Section 3
Construction and Installation
3.1 Introduction

The correct installation of sewer systems is critical to the efficient and effective sewer system operation. Poor construction practice causes defects in the sewer at joints, along pipe barrels, at manholes, transition points (e.g. pipe to manhole), etc. Adequate site supervision and certification by consultants, with reference to approved design drawings, are therefore also required.

The various construction and installation aspects of sewer system can be divided into:

a) Pipes and Fittings Delivery and Handling
b) Trench Excavation
c) Pipe Laying
d) Pipe Jointing
e) Special Requirements for Ancillaries and Protection
f) Connections to Public Sewers

A description of the requirements for each stage is given below.

3.2 Pipes and Fittings Delivery and Handling

3.2.1 Pipes and Fittings Delivery

a) Materials delivered shall be from approved suppliers.

b) Pipes and fittings on the delivery truck shall be secured firmly without damaging the pipes and fittings. Pipes and fittings shall be protected from any damage from the chain secureings by using rubber, carpet or textile paddings.

c) Pipes and fittings shall be checked to ensure that they have not moved during transportation.

d) The pipes and fittings shall not be stacked in contact with each other and shall be separated by wooden spacers. The pipes stack can be secured by strapping or crating or can be secured by chocks at the outer pipes of each layer.

e) Sockets of pipe in adjacent layers should be placed at opposite ends. Alternatively, sockets of adjacent pipe can be placed at opposite ends.

f) Thermoplastic pipes (PE, ABS) shall not be supported in such a way that will cause the pipes to be twisted or bowed.
g) Sewer pipe and components shall be checked for damage before being removed from the delivery truck.

h) The delivered pipes and fittings shall be checked against the design drawings and the delivery docket to ensure the pipes and fittings delivered are of the strength, stiffness, pressure class, length, joint type, diameter, fitting type, etc. specified.

i) The delivery truck shall be positioned on a flat ground or in such a way that pipes and fittings would not fall off the truck when unsecuring the fastenings.

j) Pipes and fittings shall not be pushed off the delivery truck and shall not be allowed to drop to the ground.

k) When pipes are delivered in crates, the crates shall be removed intact, wherever possible.

l) Pipes and fittings shall be lifted from the delivery truck using approved slings. Plastic covered wire mesh slings, hemp rope slings and chain slings without rubber sleeving are not suitable. For plastic pipes or pipes with external coating, webbed synthetic slings shall be used.

m) Alternatively, pipes and fittings can be removed from the delivery truck by rolling a pipe at a time down the wooden runners. The pipe rolling shall be simultaneously controlled by ropes.

n) Uncrated light thermoplastic pipes shall be lifted manually and carefully off the truck and shall not be dragged across the truck bed, edges or other hard and sharp surfaces. This is to avoid the scoring of plastic pipe.

3.2.2 Pipe Handling at Site

a) Pipes shall not be dragged or pushed over the ground.

b) Pipes and fittings shall not be dropped in any way.

c) Pipes and fittings shall not knock against each other or any other objects.

d) The pipe lifting shall be controlled, where necessary, using ropes or by hand to ensure they do not knock against other objects.

e) When rolled, pipes shall be rolled on smooth timber bearers, which are free of nails, fasteners, etc., and sufficiently raised above the ground to prevent hitting any rocky ground, tree roots, etc.

f) When rolled on timbers, pipes shall not be pushed with a machinery bucket.

g) Pipes with external coatings shall not be rolled. Instead, these pipe shall be lifted into place.

h) Pipes and fittings shall be lifted using approved slings

i) Pipe lifting equipment shall be of sufficient strength and reach to lift the intended individual pipe or crate of pipes.
j) Mechanical lifting units (cranes, backhoes etc.) shall be stable or properly stabilised prior to lifting operations to ensure they would not tip and damage pipes and fittings.

k) The slings or chains used for lifting the load shall be secured to the load in the right manner to ensure the load does not slip or tilt excessively.

l) All other safe lifting procedures not covered above shall be adopted.

m) The lifting and moving of all the steel pipes and any pipes that contain internal linings shall follow the manufacturer instructions.

