ST. MARY'S UNIVERSITY

School of Science, Engineering and Technology
Department of Engineering

Trash Collection Device and Water Quality Sampling Device

By
Briley Perkins*, Benjamin Canas*, Kyndall Quiroz*, Aaron Rodriguez*, & Fernanda Moreno+

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Supervising Advisor: Dr. Juan Ocampo
ASSOCIATE PROFESSOR OF MECHANICAL ENGINEERING

ABSTRACT

This project contains two distinct initiatives aimed at environmental sampling and waste management practices for the San Antonio River Authority (SARA). The primary objective focuses on improving the functionality of the ISCO 6712 water sampler to ensure accurate sample collection during rainy periods. By refining the timing mechanisms, we aim to facilitate precise time usage of our solution to create a blank slate the next time the sampler is used. Additionally, the project requires designing ideas to develop an innovative trash collection device tailored for river and creek management within SARA's jurisdiction. This device is designed to efficiently capture post-rainfall debris, minimizing manual cleanup and promoting environmental stewardship. Emphasizing affordability, operational efficiency, and environmental compatibility, the trash collector aims to improve waste management processes while conserving resources and preserving local ecosystems. Through these initiatives, SARA seeks to follow city regulations to properly install the device on the correct timeline, ultimately fostering sustainable management practices for the benefit of the community and the environment.

ACKNOWLEDGEMENTS

This project would not have been possible without the generous sponsorship of SARA (San Antonio River Authority). We are thankful to Ms. Joan Bryant, Mr. Douglas Knaby, and Ms. Alicia Ramsey for their time, mentoring, and support. We would like to express our gratitude to our faculty advisor, Dr. Juan Ocampo, for his role in this journey. He has been by our side every step of the way, giving us advice, talking with our sponsor, and guiding us through difficulties. We would also like to thank Gail Jaszcz for helping us order the parts needed to complete our project.

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1. INTRODUCTION

The San Antonio River Authority (SARA) is dedicated to preserving and protecting the San Antonio River basin through various conservation efforts. Our team has been tasked with designing a trash collection device to remove debris from the river system and redesigning a faulty water quality sampling device to be able to monitor the quality of the water in the river systems and the aquifer. The trash collection device aims to create a cost-effective solution that can be installed in the river to catch common trash items and thatch before they accumulate in the rivers and cause environmental harm. The water quality sampling device redesign is focused on restoring measurements of key indicators like dissolved oxygen, pH, temperature, and contaminants so SARA can track water conditions and identify any pollution issues. The goal is not only to improve the efficiency of trash removal but also to improve the water quality monitoring capabilities, ensuring the sustainable management of the San Antonio River System for the benefit of the local community and the environment.

1.1. COMPANY DESCRIPTION

The San Antonio River Authority (SARA) is dedicated to the preservation, management, and development of the San Antonio River Basin. Founded on a commitment to environmental protection, community engagement, and sustainable water resource management, SARA plays an important role in guarding the region's waterways and enhancing the quality of life for residents. With a history dating back decades, SARA continues to lead by example, implementing innovative strategies, forging strategic partnerships, and uses technology to ensure the vitality and resilience of the San Antonio River Basin for generations to come.

1.2. PROBLEM STATEMENT

The San Antonio River Authority (SARA) is in charge of maintaining and monitoring the waste and debris in the San Antonio River systems as well as checking the quality of the rainwater and ground water using a water quality sampling device that is installed at the SARA headquarters. The presence of pollutants not only jeopardizes the health of aquatic ecosystems but also poses a threat to the overall well-being of the community relying on the river for various purposes. The current methods employed for trash management have proven inadequate, resulting in ongoing debris buildup with detrimental effects on aesthetics, aquatic life, and recreational safety. Our goal is to create a more cost-effective and overall better trash collection device that can be placed in any of the existing San Antonio rivers. The device will collect trash and thatch, which is the ultimate problem that SARA and our San Antonio community face. Simultaneously, the existing water quality monitoring device faces limitations in providing real-time and precise data. This is a problem because it does not allow for water to be collected after a rain event and therefore, it cannot be clean of its contaminants before being released into our waterways again.

1.3. OBJECTIVES

Water Quality Sampling Device:

The main goal of this first project is to improve how the ISCO 6712 collects water samples during rainy periods by ensuring precise timing for sample collection. This enhancement will enable the lab analysis of samples for various contaminants, substances, minerals, and other factors of interest to SARA. Additionally, we aim to maintain the proper operation of the sampler and avoid damaging the underground piping used for its suction and bubbler lines, without the need for redesign.

Trash Collection Device:

This project aims to create a new type of trash collecting device for use in rivers and creeks managed by SARA. The device needs to catch trash and waste after it rains, so workers don't have to spend as much time and effort cleaning up the river and creek banks by hand. With these devices in place, workers will only need to empty and maintain the trash collectors, which will save a lot of time and work. The trash collector must be an affordable solution that doesn't damage the environment or clash with local cultural practices. The main goal is to give SARA a good way to keep trash out of their rivers and creeks while spending less money and worker hours on cleanup duties.

1.4. LITERATURE SEARCH

Water's natural state follows gravity; therefore, it will always move down. This means that rain will eventually find its way into rivers, and it will move anything that is within its power along with it. Rivers are connected to our aquifers, which are an important source of groundwater that will be used for crops or in our daily lives. During a rain event, trash will likely end up in the river streams, this is referred to as aquatic trash. Aquatic trash not only pollutes outdoor spaces, but it also endangers wildlife. Many aquatic animals confuse plastic debris for food or accidentally ingest it. When organisms ingest these, they make their way up the food chain. Trash pollution can also damage habitats, when litter accumulates it can create health risks and even have economic impacts through tourism (EPA, 2023). This is why trash collection devices in rivers are so important. We will now describe trash collection devices that can be found commercially.

Mr. Trash Wheel – As shown in Figure 1, Mr. Trash Wheel is an innovative and environmentally friendly device designed to clean up water bodies, particularly urban harbors and rivers. It functions as a water-based trash interceptor, powered by solar energy and water current. The system comprises a series of large, floating, and wheel-like conveyors equipped with a collection of nets and screens. As water flows into the wheel, it carries along with it all sorts of debris and garbage. Mr. Trash Wheel uses its rotating conveyors to capture this waste, preventing it from reaching the open water. The collected trash is then deposited into a waiting dumpster, which can be emptied later. Mr Trash Wheel cost around $820,000 to make and cost around $180,000 is operate per year. This ingenious invention, typically adorned with a whimsical character face, has become a symbol of sustainability and a practical solution for mitigating water pollution in urban areas.

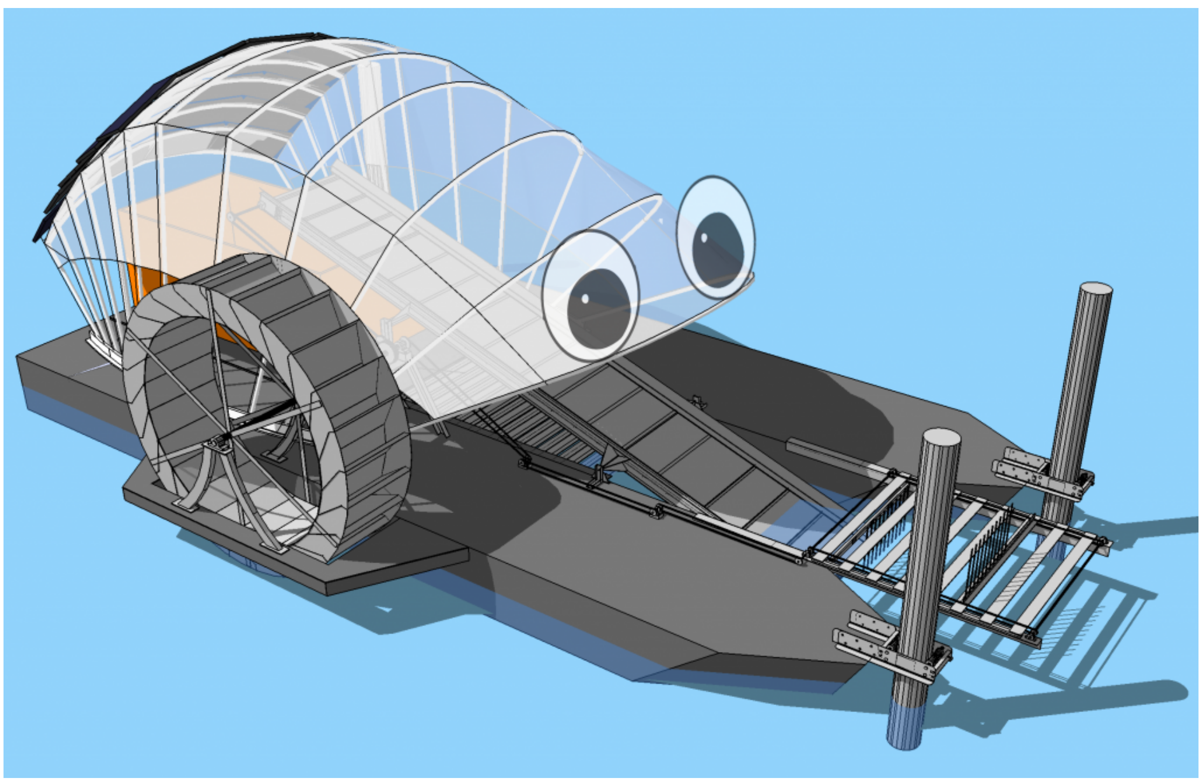

Figure 1: Mr. Trash Wheel

The Ocean Cleanup – As shown in Figure 2, The Ocean Cleanup is an innovative environmental organization dedicated to addressing the critical issue of plastic pollution in the world's oceans. Founded by Boyan Slat in 2013, it operates by deploying advanced technology to collect and remove plastic waste from the ocean. The organization utilizes a combination of floating barriers and vessels equipped with high-tech sensors to passively capture and concentrate plastic debris as it drifts with ocean currents. These concentrated plastic collections are then periodically retrieved and hauled back to shore for recycling, preventing further harm to marine life and ecosystems. The Original Interceptor cost around $777,000 to operate and build. The Ocean Cleanup's mission is to reduce the vast patches of floating plastic waste, such as the Great Pacific Garbage Patch, and contribute to the long-term preservation of our oceans and marine biodiversity.

Figure 2: Boyan Slat and Interceptor 004 in the Dominican Republic

Brute Bin - The Elastec Brute Bin is a cutting-edge waste containment and collection system that provides a powerful solution for managing solid and liquid waste in a wide range of industrial and environmental settings. This innovative system, as shown in Figure 3, is designed to handle and contain debris, trash, or other materials, making it particularly valuable for disaster response, environmental remediation, and industrial operations. The Brute Bin operates by employing a durable, high-strength fabric material and a rigid support structure, enabling it to withstand harsh conditions and a substantial volume of waste. It can be easily transported to remote or challenging locations, where it efficiently captures and contains waste materials. The Brute Bin plays a vital role in maintaining environmental cleanliness and facilitating efficient waste management in various applications, making it a valuable tool for safeguarding our ecosystems and promoting sustainable practices.

Figure 3: Brute Bin Floatable Trash Collection Device

1.4.1 COMMERICIAL PRODUCT REVIEW

Mr. Trash Wheel and the Brute Bin are both very efficient cleaning devices that clean trash from the water and were used for a few considerations throughout the design process. In regard to the pros and cons of these technologies, they are in relation to the pros and cons given all our requirements and constraints established in the project.

While cleaning up the trash is important, having the device look presentable is important if it is in a populated area where it is visible. Mr. Trash Wheel took the approach of making cleaning trash fun, while bringing attention to the public around the damage that could be caused. Appearance is an important factor in our project because of the location of the trash site. Additionally, Mr. Trash Wheel has a trash rack and conveyor belt that carries the trash from the water to the dumpster waiting at the end. The trash being able to be taken from the water into the trash without manual labor was important to us and the sponsors and was implemented into our own design. The Brute Bin brought in another important factor which is varying heights of water, since our site is based in a place that is dry most of the year except for rain events. The design involved a buoy system in place to direct the trash to a certain area. The buoys adapt to the water which is necessary in a rain-event designed system. In addition to their adaptability, the buoy system directs the trash to the bin makes the flow more natural and there is something helping direct trash without manual labor.

Although the technologies seemed to have no wrong, there were a few cons that made us decide not to include it in design or it was not plausible given our conditions to the project. While Mr. Trash Wheel works efficiently and the people around the area adore the machine, there are two issues we run into. The main problem being that our project will not be in water 24/7 therefore our design would be completely different. Secondly, it utilizes renewable energy, which is efficient, but that means it would cost more money which is not our objective. Speaking of money, the Brute Bin device would require a large initial investment in the device itself and its surrounding factors. In addition to the large investment, it is not very appealing to the people who may transit near the creek making it not suitable for use in waterways around the parks or trails. After researching trash cleaning technologies and making a pros and cons list, we identified what did or did not need to be included in our project's design.

1.5. PROBLEM CONSTRAINTS, REQUIREMENTS, AND SPECIFICATIONS

The trash collection device for the San Antonio rivers must meet various requirements, including being able to effectively collect and store floating trash and thatch material without affecting water flow or navigation. It should be capable of operating in different river conditions and water levels. For the water quality monitoring device, accurate and real-time measurement of contaminants like heavy metals, bacteria, and other pollutants need to be retrieved from the device. Both devices have constraints like limited power sources, environmental exposure, and potential vandalism/tampering. Additionally, the trash collector must avoid damaging ecosystems or collecting wildlife, while the water monitor requires frequent calibration and servicing. Consideration of local regulations and environmental impact is necessary in the specification process. Meeting all requirements within the given constraints is the primary challenge.

Water Quality Sampling Device:

1. Constraints
    a. Budget ($350)
    b. Time (10 months)

c. Main apparatus is underground

d. Knowledge of the machinery that is already installed at SARA

e. Can not excavate the existing underground materials (pipes)

f. Can not change the location of the machine

g. Bubbler tubes cannot be replaced for a longer one

2. Requirements

a. Must read data accurately

b. Must not obtain noise or false readings

c. Must allow flow of water properly

d. Sensor must read correctly

3. Risks

a. Reads incorrect data

b. Bubbler line could kink or bend awkwardly

c. Damage the machinery with it being set off at the wrong time

Trash Collection Device:

1. Constraints

a. Budget ($9650)

b. Time (10 months)

c. Width of river or creek (106 ft)

d. Flow of the river

e. Outdoor elements

f. Flood plain level

g. Cannot be attached to the riverbed

2. Requirements

    a. Must be able to catch trash

    b. Must fit the width of creek or river

    c. Must catch heavier trash without breaking

    d. Must not interfere with wildlife nor their habitat

    e. Create a budget proposal

    f. Must continue flow of water with thatch material

    g. Must not be able to raise flood plane

3. Risks

    a. Collecting device could be ripped and float in river making it become trash

    b. Thatch material could rip the nets

    c. Heavy trash could rip nets or pull machinery

    d. Machinery could break during outdoor elements

1.6 INITIALLY PROPOSED SOLUTIONS

Both projects consist of initially proposed designs by each team member. Since there are quite a few constraints for the water quality device, we collaborated to come up with one collective design given our limitation on what we can actually do. However, for the trash collection device, each team member came up with a unique solution. Certain aspects were taken from each team members solution and added to the final overall design.

1.6.1 WATER QUALITY SOLUTIONS

Figure 4 displays the setup of the device we are working on for our first project. Our main issue with the device given to us is the bubbler line and the pipe. There is a reading happening when it is not supposed to occur, most likely due to the water that is left over from a rain event, which is causing false to no readings. In addition, the bubbler line that was already set up before we first tested it, had been duct taped together because of a kink that got into the line.

