CLIMATE CAFE: RIVER SCAN CHALLENGE

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Solution to a Clean
Guadalupe River Downstream

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Design of the Solution

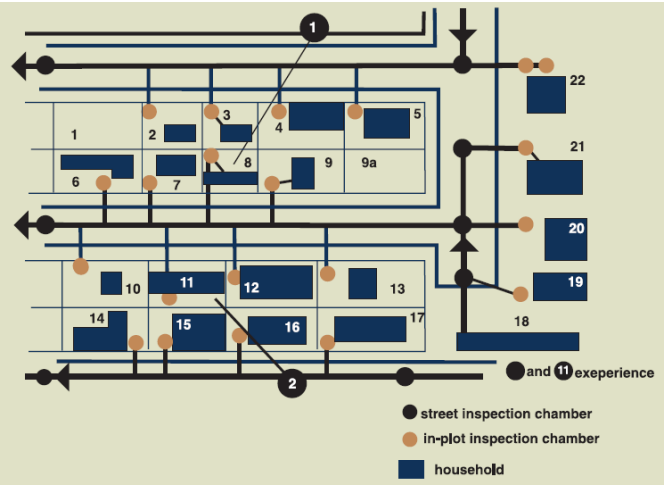
The team identified that the main pollution of Guadalupe River Downstream is its Fecal Coliform Count which is 19712.39% higher than the critical level. To address this problem, the team aims to implement a wastewater treatment system for the informal settler living along the Guadalupe River.

The proposed solution is to have a Combined Sewerage Collection System; Communal Septic Tank as First Treatment; Floating Wetlands as Secondary Treatment before being disposed to the river.

Collection:	**Combined Sewerage**
First Treatment:	**Communal Septic Tank**
Second Treatment:	**Floating Wetlands**
Discharge:	**Disposal to River**

A. Combined Sewerage[1]

Combined Sewerage is a design wherein septic wastes from households are collected through main pipes to deliver it to the communal septic tank. This addresses the concerns of households that do not have septic tanks and disposes their septic wastes to the river through pipes.



The capacity of Combined Sewerage depends on the sewage volume generated in the area. This system is already common in Metro Manila and found acceptable and feasible.

Construction Materials:

1. Pre-cast reinforced concrete pipe / PVC
2. Concrete slabs for cover slab
3. Cast-in-frames and covers for manholes
4. Bricks, pre-cast concrete or cast-in-place concrete for manholes
5. Steel and timber tide gates

Maintenance:

1. Regular cleaning of storm drains, canals, drainage pipes or channels.
2. Rodding or removing clogs/stoppages.
3. Repairs of sewer line.
4. Inspection of sewer overflow structures.

Advantages:

1. Low first cost.
2. Less costly to construct than separate sewers.

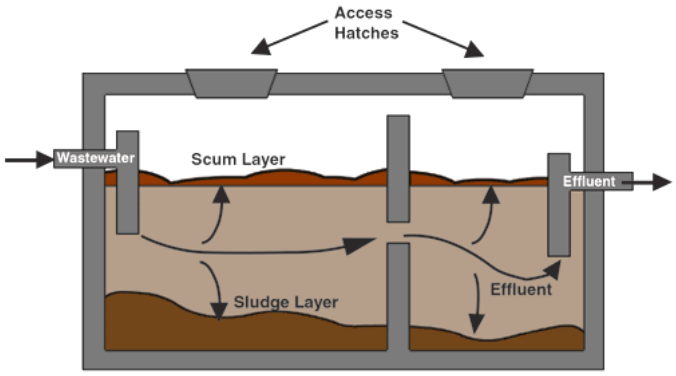
Disadvantages:

1. Considerable sewage flow bypassed
2. Unsightly condition.

B. Communal Septic Tank

A communal septic tank is a water-filled box designed to collect and partially treat toilet wastes (feces and urine) from the community. When the toilet is flushed, the wastes flow through a pipe into the top of the septic tank. Heavy solids, such as feces, settle to the bottom of the tank, while liquids pass through before overflowing into a disposal system. Over time, bacteria within the septic tank break down some of the organic matter, thus the larger the tank is, and the more chambers it has, the better the treatment provided.

