QUEENSLAND Urban Utilities

Technical Specification for Design and Construction of Water and Sewerage Main Systems

TMS1435

Document Change History

Version History

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Contents

1 General

1.1 Scope

This Technical Specification applies to the design and construction of water and sewerage mains for water and wastewater infrastructure assets by Queensland Urban Utilities.

The purpose of this Technical Specification:

- Is to maintain consistent designs, construction and durability, and appearance requirements for all water and wastewater infrastructure.
- It shall be read in conjunction with all relevant Australian and International standards, and legislative requirements.
- It does not relieve the designers' responsibilities for the design and construction of infrastructure.

The design and construction of water and sewerage mains involves design, construction planning, fabrication and erection, construction and maintenance. The work, at each stage, shall be carried out in a manner that all requirements specified in an upstream stage are satisfied. These tasks must be performed consistently.

This Specification provides the standard methods of verification for durability, safety, serviceability and restorability of water and sewerage mains in the design and construction stage of the structure.

1.2 Design Requirements

The water and sewerage mains in this Specification shall be designed for ultimate strength and limit states in accordance with the general principles for design specified in the relevant Australian Standards, Codes and is also permissible to carry out design checks for strength and serviceability by testing a structure or component member.

Where the structures are to be used in extreme environments and the design is of a specialist's nature with specialist construction techniques, the Project Brief shall include the particular requirements where appropriate.

1.2.1 Basic Design Rules

- The design shall include the identification of performance requirements for a structure, structural performance and detailing to meet these performance requirements, and the verification to confirm the performance requirements are met throughout the design service life of the structure.
- All performance requirements that need to be met in order to meet the intended purpose of the structure during construction and during the design service life of the structure shall be determined at the design stage.

- The structural planning stage shall take into consideration factors such as structural characteristics, materials, construction method, maintenance method, and economy so that the performance requirements can be met.
- The structural detailing stage shall take into consideration factors such as shapes, dimensions and connection patterns. These structural details are critical for constructability. It is necessary to take these details into consideration in advance so that the designed structure does not fail to meet the constructability requirements.
- The performance verification requirements for the structure shall be verified in relation to durability, safety, serviceability, restorability, the impact on the environment and landscape throughout the design life. The performance verification refers to tasks of ascertaining, by an appropriate method, that the type of structure, structural cross section, materials to be used, structural specifications, social conditions, constructability and economy meet the specified performance requirements.

1.3 Construction Requirements

The construction requirements in this Specification are for use where structures have been designed to the relevant Australian Standards and Codes.

2 Performance Requirements

2.1 General

The design life of the structure shall be determined in consideration of the required service period of the structure, maintenance period, environmental conditions and economy.

All performance requirements of the structure during the construction and design life of the structure shall be specified for every element of the structure. The performance requirements related to durability, safety, serviceability, restorability, environment compatibility, landscape compatibility, etc. shall be specified as appropriate. Detailed requirements related to these performance requirements have to be identified. It is necessary to give careful consideration to the relationship with the performance of each individual element so that the performance required for the entire structure is met.

2.2 Durability

Durability is the resistance of a structure to performance degradation over time resulting from the materials degradation in the structure under expected deterioration actions. The durability of a structure shall be specified for the purpose of maintaining the required performance of safety, serviceability and restorability throughout the design life of the structure. Durability is not independent of performance requirements.

2.3 Safety

Safety shall mean the performance of the structure to prevent risks to users and others in the vicinity under all expected conditions. Safety includes the structural safety and functional safety of the structure. Performance requirements for both, structural safety and functional safety must be specified.

2.4 Serviceability

Serviceability of a structure shall mean the performance that enables users or others in the vicinity to use the structure comfortably and the functional performance required of the structure. Generally these requirements include:

2.5 Maintenance and Repairs

Maintenance and repairs shall mean the performance in restoring the performance of the structure that has degraded due to continued use or accidental loads. It shall be specified as the degree of difficulty in repairing the structure and all factors affected by the performance degradation.

Mechanical performance requirements related to repair ability of water and sewerage mains are specified as restorability on condition that non-repairable related factors are separately taken into consideration. When considering the repair ability of water and sewerage mains, it is necessary to determine the performance level according to the magnitude of accidental load involved, the state of the structure that can be used without doing repairs and the state of a structure that can be functionally restored in a short period of time.

2.6 Other Performance Requirements

Environmental compatibility and landscape compatibility performance requirements shall be specified on project specific basis. These performance requirements shall be carefully considered at the structural planning stage and confirmed with verifications.