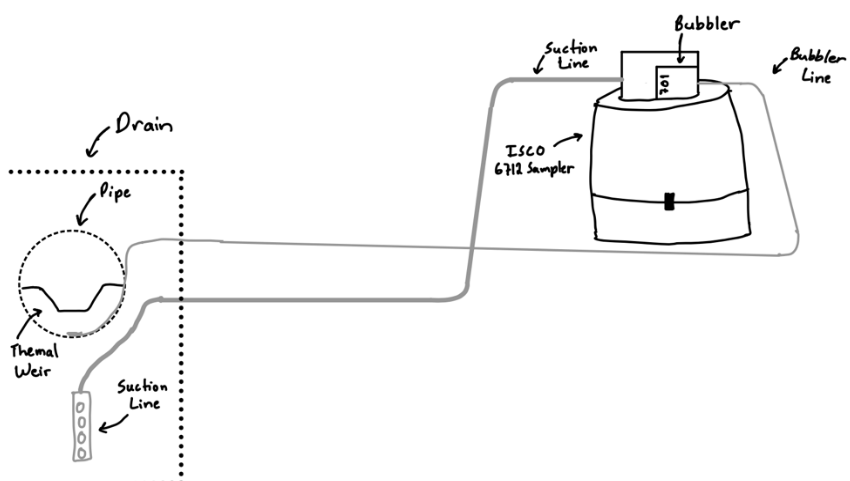

Figure 4: Sketch of Current Setup of an ISCO 6712 Sampler at SARA

In Figure 5, our proposed solution is to add a compressor to blow through the bubbler line after the samples have been taken to clear any water or debris left over to have a cleared-out pipe. The moisture filter would be added to the purging line to prevent moisture from the compressor traveling to the bubbler line. Additionally, there are three different samplers that are used during the events that SARA wants to grab data, therefore we must add a joint fitting to be able to reach all samplers. There is a power outlet between the big crates that hold the samplers which would provide the necessary electricity that we need to power the compressor.

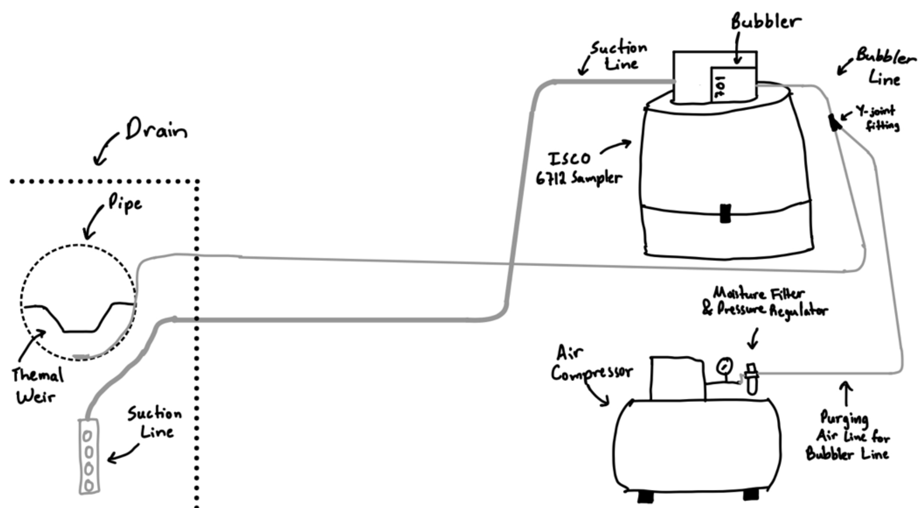

Figure 5: Sketch of Proposed Solution to Water Quality Sampling Device

1.6.2 TRASH COLLECTION DEVICE SOLUTIONS

In Figure 6, the design's goal was aimed at a concrete bottom surrounded by vegetation. A three net catching system was implemented to catch the varying sizes of trash ranging from tires to gas station cups. The buoys are used to lift the system for when the water level rises. Lastly, all the nets would be connected via cable and would be able to be retracted to create an easier way of collecting trash.

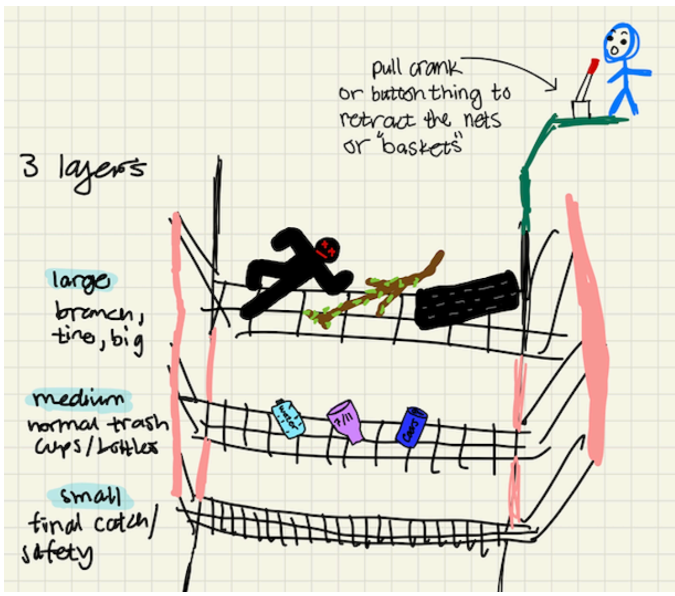

Figure 6: Briley's initial sketch

In Figure 7, the system consists of a three net buoy system. The lines connected to each net would be anchored down to the outside bank of the river to ensure they don't float away with strong river current. The first net has the largest hole size to catch larger item and to make sure the flow of the river is not restricted. The smaller items will then pass through to the second net and the ones that pass through that net will be caught in the third and final net, which has the smallest hole size. The buoys on either side of the nets allows for them to adjust to height of the river depending on rainfall.

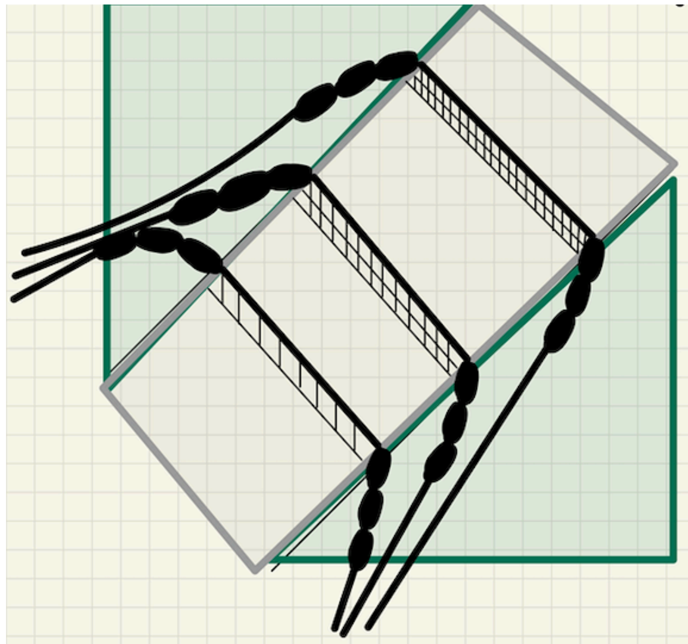

Figure 7: Briley's sketch for SARA

Figure 8's initial design was made for a fully concrete creek. The rotating fork arm would be the first device that removed any initial thatch and litter and deliver it to the above grate. The second blue grate was supposed to catch additional trash and items. There is also a designed cage to sit in the bottom on the river in front of the last blue grate to collect any heavier items like tires or mattresses that may sink and could be lifted by a crank after a storm or rain event to retrieve these items.

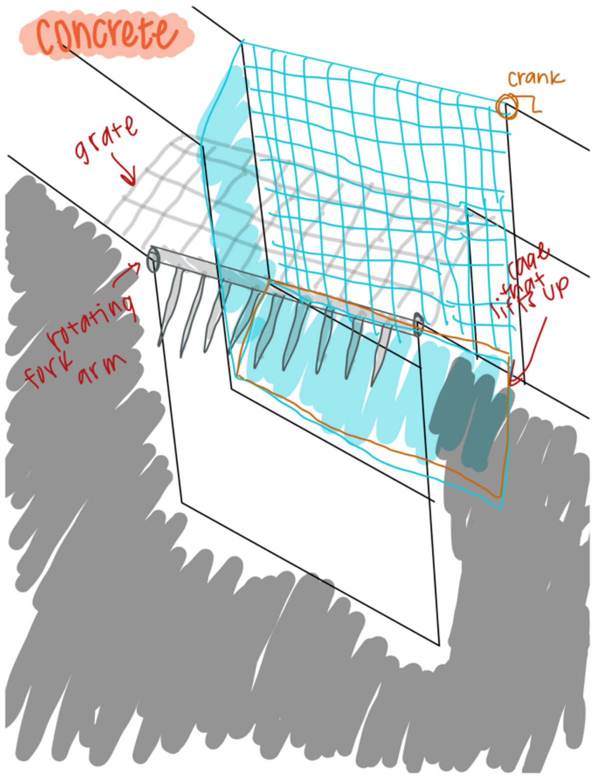

Figure 8: Kyndall's initial design

Figure 9 shows a prototype of a trash collection device that uses boueys to gather trash in a specific spot. Specifically, this design requires a conveyor belt system and a net to be used as a defense system againt trash. The larger trash will be captured in the water using the nets at the back of the device. The trash that is small will flow towards the conveyor belts, that will then be used to tranfer the trash from the river to a designated trash spot or container.

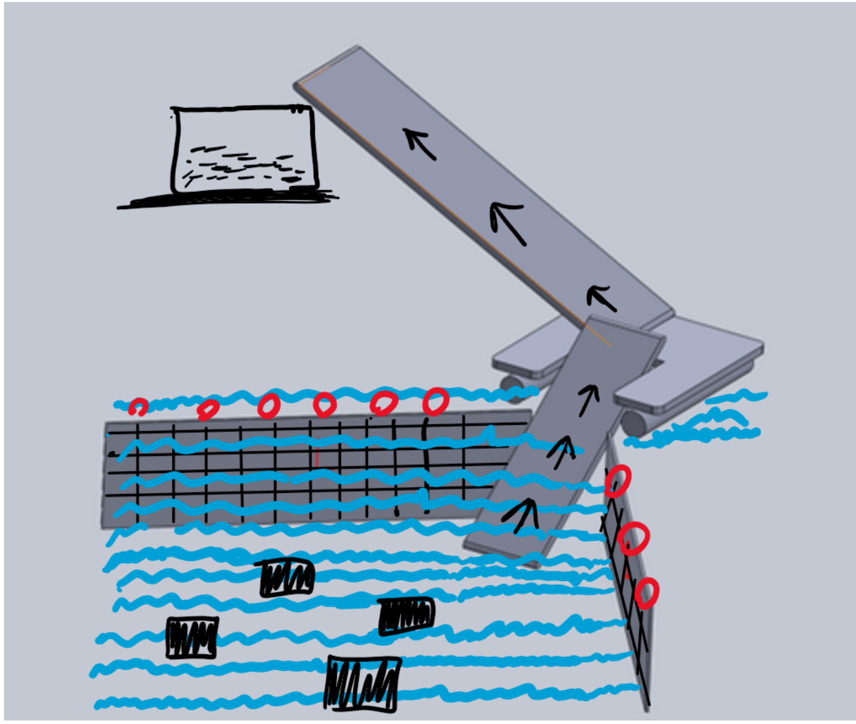

Figure 9: Aaron's proposed solution

The multi-gate approach shown in Figure 10 is intended to be used in a fully concrete walled creek but surrounded by vegetation. The first gate only has metal bars making the squared pattern and is intended to capture the larger objects. The second gate has a mesh that will capture smaller objects like branches. The third gate has a mesh with smaller holes that is ultimately intended to capture everything not captured by the previous two gates that could be leaves, small debris, bottles, etc. The end goal was to be able to lift the gates up full of the trash and sweep the trash to the end of the gate to be collected.

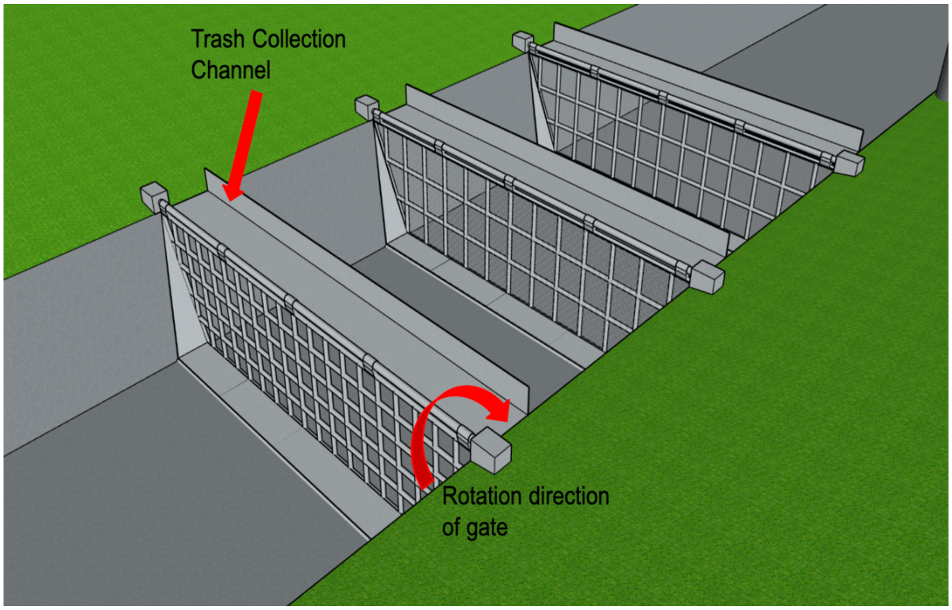

Figure 10: Benjamin's multi-gate approach

In Figure 11, the design is a bandalong litter trap float with a three-stage filtration for different sizes of trash connected to a bell drive. The last stage was for removal of thatch or bigger items that get through to the back versus the first stage was to prevent clogging of big materials and just catch the small objects of trash. The bell drive could potentially be solar powered and would be placed on the side of the riverbed where maintenance has easy access for cleanup.

