EGB100: Engineering Sustainability and Professional Practice

EWB Challenge: Cape York Team
Design Area: 5.2

Tutor: Corey Miller 9am Tuesday

Team Members: Chazka Tan

Luca Grinover

Jordan Thuo

Einstein Roi Dimalibot

Ayden Montgomerie

Aleksei Solntsev

Word Count: 5446 Words

Executive Summary

The purpose of this report is to propose a potential solution for implementation in the region of Cape York with the help of Engineers Without Borders. This report will present a good overview of the mobile solar-powered bore pump which covers its strengths and limitations and its impact on the people and the community of Cape York. The application of this design solution should improve the water situation in Cape York and provide the residents a reliable and sustainable water source.

There were 3 initial designs considered for the solution, two were vehicle-transported and one was hand-held. The two vehicle-transported designs were a vehicle mounted system and the trailer mounted system. The main advantages of these designs are their ease of use and portability, though they suffered in their environmental impact and cost. The hand-held design was a pump that could be disassembled into many parts and transported by hand. This design had a low cost and impact on the environment, though required a lot of training to be used and lacked in portability. Overall, after assessing the initial designs through a decision-making matrix, the trailer mounted design was selected for development.

Therefore, the proposed solution was a trailer mounted solar powered bore pump that required 1-2 workers to operate. The general parts for the unit are fitted to the trailer and only the pump and hoses are removed for usage. It is assumed that this project will be funded by government grants and that Cape York experiences more than 3 hours of sunlight daily. The design is constrained by the availability of materials in the rural areas and the possible damages the environment could inflict. It aligns and furthers goals 6 and 7 of the global sustainable development goals.

Throughout the development process, the impacts of social, environmental, and economic sustainability were evaluated to identify the potential benefits and possible limitations and constraints within the community. The proposed design solution purposefully utilises solar energy to enhance community wellbeing and improve water accessibility and hygiene in Cape York. The solar powered bore pump will be able to supply the current and future water demands of the community. Ultimately, the design minimises the ecological footprint and sources renewable energy as well as cheap and durable materials that are easy to replace and maintain. However, limitations identified the limited availability of registered vehicles that can tow the trailer and the lack of education in the community required to operate the bore pump. Several recommendations are discussed to reduce these limitations and improve the potential of implementation within the community.

The design area considered for this project is related to many other areas in the EWB challenge. To improve efficiency of EWB project implementation, future projects may be designed within the proposed solution to produce a design that covers multiple project opportunities. The design used may also work together with other existing and upcoming projects developed by EWB and CfAT to create a network of sustainable projects.

As a result, the mobile solar-powered bore pump provides sustainable access to water to the communities in the Cape York region. It achieves this whilst considering and mitigating potential social, environmental, and economic benefits and limitations. In relation to the triple bottom line, the benefits of the final design showcase the trailer-mounted bore pump as the most efficient and sustainable design to suit the challenge posed by the chosen project opportunity.

TABLE OF CONTENTS

List of Figures

List of Tables

1 INTRODUCTION

1.1 CONTEXT

Engineers Without Borders' (EWB) annual design challenge for 2021 focuses on Cape York, a region in far Northern Queensland. Cape York suffers from poverty, poor environment, and damaging weather.

Figure 1.1: Map of Cape York

This region consists of less than 8000 residents, with over 50% being Aboriginal and/or Torres Strait Islander (2016 Census QuickStats: Cape York, 2021). According to the Australian Bureau of Statistics, there is only 444 people or 7.7% of the residents above the age of 15 in Cape York that have a bachelor's degree level or above. This figure is lower compared to Australia's result at 22% of the population having a bachelor's degree level or higher (2016 Census QuickStats: Cape York, 2021). There are many factors that contribute to the lower educational background statistics in Cape York, these include families being financially unstable and young teenagers required to work full time to support their families. Since only few people receive the opportunity to pursue high level education in Cape York, there is a limited population of people who have the required level of knowledge to operate complex technology and projects.

Additionally, weather is a significant factor in Cape York. Regions within far Northern Queensland have a seasonal climate, in which climate change predictions anticipate that the environmental impact of seasonal fluctuations will become more damaging. Heavy rainfall in this region is experienced during the monsoonal period between October and April (Regional Weather and Climate Guide, 2021). Furthermore, it was stated by the Queensland Flood Summary that severe flood was experienced in the region of Cape York for seven of its nine wet seasons from the year 2000 to 2009 (Regional Weather and Climate Guide, 2021). The amount of rain that this region receives in such a short period of time has a significant influence on the geographic conditions, isolating roads and forcing streams and rivers to overflow and merge, resulting in a major and destructive flood. Therefore, this makes accessing Cape York extremely difficult, as some regions are only accessible by aircraft or boats. External organisations often volunteer to aid and support communities within the Cape York region. As there is a large indigenous population, each community may showcase unique heritage sites. These vital locations are intrinsically linked to the natural world, and they have strong ties to the local wildlife and environment (Climate change in the Cape York region, 2021).