3 Water and Sewerage Piping systems

This Specification is for the design and construction of water and sewerage main systems work. It consists of a variety of work including replacement, renewal, and new work. The work consists of:

a) Water Main Systems using:

- Trenchless methods.
- Open cut methods.
- Associated water works such as pressure reducing valves, pits, flow meters, valve pits, new and replacement valves, scour valves and fire hydrants.

b) Sewerage Main Systems using:

- Trenchless methods.
- Open cut methods.
- Associated sewerage works such as new maintenance holes, rehabilitation of maintenance holes, valves, weirs, overflow structures and property connections.

The contractor shall investigate, design, supply, install, test, commission, and re-connect the water and sewerage main systems. Isolate the existing main including supply of all materials, equipment, plant and labour required to complete each Project.

c) Trunk Water.

The scope of work shall be supply, construction, testing and commissioning of the trunk water main. Isolate the existing main including supply of all materials, equipment, plant and labour required to complete each Project. The water main material shall be either PE pipe DN400 to DN800 or MSCL pipe OD 406 mm to OD 1200 mm. The design will be supplied by Queensland Urban Utilities.

The Contractor shall supply advances in new and innovative technologies as normal in-scope activity wherever practicable.

3.1 SCOPE OF WORK

3.1.1 Water Main Systems

The scope of work shall generally include:

- Project inception meetings at Queensland Urban Utilities office at 15 Green Close, Fortitude Valley.
- Minutes of meetings.
- Investigate existing site conditions.
- Design.
- Permits and approvals identified in the STEP Assessment document.
- Supply.
- Construction.
- Flow and valve control, and shut plans.
- Pressure and bacterial testing.
- Live connections.
- Pressure reducing valves and associated work.
- Valve pits.
- Valve installation or replacement.
- Scour valves.
- Fire hydrants.
- Site restoration.

3.1.2 Sewerage Main Systems

The scope of work shall generally include:

- Project inception meetings at Queensland Urban Utilities office at 15 Green Close, Fortitude Valley.
- Minutes of meetings.
- Investigate existing site conditions.
- Design.
- Permits and approvals identified in the STEP Assessment document.
- Supply.
- Construction.
- Flow control.
- Vacuum/Pressure testing.
- Live connections.
- New maintenance holes.
- Existing maintenance holes rehabilitation.
- Valves and weirs installation or replacement.
- Overflow structures.
- Property connections.
- Junction reinstatement systems.
- Compliance testing.
- Re-bench maintenance holes.
- CCTV inspections.
- Site restoration.

4 DESIGN

4.1 INFORMATION SUPPLIED

Queensland Urban Utilities will provide the following (if available) in the form of a drawing and data sheet for each project where available. The information provided below is extracted from Queensland Urban Utilities GIS.

4.1.1 General Data

- Static head pressure for water supply.
- Length of new main.
- Pipe diameter and material of new main.
- Connection points of new main.
- Stop valve locations (best practice).
- Extent of main to be abandoned/replaced/augmented/decommissioned.
- Drawings of recent and/or work soon to be constructed that may impact the proposed project.
- Project specific notes and special requirements.

- Boundaries.
- Street numbers.
- Lot and RP.
- Street names.
- Department of Transport and Main Roads.
- Preliminary STEP Assessment or a STEP Gap Analysis.

4.1.2 Existing Water Main

- Pipe type (reticulation/trunk/ transferred to Link Water).
- Pipe length.
- Pipe diameter.
- Pipe material.
- Pipe alignment/location.
- Fire hydrant locations.
- Valve locations.
- Scour locations.
- Fittings.
- Water service location/connection points DN100 or greater.
- Drawings used for scope development.

4.1.3 Existing Sewer Main

- Pipe type (reticulation/main).
- Pipe Invert Levels.
- Pipe length.
- Pipe diameter.
- Pipe material.
- Pipe alignment/location.
- Maintenance holes location.
- Maintenance holes surface levels.
- Property connections details.
- Flow control data.
- Drawings used for scope development.
- Drawings for recently constructed/soon to be constructed work that may impact the proposed project.

The contractor will be required to verify all information provided.

4.2 CONCEPT ENGINEERING

This section covers engineering activities required for the investigation into a defined engineering issue. The items or issues which are problems and which require further action are to be covered and shall include:

- Probable solutions.

- Local council requirements e.g. AC pipe replacement.
- Discussion and conclusion.
- Appropriate drawings.
- A cost and time estimate.

