N1 - Rainwater Harvest System

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Problem Statement

Group N1 is tasked with designing a **Rainwater Harvesting (RWH)** system to provide clean, reliable drinking water for a two-person household in **Van Anda**, a remote community on Texada Island in British Columbia.

Table of Contents

Stakeholder Needs

Low costs, with **reduced shipping costs** and **front end load**

Reliable, with a **self-powered** system providing **year-round** potable water

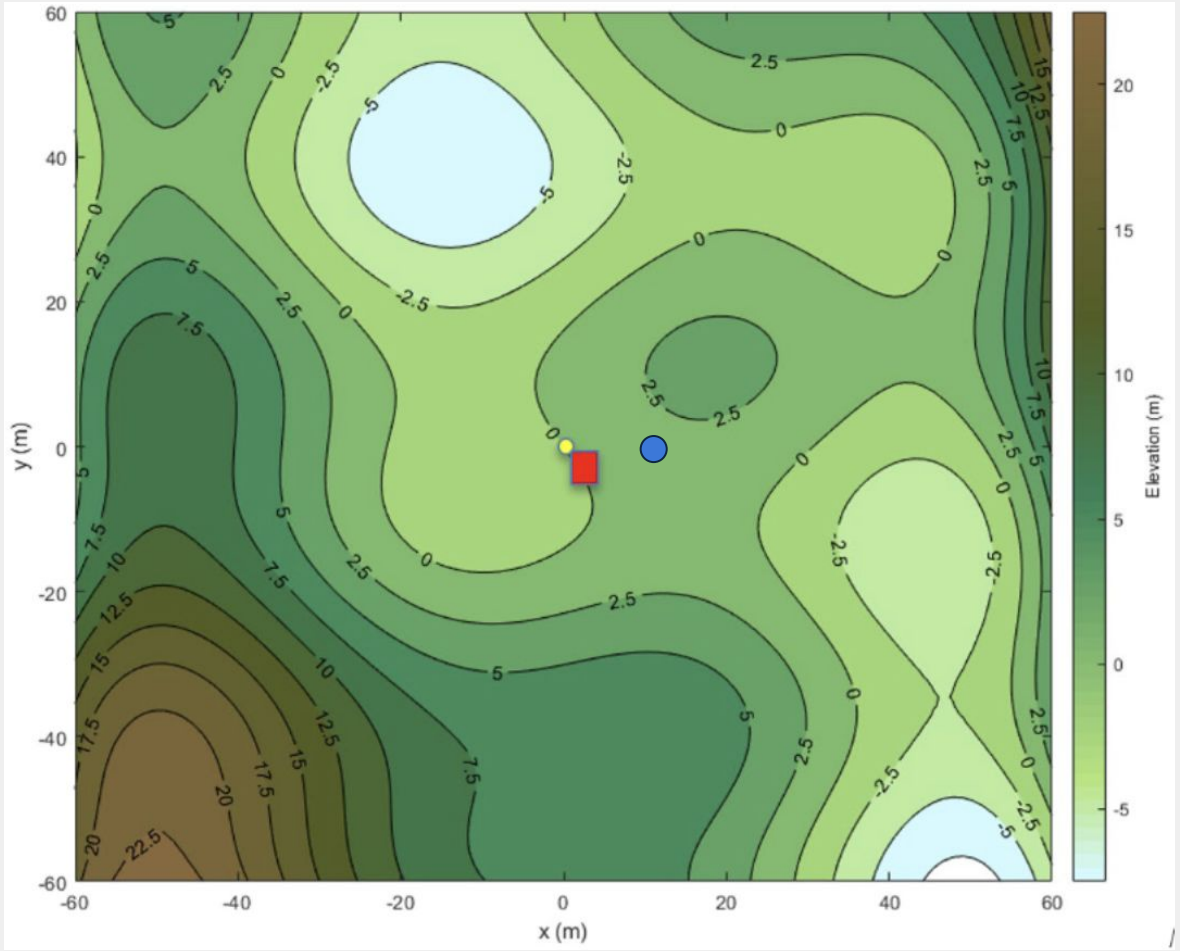
Simple system, with **minimal maintenance** and **no chlorine** usage

Topography

1. Refers to the position of the tank
2. Origin at Yellow Dot
3. Chosen distance and elevation:

   (distance = 10 m)