1.2 Background

Communities in rural Australia such as Cape York, often encounter significant challenges such as the lack of clean water. There are 7513 residents in this remote region, and many communities do not have an adequate water supply (National Indigenous Infrastructure Guide — Centre for Appropriate Technology, 2014). Bores are among the greatest sources of water for the community in this area. Certain bores are only in operation during the dry season, when specific work in that area must be completed, such as fire-fighting and refilling head tanks.

1.3 The Problem

The construction and maintenance of a stationary bore pump within each community is too expensive and not sustainably achievable. Thus, a mobile, self-sustainable bore pump that can be transported to the location where it is required would solve this issue. Replacing the need of stationary pumps, a mobile pump could service several bores, significantly reducing expenses.

1.4 Scope

The ideation process considered multiple ideas for this design opportunity before deciding on the most efficient and sustainable solution for the situation in Cape York. Factors such as cost, conveniency and safety were considered prior to selecting the final solution. After the evaluations of all the ideas, it was determined that the mobile solar-powered bore pump is the best solution for the condition in the region of Cape York. This proposal's implementation in the region of Cape York, will also provide the people and the community a very reliable and easy access to sources of water.

2 DESIGN OPTIONS

2.1 DESIGN CONSIDERATIONS

To produce a sustainable solution for our selected design area, these factors had to be taken into consideration:

- Ease of construction
- Cost
- Sustainability
- Practicality
- Learnability
- Safety
- Environmental Impact

The reasoning behind choosing these factors relates back to the specifics of the Cape York and far north Queensland region.

One of the main factors that were taken into consideration was the ease of construction. This was because the region does not have highly developed infrastructure or economy, forcing the designs to be simple and easy to produce, relying on pre-existing parts and easily source-able materials. When combined with simple construction, the design becomes possible to produce and maintain in the region, allowing for greater autonomy from the surrounding cities. For the design to be effective, the ease of construction must be combined with cost and sustainability.

The cost and sustainability of the design is a very important factor in the design. This is because of the region's poor economy, requiring solutions to be affordable and realistic to maintain. This allows the communities to be able to afford the solution as well as maintain and utilise it for as long as possible, until proper servicing needs to be done on the pump and electronics.

The usability and maintainability of the solution is reliant on the learnability, practicality, and safety. This is because if the device is difficult to understand, the communities may not be able to fully utilise it. This underutilisation and lack of understanding will reflect on the solution's safety and practicality, since users may not know how to properly handle equipment, increasing the chance of injuries and reducing effectiveness.

Since the environment of the region is fundamentally important to the aboriginal communities, a great deal of attention was allocated to the environmental impacts of the designs. One of the main limitations were the accidental transportation of weeds that could occur if the designs considered were wheeled or self-propelling. Another limitation is the disturbance of natural habitats and reducing the underground water table, disrupting the redistribution of the water cycle. Other problems such as pollution and trampling of flora and fauna were also important, though were often unavoidable.

2.2 ALTERNATIVE APPROACHES

2.2.1 Vehicle Mount

The first of the vehicle portable designs is a vehicle mounted system. The vehicle mount itself will likely be a utility car that has its tray modified to carry the pump, solar panels, battery, computer as well as hose and wire reels. This design aspect has a range of significant advantages and disadvantages.

In terms of advantages, the mounted design is distinguished by its ease of use, learnability, and practicality. The ease of use and learnability is established from the prefabricated nature of the pump as well as the low requirements to operate and transport. This is because the pump is mounted to the vehicle itself, allowing any person who can drive a utility vehicle to effectively use the design. This combines well with the pre-built pump, as the only actions the operator needs to perform is to drive to the location and lower the pump into the bore hole.

However, considering the disadvantages, the mounted system struggles with cost and reliability. In terms of cost, the fact that the vehicle which is modified to carry the pump will be rendered unusable for other tasks, essentially requiring the price of the vehicle to be included in the overall cost of the system. The reliance on the vehicle also causes problems with the reliability, as any breakdowns of the pump vehicle would render the pump unusable.