3.2.3 Pipe Storage

a) The pipe and fittings storage area shall be away from traffic and shall not obstruct any property access or pedestrian route.

b) The pipe and fittings storage area shall be at a location that allows lifting machinery to position easily and safely for lifting pipes and fittings.

c) Pipes shall be stacked on a flat and level firm ground or the base of the pipe stack shall be made level using additional solid timbers under base bearers.

d) There shall be no rocks, tree roots, etc. under the pipe stack, which may cause point load.

e) The sockets shall be alternated to different ends for each pipe stack layer. The sockets shall be protruded out of the stack.

f) The base timber bearers shall be sound and without protrusions. The cross section of each timber shall be at least 75 mm by 75 mm. The base bearers shall provide support near the pipe ends, but placed behind sockets. The placement of base bears shall not be more than 1.5 m apart.

g) VC, RC, DI, Steel and GRP pipe layers shall be separated using timber spacers of at least 50 mm wide and 50 mm thick. These spacers shall not be placed more than 1.5 m apart. These spacers will prevent pipes in each layer from touching pipes in the next layer.

h) For VC and RC pipes that are not crated, the pipes shall not be stacked more than 3 pipes high. The pipe stacks shall be wedged to prevent them from rolling off the stack.

i) Thermoplastic pipes (PE and ABS) shall be stacked in such a way to prevent them from being twisted or bowed.

j) Thermoplastic pipes shall be either stacked in a pyramid with no more than 1 m high or in a square with vertical side supports for more than 2 pipes high.
k) Plastic pipes and fittings shall be kept under a cover that prevents direct exposure to sunlight.

l) Plastic pipes and fittings shall not be covered with plastic sheeting.

m) Plastic pipes and fittings shall be stored away from oils, greases, solvents and other aggressive chemicals.

n) Plastic pipe shall be stored away from sources of heat such as engine exhausts.

o) Care shall be taken to prevent scoring and scratching of plastic pipe and fittings.

p) Joint lubricants, rubber rings and other jointing materials shall be stored in a secured area that cannot be accessed by the public.

q) Any safe pipe stacking procedure not covered above, but recommended by the manufacturer, shall be adopted.

r) The rubber rings that are not delivered fitted to the pipe socket or sleeve shall be stored away from direct sunlight or continual artificial light. Also, the rubber rings shall be stored in a cool area that is away from oils, greases or other petroleum products.

s) When rubber rings are delivered fitted to a pipe socket or sleeve, the pipe ends with the rubber ring shall be shielded from sunlight using a hessian cloth.

t) Rubber rings shall be retained in the original sealed packaging until they are required.

3.2.4 Pipe Damage

a) Pipes, fittings (including coatings and linings) and rubber rings shall be inspected for damage on delivery, immediately before laying and after laying.

b) Damaged pipes and fittings shall be identified and marked with an indelible marking of “Damaged” in a clearly distinguishable colour.

c) Damaged rubber rings shall be cut through completely to prevent inadvertent use.

d) Damaged pipes, fittings, and rubber rings shall be set aside and separated from the undamaged components.

e) Pipes or fittings shall only be repaired if they can be restored back to a satisfactory state. Approval for repair shall be sought from the Commission before the repair.

f) Pipes or fittings that are damaged and are in a repairable state shall be repaired according to the manufacturer’s instructions.

g) Damaged pipes and fittings that are not permitted to be repaired shall be removed from the site as soon as possible.
h) PE and ABS pipes with damage in the barrel, shall have the damaged section and at least 100 mm either side of the damage cut from the barrel.

i) Repaired pipes and fittings shall be used only after the approval for reuse from the Commission is granted.

3.3  Trench Excavation

3.3.1  Protection of Affected Services, Structures, Pavements and Vegetation

a) Owners of affected property, structures, services and other pipelines (sewer, water, gas, electricity, telecommunications lines, fuel lines, chemical pipelines) along or within 3 m of the excavation shall be notified.

b) Services and other pipelines shall be protected, uncovered, temporarily supported or temporarily relocated in accordance with the conditions specified by the owner.

c) Where the shutdown of a service or pipeline cannot be avoided, arrangements shall be made with the owner of the service or the pipeline on the closure and reinstatement requirements.

d) Damages to any affected structure, service or pipeline shall be avoided.

e) Damage to any structure, service or pipeline shall be informed to the owner and shall be repaired as quickly as possible in accordance with the requirements of the owner.

f) Damage to vegetation (trees, bushes, gardens), paved areas (roads, footways, kerbs), fences or other property within the construction zone shall be minimised.

g) The length of time that any paved route is out of use shall be minimised.

h) Not more than half the width of a roadway shall be disrupted at any one time.

i) Spoils shall not be placed on road surfaces. Where there is no other approved storage area, spoil shall be carted away.

j) Non-reusable material excavated from roadways shall be disposed of in an appropriate manner. Only fillings approved by the responsible authority for the roads shall be used as refill.

k) Excavations shall be sufficiently clear of building foundations.

l) Excavations adjacent to roads shall be at least 1 m clear of the road edge except when otherwise approved by the Commission.
m) Trenches adjacent to roads, buildings and structures shall be continuously supported until the trench is refilled.

