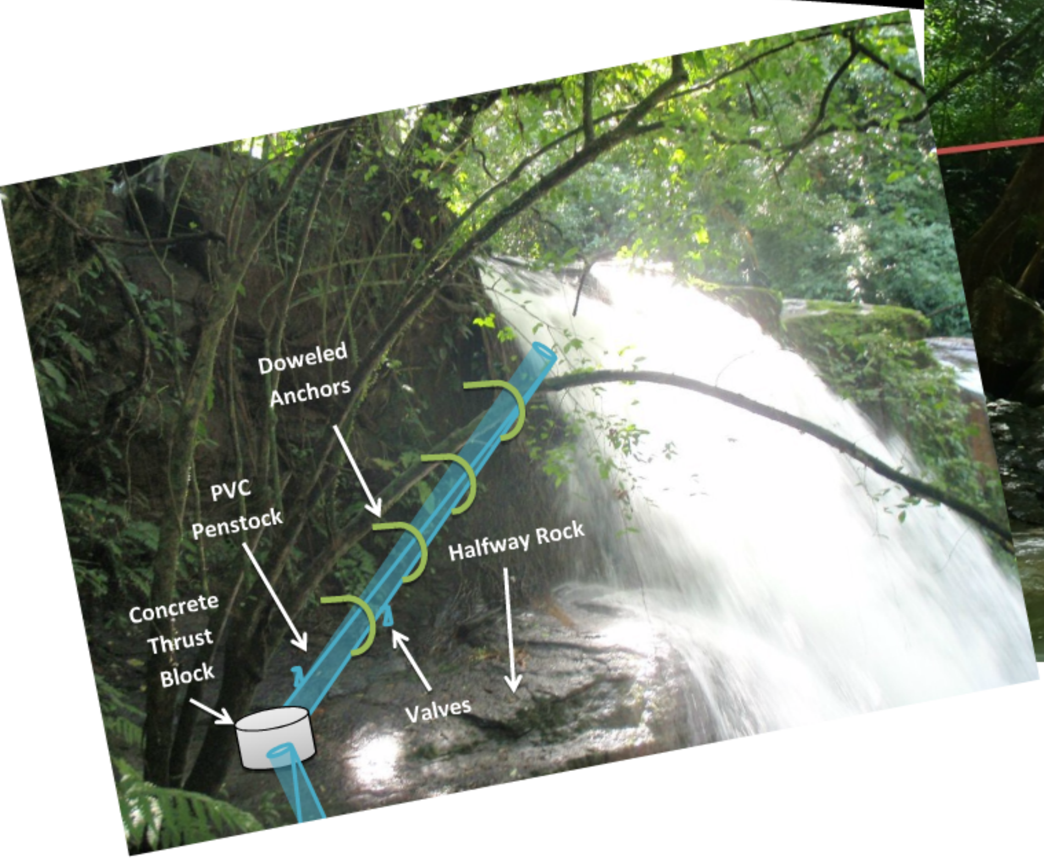


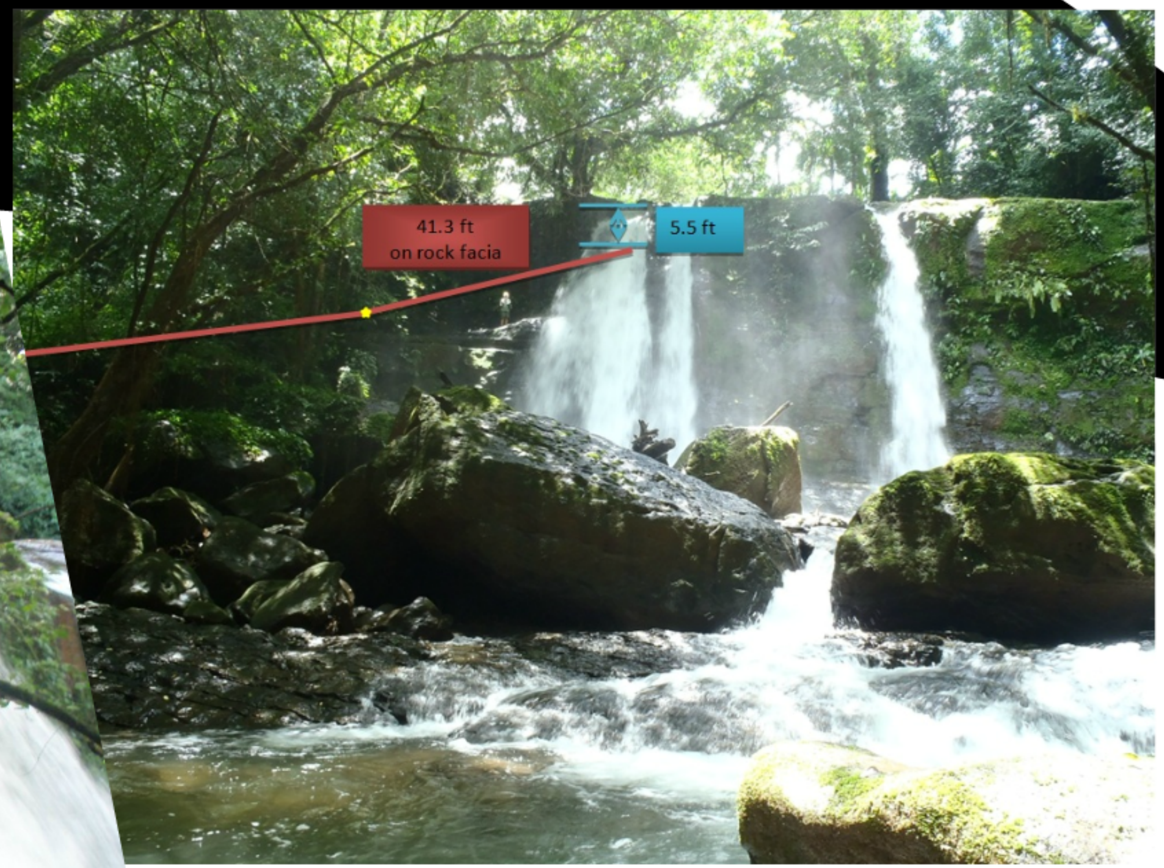
Inlet Design



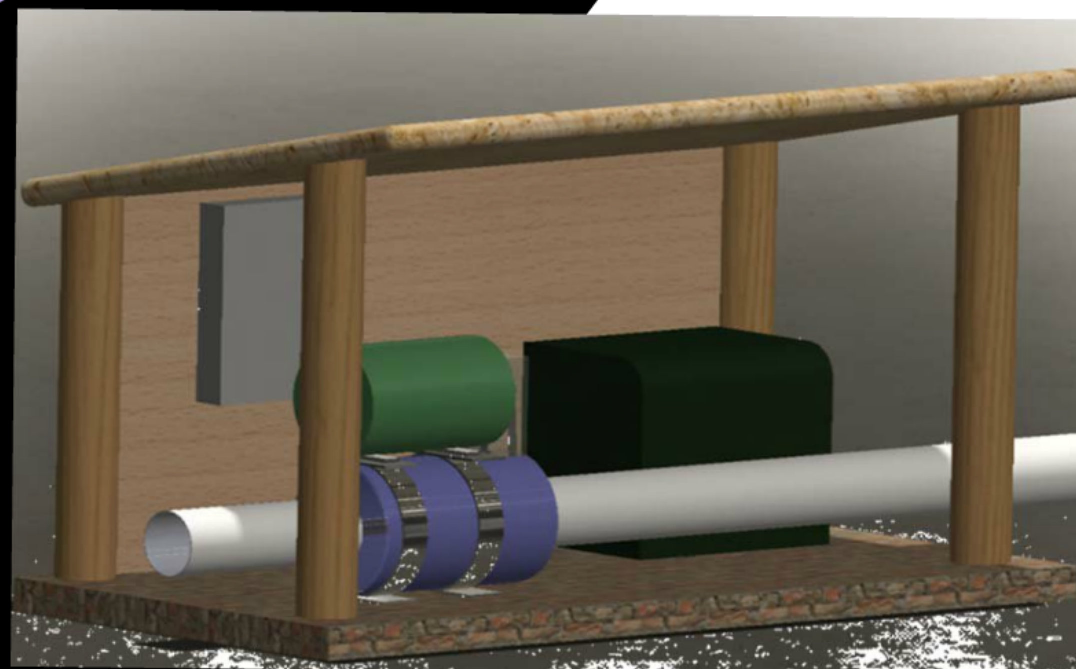


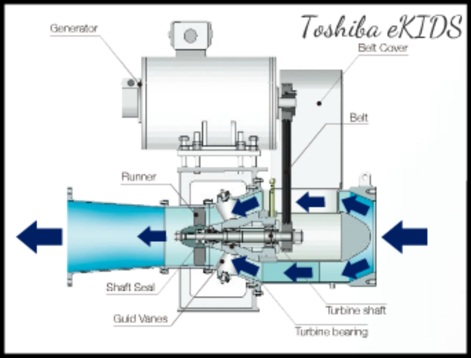
Penstock Design

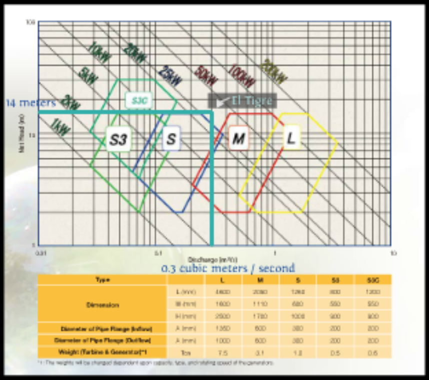


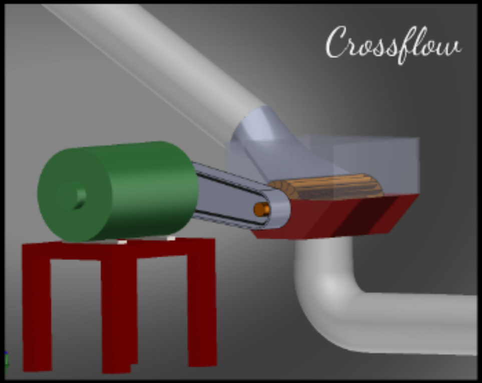


Turbine Shelter