2.2.2 Trailer Mount

To resolve this issue of reliability with the vehicle mount, an alternative design was proposed. This design incorporates all the components of the vehicle mounted solution, but on a trailer. This allows the pump to be transported by any mode of transport that accepts a pintle mount.

This solution also inherits many of the traits of the vehicle mounted solution, though differing in a few significant ways such as cost, sustainability, and reliability.

In terms of cost, the trailer mounted solution would be cheaper than the vehicle mounted solution, as it does not require the vehicle to be included in the cost. This is partly counteracted as the trailer must be purchased, which incorporates the community’s verbal input and is funded by the government.

In terms of sustainability and reliability, the trailer solution is simpler and therefore more easily serviced and maintained. This is because the system is not reliant on the reliability of its transport and uses a simple trailer that can be repaired and patched by the locals. The separation of transport and pump increases the amount of effort and water spent at a wash-down station. This is because if the trailer is not cleaned properly, it could spread weeds in the region, starving out the native plants.

2.2.3 Modular Design

An alternative to the vehicle transported system would be the hand-held pump that can be taken apart. This ability to be stripped down to its components is highly important as a powerful, fully assembled pump is not only heavy, but is also bulky and not very easy to transport. This requirement for disassembly also encompasses significant factors not required within the previous solution ideas. This results in multiple strengths and limitation in the areas of cost, learnability, and environmental impact.

In terms of cost, the modular solution is overall cheaper to implement, as it does not require vehicular transport, eliminating one of the greatest contributors to the overall cost. This elimination of a need for transport also allows the solution to be carried on foot, eliminating certain environmental impacts that the other solutions include.

These positives, however, are counteracted by the one significant limitation of this solution: the reliance on user knowledge. This is because the operator must have an in depth understanding of the assembly and operational system. Therefore, requires training and specialised personnel for the pump to be exploited to its full ability.

2.3 Selection Process

To properly compare the different design solutions, a decision matrix was created. This matrix incorporated a weighting system to allow more important and less important categories to be weighted accordingly. The weightings can be seen below in Table 2.1.

Category	Weight	% Weight
Cost	0.049645	4.96
Learnability	0.056738	5.67
Environmental Impact	0.156028	15.60
Sustainability	0.170213	17.02
Cultural acceptance	0.106383	10.64
Reliability	0.156028	15.60
Practicality	0.120567	12.06
Safety	0.184397	18.44
Total	0.049645	4.96

Table 2.1: Weightings of Categories

The values from Table 2.1 were then combined with the individual scores of the different designs for their respective categories, producing Table 2.2 below.

Category	Score(Weighted)		
	Mounted	Trailer	Modular
cost	1(0.05)	5(0.25)	7(0.35)
learnability	8(0.45)	8(0.45)	1(0.06)
en. impact	3(0.47)	7(1.09)	8(1.25)
sustainability	4(0.68)	7(1.19)	5(0.85)
cul. accep.	5(0.53)	5(0.53)	5(0.53)
reliability	5(0.78)	6(0.94)	4(0.62)
practicality	9(1.09)	9(1.09)	3(0.36)
safety	7(1.29)	7(1.29)	9(1.66)
Total	42(5.34)	54(6.83)	42(5.68)

Table 2.2: Comparison of Solutions

As seen in Table 2.2, the trailer mounted solution has scored the highest and therefore was chosen as the final design, getting further development.

3 FINAL DESIGN

3.1 DESIGN METHODOLOGY

The proposed solution is to mount parts for bore pumping directly onto a trailer that can be transported to the water sources. The components for the design will be shipped to Cairns where most materials are more available than in the rural areas of the Cape, where it can be assembled and then driven on country. A visualisation of the proposed design is shown in Figure 3.1 below.

The general components are specified in Figure 3.1 and colour coordinated. The base is designed for a regular 6x4 trailer since smaller trailers could not handle the required space for solar panels and larger trailers had excess unnecessary space and were not worth the cost. The Cairns Bunnings can provide a reliable source of these trailers for a reasonable price (Bunnings, 2021). The calibre of submersible pump required was specified in the EWB brief and had to be capable of pumping 2000-5000L generally and 10000L in emergency situations from 100m deep bore holes (EWB, 2021). The proposed solution incorporates a pump kit that includes the required panels and control unit in one purchase, the most suitable kits can be sourced from Commodore Australia (Commodore, 2021). The Commodore kits provide a pump control unit (PCU) for variable pumping rates. Powering the pump configuration, the solar panels (Commodore, 2021) lead into a 12V DC battery that connects to the PCU and pump. Sourcing the battery has been left open ended since it could be reused from other projects or bought locally in Cairns. The main power and hose reels need to be capable of reaching the 100m deep bores, the main hose reel holds 150m of hose to facilitate filling sources within 50m of the bores. The design further incorporates 50m more of emergency hose to extend the range to 100m away from the bore. The hose chosen is designed to support the weight of the pump when submersed (Crusader Hose, 2021).