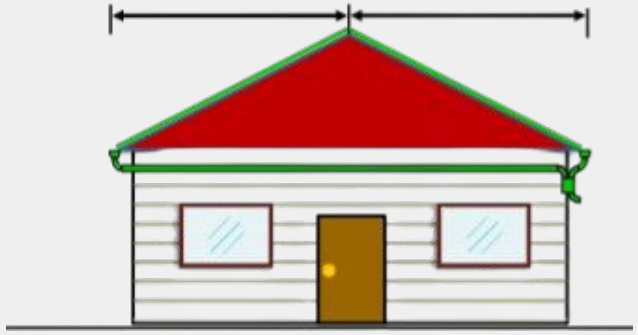
   (elevation = 2.3 m)



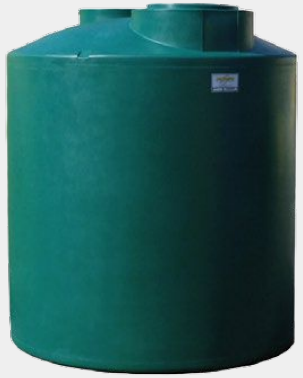
Rainwater Collection

Total Catchment Area: 100m^2

Collection Tank Volume: 2 500L

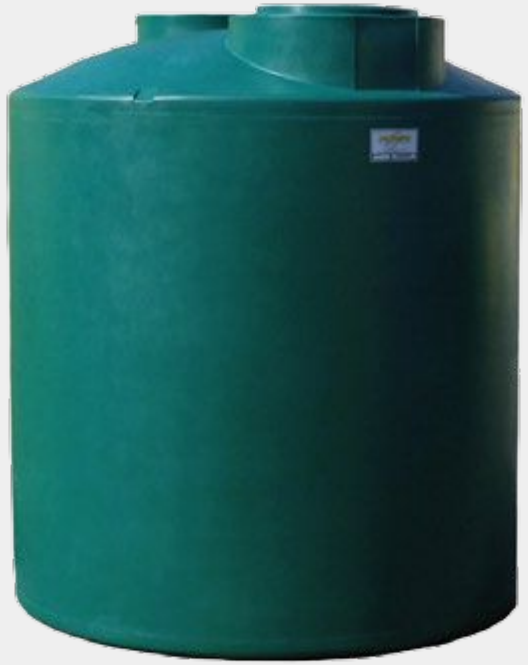


Full Roof Catchment



2 500 L Catchment Tank

Water Storage



2500 L Catchment Tank

- 40000L Storage Tank
- 3m water tower
- Most efficient use of volume
- Meets requirement of daily consumption and rainwater collection

Disinfection

- Overall lower cost in the span of five years.
- No significant impact to the environment nor personal health
- No chlorine taste in water

Ozone Disinfection

Filtration

Filter Location: Filter to storage

Filter Components: 1 µm, 5 µm and 200 µm

Bag Filter
200 µm

Cartridge Filter
5 µm

Cartridge Filter
1 µm

Pump Chosen - Pump A

- 70% efficiency
- Upfront cost of $640
- 900 running hours

Considering cost, flow rate, power consumption and efficiency, Pump A presented itself as the optimal Choice.

Power System

Diesel Generator

+

4 Batteries

+

15 Shipments of Diesel

Power System

Selection Justification:

- Most affordable costs, meeting the demands and resulting in high satisfaction of customers
- Consistent power generation unaffected by time or weather.
- Lower maintenance occurrences.

Risk Exposure

Chlorine Refilling Risk:

- N1 opted for UV filtration making chlorine risk nonexistent.

Diesel Refueling Risk:

- The average refuelling period of 120 days had to be assumed from the given data.