Nevertheless, however the septic tank functions, both the solids within the tank and the liquid that overflows from it contain harmful pathogens, hence are a potential source of infection and disease. For this reason, the effluent liquid must always be safely disposed or directed to another treatment process.



Schematic Process of a Septic Tank

Efficiency: [1]

- 30 to 60% BOD Removal
- 80 to 85% Suspended Solid Removal
- 50% Coliform Removal

How important is its efficiency?

Biochemical Oxygen Demand is the amount of dissolved oxygen (DO) needed by aerobic biological organisms to break down organic material present in a given water sample at certain temperature over a specific time period. High BOD makes organisms be stressed and die.

Suspended solids refer to small solid particles which remain in suspension in water as a colloid or due to the motion of the water. Suspended solids can clog fish gills, either killing them or reducing their growth rate. They also reduce light penetration. This reduces the ability of algae to produce food and oxygen.

Coliform bacteria are organisms that are present in the environment and in the feces of all warm-blooded animals and humans. Fecal coliform bacteria can enter rivers through direct discharge of waste from mammals and birds, from agricultural and storm runoff, and from untreated human sewage. Most coliform bacteria do not cause disease. However, some rare strains of E. coli, can cause serious illness.

Installing a communal septic tank answers the problem of informal settlers who do not have own septic tank at home. In this way, sewage disposal will be properly managed by the community.

Pilot Project: [2]

The team has decided to start first with a pilot project catering only a hundred households to test the success of the project. The project may succeed in areas of Manila but the location of where the project will be implemented is a great factor.

With Compliance to the National Plumbing Code:
For Every 100 Households

Number of Septic Tanks	2
Effective Depth	2.5 meters
[Liquid Depth]	2.0 meters
[Air Space]	0.5 meter
Width	3 meters
Length	17 meters

Maintenance:

Settled solids gradually accumulate at the bottom of the septic tank. When this sludge, or septage, occupies two-thirds of the depth of the tank, it needs to be removed, otherwise there is a risk that excreta will pass directly through the tank and overflow into the disposal system. The sludge is smelly, wet and highly pathogenic, so should always be removed by mechanical means (e.g., using a vacuum tanker) before being taken to an approved sludge treatment and disposal site.

Where Do We Dispose the Sludge Every 5 Years?

With the help of MCWD Sewage Treatment Project, MCWD can possibly collect the sludge from the communal septic tanks. The sewage treatment factory of MCWD is still in its process. This is also not yet final because we have yet to confirm with MCWD.

Construction Materials: [1]

1. Concrete hollow block walls, reinforced concrete (RC) top slab and bottom
2. RC manhole cover
3. Polyvinyl chloride (PVC) inlet and outlet pipes
4. Cast iron (CI) or PVC clean outs

Advantages: [1]

1. Flexible and adaptable to a wide variety of individual household waste disposal requirements.
2. Essentially no maintenance needs except the periodic desludging.

Disadvantages: [1]

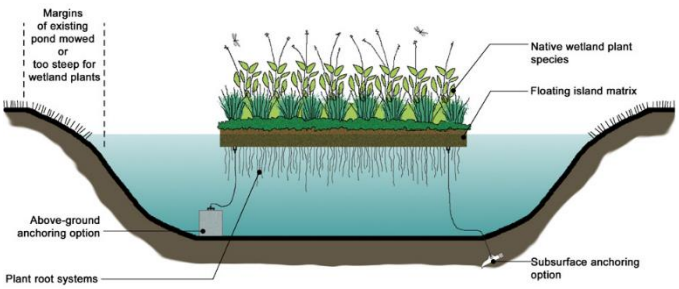
1. More expensive than other on-site waste treatment systems.
2. Drinking water sources must be set away from septic tanks (about 25m.)
3. Needs piped water supply.

