APPENDIX 2C: SEWAGE TREATMENT PROCESS

1. General

The Sequencing Batch Reactor (SBR) sewage treatment process is selected as a major process unit for Peng Chau Sewage Treatment Works Upgrade. For the whole treatment process, the relevant units used in this Project are depicted as follows.

2. Preliminary Treatment

2.1 Screening

Treatment will start from the screening units. The general purpose of screens is to remove large objects such as rags, paper, plastics, metals, timber and the like. This can avoid damage of pumping and sludge removal equipment, hang over weirs, channels and pipelines and other operation and maintenance problems.

Two mechanically raked fine screens (one duty and one standby) will be provided. Each screen is designed to handle the maximum flow (150 l/s) from the Peng Chau Sewage Pumping Station. The standby screen and channel is capable to change over automatically while duty unit is out of service or the high water level appear in the duty channel.

As the sewage has already passed through a basket screen of an aperture size 50 mm at the Peng Chau Sewage Pumping Station, only fine screen of aperture size 6 mm will be required in the inlet works.

2.2 Grit Removal

Following the screens, grit removal will be required to remove inorganic grit (of around 0.2 mm) to protect moving mechanical equipment from unnecessary wear and abrasion, prevent clogging in pipes, heavy deposits in channels, cementing effects on the bottom of sludge storage and treatment tanks and accumulation of inert material in equalization and sewage/sludge treatment tanks which will result in loss of usable volume.

Grit removal will be achieved by using a stirred/vortex type of grit chamber period (one duty and one standby). Each unit could handle a maximum flow of 120 l/s (PDF+Storm Allowance) and the relatively small flow in off peak period.

2.3 Equalisation Tank

After the preliminary treatment (screening and grit removal), the sewage will flow into equalisation tank. The equalisation tanks will be used for storing sewage temporarily and used as a preventative measure to protect effluent quality in extreme storm conditions. The equalisation tank also acts to equalise the flow in terms of organic loading. Mixing will be provided by submersible mixers to prevent sewage from septic.

A two-compartment equalisation tank is proposed. In normal condition, only one compartment will be used as a wet well of the pump. In heavy storm condition, two compartments, with capacity of 1,000 m^3, will be used to temporary store the flow exceeding the capacity of the SBR.

When the SBR is not available to receive sewage, the screened and de-gritted sewage will be temporary stored in the equalisation tank and pumped when SBR is ready to receive the sewage. The equalisation tank will be design to allow flows by gravity, if possible, to the SBR tank. It could save the energy/cost on pumping for re-lift the sewage from equalisation tank.

The two-compartment design could facilitate the maintenance of equalisation tank without affect the normal operation and avoid higher pumping energy to lift the sewage which is always at low level due to a large area of a single compartment's equalisation tank.

2.4 Pumping Station

A pumping system may be required to provide sufficient hydraulic head to lift the sewage from the equalisation tank to the SBR. There are two submersible pumps (one duty and one standby) installed inside the equalisation tank. Each pump could handle 55 l/s (PDF) or the flow required to match with the SBR filling cycle. The function of automatic change over in case of the duty unit is out of function will be included in the design.

3. Sequencing Batch Reactor Biological Treatment

The screened and degritted sewage will be treated in the SBR. There are four SBR tanks. They could handle peak flow of 4740 m^3/d (3 x ADWF). In case of one tank is out of service, the equalisation tank will temporary store the flow exceeding the SBR's capacity during the peak flow. During off peak period, the reminder three units will treat the sewage stored in the equalisation. In the SBR reaction tank, complete metabolism of the adsorbed materials occurs during the treatment cyclic. The SBR operation will be automatically controlled by the SCADA/PLC system in a pre-determined cycle. The treatment can be operated in different cycle times to enable operational flexibility. For normal operation, the operation consists:

(1) Filling Phase

Filling phase starts from sewage influent and ends at having the desired volume ready for starting the reaction phase. In this phase, the aeration, mixing and settling could occur to achieve different treatment targets.