Total Health Risk: 3.20

Total Environmental Risk: 4.80

Total Risk: 8.00

Greenhouse Gas Emissions

GHG from existing system

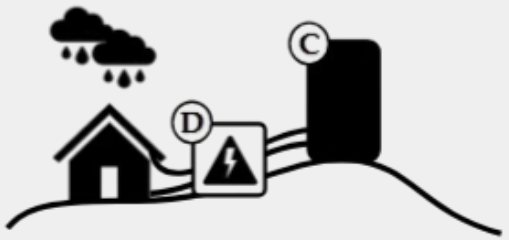
- Centralized water treatment
- Land & sea transport
- Storage & distribution

- 10 117 kg CO2e

GHG from new system

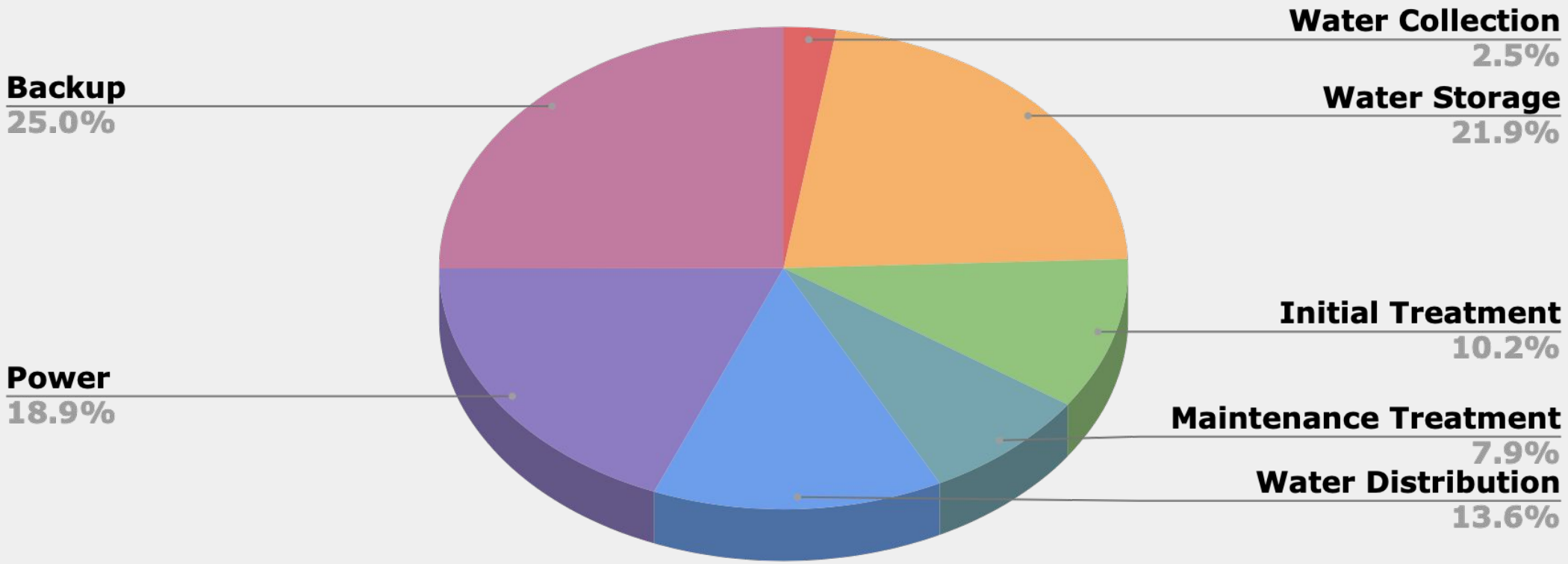
- Local water treatment
- Storage & distribution

