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BERSIH INDONESIA ELIMINASI SAMPAH PLASTIK Powered by ALLIANCE TO END PLASTIC WASTE	BERSIH INDONESIA PROGRAMME Material Recovery Facility (MRF) and Transfer Station (TS) Solution Detailed Engineering Design (DED) Kabupaten Malang, Indonesia	PT. CIRIAJASA E.C.

WATER & WASTEWATER TREATMENT PLANT ANALYSIS MRF PARAS

BERSIH INDONESIA PROGRAMME MRF and TS Solution DED Kabupaten Malang, Indonesia		
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RECORD OF REVISION

The revisions listed below have been incorporated in this copy of the document.

REV. NO.	PAGE NO.	DESCRIPTION OF CHANGES

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1)

1. INTRODUCTION

The Alliance to End Plastic Waste Inc. (the “Alliance”), has initiated the Bersih Indonesia Programme in order to support the Indonesian Government’s ambitious vision of cutting marine plastic debris by 70% by 2025 and making Indonesia plastic pollution free by 2040. The Programme is split into three phases, where the Phase 1 of the Programme aims at proving technical and commercial viability through an improved waste management system in Malang Regency (the “Project”). The Project is expected to serve a population of 2.6M people.

Subsequently, Phases 2 and 3 aim at proving replicability by adapting the system to Magelang and Sukabumi Regencies, in central and west Java, which, including Malang, serve a combined population of 6.5M people across Java. The Project features a public sector and a private sector component. The public sector component consists of the development, construction and taking into operation of a public waste collection and sortation service in Malang Regency, consisting of a network of 5 Material Recovery Facilities (MRF’s) and four 5 Transfer Stations (TS’s).

In order to ensure successful implementation on the ground in Malang, the Alliance, as programme sponsor and lead developer, has engaged a consortium made up of Mott MacDonald Indonesia – as Project Management Office (PMO), and Systemiq – a global climate advisory and investment firm and co-founder of Project STOP. The consortium’s support to the Project includes project management, local capacity building, government relations, community engagement and market research.

This national Programme has been designed from the bottom up, based on critical early local community insights gained through the Alliance sponsored STOP Project in Jembrana, Bali. Governments at the local, regency and national level have been involved throughout the process in selecting the priority participating Regencies and are supportive of the program. An MOU will be signed with the Coordinating Ministry of Maritime Affairs and with each Regency.

2. PROJECT BRIEF

Bersih Indonesia (called as BI hereinafter) has a program to support its community recovery programs in Kabupaten Malang, East Java, Indonesia. These communities are seeking to improve their waste management and recycling activities in an active attempt to prevent leakage of waste into the environment. To this end, Bersih Indonesia program plans to develop a recycling and solid waste infrastructure in several locations in Kabupaten Malang to reorient disposal behavior of the local population toward disposal in approved facilities, recovery of recyclables, and diversion of organic waste through composting.

Specifically for this project, the BI program is seeking Detailed Engineering Design (DED) for:

- 2 (two) Material Recovery Facilities (MRF's)
- 2 (two) Transfer Stations (TS's)

including Water & Wastewater Treatment (WWT) in each of MRF and TS (total of 4) in Kabupaten Malang.

A. MRF - Material Recovery Facility

MRF or Material Recovery Facility (in Bahasa TPST-Tempat Penampungan / Pengolahan Sampah Terpadu) is a building facility of suitable concrete floors with the standard building scope of supply shall include the structural framing, covering metal roofing and wall includes accessories and provides access to all architectural and functional requirements, where collected household trash from Transfer Stations are being sorted into several parts. There will be a conveyor belt system in the building which will help the workers perform the sorting of plastic waste from other materials

B. TS - Transfer Station

TS or Transfer Station (in Bahasa SPA-Stasiun Peralihan Antara) is an area of split-level concrete floor where tricycles bring the household trash (organic and inorganic) from the surrounding area to transfer into larger containers. Then the collected trash is sent to MRF/TPST for sorting.