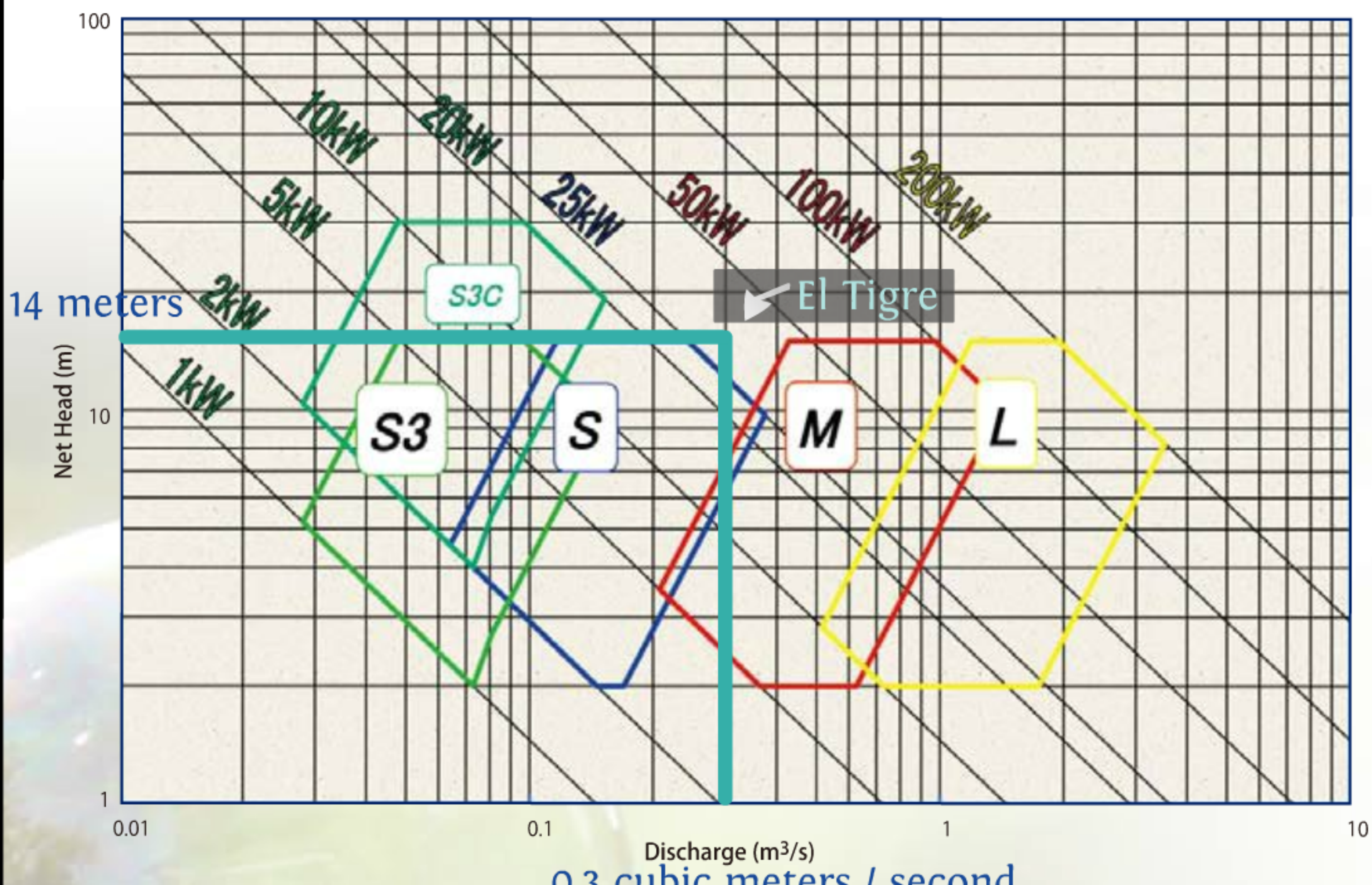



Toshiba eKIDS
Generator
Belt Cover
Belt
Runner
Shaft Seal
Guid Vanes
Turbine shaft
Turbine bearing


14 meters
El Tigre
S3C
S3
S
M
L
1kW
2kW
5kW
10kW
20kW
25kW
50kW
100kW
200kW
0.3 cubic meters / second

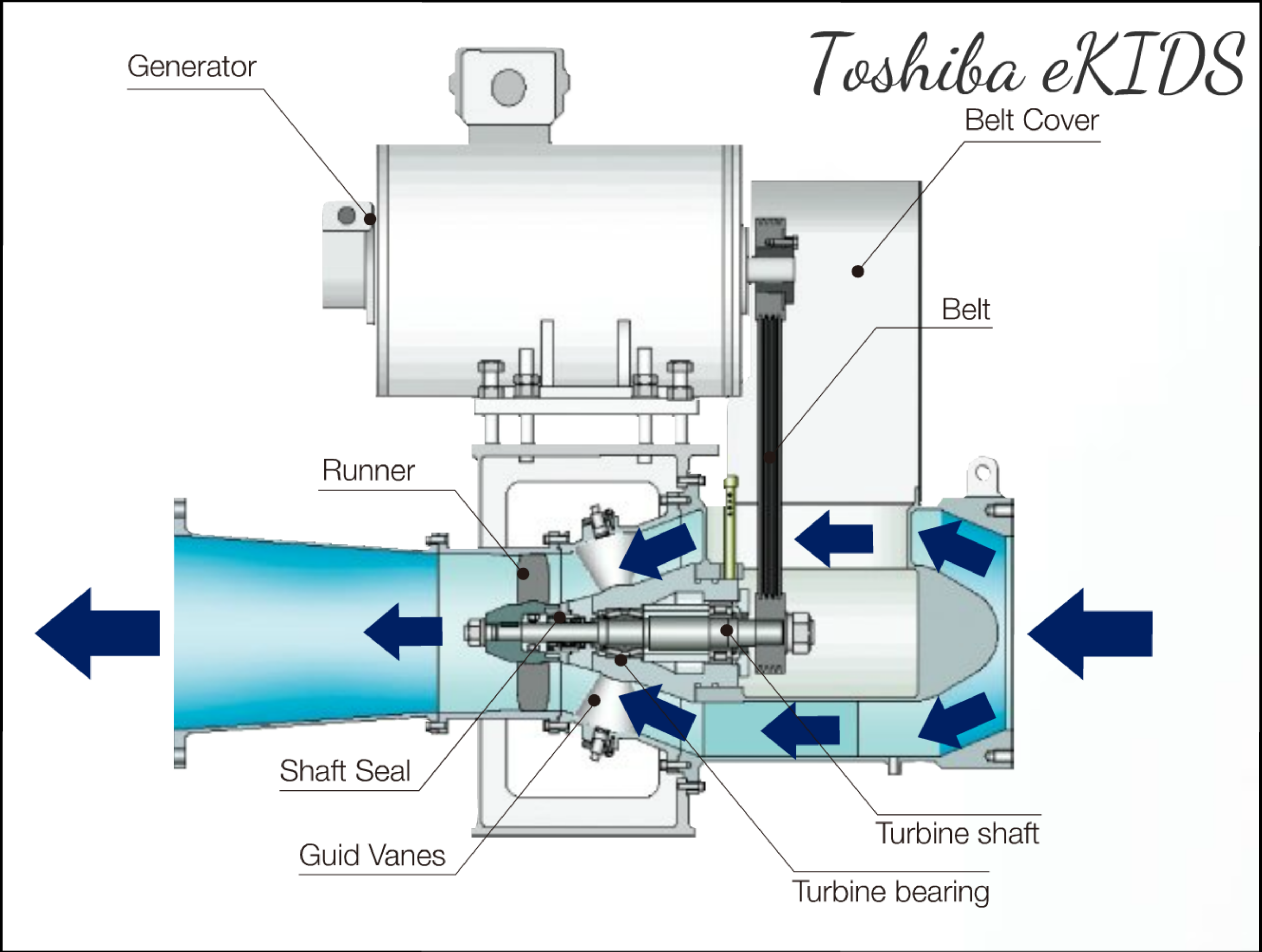

Crossflow

Turbines



Type		L	M	S	S3	S3C
Dimension	L (mm)	4600	2050	1260	800	1200
	W (mm)	1600	1110	600	550	550
	H (mm)	2500	1700	1000	900	900
Diameter of Pipe Flange (Inflow)	A (mm)	1350	600	300	200	200
Diameter of Pipe Flange (Outflow)	A (mm)	1000	600	300	200	200
Weight (Turbine & Generator)*1	Ton	7.5	3.1	1.0	0.5	0.6

