Current Situation of Wastewater Treatment Plant for Sewage in Batam City

1Yusra Aulia Sari  2Mulia Pamadi
1,2Civil Engineering Department, Batam International University, Gajah Mada Street, Baloi - Sei Ladi, Batam 29442 Indonesia

yusra@uib.ac.id

Abstract. The aim of this research was conducted to identify the current situations of wastewater treatment plant for sewage in Batam City. This research uses descriptive qualitative methods to describe and analyze existing phenomena and real situations in the field. Descriptive method was chosen because the research conducted was relating to ongoing activities. The research instrument is the researcher, which is done through observation, interviews, and documentation. The results of this research are that the WWTP project is the right solution for Batam City in waste management, especially sewage. Batam is a pilot because there are not many cities that use integrated sanitation processing systems in Indonesia. WWTP provides benefits for environmental problems with natural and technological integration. Thus, the benefits of this research are references for researchers who want to discuss WWTP and are expected to help Batam authorities (BP) to develop the WWTP Project. The impact of this research in the field of civil engineering is the application of the Sustainable Urban Water and Sanitation Management.

1. Introduction

Water is one of the resources of concern in recent years. Problems related to water resources and waste management are challenges for scientists, environmentalists, technology and engineers. Wastewater can be classed as sewage, commercial, industrial, or surface runoff. Several countries such as the United States, Australia, South Africa and Japan have experienced rapid expansion of waste water reuse and are applied in most projects such as agriculture and irrigation [1] [2]. In Indonesia waste treatment, especially sewage is still a challenge in major cities. Generally, sewage is generated through residences activities such as laundry wastes, washing water, and human waste.

Sewage Treatment is the process of removing contaminants from wastewater and household waste, both runoff, domestic, commercial and institutional through physical, chemical and biological processes. The aim is to produce a waste stream that is safe for the environment to be discarded or reused. Waste water treatment not only important for health but also to keep the environment clean and healthy [3]. Sewage is water that undergoes changes in structure both chemically and biologically because it contains a variety types of pollutants that affect balance and the environment ecosystem. WWTP (Wastewater Treatment Plant) is a Batam authority (BP Batam) project to build networks and systems for wastewater treatment. This project was integrated into 7 points and divided into several phases. The first phase was held in Batam Centre. This project is currently the biggest in batam city due to public projects covering a large part of the region, so it needs to pay attention to the obstacles and challenges in project execution.
2. Methodology
The aim of this research was conducted to identify the current situations of wastewater treatment plant for sewage in Batam City. This research uses descriptive qualitative methods to describe and analyze existing phenomena and real situations in the field. Descriptive method was chosen because the research conducted was relating to ongoing activities. Descriptive research does not manipulate or change variables studied, but describes the actual conditions. The research instrument is the researcher, which is done through observation, interviews, and documentation. Qualitative research aims to explore phenomena that are cannot be measured like a process work steps, formulas for recipes, ideas about something, various concepts, characteristics of goods and services, images, styles, cultural procedures, and physical models of artifacts [4].

Data collection was carried out by means of observation, interviews with 4 stakeholders consisting of BP Batam as the owner, Sunjin Engineering and Architecture as an Engineering consultant, Hansol EME as a Company, Adhya Tirta Batam as Manager of the water network, and documentation about the WWTP project. The scope of this study describes the master plan in batam, piping line works, pumping station works, wastewater treatment plant, house connections and challenges and issues on site.

3. Results and Dissucion
3.1 Master Plan
The Batam Authority (BP batam) has received support from the Korean Government Korea's EDCF (Economic Development Cooperation Fund) through soft loan to build a Waste Water Treatment Plant (WWTP) in the Batam area. Construction of waste water treatment plant is needed because currently Batam no longer has the ability to process its own waste. The amount of sewage from bathing, washing, latrines is increasing every day. Batam City has fast population growth. Previously, the South Korean Government and The Korea International Cooperation Agency (Koica) had conducted research since 2011 [5].

