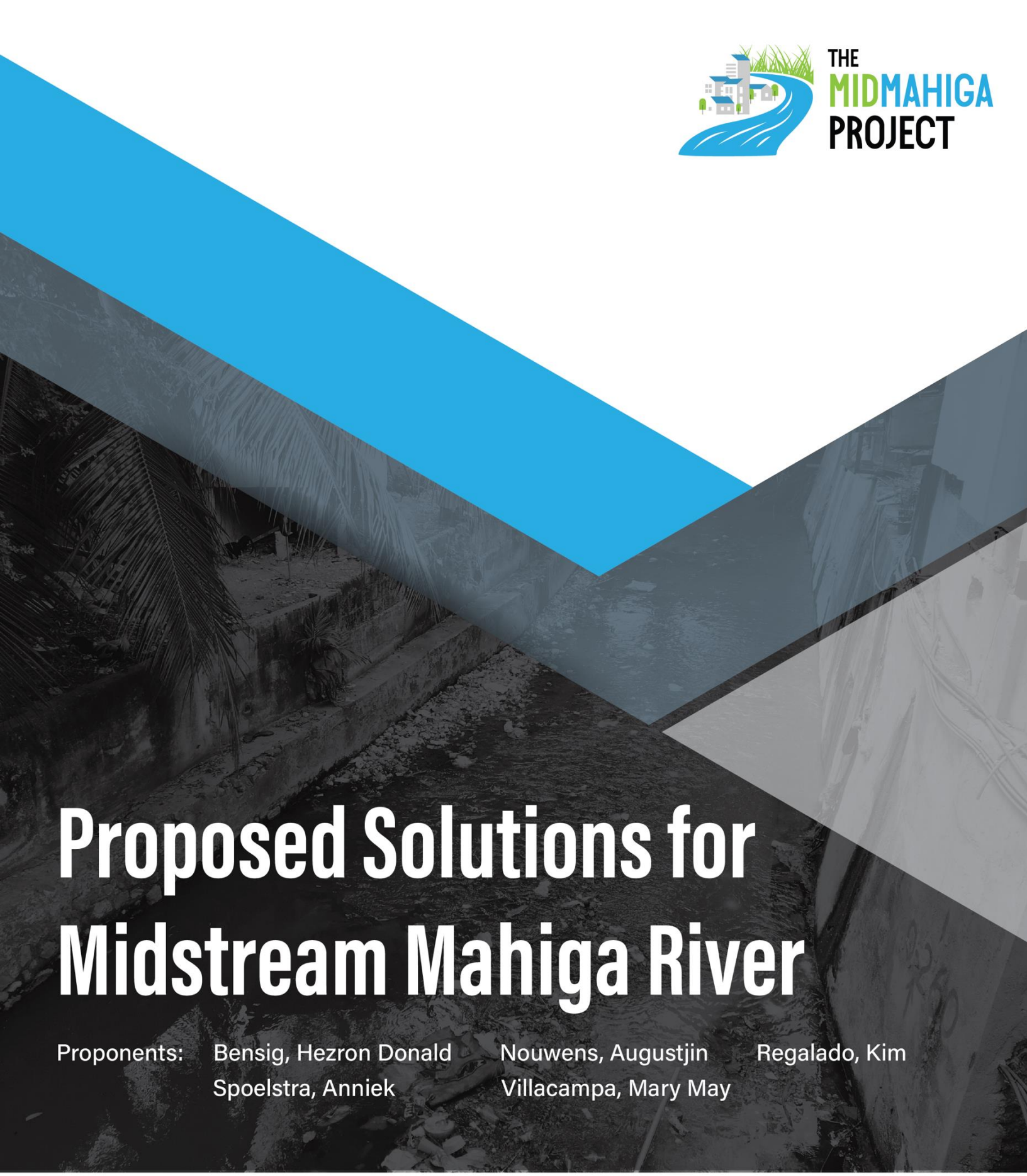
THE MIDMAHIGA PROJECT



Proposed Solutions for Midstream Mahiga River

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CHAPTER 1
INTRODUCTION

In the metro Cebu City there are a lot of rivers streaming through the city. It prevents clean water but at the moment they are polluted, that is a problem for the area. Now, buildings stand next to the rivers. So, with heavy rainfall the water runs off to the river. The river gets shallower and the garbage also shallows the streaming area of the river. The focus in this report is on the Mahiga river.

