



SINGLE-STAGE WATER FILTER WITH DUAL SAND MEDIA SIZES

Team Hydration Station

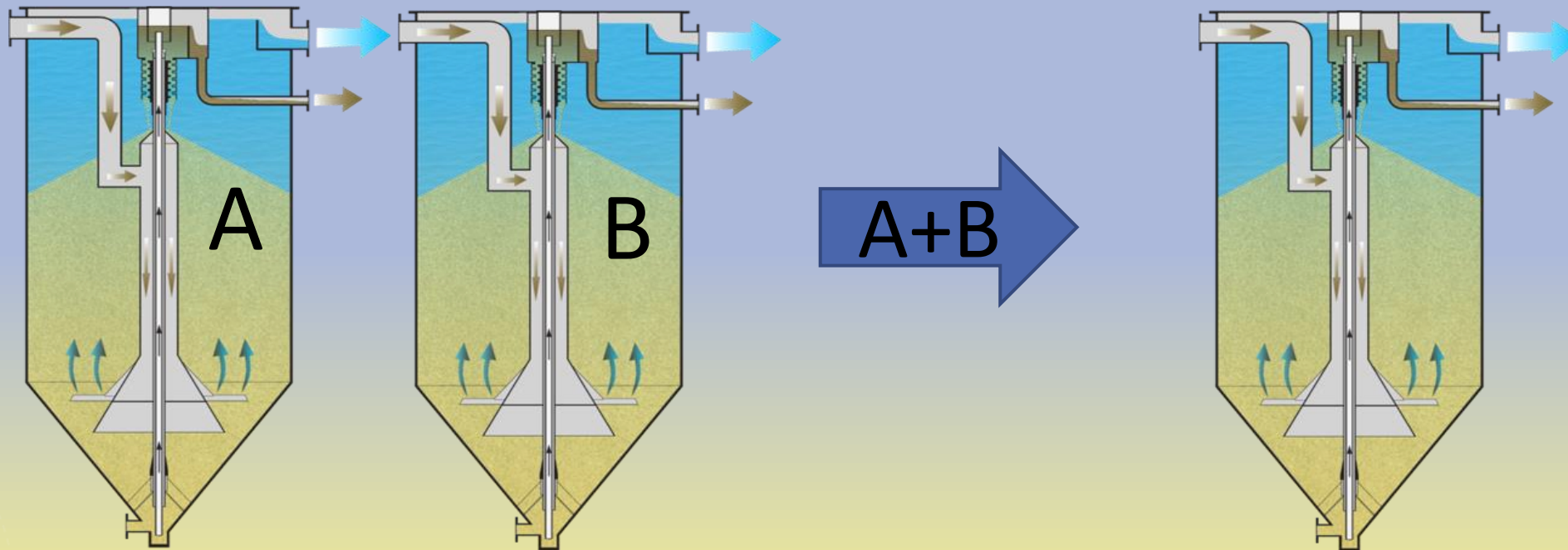
Jaden Cavender (ME)

Tobias Flores-Wentz (BE)

Benjamin Marek (ME)

Tayson Thompson (BE)

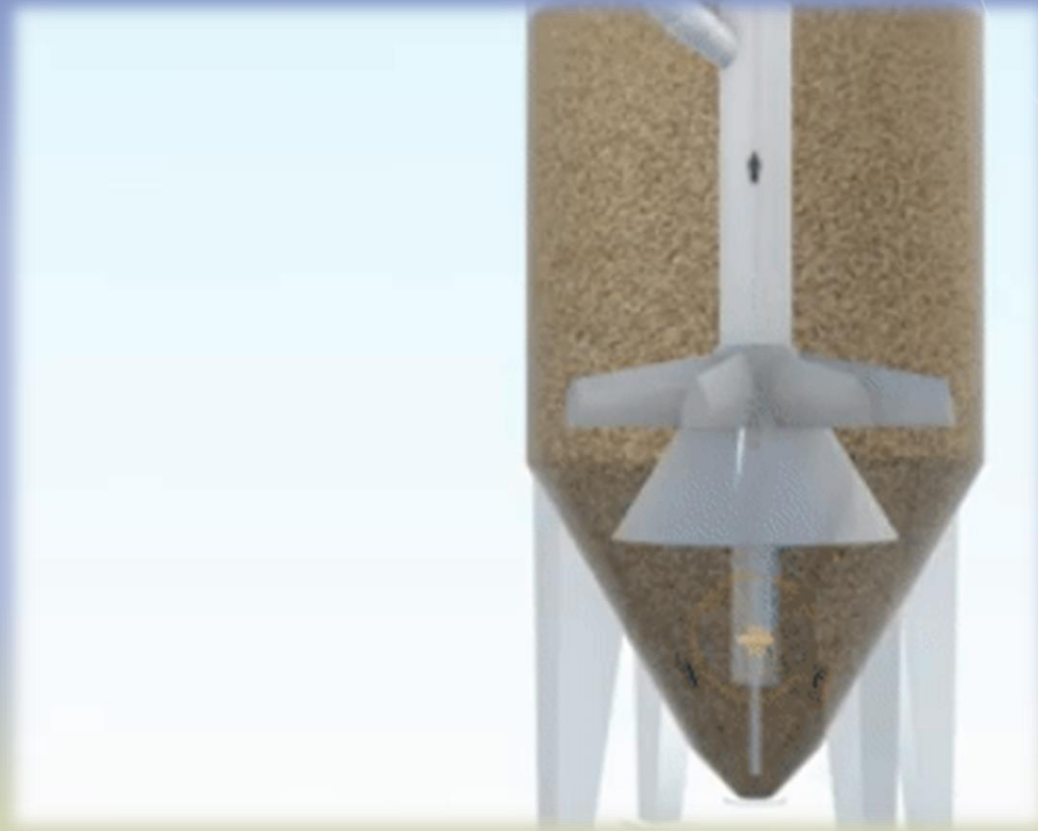
Blake Urie (BE)