In an effort to realize the desired situation and condition of healthy settlements and fulfill the Millennium Development Goals (MDGs) agreed at the United Nations Millennium Summit in September 2000, where integrated, efficient and effective plans, programs and activities were needed, as well as programs and activities needed. Requires National Policy and Strategy for the Development of Settlement Wastewater Management Systems.

BP Batam said “The construction of waste water treatment plant will be built in seven locations in Batam Centre, Bengkong Sadai, Tanjung Uma, Sekupang, Tembesi, Telaga Punggur, and Kabil. The construction budget of this project is around USD 43,055,776. The scope of work is 20,000 m³/day (230 lt/sec) WWTP 1 Unit, Pumping Station 5 Unit, Sewerage pipe line 114 km, House Connection 11,000 Point, and PC (Procurement and Construction) + Commissioning”.

[4]
Processing of sewage in Batam will be carried out thoroughly with an integrated network of pipes. Sewage will be processed until the pollutant level meets environmental quality standards and is channeled to the sea. Currently there are several housing units in the process of pipe connections such as Sukajadi housing, Bella Vista, Anggrek Mas 1, Angrek Mas 2, Angrek Mas 3, Citra Batam and Meditrania. Based on the results of the interview with the Hansol EME "The progress of the project development in Bengkong Sadai is currently running at around 10.87 percent. Pipes on the main route with a length of about 42 km have reached 90 percent, while for the secondary it is only 4 km from the plan total reaches 75 km". He added, there are 43 housing units that will be passed by waste water treatment plant pipes outside the shop houses and other buildings. "Now start installing in Meditrania housing"

The process of pipe connecting work has been carried out since April 2017. Several points have been installed in front of the Riau island Mall which has been connected with about 1,077 meters of pipe from the target of 1,222 meters. From McDonald’s Intersection to Green Land from a target of 1,262 meters, now the pipe that has been connected is about 347 meters. Next is the Kabil Intersection to Frenky Intersection, of the target of 2,449 meters, it has been connected around 1,780 meters. From the Jam Intersection to Simpang BNI, it is installed along 1,144 meters of the target of 1,249. Then from Yos Sudarso School to Harmoni One from the target of a 739 meter long pipe, it has been installed along 268 meters. The Batam City Government targets early 2019 to complete the main pipeline, while completing the secondary pipeline and piping connections to residential areas

3.2 Piping Line
There are certain locations where it is possible to drain sewage by gravity into the WWTP building using GRP & PVC pipes for gravity pipes. Pumping of sewage is different than water pumping because of the nature of contaminated wastewater contains suspended solids and floating solids that can clog the pump. Decomposition organic and inorganic materials present in sewage can react chemically with pumps and pipe material and can cause corrosion. Disease that causes bacteria to be present in the sewer can cause health hazards to workers. Sedimentation of organic matter in the sump well can cause decomposition and spread of foul odors at pumping stations, which are in need proper design to avoid deposition. Also, variations in the sewage stream at certain times are a challenge.

Processing of sewage in Batam will be carried out thoroughly with an integrated network of pipes. Sewage will be processed until the pollutant level meets environmental quality standards and is channeled to the sea. Currently there are several housing units in the process of pipe connections such as Sukajadi housing, Bella Vista, Anggrek Mas 1, Angrek Mas 2, Angrek Mas 3, Citra Batam and Meditrania. Based on the results of the interview with the Hansol EME "The progress of the project development in Bengkong Sadai is currently running at around 10.87 percent. Pipes on the main route with a length of about 42 km have reached 90 percent, while for the secondary it is only 4 km from the plan total reaches 75 km". He added, there are 43 housing units that will be passed by waste water treatment plant pipes outside the shop houses and other buildings. "Now start installing in Meditrania housing"

