Design proposal

Design

This system is to be utilized in remote communities where fresh water sources are sparse and connection to the state electricity grid may be difficult. The design is to consider various aspects relating to: tank and stand, pump and filter, and solar array. The design goals have been defined in the Client Brief as: 1 . Maximize the rate at which potable water can be produced; 2.

Minimize the capital cost of equipment; 3. Maximize the volume of stored water without exceeding the budget. To achieve optimum results, Amorphous Systems has analyses variables such as tank dimensions, stand height, maximum bore head, pump models (A and B), solar panel numbers and whether a solar tracker is to be used or not. As a result of this study, we have identified incompatible equipment and removed these from consideration for the project. This comprehensive analysis has led us too solution we believe best suits the goals of Sunshine Water Pity Ltd.

Our recommendation will comply with the minimum requirements for potable water production, and use savings from the areas of solar panel numbers and pump type selection to construct the largest possible storage tank. This system will produce over 104% of the required dally potable water, is under budget, and stores over 29, 000 Liters of potable water In the storage tank. This recommendation will be explained further In the report. Table of Contents 2 Introduction desalination system for use in remote communities from Amorphous Systems.

The project goals and guidelines supplied by Sunshine Water Pity Ltd (Client Brief Version 2, 2014) have been used to provide an optimized design

solution to the problem. This reports will provide a summary in relation to the following technical analyses: 1 . The Storage Tank Dimensions and Stand; 2. The Pumps, Reverse Osmosis (OR)Filter and Energy Recovery Unit (ERE); 3. The Solar Panels and Solar Tracker Consideration. The aforementioned topics have been modeled to manipulate practical variables in order to achieve the recommended optimal design. Technical Analysis In the following three sections, a summary of the engineering science used to find a solution to the project will be presented. These sections have been nominated by Sunshine Water Pity Ltd as per the Client Brief. 3. The Storage Tank Dimensions and Stand The storage tank and stand are to be calculated with regards to volume (minimum 20, LOLL), surface area, minimum head (kappa) and total height above ground. The total maximum tank height above ground is dependent upon the pressure of the potable water out of the OR filter, which is kappa.

The formulae to determine maximum and minimum possible heights above ground are given below: Equation 1 Equation 2 Where h is the height above ground, and are the pressures at the outlet of the tank and out of the OR filter respectively, g is the gravitational acceleration, and is the insist of potable water. Since these factors are limiting the depth of the tank, to achieve optimum surface area in keeping with budget considerations, this value of tank depth will be a constant of 2. Mom.

Using this constant, the minimum length for radius to comply with minimum storage requirements of 20, LOLL, the equation below is used to find this value: (Minivan 2011, IPPP) Equation 3 From this equation, we found that the minimum radius length will be 1771 mm. To support the tank, the steel legs

will be buried underground to a depth of two meters. This means that each of the 4 legs will be a length of 12. meters (total 48. Mm), and a total of 9 lengths of steel will need to be purchased.

The dependent variable for this section of design is the tank volume and its relationship with surface area with regards to cost. See Figure 1 below for a visual representation of surface area and tank volume (for the alternative designs) relative to cost. Figure 1 - Cost and Volume relative to Surface Area for considered designs 3. 2 The Pumps, Reverse Osmosis Filter and Energy Recovery Unit To produce potable water at a rate of 4000 liters per day, we must first analyses the percentage of table water relative to saline water pumped from the bore (30%) and the 6 hours (per day) of system operation.

Converting this to cubic meters per second, we find that the minimum rate of flow through the system is . The Client Brief stipulates that, " the system must be able to raise water from a bore at least mm deep," (Client Brief these known values into the equation below to find the minimum pressure requirement of 695. 41 kappa for pump A. = 695. 41 kappa Equation 4 In this equation is the height in meters, is the density of saline, and and are the erasures of: minimum required for pump A, and the output of pump A respectively.

This determines that pump PL-I is not a viable option for pump A. A similar formula is used to determine the appropriate pumps for pump B. After subtracting the kappa provided by pump A and adding the required kappa required at the output Owe find that the only suitable pumps for pump Bare PH-2 and PH-3. There is no advantage in increasing as the output pressure of

potable water and concentrate from the OR Filter are predetermined as outlined in the Client Brief to complement an input value of kappa.

The ERE is used to assist in the powering of pump B and is dependent on the flow rate through the system. Using the equation below, the minimum value of output power from the ERE: Equation 5 Where P is the power generated, is the pressure into the ERE, 0. 7 is the constant which is representative of the 70% saline output volumetric flow from the OR filter, Q is the total volumetric flow through the pumps, and beef_e is the unit efficiency.