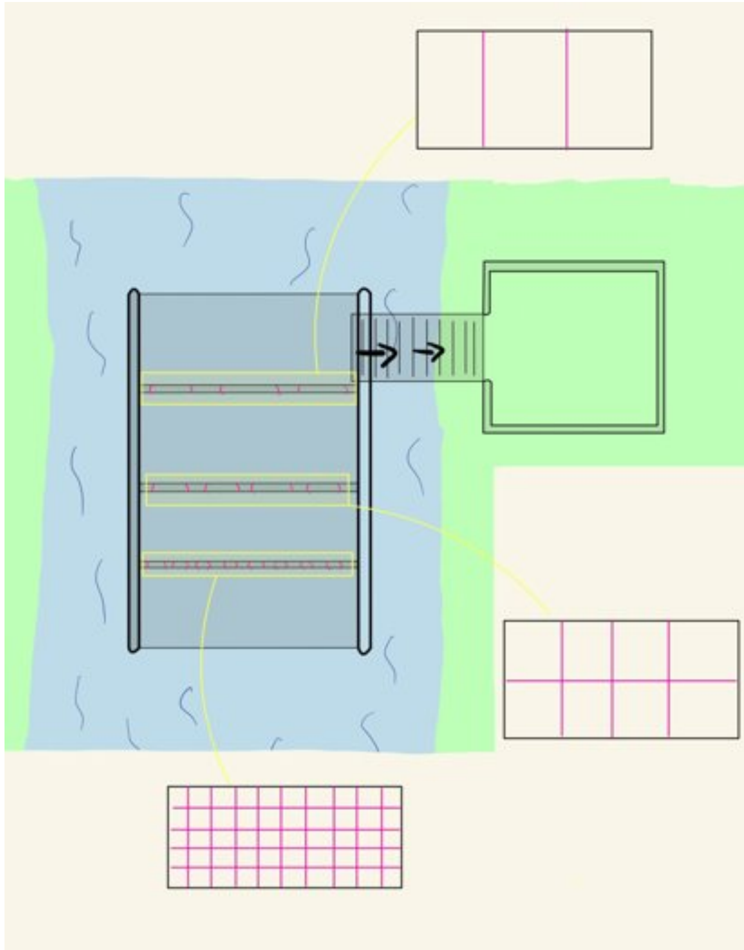

Figure 11: Fernanda's initial proposed design

2. SUMMARY OF ENGINEERING METHOD

The project had two main parts: making a device to collect trash from the San Antonio River and redesigning a device to accurately check the water quality of rainwater. We started by figuring out the problems with trash in the rivers as long as what was wrong with water quality device and why it wasn't collecting samples properly. Then, we made designs for each device, making sure they worked properly and were good for the environment. We worked closely with SARA to make sure everything met their guidelines. After building and testing prototypes separately, we improved them based on feedback from SARA and our advisors. Finally, we built the final design with installation instructions as well as the blueprint of the overall trash collection device. Any additional products that would be needed can be printed by them, because all the files created in SolidWorks that is necessary will be sent as well.

3. ITERATIVE DESIGN

3.1 WATER QUALITY SAMPLER DEVICE SOLUTIONS

After SARA accepted our proposed solution shown in the sketch in Figure 5, we proceeded to create an electrical controller box for our compressor to control the bleed time. With this box we could ensure all the bubbler lines were bleed to 100% ensuring they would be ready for the next rain event free from moisture that could contaminate the data. Resulting from this design are the following diagram shown in Figure 12 and Figure 12.

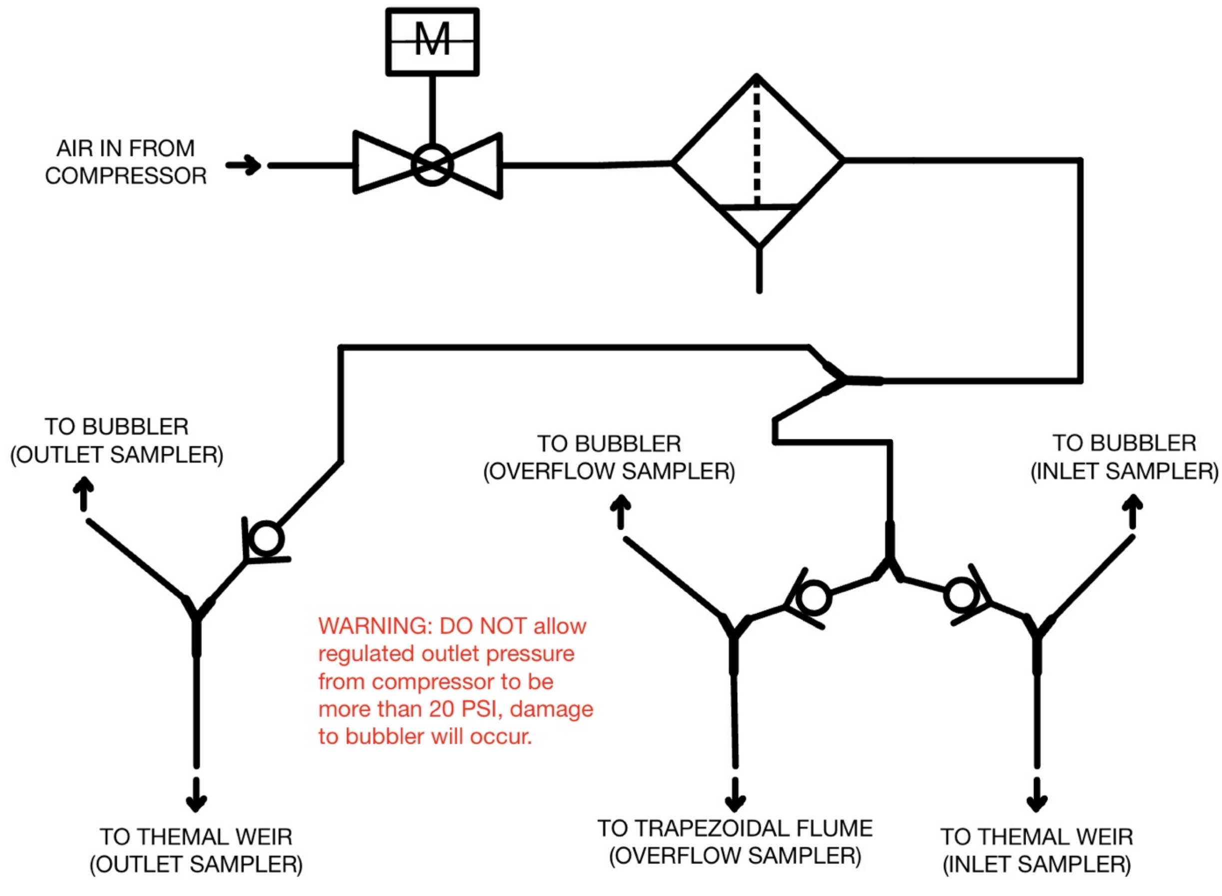

Figure 12: Pneumatic Schematic Diagram of Sampler Solution

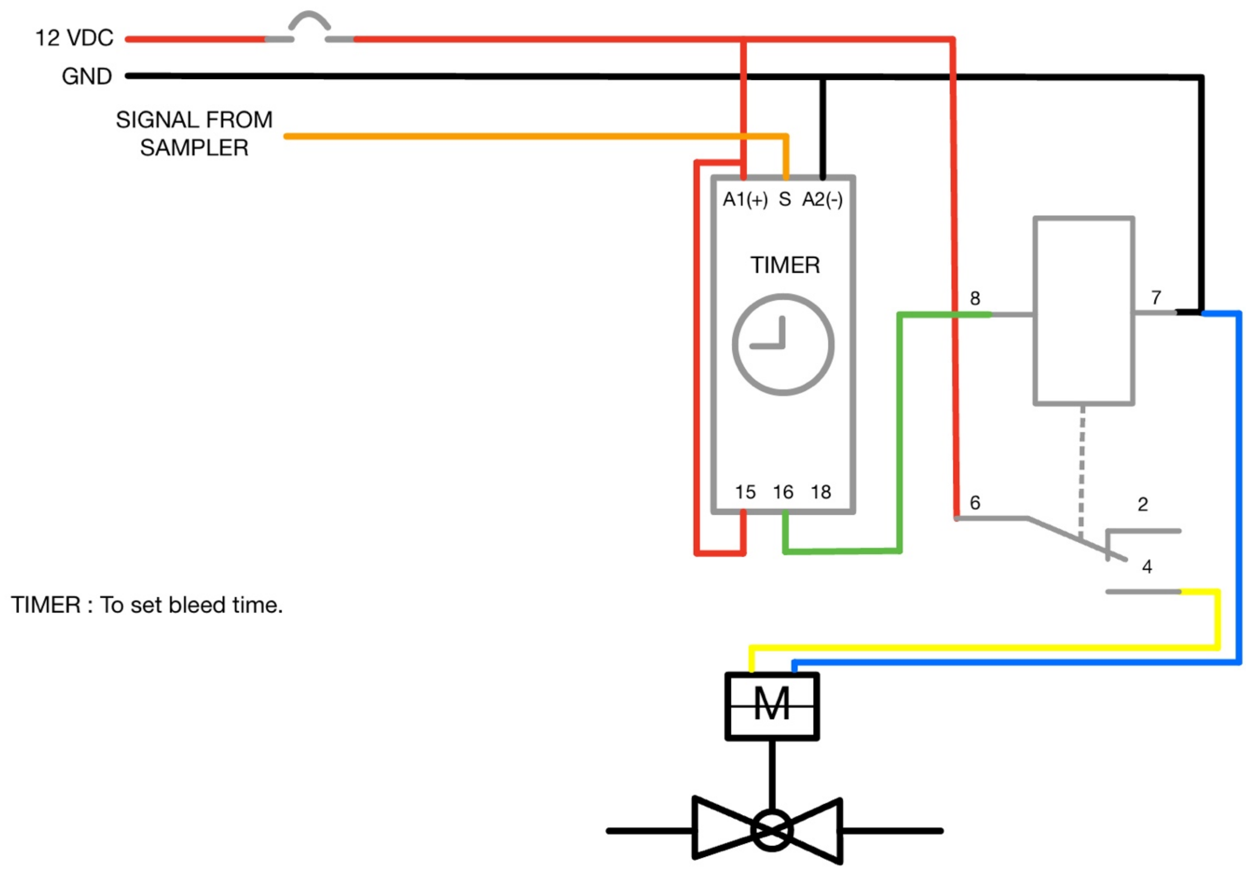

Figure 13: Electrical Schematic Diagram of Sampler Solution

After having met with our sponsors to test the solution the first time, they asked if we could add another timer to set a delay from when the sampler was done to when the bleed of the bubbler lines would occur. They wanted to include this second timer as a safety device to makes sure the Sampler was completely done before bleeding the line and jeopardizing the data being collected at an event. This led us to the improved electrical diagram shown in Figure 14.

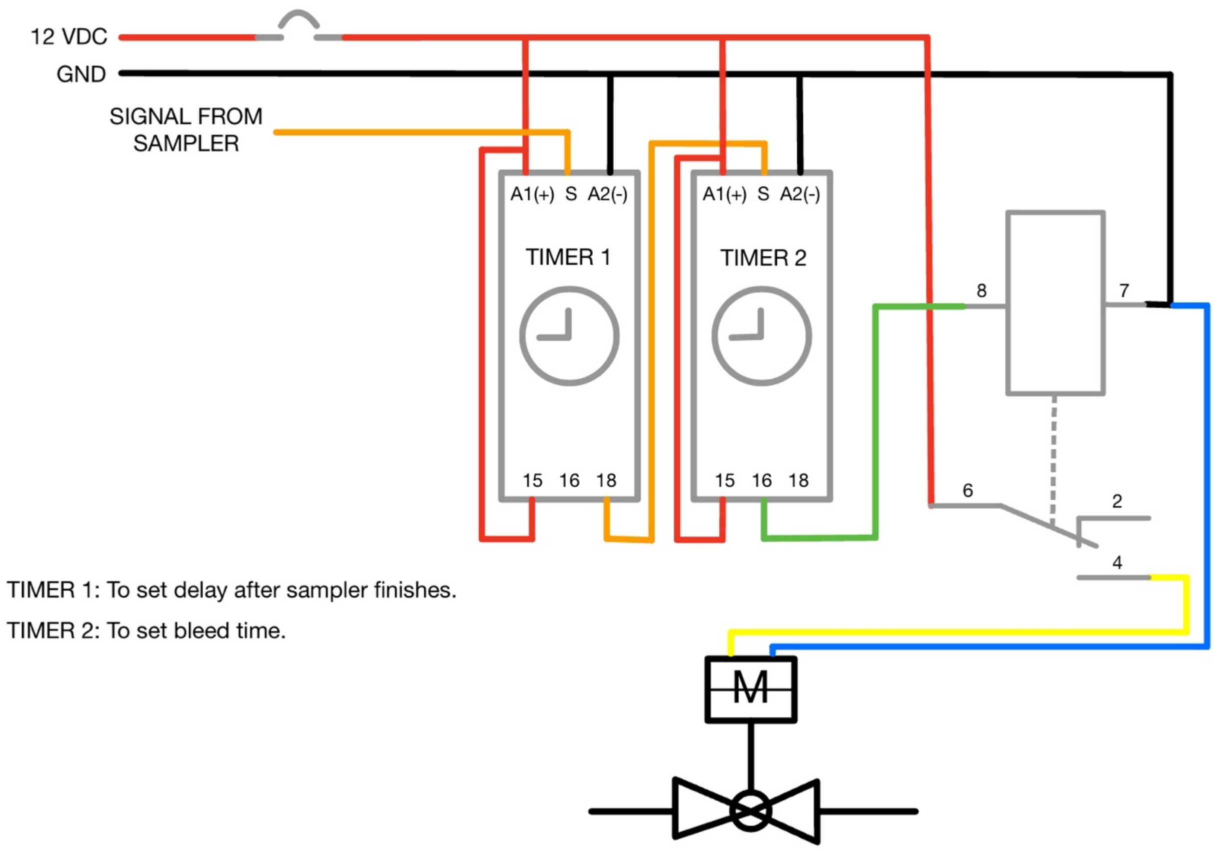

Figure 14: Final Electrical Schematic Diagram of Sampler Solution

3.2 TRASH COLLECTION DEVICE SOLUTIONS

After consulting with out sponsors, Kyndall drew out the first final design of the trash collection device. In figure 15, the first line of defense is a set of buoys that are designed to be a turbine underwater to spin moving the lighter trash towards the conveyor belt. The second layer of buoys will consist of regular buoys with a net that goes only halfway down to allow any animals to pass through underneath. A conveyor belt will then transfer the collected debris into a bin that can be changed by San Antonio River Authority officials.

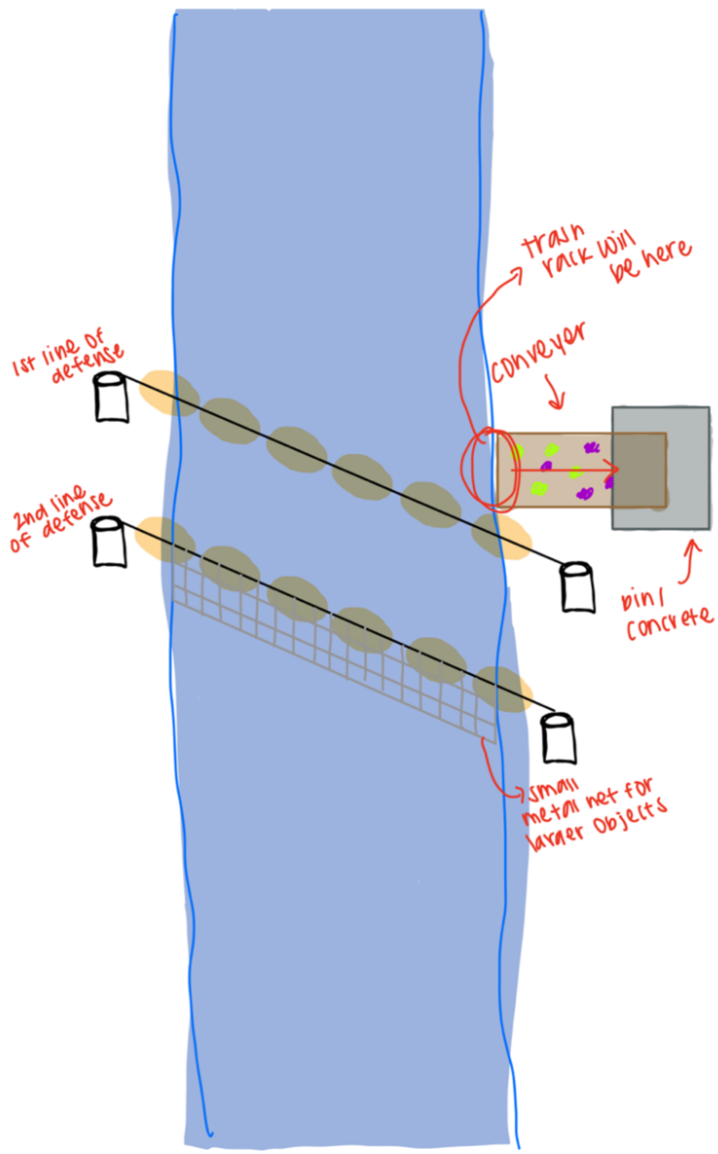

Figure 15: Final Design of Trash Collection Device

An engineering drawing of the buoys is illustrated below in Figure 16. This detailed schematic provides a comprehensive view of the buoy's structure and components, essential for understanding its functionality and design. The drawing highlights the buoy's dimensions and materials used, emphasizing its construction and suitability for marine environments.