Mahiga river is a prominent urban river with an upstream located at the Banilad mountains, down to Subangdako as its midstream and downstream at Mabolo Reclamation Area. The river starts in the mountains at a height of 356 meters. The river has a total length of 9.1 km which traverses six barangays from Cebu City to Mandaue City namely, Apas, Banilad both in Cebu and Mandaue City area, Kasambagan, Mabolo and Subangdako and this waterway ends up at the Mactan Channel. The river used to be a source of water for bathing and laundry of the local residents in the area. Due to the discharge of domestic wastewater and solid wastes, the river has become heavily polluted over the years. In 2018, the Mahiga River was considered to be biologically dead.

Figure 1.1 The Mahiga Stream Between Cebu and Mandaue city

1.1 BACKGROUND OF THE STUDY

Due to the arising pollution issues of several major rives in Cebu City and Mandaue City, several proposals have been planned to revive these bodies of water. TO help resolve and participate on this environmental concern, student from the Netherland and the Philippines are collaborating to resolve this long-drawn out issue. This project will be providing rehabilitation solution to the creeks and river of Cebu City and Mandaue City. Moreover, the project is divided into areas due to the large scope and its complexity. Specifically, the team will focus on the issues on pollution concerning the midstream section of the Mahiga River, encompassing Cebu City and Mandaue City.

1.2 PROBLEM STATEMENT

The Mahiga Creek is one of the many small rivers that flow through Cebu City and Mandaue City. These small flows often have no clear origin and usually flow from a higher point to a lower point. The river originates at two points and converge in a larger river that ends in the Mactan Chanel. Several attempts have been made by the government to clean up the river, such as clean-up campaign, in which about 50 tons of waste was collected. Unfortunately, such measures since among of the main problems - illegal settlements and dumping of waste, have not been solved.

1.3 OBJECTIVES

Currently, the Mahiga creek has two major problems, and these are the high level of pollution in the water and the flooding that happens when it rains too hard or for too long. The aim of this project is to give this river a new life by coming with new innovations that can help solve the problem of the pollution and flooding. Specifically, this project aims to:

- Raise awareness among the residents of how one's action can cause the whole ecosystem and quality of life to fall apart. Hence encourage the residents to work together with the government so that they can improve the quality of life and ecosystem of the river.
- Present detailed solutions in two different infographics, that shows where in the river the solution should be applied,
- Identify the cost of the project and who are involved in the realization of this project.

1.4 GLOBAL QUESTIONS

To help resolve the issue and suggest solution, the following main questions wished to be addressed in this project:

1. How can the water quality of the Mahiga river be improved?
2. What is the behavior of the residents?
3. What is the role of the government in this project? How much can the government afford?
4. What solution can be applied here in the Mahiga creek to create a better-quality water?

CHAPTER 2
PROPOSED SOLUTIONS

In this chapter the solutions for the problems in the river will be explained. The group focused on different solutions which can be combined to a great solution for the entire midstream. We limited ourselves to a solution to raise social awareness as a social solution. For the technical solutions we took a look at a drainage outfall and a wastewater treatment system. In a PowerPoint of the DENR these different concerns are given. We based the solutions on this model that has been given by the environmental bureau.