The work will require input to the project from Queensland Urban Utilities stakeholders. The input is to be recorded and issued as an attachment to the project.

4.3 Standards Applicable for Water and Sewer Main Systems

The current standards are:

- South East Queensland Water Supply and Sewerage Design and Construction Code. .
- Relevant current Australian Standards.

4.4 Performance Attributes

4.4.1 System Design Life

Water Supply

The pipeline system shall be designed for a nominal asset life of at least 100 years without rehabilitation. Some components may require earlier renovation or replacement which shall comply with the South East Queensland Water Supply and Sewerage Design and Construction Code. .

Sewerage Supply

The pipeline system shall be designed for a nominal asset life of at least 100 years without rehabilitation. Some components may require earlier renovation or replacement which shall comply with the South East Queensland Water Supply and Sewerage Design and Construction Code. .

4.5 Design Requirements General

4.5.1 Earth Pressure Loading

Vertical earth pressures shall comprise the full height of soil above the pipe subject to trench effect.

4.5.2 Hydrostatic Pressure

The pipe shall be designed to withstand hydrostatic pressure based on the groundwater level.

4.5.3 Soil Modulus

If the geotechnical investigation show that the Native Soil Modulus at the depth of the pipe is greater than 5.0 MPa, a Combined Soil Modulus E' = 5.0 MPa may be used for deflection and buckling calculations where pipes have been laid in a trench.

4.5.4 Traffic Loads

Road vehicle loads shall be calculated in accordance with AS/ANZ 2566.1 Clause 4.7.2 for the following traffic loading.

Type	Road Type	Loading
Type A	Main Road	Multiple adjacent lanes of Standard W80 wheel loads.
Type B	Light Road	Single lane of Standard W80 wheel loads.
Type C	Field Load	60 per cent of light road loading.

4.6 Design Requirements for Water Systems

Compliance is to be confirmed by the contractor with the relevant Local Council requirements for the Typical Trench Detail.

Where a metallic water main is to be replaced using plastic pipes, the electric supplier or a licenced electrician shall assess affected properties electricity supply for defects and the likely effect on earthing adequacy. Work can commence once the electricity supplier/electrician declares in writing that it is safe to proceed.

4.7 Design Requirements for Sewerage Systems

4.7.1 Abrasion Resistance

The pipe material shall have satisfactory abrasion resistance to the migration of silt, sand, grits and other solid debris along the pipe. The abrasion resistance of the pipe material shall be tested or certified with an appropriate approved test method to confirm the claimed resistance.

4.7.2 High Pressure Cleaning Resistance

The pipe material shall:

- Be robust and not be damaged by sewer cleaning or inspection equipment.
- Not be subject to reduction in quality or damage which may influence the operation and long term performance due to sewer cleaning or inspection equipment.

4.7.3 Chemical Resistance

The pipe material shall be internally resistant to chemical and biological exposure of sewage, sewage related gases and mild concentrations of industrial effluent for the service life of the sewer. Chemical resistance shall include satisfactory performance to the exposure of small quantities of carbon monoxide, carbon dioxide, methane, hydrogen sulphide, traces of mercaptans, gasoline, vegetable oil, kerosene, saturation with moisture, detergent, soap, and diluted concentrations of sulphuric, nitric and phosphoric acid. The pH exposure range shall be 1 to 10. The pipe material shall be resistant to external exposure of soil conditions.

4.7.4 Water Tightness

The pipe material shall be laboratory tested for water tightness to APS Guidelines.

4.7.5 Thermal Movement

The pipe material shall be tested for temperature movement stress tests.

4.7.6 Tensile Adhesive Strength

The rehabilitation and junction reinstatement systems that rely on chemical bonding must have a minimum short term tensile adhesive strength of 1.5 N/mm2. The chemical bond shall be tested against the following surfaces cleaned and prepared to the manufacturer's requirements:

- Dry concrete.
- Wet concrete.
- Dry, glazed vitrified clay.
- Wet, glazed vitrified clay.

4.7.7 Hydraulic Capacity

The hydraulic capacity of the system is to be either maintained or improved. Account shall be taken of the build-up of slime and any defects, which may affect hydraulic performance.

Hydrostatic Testing

The Contractor shall provide certified test data that the proposed system will withstand the specified maximum hydrostatic loads in individual systems. The Contractor will be required to carry out approved factory hydrostatic tests of a representative length of the proposed system(s).

4.8 Design Services

The following services are required as appropriate:

- Site visits including inspection of maintenance holes.

