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Portable Water Filtration System

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Abstract

Access to potable water has become increasingly difficult due to climate change, infrastructure failures, and urbanization. There are sustainable materials within our natural environment well suited for drinking water treatment. Our goal was to design a portable water filtration column that could be implemented under emergency conditions to provide communities with a resource for treating unsafe drinking water. We chose a scenario that involved a response to the potential contamination of rivers by mine tailings. Our system efficiently reduced turbidity, iron, color, and odor while raising pH, with an effluent water discharge rate of 10 gallons per hour. Previous studies have demonstrated improvements in these parameters by testing biofiltration systems and wastewater treatment plants, the results of which were not compared to meet drinking water standards. Larger particle media (anthracite and lightweight expanded clay aggregate) strategically placed at the system's influent mitigates clogging, while finer media (sand and granular activated carbon) at the system's effluent facilitates particulate removal to 250 microns. A fine mesh (number 200) serves as a polishing step, further removing particulate to 74 microns from the resulting effluent. Anthracite and granular activated carbon effectively reduce odor and color, while lightweight expanded clay aggregate absorb microbial contaminants and effluent pH. Efforts have been made to incorporate sustainable materials, enabling composting of all filter media. Further project expansion may include implementing backwash systems for ease of maintenance and consideration given to improving additional water quality parameters.

PORTABLE WATER FILTRATION SYSTEM

A BOISE STATE UNIVERSITY DESIGN

DEPARTMENT OF CIVIL ENGINEERING

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ABSTRACT

Access to potable water has become increasingly difficult due to climate change, infrastructure failures, and urbanization. There are sustainable materials within our natural environment well suited for drinking water treatment. Our goal was to design a portable water filtration column that could be implemented under emergency conditions to provide communities with a resource for treating unsafe drinking water. We chose a scenario that involved a response to the potential contamination of rivers by mine tailings. Our system efficiently reduced turbidity, iron, color, and odor while raising pH, with an effluent water discharge rate of 10 gallons per hour. Previous studies have demonstrated improvements in these parameters by testing biofiltration systems and wastewater treatment plants, the results of which were not compared to meet drinking water standards. Larger particle media (anthracite and lightweight expanded clay aggregate) strategically placed at the system's influent mitigates clogging, while finer media (sand and granular activated carbon) at the system's effluent facilitates particulate removal to 250 microns. A fine mesh (number 200) serves as a polishing step, further removing particulate to 74 microns from the resulting effluent. Anthracite and granular activated carbon effectively reduce odor and color, while lightweight expanded clay aggregate absorb microbial contaminants and effluent pH. Efforts have been made to incorporate sustainable materials, enabling composting of all filter media. Further project expansion may include implementing backwash systems for ease of maintenance and consideration given to improving additional water quality parameters.

APPARATUS

The image below represents the portable water filtration system. This system has been designed for easy assembly and storage. Assembly can be completed in approximately 15 minutes with a team of four. Upcycled materials such as a bike sprocket, scrap metal, landfill bound wood, and compostable rope have been used for sustainable elements.

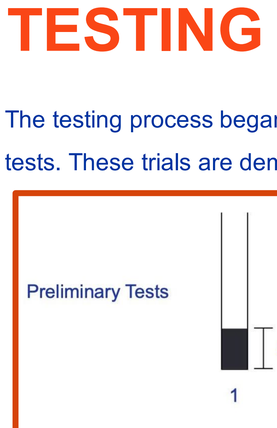
MATERIALS & EFFECTS

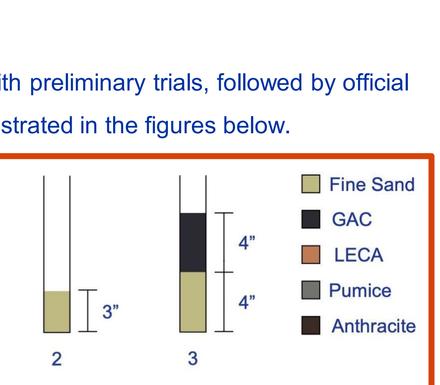
Anthracite	Decreased suspended solids, improved color
Lightweight Expanded Clay Aggregate (LECA)	Decreased suspended solids, removed particulates
Pumice	Neutralized acidic components
Granular Activated Carbon (GAC)	Removed particulates
Sand, 0.3 - 0.4mm	Slowed the flow rate, decreased suspended solids, improved color

