CODE OF PRACTICE

ON

SEWERAGE AND SANITARY WORKS

(2nd EDITION – JAN 2019)

(INCLUDED AMENDMENTS UNDER ADDENDUM NO.1 – MAR 2021)

PUB SINGAPORE'S NATIONAL WATER AGENCY

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CODE OF PRACTICE
ON
SEWERAGE AND SANITARY WORKS

PUB would like to thank the following Professional Bodies, Trade Associations and members of the Inter-Agencies Coordinating Committee (IACC) for their constructive feedback and comments on the Code of Practice on Sewerage and Sanitary Works (2nd Edition):

Association of Consulting Engineers, Singapore (ACES)
The Institution of Engineers, Singapore (IES)
Singapore Institute of Architects (SIA)
Singapore Plumbing Society (SPS)
Real Estate Developers' Association of Singapore (REDAS)
The Singapore Contractors Association Ltd (SCAL)

Members of IACC:

Housing & Development Board (HDB)
National Environment Agency (NEA)
National Parks Board (NParks)
Building and Construction Authority (BCA)
Energy Market Authority (EMA)
JTC Corporation (JTC)
Land Transport Authority (LTA)
Singapore Civil Defence Force (SCDF)
Urban Redevelopment Authority (URA)
Ministry of Manpower (MOM)
Ministry of Finance (MOF)

CONTENTS

INTRODUCTION

Sewerage systems are essential to maintain a high standard of living in a city. In Singapore, it is also an important part of the "Water Loop", the management of which is key to reclamation of our precious water resources. All developments should therefore have sanitary and sewerage facilities to convey sewage to the public sewerage system.

This 2019 edition of the Code of Practice on Sewerage and Sanitary Works (COPSSW) incorporate changes and updates made over the years to address new technical issues faced and feedback from the public and industry. It is intended to guide developers, Qualified Persons (QPs) and Licensed Plumbers in planning for sewerage and sanitary plumbing provisions to meet requirements for the developments.

For projects with specialised functions such as major infrastructure projects, hospitals, farms, projects on temporary/transitional land-use and projects utilising internal water reclamation, developers should consult PUB early prior to development submission as specific requirements beyond those covered by the COPSSW for each project are different and may impact project costing, schedule or even feasibility.

This COPSSW should be read in conjunction with the Sewerage and Drainage Act (SDA) and its Subsidiary Legislations where compliance of the requirements is mandated.

PUB, Singapore's National Water Agency

TERMINOLOGY

"discharge pipe"	means a pipe which enables any sewage or sullage water to be conveyed from a sanitary appliance or floor trap to a drain-line;
"discharge stack"	means a main vertical discharge pipe that extends through at least one storey with or without offsets;
"drain-line"	means a pipe which enables any sewage or sullage water to be conveyed from waste sumps or inspection chambers to a sewerage system;
"Professional Engineer (PE)"	means a professional engineer registered under the Professional Engineers Act (Cap 253) whose qualification is appropriate to the nature of those works and has in force a practicing certificate issued under that Act;
"PUB"	means the National Water Authority PUB, established under section 3 of the Public Utilities Act (Cap. 261).
"public sewerage system" and "public sewer"	means any sewerage system or any sewer owned, managed or maintained by PUB.
"public sewer corridor"	means the land and space bounded by 2 vertical planes through which any sewer, main or pipe of a public sewerage system runs (whether under, on or above ground);
"qualified person"	means a qualified person appointed under the Building Control Act (Cap. 29) whose qualification is appropriate to the nature of those works;
"sanitary appliances"	includes wash basins, bathtubs, sinks, urinals, toilet bowls, bidets and other similar fixtures;
"sanitary drainage system"	means a network of drain-lines including any waste sump, inspection chamber and any other related appurtenances;
"sanitary facilities"	means facilities for collection of sewage and sullage water and includes bathrooms, toilets, facilities for washing and sanitary appliances, together with the associated pipework, which connect to a sewerage system;
"sanitary plumbing system"	means a network of discharge pipes including any discharge stack, ventilating pipe, ventilating stacks, floor trap, pump, fitting and any other related appurtenances;

“sanitary works”	means (*a*) constructing, altering, repairing, replacing, discontinuing or closing up any discharge pipe, ventilating pipe, drain-line, fitting, floor trap, inspection chamber, grease trap, pump or any other appurtenances related to the conveyance of sewage or sullage water from any sanitary appliance or sanitary facility to a sewerage system; and (*b*) installing, fixing, altering, repairing or removing a sanitary appliance or sanitary facility, and any other connected works;
“sewage”	includes water-borne domestic waste and trade effluent;
“sewerage system”	means a system of sewers, pumping mains, pumping stations, sewage treatment plants and sewage treatment works and water reclamation facilities for one or both of the following purposes: a) the collection, treatment and disposal of sewage; and b) the recovery and treatment of water, which is supplied to the board or by Board, and includes any main or pipe carrying reclaimed water or sewage, outfall pipe, sanitary pipe, drain line, grease trap, cesspit, holding tank for the temporary holding of sewage, septic tank, privy, and any part thereof;
“sewerage works”	includes engineering works for the construction, alteration and maintenance of any sewerage system;
“ventilating pipe”	means a pipe provided to limit the pressure fluctuations within any discharge pipe;
“ventilating stack”	means a main vertical ventilating pipe that extends through at least one storey with or without offsets;
“waste pipe”	means a pipe which connects any wash basins, baths/showers or sinks to a floor trap or any urinals to a urinal trap;

1. PLANNING FOR DEVELOPMENT WORKS

1.1 PLANNING CONSIDERATIONS

1.1.1 Duty to investigate to locate sewers and pumping mains

Before proceeding with design of a development, the Sewerage Information Plan (SIP) shall be obtained. The exact position, alignment and level of each of the affected sewers and pumping mains must be ascertained at site and shown in the submitted plan.

1.1.2 Connection to Public Sewer

Sanitary facilities and sewerage system of all developments shall be connected to a public sewer at a connection point, usually at public area, approved by PUB.

1.1.3 Existing Public Sewers within Development Site

a. The development shall comply with the following:
   i. structures not to be built over sewers (see 1.2.4)
   ii. proposed permanent structures shall meet the specified public sewer's 'setback distances' (see 1.2.5)

b. If the development is unable to comply with 1.1.3(a), PUB's approval shall be sought to either:
   i. relocate the existing sewer affected (see 1.2.6); or
   ii. co-locate with the existing sewer affected with provision of reinforced concrete trench (see 1.2.7)

c. Comply with the sewer protection requirements (see Section 2) to protect the public sewerage system.

1.1.4 Temporary Holding Tank

Where a development cannot be served by public sewers, PUB may allow the use of temporary holding tank (see **Annex J**).

1.2 TECHNICAL CONSIDERATIONS

1.2.1 Sanitary Drainage System

a. All internal sanitary drainage system serving a development shall be connected to a public sewer at connection point(s) approved by PUB.

b. Top levels of Inspection Chambers (IC) shall be at the same level or higher than the top level of the manhole to which the development connects.

c. Pumped system (see 3.3 and 4.1(c)) shall be provided where:

   i. top level of ICs and floor traps within a development are lower than the public sewer manhole cover level to which the drain-line is connected; or
   ii. there is sanitary facility in basements.

1.2.2 New Sewer

All new sewers to be handed over to PUB shall be sited in public land unless exempted by PUB. Developers shall obtain approval from relevant Government agencies managing the affected public land for the new sewers/manholes.

1.2.3 Connection of Drain-line to Public Sewer for New Development/Redevelopment

a. The drain-line from the premises to the public sewer, including the section beyond the development lot boundary, belongs to the user it serves. The developer shall provide this drain-line.

b. If the new connection extends beyond the development lot boundary, the developer shall obtain the consent of the owners of any affected land for the proposed drain-line.

c. For development with multiple lots, e.g. detached or terrace houses on individual lots (not landed strata housing), every lot shall be provided with an individual drain-line connection to the public sewer (see section 4.2.1(d)).

d. For condominiums, apartments, mixed residential/commercial developments, worker dormitories, commercial buildings and major industrial developments, the drain-line connection to the public sewer shall be made via a manhole.

e. For a development stated in (d), all existing raised or 'Y'-junction connections to the public sewer serving developments shall be upgraded to manhole connections.

f. The drain-line connection must have adequate capacity and in good condition.

g. For redevelopment, existing drain-line connection going into neighbouring premises shall be discontinued where direct connection to public sewer in the public area is feasible.

1.2.4 Structures over Sewer

a. No structure or buildings shall be placed over or across any sewer without the approval of PUB.

b. 'Structure' excludes lightweight and demountable elements such as awnings, surface drains, compound boundary wall & fencing, planting troughs and link-way shelters.

c. Utilities may over-cross or under-cross sewer at minimum 1m vertical clearance but shall not be laid parallel to and over the sewer. Utilities laid parallel to the sewer shall keep a minimum 1m horizontal clearance from the sewer edge. Where the utility authorities require clearance of more than 1m for on sewers near their utilities after they are put into use, their proposed utilities shall keep the same clearance to the existing sewer in any direction when the utilities are laid.

d. No manhole shall be built inside any building or under any structures. Manhole shall not be covered up or paved over without the approval of PUB.

1.2.5 Setback from Sewer

All structures shall maintain the following minimum distance from sewers:

Table 1- Sewer/Pumping Main Setback

Sewer/Pumping Main Nominal Diameter(mm) D	Sewer Depth (m)	Minimum Distance (m)*
≤ 600	≤3	1.0
	>3 and ≤5	1.5
	>5	2.0
> 600 to 1500	All	0.5D + 2.5
>1500 to 2500		0.5D + 3
>2500		0.5D + 4
Deep Tunnel Sewerage System (DTSS)		0.5D + 6
* measured from the outer most edge of the structure, including footings and overhangs, to the centreline of the sewer pipe or DTSS.		

1.2.6 Diversion of Sewer

PUB may consider proposed diversion of existing public sewers for better land utilisation of development when carried out at the developer's cost.

1.2.7 Access to Maintain Sewers at All Times

Where the condition in 1.2.4, 1.2.5 or 1.2.6 cannot be achieved, a reinforced concrete (RC) trench complying with requirements in **Annex A** shall be provided for repair and maintenance of the sewer.

1.2.8 Abandoning Disused Sewerage System

a. No sewerage system shall be discontinued or closed up without approval from PUB.

b. The following requirements shall apply for abandoning disused sewerage systems:

   i. The ends of abandoned drain-lines/public sewers shall be sealed and made watertight with 225mm thick brickwork rendered with cement mortar.

   ii. Pipes of all sizes within road reserve and pipes of diameter 300mm and above elsewhere shall be filled/grouted with cement grout or approved material~~s~~.

   iii. The top 600mm, or a depth required by the relevant Authority, of the abandoned chambers and manholes shall be removed and the remaining chambers/manholes shall be filled with well compacted approved soil.

2. SEWER PROTECTION

2.1 SEWER PROTECTION CONSIDERATIONS

2.1.1 Provisions to Protect Sewers

a. All developments and construction activities shall be carried out with provisions to protect the sewers in the vicinity of the developments.

b. Submission is required for Specified Activities carried out in Public Sewer Corridor (see 2.1.2)

c. Any Specified Activities in a Public Sewer Corridor must be:
   i. carried out in accordance with the plan approved by PUB; and
   ii. supervised by a PE (Civil, Structural or Geotechnical) where applicable.

d. It remains the responsibility of the Developer/contractor or the supervising PE to take measures to protect the sewers even if their activity is not a Specified Activity or carried out outside the Public Sewer Corridor.

e. The alignment of the sewers or pumping mains must be pegged and public sewer corridor must be marked on site so that they are clearly visible and appropriate precautions and protection measures can be taken to safeguard the sewers or pumping mains during the carrying out of the Specified Activities.

2.1.2 Public Sewer Corridor and Specified Activities

a. "Public Sewer Corridor" means the land and space bounded by 2 vertical planes as illustrated below, through which any sewer, main or pipe of public sewerage system runs (whether under, on or above ground).

