CINNAMON CREEK CAMPGROUND POWER SUPPLY FEASIBILITY STUDY

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by

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A Capstone project submitted to

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EXECUTIVE SUMMARY

In accordance with the request from Roy McDaniel, we have completed a feasibility study associated with a proposed solution to the current conditions of the Cinnamon Creek Campground. Cinnamon Creek Campground is owned and operated by the Church of Jesus Christ of Latter-day Saints, it has had problems providing light and power to the facilities at the campground. Currently campers use their own flashlights, lanterns, and generators to light and power their needs. The primary objective of this feasibility study is to provide cost estimates for two systems to solve this problem. One of the challenges of this project is the uncertainty of exact usage of power. The entire study is based on our current camp knowledge and information collected with respect to conservative power usage design. The first powering system solution integrates both solar and hydroelectric power. The second powering system solution exclusively involves solar power. Out of the two solutions we propose the solar and hydroelectric powering system. We propose the overflow water from the lower storage tank be piped down to the old treatment location where the water will drive a hydroelectric turbine, providing power to the lower facilities. Solar panels will be installed on the facilities roofs as the power source for the upper facilities. A battery system will store the excess electricity from both the solar panels and hydroelectric turbines. Therefore, the hydroelectric generator will provide power to the bottom camp facilities, and the solar system will deliver power to the upper camp facilities. A detailed description of our proposed solution, and subsequent cost analysis findings are included in this study for the LDS Church to make a reliable decision on powering their facilities for campers at their Cinnamon Creek Campground.

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INTRODUCTION

Cinnamon Creek Camp is situated in the southern part of Cache Valley in northern Utah. The camp accommodates up to 1100 campers spread out over a 2-mile-long stretch along the stream. The elevation ranges between 5400 and 8200 feet above sea level. Due to high elevation and cold winter conditions the camp is open each year from May through September. The design length is limited to these 5 months. Assumptions made throughout our design process will be noted in this report. It should be recognized that J.A.M. Engineering dos not employ any Professional Engineers. Any proposed solution for the Cinnamon Creek Campground will be reviewed by Roy McDaniel of The Church of Jesus Christ of Latter-day Saints, who will decide whether or not to implement our suggestions.

Figure 1. Cinnamon Creek Campground

PROPOSED SOLUTION

We propose treating the spring water downstream from the storage tanks. The untreated water will pass sensors to measure the initial water quality. Then, the water will pass through a 20- micron prefilter and 5-micron filter, which will provide a 2.5-log removal of Giardia. Next, a sodium hypochlorite solution will be injected into the water to provide the remaining 0.5-log removal of Giardia and 4-log removal of viruses. The water will then pass a second set of sensors which will measure the treated water conditions. Before being piped to the existing camp water system, the water will flow through a large diameter pipe in order to achieve an appropriate contact time. A visualization of this process is shown in Figure 1. Our solution is discussed in more detail in the following sections.

Figure 1 System Diagram

Solar Power Generation

Solar Cost Estimate

Hydroelectric Power Generation

One of the main challenges of this project is to develop electricity at the project site to power the geography of the project site, harnessing the hydraulic energy of the water will be possible. Using the provided AutoCAD drawings of the Cinnamon Creek campsite, rough calculations of the potential energy were done.

At the lower spring, there is 160 feet of elevation head and between 30 gpm of excess flow available.

Table 2. Summary of Available Potential Hydraulic Energy.

Spring	**Head** (from spring box to generator in feet]	**Flow** [gallons per minute]
#1	129	54-154

Including the parameters of the site, the power available from elevation head of water was calculated. The power from elevation head of water was calculated as follows:

Equation: $P = \rho\ q\ g\ h\ n$

P = power available (Watts)
ρ = density (kg/m^3) (~ 1000 kg/m^3 for

water) q = water flow (m^3/s)

g = acceleration of gravity($9.81 m/s^2$)

h = head (m)

n= efficiency of turbine (assume 60%, 0.6)

The results of these calculations are shown in Table __. For the spring, a conservative flow The efficiency of the turbine is conservatively somewhere around 60 percent. The results

This amount of electricity would power the necessary facilities.

