

QUEEN ELIZABETH HOSPITAL, RODRIGUES
SPECIFICATIONS FOR
PROPOSED SEWER TREATMENT PLANT

A. INTRODUCTION

At the Queen Elizabeth Hospital, Rodrigues, it is proposed to upgrade the Waste & Sewer system, including:

- (i) Refurbishment of existing underground sewer lines and construction of new underground sewer lines and manholes.
- (ii) Refurbishment of existing underground waste water lines and construction of new underground waste water lines and gully traps.
- (iii) Refurbishment of existing Storm Water Drains on site.
- (iv) Provision of a new Sewer Treatment Plant for treatment of the sewer & waste. It is proposed to have an MBBR (Moving Bed Biofilm Reactor) STP installed. The MBBR plant shall be compact and with low energy consumption.

The waste & sewer volume flow at the Hospital, taking into account of all new & future developments at the hospital etc, is estimated to be 60 m³ daily,

Laundry water to the tune of 2 m³/day will be directed to the proposed STP via the nearest sewer manhole.

B. POLYETHYLENE MANHOLES

The new sewer manholes shall be made of PE material in accordance to BS EN 13598-2:2009 and suitable for use in non-pressure underground drainage and sewerage system conforming to EN 1401-1:1998 and EN 13476-1:2007 for installations in pedestrian / garden areas. The manhole and proprietary cover shall be built to **medium-duty**.

It shall comply to the requirements of EN 13598 and include the manufacturer's name, material, date of manufacture, nominal size, height, application area code, product standard.

Manufacturing shall be by rotational molding process with virgin polyethylene compound (in powder form), with all required additives so that no further treatment is required prior to use. The finished product shall be a monobloc structure in black UV stabilized PE.

The manhole shall have a base and riser shaft of internal dia 600mm to allow cleaning, introduction of equipment and the removal of debris for inspection and maintenance of the system. Inlets are to be provided at 45°, 90° right & left and 180° of direction of flow and allow for connection of pipes DN 110 and DN 160 on all inlets to allow flexibility for installation on site. The base outlet shall be sloped 1-2% with a standard outlet pipe connection of DN 160 mm.

The riser shaft outside shall be reinforced with circular ribs of suitable dimensions to enhance the product's resistance to compression and anchoring in the soil.

Each manhole shall have an RC ring cover with an opening to accommodate a CI double seal cover of 600mm dia complete with frame.

The cover shall be medium-duty type.

C. SUBMERSIBLE PUMPS AT THE LIFTING STATIONS

There shall be 4 nos. lifting stations, each operating with a set of 2 pumps. The pumps shall be of a renowned make and a catalogued item. Electric motors shall be rated to operate on 3 phase 400V with built-in thermal protection and automatic reset. Ingress protection shall be to IP68 with insulation class H.

The submersible pump set shall comprise of 2 nos. pumps in a twin permanent arrangement able to work in sequential duty / standby and cascade modes. Each pump shall be able to deliver 3m³/hr @ 18m, with the total capacity of the pump set at 6m³/hr @ 18m.

The pumps shall be suitable for sewer-laden water with particles and fibrous content. All components shall be in SS 316 including casing, impeller, sleeve, bolts, and shaft. The impeller shall be multi-channel open type or similar. Free passage diameter shall be at least 50mm. Mechanical seals shall be silicon carbide or other suitable for wastewater media.

A duck foot coupling assembly is required for the installations, complete with SS guide bars, SS lift chain, non-return valves and isolating valves in a side valve chamber.

Float switches shall operate the pumps as required at low and high water levels. At overflow level, visual and audible overflow alarms shall operate to call for appropriate action by the maintenance personnel.

The electrical panel (IP 65 and UV resistant) shall be located against the external wall of the nearest building. It shall include all necessary switchgears and controls for the good running of the lifting station. LED indicators shall be installed on the panel to each pump's status, i.e. operation and/or faults.

The pump controller shall ensure automatic use of one pump if the other is out of order and also even use of both pumps for even wear and tear.

D. FIBREGLASS GREASE TRAP

The grease trap shall be in fibreglass and shall be a standard catalogued item from a reputable manufacturer. It shall have perforated baskets for solids entrapment and internal baffles. Capacity shall be 6,000L. The grease trap shall be laid underground.

Installations should be as per manufacturer recommendations.

E. SEWER PIPES

E.1 Underground UPVC

Sewer shall be collected via a networks of uPVC pipes rated to PN16. Gully traps and sewer manholes shall be erected around the building for routing all waste and sewer to Lifting stations and from there to the sewer treatment plant.