Table 2 – Public Sewer Corridor

Public Sewers	Distance X on either side from the centreline
DTSS tunnels	40m
Sewer $\geq$ 900mm in Diameter	20m
Sewer <900 mm in Diameter	10m

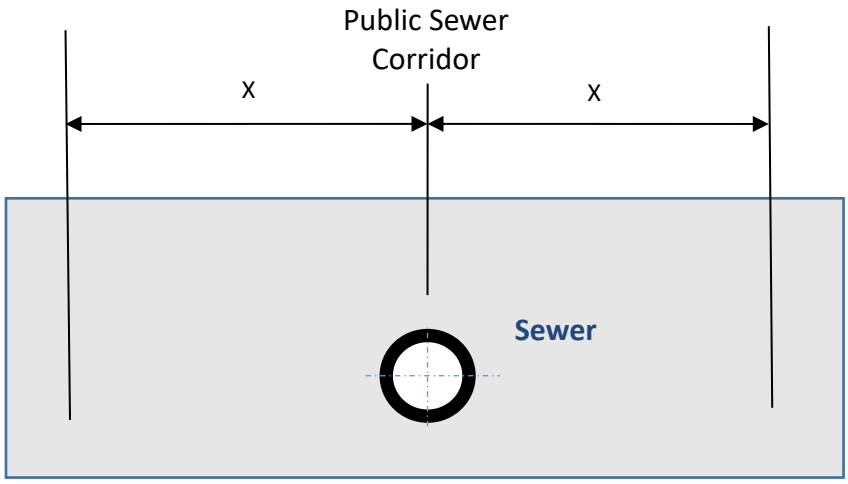

Figure 1: Public Sewer Corridor

b. 'Specified Activities' include:

i. the carrying out of any earthwork for site formation, whether by excavation, filling or backfilling;
ii. the excavation of any trench, well, pond or pool, or excavation for any underground structure which is more than 0.5m in depth;
iii. the excavation of earth, rock or other material by means of explosives;
iv. the carrying out of any ground exploratory or testing works including through soil boreholes and geological surveys;
v. the installation of any foundation, sheet-piled foundation, earth retaining or stabilising structure, ground anchor, horizontal tie-back or any other similar installation;
vi. the carrying out of any ground stabilising work including jet grouting, soil compacting, ground freezing, ground water recharging etc;
vii. the carrying out of any tunnelling, pipe jacking, mining or subterranean excavation of earth/rock;
viii. the erection of any permanent or temporary structure including any site office or show flat;
ix. the installation of any heavy construction machine/plant including the stacking and installation of any concrete block for pile testing;
x. the installation of any container box.

2.2 TECHNICAL REQUIREMENTS FOR SEWERAGE PROTECTION

2.2.1 Details to be Submitted

a. If the Specified Activity is within the public sewer corridor of sewers < 900mm in diameter:

   i. SIP showing the existing sewers/manholes within and near the site;

   ii. Layout plan showing the proposed building/structures (including retaining and boundary walls, footings drains, etc.) or engineering works. The plan shall indicate the minimum setback distance for the existing sewer to the structures;

   iii. Survey plan endorsed by Registered Surveyor (RS) showing the alignment of all the affected public sewers/manholes and the public sewer corridors;

   iv. Pre-construction closed-circuit television (CCTV) inspection report together with the CCTV video for the public sewers (see 2.2.2);

   v. Method statement detailing how the works/activities are proposed to be carried out;

   vi. Detailed drawings for the works/activities (e.g. piling plans) and details of the machinery/equipment to be used;

   vii. PE's analysis/assessment that the construction method proposed will not cause any impact or damage to the sewerage system; and

   viii. Such other plan, information, technical report, certificate and document such as Construction Impact Assessment Report (CIAR), instrumentation and monitoring plan as may be required by PUB.

b. If the Specified Activity is within the public sewer corridor of sewers ≥ 900mm in diameter or DTSS tunnel

   i. All the documents listed in (a) (i) to (viii) above;

   ii. Construction Impact Assessment Report (CIAR) (see 2.2.3)

   iii. Instrumentation and monitoring plan (see 2.2.4); and

   iv. Details of installation of web-based IP surveillance cameras if the specified activities are carried out within sewer setback.

2.2.2 Pre/Post-construction CCTV Inspection of Public Sewer

a. Before commencing the specified activity, a PUB registered CCTV contractor shall be engaged to carry out a pre-construction CCTV inspection of the sewer/manhole. Similarly, on completions of works, a post–construction CCTV inspection to be carried out to establish whether the sewer/manhole is damaged.

b. For small-scale redevelopments/A&A works for a single landed property (terrace, semi-detached and detached house), only post-construction CCTV inspection is required.

2.2.3 Construction Impact Assessment

a. The PE shall carry out an impact assessment of the Specified Activities and assess the risk, likelihood of damage to the sewers and propose measures to prevent or mitigate any adverse impact on the sewers.

b. The following limits measured or calculated at the sewers shall apply for all activities carried out within the Public Sewer Corridor:

Table 3 – Limitation of Impact to Public Sewer

Impact Analysed	Limits
Vibrations	Peak particle velocity (PPV) not exceeding 15mm/s at any frequency.
Ground displacements	If ground displacement exceeds "zero", calculated crack width shall not exceed 0.1mm in the sewer ≥900mm in diameter /DTSS tunnel structure.
Load transfer to sewers	Not to exceed an average of 10kPa
Groundwater drawdown	Not to exceed 10kPa in the vicinity of the sewers

2.2.4 Instrumentation and Monitoring Programme

The QP/PE shall implement an instrumentation and monitoring plan to monitor ground movements, vibrations, variation of ground water table and pore pressures as detailed in **Annex G**.

2.2.5 Additional Requirements for Protection of Large Sewer (≥900mm in diameter) and DTSS Tunnel

a. No building/structure (whether temporary or permanent) shall be carried out within the setback.

	b. For piling and deep excavation works within setback of sewers pre-probing shall be conducted to verify that the piles/excavation works are kept clear from the sewers and DTSS tunnels. The QP or PE shall submit the detailed method statement for the pre-probing works to demonstrate that the proposed method is non-invasive and will not cause any impact or damage to the sewers or DTSS tunnels. c. Displacement piles or piling works carried out by percussion method are not allowed within setback. d. The contingency plan to ensure that the flow is not disrupted should the existing DTSS tunnels/sewer be damaged during construction works shall be kept at site. The contingency plan shall be activated and repair works must be immediately carried out in the event that any DTSS tunnels/sewer is damaged. e. A pre and post-construction CCTV, Sonar and Laser inspection of the DTSS tunnel may be required for specified activity carried out within the setback of the DTSS tunnel/structures.
2.2.6	All other requirements are specified in the **Annex G**

3. SEWERAGE SYSTEM DESIGN

3.1 DESIGN CONSIDERATIONS

a. The sewer network is to convey sewage and shall not be combined with storm water system.

b. Sewers and their appurtenances shall be designed to:

i. provide adequate flow capacity with sufficient gradient to convey sewage by gravity (see 3.2.1);
ii. have proper hydraulic connections and drop structures (see 3.2.2 and 3.2.3);
iii. convey sewage by pumping where gravity flow is not possible (see 3.3);
iv. be watertight and durable (see **Annex D**); and
v. be accessible for inspection and maintenance.

3.2 DESIGN AND TECHNICAL REQUIREMENTS FOR SEWERS

3.2.1 Sewer Design Basis

a. Design Flow for Residential Development
The design flow shall be based on the average daily per capita flow as tabulated.

Table 4- per Capita Flow

	Average Domestic Daily Flow (litres per capita per day)	Peak Factor
Public housing	230	3
Private housing	345	

For design purpose, a single dwelling unit shall be taken to comprise 4 persons.

b. Design Flow for non-Residential Development

The proposed design flow together with the basis shall be submitted to PUB for approval.

c. Sewer Sizing

Sewers shall be sized to carry the design peak flow at a flow depth of:

i. not greater than half the nominal diameter of the pipe for pipes up to 1.0m diameter;
ii. not greater than 2/3 of the nominal diameter (i.e. two-third (2/3) bore) for >1.0m diameter.

d. Minimum Sewer Size and Depth

i. The minimum size of new sewers shall be 200mm in diameter. *[Addendum No. 1 – Mar 2021]*
ii. Sewer pipes shall be laid at a minimum depth of 1.5m below ground level unless the ground profile and the existing sewer level do not permit.
iii. For sewer pipe laid by cut and cover method, the pipe bedding shall be constructed in accordance with the section types detailed in the Standard Drawings (see Standard Drawing PUB/WRN/STD/001B).

e. Sewer Gradient and Flow Velocities

i. Sewers shall be designed to achieve a velocity of approximately 1.5m/s at design peak flow.
ii. The minimum and maximum velocity for design peak flow in the constructed sewers shall not be less than 0.9m/s or more than 2.4m/s respectively.
iii. For small development using the minimum pipe size of 200mm diameter, new sewers should be laid at a minimum grade of 1 in 50 where possible.

f. Straight Alignment between Manholes

Generally, gravity sewers shall be designed with straight alignment between manholes.

3.2.2 Sewers, Manholes and Pipe Connections

a. All sewers and manholes shall be at minimum 1.5m depth below ground and shall comply with PUB's Standard Drawings (see **Annex B**). The structural design of sewers and manholes shall be carried out by a PE.

b. Where sewers and manholes are to be constructed in reclaimed land, appropriate ground stabilisation or foundation system shall be provided to prevent the settlement of the sewers and manholes.

c. The distance between manholes shall not be more than 120m.

d. Manholes walls, the underside of all platforms, slabs and other location shown in standard drawing shall have HDPE lining.

e. Incoming sewer pipes connecting to manhole shall be joined at the soffit level of the outgoing sewer. For connection to a smaller diameter outgoing sewer, the connecting sewer pipe shall be made at the invert level of the outgoing sewer pipe. *[Addendum No. 1 – Mar 2021]*

f. Sewer pipes connecting at grade in a manhole shall not form an acute angle with the outgoing sewer.

g. All manholes and sewer connections shall pass the water-tightness test in **Annex D**.

3.2.3 Hydraulic Drop Structures

a. Hydraulic drop structures e.g. tumbling bays, backdrops, and vortex drops complying with PUB's Standard Drawings shall be provided to connect sewers at different levels as tabulated below.

Table 5 - Drop Structures Requirements

Type of Drop Structures	**Difference in Incoming/Outgoing Sewer levels**	**Sewer Diameter, D**
Tumbling Bay/Backdrop	≤ 6.0m	• ≤300mm • For 300mm <D≤ 500mm, max peak flow velocity shall be less than 1.2m/s
Vortex drop (based on Standard Drawing Design PUB/WRN/STD/009)	>6.0m	≤450mm
Vortex drop (QP design)	All depth	>450mm

3.3 TECHNICAL REQUIREMENTS FOR PUMPING INSTALLATIONS

3.3.1 Pumping Installation Design

The design of a sewerage pumping installation shall take into consideration the following:

a. Mechanical design (see 3.3.2)
b. Electrical design (see 3.3.3)
c. Pumping mains (see 3.3.4)

PUB may impose additional requirements if the sewerage pumping installation is to be handed over to PUB.

3.3.2 Mechanical Requirements

a. A pumping system shall be provided with:
   i. duty and standby pumps; and
   ii. reflux and isolating valves

b. The pump shall not be oversized and its discharge rate shall not exceed 3 times the inflow rate.

c. The pump receiving discharge from toilets and food establishments shall have a minimum free passage diameter of 64mm. The diameter of discharge pipe shall be larger than the free passage diameter.

3.3.3 Electrical Requirements

a. The electrical installations shall comply with the latest Singapore Standard (SS) CP 5, SS 551 and BS EN 60947-4.

b. The following electrical items shall be provided with:

   i. Separate fused switch or circuit breaker for each pump.
   ii. Single-phase, overload and earth fault protection for each pump.
   iii. Ammeter, indicating lights, start-stop and fault reset push buttons, and manual/automatic selector switch for each pump.
   iv. Pumping system is to be connected to the building's backup power source where available. Otherwise, separate backup power source is to be provided.
   v. Pump auto-control system with voltage not exceeding 24-volt AC system.
   vi. Alert system when pump fails to operate.