TESTING

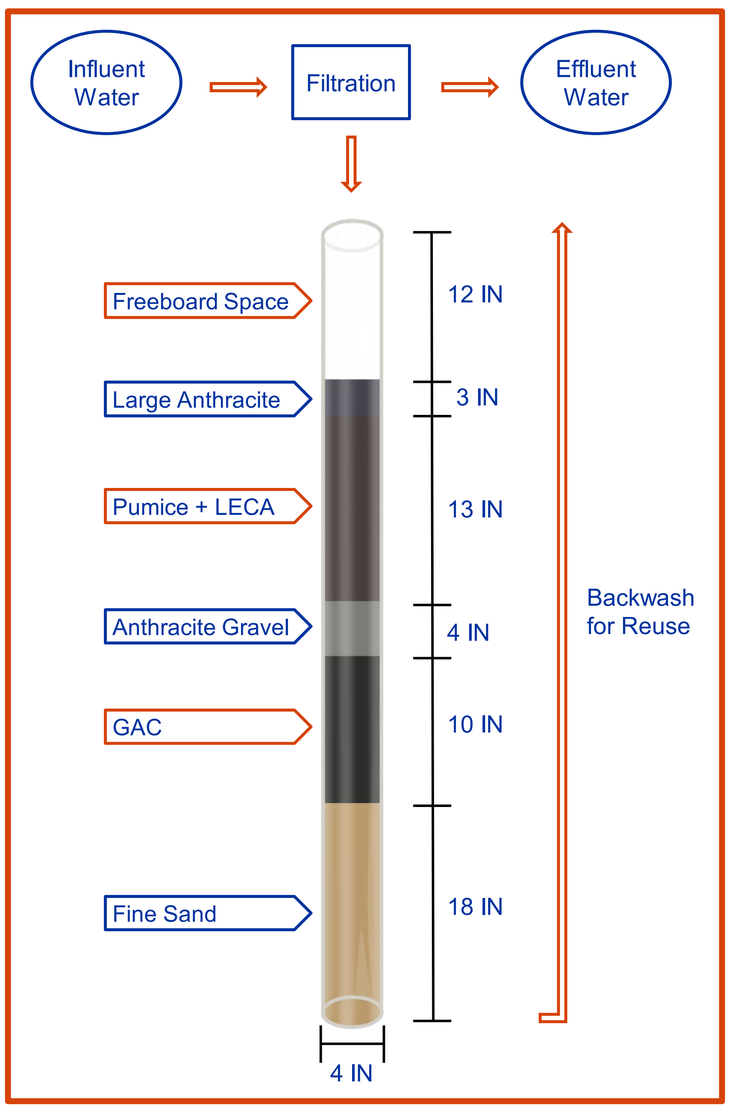
The testing process began with preliminary trials, followed by official tests. These trials are demonstrated in the figures below.

Results of official tests, trial four is shown (right) with four reiterations compared to the starting influent water (left).



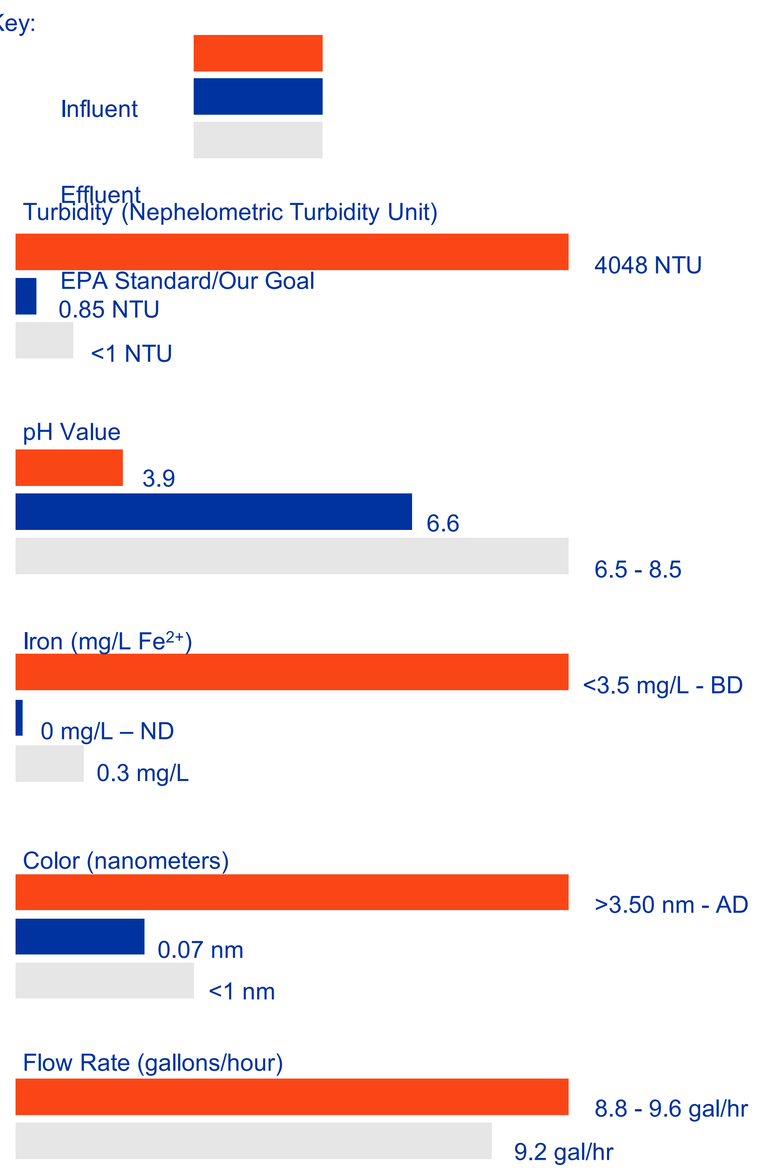


These trials provided ratio baselines for the media. Testing allowed us to verify the research claims encountered for each type of filter media. The preceding figure demonstrates final ratios and materials used along with the filtration process.



RESULTS

The following illustration demonstrates the effluent water quality parameters with our results in comparison to Environmental Protection Agency (EPA) potable water quality parameters.



Visuals of influent and effluent water (respectively) are illustrated below.

CONCLUSION

Testing concluded that the designed filter with proportioned media was able to effectively reduce turbidity, iron, color, and increase pH while maintaining a feasible flow rate. These parameters coincide with EPA potable standards and our palatable drinking water goals. This unit can successfully be implemented in crisis situations due to its easily portable apparatus. Assembly and deconstruction of the apparatus can be successfully completed with a small team. A sustainable effort has been made for all filter materials to be easily composted at the end of their useable life.

BOISE STATE ASCE ENVIRONMENTAL ENGINEERING TEAM

BOISE STATE BRONCOS

INSTALLATION INSTRUCTIONS