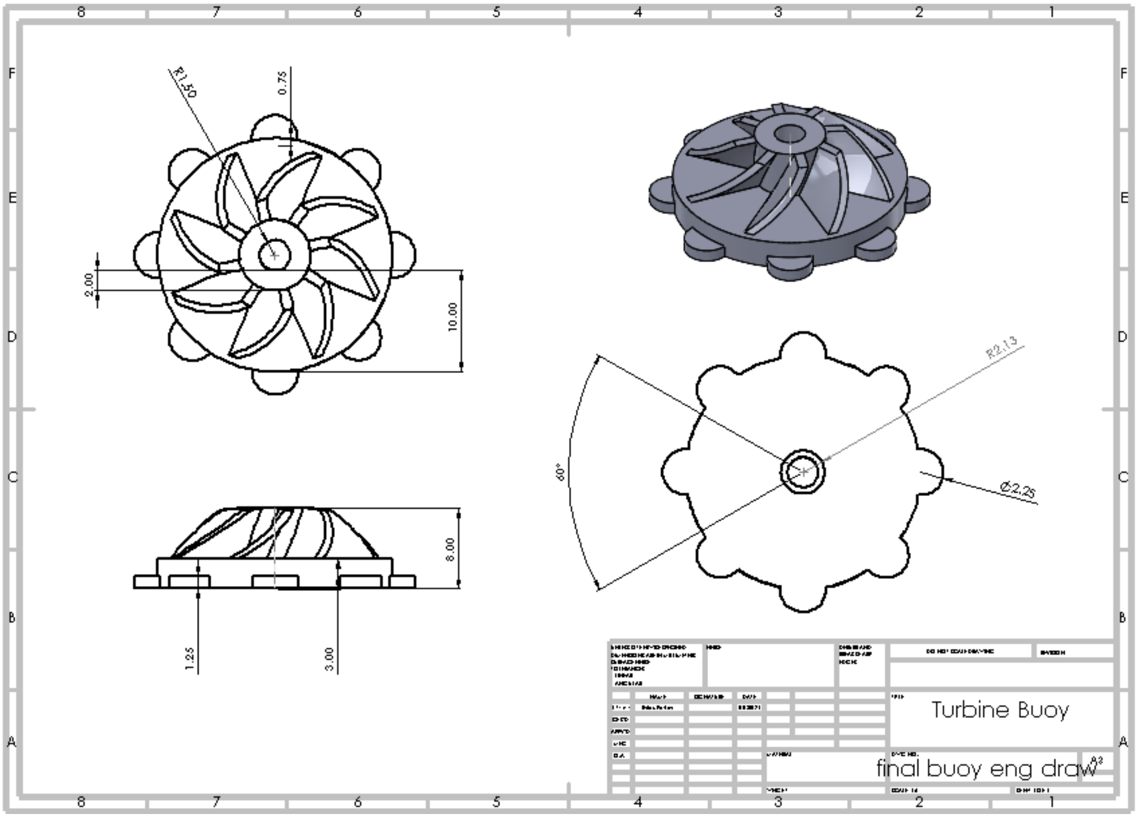

Figure 16: Bottom of Buoy

In Figure 17, our initial assembly iteration is depicted. Initially, we considered utilizing an adjustable hinge that would respond to changes in water height. Two conveyor belts were to be interconnected by this hinge, with racks installed on the first conveyor at an incline. These racks were designed to transfer thatch to the second conveyor securely, preventing any material loss during transit. Additionally, a buoy system was developed to ensure buoyancy of the conveyor assembly when submerged in creek water. The illustration also includes a representation of a cement block, depicted as a brown box, which serves as an example of a potential support system that might be implemented by the San Antonio River Authority. Following preliminary approval, we commenced the fabrication of the assembly. However, during the assembly phase, we encountered an unforeseen setback. After initiating construction, we approached the San Antonio

River Authority with a request to install two concrete pillars that would support the conveyors. It was at this point we were informed of significant delays; the installation of the pillars could potentially take up to a year. This delay was due to the location within a flood plain, necessitating extensive environmental impact studies and civil engineering calculations, along with the acquisition of numerous permits.

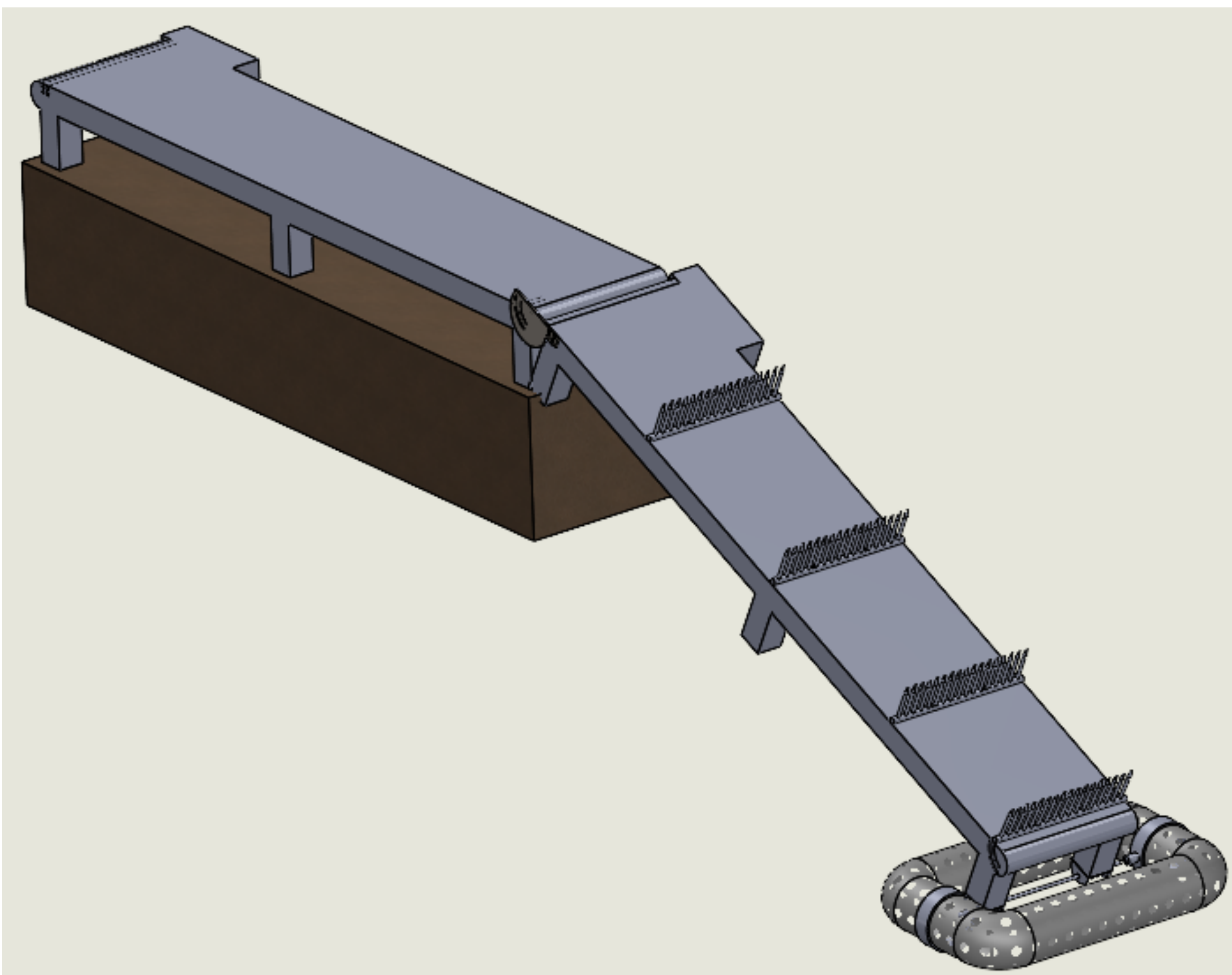

Figure 17: 1st Assembly of Conveyor Belt

Following the discussion regarding the delays, the San Antonio River Authority (SARA) acknowledged that the obstacles encountered were beyond our control. In response, we agreed to devise a comprehensive plan, complete with all necessary calculations, to facilitate SARA's independent construction of the device once the pillars were installed. Instead of storing the partially completed assembly, SARA requested that we provide them with the custom hinges we had developed. These hinges were critical for the assembly, designed to connect the pillars to the first conveyor, the first conveyor to the second, and the second conveyor to the floating buoy. We proceeded to fabricate these hinges by welding and machining holes into steel sheets, ensuring they met the specific requirements needed for a robust and reliable installation. The updated assembly configuration is illustrated in Figure 18.

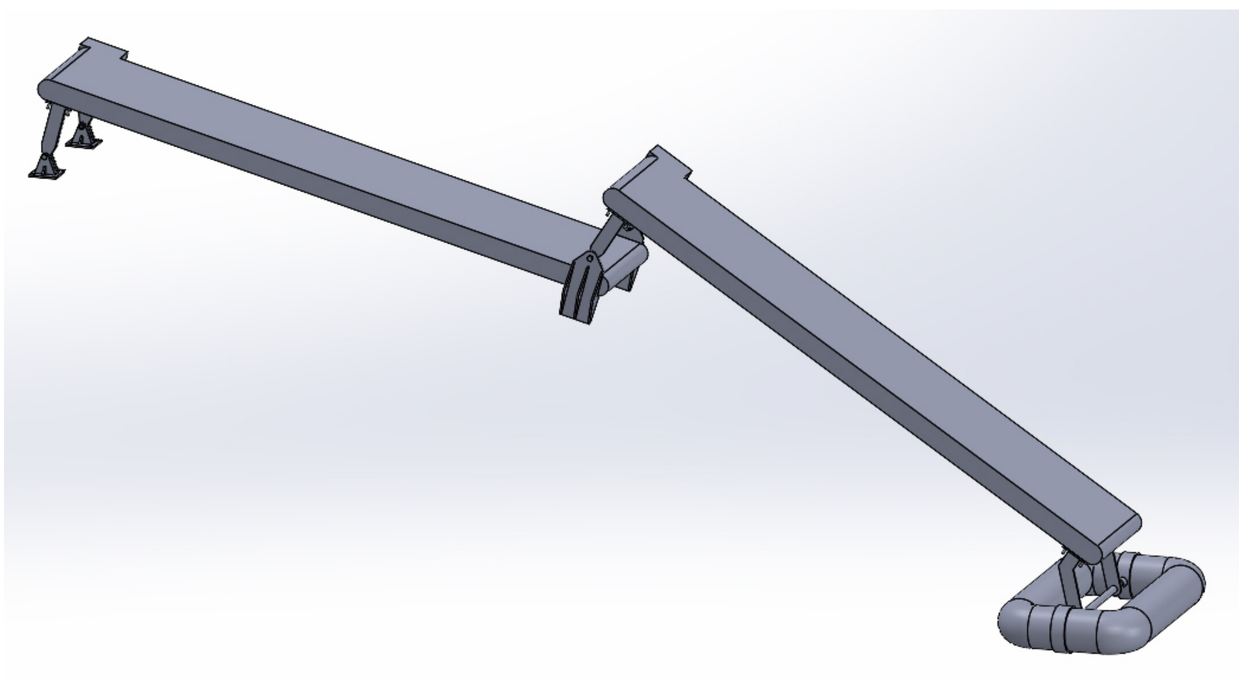

Figure 18: 2nd Assembly of Conveyor Belt

4. ENGINEERING CALCULATIONS

4.1 ISCO 6712 SAMPLER CALCULATIONS

For the ISCO 6712 Sampler improvement project we had to calculate the total volume of the bubbler lines to make sure we bought a large enough compressor that could do a full bleed of the lines without having to turn on to recharge, or a have a pressure drop that would significantly affect the bleed. For this we used the cross-sectional area of a 1/8” ID hose, lengths of 100 ft, and n, which was the number of bubbler lines.

Volume of Bubbler Lines

$$V = A * L * n$$

$$V = 0.01227\ in^2 * 1200\ in * 3$$

$$V = 44.17 in^3 \sim 45 in^3 = 0.2\ gal$$

With the volume that we got we were able to select a compressor that would more than 5 times this amount of air as this would ensure that enough air was available should bleed times be longer than anticipated or per request of the user.

4.2 TRASH COLLECTOR CLACULATIONS

Max Thatch Calculations

$$A=(\sqrt{3}/4)\times(0.4)^2$$
$$A= 0.069\text{m}^2$$
$$V=A\times 2$$
$$V=0.1385\text{m}^3$$

$1\ \text{yd}^3$ of thatch = 550lbs
$1\ \text{yd}^3 = 0.764555\ \text{m}^3$

$$V= 0.1811\ \text{yd}^3$$
$$W=V\times 550\text{lbs}$$
$$W= 90.62 lbs = 41.1 kg$$

When designing conveyor systems for materials handling, particularly those that transport loosely piled, bulk materials like thatch (which can be straw, reed, or similar materials), understanding the maximum accumulation (Max Thatch) that can occur on the conveyor belt is crucial. The calculations were done assuming the volumetric shape of a pyramid due to physical properties such as surface tension, tending to pile up rather than spread out evenly.

Max Conveyor Power Needed

$$F_g = m \cdot g \cdot \sin(\theta)$$
$$F_g = 41.1 \cdot 9.81 \cdot \sin(45)$$
$$F_g \approx 285.1\text{N}$$
$$F_f = \mu \cdot m \cdot g \cdot \cos(\theta)$$
$$Ff = 0.3 \cdot 41.1 \cdot 9.81 \cdot \cos(45\circ)$$
$$Ff \approx 63.5\text{ N}$$
$$P = {}_{Ftotal} \cdot v$$
$$P = 348.6 \cdot (0.333\text{m/s}) \approx 116.08\text{W}$$

Hydrologic Flow Rate Calculations

Q = A*V
Left of the bank:
Area: 102.01ft^2
Velocity: 1.38 ft/sec
Flow rate = 140.76 ft^3/sec

Channel:
Area: 926.96 ft^2
Velocity: 8.85 ft/sec
Flow rate= 8203.596 ft^3/sec

Right of the bank:
Area: 27.11 ft^2
Velocity: 3.15 ft/sec
Flow rate= 85.397 ft^3/sec

Total flowrate:
Q = 8429.75 ft^3/sec

We used Hec-Ras and Sara-DMR2 to obtain these numbers. When analyzing a river or stream flow, especially for hydraulic engineering and hydrologic studies, calculations are performed separately for the left and right banks as well as the channel flow rate to better understand the distribution and dynamics of water throughout the river or channel. Each of these calculations plays a role in managing water resources, designing flood control measures, and ensuring the ecological health of the waterway.