3.3.4 Pumping Main Requirements

a. Minimum Size

The minimum size of pumping main shall be 100mm diameter unless the flow cannot meet the minimum velocity permissible

b. Minimum and Maximum Velocities Permissible

The minimum and maximum velocities in pumping mains shall be 1.0m/s and 2.4m/s respectively.

c. Pumping Main Appurtenances

The following shall be provided along the pumping main for maintenance purposes:

i. Access chambers at not more than 200m apart.
ii. Air valve chambers at the high points along the pumping main. The air valve provided shall be dual orifice type with isolating valves.
iii. Wash-out chambers at all the lowest points along the pumping main.
iv. Thrust blocks shall be provided at all bends of pumping mains and designed to withstand forces at maximum operating pressure.

3.4 PIPE MATERIAL AND TESTING SPECIFICATION FOR SEWER AND PUMPING MAIN

3.4.1 Sewer Pipe Materials

Sewer pipe shall be made of the following materials:

a. Vitrified Clay (VC)

All VC pipes and fittings to comply with the latest BS EN 295.

b. Ductile Iron (DI)

All DI pipes and fittings to comply with the latest BS EN 598.
The DI pipes used to convey sewage shall be internally lined with high alumina cement (HAC) and externally coated in accordance with BS EN 598.

c. Reinforced Concrete (RC)

All RC pipes to comply with the latest SS183 or BS EN 1916.

RC pipes used to convey sewage shall have an additional internal corrosion protection liner as elaborated at **Annex C**.

d. Polymer Concrete (PC)

All PC pipes to comply with the latest BS EN 14636.

e. Any other material used to create a composite pipe

Such pipe materials may be approved for use subject to compliance with the strength requirement, design life, environmental condition and other requirements which PUB may specify.

3.4.2 Pumping Main Requirements

Ductile iron pumping mains for sewerage use shall comply with **Annex C**.

3.4.3 Testing and Inspection

a. All completed sewers/pumping mains including manholes and chambers shall be tested for water-tightness. (see **Annex D**)

b. CCTV inspection shall be carried out for all newly completed sewers/pumping mains before commissioning and prior to end of defects liability period.

4. SANITARY SYSTEM DESIGN

4.1 DESIGN CONSIDERATIONS

a. Sanitary System

The sanitary system in building consists of sanitary drainage (see 4.2) and sanitary plumbing (see 4.3).

b. Fat, Oil & Grease (FOG) Control

In commercial building and food establishments, the sanitary system shall be sufficiently sized to prevent blockage. A grease trap shall be provided to intercept excessive FOG from discharging to public sewer (see 4.2.2).

c. Pumped Sanitary System

i. As far as possible, sewage shall be conveyed by gravity to the sewers.
ii. For sanitary facilities installed below ground level or in basement where there is a high risk of backflow from the sewers, pumped sanitary system shall be provided (see 4.4).
iii. Pumped sanitary system shall be provided where the top level of ICs or floor traps are lower than the top level of:
   - the manhole to which the drain-line is connected; or
   - the downstream manhole in the case of Y-junction connection.

d. Special Installations

The following installations shall comply with the special requirements as specified.
i. Prefabricated Bathroom Unit (see 4.5);
ii. Food establishment (see 4.6.1);
iii. Market (see 4.6.2);
iv. Hospital (see 4.6.3);
v. Other specific locations (see 4.6.4).

e. Air and Water Tightness

The sanitary plumbing and drainage system shall be air and watertight within the premises and in the ground as the case may be. Air or water test shall be carried out as specified (see 4.7.2 and **Annex D**).

f. Separation of Rainwater

To prevent rainwater from entering the sewerage system, the following shall not be connected to the sewers:

i. Open areas such as backyards/courtyards/air wells, or other uncovered areas;
ii. Open-sided areas like void decks, common corridors, balconies, verandas, multi-storey car parks and pump islands at petrol stations;
iii. Swimming pool balancing tank, footbaths and open shower points; or
iv. Any other area that receives rainwater.

g. Structural concrete for IC, waste sump and foundation shall be of grade minimum C28/35. Concrete for haunching and benching shall be of grade minimum C20/25. Lean concrete shall be of grade C12/15.

4.2 TECHNICAL REQUIREMENTS FOR SANITARY DRAINAGE SYSTEM

4.2.1 Drain-lines and Inspection Chambers (ICs)

a. Discharge Pipe on Ground Level

Discharge pipe on ground level shall meet the following requirements:

i. Water Closet (WC), bidet trap, floor trap and urinal trap shall be connected directly to the IC via separate discharge pipe. Interconnection or connection to main drain-line via Y-junction is not allowed.
ii. Discharge pipe shall be straight and laid not deeper than 1.5m using the same pipe material throughout.
iii. The minimum size, maximum length and gradient of discharge pipe serving domestic premises are shown in Table 6.
iv. Discharge pipes and drain-lines serving food establishments or markets shall meet special requirements (see 4.6.1 & 4.6.2).

Table 6 – Size, Length, and Gradient of Discharge Pipe on Ground Level

Sanitary Appliance/Fitting Served	Minimum size (mm)	Maximum length (m)	Gradient
Ultra-low capacity WC (<3.5L per flush)	75	10	Minimum 1:50
Low capacity WC (3.5L to 4.5L per flush)	100	15	Minimum 1:50
Floor trap receiving flow from sanitary appliances or washing machine	100	15	Between 1:20 and 1:60
Floor trap receiving only floor washing water, i.e. no appliance connected	75	15	Between 1:20 and 1:60
Urinal trap receiving flow from: i. up to 3 urinals ii. 4 to 10 urinals	75 100	15	Between 1:20 and 1:60

b. Drain-lines

Drain-line shall be straight and shall meet the following requirements:

i. The size shall be determined by the flow from all sanitary appliances/fixture using Discharge Units (DUs) of each type of sanitary appliance based on BS EN 12056-2 Table 2 System 1, subject to a minimum size of 150mm diameter. The maximum length shall be 50m. *[Addendum No. 1 – Mar 2021]*

ii. For hydraulic drop of 500mm and above at manholes or ICs, a backdrop or tumbling bay connection shall be provided in accordance with the Sanitary Standard Drawing No. 3-4a.

iii. Drain-line shall be laid outside buildings wherever practicable. For drain-line/discharge pipe to be laid within basement slab or at car parks/ driveways subjected to vehicular loading and for drain-line to be laid under building, ductile iron pipe shall be used.

iv. For pipes going through external wall below ground, flexible joints shall be provided within 600mm of the wall to prevent fracture of the drain-line.

c. Connections of Discharge Pipe to Drain-lines

i. Discharge pipe shall be connected to the drain-line in the direction of flow within the IC/waste sump (see Sanitary Standard Drawing No. 3-1b).
ii. The soffit of the discharge pipe shall be level with or higher than the soffit of the drain-line (see Sanitary Standard Drawings No 3-2a & 3-3a).
iii. Underground discharge pipe and drain-lines in soft ground shall be supported on appropriately designed foundation system and provided with bedding and haunched in concrete in accordance with the Sanitary Standard Drawings no. 3-5a & 3-7b.
iv. Discharge pipe from a WC or a floor trap shall be connected to the IC with only one vertical bend which shall be supported on appropriately designed foundation system.

d. Drain-line Connection to Public Sewer

i. The drain-line shall connect to the public sewer at a manhole approved by PUB.
ii. The last IC shall be located not more than 2.5m from the boundary.
iii. Where the last section of the drain-line is connected to the public sewer via a Y-junction, the size of pipe and material shall follow that of the sewer it is connecting to.
iv. Where the last section of the drain-line is connected to a manhole, the size shall be minimum 200mm in diameter and no uPVC pipe shall be used.

e. Inspection Chamber (IC)

i. ICs shall be located within the property served and provided at all bends, junctions or where there is change in pipe diameter, materials or gradients of the drain-line.
ii. ICs shall have a minimum depth of 750mm and comply with the Sanitary Standard drawing No 3-7b.
iii. The first IC shall be separately ventilated unless the building's discharge/ventilating stack is connected to this IC.
iv. IC frames and covers shall comply with the PUB Standard Drawing No. PUB/WRN/STD/017A and Singapore Standard SS 30. Heavy-duty cast iron frame and cover shall be used for IC located on driveway or car park or places subjected to vehicular loading.
v. ICs shall be watertight (see **Annex D**). Prefabricated HDPE ICs shall comply with requirements in section 4.8.
vi. Measures should be taken to protect IC sited at an embankment.

4.2.2 Grease Trap Requirements

a. All food establishments shall have grease traps installed to control the oil and grease (non-hydrocarbon) to not greater than 100mg/litre. For food establishments such as cafe,

confectionery, snack bar, etc. where food is only served but not cooked at the premises, grease trap may not be required with PUB's permission.

b. The greasy discharge from sinks and floor traps shall be conveyed by a separate system of waste sumps, discharge pipes and discharge stacks discharge to the grease traps.

c. The following types of grease traps can be used:

   i. Standard circular grease traps in accordance with the PUB's Standard Drawings No. PUB/WRN/STD/040 and PUB/WRN/STD/041.
   ii. Non-standard grease traps and portable grease interceptors complying with BS-EN1825 or ASME A112.14.3.

d. The grease traps shall be sized based on the following method:

   i. Grease trap capacity shall be based on "nominal size" specified in BS-EN1825.
   ii. The maximum flow rate for selection of nominal size shall be calculated based on appliances/fittings discharging into the grease trap and typical flow rate and frequency factor in EN 1825-2, Table A.1. (See example in **Annex E**).
   iii. The PUB standard circular grease trap (Standard Drawings No. PUB/WRN/STD/040) is deemed equivalent to a nominal size 4 (NS =4) of EN 1825-1. While PUB/WRN/STD/041 is deemed equivalent to NS 2.

e. The grease traps shall be sited at a location where it is accessible for servicing and maintenance and will not give rise to nuisances or pose a safety hazard.

4.3 TECHNICAL REQUIREMENTS FOR SANITARY PLUMBING SYSTEM

4.3.1 Approved Types of Sanitary Plumbing System

a. Approved types of Sanitary plumbing system are:

   i. "Fully Ventilated System" for all building heights.
   (See Sanitary Standard Drawings No. 3-15b and 3-16b and **Annex F** for design requirements.)
   ii. "Single Stack System" for buildings up to 6 storeys.
   (See Sanitary Standard Drawing No. 3-17c and **Annex F** for design requirements.)
   iii. "Ventilated Stack System" for all building heights.
   (See Sanitary Standard Drawing No. 3-18c and **Annex F** for design requirements.)

b. Special Requirements for Single Stack System and Ventilated Stack System

For single stack system and ventilated stack system, only 2 connections are allowed per discharge pipe. The length of the discharge pipe shall not be more than 2.5m. The minimum size of discharge pipe/stack is shown in Table 7.

4.3.2 Position of Sanitary Pipes

a. Sanitary pipes shall not be placed above potable water storage tank, electrical transformer/switchgear or above swimming pools and their balancing tanks.

b. In all multi-storey residential buildings (e.g. condominium, apartment, HDB block) excluding single landed houses, the sanitary pipes shall be located such that:

i. no pipes from adjacent dwelling units shall be located within the dry areas (such as bedroom, living room, dining room, study room, etc.) of a dwelling unit.
ii. no pipes serving WC shall be located within the kitchen area of any dwelling unit.
iii. no pipes from kitchen sink, floor traps and discharge pipes shall be sited directly above the stove in the kitchen.

c. In all non-residential buildings (e.g. commercial buildings, shopping malls, hotel, hospital, etc), the sanitary pipes shall be located such that:

i. no pipes from WC shall be located at the ceiling of a commercial unit.
ii. no discharge stack or overhead sanitary pipe shall be sited within areas of the food establishment/F&B unit where food is cooked, prepared, stored or served.

4.3.3 Sizing Discharge Pipes and Stacks

a. The size shall be determined by the total flow from all sanitary appliances/fixtures using Discharge Units (DUs- litres/second) of each type of sanitary appliance (based on the BS EN 12056-2 Table 2 System 1), but subject to the minimum size shown in Table 7.

