

1.0 Sewage treatment plant

1.1 Design calculation.

i. Population equivalent (PE)

For this proposal, 40 unit of residential house and 18 unit of commercial building are consider for the development. From this table of type of establishment and the PE consist of:

Type of establishment	Population equivalent
Residential	5 per house
Commercial	3 per 100m ² area
Educational Institutions	
- Day Schools	0.2 per student
- Residential Schools	1 per student (residential)
Hospitals	4 per bed Hotels 4 per room
Factories	0.3 per employee
Market (Wet Type)	3 per stall
Market (Dry Type)	1 per stall
Petrol Stations	18 per service bay
Bus Terminal	4 per bus bay
Taxi Terminal	4 per taxi bay
Mosque	0.5 per person
Church or Temple	0.2 per person
Stadium	0.2 per person
Swimming Pool or Sports Complex	0.5 per person
Public Toilet	16 per WC (water closet)
Airport	0.2 per passenger/day
Airport	0.3 per employee
Laundry	10 per machine
Prison	1 per person
Golf Course	20 per hole

For residential areas the population equivalent is calculated as 5 per dwelling and is direct measurement from the population in an area. However for commercial areas it is calculated from the floor area, which is considered to be proportional to the number of people using premises during the day. In this case it does not reflect the population living in this area.

40 units building of residential houses.

$$\begin{aligned} \text{PE} &= 40 \text{ unit} \times 5 \text{ person per house} \\ &= 200 \end{aligned}$$

Commercial building area for 18 units is 3096.89m² $\approx$ 3100m².

$$\begin{aligned} \text{PE} &= (3100 / 100) \times 3 \text{ per } 100 \text{ m}^2 \text{ area} \\ &= 93 \end{aligned}$$

$$\begin{aligned} \text{Total PE} &= 200 + 93 \\ &= 293 \end{aligned}$$

Or than that the PE can be calculated from this formula:

$$\text{PE} = \frac{\text{BOD concentration (lb/day)}}{0.17 \text{ BOD/day/person}}$$

$$0.17 \text{ BOD/day/person}$$

$$\text{PE} = \frac{(\text{Flow, m}^3/\text{day}) (\text{BOD, mg/L})}{(1,000)(0.077 \text{ kg BOD/day/person})}$$

$$(1,000)(0.077 \text{ kg BOD/day/person})$$

For design pipe network, pump stations and sewage treatment plants, estimate need to be made of the volumetric flow rate which will be expected to be carried, pumped and treated. The PE may be converted to flow rate comply with formula set out in Malaysian standards 1228 (MS1228).

$$\begin{aligned} (\text{Flow, m}^3/\text{day}) &= \frac{\text{PE} \times (1,000) (0.077 \text{ kg BOD/day/person})}{(\text{BOD, mg/L})} \end{aligned}$$

ii. Determination of sewage treatment system for mix development.

If PE < 30 septic tank is use. If PE>30 sewage treatment plant is used. Since PE is more than 30 sewage treatment plant is used. For this proposal, we choose the rotating biological contractors (RBC) system as our sewage plant. RBC is mechanical secondary treatment systems. The primary treatment process removes the grit and other solids through a screening process followed by a period of settlement. Then it when through the secondary treatment, which consist of a series of closely spaced "circular disks" mounted on a rotating shaft which is supported just above the surface of the waste water.

The disks are partially submerged in the sewage and are slowly rotated through it. The rotating disks support the growth of bacteria and micro-organisms present in the sewage, which breakdown and stabilize organic pollutants. The bacteria used aerobic microorganism where oxygen are necessary for the degradation of the sewage pollutants.

Oxygen is obtained from the atmosphere as the disks rotate. As the micro-organisms grow, they build up on the media until they are sloughed off due to shear forces provided by the rotating discs in the sewage. Effluent from the RBC is then passed through final clarifiers where the micro-organisms in suspension settle as sludge. The sludge is withdrawn from the clarifier for further treatment.