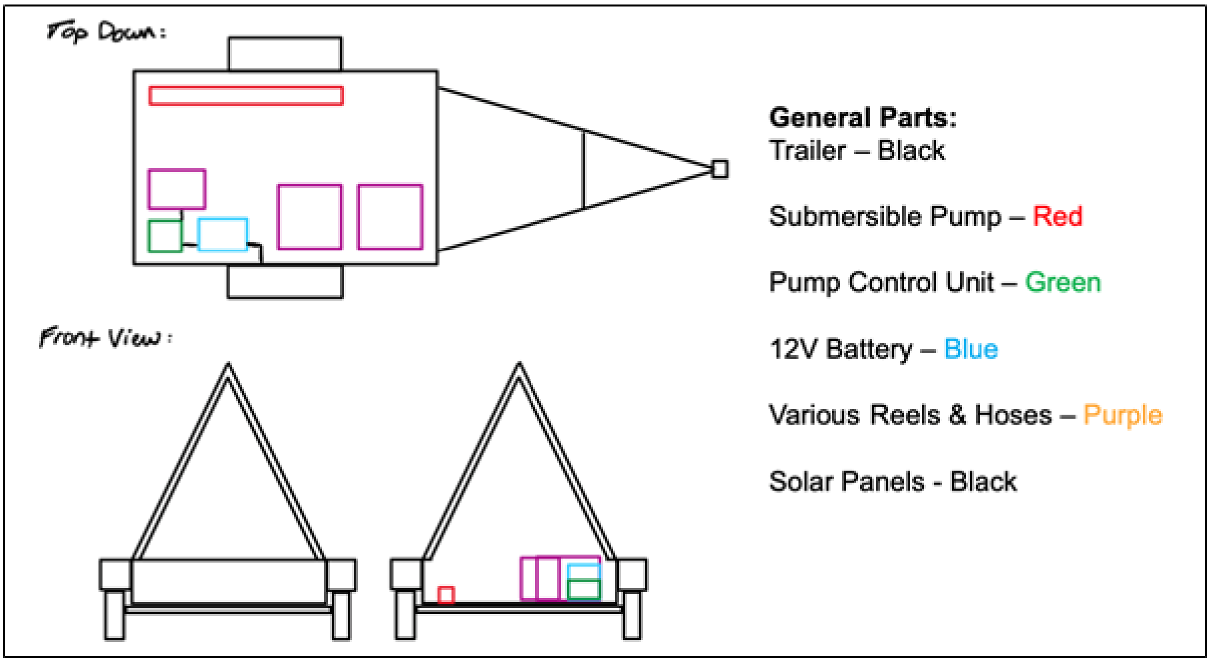

Figure 3.1: Mock-up of proposed design

1-2 workers are required to operate the design. At a bore, the pump is removed from the mounts and attached to the power cable and main hose, it can then be lowered down into the shaft and at the desired depth, the reel locks into place and the weight of the trailer holds the system in place. The pump rate is controlled via the PCU.

The total estimated cost is approximately $7500 per unit (Appendix A). Each part is replaceable, however in rural Cape York the materials are less readily available. For smaller parts recyclable materials such as scrap metal could be implemented as replacement parts. The lifespan of the pump kit best reflects the lifespan of the solution before major maintenance is required, this is implied by the warranty of 3 years, which reflects how long the company expects the pump to operate effectively for (Commodore, 2021).

3.2 Assumptions and Concepts Adopted

The nearest weather station to the Cape York region is in Cairns and therefore the average amount of sunlight the design is exposed to daily must be based on the data from the Cairns station. The most recent data showcases that February has the least amount of average sunlight and October has the most, as seen in Figure 3.2 (Weather & Climate, 2021). The final design incorporates a pump designed to operate with just 3 hours of sunlight per day and the excess will be stored in the battery (Commodore, 2021). It is assumed that the Cape York region will generally experience greater than 3 hours of sunlight daily due to the data found at Cairns.