Note: QP shall refer to Section 4 and to consult PUB for sizing of pumped sanitary system. *[Addendum No. 1 – Mar 2021]*

Table 7 – Minimum Size of Discharge Pipe and Discharge Stack (for domestic wastewater discharge)

Type of sanitary plumbing system	Minimum size of discharge pipe (mm)	Minimum size of discharge stack (mm)	Grade of discharge pipe
Fully ventilated plumbing system	100	100	1:20 to 1:60
Single stack plumbing system		100 (up to 4 storeys high) 150 (up to 6 storeys high)	
Ventilated stack plumbing system		150 (Main stack) 100 (Secondary stack)	

b. The size of the discharge pipe serving only 1 number of Ultra-low flow WC (volume <3.5 litres per flush) can be reduced to 75mm in diameter but the length of the discharge pipe shall not be more than 10m for a fully ventilated system.

c. Discharge pipe and discharge stack shall be of the same material throughout, except for the bends in discharge stack offset (see clause 4.3.4c). The size of the pipe shall not be reduced in the direction of flow.

d. All junctions, whether equal or unequal, shall be of the 45^{o} or sweep type. Opposed connections at the same level shall be made using double Y-junctions with sweep entries.

e. For fully ventilated system and ventilated stack, a secondary discharge stack of diameter not smaller than 100mm shall be provided. The discharge pipes serving the 2^{nd} & 3^{rd} storey (if no discharge pipe connections from the 2^{nd} & 3^{rd} storey, then the next 2 upper storeys of the building) shall be connected to the secondary discharge stack. This secondary stack shall be extended to serve as ventilating stack for the upper storeys.

f. No discharge pipes shall be connected to the main or secondary discharge stacks below 2^{nd} floor at the prohibited zone (see Sanitary Standard Drawing No. 3-15b, 16b, 17c & 18c).

g. Inspection openings or cleaning eyes shall be positioned at junctions/bends to allow cleaning and maintenance. Access cover on the invert of pipe shall be avoided. Access for rodding and testing shall be provided at or near the foot of the discharge stack and at junctions of discharge pipe/stack.

4.3.4 Discharge Stacks and Offsets

a. Common discharge stack serving toilets shall be located within the toilet area, in the service courtyard or outside the dwelling/commercial unit whether exposed or concealed within a vertical service shaft.

b. The discharge stack shall, as far as practicable, not form any offset throughout its length. Any horizontal offset, if unavoidable, must be sited within the toilets/bathrooms or outside the dwelling/commercial units.

c. Where the offset elbow is located at location not easily accessible for maintenance or repair, a ductile iron or lined cast iron elbow shall be used with a suitable adaptor (see Sanitary Standard Drawing No. 3-21a). The elbow shall be securely held and bolted to the building. Offset elbow located in accessible area is encouraged to follow this requirement.

d. Horizontal offset, if any, must comply with the following requirements:

   i. the offset pipe and the vertical discharge stack shall be of the same size and securely supported;
   ii. the centre-line radius of the bend shall be at least twice the diameter (2D) of the pipe;
   iii. cross-vents shall be installed between the ventilating stack and the discharge stack above the upper bend and below the lower bend in accordance with the Sanitary Standard Drawing No. 3-21a.
   iv. No discharge pipe shall be connected to the discharge stack within 500mm of the vertical bends or to the horizontal offset pipe within 2.5m of the vertical bends.

4.3.5 Ventilating Pipes and Stacks

a. Ventilating pipes shall be provided to maintain pressure equilibrium within the sanitary plumbing system to prevent the loss of water seal in the traps.

b. In the fully ventilated system, ventilating pipe from traps (WC, floor trap, urinal trap) connecting directly to a discharge pipe shall comply with the following requirements (see Sanitary Standard Drawings No. 3-15b & 3-16b). Alternatively, Air Admittance Valve (AAV) may be used in lieu of a ventilating pipe. AAV shall be installed above the spill-over level of the appliance served. AAV shall comply with EN12380.

   i. The size of the vent pipes shall not be smaller than 50mm.
   ii. The vent pipes shall be extended upwards and connected to a ventilating stack at an angle of 45^{o}.

iii. The vent pipe shall be connected to the ventilating stack at a level above the spill over level of the WC or floor trap or urinal trap served by such vent pipe.

iv. The vent pipe shall be either fixed at the crown of the trap or as close as practicable (not more than 300mm away) to the trap.

c. The ventilating stack shall not be smaller than 75mm in diameter and extend upwards either to terminate in the open air or connect to a discharge stack at a level not less than 150mm above the spill over level of the highest sanitary appliance (e.g. WC) or floor trap, whichever is the highest.

d. For the fully ventilated system and the ventilated stack system, the cross-vent pipes installed for interconnecting the ventilating stack and discharge stack shall comply with the following requirements:

i. the cross-vent pipes shall be the same size of the ventilating stack or the secondary discharge stack as the case may be, and connected to the ventilating stack or the secondary discharge stack at an angle of 45^{o};

ii. the cross-vents shall be installed at:
- 300mm above the ground floor level;
- 225mm below the lowest discharge pipe connection; and
- the top end of the ventilating stack at a level not less than 150mm above the spill over level of the highest sanitary appliance or floor trap whichever is the highest (see Sanitary Standard Drawing No. 3-15b, 3-16b, 3-17c and 3-18c);

iii. in the case of the fully ventilated system, in addition to (ii), cross-vent pipes shall be installed in accordance with the following:
- For buildings up to 20 storeys, at mid-height of the building (e.g. for an 8-storey building, cross-vent pipes to be provided at 4th storey). Exception is for landed housing development;
- For buildings higher than 20 storeys, at intervals of every ten storeys (e.g. for a 38-storey building, cross-vent pipes to be provided at 10th, 20th, 30th, etc storey;

iv. in the case of the ventilated stack system, in addition to (ii), cross-vent pipes shall be installed at intervals of every 3 storeys, i.e. 3rd, 6th, 9th, etc.

4.3.6 Termination of Ventilating Pipes/Stacks

a. Ventilating stack shall not be terminated within any private premises or private roof area. It shall be extended to terminate at the highest roof of the building in accordance with Sanitary Standard Drawing no. 3-15b, 3-16b, 3-17c & 3-18c and shall not be located within 3m from any window or building opening.

b. Ventilating stacks may be connected to a common header vent terminating to the open air at the highest point of the building. The header vent shall be at least one size larger than the individual ventilating stack.

4.3.7 Connection of Discharge Stacks to Inspection Chamber

a. For fully ventilated system or ventilated stack system, both the main discharge stack and secondary discharge stack shall be connected to the IC.

b. The invert of the discharge end of the secondary discharge stack shall be at least one diameter above the discharge end of the main discharge stack.

c. The bend at the base of the discharge stack to an IC shall not exceed 1.5m depth from the floor level and comply with the following (see Sanitary Standard Drawing No. 3-22a):
   i. Large radius bend (2D, i.e. the centre-line radius is at least twice the diameter of the bend) or
   ii. two 45^{o} bends separated by a straight pipe of length not less than twice the diameter of the pipe; and
   iii. The pipe from the bend to the IC shall be straight.

4.3.8 Connection of Multiple Discharge Stacks

Where there are multiple discharge stacks connecting to a common discharge pipe at ceiling level of ground floor or basement area, the following shall be complied with:

a. The common discharge pipe shall be sized to convey the total discharge from the stacks connected to it but shall be at least 200mm in diameter.

b. The bends at the base of the stacks shall be of the same size as the common discharge pipe. The bends shall be of large radius bends (2D, i.e. the centre-line radius is at least twice the diameter of the bend) or two 45^{o} bends separated by a short straight pipe of not less than twice the diameter of the pipe. The discharge stack shall be connected to the common discharge pipe with a 45^{o} or sweep type junction.

c. For any pipe connecting to the common discharge pipe, the following shall be complied with (see Sanitary Standard Drawing No. 3-28):

   i. The connection to the vertical section of the pipe shall not be made within 500mm before or after the bend; and

ii. The connection to the horizontal section of the pipe shall not be made within 2.5m downstream or upstream of any junction connection or bend.

d. Inspection openings shall be provided at the bends/junctions and at the upstream end of the common discharge pipe to facilitate inspection and maintenance.

4.3.9 Concealment of Pipework

a. Sanitary pipes and fittings may be concealed provided the inspection openings at the pipes/fittings are accessible.

b. No pipe shall be encased in building elements without PUB's permission except the following:

i. Vent pipes.
ii. Discharge pipe from sanitary appliances (washbasin, sink, bath/shower).
iii. Discharge pipe from shallow floor trap (see 4.3.11) connecting to a discharge pipe/stack.

c. Common discharge pipes or discharge stacks may be concealed in enclosures provided with adequate access openings to the pipework. The enclosures should be provided with a drainage outlet/pipe connecting to the nearest floor trap at the common area.

d. Concealed fittings shall be provided with inspection openings/cleaning eyes. Inspection openings shall be extended to the face of the enclosure.

4.3.10 Connection of Sanitary Appliances

a. Water closet pan shall be connected directly to a discharge pipe or an IC as the case may be, in compliance with Table 8.

b. Urinal and bidet shall have a water seal of not less than 25mm in depth and shall be connected to a discharge pipe or an IC via a urinal trap or bidet trap (with a water seal of not less than 75mm in depth) as the case may be, in compliance with Table 8.

Table 8 – Specific Installation Details for WC, Bidet and Urinal

Appliances	Specific Installation Details
WC	i. Conform to Singapore Standard SS 574. ii. A purpose made connector (pan collar, bend connector or floor flange) shall be used to connect WC to the discharge pipe. (See Sanitary Standard Drawing No. 3- 23a). *[Addendum No. 1 – Mar 2021]* iii. For change of WC, it is advisable that the connector be replaced to ensure air tightness. *[Addendum No. 1 – Mar 2021]*
Bidet	Have a fitting trap of at least 40mm in diameter at the outlet. The bidet shall be connected via a bidet trap of not smaller than 75mm in diameter to the discharge pipe or IC.
Urinal	i. Have a fitting trap of at least 40mm in diameter at the outlet and be connected to the discharge pipe via a urinal trap with an unperforated cover. ii. Urinal trap serving up to 3 urinals, the outlet of the urinal trap shall not be smaller than 75mm in diameter. For 4 to 10 urinals, the outlet of the urinal trap shall not be smaller than 100mm in diameter. A separate urinal trap shall be provided if more than 10 urinals are provided iii. The common urinal waste pipe and loop venting shall be in accordance with the Sanitary Standard Drawing no 3-25a. iv. Waterless urinals shall comply with ASME A112.19.19. A basin shall preferably be connected to the upstream of the common urinal waste pipe serving waterless urinals so as to provide flushing to the waste pipe. v. Single urinal in residential premises may be connected to a floor trap installed with an approved seal below the grating to allow drainage but prevent odour nuisance.

c. Sink and washbasin shall be provided with a fitting trap (or bottle trap) installed at the outlet before connecting to a waste pipe. The waste pipe shall be connected to the floor trap above the water seal. Specific installation details are given in Table 9.

Table 9 – Specific Installation Details for Washbasin, Bath and Shower

Appliances	Specific Installation Details
Washbasin	i. The size of fitting trap and waste pipe shall be in accordance with the Sanitary Standard Drawing no 3-24a. ii. The common waste pipe shall be ventilated in accordance with the Sanitary Standard Drawing no. 3-24a.
Kitchen Sink	i. The size of fitting trap and waste pipe shall be in accordance with the Sanitary Standard Drawing no 3-24a. ii. Waste pipe from kitchen sink shall not be connected to a floor trap in a toilet. The floor trap serving kitchen sinks shall be separately and directly connected to a discharge stack.
Bath and Shower	i. Shall be connected either to a floor trap or floor waste provided in the bathroom and shower compartment. ii. Each shower compartment of a shower group shall drain separately to a floor waste. For shower compartment in series, a common channel to a floor trap may be provided.

d. Wastewater from clothes washing machine and dishwasher shall be discharged to a floor trap.