Fluid Calculations

Static

$$A = 1056.07\ ft^2$$
$$A = 98.11\ m^2$$
$$C_y = \frac{h(2a+b)}{3(a+b)} = h_{cg}$$
$$C_y = \frac{10.35(2*50+244.88)}{3(50+244.88)}$$
$$h_{cg} = 1.2299m$$
$$y_w = \rho w * g = 998\frac{kg}{m^3} * 9.81\ m/s^2$$
$$y_w = 9790\ N/m^3$$
$$F_{gate} = y_w * h_{cg} * A$$
$$F_{gate} = 9790\ \frac{N}{m^3} * 1.2299m * 9.81m^2$$
$$\boldsymbol{F_{gate} = 1.181MN}$$

Dynamic

$V=2.56m/s$

$\rho = 1000kg/m^3$

$A = 98.11m^2$

$F = \rho AV^2$

$F = (1000kg/m^3)(98.11m^3)(2.56m/s)^2$

$F = 643kN$

The fluid calculations helped us understand how the device would interact with the river flow to optimize the device's shape, orientation, and positioning to minimize resistance and maximize trash capture. We used these calculations to determine the device's size and dimensions without causing flow blockages or overflow.

Flotation Calculations

Cross Section = D = 6”

$F_b = V \times P_{water} \times g$

$g = 32.2\ ft/s^2$

$P_{water} = 62.4\ lb/ft^3$

$$V = (\pi * r^2 * L)pipe + 4(\frac{1}{4} * \frac{1}{2} * \pi^2 * D^2 * r)elbows$$

$$V = 2(\pi * 3^2 * 22) + 2(\pi * 3^2 * 10) + 4\left(\frac{1}{4} * \frac{1}{2} * \pi^2 * 6^2 * 3.669\right)$$

$$V = 1244.07 + 565.49 + 651.81$$

$$V = 2461.37\ in^3 \rightarrow V = 1.424 ft^3$$

$$F_b = 1.424\ ft^3 * 62.4 \frac{lb}{ft^3} * 32.2\ ft/s^2$$

$$F_b = 2861.21 \text{ lb-f}$$

Hinge Stress Calculations

Given:

Material: Stainless Steel 304

Designed Dimensions of hinge: 0.2032m long, 0,0508m wide, and 0.00635m thick

$$A = 0.0508\text{m}\cdot 0.00635\text{m}$$

$$A = 0.00032278\text{m}^2$$

For Single Conveyor Belt:

$$M=F\cdot L$$

$$M=5032\cdot 2.073 \text{ Nm}$$

$$M=10436.896 \text{ Nm}$$

$$R=2516 \text{ N}$$

Stress on each hinge:

$$\sigma = \frac{R}{2(A)}$$

$$\sigma = \frac{2516N}{2(0.00032278m^2)}$$

$$\sigma = 3897345.631\ Pa$$

$$\sigma = 3.9\ MPa$$

For the combined system of the two conveyor belts:

$$M=F\cdot L$$

$$M=5032\cdot 2.073(2) \text{ Nm}$$

$$M=20873.792 \text{ Nm}$$

$$R=5032\text{N}$$

Stress on each hinge:

$$\sigma = \frac{R}{2(A)}$$

$$\sigma = \frac{5032N}{2(0.00032278m^2)}$$

$$\sigma = 7794782.82\ Pa$$

$$\sigma = 7.8\ MPa$$

Yield Strength of Stainless Steel 304 is 215 MPa therefore the hinges support the stress.

5. STANDARDS DISCUSSION

This project involves the design and redesign of two different devices that must follow the relevant industry standards and regulations. For the trash collection device intended for use in San Antonio rivers, key standards include ISO 14046 Environmental Performance Evaluation and ISO 14001 Environmental Management Systems, as well as others that will be addressed later in the report. Additionally, the design must comply with local municipal standards for operating equipment in public waterways. The water quality monitoring device for rainwater analysis must meet standards outlined in "ISO 5667 Water Quality" and "ASTM D1353 Standard Test Method for Nonvolatile Matter in volatile solvents", along with others to be discussed at a later point. Following these established standards is important to ensuring the devices operate safely, effectively and within legal guidelines for their intended use.

<u>Project A</u>

- "ISO 5667 Water Quality" serves as a standard that gives guidance on sampling and analysis of water samples.

When integrating or fixing a water sampler device, ISO 5667 can be utilized to ensure that the device operates correctly and produces samples that meet the necessary quality criteria for accurate testing and analysis. Our team used it to maintain the regular calibration and maintenance of the sampling equipment for accurate measurements. It was also used to ensure that the sampling process meets specific quality control measures.

- "ISO 16075 Water Quality" serves as a standard that gives guidelines for assessment of rainwater harvesting systems.

Our team wanted to ensure the proper operation of the water quality sampling device. ISO 16075 requires regular monitoring and maintenance to ensure the system operates safely and efficiently. By adopting ISO 16075 guidelines, developers and managers of rainwater harvesting systems can ensure that their systems are not only effective in capturing and reusing rainwater but also safe for the users and environmentally sustainable. This includes the device running at the time needed in case of a rain event.

- "ASTM D1353 Standard Test Method for Nonvolatile Matter in volatile solvents" serves as a standard that gives methods on how to conduct tests in volatile solutions.

For this project, this standard is important because the device removed impurities from the water collected. Environmental factors such as humidity, temperature, and atmospheric pressure can affect the results, so these need to be controlled as much as possible during testing. The conditions (such as temperature and duration of heating) need to be controlled and standardized to ensure consistency. By removing the humidity problem, we are able to enhance product reliability.

Project B

- "ISO 14046 Environmental Performance Evaluation" serves as a standard that assesses environmental performance.

This standard provides guidelines for conducting environmental performance evaluations related to water use and associated environmental impacts. We needed to conduct a baseline assessment of the river's environmental conditions. It also emphasizes the importance of defining the boundaries and objectives of environmental assessments, ensuring that relevant aspects are considered.

- "ISO 14001 Environmental Management Systems" serves as a standard that gives guidance to limit the environmental impact.

Implementing ISO 14001 helped identify potential environmental impacts throughout the device's life cycle. That standard was also used to ensure that the design of the trash collection device complied with relevant environmental laws and regulations governing water quality, waste management, and habitat protection. This was done by setting specific objectives related to reducing litter in rivers, minimizing energy consumption during device operation, or enhancing recyclability can help limit environmental impact.

- "ASTM D1238 Standard Test Method for Evaluating Degree of Rusting on Painted Steel Surface" serves as a standard that gives methods on how to evaluate painted surfaces in water conditions.

Our team used the ASTM D1238 standard to ensure the effectiveness and durability of the trash collection device and to select the right materials for its construction.

6. PROTOTYPE FABRICATION

At the beginning of fabrication, Benji made an Amazon Wish List of items that were going to be necessary for the Water Quality Project, or Project A, and the second list of the trash collecting device was made shortly after.

6.1 FABRICATION OF SAMPLER IMPROVEMENT AND TESTING

In the following image the fabrication of our controller for the ISCO 6712 Bubbler Bleeder is shown, which includes electric timers, a relay that operated the solenoid valve, and a waterproof box to protect the electrical components for outdoor elements as well as the air compressor that will bleed the line.

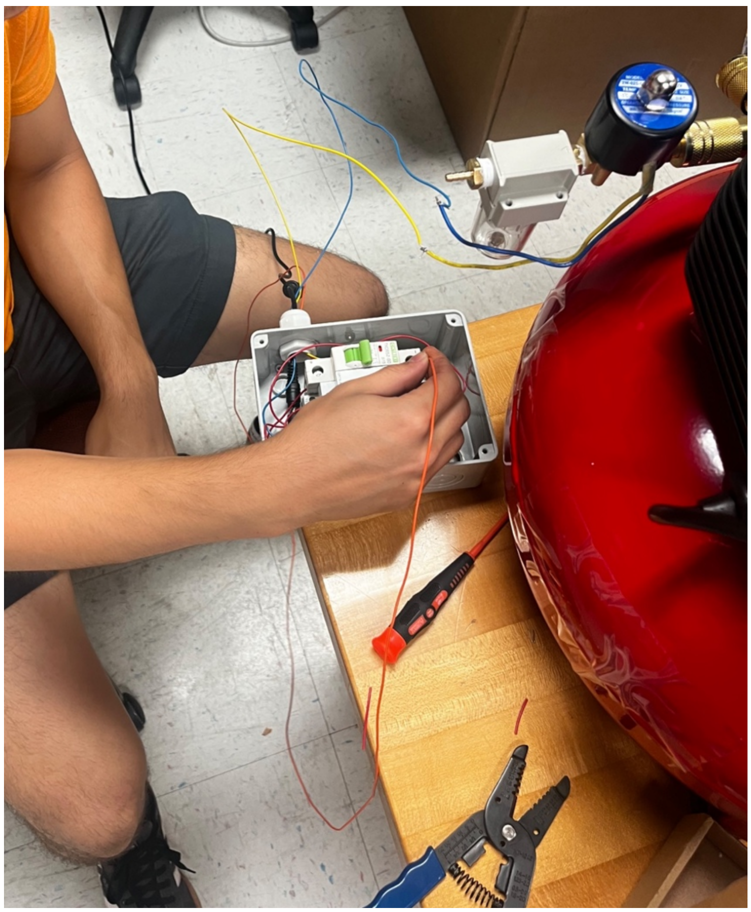

Figure 19: Sampler Bleeder Controller Fabrication

After having built the Sampler Bleeder controller, we informed our sponsors, and we went to the location where it was to be installed. The day of the installation we made sure the timers and all components were working with the samplers and we tested and calibrated the time needed for the bleed. To calibrate these times, team members were on the ends of the bubbler lines and would signal when they felt air coming out of the lines. Once they initially felt air coming out of the lines, we added 5 seconds to the purge to be sure and that's what we set on the timers.

Figure 20 (Left): Sampler Bleeder Controller Installation and Testing.
Figure 21 (Right): Testing of Purge Time at the ends of the Bubbler lines.

The re-design of the water quality device was improved quickly in about one day. The re-design consisted of adding check valves to isolate all individual bubbler lines, and a second timer to the controller. We then went again to SARA to add improvements to the device.

6.2 PROTOTYPE FABRICATION OF TRASH COLLECTOR

Prior to the items arriving, we 3D printed our buoy that was designed for the first line of defense. After the first iteration of printing, we decided that was needed to modify something about the dimensions and size of the buoy so that it was more functional when the water levels in the creek weren't as high, and we did so accordingly. Once our parts arrived, we immediately assembled the conveyor belts to test their functionality and strength to hold and transport different items. To connect both conveyors belts we needed to hand design and make brackets that would connect the conveyor belts together properly. We then purchased sheet metal and cut out the different parts needed for each bracket. Once all the parts were cut, we welded them together to form the whole bracket itself.

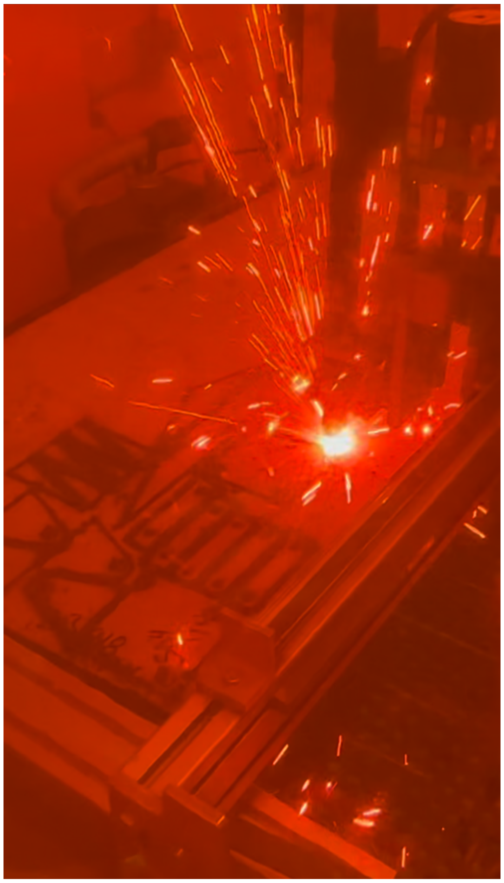

Figure 22: Plasma Cutting of Parts.

Figure 23: Fabrication of Hinges

Figure 24: Milling of Holes

7. RESULTS

In our first project, after speaking with our sponsors on the final design and testing was done, we were able to find the solution to improving the water sampler. We were able to set the time and pressure to the exact parameters needed to be able to bleed the line out dry to have a fresh start to the program any time another rain event occurs where samples are needed. Additionally, for the trash collection device, our concept was agreed upon, but SARA decided to make their own model and scale for testing. We created a SolidWorks assembly and an explosion assembly of all the parts that were given to SARA, as well as installation instructions, to be able to recreate the design we were in the process of fabricating. All the designs and instructions were given to SARA, and they will continue it as the company wishes to proceed.

8. CONCLUSION

There are times where things may seem clear and everyone is on the same track, and things can change drastically in one meeting. Additionally, documenting the entire process was important not only for our benefit of keeping track, but having all the conversations and interactions on file to make sure there were no communication issues or conflicts that arose.

9. LITERATURE CITED

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10. REFLECTIONS

Studying mechanical engineering at St. Mary's University has truly defined my college experience and shaped my path for the future. As I reflect on these years, I can't help but think of the challenges and triumphs that have enriched my journey. Balancing a mechanical engineering major and playing college tennis at St. Mary's was hard work, but it taught me a lot. The skills I learned on the tennis team—like time management and teamwork—helped me succeed in both sports and academics, making me more prepared for the future.

One of the most rewarding aspects of my time at St. Mary's has been the collaborative projects and teamwork opportunities. Working with fellow students on hands-on projects and assignments not only enhanced my technical skills but also taught me the importance of communication and cooperation in achieving common goals.

Looking back, I am grateful for the guidance and support of my professors who not only imparted knowledge but also inspired me to think critically and creatively. Their mentorship encouraged me to explore different facets of mechanical engineering and sparked a passion for innovation and problem-solving.

As I approach the end of my college journey, I feel confident and prepared for the next chapter of my life. The skills and experiences gained at St. Mary's have equipped me to tackle real-world challenges in the field of mechanical engineering. I am excited about the possibilities ahead and am grateful for the solid foundation that my alma mater has provided. St. Mary's University will always hold a special place in my heart as the place where I not only gained knowledge but also discovered my potential and passion for engineering.

-Kyndall

Reflecting on my time at St. Mary's University as an international student about to graduate with a Bachelor of Science in Mechanical Engineering fills me with an immense sense of accomplishment and gratitude. This journey has been one of continuous learning, not only academically but also personally and culturally.

To begin, the academic rigor of the Mechanical Engineering program at St. Mary's has equipped me with a solid foundation in theory and practical skills essential for my future career. From structural analysis to thermodynamics, every course challenged me to think critically, solve complex problems, and innovate. The guidance and mentorship from experienced professors have been key in shaping my understanding of the concepts I will be dealing in my professional future.

Additionally, being an international student at St. Mary's has offered me a rich cultural experience. Interacting with students from diverse backgrounds has widened my perspective and enriched my worldview. The university's inclusive environment has fostered friendships that go beyond borders, allowing me to form connections that I'll cherish for a lifetime. Engaging in student clubs, and community service initiatives has not only enhanced my social skills but also deepened my appreciation for global diversity.

However, my journey at St. Mary's hasn't been without challenges. Adapting to a new lifestyle away from home, navigating cultural differences, and balancing academics with extracurricular activities demanded resilience and determination. Yet, overcoming these challenges has grown in me a sense of confidence and self-reliance that will serve me well in my future endeavors.

As I prepare to graduate, I am filled with optimism and excitement for the opportunities that lie ahead. Prepared with a degree from St. Mary's University, I am confident in my ability to make meaningful contributions to the field of mechanical engineering and tackle the problems the world might bring. I am immensely grateful for the support of my professors, classmates, and the entire university community who have played a pivotal role in my academic and personal growth.