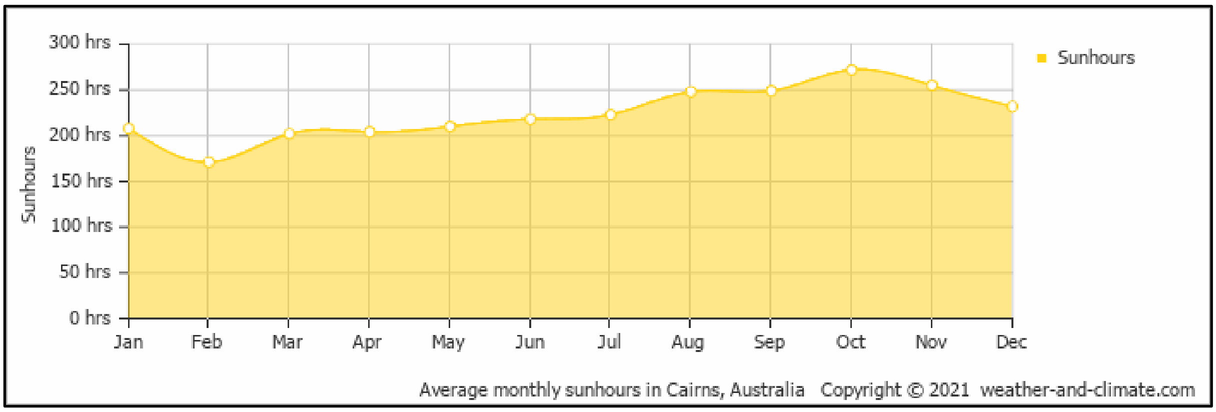

Figure 3.2: Graph of average monthly sun hours in Cairns

Funding for this project will be sourced from available grants. The Australian Government has provided funding for the indigenous communities living on country through the Indigenous Advancement Strategy (IAS). The IAS grants are awarded based on eligibility criteria, EWB satisfies these as an organisation and this project further satisfies their criteria of need, quality, efficiency, and effectiveness (Australian Government, 2019). Therefore, it is assumed that this solution will be funded by the IAS following a grant application from EWB.

3.3 Constraints and Limitations of Design

Construction of the design is limited by the material availability of parts in Cape York. The more rural areas are harder to transport materials to and lack the infrastructure to have existing sources for parts. The proposed solution adapts to this by shipping all parts to Cairns for assembly and then driving the apparatus into the Cape. However, while on country the materials are still not available for repairs and maintenance, this provides an opportunity for waste management whereby recyclable materials and parts can be repurposed to repair the mobile bore pump.

The design itself is constrained to cope with the environments of Cape York. The monsoonal season often leads to large floods which could damage the design (Bureau of Meteorology, 2010), the parts should be water resistant to ensure reusability even with floods and rain. This is advantageous to the design itself as well since the pump could leak and water damage would be negated. Similarly, the dry season could overheat the PCU on hotter days (Commodore, 2021), to accommodate this the solution required built in shade to keep the unit cool. The solar panels provided shade when mounted atop the trailer but also got the maximum amount of sunlight possible both considering the limitation and improving efficiency.

3.4 Link to SDG's

The focus of this project was sustainability, the global sustainable development goals and their links to this project were considered. The two goals that best align with this design are goal 6: Clean water and sanitation and goal 7: Affordable and clean energy.

Goal 6 is to "Ensure availability and sustainable management of water… for all." Since this project's aim is to provide a sustainable system for access to water for the rural communities of Cape York it, on a small scale, achieves this goal. Specifically, the subgoals outlined as 6.1 Access to affordable drinking water, 6.4 Increase water use efficiency and ensure fresh water supplies and 6.B support local engagement in water sanitation and management. The final design achieves all three of these sub goals.

Goal 7 is to "Ensure access to affordable, reliable, sustainable and modern energy for all." This design is a self-sustaining solar powered system and reflects affordability, reliability and sustainability. The three subgoals connected to the project are 7.1 Universal access to renewable modern energy, 7.2 Increase global percentage of renewable energy and 7.A Promote access to usage of clean energy (Project Everyone, 2021). The apparatus does increase the usage of renewable energy in the Cape and gives it to communities who might not have had access prior. The more successful these pumps are, the more likely other communities are to adopt them, thus promoting the benefits of renewable energy.

4 Overall Outcomes

4.1 Potential Benefits to the Community

Throughout the entire design process, an equity-centred community design approach was used to enhance and improve community engagement, problem solving, and create inclusive and equitable outcomes. As a result, the Solar Power Bore Pump solution was assessed against the triple bottom line criteria to determine the overall sustainability and identify potential benefits to the community and possible limitations and constraints that need to be addressed.

The triple bottom line is a concept of sustainable development which analyses the interrelationship between the three primary subsystems of sustainability, people, planet, and profit.