- 9 282 kg CO2e



- **Relative GHG% : 92%**

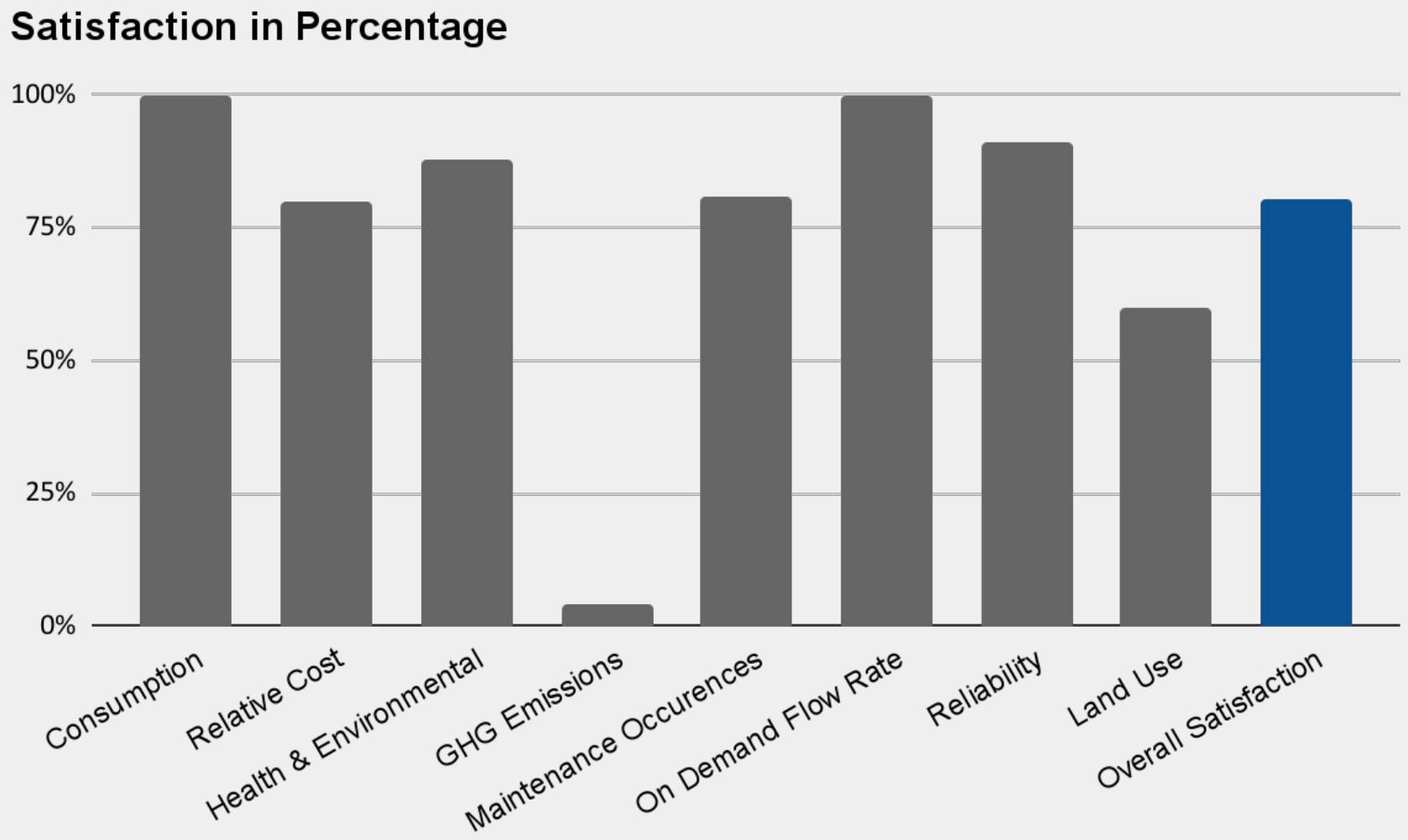
Cost



Total Cost: **$50,968.84**

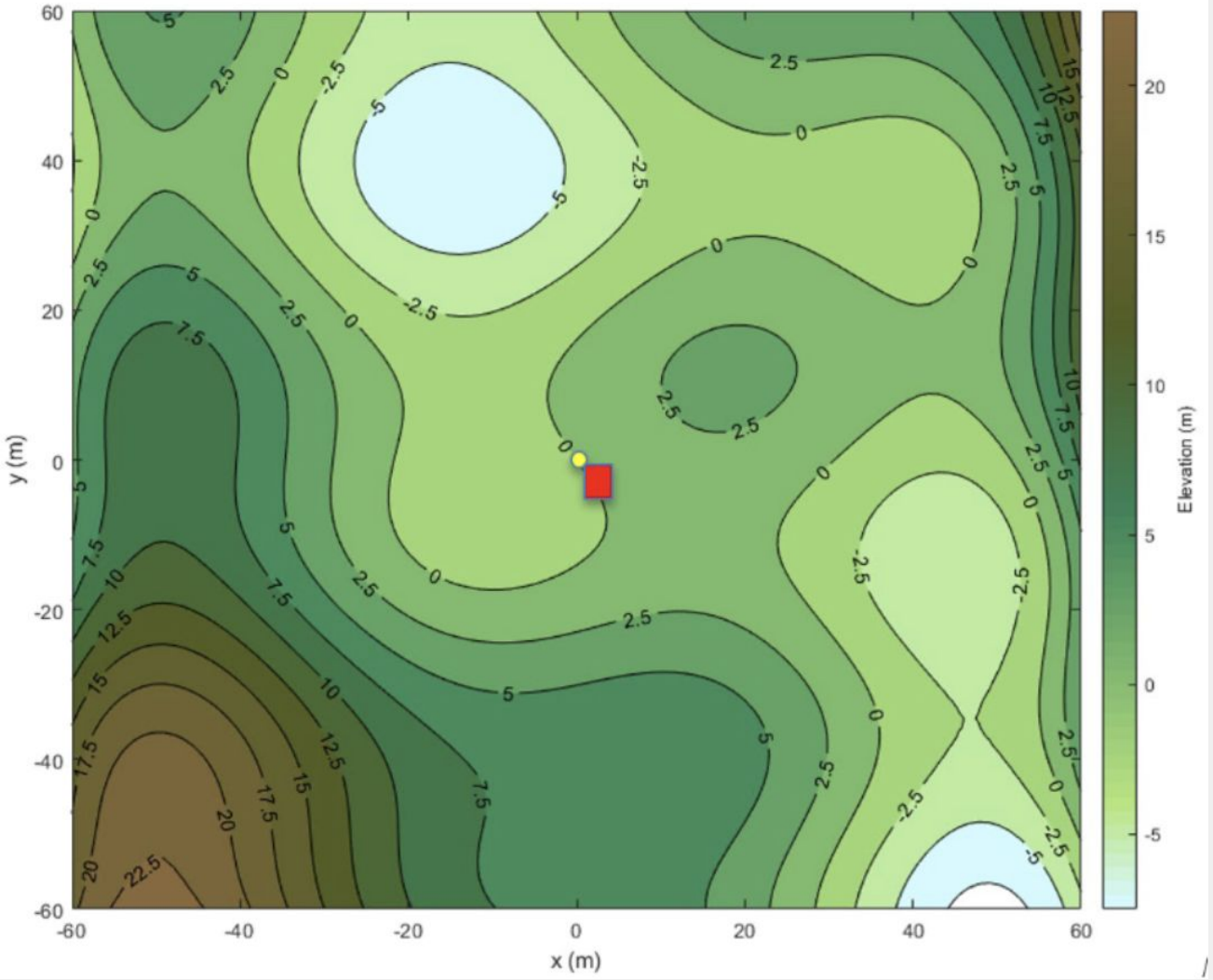
Budget Limit: **$115500**

Satisfaction



The Team

Appendix: Topography Map



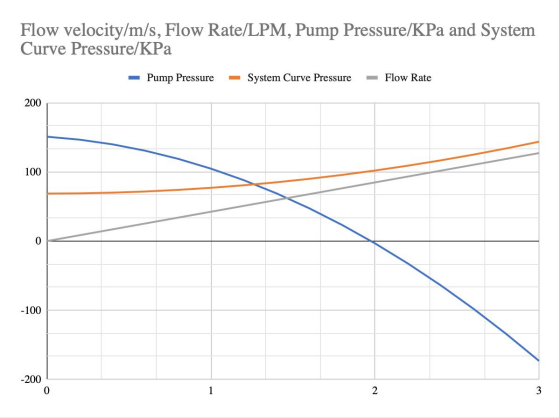
Appendix: Parameters

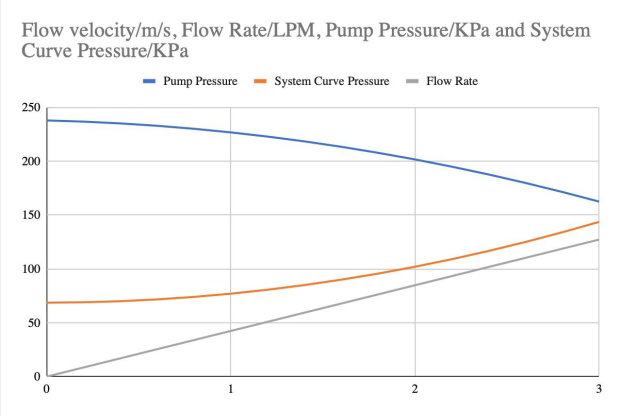
GIVEN & DECIDED PARAMETERS	
Initial Stored Water (m^3)	0
Daily Consumption (m^3)	0.3
Catchment Whole Roof (m^3)	100
Collection Tank Volume (m^3)	2.5
Storage Tank Volume (m^3)	40
Storage Tank Distance from House (m)	10
Storage Tank Elevation (m)	7
Pump Pressure (kPa)	121.0695704
Chemical Treatment	Ozone
UV Purifier Power (W)	50
Filter	Line Storage to House
Power Strategy	Diesel
Battery Power (Wh)	2000
Battery Efficiency in	0.96
Battery Efficiency out	0.96
Pipe Friction Factor	0.05