Table 3. Power Available from spring

	Flow (q) [m^3/s]	Head (h) [m]	Power (P) [watts]
Lower Spring	0.0034	39	910

After further research into small hydroelectric turbines, it was found that a Pelton-type turbine would best fit the site needs. Pelton turbines pass water through nozzles; the water jet turns blades mounted on a wheel. The water then spins the wheel which powers an electric generator. The Pelton turbine we found to have high quality was the PowerSpout. A picture of a PowerSpout turbine is shown in Figure 2.

Figure 2. PowerSpout Turbine

The overflow from the storage tank will be used to power the turbine. During peak hours the power will be used from battery storage. During low use, water will flow through the overflow and charge the batteries. The turbine will generate high amounts of energy during the night, then the storage will be used the following day. A qualified electrical professional will connect the correct inverters to switch on and off during peak hours.

An improvement of using both hydroelectric and solar power for the facilities power, is in cost savings. Incorporating the hydroelectric generator for the lower facilities allows greater use of the spring resource. The turbine and solar panels will be tied into the campground's electrical grid system, which is currently powered by gas generators. With the proposed installation of the solar and hydroelectric power system, the electricity could be sufficient to power the entire camp facility needs.

HYDROELECTRIC COST ESTIMATE

For the purposes of this project, a detailed list of cost estimates was based off best gathered information. Specific detailed specs were not found, so cost was best estimated. Also, some project specs were found with exact cost values. All the materials and equipment used for this estimate are listed in the Appendix.

Table 4. Cost Estimate Summary

CONCLUSION

Hydroelectric generator will provide power to the bottom camp facilities, and the solar system will deliver power to the upper camp facilities. Our proposed hydroelectric generator and solar system solution will provide power to the campground's complete facilities.

APPENDIX

A –EQUIPMENT SUMMARY

- Solar Power Generation:
  - Specs…
  - …
- Solar Cost Generation:
  - Specs..
  - …
- Hydroelectric Power Generation:
  - Hydro Turbine – PowerSpout Hydro Turbine ME – MPPT Enabled
  - Solar Panels – 500 watt panels
  - Charge Controller
  - Inverter
  - Battery Bank

B – DRAWINGS

PowerSpout Hydro Turbine PLT with Overvolts Crowbar Fitted

Price ~~$1,899.00~~
Sale Price: $1,799.00
You save: $100.00 (5.27%)

Quantity 1

Availability: Available for Order

PowerSpout PLT with Overvolts Crowbar
WorldwideFree Shipping!

Ruggedlybuilt, twin nozzle, 1300W micro hydro turbine. Comes with all parts and tools for field assembly. (More pictures and Video below, scroll down!)
Includes a fitted crowbar that will drop the voltage to zero if the voltage limit is ever exceeded.

PowerSpout PLT, This turbine can be designed to charge 12v 24v or 48v batteries or connect directly to a grid-tied inverter. A good choice for off-grid installations where the turbine is within 100ft (30meters) of the battery bank or a grid-tied installation where the turbine is less than 2000ft away from inverter location. If off-grid, it will require a load dump **charge controller** to protect the battery bank.
This turbine comes in models PLT(56C,100C,170C,200C,350) **Contact us** to make sure you get the right model before you order.

Features:

- Up to 1300W continuous production (production dependent upon resource head)
- Units are designed to be installed in parallel to capture very large flowrates
- Operates from 3meters of head up to 100m (10ft-328ft)
- Fitted overvolts crowbar that will drop voltage to zero if the voltage limit is exceeded.
- Over 6 years continuous field operation with zero maintenance.
- Grease Zerk fitting for easy bearing maintenance.
- Large-diameter direct-drive permanent magnet generator.
- 68% Recycled materials use in manufacturer
- 100% Renewable energy used in production.
- No exposed rotating parts or electrical connections.
- Fully protected from the elements - weatherproof.
- 3 year warranty
- Free Shipping!