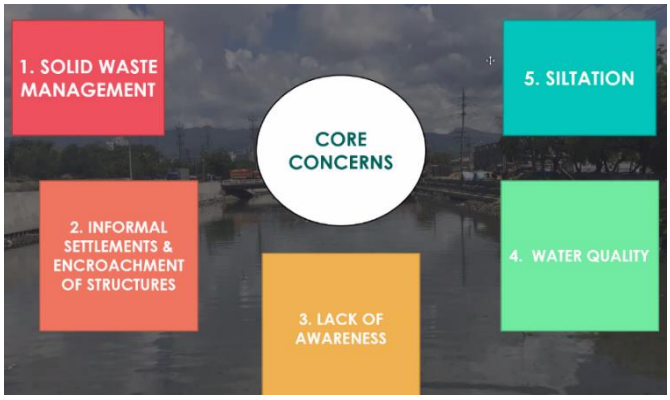

Figure 2.1 Core Concerns

2.1 SOCIAL AWARENESS

The problems in the area can't be fixed in just one solution. That's why the solution for Social Awareness can be related with one of the other solutions. The goal with this solution is to prevent the residents to throw their waste in the river or on the streets. So, the environment gets cleaner and the river just exist with water and no plastic. The problems in the Mahiga river are bigger than just the river its selves. It is also not possible to just solve them by yourself. With the social awareness solution, the idea is that the people start by themselves and inspire change for the whole community. Also, for the governments in the area it is important that they can start with preventing the river pollution. For example, make the problem signific for different groups in the area and to make the infrastructure of the water better. To relocate the informal settlers who live next to the rivers.

The solution is parted in two posters. One poster is for the government to spread among the public space and the public buildings. So not only the residents and informal settlers have the information but other stakeholders also get the correct information. The other poster is a simple figure to show the residents the concerns and what they can do about it. This can prevent the river from further pollution.

Figure 2.2 Sample Poster for Social Awareness

Figure 2.3 Sample Poster for Social Awareness

In the poster above the poster is shown for the government in the area of the Mahiga stream. The information about the river is given and the current help from the government. Also, the government from Cebu and Mandaue city did some measures in the area already. The government organizes clean up days. So, they want to clean and prevent the area from more waste.

Above the posters for the residents. These are in English and in Visayan so everyone can understand the goal of the poster. It is simple to understand and can be an eyeopener for the residents.

2.2 CENTRALIZED TOILET ROOMS WITH RAINWATER HARVESTING SYSTEM

2.2.1. Design of the Solution

The river experiences a lot of problems and issues including flooding, solid waste, informal settlements, and poor water quality. The people living in the area have no proper sewage system or worst have no own toilet rooms in their houses. The river even served as their own toilet rooms and the one who received all the sewage from their own make-up septic tanks.

Figure 2.4 Wastewater coming from household directly goes into the river

In order to address the fecal coliform situation in the river, the team decided to propose this project which provides toilet rooms with proper sewage system to the community, this project is inspired by the Sani-Embankment project in Davao City. These toilet rooms will also have a rainwater harvesting system in which the rainwater harvested will be the source of water for the toilet rooms. Since, the sani-embankment project needs a large area to realize, the group decided to only provide Centralized toilet rooms with own rainwater collection system for the community. The idea of this proposal came from two main facts gathered, the fecal coliform from the recent data from DENR- EMB is uncontrollably rising and the flooding in the area.

Private Establishments are also encouraged to install Rainwater Harvesting Systems in their own for them to help in mitigating the flood in the area given the large area they are occupying. However, further studies must be conducted to conclude if this rainwater harvesting system will be sustainable in the area. Sufficient data such as, roof area, rainfall data, water demand, flood data etc. are needed to come up to a conclusion.