- Consultation with Queensland Urban Utilities stakeholders.
- Specialist consultants and contractors for advice on their services (geotechnical, survey, environmental, etc.).
- Local, state and federal government authorities consultation on compliance with regulations, etc.

4.9 Existing Infrastructure

The water and sewer systems existing infrastructure (pressure reducing valves, flow meters, maintenance holes, valves, scours, pits, etc.) may require condition assessment, design and refurbishment.

5 Condition Assessment

The condition assessment shall comprise preliminary assessment including non-destructive testing and detailed assessment including concrete core samples.

5.1 Preliminary Condition Assessment

The Contractor shall undertake a preliminary condition assessment of the infrastructure to be rehabilitated.

The preliminary inspection shall include:

- Visual inspection of the complete structure including fixtures and fittings.
- Photographic records.
- Optical 3-D Scanning (if required) inside the structure including soffit. Residual thickness of the wall, top slab and other structural members.
- Tap test on the concrete surface at locations where concrete shows signs of corrosion.
- Delaminate tests where there are signs of concrete corrosion.
- Measure the actual thickness of structural members using non-destructive impact-echo method.
- Phenolphthalein test at delaminating test locations and any cored holes.
- Cover to the reinforcement.
- Spacing of reinforcement.
- Concrete carbonation at critical locations.
- Condition of concrete (spalling, drummy, cracks, etc.).

5.2 Detail Condition Assessment

The detail condition assessment shall be carried out based on the preliminary condition assessment. The detail assessment will include the following activities:

- Optical 3-D Scanning (if required) inside the structure including soffit. Residual thickness of the wall, top slab and other structural members.
- Concrete core samples.

- Size of the reinforcement.
- Confirm cover to reinforcement.
- Confirm spacing of reinforcement.

Optical 3-D Scanning

The internal scanning of maintenance holes, including the soffit, shall be undertaken using equipment that uses the latest 3D optical scan technology currently available (IBAK Panoramo SI 3D Optoscanner or similar). The outputs shall include 360 degree scanning inside the maintenance hole to provide a high definition photographic view. The equipment used shall be capable of capturing enough data to generate a 3D model of the maintenance hole for analysis similar to the point cloud function of the IBAK equipment. The scanning shall be undertaken vertically starting from slab soffit and continued vertically all the way up to the top of the benching level as a minimum. The equipment shall be suitable for this type of inspection and have sufficient lighting to allow the detailed recording of defects.

The Reports shall be submitted in WinCan v8 Viewer on DVD.

5.3 Concrete Core Samples

A minimum of three core samples shall be taken for each structure. The samples shall be tested for:

- Compressive strength.
- Carbonation depth.
- Chloride content.
- Sulphate content.

The concrete core diameter shall be 75 mm. The length to depth ratio shall be 2:1 and as a minimum 1:1. The cores shall not penetrate through the structural members. The reinforcement shall be located prior to coring to prevent damage to the reinforcement. The core samples shall be located such that two samples miss the reinforcement. The third sample shall go up to the depth of the reinforcement.

Testing shall be conducted by a NATA accredited laboratory to AS 1012.14.

The cored holes shall be repaired with Parchem Renderoc Rapid to the manufacturer's requirements. Curing compound Parchem WB30 shall be applied after the Renderoc has set. Alternative repair products may be used with written approval from the Superintendent.

5.4 Analysis and Design

The non-destructive tests and concrete core samples shall be used to analysis the condition of the structure and to prepare remedial designs for the refurbishment work. The analysis should determine the current remaining life of the structure. The remedial designs should extend the design life to a minimum of 50 years with minimum maintenance requirements.

Options for remedial work should consider:

- Concrete repair to build up structural member/s to original design size with the use of concrete mortar or epoxy mortar.
- Reinforcement repairs and replacement.
- Crack repairs
- Application of protective polyethylene liner.
- Application of protective coatings.
- Combination of above.
- Replace the structure or part of the structure.

The design shall include the appropriate tests for successful application for the remedial work.

Propriety products proposed should have previously been successfully applied and been operation for a minimum of:

- Ten years in maintenance holes without any maintenance requirements.
- Ten years in pits without any maintenance requirements.

The warranty periods shall be both for the product and its application.