3. ABBREVIATIONS

WWT : Water & Wastewater Treatment
MRF : Material Recovery Facilities
TS : Transfer Stations
RWH : Rain Water Harvesting

WWT : Water & Wastewater Treatment

MRF : Material Recovery Facilities

TS : Transfer Stations

RWH : Rain Water Harvesting

BOD : Biological Oxygen Demand

SS : Suspended Solid

HRT : Hydraulic Retention Time

4. MATERIAL RECOVERY FACILITY (MRF) of PARAS WATER MANAGEMENT PLAN

The water management plan for Paras MRF can be described as follow:

4.1 MRF Paras Wastewater Treatment Plan

The wastewater management plan for Paras MRF can be described as follows:

4.1.1 Water Supply

Clean water supply in Paras MRF is designed from PDAM and Rain Water Harvesting (RWH). PDAM will be used for body contact, and RWH will be used for washing vehicles, building cleaning and gardening (if any). Rain water harvesting in Paras MRF is designed to get rainwater from the roof. The rain water collected through the gutter at the lower end of the roof, and processed in the water treatment and then streamed to the ground reservoir.

4.1.2 Domestic Wastewater

a) In the Paras MRF area, the wastewater to be treated is domestic wastewater and grey water from washing vehicles. The volume of wastewater volume according to the Decree of the Minister of Health and Forestry of the Republic of Indonesia No. 68/Menlhk.Setjen/2016 using formula below:

Q_{max} = $\sum_{i}^{n} Qi$ + ….; …. ; Q_m

Qmax = The highest wastewater discharge (m^3/time)

Qi = The highest discharge of domestic wastewater from activity

Qm = The highest discharge of domestic wastewater from activity m

Q_r = (60 – 85%) x $Q_{clean\ water}$

The kinds wastewater are:

1. Black water from the toilets
2. Gray water from bathing and vehicle washing

Calculating the volume of wastewater based on SNI: 03-7065-2005 about the need of clean water for office or industry is 50 l/person/day.

The volume of clean water consuming is 584 x 50 l/day = 29.200 l/day

The volume of domestic wastewater approximates 60% -85%. In this plan assumed 60 % = 60% x 29.200 l/day = 17.520 l/day

Water demand of all follows the SNI-03-7065-2005, as described above:

- Calculating the volume of wastewater for such vehicle washing, is:
  2) The water requirement for vehicle washing is assumed to be 500 up to 600 liters/vehicle *(http://forumkatiga2007.blogspot.com/2010/03/seberapa-banyak-air-yang-kita-gunakan.html)*.
  3) The number of trucks are 5; the volume of wastewater from truck washing = 5 x 600 l = 3.000 liters.
  4) The number of tricycles are 170. The water requirement for tricycle washing is assumed to be 300 l/vehicle.
  5) The volume of wastewater from tricycle washing = 170 x 300 l = 51.000 liters.
  6) Volume of wastewater is 71.520 liters ≅ 71,52 m^3/day.
  7) Loses assumed 15%.
  8) Total volume of wastewater is 85% x 71,52 m^3/day = 60,792 m^3/day ≅ 61 m^3/day

Flow rate demand of office requirements can be calculated based on the number of people working in the office (approx. 20 persons) and workers, supervisor (564 persons), the standard requirement is according to Permenkes as presented above.

Water demand is the total requirement of office, workers, vehicle washing, public toilets, meanwhile the supply comes from PDAM (for office requirement only), RWH ~~and supply water from deep wells (if any).~~