Typical values of RBC are as follows:

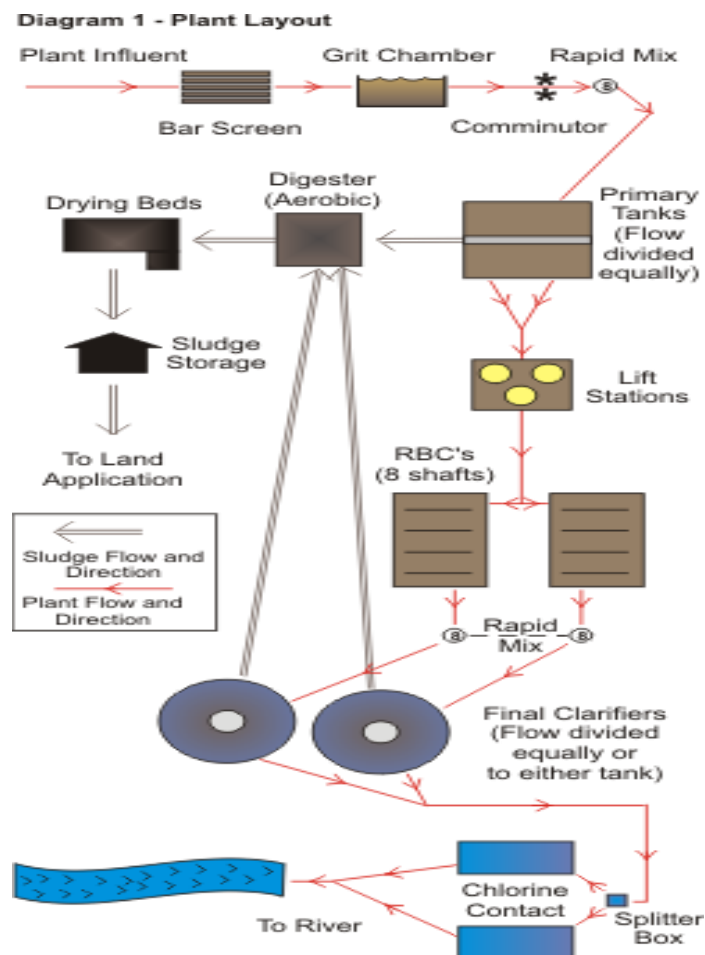
mg/L	Raw Sewage	Effluent	DOE standard A
Biological oxygen demand (BOD)	200-400	10-30	20
Suspended solids	200-350	15-40	50

These treatments are chosen for this proposal because it's:

- 1) Suitable for staged development.
- 2) Suitable for where land is restricted.
- 3) They are quite and consistently produce a high quality effluent.
- 4) Operations and maintenance costs are lower than for other forms of mechanical treatment.
- 5) Short contact periods are required because of the large active surface.

- 6) They are capable of handling a wide range of flows.
- 7) Sloughed biomass generally has good settling characteristics and can easily be separated from waste stream.
- 8) Operating costs are low because little skill is required in plant operation.
- 9) Short retention time.
- 10) Low power requirements.
- 11) Elimination of the channelling to which conventional percolators are susceptible.
- 12) Low sludge production and excellent process control.

The treatment plant should be design and install according to Malaysian standard, MS 1228: 1991 Code of practice for design and installation of sewerage systems. The treatment shall be build at low elevation area for gravity flow, with moderate slope for locating treatment units in their normal sequence without excavation or filling.



1.2 Sewer reticulation pipe.

i. Design parameters.

a) Flow.

In accordance with MS 1228 C1.3.2: average design flow.

Average daily design flow = 50 gallons per day per PE = 225 L per day per PE.

$$= 225\text{L} \times 293\text{PE} = 50 \text{ gallons} \times 293$$

$$= 65925 \text{ L} = 14650 \text{ gallons}$$

In accordance of MS 1228 C1.3.6: Peak flow. To cater for peak hourly flow, as required in the design of sewers, pumping stations and components of the treatment plant.

Peak flow factor $= 4.7 \times p^{-11}$ where p is the estimated PE in thousands.

$$\text{Cumulative design flow (l/s)} = \frac{\text{PE} \times \text{peak flow factor} \times \text{average daily flow (L/person)}}{(24 \times 60 \times 60)}$$

$$= 293 \times 4.7 \times p^{-11} \times 65925 / (24 \times 60 \times 60)$$

$$= 1.05 \times 10^{-8} \text{ L/s}$$

ii. Pipe.

Main sewers are located along the centerline of a street about 1.2 m or more below the surface. Main sewer will be made from vitrified clay pipes (VCP) with 225 mm in diameter complying with MS1228 C1.4.3.4.2. The domestic connection to main sewer should be made from VCP with 150 mm in diameter, with invert level of 1.2m minimum in accordance to the depth of the manholes complying with MS 1228 C1.4.3.3. The minimum distance in horizontal should be 3m and vertical should be 1m from the sewer pipes in complying with MS 1228 C1.4.3.2.

Minimum pipes size for household should be located 1.2m or less below the ground level, at maximum gradient of 1:40 and 100mm in diameter (upstream) and increasing to 150mm in diameter (downstream) made from VCP. The clay pipes, bend and fittings should be approved manufacture and comply with B.S 65 and 540 part 1 and 2 and B.S 2494.