-Benjamin

Originally, I started out as a math major because I was good at math, and I didn't know what I wanted to do. It wasn't until registration for the spring semester of 2021 that I realized that I wanted to change paths in my education and go into mechanical engineering. I am glad I switched to mechanical engineering because of the number of things that I would be able to learn in a field that can be hands on and more involved with people rather than sitting behind a screen all day. I was able to learn how to solve real-world problems in the matter of designing physically and technologically using SolidWorks to be able to print a physical object is something I found that I loved doing design and researching its properties. I would not have known that had I not changed my major to mechanical engineering.

On top of pursuing a mechanical engineering degree, I was a student athlete and played for the women's basketball team for the school. I learned many soft skills, balancing student-to-athlete life, making sure to put my priorities where needed. Although the road throughout my athletic career was difficult it is what has shaped me to who I am today and has given me the ability to conquer the academic road I have taken.

I am thankful to have been given the opportunity to go to St. Mary's where I was given an advisor who cares for my success rather than pushing me along to just get my degree. I was hesitant to switch majors because of credits and the what ifs of the new major, but after meeting Dr. Ocampo on Zoom (...Covid) I knew I had made the right decision. I have been given great opportunities that have developed my technical and soft skills and will help me in the future with my career. Even if it took an extra year, it was worth the wait.

-Briley

Since a young age, my life goal has always been to become an engineer, and now, after four years of rigorous coursework at St. Mary's University, I will earn a Bachelor of Science in Mechanical Engineering. It's incredible to think about all the time and hard work that went into this achievement, including developing lasting connections with faculty and fellow students. Looking back, I am very pleased with my decision to attend St. Mary's because of the unique student-to-faculty ratio and the opportunity to be involved not only in school but also in my hometown community.

In my freshman year of college, I was fortunate to receive a Summer Undergraduate Research Fellowship alongside Mr. Cardenas, the Chair of the Physics Department at St. Mary's. Excelling in my summer research led to the opportunity to intern at Lawrence Berkeley National Laboratory. After my time with Dr. Lombardini at Berkeley, I developed a keen interest in research. This interest was further nurtured through an internship at Stanford Linear Accelerator Center (SLAC), where I learned not only to apply classroom knowledge to real-world situations but also key industry skills such as communication, teamwork, and perseverance. I was inspired by the cutting-edge science being conducted around me and was amazed at how I could contribute to it. These internships were crucial in developing my ability to think like an engineer.

The exceptional coursework at St. Mary's was greatly enhanced by my ability to form personal connections with my professors. I would like to thank Dr. Cortina, Dr. Aguirre, and Dr.

Ocampo for their invaluable time during office hours and for supporting my engineering dreams. The small number of students in each class allowed me to receive firsthand support with missed lectures, homework, and projects. Without this aid, completing my degree would not have been possible. I am particularly grateful to these professors for the support they provide to each student, pushing us to develop to our fullest potential. I am beyond happy with the growth and development St. Mary's has facilitated during my time here, and I cannot wait to apply what I've learned to solving real-world problems that can change the world.

-Aaron

I have always had an interest in engineering and the environment. At St. Mary's University, I was able to merge my interests into a career and to explore these passions while also deepen my understanding of both fields. I initially started school majoring in environmental science, I soon realized how much I missed mathematics in my life, which I certainly got a lot of. The journey as an engineering major was challenging but rewarding.

Throughout my college career, I've been fortunate to have dedicated faculty who guided and inspired me to reach higher. They instilled in me a drive for continuous improvement and a commitment to excellence. My transition into engineering opened up a world of possibilities, allowing me to blend my environmentalist mindset with the practicality of engineering solutions like my dad has always taught me as an engineer himself.

Participating in our senior design project played a truly important part in forming my academic journey. It provided a platform to apply my knowledge and skills in a real-world setting, tackling complex environmental challenges with innovative engineering solutions. I really enjoyed collaborating with my team, mentor, and sponsors. Together, we navigated through uncertainties, adapted to changing requirements, and came out as a stronger and more resilient team. One of the most valuable lessons I learned was the importance of flexibility and adaptability in the face of evolving circumstances. Plans may shift, and client expectations may change, but our ability to find creative solutions is what sets us apart as engineers.

As I reflect on the past four years, I'm filled with gratitude for the experiences and opportunities that shaped me into the person I am today. None of this would have been possible without the unwavering support of my family. Their encouragement and belief in my dreams have been my greatest source of strength. Looking ahead, I am excited to continue my journey, with newfound knowledge, experiences, and a deep sense of purpose. Engineering has empowered me to make a difference in the world, and I am eager to embrace the challenges and opportunities that lie ahead.

-Fernanda

11. APPENDIX

11.1 BUBBLER BLEEDER INSTALLATION AND USER MANUAL

Bubbler Bleeder Instructions Manual

The Bubbler Bleeder includes a timer control box (1), and a pneumatic bleeder control (2) as shown below.

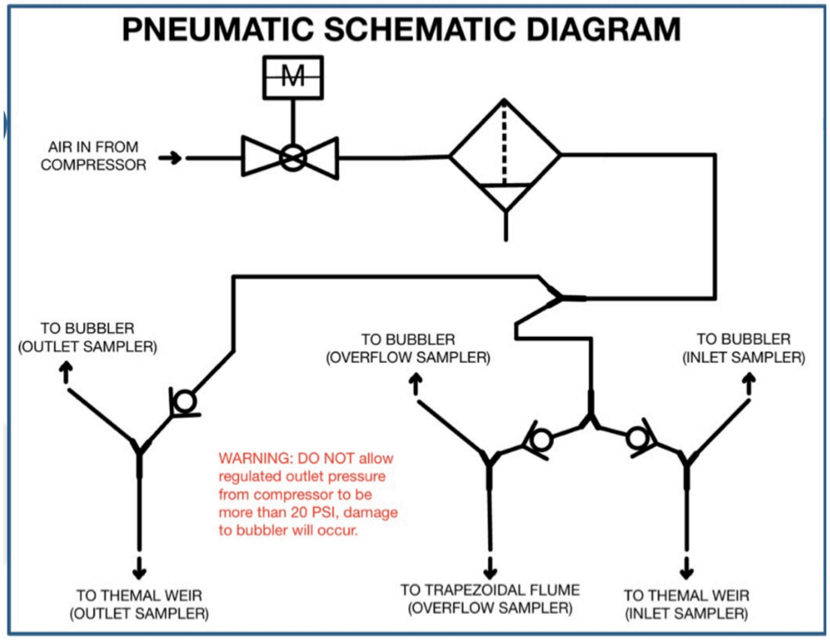
To install the Bubbler Bleeder you need a compressor capable of supplying enough air for the total length of Bubbler lines to bleed. On the compressor set the output pressure to 10-15 psi. **DO NOT EXCEED 20 PSI**, permanent damage to bubbler module will occur.

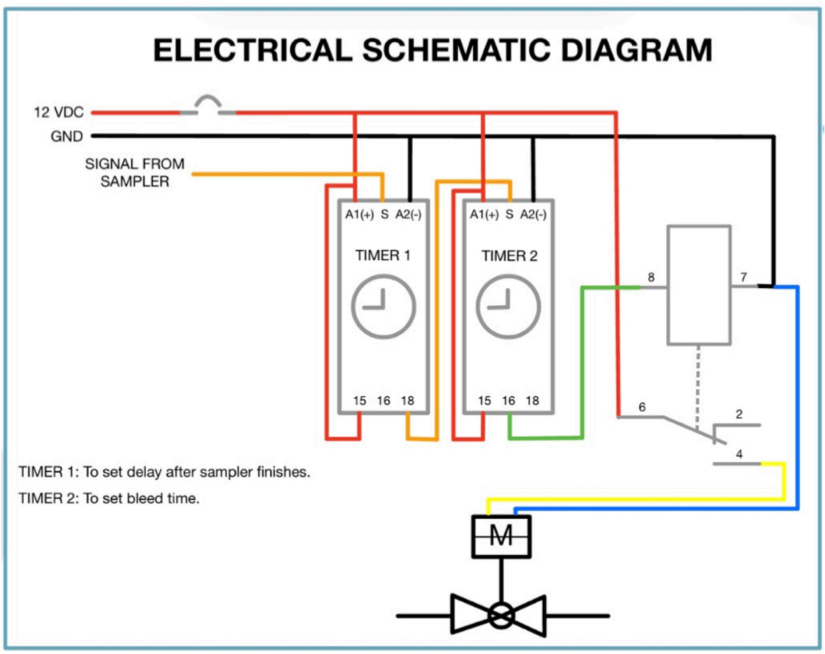
To install system:

- Attach pneumatic bleeder control to the quick connect on the compressor.
- Attach bleeder line to pneumatic bleeder on barbed fitting.
- Attach check valve to other side of bleeder line, with check direction allowing flow from compressor.
- Connect a 1" long piece of line between check valve and Y-adapter.
- Connect a 8" piece of line from bubbler module to the 2nd port of Y-adapter.
- Connect the bubbler line coming from the Themal Weir to the 3rd port of Y-adapter.
- Plug to a 110V outlet the power cord coming from the timer control box.
- Flip the breaker to the "ON" position in the timer control box.

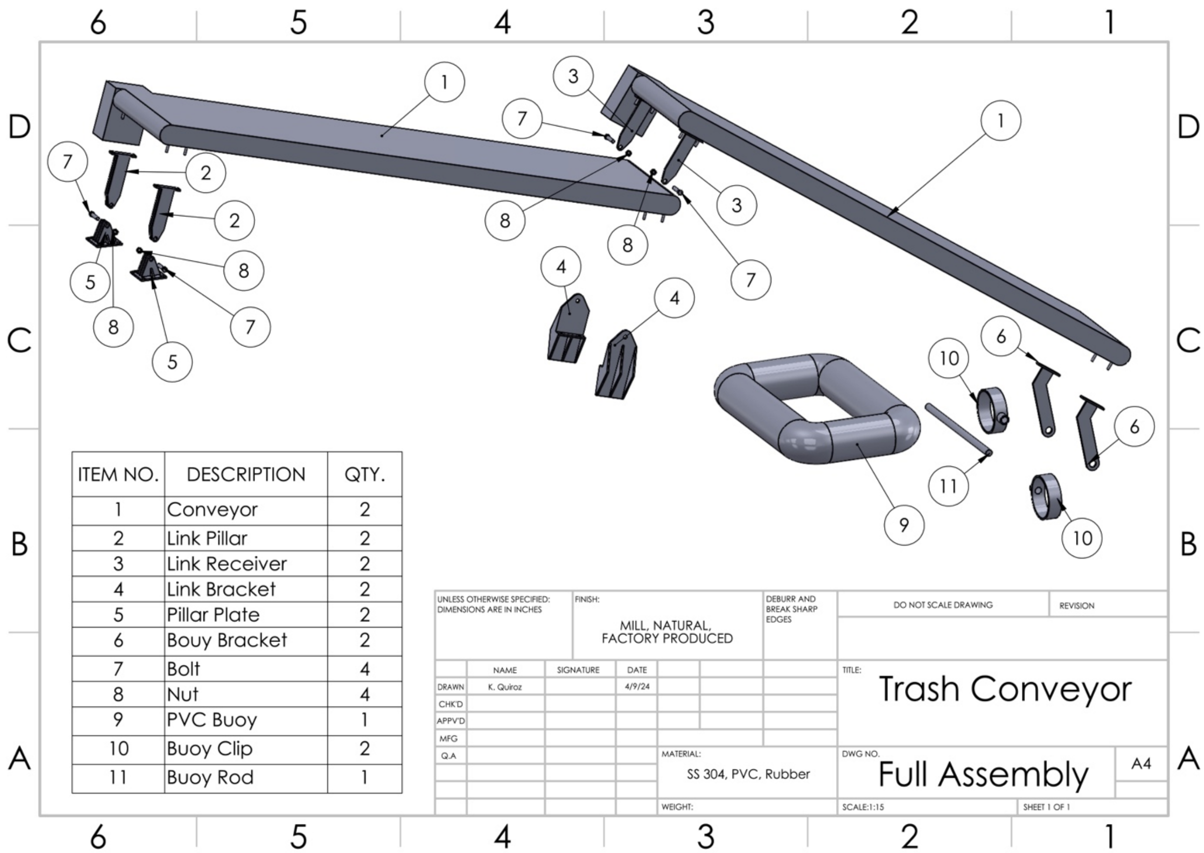
To set the timers:

- Timer 1 controls the delay between the moment the sampler is done collecting samples and when the bubbler blended should activate. Timer 1 has to times to be set, the first time should be the delay (ie. 24hrs) and the second time affects how long will a signal be sent after the first set time has elapsed. This time does not have to be long, 1 sec max should suffice.
- Timer 2 controls how long the bleeder will allow air to flow so that the lines are bled. This time will vary according to how many/ how long the bubbler lines are.
- The timer box also has a ORANGE wire. This wire is to be connected in the serial port of the sampler which will set to trigger the Bubbler Bleeder.
- The ISCO Sampler should be programed to output an alarm after the sample collecting program is done. This can be done by using the "ANALOG OUTPUTS" in the options of the sampler.


PNEUMATIC SCHEMATIC DIAGRAM
M
AIR IN FROM COMPRESSOR
TO BUBBLER (OUTLET SAMPLER)
TO BUBBLER (OVERFLOW SAMPLER)
TO BUBBLER (INLET SAMPLER)
WARNING: DO NOT allow regulated outlet pressure from compressor to be more than 20 PSI, damage to bubbler will occur.
TO THEMAL WEIR (OUTLET SAMPLER)
TO TRAPEZOIDAL FLUME (OVERFLOW SAMPLER)
TO THEMAL WEIR (INLET SAMPLER)


ELECTRICAL SCHEMATIC DIAGRAM
12 VDC
GND
SIGNAL FROM SAMPLER
A1(+) S A2(-)
TIMER 1
15 16 18
A1(+) S A2(-)
TIMER 2
15 16 18
8
7
6
2
4
M
TIMER 1: To set delay after sampler finishes.
TIMER 2: To set bleed time.