*1: The weights will be changed dependent upon capacity, type, and rotating speed of the generators.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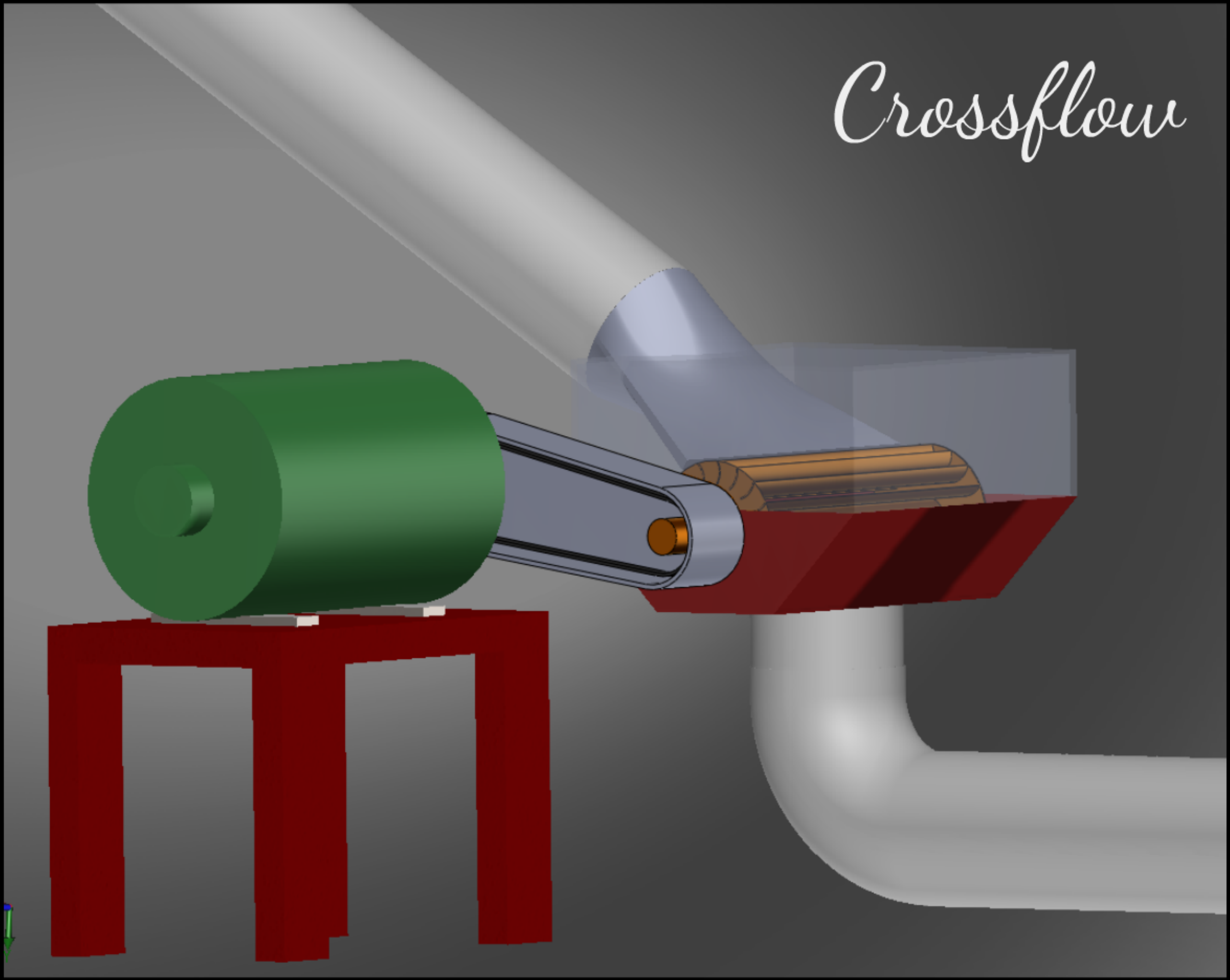