All external pipes shall be properly and neatly laid underground on a compacted rocksand bed at slope of 1:90. Excavation for installation of pipings and items shall be carried by civil contractor. 110/160mm diameter push-fit SN8 type with rubber ring joints sewer pipes (pink/brown colour to MS6 Standards.) shall be used to convey sewer water between the different manholes on site.

All new sewer lines shall be subject to a Ball test to verify proper slopes.

E.2 HDPE Pipes

All pipes *rising from the lifting stations* to the STP shall be in HDPE type PE 100 SDR11 with standard pressure rating of 16 bars with diameter 160mm.

All fittings on these pipes shall be of electrofusion types.

All pipes shall be laid underground. Pipes crossing the public road shall be laid in HDPE sleeves and shall have a concrete surround.

All pipe installations shall be looped and hydraulic pressure tested after installation and reports shall be sent for each part tested.

F. VALVES

Isolating Valves and non return valves shall be provided in valve chambers on rising mains from submersible pumps at the lifting stations. All valves shall be of high quality to BS1010 with **inox** handles.

G. SEWER TREATMENT PROPOSED

G.1 Treatments Proposed:

The STP shall incorporate the following treatments:-

- (i) Localised grease trap for removing kitchen oils and grease.
- (ii) A Stainless Steel inlet screen consisting of an inlet box with 4 inlets, a fine screen, a motorized shaftless screw spiral to lift all solid materials trapped for compaction and disposal, and an outlet.
- (iii) A primary settling tank at the STP, where the inlet sewer shall collect and slowed down. Anaerobic digestion starts at this tank and suspended solids collect at the

- (iv) bottom. This tank shall be in two sections, an anaerobic section and an anoxic section, separated by a hung wall.
- (v) The anoxic section is where the recirculated sludge from the clarifier is circulated back for de-nitrification.
- (vi) A buffer tank where the effluent gets collected and pumped in a regulated and balanced way to the MBBR tank for anaerobic treatment.
- (vii) Aerobic treatment in MBBR Bio-reactor tanks containing plastic bio-carriers in suspension and coarse air bubbles being diffused into the tank via coarse air bubble diffusers fixed at the bottom of the tanks. This section shall consist of 2 tanks in series.
- (viii) A flocculation process where coagulation takes place of the dissolved solids.
- (ix) The treated water shall be subject to clarification in a conical shaped clarifier with lamella packs at the top. Clear water shall collect at the top surface and sludge shall deposit at the bottom.
- (x) The deposited sludge shall be re-circulated to the inlet of the STP, where it shall be subjected to a de-nitrification process.
- (xi) The clear water shall overflow into a chlorine contact tank where it shall be sanitized by means of chlorine solution injected into it.
- (XII) The final treated water shall be of irrigation quality and shall be stored in a tank and used for irrigation as per Client's instructions

H. TREATMENT PROCESS

H.1 Process calculations for the proposed Treatment Plant

Expected maximum flow = 60 m³/day
 Average flow = 60/24 = 2.5 m³/h
 Peak flow (3 hours of flow over 1 hour) = 2.5 x 3 = 7.5 m³/h

H.2 Expected constituents in the raw waste & sewer flow (ASSUMED)

BOD₅ @ 400 mg/l = 24 kg/day
 COD @ 800 mg/l = 54 kg/day
 TKN @ 100 mg/l = 6 kg/day
 TSS @ 450mg/l = 9 kg/day

H.3 Processes

H.3.1 Primary treatment as follows :

- (i) Grease Removal

Grease removal from the kitchen waste water by means of a grease Trap (Located near the kitchen) of total capacity 6,000 L (To be in Fibreglass and installed underground)

(Assuming 1/3 of daily waste water and sewer flow at kitchen)

Waste water flow from all kitchen = $60/3 = 20\text{m}^3/\text{day}$ (Maximum)

Assume that the kitchen operates at full capacity 3 times daily and over 2 hours each, therefore the flow from the kitchen sink = $20/6 = \text{about } 3.33\text{ m}^3/\text{h}$.

Assuming a peak flow of 3 hours over 1 hour

Total peak flow from kitchen = $(3.33 \times 3) = 10\text{ m}^3/\text{h}$

Now, Proposed grease tank volume = 6,000L

Therefore retention time for the flow at grease trap = $6,000/10,000 = 0.6\text{ h} = 36\text{ minutes}$. (AT PEAK FLOW)

(ii) Screening

A screening system shall be provided at the inlet where all the pumped sewer from the lifting stations shall be received and screened prior to treatment. Solids removed shall be compacted by means of a continuous screw system and dumped into a bin. This screening system shall comprise a Stainless Steel box with 4 nos inlets, a SS screen and an outlet to the first compartment of the STP. (Tank 01)

The collected solids shall be disposed of through the municipal collection services.