OVERVIEW

- Objective
- Value Proposition
- Background
- Requirements
- Key Attributes
- Drawings
- Bill of Materials
- Manufacturing Plan
- Summary of DVP
- Project Schedule
- Budget
- Risks





VALUE PROPOSITION

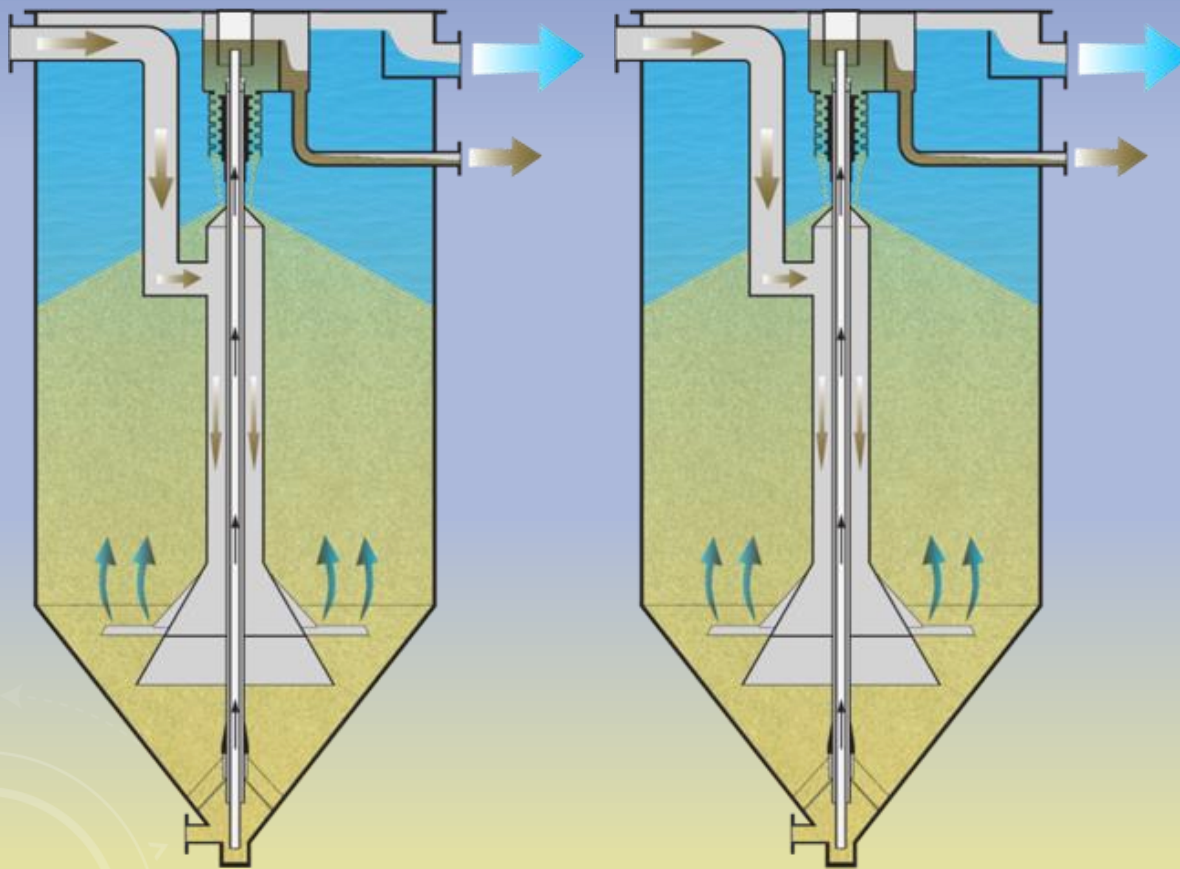


Clean water is arguably the world's most valuable resource; therefore it is important to invest in water filtration technology. Currently the U of I's Clean Water Machine design is a two-stage dual media sand filter, but by refining the design to require a single filtration stage, a significant reduction in maintenance and increased efficiency can hopefully be achieved.