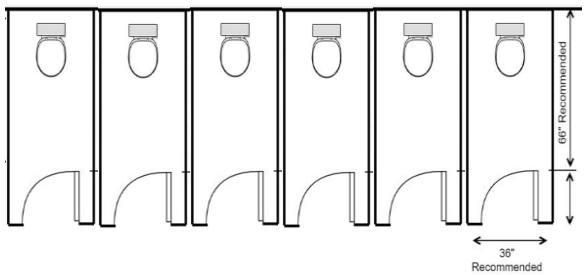

Figure 2.5 Floor Plan of the Centralized Toilet Room with Six Cubicles

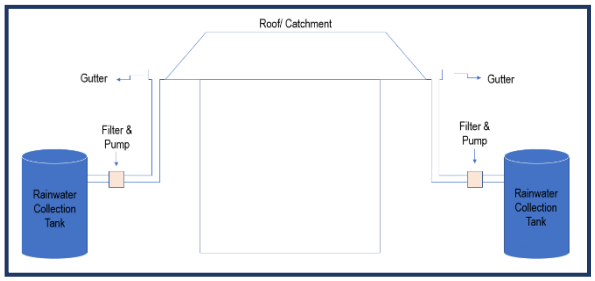

Figure 2.6 Schematic Diagram of Rainwater Harvesting System

The factors affecting the cost of this project includes the construction materials, the excavation needed, and the survey done before realizing this project. The costing of this project is lesser than the Sani-Embankment project in Davao which costs 300M. The estimated cost of this project will be 6M-7M and with the installation of rainwater harvesting system which costs Php 400,000- 600,000 each depending on the tank size. So, the project will have a total estimated cost of 9M to 10M.

Cebu City and Mandaue City being the main affected areas for this environmental concern, both LGU's shall cooperate and agree with each other to initiate the funding of this project. Private partners or establishments in the nearby area can also be tapped in this project since this can greatly help the affected area.

Before the final planning, designing and construction of the said project, a survey of the community should be conducted on site and further studies should be conducted with regards to the sustainability of the project proposed. Once this proposed plan is already backed up with sufficient data, final planning will now be done and orientation with local officials and the community should be done simultaneously.

This project is not just care of the LGU, private establishments, and the government but also a unified effort of all the residents. Since all are contributing to the problem and as part of the problematic system, taking part of the solution is necessary. At the end of the day, all the residents will all be benefiting with the project and in the long run, the good effects will spread like a wildfire, it just takes a single step.

In the funding of the project, the LGUs and private establishments could take part in it. With the operation and maintenance of the proposed project, the community should have a system in which groups of people are assigned to maintain the cleanliness of the area. Furthermore, the maintenance of the toilet rooms, reports from the residents or site visit should be done in barangay levels.

2.3 PHYLOREMEDIATION

One of the main problems in the Mahiga River is the water quality. In a report by Pepito (2020), the physicochemical properties of the water in the river such as dissolved oxygen (DO), biochemical oxygen demand (BOD), total suspended solids (TSS), and fecal coliform were tested. Both the BOD and the fecal coliform test did not pass the criteria for good water quality according to Department of Environment and Natural Resources (DENR) standards.

The water quality problem may be remediated with the use of phytoremediation technology where plants are used to efficiently remove inorganic and organic pollutants in contaminated soil or water. This technology has been accepted in the past years as a more cost effective and noninvasive way to clean environmental contaminants (Pilon-Smits, 2005).

3.2.1. Design of Solution

There are a variety of plant species that can be used for phytoremediation. Several studies on wastewater treatment using water hyacinth (*Eichhornia crassipes)* have been published, however it is also considered to be the world's worst invasive plant species due to its fast-growing nature. It can form thick layers over the water which outcompetes native aquatic species, depleting the amount of dissolved oxygen in the water. Constructed wetlands use the natural processes involving an artificial wetland vegetation to treat industrial or municipal wastewater, greywater, or stormwater runoff. It consists of a shallow depression in the ground where the flow of water is controlled to spread evenly among the wetland plants. The wetland plants filter suspended solids and absorb organic materials as nutrients (National Small Flows Clearinghouse, n.d.).

The main components of a constructed wetland wastewater treatment system include a septic tank, which provides primary treatment by removing the settling solids and floating solids from wastewater, and a constructed wasteland for secondary treatment. This paper introduces the design of a horizontal flow constructed wasteland (HFCW) where a multilayered substrate is to be structured for an efficient hydraulic performance and pollution removal.