5.5 Concrete Mortar

The reinstatement concrete repair mortar (where the section loss exceeds 30 mm) shall be a high strength cementitious mortar. It shall be resistance to H2S and abrasion. The mortar shall be a single component, polymer-modified, cement-based blend of powders to which only the site addition of clean water shall be permitted. It shall be manufactured to achieve maximum compatibility with parent concrete and shall exhibit the following characteristics:

Characteristic Strength	**Value**	**Standard**
Compressive	> 40 MPa @ 7 days	BS6319 Pt.2
Flexural	> 20 MPa @ 7 days	BS6319 Pt.3
Tensile	> 5 MPa @ 7 days	BS6319 Pt.7
Elastic modulus	18000 MPa @ 28 days	BS6319 Pt.6
Coefficient of Thermal Expansion	11 x 10-6 / OC	Standard

The Contractor shall use Parchem Renderoc HB70 mortar or an approved equivalent for the repair of maintenance holes.

5.6 Epoxy Mortar

The epoxy mortar shall be a two component Epoxy based mortar. It shall be formulated to provide maximum chemical and abrasion resistance and shall exhibit the following characteristics:

Characteristic	Value	Standard
Compressive Strength	> 40 MPa @ 7 days	BS 6319 Pt.2
Flexural Strength	> 20 MPa @ 7 days	BS 6319 Pt.3
Tensile Strength	> 5 MPa @ 7 days	BS 6319 Pt.7
Adhesive bond strength to Concrete Repair Mortar	> 1 MPa substrate failure	ASTM D4541

5.7 Polyethylene Liner

High density polyethylene liner shall be from an approved manufacturer.

- The anchoring system of the polyethylene liner, consisting of conical anchor studs, shall be integrally and homogenously formed with the sheet during manufacture.
- The polyethylene liner shall comprise an anchoring system of a minimum of 395 anchors per square metre with a minimum sheet thickness of 2.5 mm.
- The polyethylene lining systems incorporating a glued or welded anchoring system will not be accepted.
- The polyethylene liner shall be white or beige in colour.
- Exposure of the polyethylene liner to sunlight during construction should be kept to a minimum.
- The polyethylene liner sheet width shall be sized for minimal site joints.
- The polyethylene material shall be free from holes, blisters and folds.
- The pull out resistance per anchor shall be a minimum of 0.7 kN.
- The space between the liner and the wall shall be filled with grout.

5.8 Concrete Patch Repair

The break-out area shall extend 50 mm past the cleaned damaged area or corroded reinforcement into sound concrete or reinforcement to confirm incipient anode effects do not occur. The extent of the concrete patch repair shall be agreed to between the Superintendent and the Contractor prior to repair works commencing. The edges of the agreed section shall be saw cut perpendicular to the surface to a minimum depth of 10 mm.

5.9 Reinforcement Repair

Corroded reinforcement shall be cleaned to a Class 2.5 metal finish in accordance with AS 1627:4. The Reinforcement shall be primed with SikaTop-110EpoCem or similar approved product applied in accordance with the manufacturer's requirements.

The reinforcement bar shall be replaced if the cross sectional area of the corroded reinforcement bar is less than 70% of the original cross sectional area. The new reinforcement bar shall be the same type, grade and diameter as the existing reinforcement bar to AS 4671. The concrete break-out area shall extend

50 mm past sound reinforcement to confirm incipient anode effects do not occur.

6 Structural Relining/Rehabilitation of Sewerage Infrastructure

The selected structural relining/rehabilitation system shall be of proven quality for similar works and shall meet the following requirements:

- Have excellent adhesion to existing concrete.
- Have excellent chemical resistance to sewerage environment.
- Have excellent abrasive resistance to sewer cleaning methods.
- Not induce undue darkness to infrastructure.

Where liners have been installed to a maintenance hole, the maintenance hole channel shall be rendered to form a smooth slope from the liner to prevent accumulation of solids at the liner edge.

6.1 Infiltration Repairs

The selected infiltration sealing system shall be of proven quality for similar works and shall meet the following requirements:

- Ability to fully seal cracks in concrete surfaces over a crack width range of 0.3 mm to 3.0 mm.
- Ability to seal cracks in concrete surface to a minimum depth of 40 mm from the concrete surface.
- Excellent adhesion to concrete.
- Fast curing.
- Solvent free.
- Non-shrink or expansive.
- Chemical resistant to sewerage environment.