BACKGROUND

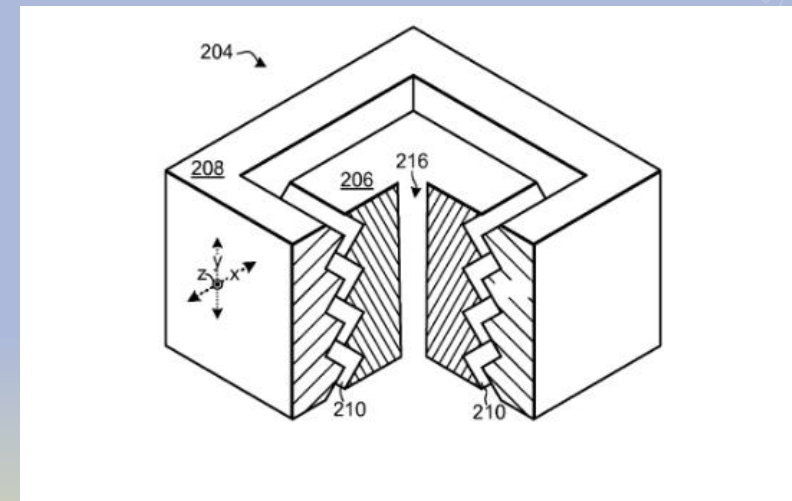
Current Design : Dual Stage Filtration

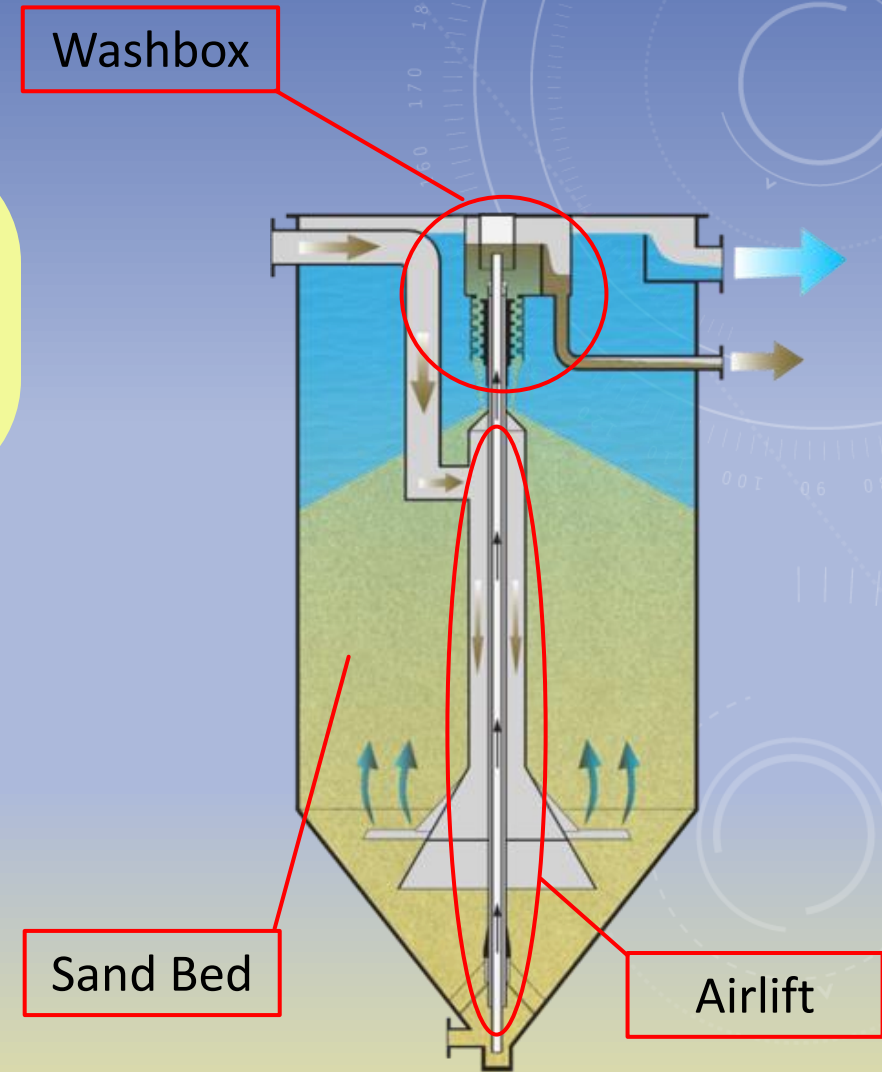
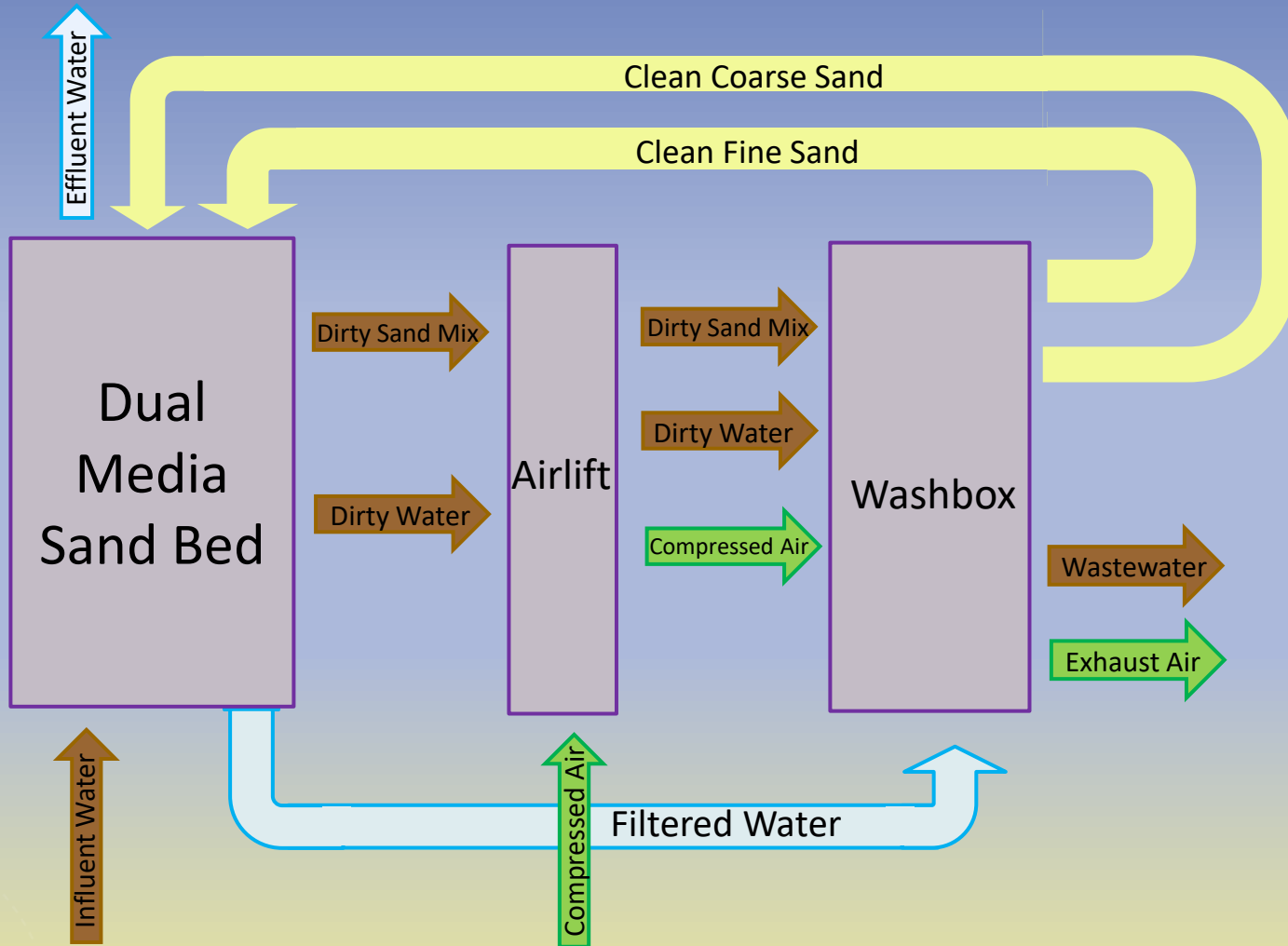