Flowchart Paras Wastewater Treatment

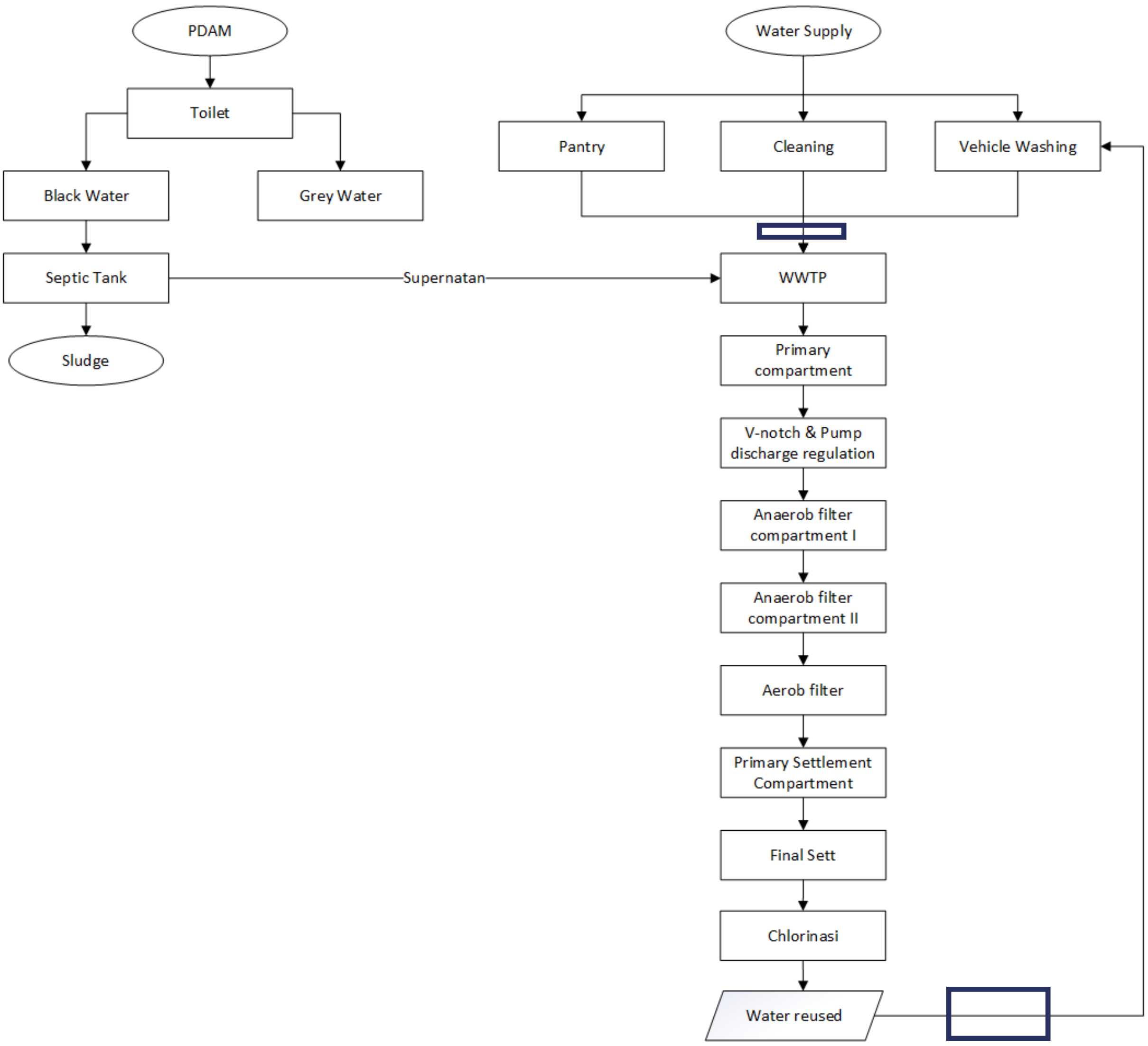


Figure: Flowchart Paras Wastewater Treatment
Source: Expert Analysis

Wastewater before entering the fat separator basin, flowed through the filter to capture the garbage carried by the wastewater flow during vehicle washing. Wastewater after being filtered enters the fat capture basin and then into a collection or equalization basin. From the catch basin, the wastewater is then pumped to the anaerobic treatment basin and the discharge is regulated. The next process is aerobic treatment. In the aerobic tub, a blower pump is given to increase the amount of oxygen in the aeration process. The wastewater is then flowed to the chlorination process and flowed to the ground tank ready for reuse.

4.1.3 Dimension Analysis

Planned Domestic WWTP Capacity

Planned Design Capacity:

Processing Capacity : 66,5 m^3/day

: 46 Liters/minutes

Average wastewater BOD : 300 mg/L *)

SS concentration 300 mg/liter

Processing efficiency : 90% - 95%

Processed BOD : 20 mg/L

Processed SS : 20 mg/L

*) NSF Standard No.40 BOD average of Domestic waste water 100 - 300 m/l

1) Design of Grease Separation Tank

The planned grease removal tank is a simple gravity type. The tank consists of two rooms equipped with a bar screen at the inlet.