Substituting known values into this equation, it can be found that the minimum power output from the ERE is approximately 1. Skew. Below is Figure 2 which presents ERE power outputs for the considered designs. Figure 2 - ERE power outputs for considered designs 3. 3 The Solar Panels and Solar Tracker Consideration The number of Solar Panels needed for each design is directly related to the amount of power required by the pumps, for a particular flow rate, until a high flow rate is required.

In these special cases where the system requires 15 or more panels, it can be advantageous to use a Solar Tracker. To determine this, firstly a cost benefit analysis is performed and it is found that if the Solar Tracker replaced the power alee for at least two Solar Panels, it is beneficial to cost. Therefore, to plot the value per watt for a particular system, the equivalent number of Solar Panels in a Solar Tracker system must be two less than the comparable system without a Solar Tracker.

This is best illustrated in Figure 3 below: Figure 4 - Price/power comparison in different systems For systems that use 14 Solar Panels or less, the following

formula is used to determine the number of required solar panels: Equation 6 In the preceding formula, is the power required by the pumps, Beef_p is the efficiency f the pumps (85%), Beef_CB is the efficiency of the charger, battery and controller (95%), and is the output power of one solar panel (235 Watts). By substituting minimum values for power found in previous equations, it can be found that the minimum number of Solar Panels is 13.

Since the number of Solar Panels has a directly proportional relationship with the flow rate of the system, the flow rate can be optimized to the number of Solar Panels for a particular system. 4 Design Solutions as follows: GIG . Maximize the rate at which potable water can be produced; 62. Minimize the capital cost of equipment; 3. Maximize the volume of stored potable water without exceeding the budget. From these goals, 4 solutions were found, one of which is our proposed design which is presented in section 5 of this report.

The solution which best suits Goal 1 is listed within Table 1 in detail below: Table 1 - Design to best suit GIG Maximum Rate Variable Value Cost Tank Radius 1. 861 m Tank Depth 2. Mom Tank Volume 22. 09 Tank Surface Area 45. 50 $4, 549. 75 Total Steel Length 48. Mm $1, 350. 00 Minimum Head 100. Kappa Mass of Empty Steel Tank 545. Keg Pump A PL-3 $1, 000. 00 Pump B PH-2 $4, 000. 00 Maximum Bore Head 55. Mm Saline Flow Rate Into OR Filter Potable Water Flow Rate into Tank LOLL/day OR Filter $6, 000. 00 ERE Number of Solar Panels 14 $5, 600. 00 Solar Tracker Yes $500. 00 Maximum Power Generated skew Total Power consumed 3614. Sky Total $23, 999. 75 This design would be useful in communities where the demand for water is high, and has suitable access to maintenance assets. However, this solution is not recommended, as the margin for error is too fine to be

useful in a remote community. Table 2 - Design to best suit GO Cheapest 1. 771 m 20 42. 3 507. Keg PL-2 $800. 00 0. US LOLL/day 13 No $0. 00 skew 902. Kick $22, 579. 57 This design has been calculated to give the greatest return on investment. By using the bare minimum and optimizing the flow rate for number of Solar Panels, this design would be particularly useful in mass production.

Once again, the margins are too fine and any breakdowns that may occur beyond the safety buffer may have catastrophic results. Table 3 - Design to divide priority between all 3 Goals Mid-Range mm 25. 51 50. 64 607. 71 keg 4541 L/day $233 4. 25 This design was not used as the key to this study, as seen by Amorphous Systems, lies within the definition " remote community. We believe that storage is the key to success with this project, and as such, this design would be useful in a semi-remote community as it has a good balance between storage and potable water productivity.

To demonstrate why Amorphous Systems has proposed the solution described in section 5, the solution caters for a " worst-case" scenario, where the storage tank is full and there is a pump breakdown. Considering the proposal is for remote communities, access to replacement parts may be too difficult to achieve within 5 days. The pertinent Figure 5 demonstrates these catastrophic conditions for each sign in the event that the average potable water can be decreased to 3000 Liters per day for the community.

Figure 5 - Considered designs under pump fault conditions 5 Recommendation The following design was chosen because it offers the most sustainable solution to the given problem. By maximizing storage

through utilization of the complete budget, the remote communities can rest at ease knowing that there are plenty of reserves in the event of a breakdown. Furthermore, the work and cost involved in current design), and / or integrating another Solar Panel into the array is far less than hat of replacing the entire storage tank.

through utilization of the complete budget, the remote communities can rest