Coarse Sand Bed

Fine Sand Bed

Current Design: Adjustable Washbox







REQUIREMENTS

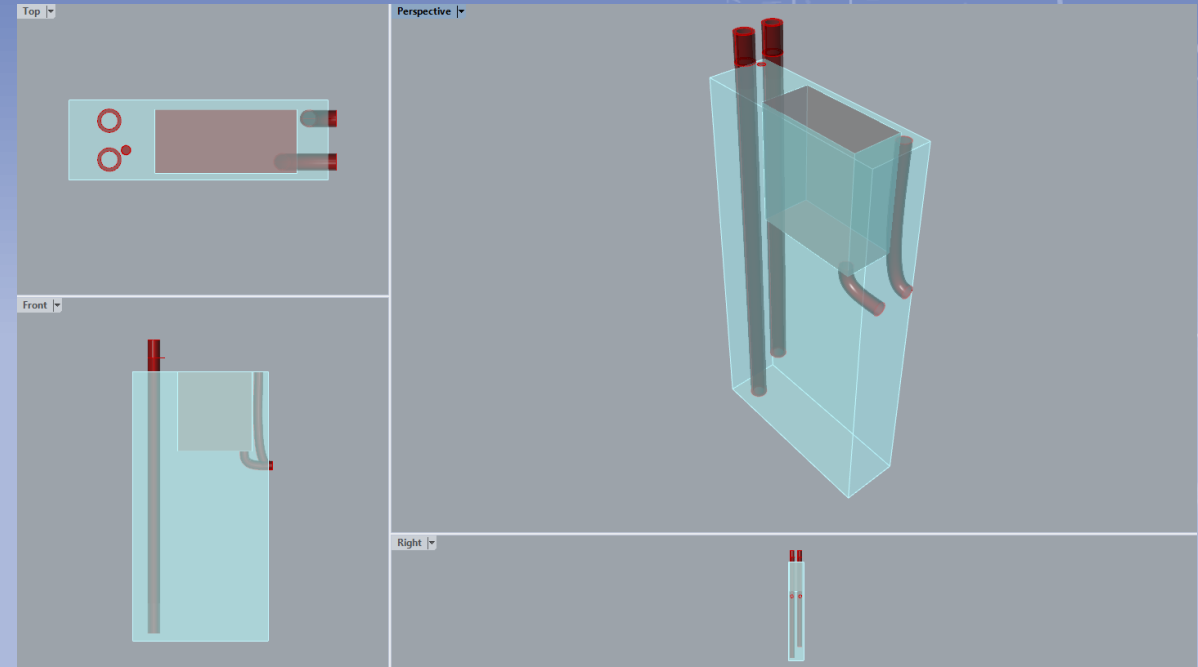
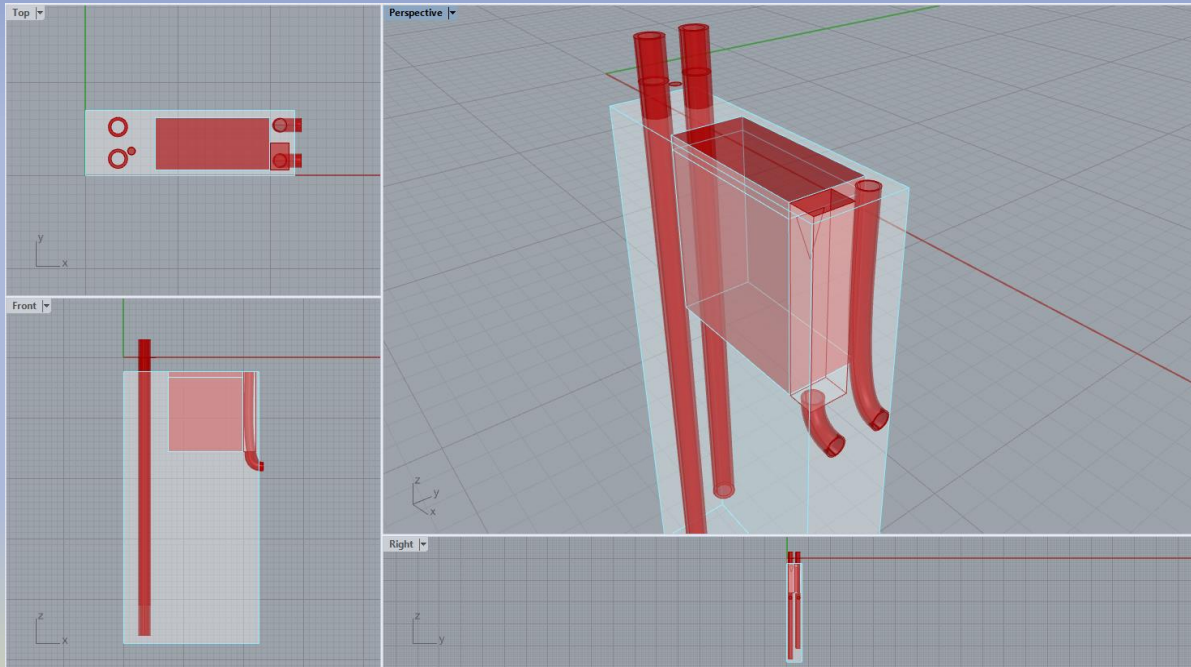
- Separation of the two sand sizes
- Chemical and corrosion resistance.
- Minimum up flow rate of 1.8 gallons per minute (gpm)
- Maintain a bed turnover rate of 0.7 to 1.4 inches per minute.
- Continuous operation with a maximum of 30 minutes of routine weekly maintenance