C. Floating Wetlands

Floating wetlands consist of a suspended wetland plant. Floating wetlands encourage settling of sediments contained in the water and remove nutrients due to plants roots.

How does this work? [3]

The ability of plants and microbes to absorb nutrients (such as phosphorus and nitrogen) and break down contaminants through bioremediation. Wetlands can improve water quality of storm water runoff and manage watershed nutrients, as well as treatment of wastewater and other industrial contaminants. The primary mechanisms for nutrient removal is transformation and uptake by microbes and plants, assimilation and absorption into organic and inorganic sediments, and converted into gas through volatilization. Aquatic plants, both above the water and submersed, take up and remove these elements from the sediment and water column into their plant material or biomass.



What plant are we going to use?

Water Hyacinth
Scientific Name: *Eichhornia crassipes*

Water hyacinths have been effective in removing algae, fecal coliform bacteria, suspended particles, trace toxic metals, organics, and many other dissolved impurities from wastewaters. Water hyacinths produce large standing crops and utilize large amounts of nutrients. The culturing of water hyacinths in a sewage lagoon system reduces BOD_5 (up to 95%), TSS (up to 90%), and pesticides. Use of water hyacinths for wastewater treatment has been proven to be highly efficient and inexpensive.

Are Water Hyacinths common in Cebu?

Water hyacinths are prevalent in almost all cities in Cebu. Water hyacinths survive in areas with even only 3 inches depth of water. Water hyacinths can grow floating in swamps or rooted in land. It is very invasive and aggressively populates an area. Using water hyacinths as wastewater treatment plant would also address the issue of overpopulation of water hyacinths.

Materials:

1. Plastics to make the wetland float
2. Nets to contain the plants
3. Pipes to store the plastics
4. Aquatic Plant (Water Hyacinth)
5. Nets or Thin Bars to serve as barrier

How do we protect these from strong floods?

We could possibly add ground anchoring options to keep the wetlands from washing away during a strong flood. To protect the plants from the harsh waves, we could also add a barrier surrounding the individual wetlands.

In summary, septic waste of the community will be collected through main pipes and delivered to the communal septic tank and from there it will undergo the first treatment. After that, the treated wastewater would be discharged into the river. When it is already in the river, it will undergo the second treatment which is the Floating Wetland. Water quality of the river will be improved with this proposed solution.

Location Analysis

In the provided aerial photos and videos given by the coordinators of the Climate Café: River Scan Challenge and with the aid of the Quantum Geographic Information System (QGIS), it was observed that the downstream portion of the Guadalupe River, where Barangay Ermita and the mouth of the river is located, is congested by homes of the settlers living on the riverside. This will be a huge factor and can reinforce the reason why the proposed project cannot be made or applied in the area since the proposed project takes a lot of space. With this factor being said, our team discussed that it may be possible to apply our solution on the north part of the downstream. Possible location for this project is in Barangay Pahina (Central) as it was shown to have an adequate amount of space to implement our solution.

Map 1. Barangay Ermita
(Mouth of Guadalupe River)

Map 2. Barangay Pahina (Central)

Photo 1. An aerial view of an open-area in Barangay Pahina (Central)

Cost Benefit Analysis

Any solution that aims to solve a major problem requires a lumpsum money to be implemented. Long term solutions are costly but short-term solutions are more expensive. This is because short term solutions are not designed to solve the problem but only serves as alternative or immediate response to the situation. You must repeat the process all over again but in the end, you are not solving the root of the issue.

Hence, the team proposed a long-term solution to address the lack of wastewater treatment system of the communities living in the riversides.