Goal zero YETI

C – CONTACTS

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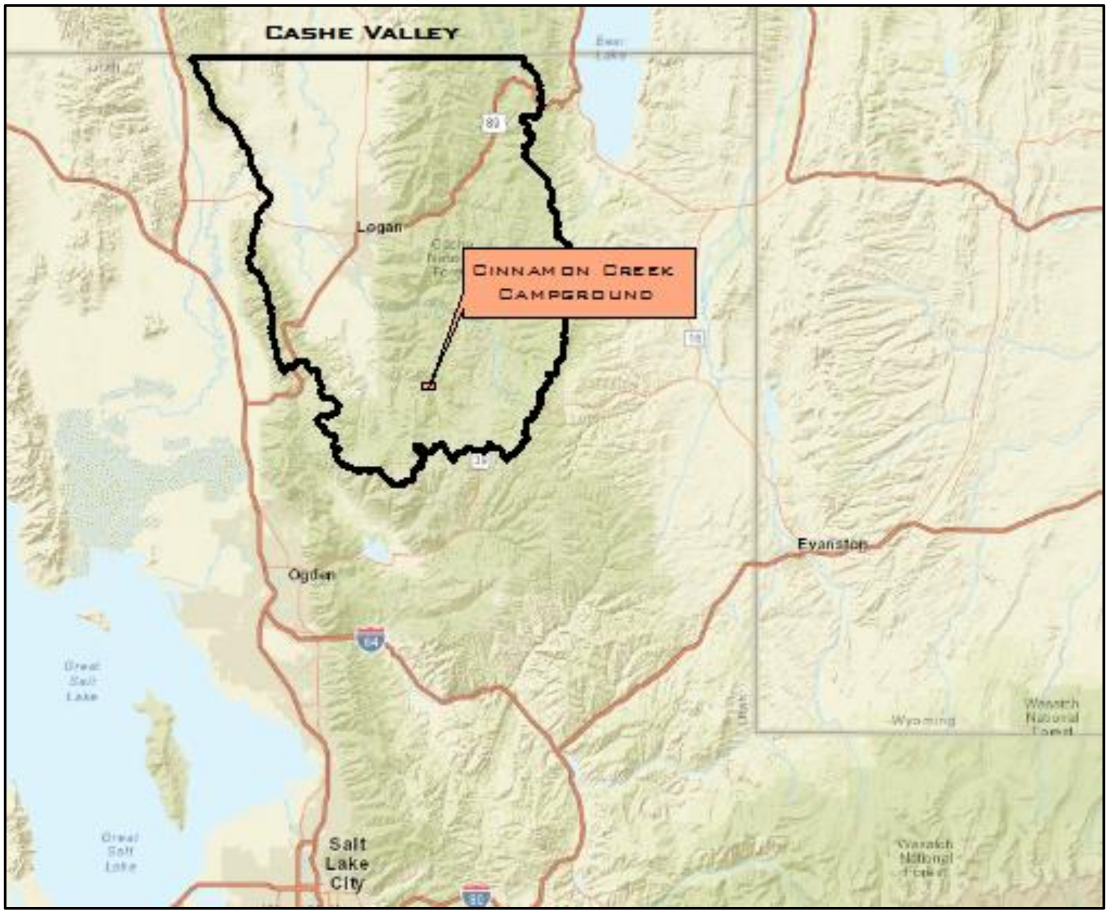
D – EQUIPMENT DATA SHEETS

1. Hydro Turbine – PowerSpout Hydro Turbin

Figure 1. Cinnamon Creek Campground


Cashe Valley
Cinnamon Creek
Campground
Logan
Ogden
Evanston
Salt
Lake
City
Great
Salt
Lake
Wyoming