Martin Baker and Greg Möller with the Clean Water Machine



TEST STAND MODEL



Model designed by Martin Baker

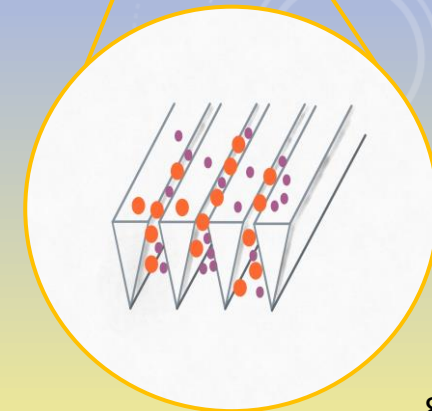
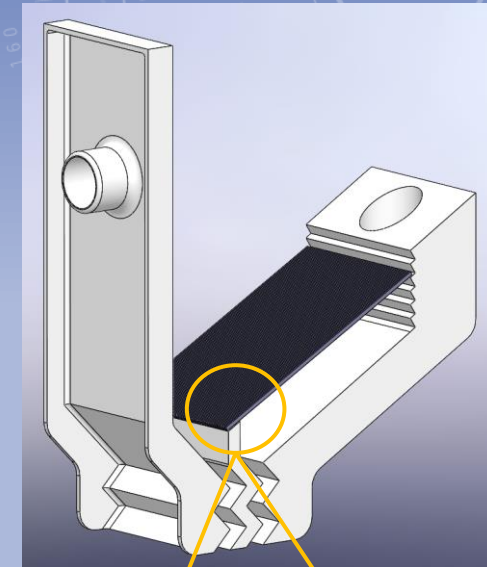
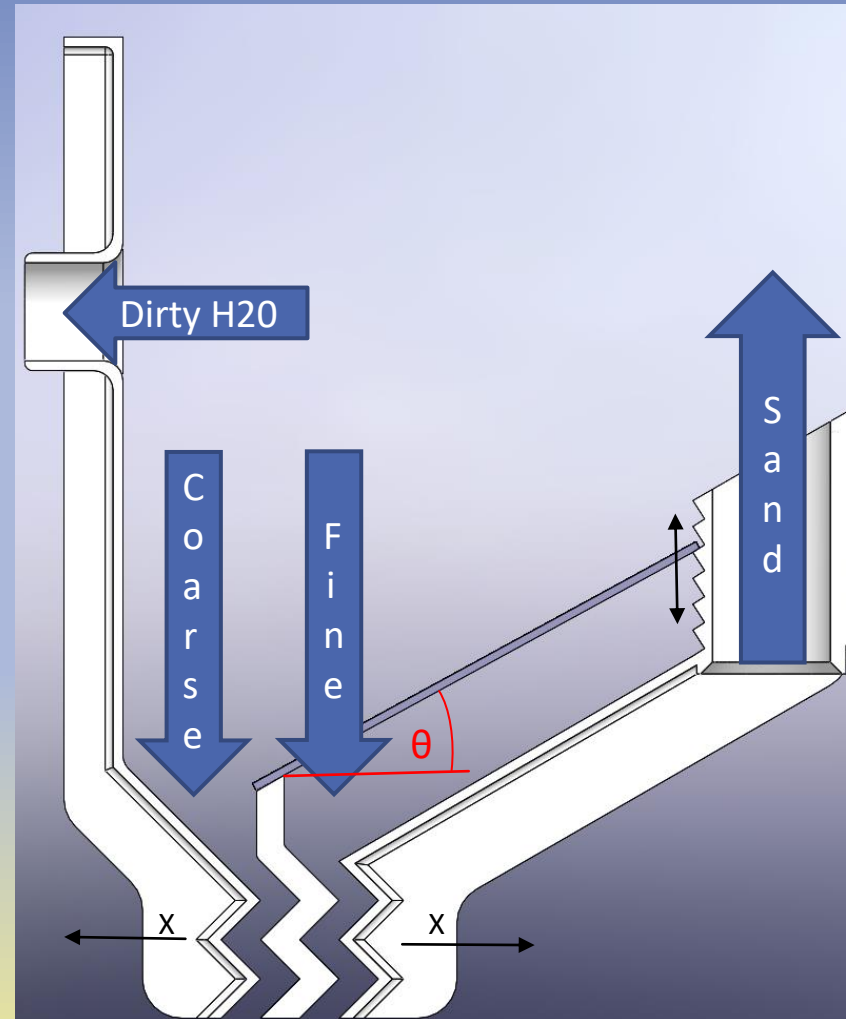


WASHBOX VALIDATION

- Design Validation is being conducted on an experimental model.
- The part will model sand separation and screen resistance.