SOCIAL BENEFITS

Socially, the solar powered bore pump aims to contribute to the general community wellbeing and improve access to clean potable water for drinking and hygiene purposes. This is achieved as the social impacts of sustainability analysed within the final design solution demonstrated that access to a safe and reliable water supply is fundamental for consumption, hygiene, and community wellbeing (Department of Health, 2021). It is an essential resource for socioeconomic development and linked to reducing factors such as illness and mortality rates since the minimum amount of water required for drinking and hygiene purposes is 50 litres per person per day (National Indigenous Infrastructure Guide — Centre for Appropriate Technology, 2014). Therefore, the benefit of having a portable bore pump is that communities can have continuous access to water and can supply the current and future water demands of the community.

Furthermore, the pump naturally blends within site-specific and regional management strategies (National Indigenous Infrastructure Guide — Centre for Appropriate Technology, 2014) and involves the community throughout the design process. This will enhance appropriate education on the sustainable extraction of water from underground water sources, promote cultural acceptance and increase a sense of ownership and pride.

ENVIRONMENTAL BENEFITS

Environmental sustainability plays an integral role in the triple bottom line analysis. Recognising this, the final design utilises solar energy to pump water to local communities, therefore, minimising the ecological footprint. The design does not require the reliance on grid electricity or diesel fuel, which are both unsustainable and scarce resources within Cape York.

In addition, the trailer design is mobile, and can be attached at any bore hole. The alternative is building more bores and subsequent stationary bore pumps. This has a detrimental effect on the underground water table and surrounding distribution of the water cycle.

ECONOMIC BENEFITS

The capital and recurrent cost considerations should be considered when managing water supply. The economic benefits of the solution are that it is cheap and uses durable materials that are easy to replace and maintain.

Furthermore, with the improved access to water, this allows for the increase in agricultural and farming opportunities within Cape York. This ultimately provides numerous job opportunities and enhances the financial stability of communities within the northern regions of Queensland.

4.2 Potential limitations and constraints to the community

It is important to identify the potential constraints and limitations to a solution, particularly on the community, when taking a people-based approach to solving a problem. A major hindrance to the implementation of this proposal is the ability for the community to be able to use mobile solar powered bore pump. According to 2016 census data approximately 23 percent of Aboriginal and/or Torres Strait Islander people in Cape York attended high school and around 3 percent attended tertiary education (Census QuickStats, 2016) This means that large portions of many communities may be able to simple operate the pump but may not have the technical skills to work on it. Thus, once the pump is built and ready to function it would see minimal use. Due to the community not having the education to be able to fix any issues which may arise the pump may become completely unused once one does appear.

In addition, it is a possibility that the community may not feel comfortable using this solution as it may seem complicated and the technology out of reach. However, this is not expected to occur as many communities have been in contact with bore pumps, solar power and trailers on an individual basis and this solution is purely a combination of these components.

Similar previous projects and when implementing new technology in Cape York, several influential members of the community will be included in the building process of the unit. This will serve two purposes; first it will allow these members to become comfortable around the unit and thus, due to their influence, allow the rest of the community to feel comfortable as well; furthermore, they will understand how the components were assembled and will also be taught how to use the unit, creating a group of specialised technicians to work on the pump should it ever need to be worked on.

A further solution which will aid in prolonging the life and allow the proper use of the pump will be the creation of information or instruction sheets. These are a simple, cheap yet durable and effective set of instructions which will be printed onto A4 paper, laminated, and then strung together, allowing them to be used under rainy weather and not be lost.

Another major hindrance is the availability of registered vehicles able to tow the trailer. According to 2016 census data collected from Cape York at least 74 percent of private housing in Cape York owned at least one vehicle (Census QuickStats, 2016). However, a couple of things should be noted; first not all residences of Cape York would have received the census survey so the percentage of registered vehicles may differ from the one given by the 2016 census data; Further, it should be noted that a registered vehicle will not necessarily mean a vehicle that can tow a trailer, thus this data cannot be used to identify whether all communities will be able to share the trailer. However, a simple yet effective solution to this issue would be to assign the trailer a vehicle which will be the sole towing vehicle, it will tow the trailer to where it needs to be used. Then once the pump has been installed and is functioning the vehicle can be disconnected and used for other purposes. If the towing vehicle were a permanent part of the solution the cost would have been factored into the final cost, however, as this is a solution that communities will decide on their own these cost estimates were left out.