n) Structures, services, vegetation, paving, or other property not within the construction zone shall not be damaged.

o) Temporary fencing shall be provided where barriers such as fences and walls are dismantled.

p) Warning signs and temporary fencing shall be provided at the work site for excavation spoils, access routes, steep or loose slopes resulted by excavation work.

q) Warning signs shall be in accordance with the relevant Malaysian Standards. Some of the relevant Malaysian Standards are:
   i) MS 980 Specification for safety signs and colours: colorimetric and photometric properties of materials
   ii) MS 981 Specification for safety signs and colour: colour and design
   iii) MS 982 Specification for safety signs, notices and graphic symbols

r) Adequate lighting and reflective signals, which can make clearly visible the perimeter of the work site to pedestrians and traffic, shall be provided.

s) Adequate lighting shall be provided for works undertaken in poor lighting or at night. Lighting in confined spaces shall be explosion proof.

t) Alternative means of access shall be provided to rights of way, buildings and property where usual means of access are disrupted by the excavation.

u) Soils shall not be taken out of the work site, put onto pavements or flushed down to drains or water courses.

v) Road drains, gutters and channels shall not be obstructed.

w) Drains disturbed by works shall be rerouted to ensure continual operation.

x) Sufficient top soil that will be used for surface reinstatement shall be removed and stockpiled separately.

y) When dewatering, care shall be taken to ensure that the adjacent structures, services and building foundations are not affected.

z) Water removed from the excavation shall be disposed of without damaging other property or causing a public nuisance.

3.3.2 Excavation Requirements

a) The required line of the sewer and manhole locations shall be set out using accepted surveying practices.
b) Manhole locations shall be pegged and the line of the excavation between manholes shall be maintained straight using one or more of pegs, chalk lines laser beam lines and string line.

c) Changes to the line, grade or level due to unforeseen obstructions or proximity to services shall be approved by the Commission prior to making the actual changes.

d) The trench shall be excavated precisely along the marked alignment to ensure the sewer will be in the centre of the trench.

e) The trench shall be excavated to a depth so that the sewer can achieve the specified level and grade when the specified bedding depth is used.

f) Over-excavation of the trench depth shall be avoided.

g) For open excavation, depending on depth of sewer and soil condition, sufficient slope protection must be provided and supported by approved consultant drawings and design.

h) When the excavations are required to cross rivers, railway lines, and any other obstructions, minimum soil cover requirements specified by the responsible authorities shall be observed. In extreme cases, inverted siphons may be necessary. Minimum requirements for inverted siphons are shown in the standard drawings in the Appendix, and they must be designed individually based on actual locations.

i) When working with poor ground conditions, construction depth shall be minimised. Reference shall be made to the approved longitudinal and cross-sectional sewer profile drawings, which give details of construction based on soil reports.

j) The base of the trench shall be trimmed carefully to level and grade.

k) Where sight rails are used to determine trench excavation depth, at least three sight rails shall be used for each manhole length.

l) Sight rails shall be fixed to a uniform height above sewer invert.

m) Rocks that cause an uneven trench base shall be removed. The resulting holes shall be refilled with the specified embedment material.

n) The trench in the pipe zone shall be excavated to the minimum width limits as given in the specification, except where a wider trench is needed due to unsupportive soil adjacent to the pipe zone.

o) The trench sides shall be vertical except where permitted otherwise by the Commission.

p) To prevent trench wall from collapsing which may lead to injuries and pipe damage, timber or steel support shall be provided in the trench when the trench is deeper than 1.5 m. These supports must be adequately designed for.
q) Where possible, spoil shall be placed only on one side of the trench.

r) Spoil shall be placed at an appropriate distance away from the edge of the trench (minimum 600 mm). This is to prevent the spoil material from falling into the trench or to prevent the weight of the spoil from collapsing the trench wall.

s) Unsupportive (very soft, loose, spongy or puddly) soil in the base of the trench (as determined by the Commission) shall be removed and replaced. The replacement based shall be sufficiently supportive and shall require approval from the Commission.

t) Excessive excavation shall be refilled with approved materials to the specified compaction.

u) Where possible, the excavated trench shall be kept free of water until sufficient backfill is placed above the sewer. This is to prevent the base of the trench from becoming spongy and to prevent the pipe from moving off line or grade.

v) Changes to the line, grade or level of the sewer shall be properly recorded for incorporation in the as-constructed drawings. All as-constructed drawings, irrespective of whether there are changes to the original design drawings, shall be certified by consultants and shall include sufficient details, including as-built sewer invert levels. These drawings shall be submitted to the Commission.

w) Excavation shall not proceed too far ahead of pipe laying to avoid damages from flooding or spoil.

x) Excavation shall not proceed too far ahead of the required trench support placing to avoid trench wall from collapsing.

y) Excavation shall comply with the relevant Occupational Safety and Health Act (OSHA) requirements for safety.