Processing capacity : 66.5 m3/day

: 46 liters/minute

HRT design criteria : ± 30 minutes

Required tank volume : 30/(24 x 60)*66.5 m3/day

: 1,39 m3

Tank Dimensions:

Depth : 1 m

Free space : 0,5 m

Minimum length : 1,5 m

Minimum width : 1 m

Effective volume : 1.5 m3 (compliant)

Construction : 1 stone impermeable brick masonry

2) Design Equalization Tank/Wastewater Storage Tank

Tank Residence time (HRT) = 4 – 8 hours

Set the residence time in the equalization tank 5 hours

Required tank volume = $\frac{5}{24}$days x 66.5 m3/day

= 13.85 m3

Set tray dimensions:

Depth : 2 m

Free space : 0.5 m

Length (minimum) : 4 m

Width : 2 m

Effective volume : 16 m3

Construction : 1 stone waterproofing masonry brick

Check dimensions:

(Tank volume/discharge) x 24 = (16 m3 : 66.5 m3/day) x 24 hours = 5.8 hours

The tank can be used for a residence time of 5.8 hours, it means the dimensions are sufficient.

3) Wastewater Pump

Discharge 66.5 m3 / day = 46.18 l / min

Pump specification

Type : submersible pump for dirty water

Capacity : 40 - 120 l/min

Total Head : 5 - 8 m

Electrical output : 120 - 350 watts

Material : Glass fiber and techno polymer

Recommended pump:

Brand : Showfou, Pedrollo, HCP or equivalent.

Type : SC0511

Brand : Pedrollo

Type : Top 2

Or equivalent type

4) Initial Settling Tank

Wastewater Discharge : 66.5 m3/day

Incoming BOD : 300 mg/liter

Efficiency : 25%

Outgoing BOD : 225 mg/liter

Residence time in the tub : 2 - 4 hours

Set 3 hours

Required volume: (3/24) * 66.5 m3 = 8.31 m3

Dimensions set:

Width (minimum) : 1,5 m

Effective water depth : 2 m

Length : 3 m

Free space height : 0,4 m

Construction : 1 stone waterproofing masonry brick

Check the residence time (Hydraulic Retention Time / HRT):

T = (vol compartment / discharge) x 24 hours / day

= {(1.5 x 2 x 3) m3 / 66.5 m3/day} x 24 hours/day = 3.25 hours

Surface load **)

= Discharge/surface area

= 66.5 m3/day/(1.5 x 3)m2 = 14.8 m3/m2. per day**)

Surface load 20-50 m3/m2 per day

((http://ciptakarya.pu.co.id/plpupload/peraturan/pedoman-teknis-ipal-2011.pdf) set 20 m^3/m^2.per hari

- Residence time during peak load = average HRT/2 (assuming that during peak load, the volume of waste is 2 times the average volume), so that the residence time is half of the calculation HRT

  = 3.25 hours / 2 = 1.62 hours

- Average surface loading = Volume (m3/day) / compartment surface area
- Surface load at peak time = average load x 2

  = 4.44 m3/m2 per day x 2 = 8.88 m3/m2 per day (lower than standard 20 - 50 m3/m2. per day (JWWA))

Standard residence time 2 - 4 hours, set at 2 hours.

5) Biofilter Anaerobe

Inlet BOD = 225 mg/l
Efficiency = 80%
Outgoing BOD = 45 mg/l
Effluent discharge = 66.5 m3/day

BOD load per media volume 0.4 - 4.7 kg BOD/m3 day
Determined BOD load is 1.0 kg BOD/m3 day

- BOD load in waste = 66.5 m3/day x 225 g/m3
  = 14,963 g/day = 15 kg/day
- Media volume required = (15 kg/day)/ 1.0 kg/m3.day = 15 m3
- The media volume is set at 60% of the reactor volume.
- Required reactor volume = 100/60 x 15 m3
  = 25 m3.