(2) Aeration Phase

Aeration is provided to meet the process oxygen demand for carbonaceous oxidation, nitrification and for mixing. The diffusers located at the bottom of basin are provided to supply air in each basin. A dissolved oxygen (DO) sensor is usually employed for aeration control to maintain appropriate DO level to enhance simultaneous nitrification-denitrification.

(3) Settlement Phase

Immediately after the aeration, settlement/clarification occurs. Once aeration has stopped, the sludge settles. The conditions in the basin become anoxic. Further carbonaceous oxidation and denitrification occur during this phase.

(4) Decant Phase

Following the settlement phase, the decant sequence is initiated to skim-off the clear, treated liquor. The supernatant is skimmed-off by a surface skimming decanting system including a mechanical actuator. The decanter is sized to ensure uniform skim-off rate without disturbance of the settled sludge interface. Adequate buffering distance will be incorporated in basin depth between the bottom water level and the sludge blanket.

Carbonaceous oxidation and denitrification continue to occur during this phase. Surplus sludge is wasted to the sludge thickener during this phase. This is accomplished using the submersible desludge pump with proper flow control.

At the end of the decanting phase, the cycle is repeated with the start of filling.

4. Others

4.1 Effluent Pumping Station, if required

If the hydraulic level of the effluent from the SBR tanks is lower than that in chlorine contact tank (CCT), the effluent pumping station will be required. It will provide not only a balancing capacity for decanted flows from SBR tanks but also lifting the hydraulic gradient to that in CCT. The pumps will be designed to handle the maximum decanted flow before next start of decanting cycle.

4.2 Chlorination and Dechlorination

The treated effluent will be disinfected through the chlorine contact tank. Although the effluent is treated, it contains many types of human enteric organisms that are associated with various waterborne diseases. Disinfection can selectively destruct the disease-causing organisms in the sewage effluent. The chlorine contract tank and the associated chemical dosing facilities will be designed to meet the *E.coli* criteria of ≤ 1000 /100 mL (geometric mean).

The Sodium hypochlorite solution (at 7%) is proposed. An average dosage of 5 mg/L and peak dosage of 10 mg/L will be designed to dose at the inlet pipe of chlorine contact tank to mix with the effluent from SBR. A chlorine contact time of 45 minutes under the average flow (or 15 minutes for the peak flow) will be used for the design.

The effluent from chlorine contact tank will flow to the dechlorination chamber in which sodium bisulphite solution (at 38%) with an average dosage of 1.5 mg/L and peak dosage of 4 mg/L is proposed for dechlorination of the effluent to meet the effluent quality requirement of residual chlorine less than 1 mg/L prior to outfall discharge.

There are two hypochlorite dosing pumps (one duty and one standby) and two bisulphite dosing pumps (one duty and one standby), they are responsible to convey their corresponding chemicals from the respective storage tanks to their dosing points.

4.3 Submarine and Emergency Outfalls

The proposed submarine and emergency outfalls with approximately 100 m and 40 m long extend from the western coast of Tai Lei Island respectively will finally convey the effluent to offshore. Six diffusers with 100mm in diameter will be provided on the outfall pipe with 250mm in diameter in order to obtain the minimum dilution ratio of above 80 in the normal condition.

4.4 Return Liquor Pumping Station (RLPS)

The return liquor pumping station is designed to act as a buffer for receiving all equipment drains from screening compactor, grit classifier, sludge dewatering units and etc. It also receives the process tank drains from grit chamber, SBR basin, sludge storage and treatment tanks and chlorine contact tank. Two submersible pumps (one duty and one standby) are designed and located in the wet well of RLPS for pumping the liquid back to the equalization tank. We will consider to combine this with the equalization tank during the detailed design stage, if possible.

4.5 Screenings Handling

The screenings removed by the screens will be conveyed to a storage skip directly or through a conveyor and screening washpactor. The screenings washpactors are to provide a function of washing and compacting of screenings. In case of conveyor or washpactor failure, their standby units will automatically switch over to take their normal duty.