3.3.3 Bored Excavation

a) The bore shall be on the line, level and grade and of sufficient diameter to allow pipes to be inserted without over-stressing the joints or damaging the pipes.

3.4 Pipe Laying

3.4.1 Pipe Bedding

a) Only approved materials are allowed to be used for pipe embedment. They shall be in accordance to the approved longitudinal and cross-sectional sewer profile drawings, which shall also provide details of the designed bedding types.
b) The bedding material shall be placed as soon as possible after the base of the trench is prepared and excess water has been removed.

c) Granular bedding shall be placed, compacted and graded so that it offers continuous support to the sewer. The compacting, where required, shall achieve a uniform density.

d) A small hole shall be left in granular bedding for each socket, jointing sleeve, flange, etc. that may project into the bedding. The holes shall be of size that is just sufficient for projections to be clear of bedding. Long and large holes that may undermine the pipe barrel support are not allowed.

e) A recess shall be made in the bedding to permit the withdrawal of the sling without disturbing the remaining bedding.

f) Where the bedding is disturbed, the pipe shall be raised again to repair the bedding.

g) Pegs or other temporary aids to levelling shall be removed before pipe laying.

3.4.2 Pipe and Fittings Placement

a) Before lowering the pipes into the trench, pipes shall be placed next to the trench away from the trench edge. The pipes shall be placed on the opposite side of the spoil beside the trench with their sockets facing upstream. Where required, the pipes shall be blocked or chocked to prevent any rolling.

b) Pipes and fittings (including linings, sheathings and protective paintworks) shall be checked for damage before and after laying in the trench.

c) VC pipes shall be carefully tapped at mid length and either end with a wooden mallet or, otherwise, a metal bar. This is to detect a clear ring that indicates soundness. This is best undertaken while each pipe is lifted in free air with a lifting sling.

d) Pipe and fittings shall not be dropped into the trench. Instead, pipes shall be lowered into the trench using approved slings.

e) Pipes shall be laid from the downstream end towards the upstream end.

f) The laying of pipes shall proceed carefully to ensure the line, level and grade are within the specified tolerances.

g) Pipes shall not be dropped or impacted forcefully into the bedding to obtain the specified level or grade.

h) Concrete pipes with elliptical reinforcement shall be laid with the load line on the vertical axis at the top or bottom position.

i) Holes made in granular bedding for projections of sockets, flanges, etc. shall be lightly filled where necessary without pushing the pipe/fitting off line, level or grade.
j) Bedding shall be checked to ensure continuous support along the pipe barrel. Further bedding material shall be placed to an even height and uniformly compacted across the trench to ensure the full support of the pipe haunch.

k) Pipes that are laid on concrete, grout, cement stabilised bedding or connected to a concrete structure shall consist of a flexible joint at the upstream end immediately outside such a zone.

l) Pipe level, grade and alignment shall be sighted using sight rails and boning rod or laser and target. They shall be in accordance to the approved longitudinal and cross-sectional sewer profile drawings, which shall be submitted for approval before work at site is allowed to begin.

m) The invert level of each pipe laid shall be checked during laying and immediately after laying completion, and with reference to the approved drawings.

n) Boning rods shall have a foot to rest on the pipe invert with a vertical spirit level attached and shall not be more than 45 m apart.

o) The pipe interior shall be cleaned after laying and kept clean and free of water.

p) The pipe ends shall be sealed with a tightly fitting plug immediately after laying, cleaning of the pipe interior and at the end of the day after laying.

q) The branch arm of the oblique branch junction fitting, if installed, shall be laid in such a way that it is at approximately 45° off horizontal level.

r) Junction fittings shall be properly supported using well compacted crushed rock (or, where required, concrete). The coverage of the support shall be across to the trench wall and into the junction trench.

s) Branch connections shall be sealed with an approved plug where connections are to be made at a later time.

t) Any pipe laid that is out of alignment either vertically or horizontally or shows undue settlement shall be taken up and re-laid correctly.

u) Photographs shall be taken during pipe laying and after sewer pipe laying for all lengths of pipes and manholes.

3.4.3 Pipe Jacking

a) Jacking method of pipe laying shall be employed only when the conditions or the requirements of the responsible authorities require such a method.

b) The pipes used for jacking shall be able to withstand the laterally induced jacking stresses without damage.
c) The setting out of the guide rails for the pipe and the actual jacking operation shall maintain a high accuracy level of line and grade.

d) The direction and grade for jacked sewer shall not deviate from the designed alignment for more than 100 mm for every 100 meters of sewer.

e) All the joints used for connecting the jacked pipes shall be watertight and durable.