- Residence time in the Anaerobic reactor
  = Reactor volume/waste discharge per day)*24 hours
  = 25/66.5) x 24 hours = 9 hours.

Anaerobic Reactor Dimensions Defined
Effective depth = 2 m
Length (minimum) = 3.6 m
Width (minimum) = 2m
Free height = 0.4 m

Effective volume

Dimension (p x l x t) 3.6 x 2 x 2.4 = 14.4 m3.

The number of spaces is divided into 2 rooms

1 stone waterproofing masonry brick

- Average Anaerobic Reactor residence time =
  (14.4 m3/66.5 mg/day) x 24 = 5.2 hours
- Average residence time 5.2/2 hours = 2.6 hours = 3 hours
- Sludge chamber height = 0.2m
- Microbial culture media bed height = 1.2m
- Water level above media bed = 30 cm
- Aerobic biofilter media volume = 1.8 m3

BOD loading per media volume

= 15/volume = 15/(3.6 x 2 x 2) = 1.04 kg BOD/m3 day

If the media used has a specific area of ± 150 m2/m3 media, then

- BOD loading per media surface area =

1,040 gr/150 = 6.9 gr

BOD/m2. day E 7 gr BOD/m2.day

6) Biofilter Aerobe

Effluent discharge = 66.5 m3/day

Incoming BOD = 45 mg/l

Efficiency = 60%

Outgoing BOD = 18 mg/l

- BOD load in wastewater = 66.5 m3/day x 45 mg/l = 2992.5 g/day E 3 kg/day
- BOD removed = 60% x 3 kg/day
  = 1.8 g/day
- BOD load per volume of media used is set at 0.5 kg/m3.day
- Media volume required = (3 kg/day : 0.5 kg/m3) = 6 m3
- Media volume is set at 40% of the reactor volume
- Reactor volume = 100/40 x media volume
  =100/40 x 6 m3 = 15 m3

The aerobic biofilter consists of 2 chambers, namely the aeration chamber and the bed media.

Aerobic Biofilter Reactor Dimensions:

- Aeration Room:
  Width = 2 m
  Effective depth = 2 m
  Length (minimum) = 1.5 m
  Free height = 0.4 m
  Total effective volume of Aerobic biofilter
  = 2 m x 2 m x 2 m = 8 m3

- Media Bed Space
  Width = 2 m
  Effective water depth = 2 m
  Length = 2 m
  Free height = 0.4 m
  Volume = 2 m x 2 m x 2 m = 8 m3
  Total effective volume of Biofilter = 8 m3 + 8 m3 =16 m3

Check

- Average total residence time = (16/66.5) x 24 hours
  = 5.8 hours
- Total residence time at peak load = average residence time/2 = 2.9 hours
- Sludge chamber height is set at 0.5 m
- Microbial breeding media bed height = 1.5 m
- Total volume of media in Aerobic Biofilter =
  2m x 2 m x 1.5 m = 6 m3

Check

- BOD loading per media volume = BOD load per day / Aerobic biofilter media volume
  = 3 kg/day : 6 m3 = 0.5 kg BOD/m2.day
  (Standard high rate trickling filter = 0.4 - 4.7 kg BOD/m2.day)

If the media used has a specific area of 150 m2/m3, then

- BOD loading = 0.5 kg BOD/m2.day
  = 500 gr BOD / m2.day : 150 m2/m3
  = 3.3 gr BOD/m2 media area per day.

Oxygen Requirement

The oxygen requirement in the aerobic biofilter reactor is proportional to the amount of BOD removed.

Theoretical requirement = amount of BOD removed = 1.8 kg/day

Safety factor set at ± 2.0

Theoretical oxygen demand = 2 x 1.8 kg/day = 3.6 kg/day

Average air temperature in 2022 = 25.65°C E 26°C

However, at the MRF location, because there are trash dumps in the landfill, it is estimated that the average air temperature is higher than the average air temperature of the surrounding area. The air temperature is assumed to be 28°C.

The weight of air at 28°C is 1.1725 kg/m3.