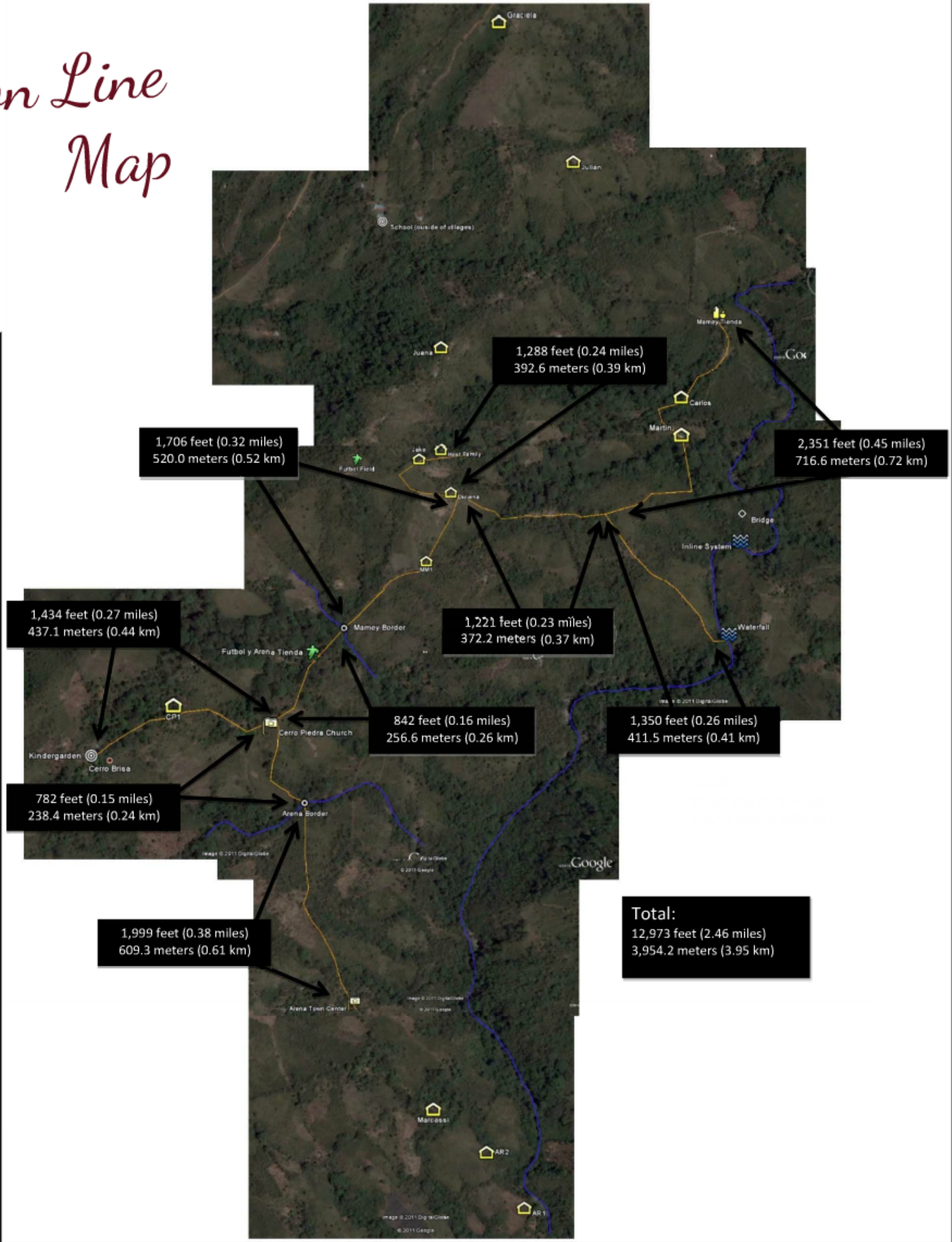
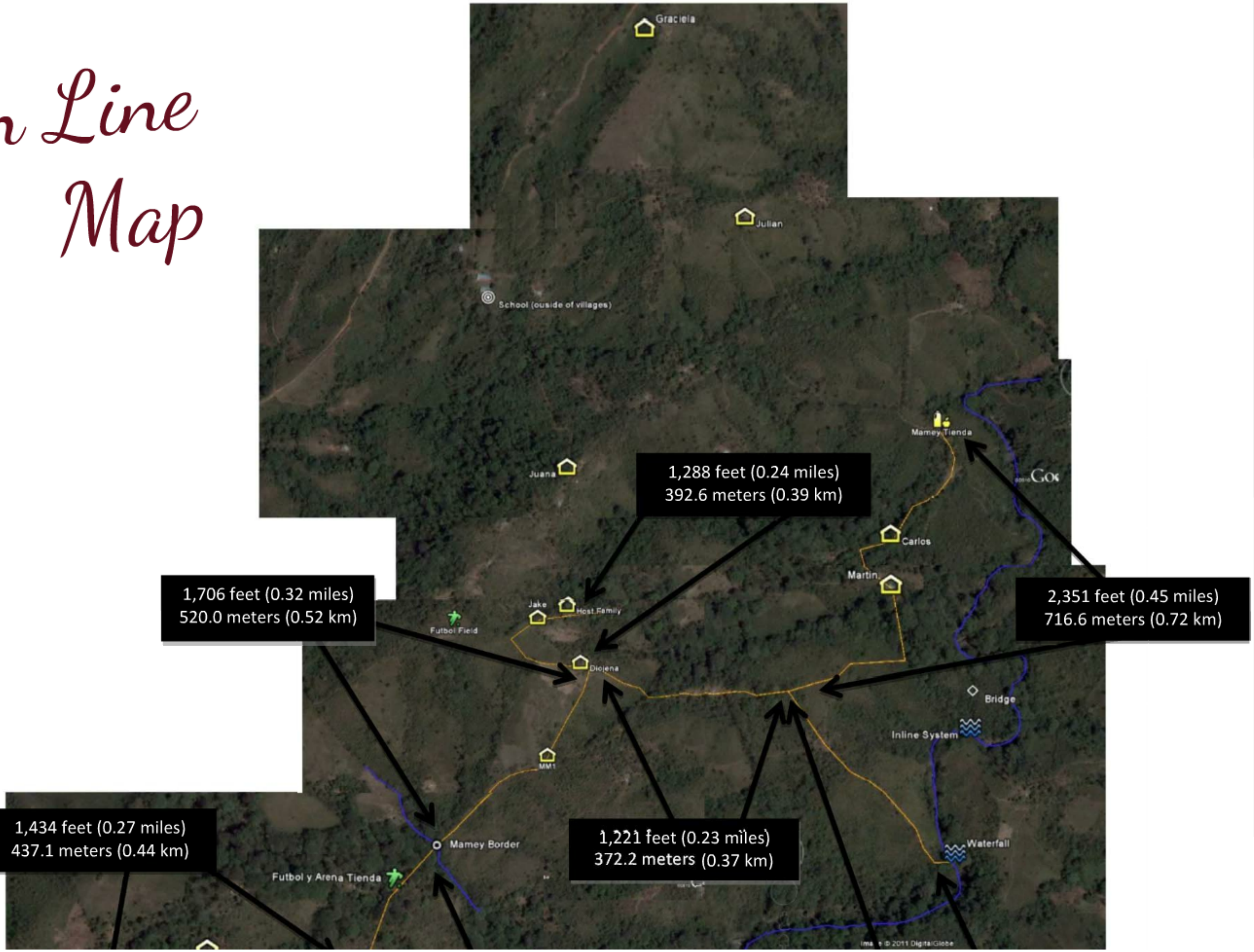
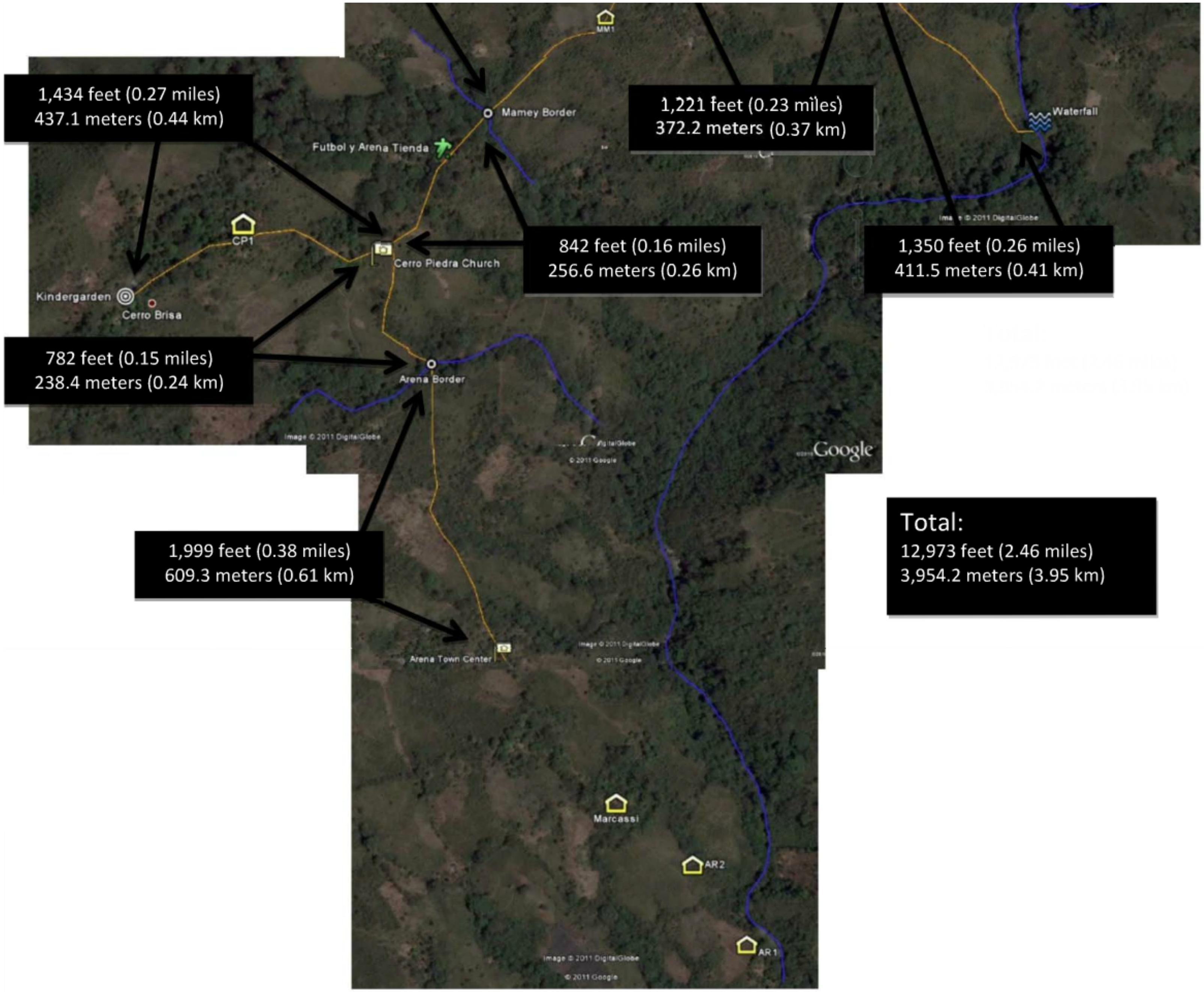