3.4.4 Concrete Pipe Support

a) Concrete used shall be 20 MPa Portland cement concrete with a slump no greater than 80 mm.

b) When purpose-made pre-cast concrete blocks are used, the block shall have approximately the same width as the trench and shall be positioned just behind each pipe socket. A compressible packer of polystyrene or particle board shall be placed between the pipe and the concrete block.

c) Concrete shall be poured in one lift.

d) Pipes shall be prevented from floating or other movement during concrete pouring.

e) A space shall be left between the concrete supports for the pipe socket by use of a polystyrene spacer of 20 mm minimum thickness. This is to retain rotational flexibility at the joint.

f) The concrete support shall fit the pipe closely after hardening.

g) Concrete shall be allowed to cure for at least 7 days before applying any load.

h) Where the trench base is soft or puddly, a blinding layer shall be placed on the trench base before the concrete is placed.

3.4.5 Pipe Cutting

a) Only VC, HDPE, ABS and DI pipes are permitted to be cut in the field. However prior approval from the Director General is required should the HDPE helically wound profile wall pipe needs to be cut in the field. All pipes shall be cut in accordance to approved methods.

b) Rough edges and burrs shall be removed from inside and outside of HDPE and ABS pipe with a rasp or file.

c) Pipes shall be cut in a neat and skilful manner by workers experienced in pipe cutting.

d) Pipes shall be cut perpendicularly to the pipe axis.

e) Any damage to the cement lining of DI pipe shall be repaired to the satisfaction of the Commission.
3.4.6 Backfill of Trench

a) Selected excavated material shall be placed above the specified pipe support until 300 mm above the sewer. They shall be in accordance to the approved longitudinal and cross-sectional sewer profile drawings, which also give the bedding details and the types of fill material.

b) Trench support shall be progressively removed as the backfill is placed.

c) There shall be at least 300 mm of cover over the sewer before light mechanical compaction can commence.

d) There shall be at least 1000 mm of cover over the sewer before heavy mechanical compaction can commence.

e) For plastic pipe, a metallic marker tape shall be laid along the line of the sewer at approximately 500 mm below the surface level.

3.4.7 Other General Requirements

a) Reference shall be made to the approved longitudinal and cross-sectional drawings of sewer profiles of both gravity sewers and force mains. These drawings submitted for approval must include details of bedding types and manhole types, and their design must be supported by soil reports.

b) Pipe laying shall be such that there is adequate access for operations and maintenance of completed sewers, especially in undulating ground profiles, with a minimum width of 6 metres, which shall be supported by drawings with ground profiles during drawings approval stage.

c) For easy identification of underground forced sewer mains, their layout shall be planted with marker posts at every 200 m length and at every change of pipe directions. Valve chambers provided shall have adequate access for operations and maintenance.

d) There shall be adequate site supervision of construction, and at least these documents must be submitted before approval of construction:

i) Photographs showing sewer pipe laying during an after construction for all lengths.

ii) Testing certificates from the consultants (see Section 4 on Sewer Testing)

iii) Supervision certification from the consultants

iv) As-built drawings certified by the consultants

e) The construction and installation works shall incorporate the consideration of health and safety.
3.5 Pipe Jointing

3.5.1 Flexible Joints

a) Joint components (i.e. spigots and sockets or sleeves and rubber seals) shall be checked for damage after delivery, before and after usage.

b) Every part of the rubber ring shall be bent by hand to detect cracks.

c) VC pipe sockets shall be gently tapped with a wooden mallet or, otherwise, a metal bar to detect a clear ring that indicates soundness.

d) Steel sleeve collars used for jacking pipe shall be checked for damage to the coating.

e) Pipe jointing surfaces and rubber seals shall be wiped clean immediately before jointing using a clean cloth.

f) The rubber ring shall be placed correctly around the pipe joint.

g) The rubber ring shall not be twisted in any way prior to jointing and shall be seated in the correct position.

h) For skid type of joints (i.e. the sealing ring remains stationary and does not roll into place), the spigot shall be lubricated with an approved lubricant.

i) The pipe to be jointed shall be aligned with the laid sewer before pushing in the joint.

j) The pipe to be laid shall be orientated so that the offset inside the pipe at the joint is minimise at the invert.

k) The pipe that is already laid and to be connected to another pipe shall be restrained to prevent its pipe joints being further stressed and to prevent the laid pipe from being pushed off grade or alignment.

l) Pipe joints shall be connected using a bar and block (crow bar and a block of wood to protect the pipe end) or a pipe puller.