Adjustability

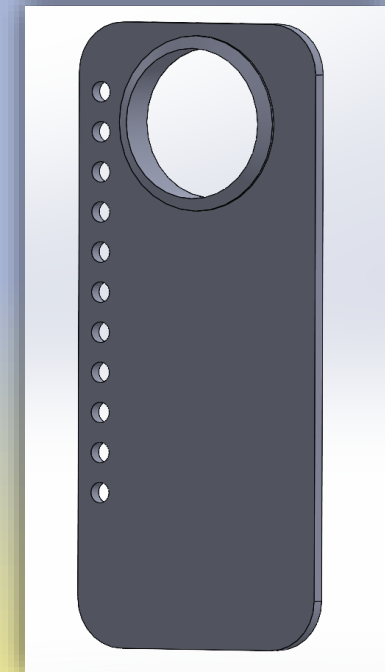
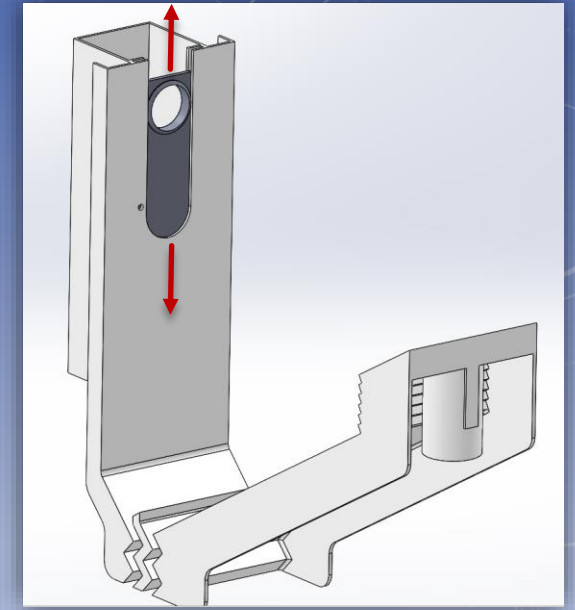
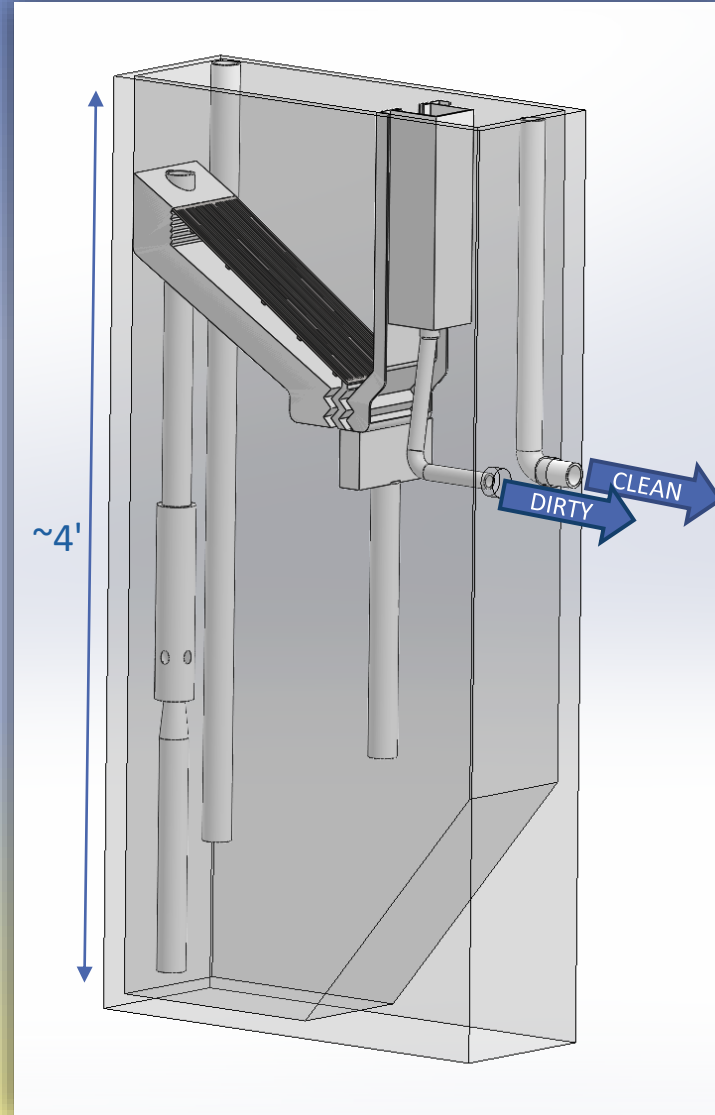
- Channel Velocity
 - .43 -.87 in/s
- Screen Angle: θ
 - 16 –42 degrees



Above: Screen separated wash box assembly.

WASHBOX & TESTING MODIFICATIONS

- Tank
 - Fully modular.
 - Airlifts, washbox, inlets and overflow reservoir.
- WashBox
 - Screen
 - Increased angle variability.
 - Increased screen width and length to increase media-screen contact.
 - Adjustable dirty outlet height
 - Outlet adjustable to 4+ inches.
 - Adjust water depth in washbox.
 - Allows for channel mass flow adjustments.
 - Airlift outlet submerged depth adjustment.





POTENTIAL RISKS

- Clogging of the wedge wire screen.
- Parts abrasion due to sand movement at high velocity.
- Granular convection at any sand bed interfaces and insufficient sand segregation.
- Overall incompatibility with current filtration system.