Crossflow

Transmission Line Map

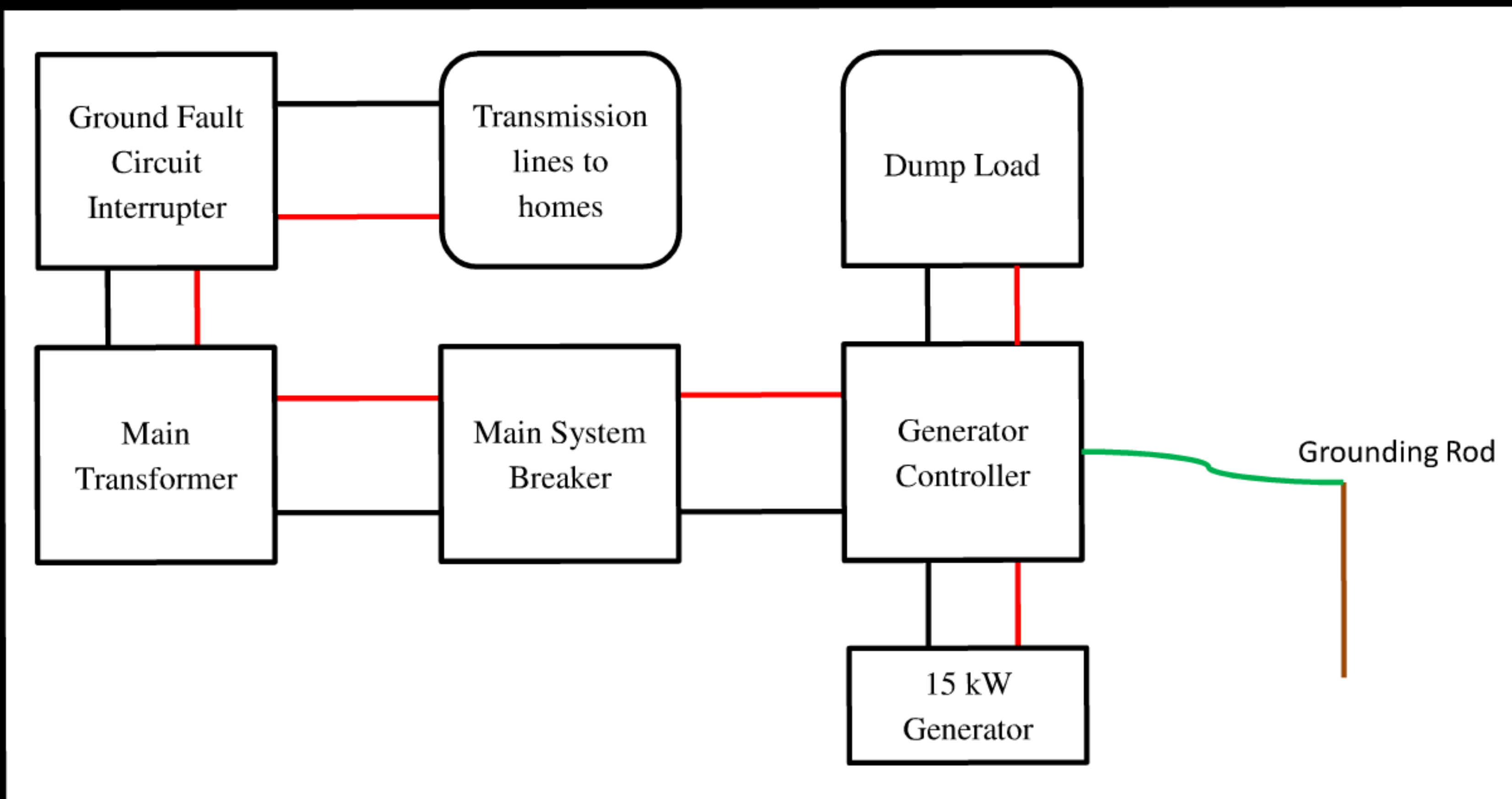


ssion Line Map

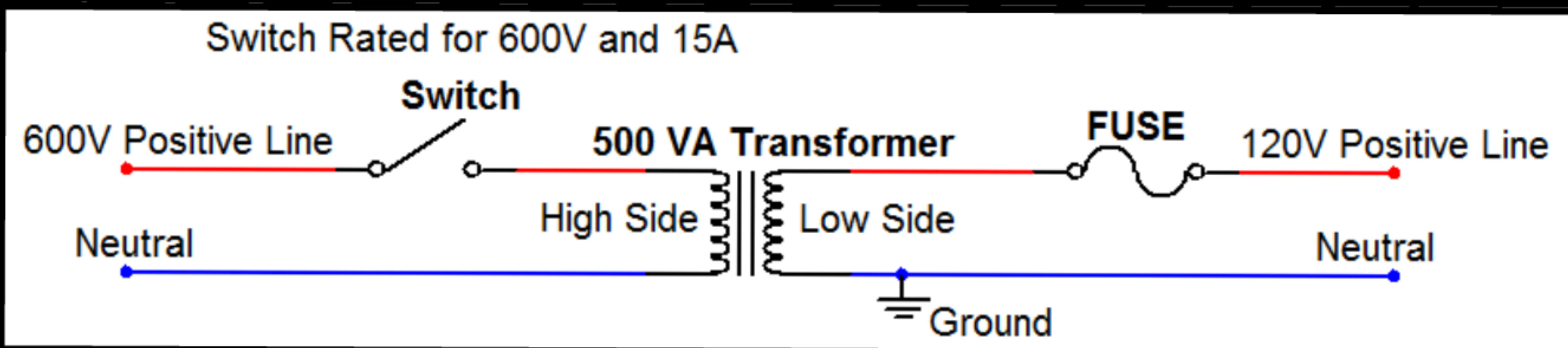




1,434 feet (0.27 miles)
437.1 meters (0.44 km)
Mamey Border
Futbol y Arena Tienda
MM1
1,221 feet (0.23 miles)
372.2 meters (0.37 km)
Waterfall
CP1
Cerro Piedra Church
842 feet (0.16 miles)
256.6 meters (0.26 km)
1,350 feet (0.26 miles)
411.5 meters (0.41 km)
Kindergarden
Cerro Brisa
782 feet (0.15 miles)
238.4 meters (0.24 km)
Arena Border
Google
Total:
12,973 feet (2.46 miles)
3,954.2 meters (3.95 km)
1,999 feet (0.38 miles)
609.3 meters (0.61 km)
Arena Town Center
Marcassi
AR2
AR1