11.2 TRASH COLLECTOR ASSEMBLY



ITEM NO.	DESCRIPTION	QTY.
1	Conveyor	2
2	Link Pillar	2
3	Link Receiver	2
4	Link Bracket	2
5	Pillar Plate	2
6	Bouy Bracket	2
7	Bolt	4
8	Nut	4
9	PVC Buoy	1
10	Buoy Clip	2
11	Buoy Rod	1

11.3 TRASH COLLECTOR INSTALLATION & BRACKET ENGINEERING DRAWINGS

Trash Collection Installation Process

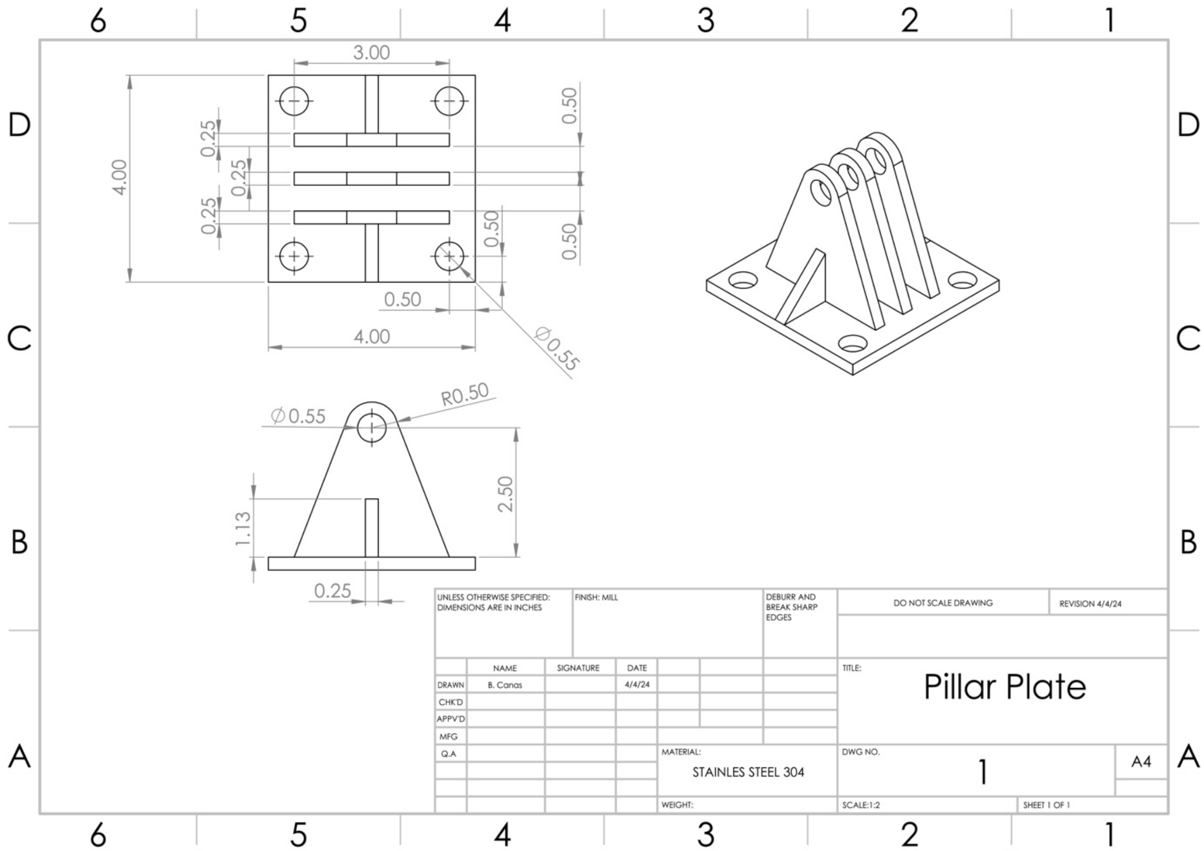
Conveyor Belt Buoy:
The buoy that is attached to the bottom end of the second conveyor belt will be built from six PVC pipes that consists of four elbow joints and two straight pipes. These pipes will be conjoined by PVC glue to ensure they stay attached to each other. This buoy is shown as item number 9 in the trash conveyor full assembly.

Conveyor Belts:
The two conveyor belts (Item # 1) will be attached by different welded joints and brackets that we have manufactured specifically for these conveyor belts (Item # 2,3,4,5,6). Item number 2 will connect the conveyor belt to the pillar via the pillar plate (Item # 5). The pillar plate (Item # 5) will sit on top of the cement pillar that will need to be installed by SARA. The conveyor belt that sits on the bank of the river will be cemented into the ground to ensure that it is not stolen and does not float away. The permits regarding this cemented block will be taken care of by SARA. In order to connect the two conveyor belts, the link receiver (Item # 3) and the link bracket (Item # 4) need to be utilized. This conveyor will be able to raise and lower according to the water levels. Finally, in order to connect the second conveyor belt to the conveyor belt buoy, the buoy bracket (Item # 6) needs to be attached to the bottom on the second conveyor belt. After this is complete, you will needs to use the buoy clip (Item # 10) and the buoy rod (Item # 11) to connect the buoy bracket (Item # 6) to the PVC buoy (Item # 9).

Buoy System #1:
The first buoy system will be constructed from the Solidworks STL file of the turbine buoy we have designed. These buoys will need to be 3D printed at a size that efficiently fits the width of the river. They will then be strung together on a line by a water-proof rope and anchored into either side of the river bank.

Buoy System #2:
The second buoy system will just be a simple net with a weighted bar at the bottom so the net sits about halfway in between the bottom and top height of the river. This system will also be anchored to the sides of the river bank at an appropriate distance behind the first buoy system.

Concrete:
The concrete will need to be placed and poured an appropriate distance away from the edge of the bank so that the conveyor belts sit properly with the geometry of the creek. The appropriate permits need to be acquired to be able dig alongside the river so that the concrete can be poured. The concrete needs to be thick enough so that the pillar plates (Item # 5) can be securely bolted and fastened to ensure the conveyor belt does not get stolen or float away.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DEBURR AND BREAK SHARP EDGES
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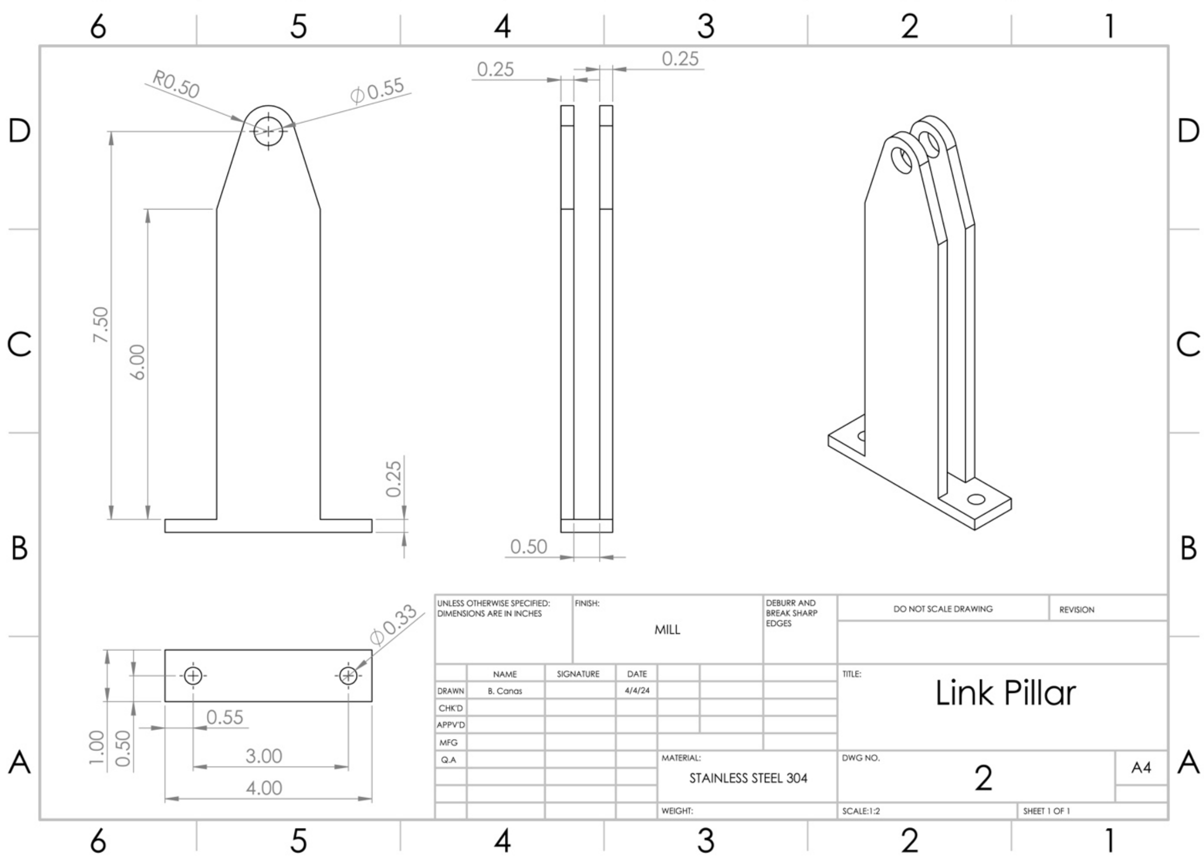
4/4/24
CHK'D
APPV'D
MFG
Q.A
TITLE:
Pillar Plate
MATERIAL:
STAINLES STEEL 304
DWG NO.
1
A4
WEIGHT:
SCALE:1:2
SHEET 1 OF 1


R0.50
Ø0.55
7.50
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UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES
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DEBURR AND BREAK SHARP EDGES
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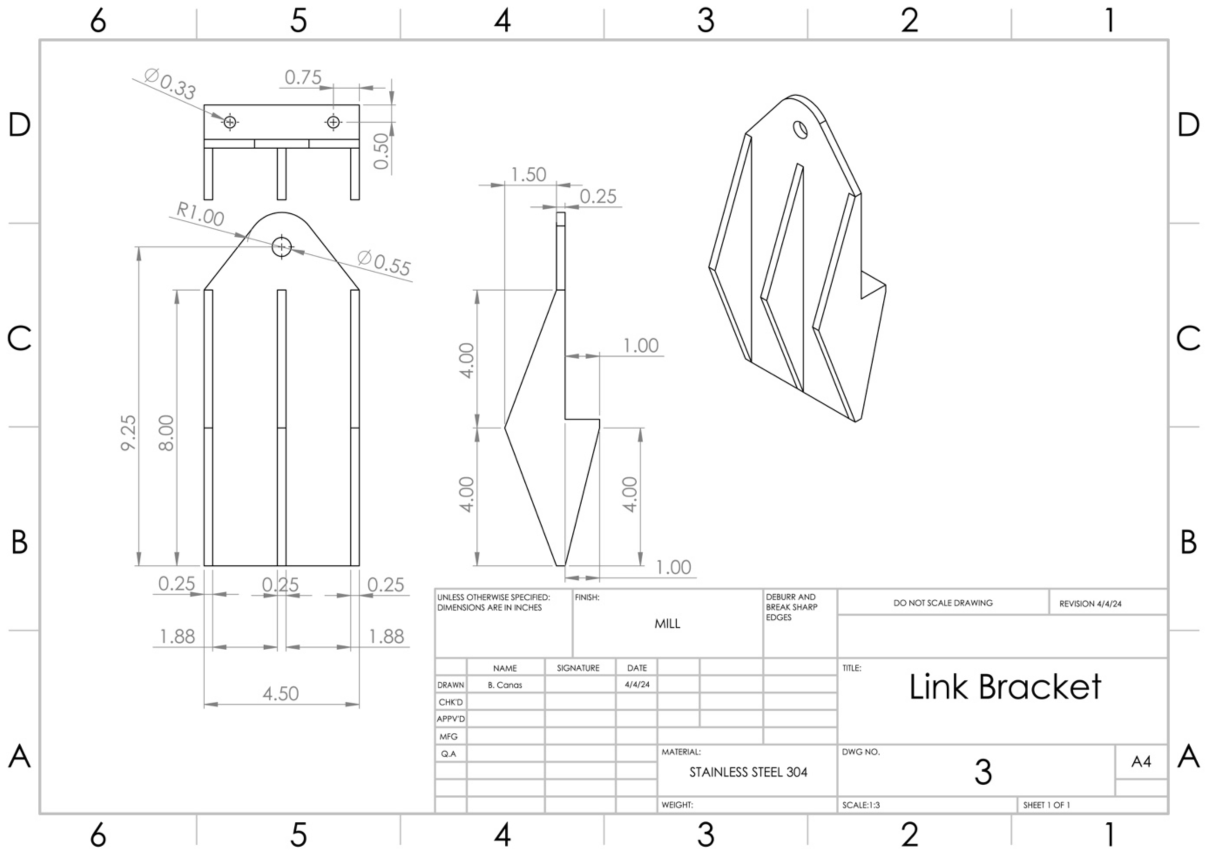
CHK'D
APPV'D
MFG
Q.A
TITLE:
Link Pillar
MATERIAL:
STAINLESS STEEL 304
DWG NO.
2
A4
WEIGHT:
SCALE:1:2
SHEET 1 OF 1



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1.88
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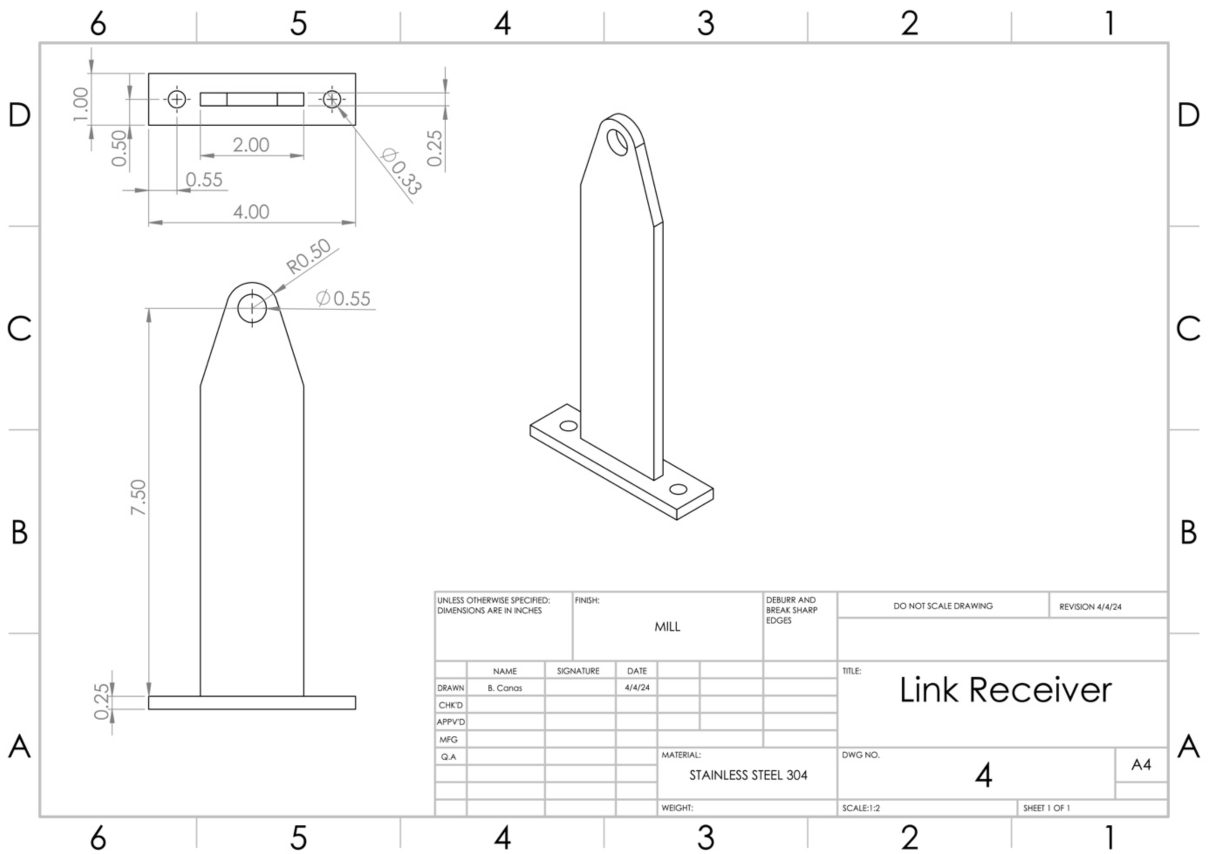
UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES
FINISH:
MILL
DEBURR AND BREAK SHARP EDGES
DO NOT SCALE DRAWING
REVISION 4/4/24
NAME
SIGNATURE
DATE
DRAWN
B. Canas
4/4/24
CHK'D
APPV'D
MFG
Q.A
TITLE:
Link Bracket
MATERIAL:
STAINLESS STEEL 304
DWG NO.
3
A4
WEIGHT:
SCALE:1:3
SHEET 1 OF 1