The process of pipe connecting work has been carried out since April 2017. Several points have been installed in front of the Riau island Mall which has been connected with about 1,077 meters of pipe from the target of 1,222 meters. From McDonald’s Intersection to Green Land from a target of 1,262 meters, now the pipe that has been connected is about 347 meters. Next is the Kabil Intersection to Frenky Intersection, of the target of 2,449 meters, it has been connected around 1,780 meters. From the Jam Intersection to Simpang BNI, it is installed along 1,144 meters of the target of 1,249. Then from Yos Sudarso School to Harmoni One from the target of a 739 meter long pipe, it has been installed along 268 meters. The Batam City Government targets early 2019 to complete the main pipeline, while completing the secondary pipeline and piping connections to residential areas
Sunjin Engineering and Architecture said “In the first phase, by constructing a new waste water treatment plant, the construction of a 114 km sewerage system pipeline that connects pipes with houses as many as 11,000 households and there are 5 relay pump stations. The Batam city government is targeting completion of phase I to manage 20,000 m³/day of liquid waste or 230 l/s”.

### 3.3 Pumping Station

One of the facilities and equipment that provides waste water transportation for WWTP or to continue gravity pipes are pumping stations. Pump station system is complex because if the gravity system does not work it will be overcome by the pump station. Moreover, the disruption of the pump station operation can cause failure of the overall sewage system [6]. There are 5 pumping stations throughout the network. It is a closed reinforced concrete room with a pumping system. Most networks operate by gravitational flow. For gravity pipes, the slop is 1.5%. All 100m pipes that they have to dig in are 1.5m deep. If the topography is in accordance with the project, they don't need to dig much but sometimes to avoid building a new pumping station they install pipes at depths of more than 3m. Figure 3 below is a map of 5 different pump stations and the direction of the gravity pipe. This Research will explain the B3 zone. Part of the South-Est project.

---

**Figure 2. Pipeline Work Status**

*Source: Batam Authority (2019)*
The topographic condition of the area in figure 4 is around 2 km² and to find out how to install pipes for a slope of 1.5%. The purpose of the pumping station is to increase the water level. To save maximum energy, the pipe level at the station must not be underground but at 9m.

1. Part 3 is 500 m. For a slope of 1.5% it has a difference between 2 points C and D of a 7.5m pipe. The natural difference is 4m, so at point C it is necessary to raise the pipe to a height of 3.5 meters. It is not possible to do it at point C so it must bury point D at 3.5 meters.
2. For part 2, the difference is 1m. Need to bury point B at 1 meter.
3. For part 1, the difference between the natural slope and the slope for the pipe is 0.25 m. So it must bury point C around 0.25 meters.

Because part 1, point C must be at a depth of 0.25 meters, so that point B is at a depth of 1.25 meters and point D at a depth of 3.75 meters. Minimum burial depth is 0.5 m.
Table 1. Calculation of Estimated Pipe Depth

|                | A (m) | B (m) | C (m) | D (m) |
|----------------|-------|-------|-------|-------|
| Basic estimation | 0     | 1.25  | 0.25  | 3.75  |
| With minimum depth | 0.5  | 1.75  | 0.75  | 4.25  |
| Average of depth: 1.5m |      |       |       |       |

Currently, only installations in the main pipeline and will be connected to residents area when the project will be completed [ HYPERLINK \"Eli19\" 7 ].

3.4 Wastewater Treatment Plant

Currently, like most cities in Indonesia. Waste water treatment in Batam City is carried out directly on site, usually in the form of a septic tank for several residences. Because this septic tank is not connected to a network that carries waste directly to the processing plant, it is necessary to do this “manually” by truck. Once arrived to the plant, sewage undergoes a process to treat it. This is a biological treatment called activated sludge. This is a conventional process and is proven to be used by almost all wastewater treatment in Indonesia.