ASSEMBLIES/SUBASSEMBLIES/BOM

- Subassembly 1: Washbox
- Subassembly 2: Tank Features
- Subassembly 3: Piping and Fittings

Test Stand Bill of Materials

Total Cost: \$1452

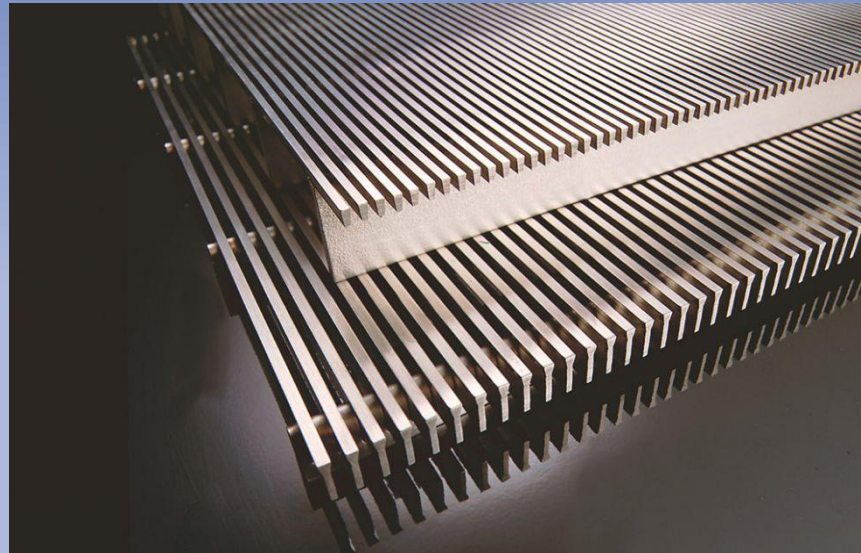
- Acrylic Panes - \$1300
- PVC - \$17
- Vinyl Tubing - \$62
- Adhesives/Sandpaper - \$58
- Ports/Fasteners - \$15





MANUFACTURING METHODS

- Main methods of manufacturing:
 1. Bandsawing of pipes/fiberglass
 2. 3-D printing/Sheetmetal fabrication
 3. Waterproofing with sealant and adhesives





RISK MANAGEMENT

1. Added additional reinforcement via rebar to stop any expansion of glass or cracking from freezing.
2. Crafting additional fiberglass wedge on the tank base to maintain even sand distribution.
3. Putting in an additional filter in outflow box for cleaning any remaining residuals due to screen-based failure.



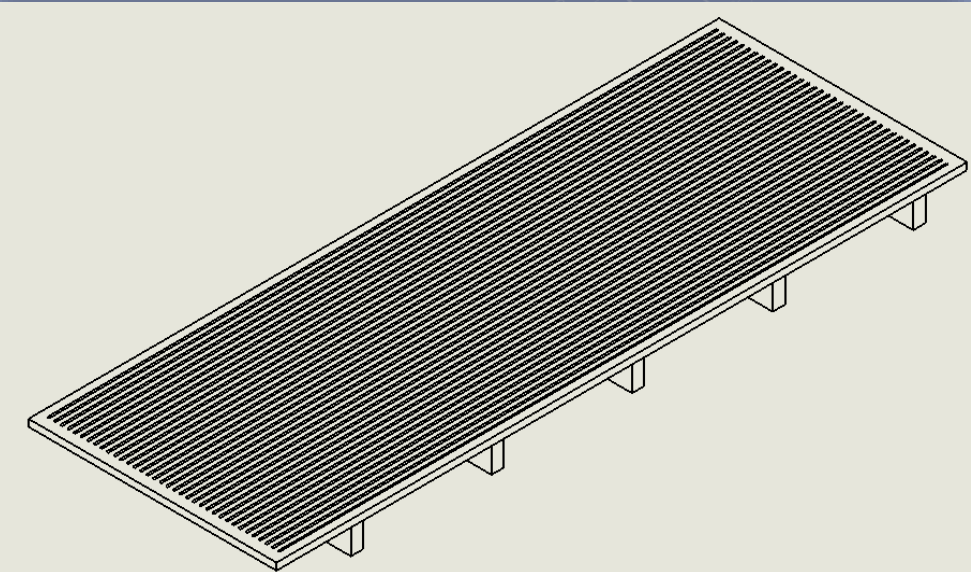
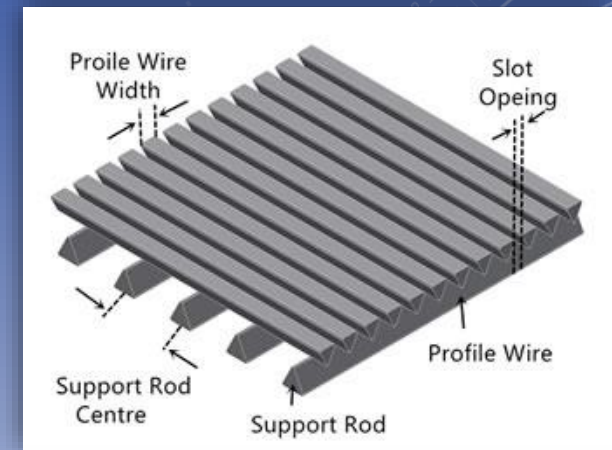


TESTING/VERIFICATION

Main Sand Separator: Wedge wire screen

Best design being experimentally verified.
Variables to consider: Sand velocity, upflow velocity, gap length, screen angle, screen surface area, and vibrational intensity, .

Also testing uncertainty in sand size and measuring profile deviation.



5 Rectangular Supports
35 Wedges, 90V Wedge Profile
Supports: 1/2" High, 1/4" Wide
Wedge Gap: .039"-.043"



PROOF OF CONCEPT

- Stage of proof of concept: Manufacturing and testing on larger scale.
- Building overall tank to verify material effectiveness beyond 3d printed chassis.
- Sand separation has been tested, but the next step is to test effectiveness of residual filtration with a model closer to approximating the final version.