(iii) Primary sedimentation

Primary sedimentation takes place at the collection tank of capacity 30m^3 . Settling of the solids in suspension (TSS), removal of about 25-30% of BOD₅ and about 10% of TKN take place.

This tank is in two main sections, (tanks 01 & 02) separated by an overhang wall. A buffer tank (tank 03) after this primary sedimentation tank serves as a buffer tank.

At the primary sedimentation tanks, (tanks 01 & 02) the effluent is also subjected to an Anaerobic decomposition of the bio-mass in the absence of air.

At the 2nd compartment also (tank 02), Sludge from the clarifier is re-circulated back to this tank for further anoxic treatment.

During the primary treatments, around 25% of the BOD₅ and 10% of TKN are removed.

Total BOD₅ after primary treatments = $24 \times 0.75 = 18\text{ kg/day}$

Total TKN after primary treatments = $6 \times 0.9 = 5.4\text{ kg/day}$

After this primary treatment, the waste water & sewer flows into a buffer tank cum lifting station, (Tank 03), which contains lifting pumps. The flow is regulated to the next process tank which is the MBBR tank. The balancing tank has volume 10 m³.

This is obtained as follows:

Peak flow (3 hours of flow over 1 hour) = 7.5 m³/h

Balancing tank = 10 m³.

H.3.2 Secondary treatment

(i) Moving Bed Bio-Reactor Tank (Tanks T-04, T-05)

- *Description*

BOD₅ content in the influent to MBBR tank = 18 kg/day

Allowable BOD₅ content in final effluent = 40mg/l (as per the Environmental Protection

Act of 2002) or 2.4 kg/day

Hence, BOD₅ to be removed by the MBBR process = 18 – 2.4 = 15.6 kg/day

From the buffer tank, the waste water & sewer is pumped in a regulated way at about 2.5m³/h to the primary MBBR Tank 04, and then on to the secondary MBBR tank 05.

Each tank shall have a set of air diffusers installed at the bottom, and fed from air blowers installed at the technical room.

Special Plastic bio-carrier nodules shall be provided in the bio-reactor tanks. These are specially designed assemblies of Plastic Hexagonal tubes having an active surface area of 200m² per m³.

These bio-carriers units remain in suspension in the water by means of the air bubbles. Processes with the nodules restrained in bags shall not be accepted.

- *Oxygen supply*

Oxygen for the biological processes shall be supplied by blowers and conveyed to diffusers arranged at the bottom of the MBBR tanks, from which the Oxygen diffuses out in the form of bubbles. Aerobic treatment of the biomass takes place. The active bacteria attach themselves to the inner surfaces of the Bio-carriers and

feed on the Bio-degradable wastes in the water and are thus transformed into harmless substances, oxydised or merely absorbed by the plant.

- *Processes taking place at the MBBR tanks are:*

Organic nitrogen is transformed into ammonia with the oxygen present.

Water + organic pollution + micro-organisms + O₂ = CO₂ + H₂O + NH₃ + Sludge.

Nitrification takes place in the presence of oxygen and ammonia is transformed into nitrates:



- Oxygen requirement

The mass of AIR required for complete digestion of the 15.6 kg BOD₅ and the 5.4 kg TKN is obtained as 200 kg of air/day. Or 160.2 m³/day or 8.33m³/h

Assuming an oxygen transfer efficiency of 50%, then air requirement for MBBR tanks = 16 m³/h or 20m³/h

The air blower must supply the air with a pressure corresponding to 2.2 m of water depth (or approximately 220 mbar) + head loss over diffusers of 50 mbar (for a clean diffuser) + increased head loss over a dirty old diffuser (e.g. another 40 mbar) + head loss in the pipe system leading from the air blower to the diffusers (all dependant on the actual pipe system, length, velocity, valves etc.,) – e.g. 100 mbar. Total pressure head for air blower: 410 mbar.

- Bio-carrier requirement

Mass of BOD₅ to be removed by MBBR plant = 15.6 kg/day

Assuming a loading rate of 8gBOD/m² of active surface of the bio-carrier units, the required active surface required = 15,600/8 = 1,950 m²

Assuming Active surface area of the bio-carrier unit = 400m² per m³ of media

Volume of bio-carrier units required = 1,950/400 = 4.875 m³ **Say 5 m³**

(ii) Flocculation

The next tank is a flocculation tank (tank 06) where effluent is subject to a dosage of an alum flocculant compound through flash mixing process and then a slow mixing process. Impurities, dissolved solids and bacteria separate from the water and coagulate.

(iii) Clarification

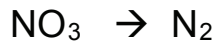
The effluent flows from the flocculation basin to the clarifier (tank 07) where settling of the sludge takes place.