m) A machine bucket shall only be used to connect a pipe joint where approval is given by the Commission. This method shall only be used for large diameter pipes (larger than 600 mm diameter pipe) where the jointing compression force makes it impossible to use a bar and block or pipe puller. A timber shall be placed across the pipe end to protect the pipe from damage. Pressure shall be applied by the bucket gently while the insertion shall be carefully monitored and directed by a person next to the joint.

n) No excessive force shall be applied to make the joint.

o) After pushing the spigot into the socket, the seal shall be checked to ensure the seal is correctly located and the spigot is properly
inserted. No contaminants are allowed between jointing surfaces. The joint or pipe shall not have damage from jointing.

p) Any allowable deflections at joints shall only be made after the pipe jointing is made.

q) Where a pipe is to be deflected at a joint, the deflection shall not exceed the allowable limit for the specific type of joint.

### 3.5.2 Solvent Weld Joints

a) The socket and spigot shall be checked for damage before and after jointing.

b) Damaged spigot ends shall be cut from the pipe with 100 mm clearance to the damage. The spigot end shall be cut perpendicularly to the pipe and any burrs shall be removed.

c) The spigot shall be inserted up to the witness mark.

d) If a witness mark is not already on the pipe, the mark shall be made to ensure that the spigot is inserted to the appropriate length.

e) Witness marks drawn on site shall be made with a soft pencil or felt pen marker that would not score or scratch the pipe.

f) The witness mark shall be of the depth of the socket and shall be measured from the pipe end.

g) A dry fit of the joint shall be made before the jointing.

h) Jointing surfaces shall be wiped clean and dried with a clean cloth.

i) Jointing surfaces shall be primed using an approved priming solution. The priming shall be applied with a clean cloth or swab freshly dipped in the fluid immediately before jointing.

j) A thin and even coat of solvent cement shall be applied to the socket and the spigot, which should then be inserted up to the witness mark.

k) The jointing surfaces shall not be contaminated with water, dirt, etc.

l) The jointing shall be made immediately after the application of solvent cement.

m) After the spigot is pushed firmly into the socket, the joint shall be held in the same position for at least 30 seconds without moving.

n) The jointed pipes shall not be moved for at least 5 minutes after jointing. The jointed pipes shall be handled with extreme care for at least another hour.

o) Joints shall be left to dry for at least 24 hours before pressure testing.

p) Containers of solvent cement and primer shall be kept tightly sealed when not in use.
q) Solvent cement and priming fluid are highly flammable. Therefore, the solutions shall be stored in a cool place away from any source of spark or fire.

3.5.3 Flanged Joints

a) Flanges, particularly flange faces and rubber seal shall be checked for damage before and after jointing.
b) Appropriate metal backing plates shall be used on plastic flanged pipe.
c) Screwed-on flanges shall have the screw thread sealed with a compound suitable for sewers.
d) Flanged ends shall be correctly aligned before jointing.
e) A steel bar or similar object shall not be used as a lever through the flange holes to bring the bolt holes into line prior to bolting.
f) The rubber seal between flanges shall be made of an approved compound and shall meet the specified requirements.
g) The flange faces and the rubber seal shall be wiped clean with a cloth immediately before jointing.
h) Bolts shall be tightened evenly and gradually in rotation.
i) Bolts and nuts shall be tightened with a torque wrench set at an appropriate torque.
j) Plastic flanges shall not be distorted before or after jointing.
k) After pressure testing, metal flanges shall be reprimed and painted with two coats of bituminous based coating in accordance with BS 4147 for below ground protection.

3.5.4 Steel Pipe Welded Joints (Field Welding)

a) The welded joint shall use a socket-spigot joint with taper sleeve wherever possible.
b) Welding surfaces shall be cleaned to a bright metallic finish before welding.
c) Welders shall be qualified in accordance with the requirements of British Standard BS 4515 Specification for welding of steel pipelines on land and offshore.
d) Welding procedures shall be tested, qualified and approved in accordance with BS 4515.
e) Welds shall be inspected and tested in accordance with BS 4515.
f) After welding, exposed external surfaces shall be cleaned by sand blasting or wire brushing. The dry surfaces shall be wrapped in an approved manner with an approved wrapping tape to provide corrosion resistance.
3.5.5 Polyethylene Butt Welded Joints