4.3 Recommendations for future adaptation

Several recommendations for the future adaptation of the proposed solution are:

· Improved cost analysis to determine accurate total delivery costs and attempt to minimise where possibly by exploring locally available materials and components.

· Enable a strong connection between engineers and the community and ensure community acceptance by implementing further community interaction and communication.

· Further refine the design to have a lower centre of gravity to make it more suitable for off-road conditions.

It would be beneficial to research and create a partnership with the planned dispensary of trailers (Bunnings) or directly with the manufacturers of the trailers. This would provide a customisable platform and possibly cost savings. A potential link may exist where the mobile solar powered pump may also be used as a mobile power storage supply. This would need further research into battery and plug technology and implementation on the design of the trailer. It would benefit in emergencies if the trailer may need some work done to it requiring electrical power or be brought to a location to power communication units or any other essential items temporarily.

5 Wider EWB relationships

The design covers a large range of design areas and project opportunities. The design team explored project opportunity 5.2, a mobile solar powered bore pump. This project opportunity is aligned with the water management design area, however its interrelationship with other design areas is apparent when the project is explored. As EWB and CfAT currently have various operational projects implemented in the Cape York region, the mobile solar powered bore pumps may interact with these existing projects. Special considerations are required to ensure that minimal overlap between the purpose of existing EWB projects and the proposed design in this report does not occur. Ideally, the discussed project should holistically interact with existing projects and become mutually beneficial for the community.

The mobile solar powered bore pumps considered in this report and the mobile solar power supply from design area 4 share common characteristics and qualities that would make a combined system of the two more efficient than one standalone system. As the proposed design already incorporates solar energy from the solar panels, including a way to transport this power from community to community is a simple and cheap inclusion. For instance, a large battery could be placed in the trailer and connected electrically to the solar panel in conjunction with the pump. Then any power that is not used by the pump is stored by the battery and can be used by the community while the trailer is in use. This would provide solutions to both water and electrical issues communities may face in the Cape York region.

The design of a mobile solar powered bore pump may also provide a solution or improve existing solutions to various EWB and CfAT projects in the region. An example of this is the Lama Lama water supply project (Engineers Without Borders, 2019). In this scenario, the Lama Lama community was facing a severe water issue, where access to clean water was extremely limited and the only solution was to pump water from underneath a lakebed which posed many contamination risks. EWB's solution to this was to install a permanent non-vertical solar powered bore intake, which included necessary air and water filtration devices. The mobile solar powered bore pump outlined in this report is a viable solution in place of a permanent pump, as when it is not in use, it can be easily transported to other communities. This would have made the solution for the Lama Lama community more ecologically friendly and sustainable.

6 CONCLUSIONS

The solar powered bore pump was designed with the aim to benefit the many communities in the Cape York region. The success of the design can be assessed with the number of benefits it provides to communities in accordance with the triple bottom line. Socially, the pump benefits the community wellbeing by providing communities with an essential resource that can be used for drinking and hygiene purposes. By using solar energy in place of a diesel generator, the pump will ensure that no unwanted pollution is introduced onto country. While the economic benefits of the pump were not considered to be essential in determining the success of the design, its positives should not be overlooked. With a low cost of $7500 per unit, many of these mobile pumps can be created and placed around the cape York region. The materials that have been considered are also durable so that maintenance and repairs are low cost. By providing communities with clean water, agriculture job opportunities will become available which will improve the economy in the region.

The aim of this challenge was to design or improve upon a project that aimed to "support people in regional and remote Australia in the choices they make in order to maintain their relationship with Country" (EWB, 2021). The design that has been created and outlined in this report completes this mission, as it gives communities in the Cape York region a chance to maintain their current living position, rather than moving away from Country. It does this by solving the clean water challenge that many communities in the region faced and does this in a cheap and sustainable way. This design aims to improve the lives of the many suffering communities in the region, and in conjunction with ongoing and new projects developed by EWB, will holistically work together to create a network of technology that will significantly improve those people's lives.

7 REFERENCES

Australian Bureau of Statistics. 2016. *"2016 Census QuickStats: Cape York."* Accessed 27 May 2021 Available at: https://quickstats.censusdata.abs.gov.au/census_services/getproduct/census/2016/quickstat/315011396#mortgage-rent.

Australian Government. 2019. *"Indigenous Advancement Strategy Grant Guidelines."* https://www.niaa.gov.au/sites/default/files/publications/ias-grant-guidelines-march-2016-amended-august-2019-3.pdf.