4.3.11 Floor Trap, Shallow Floor Trap and Floor Waste

a. Floor trap shall be provided to receive the flow from sink, washbasin, bathtub, shower and floor waste. The floor trap on an upper storey shall be connected to a discharge pipe while floor trap on the ground floor shall be connected to an IC. Such floor trap shall not receive flow from different premises/units/rooms. *[Addendum No. 1 – Mar 2021]*

b. The floor trap shall have a minimum outlet diameter of 100mm and retain a depth of water seal of not less than 50mm.

c. The incoming waste pipe shall be connected to the riser of the floor trap below the grating and above the level of the water seal. The floor trap including the riser pipe shall be of the same diameter throughout. The riser pipe shall be extended to the finished floor level and fixed with a grating cover.

d. The floor trap shall not be located in an open area receiving rainwater or surface runoffs.

e. Floor trap shall be incorporated with measure to prevent mosquito breeding in compliance with the latest Code of Practice on Environmental Health.

f. Shallow floor trap shall be of a type complying with the following requirements and passing the performance tests in accordance with BS EN1253-1.

Table 10 – Requirements of Shallow Floor Trap

Descriptions	Standard Requirements
Depth of water seal	Min 50mm
Passage clearance	Min 25mm
Outlet diameter	Min 75mm
Water seal compartment	Shall be integral type
Grating and cover	Dimension shall comply with SS213
Service plug for the trap compartment (if provided)	To provide permanent instruction label to put back the service plug after cleaning.

g. Shallow floor trap shall be installed embedded in the concrete floor slab such that no part of the trap protrudes below the floor slab. (See Sanitary Standard Drawing No. 3-27)

h. Shallow floor trap shall not be used for receiving wastewater from kitchen sink or dishwasher.

i. Floor waste shall be connected to a floor trap above the water seal of the trap and the length of the waste pipe between the floor waste and floor trap shall be as short as possible.

j. The floor waste shall not be smaller than 50mm in diameter. Where it is also serving a basin, bathtub, dishwasher and washing machine the size shall not be smaller than 75mm in diameter.

k. The floor trap or floor waste shall be covered with a grating complying with SS213.

4.4 Pumped Sanitary System

a. Small bore macerator pump or ejectors may be used in a small pumped sanitary system. Where pump sump systems are proposed, PUB should be consulted on the specific requirements (see 3.3).

b. When pumped sanitary system are used the outlet shall be connected to an IC. Direct connection of the outlet to a gravity discharge pipe/stack is not allowed.

c. Ejector systems shall be provided with a ventilating pipe. The enclosure or pit where the ejector is placed shall be provided with a sump pump connected to the ejector's discharge pipe.

4.5 SANITARY FACILITIES FOR PREFABRICATED BUILDINGS

Approval from PUB shall be obtained for the use of prefabricated bathroom unit (PBU) or Prefabricated Prefinished Volumetric Construction (PPVC). PBU or PPVC shall comply with the following requirements:

a. Requirement for shallow floor trap if used (see 4.3.11 and Table 10).

b. A stainless/mild steel plate of 5mm thickness shall be embedded in the floor slab below the shallow floor trap for protection to the shallow floor trap.

c. High pressure air test shall be conducted for every PBU or PPVC module at the factory.

d. If WCs and floor traps are also to be pre-installed, in addition to (c), low pressure air test shall also be conducted for every PBU or PPVC module with the WCs and floor traps charged with water, at the factory.

4.6 SANITARY REQUIREMENTS FOR SPECIAL INSTALLATIONS

4.6.1 Food Establishments

a. Floor wastes/floor traps/waste sumps shall be provided for the sullage water discharge from the kitchen/food stalls into the grease trap.

b. The size of the discharge pipe from the floor trap connecting to a waste sump or a Y-junction shall not be smaller than 100mm in diameter.

c. For ground level, the size of the drain-line between waste sumps, waste sump and screen chamber, ICs, IC and screen chamber at upstream of grease trap shall not be smaller than 250mm in diameter.

d. For above ground level, the size of the discharge stack and discharge pipe between waste sumps, waste sump and discharge stack, discharge stack and IC at upstream of grease trap shall not be smaller than 250mm.

e. A waste sump shall be provided at interval of 5-stall length.

f. Air and watertight covers shall be provided for the waste sumps and ICs.

g. The pipe material for the drain-lines shall be ductile iron or vitrified clay. Vitrified clay pipe shall be used for the connection line to public sewer. *[Addendum No. 1 – Mar 2021]*

h. The discharge pipe serving food establishment shall be of corrosion resistant, high temperature resistant (min 90 deg C intermittent), and with a minimum 2 bar (PN2) pressure rating.

i. The floor trap cover shall be securely bolted or screwed down to the frame to deter unwarranted opening of the cover.

4.6.2 Market

a. The sanitary drainage and plumbing system serving market shall be in accordance with the Sanitary Standard Drawing no. 3-12b. Floor sump (see Sanitary Standard Drawing No. 3-13a) shall be provided at every stall and along the service corridors and the common passageways to collect and convey sullage water.

b. Waste sump (see Sanitary Standard Drawing No. 3-10) shall be provided along the service corridors away from the public areas. IC shall be sited outside the market proper.

c. The size of the discharge pipe from the floor sump to the waste sump shall not be smaller than 225mm in diameter.

d. The size of the drain-lines between waste sumps, waste sump and IC or ICs, last IC and public sewer shall not be smaller than 250mm in diameter.

e. A cast iron gully trap (see PUB/WRN/STD 045A) shall be provided in a sump connecting to the last IC.

f. The discharge pipes from the waste sump and discharge stacks for market located at upper storey shall not be smaller than 250mm in diameter. The discharge stacks shall be directly connected to the gully sump (refer to (e) above) at ground floor before connecting to the IC.

g. The size of the combined main drain-lines receiving all the flow discharged from both the market and food centre in the same building, including the connection line from last IC to the public sewer shall not be smaller than 300mm in diameter.

h. The pipes and fittings for the drain-line and discharge pipe/stack shall be of heavy-duty material (e.g. ductile iron pipes). Vitrified Clay pipe shall be used for the connection line to public sewer. Air and watertight covers shall be provided for the waste sumps and ICs.

i. The discharge pipe serving market at upper storey shall be of corrosion resistant, high temperature resistant (min 90 degree Celsius intermittent), and with a minimum 2 bar (PN2) pressure rating.

4.6.3 Hospital

a. Discharge from hospital/medical clinic/centre except those from toilet (excluding isolation ward toilet) is regarded as trade effluent regulated under the Sewerage and Drainage (Trade Effluent) Regulations [TER]. Written Approval (WA) for discharge of trade effluent into the public sewerage system shall be obtained from PUB.

b. The discharge to a public sewer shall not contain any of the substances specified in Regulation 9 of the TER. In particular, the following types of biohazardous wastes shall not be discharged to the public sewer.

   i. Any waste specified in the Environmental Public Health (Toxic Industrial Waste) Regulations. These include pathological, pharmaceutical, chemical and contaminated waste, etc.

   ii. Blood waste, infectious waste and other waste contaminated or likely contaminated with pathogens of an infectious disease.

   iii. Radioactive waste unless it has been decayed to a safe level in accordance with NEA's requirement before discharging to sewer.

c. Discharge from isolation wards (including toilets in the isolated ward) for infectious diseases patients shall be conveyed via separate sanitary pipes to disinfection plant for disinfection before discharging to public sewer. The trade effluent and disinfectant in

disinfection plant shall be thoroughly mixed and have sufficient contact time. Its disinfected effluent discharge to the public sewer shall contain at least 0.5ppm of residual chlorine.

4.6.4 Discharge Connection for Other Specific Locations

a. Sullage water from the following installations shall be discharged into the sewerage system via a floor trap (See Sanitary Standard Drawing No. 3-6a).
   i. Backwash water from swimming pool filter
   ii. Boiler blowdown via pit
   iii. Covered wash area
   iv. Service yard within building
   v. Steam condensate via cooling pit
   vi. Wastewater from cooling tower

b. Sullage water from bin centre or refuse chute shall be discharged into the sewerage system via a cast iron gully trap with strainer (see Standard Drawing No. PUB/WRN/STD/044A) in accordance with the Sanitary Standard Drawing no. 3-11b.

c. Sullage water from motor garage or lubrication bay and car washing bay of petrol station shall be discharged into the sewerage system via an oil interceptor (see Standard Drawing No. PUB/WRN/STD/042A).

d. For the above sullage water discharge, waste sumps shall be provided at junctions of the waste discharge pipes to facilitate ease of maintenance. Details of waste sump are shown in Sanitary Standard Drawing No 3-10b.

e. Car park that receive rainwater shall not be connected to the sewerage system.

f. Car washing area in the car park shall be sheltered and appropriately kerbed to prevent rainwater from entering the sewerage system. It shall be provided with either a floor waste or floor trap that is connected to the cast iron gully trap (see Standard Drawing No. PUB/WRN/STD/043) before connecting to the IC.

g. Shower/bathroom facilities and wash area at the beach and construction site shall be connected to a silt sump before an IC (see Sanitary Standard Drawing No. 3-14a).

h. Wash area shall be sheltered and appropriately kerbed to prevent rainwater from entering the sewerage system. The wash area shall be connected direct to a floor trap or to a floor waste followed by a floor trap (see the standard sanitary Drawing No 3-8a).

4.7 TESTING OF SANITARY SYSTEM

4.7.1 Testing of Sanitary Drainage System

The sanitary drain-lines and ICs shall be tested for water tightness in accordance with the testing specification given in **Annex D**. The water tightness test shall be done before covering up the pipes.

4.7.2 Testing of Sanitary Plumbing System

a. The sanitary discharge/ventilating pipes/stacks shall be subjected to air test in accordance with the testing specification given in **Annex D**.

b. Such tests may be carried out progressively with the installation of the sanitary pipes before they are closed up in service ducts or encased in concrete.

c. Flood test may be carried out for pipes serving the lowest sanitary appliances. The test is deemed pass if there is no visible leak after 5 minutes.

4.8 MATERIAL AND PRODUCT STANDARDS

a. Pipes and fittings used in sanitary drainage shall comply with the following standards:

i.	uPVC (underground, rubber ring joints)	SS 272
ii.	Ductile iron	BS EN 598
iii.	Vitrified Clay	BS EN 295
iv.	Reinforced Concrete (RC) (Internal liner complying with **Annex C** shall be provided)	SS 183/BS EN 1916
v.	Polymer concrete	BS EN 14636
vi.	HDPE	BS EN 1519
vii.	Manhole/IC frames and covers	SS 30 & PUB Standard Drawings
viii.	HDPE IC	BS EN 13598-1 and 2

b. Pipes and fittings used in sanitary plumbing shall comply with the following standards:

i.	uPVC (including pan collar, bend connector)	SS 213
ii.	Ductile iron	BS EN 598
iii.	Hubless cast iron with epoxy coating	BS EN 877;
iv.	Polypropylene (PP-R, PP-H)	BS EN 1451-1
v.	HDPE	BS EN 1519

c. Materials and products tested to the above standards and certified by a conformance assessment body or certification body accredited by SAC-SINGLAS or under its Mutual Recognition Agreements (MRAs) are deemed approved and can be used in the sanitary

work/sewerage works. PUB may require such certificates/test reports to be submitted for verification.

d. The manufacturer's name/brand name or mark and the standards under which the products are conformed to shall be marked clearly on the pipes and fittings, manhole/IC frames and covers.