a) The pipes to be joined shall be of the same grade of polyethylene and of the same wall thickness.
b) The butt welding machine shall be of an approved type and shall be fit for use.
c) The welding machine shall be sheltered from wind and rain during the welding process.
d) A practice weld shall be performed and discarded to check the operational effectiveness of the machine.
e) The pipe ends shall be trimmed square.
f) The ends to be jointed shall be kept free of dirt, grease and moisture after trimming.
g) The heating plate shall be brought into contact with the pipe ends only after it is at the correct temperature.
h) The pipe ends shall be held against the heating plate for the specified time appropriate for that pipe size.
i) Immediately after the removal of the heating plate (no longer than 15 seconds after heating), the pipe ends shall be pressed together with an appropriate pressure for a specified time appropriate for that pipe size.
j) The joint shall be maintained clamped and pressurised in the machine for a suitable period of cooling time (approx. 10 minutes minimum).
k) After removed from the machine, the joint shall not be stressed until it has completely cooled (approx. 10 minutes minimum).
l) The weld shall not be artificially cooled with cold air or water.
m) The external bead shall carefully be removed. The joint zone shall be thoroughly checked.
n) A pipe end that has undergone a complete heating cycle but not joined shall not be reheated. The unjoined pipe end shall be cut off to at least 250 mm from the end.

3.6 Special Requirements for Sewer

3.6.1 Thrust Blocks for Pressure Pipelines

a) The thrust block shall be extended to approximately 180° around the fitting.
b) The thrust block shall not cover a flexible joint.
c) The thrust block shall be constructed equally around the centreline of the fitting.
d) The thrust block shall bear firmly against a recess at the side of the trench.
e) The trench face which the thrust block bears against shall be freshly cut and undisturbed.
f) Each thrust block shall have sufficient bearing area.
g) Thrust block shall be cast-in-place with 20 MPa concrete.
h) For plastic pipe or pipe with a protective coating, a compressible membrane of rubber, felt or cork shall be placed on the pipe to protect it from damage from its movement in the thrust block.
i) Formwork shall be used to cast the thrust block to the required dimensions.
j) Formwork shall be removed before any testing.
k) Reference shall be made to the standard drawings for thrust block to ensure proper shape and size, which must be designed for each individual thrust blocks.

3.6.2 Pipe Restraints and Bulkheads on Steep Slopes

a) A bulkhead to prevent soil erosion shall be used where the gradient of the sewer is steeper than 1 in 40.
b) A restraint to prevent sewer slippage shall be used where the gradient of the sewer is steeper than 1 in 6.
c) The restraint or bulkhead shall be placed at the downstream side of the socket.
d) Concrete bulkheads shall be keyed into the base and sides of the trench by at least 100 mm.
e) A weep hole with the upstream end covered with a geotextile filter shall be provided through a bulkhead immediately above pipe invert to allow drainage of groundwater.

3.6.3 Pipe Embedment and Overlay

a) The embedment material type and its grading shall take considerations of the sewer type or length.
b) Reference shall be made to the approved longitudinal and cross-sectional drawings of the sewers showing the bedding types, which shall be designed based on supporting soil reports.
c) Embedment material shall not be contaminated with other soils.
d) Embedment material shall be brought up evenly in layers on each side of the pipe.
e) Each embedment layer shall be placed to a depth that permits the compaction equipment to achieve the specified density.
f) The pipe shall not be pushed off alignment, level or grade while placing the embedment.
g) Where the embedment requires tamping, tamping equipment shall not come into contact with the pipe.
h) Temporary trench wall support shall be lifted when the embedment is compacted.
i) While placing the embedment for the pipe haunches, unnecessarily voided areas shall be avoided.
j) At least 300 mm of cover shall be placed over the pipe before light mechanical compaction, such as a hand operated whacker, can commence.

3.6.4 Sleeving of Ductile Iron Pipe

a) Plastic sleeve shall be secured immediately behind the second spigot jointing witness mark with three overlapping turns of adhesive tape. After that, sleeve shall be tightly wrapped around the pipe by folding over surplus sleeving. Then, the sleeving shall be further secured with three winds of overlapping adhesive tape at one meter intervals.
b) The pipe shall be placed in the trench with the folding of the sleeve located at the top of the pipe.
c) After the pipe jointing, the sleeve of the preceding pipe shall be brought over to cover the socket and the cover shall follow the socket outer surface closely.
d) The sleeve of the preceding pipe shall overlap the sleeve of the next pipe. The sleeve overlap shall be secured with three overlapping winds of tape.

3.6.5 ‘Rocker’ Pipe Connections to Manholes

a) The ‘rocker’ pipe connecting sewers to manholes shall have sufficient cast insitu concrete surround and extended concrete base as shown in typical manholes drawings in Appendix A.