![Activated Sludge Process](image1.png)

**Figure 4.** Activated Sludge Process

Although the activated sludge treatment method is effective by ensuring a minimum residual impact but it becomes a serious problem in the treatment of large amounts of sludge to the environment especially in water pollution 8]. Figure 4 is Activated Sludge Process. The steps of this treatment are [ HYPERLINK \"AKh16\" 9 ]:

1. Preliminary Treatment (screening)
   - Solid Removal, sewage through the sewer system, then sent to the bar screen to choose large solids such as sticks and cloth.
   - Grit Removal, water flows slowly, enters the sand tank to choose sand, gravel, and other small particles that settle at the bottom of the screen bar.
   - Degreasing-de oiling all the collected derbish from the sand tank and filter is disposed of in the sanitary landfill.

2. Primary Treatment (primary settling)
   - In this second step is the process of physical separation of solids and greases. The filtered wastewater then flows into the settling tank and solid particles settle at the bottom and greases to float to the top. Remove 60% of solids and 35% of BOD.

3. Secondary Treatment (e.g. activated sludge)
   - Biological treatment process for removing dissolved organic matter in waste water. then waste water flows gravitationally to the aeration tank. Solid mixed water contains oxygen (use of air bubbles for mixing and oxygen supply). Liquid mixture of solids and microorganisms is sent to the clarifier. in clarifier several solids and sended to the recycling process. Remove 85% of BOD and solids.

4. Final treatment (disinfection)
Disinfected water is then discharged to flow into the river or reuse. Chlorination is generally used for the purpose of disinfection.

5. Solids Processing (sludge management)

The primary solids of the settling tank are sent to the digester. Microorganisms use organic matter at solids are converted into a by-product as methane and water. Digestion results in a 90% reduction in pathogens and production of wet soil-like materials called "biosolids" contains 95-97% water. To remove water, mechanically equipment such as pressing filters are used squeeze water from biosolids to reduce volume before being used as fertilizer or soil change.

FCR (food chain reactor) in WWTP is a type of integrated fixed-film activated sludge system that offers great benefits, both technical and economical. Organica FCR is based on the same activated sludge process that has been used in wastewater treatment for almost a century, where microorganisms and bacteria (collectively referred to as biomass) oxidize contaminants available in wastewater.

The first phase of pre-treatment is similar to the traditional process of removing solids through the mesh. The second stage of biological processing consists of six serial reactors in which wastewater circulates and meets different microorganisms with different levels of aeration to create anoxic and aerobic reactions. The reaction of anoxia allows denitrification. Then, aerobic reactions allow degradation of organic matter.

The final step is to separate pollutants suspended from water by decantation. In the same way as for conventional methods, some of this sludge is transferred to the cycle to maintain the biological system. Excesses are reprocessed and stored for reuse for other purposes. Water eventually undergoes ultraviolet disinfection treatment before being released into the natural environment.}

Figure 6. FCR (Food Chain Reactor)

The advantage of FCR compared to activated sludge treatment is that the FCR is placed in a pleasant aesthetic structure that is odorless and suitable for tropical climates with the appearance of botanical gardens but WWTP in Batam City were not built in the middle of the city because of gravity. WWTP must be built on land lower than the land in the middle of the city causing public botanical gardens to not function, maintaining the value of the surrounding land and allowing WWTP to be placed directly adjacent to waste water sources, thereby greatly reducing infrastructure costs (reducing construction energy consumption costs).
3.5 House Connections
The aim of the house connections is to make connections to bring used water from the residence directly to the system. The septic tank is not effective so it must be replaced. Sewage in residence flows into the sewer that has not been integrated. Septic tanks that are often dumped carelessly into the sea, rivers, vacant land, and next to highways can pose a danger to health and the environment. Liquid substances seep into the soil and contaminate water sources [12].