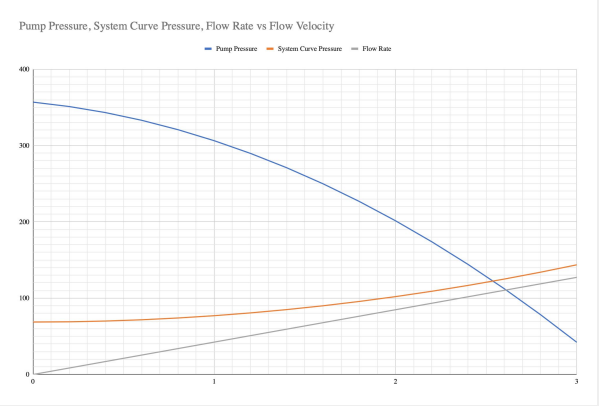
These parameters were either given in the *Component Selection Guide* or found with the data given

Appendix: Flow rate and Pump Pressures

Pump Parameters					Efficiency Curve						
System Curve	a	b	c		A	B	Qmax				
Pump A	–0.0172	–0.3605	150.9		0.7	0.39	83.7 LPM				
Pump B	–0.0039	–0.096	237.86		0.94	0.85	245.7 LPM				
Pump C	-0.0151	–0.5516	356.8		0.72	0.55	136.5 LPM				
								System curve			
	Pump A	Pump B	Pump C						a	0.04930332986	
a	-0.0172	-0.0039	-0.0151		pressure = (a)*(Flow Rate)^2 + (b)*(Flow Rate) +c				b	0.01350690021	
b	-0.3605	-0.096	-0.5516						c	68.67	
c	150.9	237.86	356.8					Quadric Equatio	A	B	C
Initial Cost	$640	$1,250	$3,250					a	-0.06650332986	-0.05320332986	-0.06440332986
efficiency	70%	72%	65%					b	-0.3740069002	-0.1095069002	-0.5651069002
MTBF	900	1650	1800					c	82.23	169.19	288.13
								Q	32.463921	55.372311	62.643229
								P	121.0695704	220.5864961	262.9909654







Appendix: Cost Breakdown

System	Cost
Power System	9610
Pump	$640
Filter - Initial Costs	$335
Filter - Maintenance	$3,500
Ozone - Initial costs	$4,000
Ozone - Maintenance	N/A
UV - Initial Costs	$850
UV - Maintenance Costs	$550
Collection Tank	900
Storage Tank	3000
Tank Tower	8183.84
Piping	6300
Roof Catchment	350
Shipped Water	12750
TOTAL	50968.84

Appendix: Power System Results

FINAL RESULTS (OVER 5 YEARS)					
COSTS ($)		**GHG (kgCO2e)**		**MAINTENANCE (how many times)**	
Panel	N/A	Panel	N/A	Panel	N/A
Battery	1560	Battery	960	Oil Change	5.753928689
Inverter	N/A	Inverter	N/A	Refuelling	14.38482172
Generator	3250	Generator	1250	**TOTAL**	21
Fuel	4550	Fuel	4675.06706		
Oil Change	250	**TOTAL**	6885.06706		
TOTAL	9610				

Appendix: Satisfaction Attributes Breakdown

Attribute	**Weight**	**Satisfaction**	**Weighted Satisfaction**
Consumption	13%	1.00	0.13
Relative Cost	22%	0.80	0.18
Health & Environmental Risk	7%	0.88	0.06
GHG Emissions	5%	0.04	0.002
Maintenance Occurrences	15%	0.81	0.12
On-Demand Flow Rate	13%	1.00	0.13
Reliability	10%	0.91	0.09
Land Use	15%	0.60	0.09
Total	100%		**0.80**