4.6 Grit Handling

The grit slurries from the girt chamber will be pumped to grit classifier by two grit pumps (one duty and one standby). The grit classifier is to perform grit washing and classifying to remove the organic substance attached on the grit so that the odour from grit can be minimised. The classifier will then convey the washed grit to wheeled storage skip.

4.7 Sludge Handling and Disposal

4.7.1 Sludge Thickener

The surplus (waste) sludge from SBR basins will be pumped to the sludge thickener. Two thickener tanks will receive the sludge, which contains large volumes of water. Thickening of sludge is used to concentrate the solids and reduce the volume. The thickened sludge requires less tank capacity and chemical dosage for stabilization and smaller pipe and pumping equipment for transport. The waste sludge with a concentration of less than 1% will be thickened to about 2-4% concentration through the gravity thickener.

4.7.2 Sludge Stabilisation

Two Aerobic Sludge Digestion Tanks (ASDT) will be located at the down stream of gravity sludge thickener and received thickened sludge pumped from thickener tank. Stabilisation can reduce the sludge volume and volatile solids in sludge, lower BOD concentrations in supernatant liquor and production of an odourless, humus-like, biologically stable end product.

Two digestion tanks are designed to hold average production of thickened sludge with 3% solid for 15 days. The sludge will be further digested aerobically in ASDT. The aeration will stop periodically so as to allow the solid to settle and thicken. After a short period of settling time, the supernatant valve mounted on the different level of ASDT's wall will open to discharge the supernatant in ASDT by gravity to the Return Liquor Pumping Station then pumped back to equalisation tank.

4.7.3 Sludge Dewatering and Disposal

Two arrangements of sludge dewatering and disposal, namely sludge export scheme and onsite drying bed dewatering scheme have been considered. Sludge export scheme would involve transporting of wet digested sludge at about 3-5% solids to other designated sewage treatment works for centralised dewatering and disposal. Sludge drying bed is capable of increasing sludge solid contents to 30% and dry sludge can be transported to designated landfill via Peng Chau Refuse Transfer Station.

In the initial operational stage of STW Upgrade, there will be constraints on land availability for constructing sludge dewatering facility such as drying bed. However, it is expected that the inflow is below the design capacity, due to the time lapse of household sewerage connection works. Accordingly, the sludge volume generated is estimated to be small and it would be more cost effective to adopt sludge export scheme for centralised sludge dewatering and disposal of. After the demolition of unnecessary existing buildings, sludge drying bed with odour control units can be constructed as standby units.

Sludge export scheme would become less cost effective when higher volume of sludge would need to be barged away. In addition, this scheme would also be constrained by the treatment capacity of the designated centralised dewatering facility. In view of the above, DSD may consider switching the sludge export scheme to on-site sludge drying bed scheme as duty dewatering facility. Therefore, installation of odour control units are required. Infrequent sludge export scheme would remain as a backup should breakdown or maintenance of odour mitigated sludge drying bed be occurred.

4.8 <u>Instrumentation, Control and Automation System</u>

A complete, fully functioning, fully automatic SCADA system will be designed for the full process of upgraded Peng Chau STW. Each process facility or plant shall be equipped with the dual redundant hot-standby functional processors and associated I/O. All functional process shall be connected with field instrument/device by hardwire and connected with SCADA system through a dual redundant system information network. The existing telemetry panel will be demolished and its existing functions will be incorporated in the SCADA system.

The communication among the Peng Chau STW, Peng Chau Pumping Station and Cheung Chau STW will be maintained through the telephone leased line.

The following instrument shall be provided for the process control and on-line monitoring of the operating conditions for the sewage treatment plants

(a) Ultrasonic Level Sensor

(b) Electromagnetic Flowmeter

(c) Dissolved Oxygen (DO) Sensor

(d) pH / temperature sensor

(e) Residual Chlorine Monitoring Unit

(f) Automatic Sampler

(g) Overflow Monitoring Device