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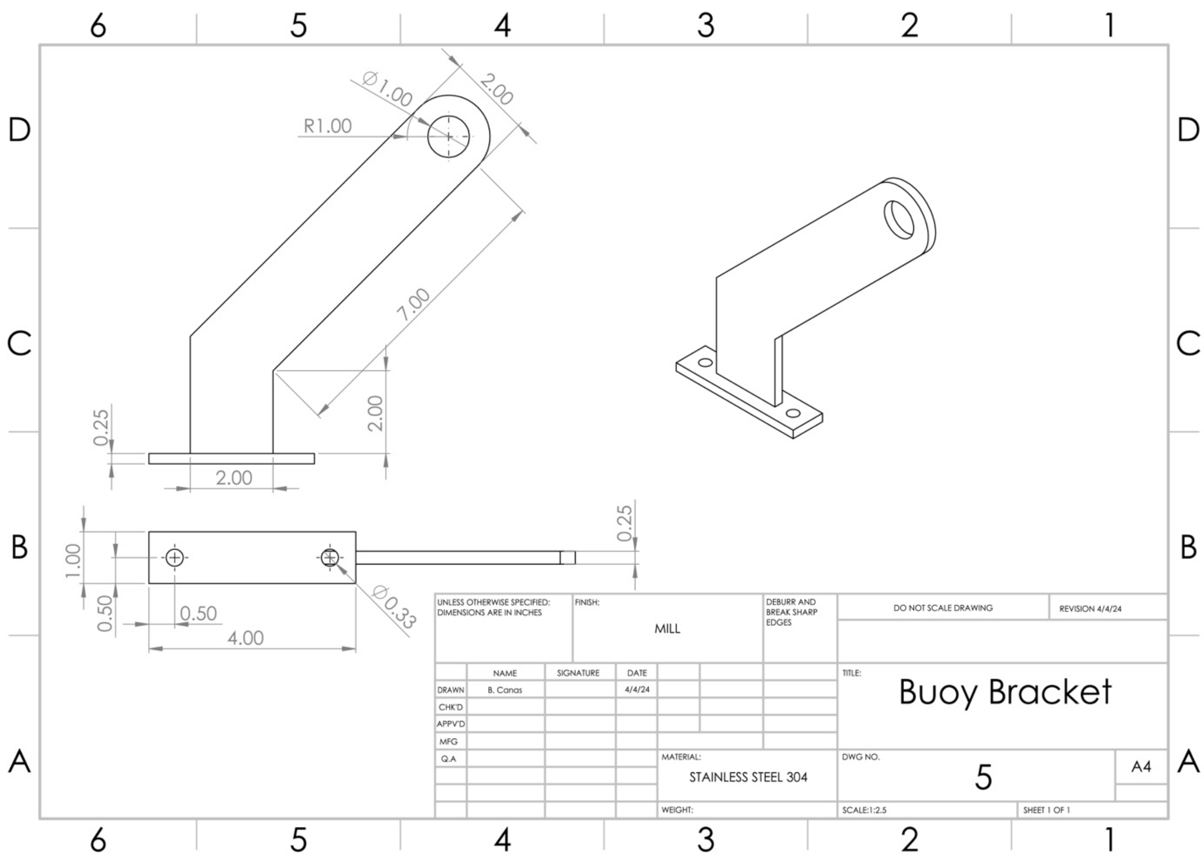
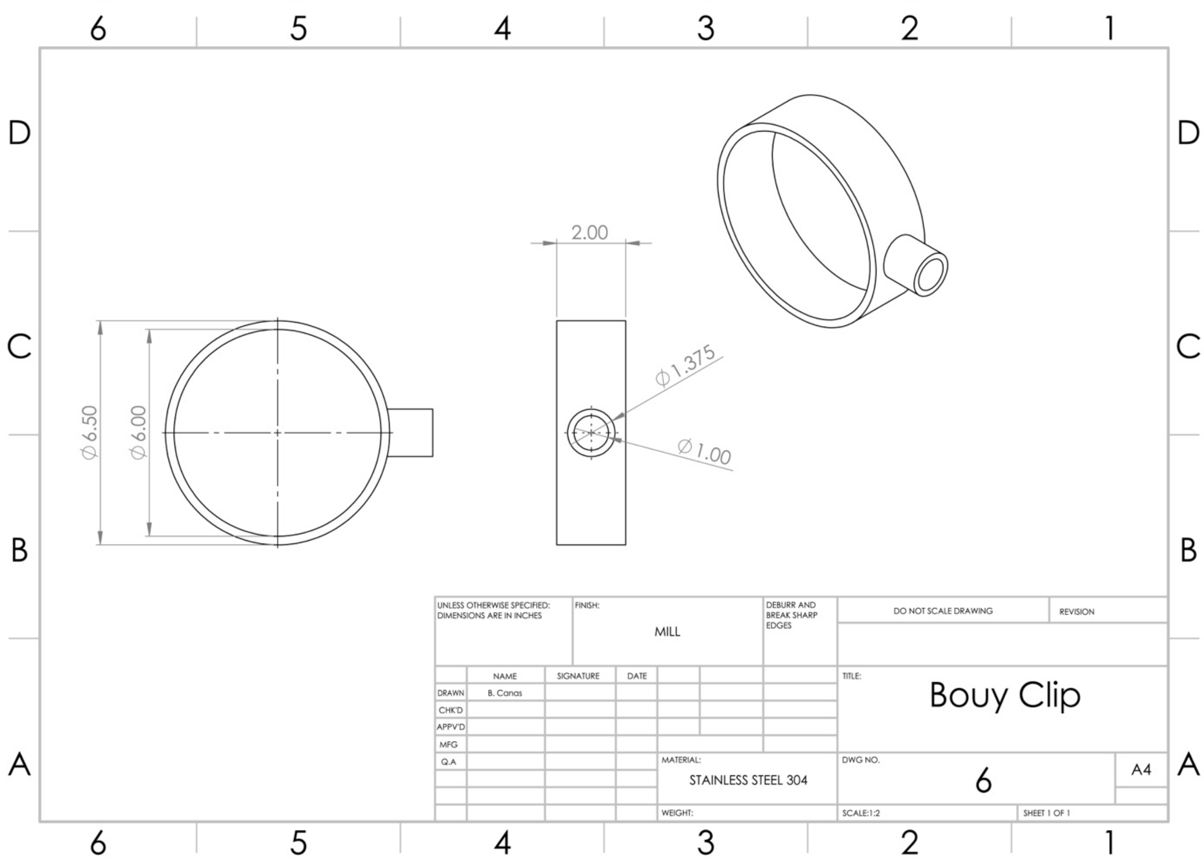
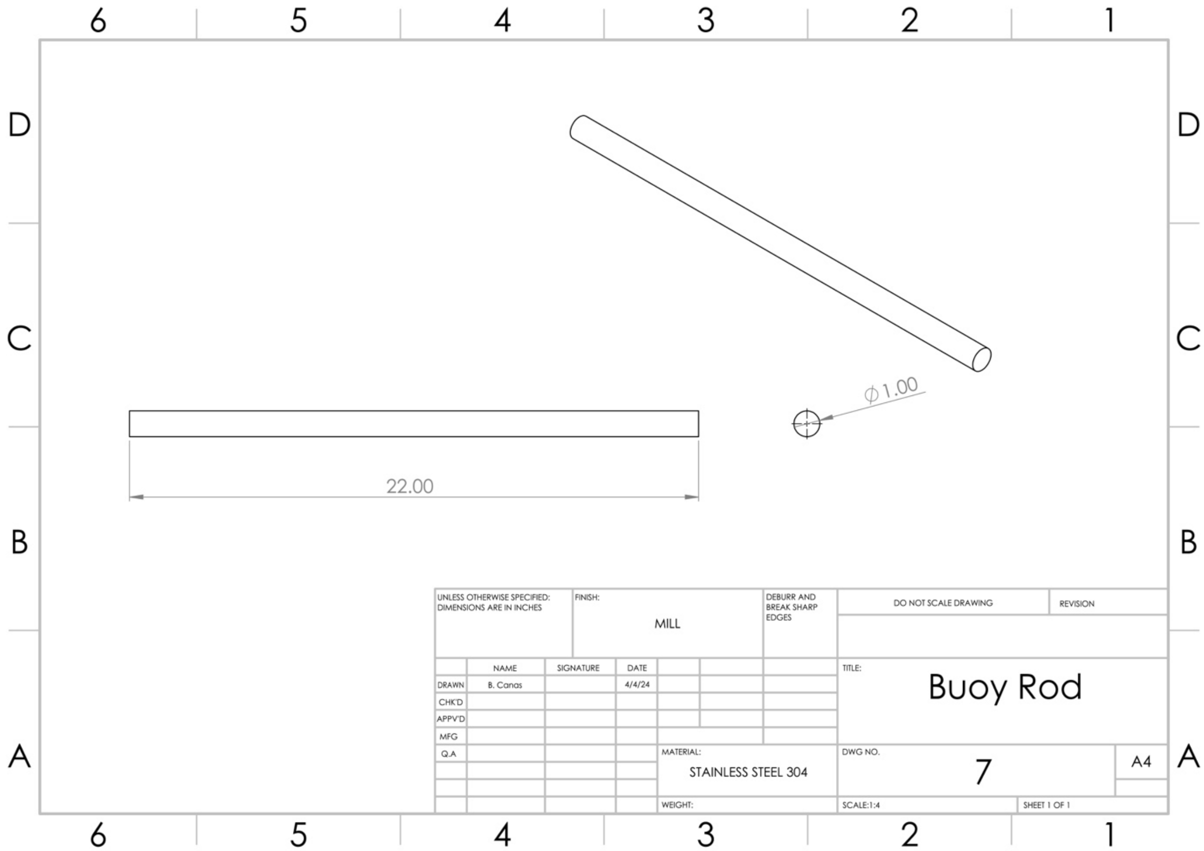
FINISH:
MILL
DEBURR AND BREAK SHARP EDGES
DO NOT SCALE DRAWING
REVISION 4/4/24
NAME
SIGNATURE
DATE
DRAWN
B. Canas
4/4/24
CHK'D
APPV'D
MFG
Q.A
TITLE:
Link Receiver
MATERIAL:
STAINLESS STEEL 304
DWG NO.
4
A4
WEIGHT:
SCALE:1:2
SHEET 1 OF 1

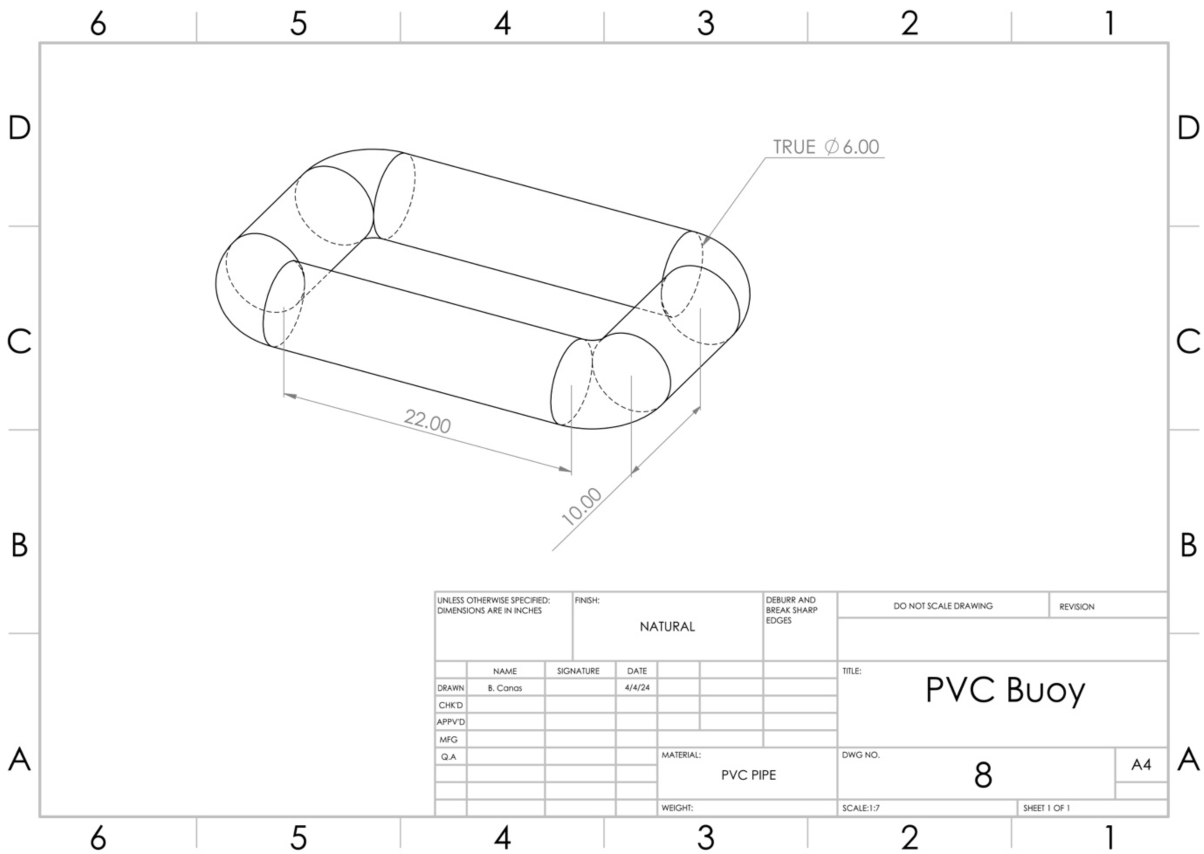


Ø1.00
2.00
R1.00
7.00
2.00
0.25
2.00
0.25
1.00
0.50
0.50
4.00
Ø0.33
UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES
FINISH:
MILL
DEBURR AND BREAK SHARP EDGES
DO NOT SCALE DRAWING
REVISION 4/4/24
NAME
SIGNATURE
DATE
DRAWN
B. Canas
4/4/24
CHK'D
APPV'D
MFG
Q.A
TITLE:
Buoy Bracket
MATERIAL:
STAINLESS STEEL 304
DWG NO.
5
A4
WEIGHT:
SCALE:1:2.5
SHEET 1 OF 1



2.00
Ø1.375
Ø1.00
Ø6.50
Ø6.00
UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES
FINISH:
MILL
DEBURR AND BREAK SHARP EDGES
DO NOT SCALE DRAWING
REVISION
NAME
SIGNATURE
DATE
DRAWN
B. Canas
CHK'D
APPV'D
MFG
Q.A
TITLE:
Bouy Clip
MATERIAL:
STAINLESS STEEL 304
DWG NO.
6
A4
WEIGHT:
SCALE:1:2
SHEET 1 OF 1


22.00
∅1.00
UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES
FINISH:
MILL
DEBURR AND BREAK SHARP EDGES
DO NOT SCALE DRAWING
REVISION
NAME
SIGNATURE
DATE
DRAWN
B. Canas
4/4/24
CHK'D
APPV'D
MFG
Q.A
TITLE:
Buoy Rod
MATERIAL:
STAINLESS STEEL 304
DWG NO.
7
A4
WEIGHT:
SCALE:1:4
SHEET 1 OF 1


TRUE ∅6.00
22.00
10.00
UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES
FINISH:
NATURAL
DEBURR AND BREAK SHARP EDGES
DO NOT SCALE DRAWING
REVISION
NAME
SIGNATURE
DATE
DRAWN
B. Canas
4/4/24
CHK'D
APPV'D
MFG
Q.A
TITLE:
PVC Buoy
MATERIAL:
PVC PIPE
DWG NO.
8
A4
WEIGHT:
SCALE:1:7
SHEET 1 OF 1