3.7 Reinstatement

a) All structures, services, fences, drains, gardens, improved surfaces, etc. disturbed by the construction shall be restored within 7 days after backfilling. The restored conditions shall be as similar as possible to their original condition. Also, the condition shall be to the satisfaction of the Commission, other responsible authorities and property owners.
b) Where a structure or service is affected by construction, the trench fill shall be compacted to the equivalent of that under a pavement.

c) Within 7 days after backfilling, fill over unimproved surfaces shall be placed to a height that will make the filled surface level and the adjacent undisturbed surfaces closely matching after settlement. All contours shall be similar to the original condition.

d) Unimproved surfaces shall be levelled and settled to as near as possible to their original condition in 30 to 40 days after backfill.

e) Road pavements and access ways shall be temporarily restored to a safe condition, immediately after completion of backfilling. Then, the pavements shall be permanently restored to as similar as possible to their original condition within a time frame specified by the responsible authority.

f) Extra excavated material, un-reusable excavated material and all rubbish shall be removed from the site and legally disposed of.

3.8 Connections to Public Sewers

3.8.1 General

Severe maintenance problems are often caused by poorly made connections to sewers. These may lead to blockages or failure of the sewer structurally. The following procedures and formalities must be followed to ensure integrity of the sewerage system.

a) The owner must seek the approval of the Commission for any connections that involve physical work to an existing public sewer. The initial notification must be made on the appropriate form.

b) Once approved, the owner may make the connection only if his contractor is licensed by the Commission for this category of work.

c) The type and location of connections shall be determined by the Commission. The type of connection could be a connection to a manhole or a connection to a sewer through junction or saddle fittings.

d) The cost of the work in making the connection shall be borne by the owner, regardless of whether the work is undertaken by his licensed contractor or a licensed contractor employed by Services Licensee.

e) The connection must be correctly made by the licensed contractor under the supervision of an authorised inspection person.

f) When the connection is ready for inspection, the owner must notify the Commission on the appropriate form. At the same time, he must
give a copy of the notice to the authorised inspection person who will make arrangements for the inspection.

g) For a development which contains several connections from individual premises to the proposed public sewers within the development, the connections may be deemed covered by the original technical proposals. These individual connections will be inspected as part of the routine inspection by the authorised inspection person.

h) The inspection by the authorised inspection person for the connections to existing public sewers shall be subjected to a standard inspection fee.

i) The design and installations shall incorporate the considerations of health and safety.

j) The difference between each premise platform level and the nearest public sewer invert level shall not be less than 1.2 m to avoid flooding of premises.

### 3.8.2 Junction Connections

Where an existing public sewer is circular and is of diameter DN 450 or less, any connection to that sewer may be made using a Y junction fitting.

Where the location of future connections are known, Y Junction fittings and the accompanying junction connection pipework may be installed at the time of the public sewer construction.

The typical connection configuration of junction is shown in Figures A.11 and A.12 of Appendix A.

Where no junction pipework exists, a Y junction fitting may be installed by removing part of the existing sewer. The connection of such a junction shall use flexible couplings.

### 3.8.3 Saddle Connections

Saddle connections may only be permitted where the existing sewer is at least two pipe sizes greater than the proposed connection pipe. Only saddles specifically designed for the type and size of the sewer to be connected to shall be used. Also, the saddle used shall be approved by the Commission.

Making a saddle connection is a highly skilled operation. Hence, only licensed contractors who can demonstrate suitable qualifications and experience are permitted to make this form of connection.
The saddle must be purpose-made by off-site manufacture except when the existing pipe size is 900 mm in diameter or greater, which other forms of connection are preferred.

The saddles for concrete or vitrified clay sewers shall be bedded on cement mortar (mix 3:1) with a depth not less than 40 mm below the base of the saddle. A flexible joint shall be provided between the saddle and the remaining connection pipe.

The hole prepared for the saddle connection on the existing sewer shall not have any rough edges that might cause blockage. The location of the hole on the pipe shall be at a 45° to 60° angle to the horizontal. The hole shall be made at the middle of the pipe to avoid damages or excessive loading to the existing sewer pipe joints. The existing pipe may require extra strengthening by additional concrete surround to withstand the extra load from the connection pipe and fittings.

The connection pipe must not protrude into the existing sewer.

Any debris falling into the existing sewer during the connection shall be removed.

On completion, the saddle connection joint must be completely watertight to prevent infiltration.

3.8.4 Manhole Connections

Manholes may be constructed on the public sewer for private sewer connections where:

a) good practice requires a manhole for ease of maintenance, or
b) the diameter of the connection pipe is 300 mm or greater, or
c) the public sewer is more than 4.5 m deep, or
d) the point of connection is more than 5 m from an existing or proposed manhole.

Where site conditions prevent manhole construction on the existing public sewer, the manhole may be provided on the connection pipe as near to the public sewer as possible.