Upper Pavilion


Upper Pavilion - Kitchen

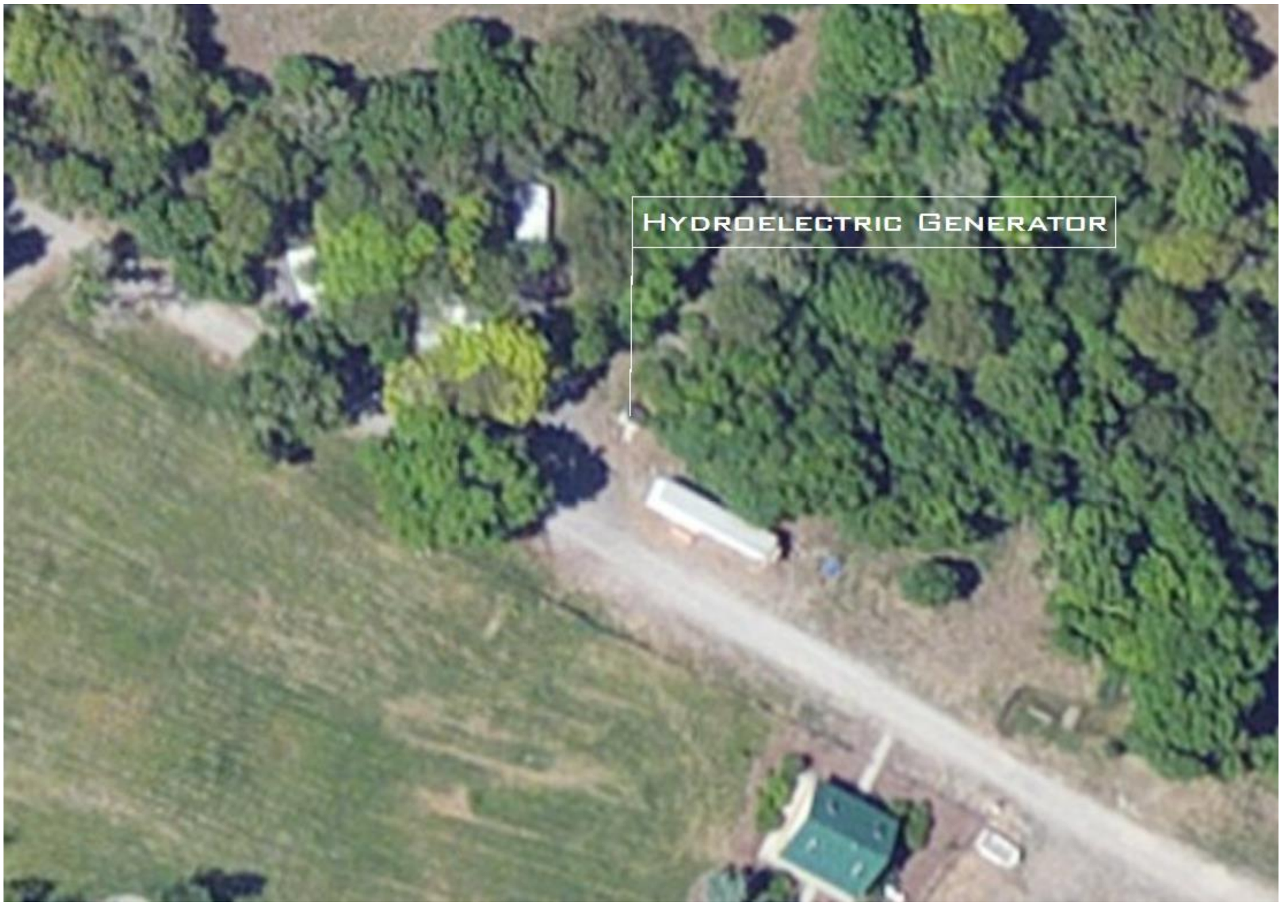

Upper Bathroom


Upper Bathroom
Upper Pavilion
Upper Pavilion - Kitchen
UPPER CAMPGROUND AREA


Upper Bathroom
Upper Pavilion
Upper Pavilion - Kitchen
Burried wire
Roof-mounted solar panels
Roof-mounted solar panels
UPPER CAMPGROUND AREA