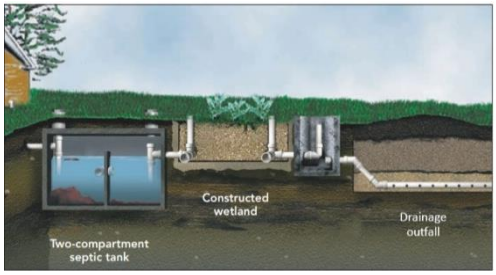

Figure 2.7 *Constructed Wetland System*

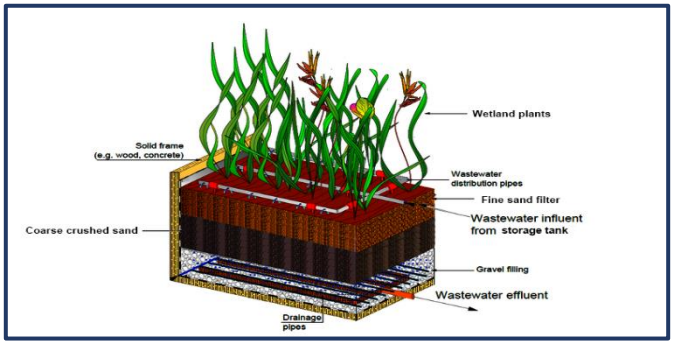

Figure 2.8. *Horizontal flow constructed wasteland design. Adopted from Napaldet, J. & Buot, I. (2019).*

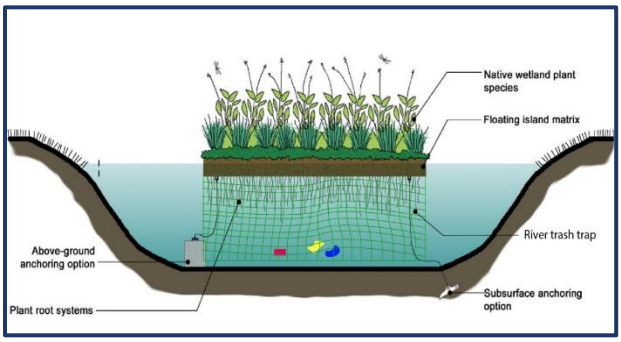

Figure 2.9. *Schematic diagram of constructed floating wetland adopted from Tanner, C. et. al. (2011)*

The design for HFCW is to be adopted from the study of Napaldet, J. & Buot, I. (2019), the wetland measures 2 m long x 1.2 m wide x 0.8 m deep with the main substrate zone. It consists of three layers namely fine river sand, coarse-crushed sand and 3/4'"-size gravel. Each layer is 20-cm deep for a total of 60 cm depth and is arranged at increasing particle size at greater depth. The 3/4'"-size gravel formed the bottom layer, followed by coarse-crushed sand and fine river sand on top. Influent distribution zone and the effluent collection zone is also installed having identical dimensions of 20 cm x 120 cm x 60 cm (length x width x height) and consist of 1"-size gravel. The water level in the HFCW should be kept 2 inches below the surface to control or eliminate odor.

A further treatment of the water quality is to be done in the Mahiga River by the use of a constructed floating wetland (CFW). The CFW is to be made with PVC pipes to provide buoyancy and have the plant shoots grow above the water and plant roots underwater. The CFW is to have a dimension of 1 m x 1 m to consider the varying width of the Mahiga River.

The HFCW is to be placed at an area close to drainage outfalls along the Mahiga River. The wastewater will be diverted into a septic tank for primary treatment and will pass through the HFCW before it will be discharged to the river. Each barangay or purok has at least 1 drainage outfall and it is recommended to have the HFCW at each area.The CFW is to be placed at the Mahiga River, spaced at least 5 meters apart to avoid obstruction of the water flow but still able to have the phytoremediation process.

Figure 2.10. *Recommended spacing for the constructed floating wetland.*

2.4 WASTEWATER TREATMENT PLANT

The main function of a wastewater treatment is to speed up the natural process by which water is purified. Wastewater treatment mainly includes three treatment processes: primary (which focuses on the settlement and removal of larger wastes), secondary (which uses biological process to further purify the wastewater) and tertiary (which include disinfection of water from remaining contaminants. The detailed process is discussed in the later section.

Aside from water discharged from sanitary pipes from residential and commercial buildings, waste water also includes storm run-off, and even harmful substances that may be washed off from roads, parking lots and roof tops which can contaminate and contribute to the pollution on the natural bod of water.