Bunnings. 2021. *"Trailers 2000 6 x 4ft Heavy Duty Galvanised Box Trailer."* Accessed June 2nd, 2021. https://www.bunnings.com.au/trailers-2000-6-x-4ft-heavy-duty-galvanised-box-trailer_p0217193.

Bureau of Meteorology. 2010. "*Queensland Flood summary 2000-2009*." http://www.bom.gov.au/qld/flood/fld_history/floodsum_2000.shtml.

Bureau of Meteorology. 2021. "*Regional Weather and climate guide*." Accessed 4 June 2021. http://www.bom.gov.au/climate/climate-guides/guides/025-Cape-York-QLD-Climate-Guide.pdf.

Commodore. 2021. *"Sun-Torque Submersible 5-128 Solar Pump | 5000l/Hr | 128m Max Head."* Accessed May 26th, 2021. https://www.commodoreaustralia.com.au/product/sun-torque-5-128-submersible-solar-pump-5000l-hr-128m-max-head/.

Crusader Hose. 2021. *"Flexibore."* Accessed May 27th, 2021. https://www.crusaderhose.com.au/flexibore-hose/.

Engineers Without Borders. 2019. "Lama Lama water supply project". Last updated September 4th, 2019. https://www.citewrite.qut.edu.au/cite/qutcite.html#harvard-internet-web

Engineers Without Borders. 2021. EWB Challenge Design Brief. https://blackboard.qut.edu.au/bbcswebdav/pid-9126670-dt-content-rid-37378525_1/courses/EGB100_21se1/2021%20EWB%20Challenge%20Design%20Brief.pdf

Legislative Assembly. Public Works Committee (1997). "The provision of infrastructure in Cape York." Report No. 38 Legislative Assembly of Queensland, Public Works Committee. Queensland

National Aboriginal and Torres Strait Islander Health Council (2003). "National Strategic Framework for Aboriginal and Torres Strait Islander Health". Context, NATSIHC, Canberra.

Northern Australia Environmental Resource Hub. (n.d.). "*Efforts, gaps and opportunities for three Cape York communities."* Accessed 31 May 2021. https://www.nespnorthern.edu.au/wp-content/uploads/2017/08/Waste-marine-debris-wrap-up-factsheet.pdf.

Project Everyone. 2021. *"The Global Goals."* Accessed May 26th, 2021. https://www.globalgoals.org/.

Queensland Government. 2021. *"Climate change in the Cape York region."* Accessed June 4th, 2021. https://www.qld.gov.au/__data/assets/pdf_file/0019/68140/cape-york-climate-change-impact-summary.pdf.

The Department of Agriculture and Fisheries. 2019. Vehicle and machinery clean down procedures. https://www.daf.qld.gov.au/__data/assets/pdf_file/0011/58178/cleandown-procedures.pdf

Weather & Climate. 2021. *"Climate in Cairns (Queensland), Australia."* Accessed May 29th, 2021. https://weather-and-climate.com/average-monthly-Rainfall-Temperature-Sunshine,Cairns,Australia.

APPENDIX

Appendix A: Specified parts list

Part	Cost	Dimensions	Specs	Sourced	Description
Trailer 	$1560	180x120cm	- 50mm Tow Ball - 750Kg Capacity	https://www.bunnings.com.au/trailers-2000-6-x-4ft-heavy-duty-galvanised-box-trailer_p0217193 In Cairns	- A suitable trailer to create a compact design - The space for a mobile reservoir will be replaced with more hosing to fill other portable tanks since the scope of the design is to simply pump the water out of the bore, not store it
Pump Kit 	$3290	Pump: - 10cmx112cm Panels: - 170cmx70cm Controller: - 18cmx24cm	- 160kg - Outlet 1.25"	https://www.commodoreaustralia.com.au/product/sun-torque-5-128-submersible-solar-pump-5000l-hr-128m-max-head/ No Shipping cost	- An easy to install kit with included controller and solar panels designed for specific pump - Pump matches regulations for bore holes in the Cape - Designed to operate in minimal sun condition winter even for the cape
Battery 	$253.30	17x18x35cm	<10kg	https://www.batteriesplus.com.au/shop/sealed-lead-batteries/panasonic/panasonic-sla-battery-12v-65ah-lcx1265p/	
Hose 	$12/m 1x 100m 1x 50m $1800	1000cm 500cm	1.25" couplings 49.5kg (total)	https://www.strongmanpumps.com.au/product/series-100-flexibore-flexible-hose-system-flexible-riser-pipe/	- Fits pump outlet
Hose Reels 	Quoted 100mx32mm 50mx32mm?	???	Works with hose	http://www.realezy.net.au/Products/FormSent.html	