According to the reference "Philippines Sanitation Sourcebook and Decision Aid" published by Water and Sanitation Program – East Asia and the Pacific of the World Bank: [1]

Capital cost: P 25,330 per m^3/day flow

Capital cost includes improvement of
existing combined sewerage system, such as:
Interceptor: P 9,480 - 14,620/m
Drainage upgrading: P 420/m - 580/m
O & M: P 350/m

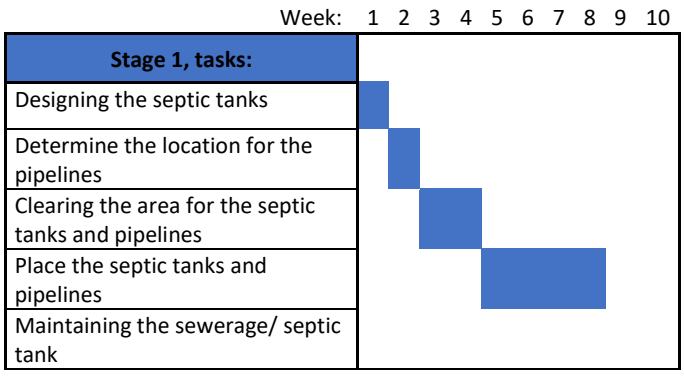
Construction cost: Septic Tank (2004)
Tank A: 2m3 tank (4 persons served) = P 45,000
Other Tanks: Tank A Cost + P 4,000/m3
Desludging cost = P 2,800 per 4-year interval

Planning

The solution will be implemented in stages. This solution will be divided into two stages. See the timetable with the stages worked out per step.

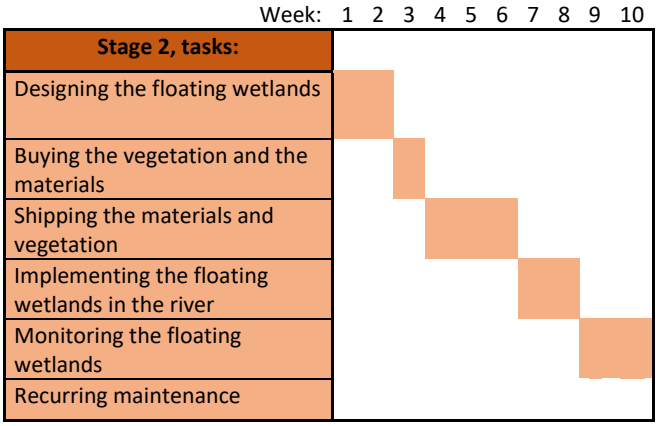
Stage one, septic tank/ combined sewerage:
The septic tank will be realized in the first stage. This tank will clean the household water before the water ends up in the river. This will prevent a great deal of pollution in the river. In addition to placing the septic tank, households will have to be connected to the septic tanks by pipeline. In this stage, two septic tanks will be installed that can handle up to a hundred households. The pipelines between the households and the septic tanks are being laid. When the septic tanks and pipes have been installed and the system is operational, stage one is completed.

First of all, the design of the septic tank will have to fit in the predetermined location. Subsequently, the locations of the sewer pipelines will have to be determined and mapped. After these preparations, the right parties will have to be approached and the necessary materials will have to be ordered. After the area has been cleared, the septic tank and pipelines can be built. Finally, it is very important that the entire system is maintained in the coming years, so that it continues to work efficiently.



Stage two biotreatment:
In the second stage, an extra measure is added to the system, namely the biofilters. With this measure, the Guadalupe River is cleaned in a natural way. Floating wetlands will be placed in the river to clean the water through the roots of the plants. The septic tank will prevent a large amount of pollution, yet not everything will be cleaned, hence this extra addition.

This stage consists of several phases. In these phases, we work towards the implementation and maintenance of this measure. First, a final design will have to be designed, so that it can be perfectly implemented in the river. After the final design has been established, the materials and plants will be ordered. Subsequently, these materials are shipped and eventually, the floating wetlands can be built. The final steps in implementing this measure will be to keep track of the results and maintain the floating wetlands on a recurring basis.



Stakeholders Involved

The following table lists the main stakeholders for our solution. This table shows the interests and influence of the stakeholders with an explanation. How to collaborate with stakeholders depends on their role within the project and on their interest and influence. Stakeholders with high interest but low influence will need to be informed. For stakeholders with a high influence a good collaboration is very important.

Influence and interest are assessed with ++, +, -, --.