4.9 STANDARD DRAWINGS FOR SANITARY WORKS

Drawing No.	Description
Drawing No.3-1b:	Layout of Sanitary Drainage System
Drawing No.3-2a:	Discharge Pipe Connection on First Storey Level
Drawing No.3-3a:	Discharge Stack Connection with Backdrop to Inspection Chamber
Drawing No.3-4a:	Backdrop and Tumbling Bay Details
Drawing No.3-5a:	Type Bedding for Drain-line
Drawing No.3-6a:	Floor Trap with or without a Sump [For Connection to Inspection Chamber]
Drawing No.3-7b:	Inspection Chamber and Break Joint for Drain-line
Drawing No.3-8a:	Wash Area
Drawing No.3-9c:	Sanitary Drainage System for Food Shop
Drawing No.3-10b:	Waste Sump at Ground Level (For Sullage Water Drainage)
Drawing No.3-11b:	Sanitary Drainage System for Bin Centre
Drawing No.3-12b:	Sanitary Plumbing and Drainage System for Market
Drawing No.3-13a:	Floor Sump for Market
Drawing No.3-14a:	Sanitary Drainage system for Toilet at Beach Site/Construction Site
Drawing No.3-15b:	Fully Ventilated System (with Single Stack) for Single Landed Housing
Drawing No.3-16b:	Fully Ventilated System (with Secondary Discharge Stack) for All Buildings
Drawing No.3-17c:	Single Stack System for Buildings up to 6 Storeys
Drawing No.3-18c:	Ventilated Stack System for All Buildings
Drawing No.3-19c:	Piping Arrangement for Floor Trap (P-Type) and Water Closet Pan Connected in Series
Drawing No.3-20a:	Ventilating Pipe for Floor Trap Connection to Discharge Pipe (Without Water Closet Connection)
Drawing No.3-21a:	Offset and Cross Venting
Drawing No.3-22a:	Details of Connection Between Discharge Stacks and Inspection Chamber (Below Ground Level)
Drawing No.3-23a:	Jointing of Outlet of Pedestal Water closet Pan to Discharge Pipe
Drawing No.3-24a:	Vent Pipe Arrangements for 3 or More Waste Basins Connected in Series and Common Waste Pipe Size for Sanitary Appliances Connected in Series
Drawing No.3-25a:	Loop Venting Requirements for 3 or More Urinals Connected in Series
Drawing No. 3-27	Sanitary Facilities on Prefabricated Buildings
Drawing No. 3-28	Connection to Common Discharge Pipe
Drawing No. 3-29	Sanitary and Plumbing System for Food Establishment (Upper Storey Level)

5. REQUIREMENTS FOR TRADE EFFLUENT DISCHARGE INTO PUBLIC SEWER

5.1 GENERAL REQUIREMENTS

a. This section applies to compliance of trade effluent discharge with trade effluent standards. All trade effluent discharged into a public sewer shall comply with the Sewerage and Drainage Act and the discharge standards stipulated in Sewerage and Drainage (Trade Effluent) Regulations. Pre-treatment might therefore be necessary.

b. Requirements may be imposed on the developer/QP before TOP or on the party discharging the trade effluent after TOP has been granted for the development. In general, the need for trade effluent sampling sump and pH monitoring equipment will be determined at Development Control submission stage (see 5.2.1 and 5.2.2).

c. All industrial premises whether on individual land lot or within a flatted factory are required to provide sampling sump.

d. Specifically, for chemical analysis laboratory, a balancing tank shall be provided before the sampling sump (see 5.2.3).

e. After obtaining TOP for the development, the operator shall apply to PUB a "Written Approval to Discharge Trade Effluent" (WA) (see 5.3).

f. PUB may require the installation of autosampler and/or additional monitoring of the trade effluent e.g. Volatile Organic Compound (VOC) monitoring when granting the WA. (see 5.3.2 and 5.3.3)

g. All effluents that are prohibited to be discharged into a public sewer shall be disposed of by only NEA licensed toxic industrial waste collector.

h. Animal wastes and sludge generated shall be stabilised, dewatered and disposed of as solid waste.

i. Any trade effluent treatment plant installed shall be designed with spillage containment facilities to channel any spillage back to the treatment plant.

j. A chemical/oil store in factory shall not have any outlet/opening leading to a public sewer. All leaks and spillage are to be collected for proper treatment or disposal as toxic industrial wastes.

5.2 DEVELOPMENT WITH TRADE EFFLUENT DISCHARGE

5.2.1 SAMPLING SUMP FOR TRADE EFFLUENT

a. For single landed industrial premises, a separate drain-line shall be provided to collect and convey only trade effluent to a sampling sump before discharging to an IC that connects to a public sewer.

b. For a flatted factory, every unit shall be provided with its own sampling sump before discharging to a common discharge stack. The discharge into the sampling sump shall not contain discharge from the sanitary facilities.

c. For a flatted factory with common trade effluent treatment plant, a sampling sump shall be provided after the treatment plant before discharging to an IC that connects to a public sewer.

d. The sampling sump shall comply with SS593.

e. Diluting trade effluent with potable water, rainwater, NEWater or industrial water to comply with the allowable limits is not allowed.

5.2.2 pH MONITORING SYSTEM

a. Where the trade effluent requires pH neutralisation to comply with trade effluent standard, a pH monitoring cum effluent discharge control system shall be provided in the last IC of the premises.

b. The monitoring and control system shall comply with SS593 Annexes J and K and be approved by PUB.

5.2.3 BALANCING TANK

a. Trade effluent generated from a chemical analysis laboratory shall first be discharged to a balancing tank before discharging to a public sewer. Notwithstanding this, the final effluent shall comply with the Sewerage and Drainage (Trade Effluent) Regulations. The balancing tank shall comply with SS593 Annex P.

b. A common balancing tank or trade effluent treatment plant may be provided to serve a number of laboratories.

5.3 REQUIREMENTS ON PARTY DISCHARGING TRADE EFFLUENT

5.3.1 WRITTEN APPROVAL TO DISCHARGE TRADE EFFLUENT

The party discharging the trade effluent into public sewer shall apply for the Written Approval in such form as required by PUB. The application shall include:

a. Particulars of the trade, manufacture, business or building construction;

b. Details of all the processes or operations to produce the final products;

c. Particulars of all the raw materials and chemicals used in the processes or operations;

d. Details of the layout of all the machinery, plant and equipment used in the premises;

e. An estimate of the amount of water consumed or used;

f. Particulars of the physical, organic and chemical nature of the trade effluent; and

g. Any other information required by PUB.

5.3.2 AUTOSAMPLER

a. For surveillance of trade effluent discharge, PUB may require an autosampler to be installed at the last IC of a trade premises.

b. Guidelines on autosampler are given in **Annex H**.

5.3.3 VOLATILE ORGANIC COMPOUND (VOC) MONITORING SYSTEM

a. For monitoring of VOCs in trade effluent discharge, PUB may require a VOC monitoring system to be installed at the last IC of a trade premises.

b. Guidelines on VOC monitoring system are given in **Annex I**.

ANNEX A - REQUIREMENTS FOR CONSTRUCTION OF RC TRENCH

The RC trench shall comply with the following requirements:

a. It shall be backfilled with sand or other approved granular material;

b. The minimum internal width of the trench shall be:

Table 11 - RC Trench Width

Sewer depth (m)	Sewer Pipe Nominal Diameter (mm)	Minimum width (mm)
≤3	≤300	750
	> 300	(900 + T) See Figure 2
> 3	All sizes	

T: (2 x Thickness of haunching) + nominal sewer diameter
E: 150mm for sewer up to 900mm in diameter. *[Addendum No. 1 – Mar 2021]*

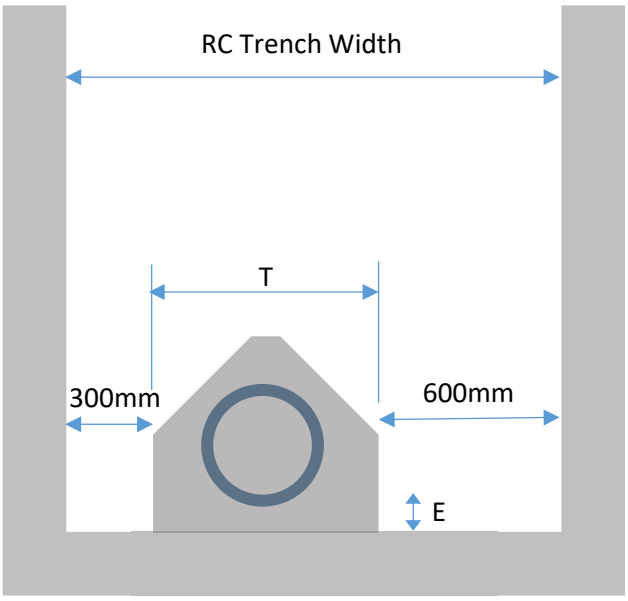

Figure 2: RC trench Width for Sewer Depth > 3m or Diameter Larger than 300mm

c. The trench shall be accessible from the top of the trench. The trench shall be covered with removable slabs or other hard covers with lifting feature.

d. Tiling of the individual removable covers is allowed provided they remain removable without cutting/hacking of tiles when access is required.

ANNEX B - LIST OF SEWERAGE STANDARD DRAWINGS

Drawing No.	Description
PUB/WRN/STD/001B	Standard Details of Main Sewers and Manholes
PUB/WRN/STD/003A	Precast Concrete Manhole Parts
PUB/WRN/STD/004B	Standard 45 Degrees Bend Manhole for 1000mm Dia. & Above
PUB/WRN/STD/005B	Standard Manhole for Sewer 1000mm Dia. and Above
PUB/WRN/STD/006B	Standard Details of Deep Precast Concrete Manhole with one Intermediate Platform
PUB/WRN/STD/007B	Standard Details of Sewer Connections
PUB/WRN/STD/008	Details of Multistrand Poly-Propylene Nylon Rope Netting
PUB/WRN/STD/009A	Vortex Drop
PUB/WRN/STD/010A	Standard Details of Ground Markers along the Routes of Deep Tunnels and Curved Sewers
PUB/WRN/STD/015A	Standard Heavy-Duty Manhole Fame & Cover
PUB/WRN/STD/016A	Standard Medium Duty Manhole Frame & Cover
PUB/WRN/STD/017A	Standard Inspection Chamber Frame & Cover
PUB/WRN/STD/018A	Recessed Type Light Duty Inspection Chamber Frame & Cover
PUB/WRN/STD/040	Standard Circular Grease Trap for Canteens, Restaurants & Eating Stalls
PUB/WRN/STD/041	Standard Grease Trap for Small Eating Stalls
PUB/WRN/STD/042A	Standard Grease, Petrol & Oil Interceptor- Three Compartments
PUB/WRN/STD/043A	Cast Iron Gully Trap for Covered Carpark & Car Washing Area
PUB/WRN/STD/044A	Cast Iron Gully Trap for Bin Centre/Refuse Centre
PUB/WRN/STD/045A	Cast Iron Gully Trap for Markets
PUB/WRN/STD/046A	Standard Aluminium Alloy Strainer Bucket & C. I. Gully Trap
PUB/WRN/STD/102A	Details of Anodised Aluminium Alloy Handrail and Safety Chain

ANNEX C - TECHNICAL REQUIREMENTS FOR SEWER PIPE

1. Allowable Material for Gravity Sewer Liner

The allowable material for internal liner for RC pipe and their specific requirements is:

a. Calcium Aluminate Cement (CAC)

The CAC lining shall be minimum 8mm over the normal RC reinforcement cover. The CAC composition shall comply with EN 14647.

b. High Density Polyethylene (HDPE)

i. HDPE lining shall be at least 2.5mm thick and fixed to the concrete surface by mechanical keys. The mechanical keys for such liner shall have a minimum pull out strength of 0.48MPa.

ii. The lining shall cover not less than 330^{o} of the internal circumference of the pipes. However, the lining may cover 360^{o} if the pipes are to be installed up to only a maximum depth of 20m.

iii. For sewer pipes to be installed at depth greater than 20m with 360^{o} liner, pressure relief shall be designed for the pipe to release water pressure behind the liner.

iv. HDPE lining to RC pipe and manhole shall be tested for corrosion resistance in accordance with ASTM D543 and shall meet the following in table 12.

Table 12 - Corrosion Resistance Test

Chemical Agents		Test Method	Change in Weight Not more than
Sodium Hypo-Chloride	1%		0.09%
Ferric Chloride	1%		0.09%
Sodium Chloride	5%		0.09%
Sulphuric Acid	20%	ASTM	0.09%
Nitric Acid	1%	D 543	0.09%
Sodium Hydroxide	5%	(7 days at	0.09%
Ammonium Hydroxide	5%	20ºC)	0.09%
Soap & Detergent solution	2%		0.09%

2. Pumping Main Requirements

a. The ductile iron pipes and fittings shall comply with the latest revision of EN 598.

b. All ductile iron pipe with socket and spigot, plain-ends and flanged-ends shall be Class K9 and fittings/bends shall be Class K12.

c. Pipes shall be internally lined with high alumina cement (HAC) mortar and externally coated with metallic zinc coating and covered by a finishing of a bituminous coating in accordance with EN 598.

d. All bolts, nuts and studs used in the installation of the pipes shall be hot dipped galvanised in accordance with EN ISO 1461.

e. Plain ended pipes shall be joined using flexible couplings/flange adaptors with gaskets that fit tightly to form tight joints. The gasket shall be made of nitrile butadiene or equivalent rubber compound suitable for use in sewage.

f. The flexible couplings/flange adaptors shall be made of rolled mild steel conforming to BS EN 10025 Grade S275 and shall be internally and externally coated with Rilsan nylon or equivalent to protect against corrosion.

g. The pumping mains and pipe fitting/joints shall be protected using polyethelene sleeves and water proofing tape. The thickness of the sleeves shall not be less than 0.2mm.

h. Where direct pipe jacking is adopted, the outside surface of the ductile iron pipe shall be covered with reinforced concrete.

i. Pumping mains to be laid in coastal area/reclaimed land shall be designed against long-term corrosion and provided with appropriate anti-corrosion protection.