Adhya Tirta Batam company said “Network management must be carried out and necessary to enable work with as little interference as possible. ATB has a concession from BP Batam to manage island water for 25 years, until 2020”

3.6 Challenges and Issues on Site.
1. Effect of local people influence
Some local residents protested the excavation work on projects that disrupted their travel routes. Another thing that many people complain about is the condition of roads that are dusty and muddy when it rains. Clean water supply is disrupted. The cause of supply disruption is due to the installation of pipes from the impact of heavy equipment.

2. Unawareness of sewerage scheme
Low awareness of citizens about waste disposal that endangers health and the environment. economic factors that consider the cost of expensive waste treatment.

3. Natural Factors
Unexpected weather in the city of Batam, such as the rainy season, often disrupts the process of extracting pipes because the soil is flooded. Some locations have humus soil types because they are near protected forest areas. when working on the project, the water
must be pumped first to dry. But after that there is still water left over when compacted. the most common occurrence was the collapse of the soil during the pipe work.

4. Stakeholders
Some sub-contractors involved in project work do not follow operational methodology and standard procedures. In this case the Batam city government takes firm action against sub-contractors who violate project rules.

4. Conclusion
In this research the WWTP project is the right solution for Batam City in waste management, especially sewage. Batam is a pilot because there are not many cities that use integrated sanitation processing systems in other cities in Indonesia. WWTP provides benefits for environmental problems with natural and technological integration. The impact of this research in the field of civil engineering is the application of the Sustainable Urban Water and Sanitation Management.

Acknowledgement
Thank you to all those who helped write this research, the Civil Engineering department Batam International University to support me doing this research, my student has done an internship and the Batam Authority to research data as a port development agency and several stakeholders directly involved in the work of this project.

References
[1] Kechaouc N, Palmerid J, Deratani A, Sghaier A and Amar N B 2009 "Comparison of tertiary treatment by nanofiltration and reverse osmosis for water reuse in denim textile industry," Journal of Hazardous Materials, vol. 170, pp. 111-117
[2] Fatone F, Fabio D B, Cecchi F and Bolzonella D 2010 "Application of membrane bioreactor technology for wastewater treatment and reuse in the Mediterranean region: Focusing on removal efficiency of non-conventional pollutants," Journal of Environmental Management, vol. 91, pp. 2424-2431
[3] Kautsav C and Vrushali S 2014 "Sewage Treatment and Reuse- A Step Towards Water Conservation.," International Science Journal, vol. 2348-604X, pp. 15-22
[4] Satori D and Komariah A 2011 Qualitative Research Method. Bandung, Indonesia: Alfabeta
[5] Batam Indonesia Free Zone Authority (BIFZA) 2018 "City to City Collaboration Projects for Low Carbon City Development in Asia Seminar Hirakawacho," Chiyoda-ku Tokyo
[6] Gogina E, Schukina T, Kuznetsova N, Makisha N, Poupyrev E and Scherbakov V 2015 "Calculation of biogas facilities for recycling of organic sewage sludge of breeding factories.," International Journal of Applied Engineering Research, vol. 10 (24), pp. 44353-44356
[7] Elliot B 2019 "Wastewater Treatment in Batam," Department of Civil Engineering Batam International University and Polytech Annecy Chambery, Batam, Internship
[8] Isa M H and Heng G C 2018 "Enhancement of activated sludge disintegration and dewaterability by Fenton process ," IOP Conf.Series : Earth and Environmental Science, vol. 36
[9] Khumar A 2016 "Wastewater Treatment Processes," USA
[10] Organica Water Company 2016 "How Does The Organica FCR Compare to Other Solutions?," Article I
[11] Francois C 2019 "Improvement of coal power plant thermal efficiency," Department of Civil Engineering Batam International University and Polytech Annecy Chambery, Batam, Internship
[12] Sanchez O, Arias C A, Becares E, Garrido L, Mas J, Brix H, Morato J and Adrados B 2014 "Microbial communities from different types of natural wastewater treatment systems: vertical and horizontal flow constructed wetlands and biofilters," Water Res., vol. 55, pp. 304-312