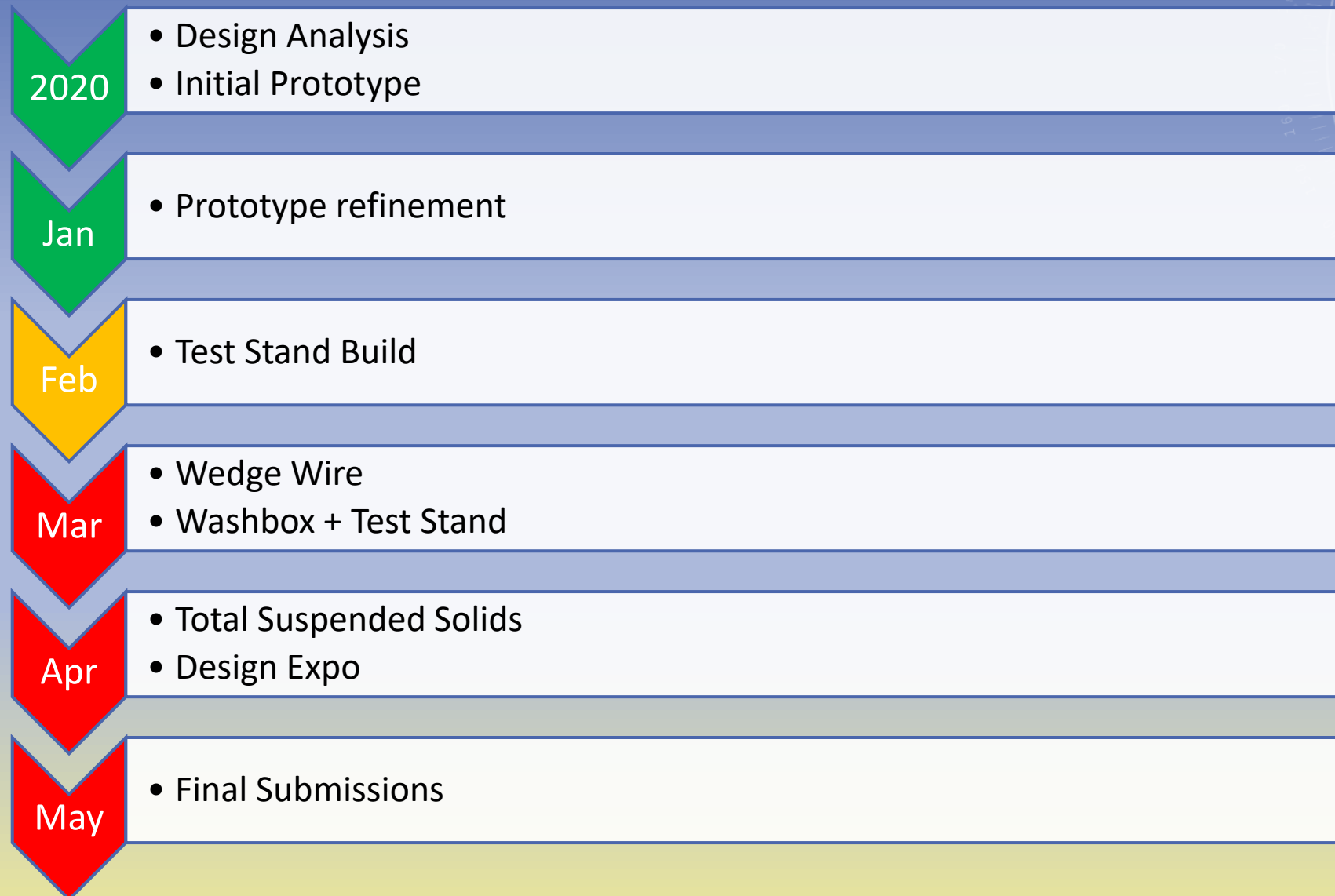


DESIGN VALIDATION PLAN

Requirement	Test	Test Subject	Target Date	Result	Recommendation
Submit design considerations for scale model testing stage filter design.	Determine if the scale model will be customizable and accurate enough to be useful during testing.	Testing stage apparatus.	11/06/2020		
Achieve 75% sand separation in a continuously run dual media water filtration unit.	CFD analysis in SolidWorks and with the help of undergraduate specialists and possible wear analysis/consideration.	Fully functional model #1	11/20/2020	CFD Results were unable to model multiphase flow. Upwards water flow was analyzed	Sand interactions and settling velocities will need to be modeled via experiments.
Achieve 75% sand separation in a continuously run dual media water filtration unit.	Live test of fabricated prototype in small scale testing stage filter.	Fully functional model #1	2/23/21 - 3/04/21 (Continuous)		
Maintain banding of separated sand in filter bed.	Live test of fabricated prototype in small scale testing stage filter.	Fully functional model #1			
1.8 to 3.6 gallons per minute upflow rate maintained.	Live test of fabricated prototype in small scale testing stage filter.	Fully functional model #1			
Percent removal of total suspended solids (TSS)	Before and after mass analysis of known volume of sample.	Fully functional model #1	3/11/21		



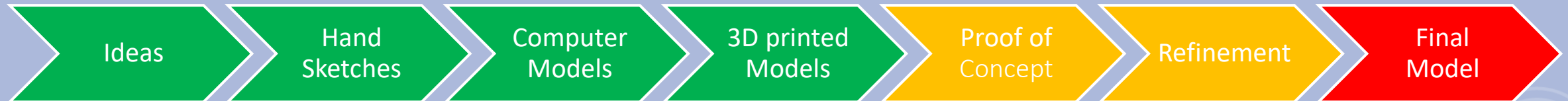
SCHEDULE OVERVIEW





RECAP

Our objective is to combine a two-stage filtration system into a single-stage dual media filter.





ACKNOWLEDGEMENTS

- Dr. Sarah Wu our advisor
- Mr. Martin Baker and Dr. Greg Möller our sponsors