The clarifier is a concrete basin, rectangular at the top with a conical bottom. Lamella packs shall be placed in the basin to aid in the settling of the sludge.

Settled sludge at the clarifier is re-circulated to the anoxic tank by means of a submersible pump for de-nitrification and associated BOD₅ removal, stabilization and volume reduction.

(iv) De-Nitrification

At the anoxic tank, de-nitrification takes place in the absence of dissolved oxygen (anoxic) and in the presence of oxygen combined with the organic nitrates to form gaseous nitrogen.



This Primary sedimentation/anaerobic/anoxic tank shall be de-sludged once every year by means of cesspool emptiers which shall cart away the sludge to be disposed of at WMA authorised stations.

H.3.3 Tertiary Treatment

(i) Dis-infection by Chlorination

The effluent, after the clarification process, flows by gravity to a chlorine contact tank (tank 08) where it is subjected to a chlorination process by means of a chlorine solution which is injected by a membrane pump into the water.

(ii) Filtration

Subsequently, at the end of the chlorine contact tank, the water shall be pumped up by means of submersible pumps of capacity 2.5m³/h @ 20m head to be subjected to a filtration through discs / Sand filters of the appropriate capacity and then stored in an irrigation tank to be used for irrigation. This irrigation tank shall be about 60 m³ (tank 09)

H.4 Disposal of Effluent

The final treated water shall be used for irrigation. (To be instructed by Client)

Any extra not used for irrigation shall be disposed of in an absorption pit.

I. **INSTALLED EQUIPMENT AND CAPACITY**

Grease trap = No mechanical / electrical equipment

Anaerobic tank = No mechanical / electrical equipment

Balancing tank / Lifting pumps = a set of 2 nos permanently installed submersible pumps each of capacity 2.5 m³/h of rating 0.4 kW

Bio-reactor tank: Bubble air diffusers and bio-carrier tube assemblies. No electrical equipment or any moving parts.

2 nos Air blowers at the plant room.

Clarifier = 2 nos Sludge recycling pumps each of capacity 0.5m³/h and rating 0.35kW each.

Chlorine contact tank:

- dosing = 1No automatic chlorinator consisting of a set of membrane pump of capacity 20 L/h.
- Lifting pumps: a set of 2 nos permanently installed submersible pumps each of capacity 2.5 m³/h @ 2 bars of rating 0.4 kW

Alum dosing = 1No automatic chlorinator consisting of a set of membrane pump of capacity 20 L/h.

A dedicated electrical panel for the whole STP shall be provided.

J. ODOUR NUISANCE AND ODOUR ABATEMENT SYSTEM

- (i) All sewer manholes and sewer lifting stations shall be air tight
- (ii) The grease trap shall be in fully underground. There shall be water points nearby for cleaning of baskets etc.
- (iii) The anaerobic tank where primary settling and digestion takes place, which is very odorous, shall be fully enclosed and shall operate in an anaerobic atmosphere.
- (iv) The MBBR basin is fully enclosed and shall be odourless when operating at optimum capacity. The basin shall have a ventilator pipe running to the roof of the technical room, with a cowl vent at the top end.
- (v) The Fluculation, clarifier and chlorine contact tanks shall be open types and shall be odourless.

K. NOISE GENERATION AND ABATEMENT REQUIRED

Submersible pumps for sludge recirculation are fully submerged in enclosed tanks. Noise produced is low.

The chlorine dosing pump is almost noiseless.

The air blowers and irrigation pumps are enclosed in a pump room and the noise produced is completely abated.

Overall noise level at the STP shall be low.

L. SOLID WASTE MANAGEMENT INCLUDING CONTAINMENT OF HAZARDOUS WASTE

All solid waste and grease collected at the grease trap shall be placed in refuse plastic bags and disposed of through the Local Authorities waste collection. Sludge shall be carted away by waste water carriers yearly to an approved disposal station.

No hazardous waste shall be generated at the residential complex.

M. CHARACTERISTICS OF THE FINAL TREATED WATER THAT WILL BE PRODUCED AND THAT WILL BE USED FOR IRRIGATION PURPOSES: (EPA 2002)

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|-------|--------------------------------|--------------------------------|
| (i) | PH | = 5 - 9 |
| (ii) | BOD ₅ - 24h average | < 40 mg/L (to aim for 10mg/L) |
| (iii) | COD - 24h average | < 120 mg/L (to aim for 25mg/L) |
| (iv) | Suspended solids | < 45 mg/L (to aim for 10 mg/L) |
| (v) | TKN (Total Kjeldhal Nitrogen) | < 20 mg/L (to aim for 10 mg/L) |
| (vi) | Phosphates | ≤ 1 mg |