ANNEX D - WATER TIGHTNESS TESTING

1. Testing of Sewer, Drain-lines and Manhole/IC

a. All sewers below 900mm in diameter and sanitary drain-lines shall be tested for water tightness in accordance with BS EN1610.

b. The test pressure shall be the pressure equivalent to or resulting from filling the test section of pipe with water up to the ground level of the upstream manhole/IC, as appropriate, with a maximum pressure of 50kPa (5.0m head of water) and a minimum pressure of 10kPa (1.0m head of water) measured at the top of the upstream end of the pipe.

c. Pressure shall be maintained within 1kPa (10cm) of the test pressure by topping up with water. The testing time shall be 30 minutes. The test requirement is satisfied if the amount of water added is not greater than 0.15 l/m^2 during 30minutes for pipelines or 0.20 l/m^2 during 30 minutes for pipelines including manholes/IC. (Note: m^2 refers to the wetted internal surface area).

d. Manholes and ICs which are less than 5m in depth to invert shall be tested by filling with water up to 10cm below the chamber's cover slab. When the depth is 5m or greater, the test pressure shall be not less than 50kPa (5m of head of water). The test requirement is satisfied if the amount of water added is not greater than 0.4 l/m^2 during 30 minutes for manholes and ICs.

2. Testing of Pumping Mains

a. Ductile iron pumping mains shall be tested hydrostatically in accordance with ISO 10802.

b. If the surge pressure is higher than the test pressure specified in ISO 10802, the hydrostatic test shall be performed for the maximum surge pressure.

3. Testing of Sanitary Plumbing System

When tested in accordance with the following requirements, the respective sections of the discharge pipes/stacks, ventilating pipes/stacks and waste pipes that are being tested shall be free of leaks.

a. High Air Pressure Test

i. This test should be conducted when all sanitary appliances are not yet installed and all the traps (water seals) are dry and sealed before applying high pressure air to the pipework.
ii. All the open ends of the pipes should be plugged off with pipe caps or inflatable rubber plugs.
iii. A modified pipe-end cap fixed with a T-pipe, one branch is connected to a psi/kPa pressure gauge and the other branch is fixed with an air inlet valve connected to an air pump, should be installed at the lower end of the discharge stack under test.
iv. Air is pumped into the pipes until air pressure of 34kPa (or 5PSI) is shown on the pressure gauge. The air inlet valve is then closed and pressure in the pipe works should sustained for 15 minutes after shutting off the air pump.

b. Low Air Pressure Test

i. This test should be conducted on the complete pipework when all sanitary appliances and traps are installed and the traps (water seals) are charged with water before applying low pressure air to the pipework.
ii. All the open ends of the pipes should be plugged off with pipe caps or inflatable rubber plugs.
iii. A modified pipe-end cap fixed with a T-pipe, one branch is connected to a water gauge manometer and the other branch is fixed with an air inlet valve connected to an air pump, should be installed at the lower end of the discharge stack under test. (Alternatively, a specially designed flexible tube fixed with an air pump, air inlet valve and a manometer on the other end can be inserted through the water seal of a sanitary appliance into the pipes under test).
iv. Air is pumped into the sections of the pipes until air pressure of 38mm water gauge is obtained. The air inlet valve is then closed and pressure in in the pipe works should sustained for at least 3 minutes after shutting off the air pump.

Leakage revealed by an air test can be located by:

i. apply soap solution to the pipes and joints under test. Leakage can be detected by the formation of bubbles.
ii. pump smoke into the defective pipework. Leakage can be observed as the smoke escapes.

ANNEX E – EXAMPLE ON SIZING OF GREASE TRAP (EN1825-2)

For a hawker centre with 9 stalls, each with a sink and a common washing area with 3 sinks and the sinks are fitted with 40mm outlet, the grease trap shall be sized as follows:

$$Q_S = \sum_{i=1}^{m} n q_i Z_i(n)$$

where

- Q_s is the maximum wastewater flow, in litres per second;
- i is the dimensionless counter;
- m is the reference number of fittings and pieces of equipment, dimensionless;
- n is the number of fittings/equipment of the same type, dimensionless;
- q_i is the maximum discharge from the fitting/equipment, in litres per second;
- $Z_i(n)$ is the frequency factor from Table A.1 of EN1825-2, dimensionless.

Table 13 - Extracted from EN1825-2 (Table A1)

Type of Equipment	m	q_i (l/s)	$Z_i(n)$					
			n=0	n=1	n=2	n=3	n=4	n≥5
Rinse Sink 40mm diameter outlet	5	0.8	0	0.45	0.31	0.25	0.21	0.2

$$NS = Q_s f_t f_d f_r$$

where

- NS is the calculated nominal size of the separator;
- Q_s is the maximum flow rate of wastewater, entering the separator in litres per second;
- f_t is the impedient factor for the temperature of influent; f_t=1.0 if temperature of the sullage water is always <60^{o}C, else f_t=1.3;
- f_d is the density factor for the relevant grease/oil; f_d=1.5 shall be used;
- f_r is the impedient factor for the influence of cleansing and rinsing agents; f_r=1.3 else for special cases such as hospital f_r=1.5.

Thus, there are 12 sinks with 40mm diameter outlet in total will connect to a grease trap.
Q_s = 12 x 0.8 x 0.2 = 1.92
NS = 1.92 x 1 x 1.5 x 1.3 = 3.744 (round up to 4)

A non-standard grease trap of NS 4 or higher or standard grease trap (Standard Drawings No. PUB/WRN/STD/040) can be selected.

ANNEX F – TYPES OF SANITARY PLUMBING SYSTEM

Sanitary systems are designed to allow free passage of air and water. Discharge pipe shall not be designed to flow at full bore and should be sized larger to allow free air flow to prevent water seal loss at the sanitary fittings and floor traps due to siphon or positive pressures in the system. Nevertheless, ventilation provision is a primary design requirement for sanitary plumbing systems. The following are the approved sanitary plumbing systems:

1. Fully Ventilated Plumbing System

a. The fully ventilated system is designed for use in buildings with no restriction on building height where there are large numbers of sanitary appliances that may be at widely dispersed locations, e.g. common toilets in office buildings or malls.

b. Every WC and floor trap shall be provided with a vent pipe to be connected to the ventilating stack (see sanitary standard drawing No. 3-19c, 3-15b & 3-16b).

2. Single Stack Plumbing System

a. The single stack system is designed for use in buildings up to 6 storeys.

b. Offset in the single discharge stack is not permitted and the size of the discharge stack must be large enough to allow air flow to limit pressure fluctuations in the pipes/stacks without the need for individual vents for the water seal traps.

c. See Sanitary Standard Drawing No. 3-17c for design requirements.

3. Ventilated Stack Plumbing System

a. The ventilating stack system is a modified single stack system and is designed to serve multi-storey buildings without height restrictions.

b. Cross-vents are to be installed between discharge and ventilating stack (see Sanitary Standard Drawing No 3-18c).

ANNEX G – OTHER SEWER PROTECTION REQUIREMENTS

1. Duties of QP/PE/Contractor

Before Commencement of Specified Activities

a. The copies of all SIP, PUB's approvals, including approved plans, shall at all times be kept at the site and made available for audit check by PUB.

b. PUB's approval must be obtained before opening any manhole/chamber of the public sewerage system or entering any public sewers or manholes to carry out any works.

c. The public sewers and pumping mains are not to be exposed, suspended, altered, diverted or otherwise interfered with without prior approval from PUB.

d. PUB's approval shall be obtained for any proposal to divert existing sewers. The diversion sewer shall first be completed and passed for use by PUB before commencing any work affecting the existing sewer. The cost of diverting any existing sewers/pumping mains shall be borne by the party necessitating the diversion works.

e. The supervising QP or PE shall comply with any precautionary, protective or recovery measures required by PUB.

The measures may include debonding of foundation elements, or putting in recharge wells, etc in order to comply with the limits set in Table 3 of section 2.2.3. For groundwater drawdown requirement, where the QP expects that the value will exceed 10kPa even with mitigation measures, the QP shall assess and submit analysis to verify that there will be no adverse impact (i.e. expected stress is within structural strength, crack width, etc.) to the structural integrity of the sewers and DTSS tunnels & structures.

f. Registered Surveyor shall be engaged to verify, set out and carry out the pegging of the sewer alignment and the setback line, propose tunnel/pipe jacking alignment, pile/drilling hole positions, ERSS alignment and endorse on the setting out plan.

g. The supervising QP or PE shall verify that the details in setting out plan are consistent with those in the PUB approved plans.

h. The supervising QP or PE shall check the positions of all heavy construction machinery and lifting equipment and material storage area in the vicinity of the sewer and ascertain that the imposed loads will not cause any damage to the sewer.

<u>During Implementation of Specified Activities</u>

i. The supervising QP/PE shall closely monitor the works and provide standing supervision and conduct verticality and penetration depth checks on the piles; Earth Retaining and Stabilising Structures (ERSS) to ensure that they are installed within the allowable tolerance limits in terms of setting out, eccentricity and verticality. Records of the standing supervision, verticality and penetration depth checks, as-built piling plan and ERSS drawings shall be properly maintained on-site and made available for inspection upon request.

j. QP or PE shall monitor and review the instrumentation monitoring results daily.

k. The construction works or activities shall not cover up/bury any sewer manholes or valve chambers and appurtenances for pumping mains. The public sewers and pumping mains must be accessible for maintenance and repair works at all times.

l. The developer/contractor shall be fully liable to repair or pay for the cost of repair carried out by PUB for any damage caused to any public sewers or pumping mains.

2. Instrumentation and Monitoring Programme

a. The QP or PE shall be responsible for ascertaining and setting the alert and stop work levels of ground movements, vibration levels or other changes to ensure the structural integrity and proper functioning of all sewers and DTSS structures. He shall provide comprehensive basis for the proposed levels.

b. The instrumentation and monitoring proposal shall include the preparation of action plans in the event that displacements or vibration levels exceed the alert levels.

c. Instrumentation monitoring regime may consist of inclinometers, ground settlement markers, vibration meters, piezometers, strain gauges, rod extensometers, etc.

d. A water level sensor may be required in the nearest manhole upstream of the affected sewer. The level sensor shall be provided with a data logger and an auto alarm system with pre-set alarm trigger levels. When triggered, the system shall notify the designated PUB staff via SMS immediately of high-water level in the sewer.

e. All deformation monitoring instrumentation shall be designed to allow for any ground settlements.

f. The monitoring shall commence for a period of time before the actual activities to record the ambient readings at the site to differentiate them from those caused by the proposed activities.

g. The submissions of the instrumentation monitoring reports to PUB are only for PUB's record. The QP or PE shall be fully responsible for the analysis and interpretation of all the readings and measurements.

h. The QP or PE shall certify that construction works have not resulted in displacements or vibration levels that have or will cause damage to any sewers or DTSS structures.

i. If there are abnormal readings, the PE shall analyse the readings and take immediate remedial action and inform PUB immediately.

j. Readings shall be properly kept at site and made available for inspection by PUB upon request. Such readings shall also be submitted to PUB at a frequency to be specified.