Stakeholders	Interest	Influence	Explanation
Inhabitants alongside the river	++	-	Since the citizens living alongside the river hope to see a clean river again, they are very interested in the project. The best thing to do here is to constantly inform the inhabitants that will be affected and involve them with the upcoming decision that needs to be made. This way resistance can be prevented.
The LGUs of Cebu City	++	++	Since the Guadalupe River is located in Cebu City, the local government here is involved. This stakeholder has a concern with cleaning the rivers and therefore needs to be involved with the choices that will be made.
Metropolitan Cebu Water District (MCWD)	+	++	The MCWD has a big influence in this project because this stakeholder is partly responsible for cleaning the river. Also, they are willing to finance a part of the project. A good collaboration is important
Private businesses	++	-	Private businesses alongside the river will have an interest in cleaning the river. During the construction of the measures, accessibility will be less. Therefore, they will need to be well informed
Department of Environment and Natural Resources (DENR)	+	+	This stakeholder is responsible for the country's environment and natural resources. This means that they both have influence and interest in this project and therefore collaboration is needed.

Barangay pahina (central)	++	+	the Barangay is the smallest administrative unit and serves as the primary planning and implementing unit of government policies. Therefore, it is important to involve this stakeholder with the project.

Operation and Maintenance

Combined Sewerage System

The combined sewerage system is the utilized collection system of wastewater from the houses to the communal septic tanks. The system uses main pipes in transporting wastewater, in which these pipes must be properly operated and maintained. Storm drains, canals, drainage pipes, or channels should be cleaned regularly. Clogs or any form of stoppages should be removed through proper procedures such as rodding. For instances where the sewer line is defective or obstructed, repairs should be immediately made. Lastly, an inspection of sewer overflow structures should be done on a regular basis.

Septic Tank [5]

The septic tanks will be built in compliance to the National Plumbing Code. This will ensure that the tank is in the right size, can cater the intended number of households (100), and ensure its quality, durability, and service life. On the long run, proper maintenance should be regulated, which includes the following:

- Regular inspection and maintenance of the septic tank
- Pumping and desludging of the septic tank as often as needed
- Keeping the lids of the septic tank closed and secured as well as easily accessible
- Promoting and encouraging the households to be water-wise
- Promoting and encouraging the households to never discharge garbage or household chemicals to the drainage connected to the septic tank

Floating Wetlands [4]

The floating wetlands are part of the secondary treatment of wastewater. Placed along the river for a period of time, the aquatic plants will survive through absorbing the river's nutrients and contaminants. The said treatment is crucial to the whole wastewater treatment process, and therefore must be properly maintained through the following:

- Completely remove the buckets each year and plant them along the riverbanks to establish a riverbank buffer.
- Replace with new pots of native aquatic vegetation to continue to use up nutrients in the water column.
- Avoid adding nutrients back into the river by removing plant debris from the water.
- Add more floating treatment wetlands. Research shows that 20 percent of the river surface area of floating treatment wetlands will noticeably manage some nutrients.
- Regular inspection of the floating wetlands is encouraged. Check for damages, missing parts/materials, safe anchoring system, etc.
- Barriers can be used to protect the plants in the floating wetlands.

Sources (APA)

[1] Cruz, R. et al. (2005). Philippines Sanitation Sourcebook and Decision Aid. WSP South East Asia and GTZ, Philippines

[2] One News PH, “Informal settlers in Malate receive communal septic tanks from NGO,” youtube.com, March 12,2019. [Online]. Available: https://www.youtube.com/watch?v=d_YPpV6h0nw [Accessed April 18,2021].

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[4] CarolinaClear. (2016, January 27). Installation of a Floating Treatment Wetland. YouTube. https://www.youtube.com/watch?v=eqGbzNbXkBY

[5] Do's and don'ts when maintaining your septic system. (2020, February 10). King County, Washington - King County. https://kingcounty.gov/depts/health/environmental-health/piping/onsite-sewage-systems/maintenance/dos-and-donts.aspx