The pipes must be sloped to permit wastewater flows through sewer pipes by gravity. Hydraulic design should comply with MS 1228:1991 where the pipes are sloped at velocities at minimum of 0.8m/s to allow self-cleansing and maximum at 4.0m/s to prevent scouring of sewer by erosive action of suspended matter.

The maximum infiltration flow rate should be 50 L per mm diameter per km the length of sewerage per day. The infiltration should be considered fail if exceed more than 5% than the flow rate average design during the inspection. The sewer pipe should be placed in vicinities limit of the road or alley. Pipes are laid in a series of straight lines between access point used for inspections, testing and cleaning. Branch connections are made obliquely in the direction of the flow. No sewer line should be above water main unless the pipe is adequately protected.

Pipe bedding material shall be crushed gravel or crushed stone. The material shall be acid resistant and evenly graded with sizes ranging from 1/2" to 3/4" and shall contain no fines. Limestone shall not be permitted.

iii. Manhole.

All manholes shall be made from precast reinforced concrete and with concrete on the surrounding. Step or ladder in manholes should be made from stainless steel to prevent corrosion from sulfide gases. The cover should be gastight and with machined bearing surfaces and neoprene gaskets and constructed in accordance of the Malaysian guidelines and according to Jabatan Perkhidmatan Perbentungan (JPP) cover standard.

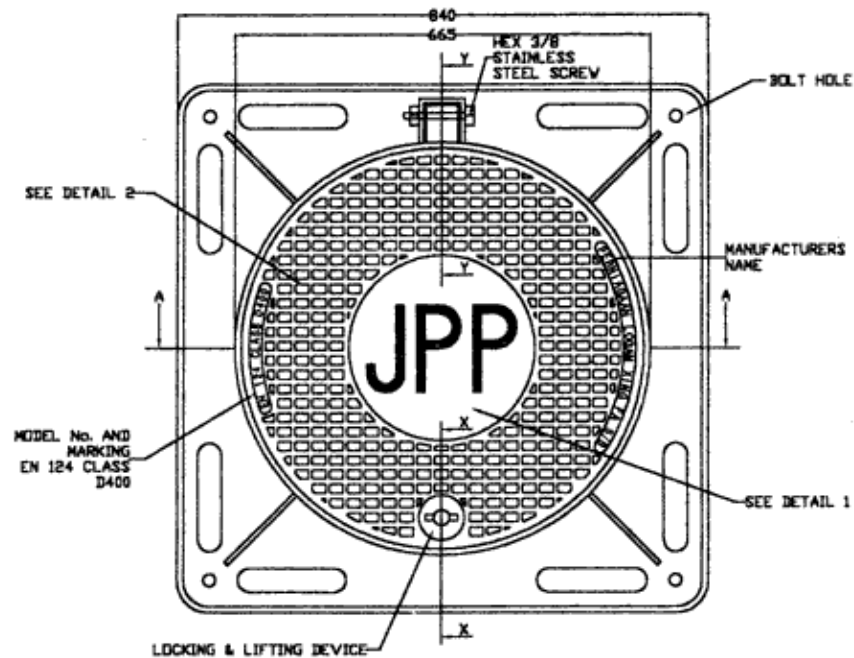


Figure 2. Manhole cover.

The cover shall be made from cast iron with minimum size of 600mm. Manholes should be in minimum of 1.2m in depth from the ground level and located at the end of the line, at the intersection of sewers, and at changes in grade and alignment except in curved sewers. All manholes should be at least at 100m apart of each other. Gradients from 1: 40 to 1: 110 will should be use to give normally give adequate flow velocities.

Drop manhole shall be provided if the difference between the incoming sewer and manhole invert is more than 600mm complying with MS 1228:1991 C1.4.5.7. If the difference between the incoming sewers is less than 600mm, the invert shall be filleted at the corners to prevent solids deposition.

2.0 Reference

<http://eng.upm.edu.my/~mariah/KBP5602/module10.htm>

<http://www.iwk.com.my>

<http://www.cee.vt.edu/ewr/environmental/teach/gwprimer/group13/rbc.html>

<http://pkukmweb.ukm.my/~ahmad/kuliah/manusia/artikel/sewage.htm>

<http://rakan.jkr.gov.my/cpum/documentation/documents/maritime/R19-Sewerage%20system%20design%20checklist.pdf>

<http://www.efka.utm.my/thesis/IMAGES/3PSM/2003/3JHH/PARTS1/ZULKIFLISHEPEISX995832AWD04TT2.doc>

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