The amount of oxygen in the air is 20%

So, total theoretical air demand =

Theoretical air demand: (Air weight x amount of oxygen in the air)

= 3.6 kg/day { (1.1725 kg/m3. X 20% g O2/g air)

= 15.35 m3/day

Diffuser efficiency = 5%

Actual Air Requirement = Theoretical air requirement/diffuser efficiency

=15.35 m3/day : 5%

= 307.04 m3/day

= 0.21 m3/minute

= 213.22 l/minute

Required Air Blower:

Blower Specifications:

Type : HIBLOW 200

Blower Capacity : 200 liters/minute

Head : 2000 mm-aqua (2 meters)

Quantity : 4 units

Power : 200 watts X 4 = 800 watts

Outlet pipe : ½ Inc.

Electricity : 1 phase

Air diffuser:

Total air transfer = 800 liters/minute

Diffuser type used: *Perforated Pipe Diffuser* or equivalent (disc shape diffuser etc.)

7) Final Settling Basin

Effluent discharge = 66.5 m3/day

Incoming BOD = 45 mg/l

Outgoing BOD = 18 mg/l

Residence time in basin = 2 - 4 hours

Set residence time = 3 hours

Required tank volume = residence time / 24 hours x waste discharge

= 3/24 x 66.5 m3 = 8.31 m3

- **Dimensions**

Width = 2 m

Effective depth = 2 m

Length = 2.5 m

Free space height = 0.4 m

Volume = 10 m3

CHECK

Average residence time (retention time) = (tub volume: discharge) x 24 hours

= (10 m3 /66.5 m3/day) x 24 hours

= 3.6 hours

Surface loading = discharge / area

= 66.5 m3/day / (2 m x 2.5m)

= 13.3 m3/m2.day

- Residence time at peak load = 2.9 hours
- Surface load at peak load = 2 x average surface load

= 2 x 13.3 m3/m2.day

= 26.6 m3/m2.day

Standard residence time = 2 - 4 hours

Surface load 20 - 50 m3/m2.day

All fall within the standard range

8) Microbial Breeding Media

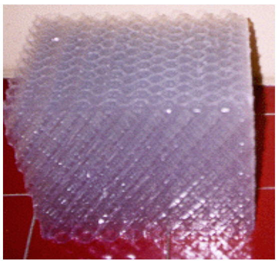
The biofilter media used is plastic media that is lightweight, durable, has a large specific area, is lightweight and has a large cavity volume so that the risk of media collapse is very small.

Specifications of biofilter media used:

Material	: PVC sheet
Module size	: 25 cm x 30 cm x 30 cm
Thickness	: 0.15 - 0.23 mm
Specific Contact Area	: 150 m2/m3
Hole diameter	: 3 cm x 3 cm
Color	: clear transparent
Specific Weight	: 30-35 kg/m3
Cavity Porosity	: 0,98

Total amount of media required = 15 m3 + 12 m3 = 27 m3

Used Wasp Nest Biofilter Media or equivalent



Type	:	Example(Honeycomb/ Sarang Tawon), cross flow.
Material	:	PVC
Module Size	:	30^{cm} x 25^{cm} x 30^{cm}
Hole Size	:	3 cm x 3 cm
Thickness	:	0,5 mm
Specific Area	:	150 m^2/m^3
Weight	:	30-35 kg/m^3
Cavity Porosity	:	0,98
Color	:	clear transparent

9) Circulating Water Pump

Hydraulic Recycle Ratio (HRR) = 0.25-0.5

Circulation Rate : 37.5 -75 liters per minute

Pump Specifications:

Type : Submersible Pump

Capacity : 37.5 - 75 liters per minute

Total Head : 5-6 meters

Quantity : 2 pieces (one for backup)

Electricity : 250 watts, 220-240 volts

Recommended pump:

Brand : Grundfos

Type : KP.150 Automatic or equivalent type

5. REFERENCES

- SNI: 03-7065-2005
- *(http://forumkatiga2007.blogspot.com/2010/03/seberapa-banyak-air-yang-kita-gunakan.html)*
- SNI-03-7065-2005
- the Minister of Health and Forestry of the Republic of Indonesia No. 68/Menlhk.Setjen/2016
- NSF Standard No.40