2.4.1. Design of the Solution

Prior to the operation of a Wastewater Treatment Plant, a proper sewerage system has to be constructed that would collet wastewater from residences, commercial buildings and run-off from roads and concrete pavements. These sewage systems shall be directly connected to the wastewater treatment plant where these wastewaters are treated prior to disposal on the river and into the ocean. Once sewerage has been addressed in these areas, then the operation of the plan can go as planned. Presented below is the detailed process of how a wastewater treatment plant works:

This entire process of treating wastes water may take up to 24 hrs. to 36 hrs. from the moment the wastewater enters the treatment facility and the moment it is chlorinated. This treated water can then be delivered into the river or, can even be stored, process and recycled for commercial use, as at this stage, this treated water is already safe for human usage.

For a detailed process of the plant operation, and operational chart is provided in the succeeding page.

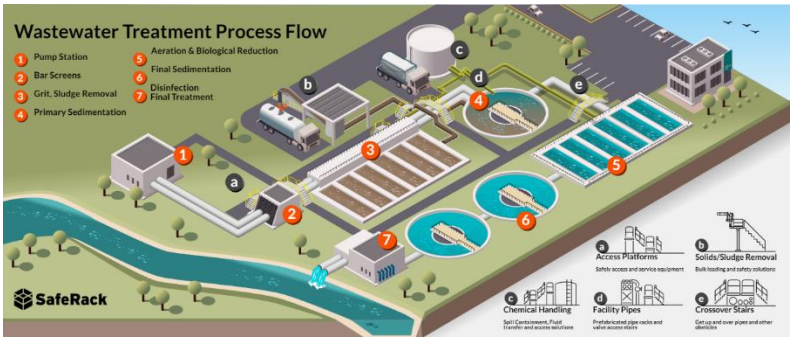

Figure 2.20. Wastewater Treatment Plan

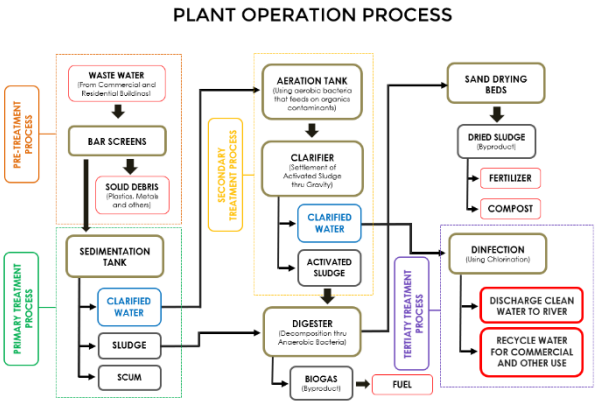

Figure 2.21. Detailed Plant Operation Process

CHAPTER 3
CONLUSION

3.1. CONCLUSION

The Mahiga river have major problems namely, untreated wastewater present in the river, water quality and other problems that needs to be addressed. The solutions discussed like the wastewater treatment plant, centralized toilet rooms with rainwater harvesting system, phyloremediation and social awareness show both long term and short-term solutions. The wastewater treatment plant will not just benefit the people nearby the river but also the people in the whole province since it will provide wastewater treatment which the cities did not have yet. The centralized toilet rooms with rainwater harvesting system are proposed in order to address the lack to no household toilet room of the people living in the area and open defecation in the river that affects its water quality. The rainwater harvesting system installed will be the source of water for the toilet rooms. In dry seasons, where there is no rain expected, the phyloremediation solution proposed also can help. Phyloremediation can address the water quality situation in the river and also can help the livelihood and benefit the residents directly. All these proposed solutions need pilot studies to test its feasibility and sustainability for Mahiga.

3.2. RECCOMENDATION

1. There has been no study conducted yet as to the amount of water discharged around the Mahiga River. So, it is recommended that prior to implementation, a research study be conducted to answer the questions concerning costing a Wastewater Treatment Plant: The water quality of the plant's effluent to be treated (such levels of contaminants); (2) The local maximum and average monthly discharge limits to the environment; and (3) The amount of water that needs to be processed per day and the speed of processing (which requires the peak gallons per minute).

2. Survey on the identified area (land area) if it is sufficient for the plant site are requirement.

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