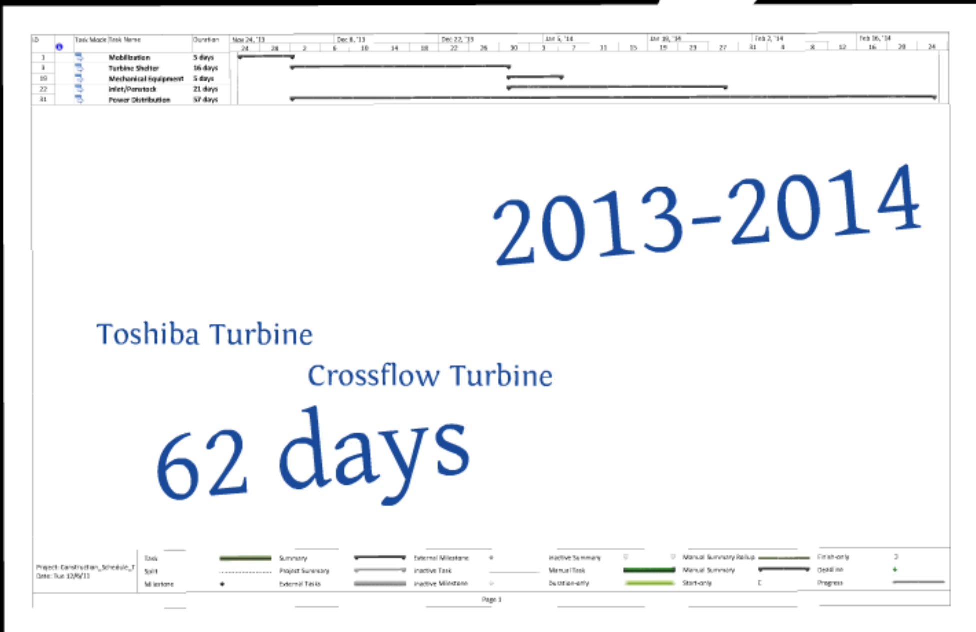


generator connections



household connections

Construction Schedule and Cost Estimate



Crossflow Cost Estimate

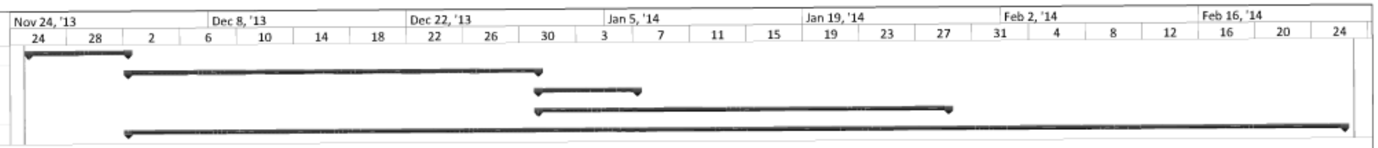
Category	Total Cost
Mobilization	500
Inlet	8,000
Penstock	11,000
Mechanical Equipment / Housing	2,000
Power Distribution	15,000
Total Cost	*$36,500*
including 7% tax	**$39,055**

Toshiba Cost Estimate

Category	Total Cost
Mobilization	500
Inlet	8,000
Penstock	11,000
Mechanical Equipment / Housing	70,500
Power Distribution	15,000
Total Cost	*$105,000*
including 7% tax	**$112,350**

Construction Schedule a

ID	Task Mode	Task Name	Duration
1		Mobilization	5 days
3		Turbine Shelter	16 days
19		Mechanical Equipment	5 days
22		Inlet/Penstock	21 days
31		Power Distribution	57 days



2013-2014

Toshiba Turbine

Crossflow Turbine

62 days

Project: Construction_Schedule_T
Date: Tue 12/6/11

Task, Split, Milestone, Summary, Project Summary, External Tasks, External Milestone, Inactive Task, Inactive Milestone, Inactive Summary, Manual Task, Duration-only, Manual Summary Rollup, Manual Summary, Start-only, Finish-only, Deadline, Progress

Construc

ID		Task Mode	Task Name	Duration
1			**Mobilization**	**5 days**
3			**Turbine Shelter**	**16 days**
19			**Mechanical Equipment**	**5 days**
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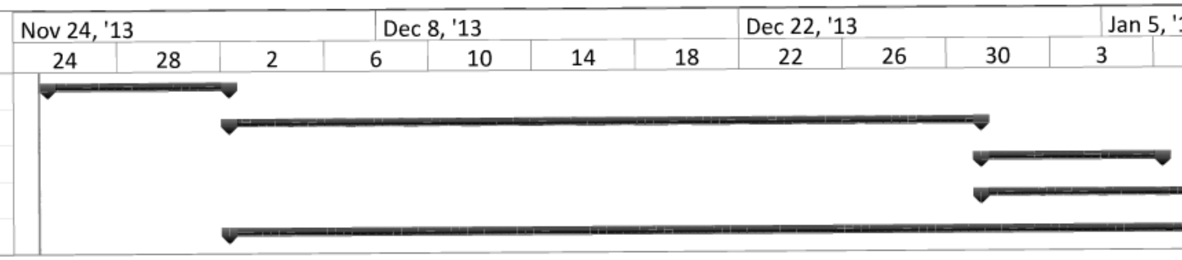
31			**Power Distribution**	**57 days**



20

Toshiba Turbine

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Power Distribution	15,000
Total Cost	*$105,000*
including 7% tax	**$112,350**

recomendations

Toshiba

- Donation
- Grant

Crossflow

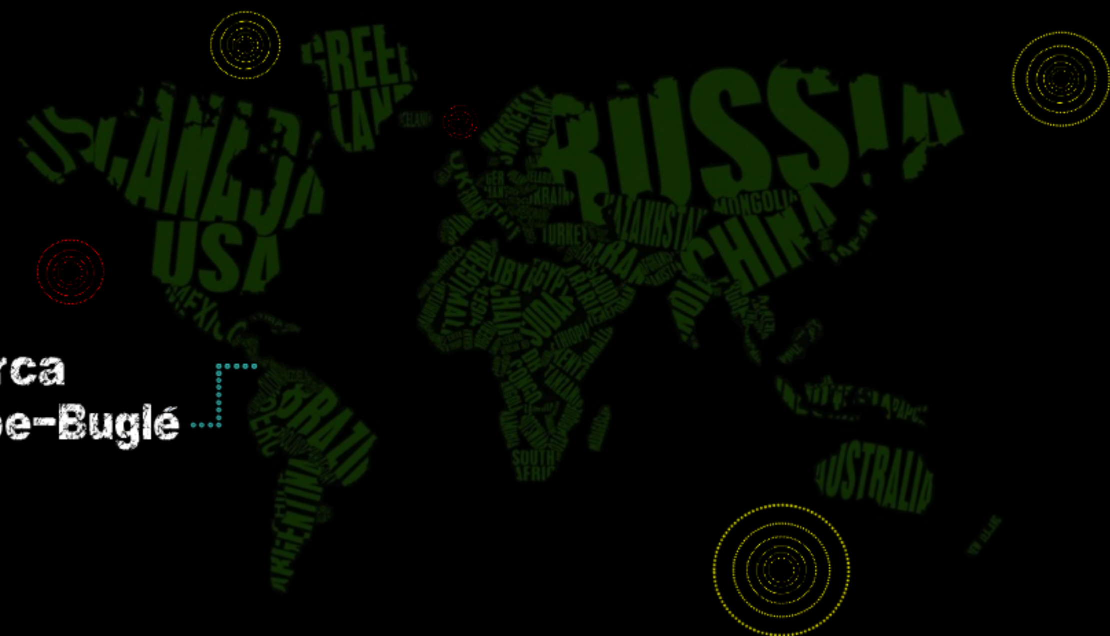
- Cost Effective
- Technical Supervision

Transmission / Distribution System

- Technical Supervision
- 40 Homes

Sustainable Design for a Hydropower System

in the Comarca Ngöbe-Buglé



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Dr. David Watkins

Department of Electrical and Computer Engineering

Dr. Duane Bucheger

John Lukowski

Dr. Wayne Weaver

Dr. Dennis Wiitanen

Spicer Group, Inc.

Russ Beaubien, P.E., CFM

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Thank you