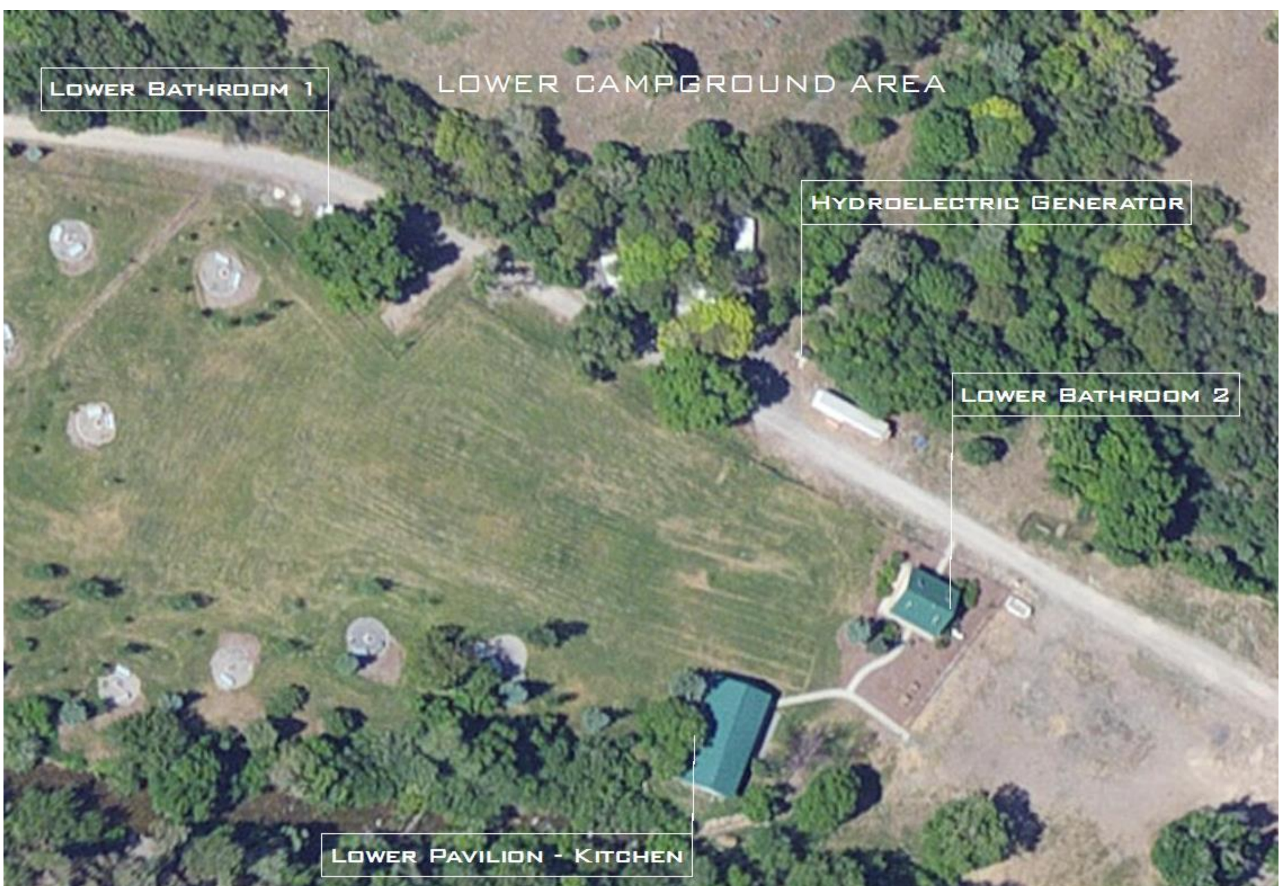

Lower Bathroom 2


Hydroelectric generator
Lower Bathroom 2
Drain from hydroelectric generator
Burried wire


Hydroelectric Generator


Lower Bathroom 1

Lower Bathroom 1
Burried wire



Lower Bathroom 1
LOWER CAMPGROUND AREA
Hydroelectric Generator
Lower Bathroom 2
Lower Pavilion - Kitchen


Spring
LOWER CAMPGROUND AREA
Hydroelectric Generator
Lower Bathroom 1
Lower Pavilion - Kitchen
Lower Bathroom 2


Spring
LOWER CAMPGROUND AREA
Proposed waterline from spring to hydroelectric generator
Hydroelectric Generator
Lower Bathroom 1
Drain from hydroelectric generator to creek bed
Proposed burried wires
Lower Pavilion - Kitchen
Lower Bathroom 2

Option two above

Points to elaborate on in report:

- Demand calculations are based off a conservative estimate using the single 8W bulbs to cover the area.
- With the total watts needed a safety factor of 6 overall KWhrs was added for miscellaneous usage.
- The sunlight hours per day used to calculate demand was 4 hours.
- The hydroelectric generator said maintenance free for 6 years, we chose 5 years as the lifespan.
- Assumed a 20 year life span