3. Provision of Surveillance Cameras for Large Diameter (≥ 900mm) Sewers and DTSS Tunnel & Structures

a. The contractor shall provide web-based IP surveillance cameras to continuously monitor construction activities in the vicinity of the DTSS tunnel/structures and large diameter (≥ 900mm) sewers. The number of cameras to be provided shall be approved by PUB and shall be sufficient to cover at least the setback distances of the sewer/DTSS tunnel/structures.

b. The surveillance cameras must be able to capture still pictures and perform continuous video recording for 1 month.

c. The contractor shall provide PUB with the Internet website address for centralized live viewing or viewing of the still picture and the recorded video.

4. Pre and Post-Construction CCTV, Laser and Sonar Inspection for DTSS Tunnel for Specified Activities Carried Out within DTSS Setback

a. Pre and post-construction CCTV, sonar and Laser inspection for the DTSS tunnel, to be carried out by a specialist contractor with proven track records for deep tunnel inspections, may be required for specified activities within the DTSS setback.

b. The pre-construction CCTV, Laser and Sonar inspection report shall be submitted prior to the commencement of works, highlighting existing defects.

c. The QP or PE shall compare the pre- and post-construction CCTV inspection reports and notify PUB whether there is any deterioration, abnormalities or defects in the tunnel condition.

d. The QP or PE shall apply to PUB for a permit to access the DTSS Shafts to carry out the DTSS tunnel inspection. The application shall be accompanied with the following details:
   i. a Risk Assessment Report;
   ii. deployment procedures & methodology;
   iii. details of the inspection system used;
   iv. the CVs of competent personnel with track record of similar inspections; and
   v. safety plans and odour control system.

e. The QP's or PE's representative (RE/RTO) and safety officer must provide standing supervision while the access shaft is opened and during the DTSS tunnel inspection to ensure that no damage is caused to the DTSS tunnel and that the safety of the contractors, any personnel or the public is not compromised.

f. The QP's or PE's representative (RE/RTO) shall ensure that the CCTV video is clear and show the tunnels conditions clearly.

g. If a forced ventilation is necessary, it should not lead to public health concerns or odour issues.

h. During the inspection, the QP's or PE's representative (RE/RTO), in consultation with the safety officer, shall ensure that all necessary/adequate measures are taken to safeguard the safety of the contractors' personnel and public. Risk Assessments should include "Hazop" to ensure all measures necessary to prevent damage to the tunnel and shaft are adopted during the inspection.

i. During the inspection process, the QP or PE shall ensure that all precautionary actions are taken to prevent damage to the DTSS tunnel and shafts. The precautionary actions shall include but not limit to the following:

<u>During the deployment and retrieval of the inspection system into and out of the DTSS shaft</u>

i. Measures must be in place to prevent excessive swaying during the deployment and retrieval of the inspection system to prevent damage to the shaft. Adequate padding shall also be provided at appropriate locations on the inspection platform to prevent damage to the DTSS shaft's internal lining.

ii. Pan-Tilt and Zoom (PTZ) CCTV camera that can rotate 180 degrees shall be mounted on the inspection system and used to view backward and forward during the deployment and retrieval to ensure that the inspection platform maintains a safe distance from the access shaft wall and does not cause any damage to the shaft.

<u>During the inspection of the DTSS tunnel</u>

iii. The contractor shall examine carefully the shaft and tunnel interior for areas that might be susceptible to scratching by the tether or the inspection instrument and take additional measures/care to prevent any potential damage to the protective liner covering the shaft and tunnel interior or structural components of the DTSS. Adequate protection such as the use of "Tiger Tails" shall be provided to prevent damage to the DTSS tunnel/shaft.

iv. An example on the deployment of "Tiger Tails" to protect the tether from scrapping against the shaft or tunnel is shown in Figure 1 below.

v. Upon the completion of the inspection of the tunnel, QP or PE shall ensure that the inspection platform re-inspect in the reverse direction using the Pan-Tilt and Zoom (PTZ) CCTV camera system to check and ensure that the DTSS tunnel was not damaged in any way due to the inspection.

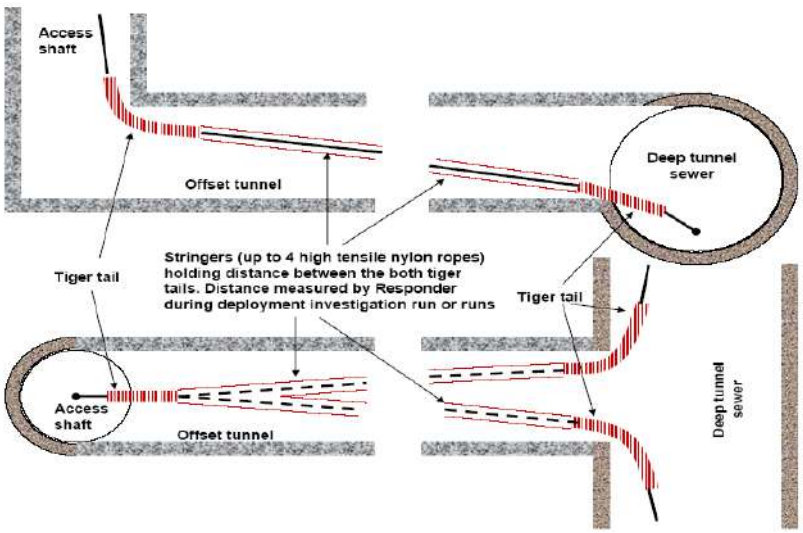

Figure 3 – Plan & Elevation View Showing Deployment of "Tiger Tails"

ANNEX H - GUIDELINES ON AUTOSAMPLER

1. The autosampler shall be provided with a sampling pump suitable for collecting wastewater sample containing toxic and industrial pollutants. The autosampler shall be capable of collecting discrete as well as composite samples.

2. The autosampler shall collect one (1) litre of discrete or composite samples based on flowrate at the last IC or pre-defined interval, which shall be decided by PUB. Trade premises shall change the sampling frequency as and when required by PUB.

3. Operational requirements for the autosampler are listed below:

Table 14 - Auto Sampler Requirements

Items	**Requirements**
Operating temperature	0 to 49°C (32°F to 120°F)
Sampling pump	High speed peristaltic
Suction head	Not less than 7.5 meters
Liquid sensor	Ultrasonic or non-wetted, non-conductive sensor that detects when liquid sample reaches pump
Intake tubing	Chemical resistant with diameter between 0.6cm to 1cm
Capacities of sampling bottles	Twenty-four (24) 1-L polyethylene container
Sampling mode	Able to quickly switch between composite and discrete sampling and capability of collecting samples in times or flow proportional mode.
Sampling program storage	Capability of retaining 3 complete sampling programs
Sampling frequency selection	Selectable in single increments from 1 hour to 99 hours in 1-minute increments
Intake retries	Sample collection cycle optionally repeated from 1 to 3 times if sample is not obtained on initial attempt
Intake purge	Adjustable air purging automatically before and after each sampling
Intake rinse	Automatic rinsing of suction line up to 3 rinses before each sampling with source sample
Data logging	Store up to 100 entries in sample history log including sample time stamp, bottle number and status of sample
User interface & local display	Self-prompting / menu driven program in English with LCD graphics display
Automatic shutdown	After completing discrete sampling program or after completing composite sampling program

4.	The autosampler shall be housed in an instrument panel, which shall be located near or within the guardhouse of premises. Door of the instrument panel shall be provided with a glass or plastic window for viewing the local display.
5.	The sampling tube of autosampler shall be fitted with a suitable strainer to prevent solids from being pumped into the sampling bottle. The sampling tube shall also be easily lifted out of the last IC and repositioned back without the need to go inside the chamber. The sampling tube shall be laid in a heavy-duty PVC conduit. The mountings for sampling tube inside the last IC shall be of corrosion resistant materials.
6.	Details of the autosampler shall be submitted for approval to PUB before installation.
7.	The operator shall be responsible for the proper maintenance of autosampler and its other auxiliary equipment.
8.	The instrument panel for the autosampler and the last IC shall be sealed by PUB. The instrument panel for autosampler and last IC shall not be opened without PUB's approval.
9.	PUB may collect any samples from autosampler at any time in the presence of the operator's representatives. When a sample fails to comply with the discharge standards stipulated in the TER, the operator will be liable for enforcement action.

ANNEX I - GUIDELINES ON VOC MONITORING SYSTEM

1. The monitoring system shall consist of:

   a. Meter cum controller (range of 0 – 1,000 ppm isobutylene equivalent);

   b. Water Sampling Kit (1 litre water sample);

   c. Chart recorder (range of 0 – 1,000ppm);

   d. Remote Terminal Unit; and

   e. Back-up Power pack.

2. The monitoring system shall be housed in the instrument panel, which shall be located near or within the guardhouse of trade premises.

3. The door of the instrument panel shall be provided with a glass or plastic window for viewing the recorder chart.

4. A suitable VOC meter, utilising the photo-ionization detection (PID) principle or its equivalent, shall be used for detecting VOC in gaseous sample extracted from the last IC. VOC meter shall provide a surrogate value in accordance with its calibrated gas media e.g. isobutylene or its equivalent.

5. A recorder chart (range of 0 - 1,000ppm) shall be provided to record the surrogate VOC values (as output) from the meter. The recorder chart shall be capable of recording the VOC values continuously for a month.

6. A water sampling kit comprises an electrically operated peristaltic pump or its equivalent shall be installed and pump wastewater from the last IC into a 1 litre sampling bottle. The pump shall be linked to the controller and the record chart. A limit switch to indicate the 'full' position of the sampling bottle shall be incorporated, and the switch shall be linked directly to the recorder chart. The pump shall be activated to fill the sampling bottle only when the surrogate VOC values exceed the pre-set value.

7. A chemical resistant sampling tube shall be laid in the last IC. The sampling tube shall be fitted with a suitable strainer to prevent solids from entering the sampling bottle when the pump is activated. The tube shall be laid in a heavy-duty PVC conduit. The

mountings for the sampling tube inside the last IC shall be of corrosion resistant materials.

8. A remote terminal unit shall send pre-determined messages to a list of recipients by the "Short Message System (SMS)" protocol or its equivalent when surrogate VOC value exceeds the pre-set limit or the sampling pump was activated.

9. Power back up shall be provided to ensure that the system continues to operate the VOC meter, recorder and the sampling kit for a period of 5 hours during power failure/interruption.

10. The operator shall be responsible for the proper maintenance of the system, which includes the regular cleaning and calibration of VOC meter and all other auxiliary equipment. The operator shall submit the maintenance report to PUB.

11. The operator shall inform PUB's authorised personnel immediately when the VOC meter detects high VOC readings. The operator shall include at least one PUB personnel in the list of recipients to receive messages from the remote terminal unit.

12. The instrument panel for VOC monitoring system and the last IC shall be sealed by PUB. The instrument panel for VOC monitoring system and last IC shall not be opened without PUB's approval.

13. Details of the VOC monitoring system shall be submitted to PUB for approval before installation.

14. The VOC recorder chart shall be endorsed by the operator before it is submitted to PUB on a monthly basis.

ANNEX J – REQUIREMENTS FOR TEMPORARY HOLDING TANK

1.	PUB may require the provision of holding tank when is deemed necessary. The use of holding tank is a temporary measure and subject to the approval of the NEA.
2.	The holding tank should be sited next to the boundary abutting the public road to facilitate future flow diversion to the sewer.
3.	Proper vehicular access shall be provided for tankers to get near to the holding tank in order to transfer the sewage to the tankers.
4.	The holding tank shall be sized to hold at least 1-day's sewage generated from the premises.
5.	The holding tank shall be installed with high water level alarms and beacon light to warn the owner when the sewage level is high and risk of overflow is significant. The high water level alarm for the holding tank shall be set at a level such that at least two hours of reaction time is available for the owner to take urgent actions to prevent an overflow.
6.	The alarm system shall be capable of sending the alarms via SMS to alert the owner and at least two other responsible personnel appointed by the owner to take immediate actions to prevent over flow of sewage.
7.	A ventilating pipe of not less than 75mm diameter shall be provided for the tank and shall be located such that it will not cause nuisance.
8.	Only NEA-licensed wastewater collector shall be engaged to dispose of the sewage to a designated Water Reclamation Plant (WRP).
9.	When PUB's permission is given for the sewage to be discharged to the sewer, the holding tank shall be demolished at owner's cost.
10.	Surface runoff and rainwater shall not be discharged to the holding tank.