6.2 Acceptance Requirements

The following acceptance tests shall be completed prior to connecting to the existing water or sewerage system:

- Visual examination of whole of the work for completeness and acceptable standard of workmanship and finish.
- The structure shall be water tight with no identifiable flow of water penetrating the work.
- A full 360 degree scanning inside the structure to provide a high definition photographic view.
- Pull out test on liner where a liner is installed.
- Spark test of all liner joints where a liner is installed.
- Acceptance testing for epoxy mortar rebuild systems shall be in accordance with ASTM D4541. Four adhesion tests shall be carried out on

locations nominated by the Superintendent. A minimum adhesion of 1 MPa without substrate failure shall be achieved for each test.

- Appropriate approved tests for particular rehabilitation materials.

All test results shall be carried by a NATA certified testing authority.

6.3 Report

The contractor shall prepare a report which shall include the following as a minimum:

d) Non destructive test results detailing.

- The test identification numbers.
- Location of tests.
- Reinforcement cover.
- Size of reinforcement.
- Photographs of the investigation.

e) Concrete core sample results detailing.

- Sample identification number.
- Locations of the core samples.
- Diameter and length of the core samples.
- NATA laboratory certificates and analysis.
- Photographs of the core samples.
- Analysis and design details including calculations.
- Recommendations.
- Relevant drawings.

6.4 Design

Design calculations and checking shall be performed by persons with appropriate qualifications and experience. The calculations shall be signed by the designer, checker and certified by a Registered Professional Engineer of Queensland. The Contractor shall provide written evidence of their internal checks for drafting checks, design checks, reports and certification when these are submitted for review. The design shall be reviewed to confirm it complies with the scope of the project.

6.5 Site Visits and Inspections

Visit the site to determine site conditions and confer with Queensland Urban Utilities stakeholders. Locate all points of access to the system to be rehabilitated and to prepare the shut plan or flow control plan as appropriate. The site visits to be adequately detailed to plan the work program. Access routes are to be determined and then confirmed at detail design stage with the intention of preparing Access Agreement Plans or Easement Proposal Plans.

The Contractor shall confirm:

- Information provided by Queensland Urban Utilities.
- Assumptions made by the Contractor in the design process prior to ordering materials.

The Contractor shall undertake investigations as required to confirm scope of work and information provided with the RFQ. The contractor shall also scope additional information required to complete the work such as survey, geotechnical, DBYD information, CCTV and other information required for design and construction.

The location of all services (electrical services, gas mains, telecommunications services, water services, sewers, oil pipe lines, overhead services, etc.) along the route, including levels at which they are laid, are to be visually determined and then confirmed at detail stage design.

6.6 Safety in Design and Risk Assessment

A safe design process is required to comply with Queensland Workplace Health and Safety Act 2011 and Workplace Health and Safety Regulation 2011. The Act states obligations by clients, project managers, designers and contractors.

The Safety in Design Report will be a live document during the design and construction phase of the project. Refer to Queensland Urban Utilities Safety in Design Report requirements.

The Safety in Design Report will be issued with the final design documents, updated during construction and then re-issued as part of the Practical Completion documents.

6.7 Water Shut Plan / By-pass

On the request for a Network Access Permit by the Contractor, a Water Shut Plan is triggered pending the impact on the network. Queensland Urban Utilities is responsible for the creation of the Water Shut Plan, which will be issued to the Contractor for implementation during construction.

6.7.1 Sewer Flow Control / By-pass

A flow control/by-pass plan will be prepared and submitted with the RFQ. The flow control by-pass plan will be based on the information provided by the client. This flow control/by-pass plan will be used to obtain the Network Access Permit during the construction phase.

The by-pass flow system shall be designed for a minimum of three times ADWF. The pipe or the liner installation shall be planned and constructed with a minimum of three days clear weather forecast and there being no impact from upstream wet weather events.

6.8 Compliance with Regulations

The contractor shall liaise with and obtain all relevant permits, approvals and directions from the relevant organisation (including State Government, Council, and Utilities) for the preparation and approval of designs and for the execution of work. Seek advice from local, state and federal government authorities on the provision of service, compliance regulations, etc.

The contractor shall prepare all necessary STEP permits and approvals identified in the Preliminary STEP Assessment and as directed by Queensland Urban Utilities. All statutory permits and approvals are to be sent to Queensland Urban Utilities for review prior to submission. Any land owner negotiations will be done by Queensland Urban Utilities.

6.9 Pipe Crossings at Waterways

The work shall include the design and construction of a new Water Supply or Sewerage main crossing a waterway to replace the existing main. The new main shall be designed to cross the waterway either below the waterway bed or suspended above ground. Refer Compliance with Regulations above for approval requirements.

6.10 Pipe Crossings at Railway Lines

The pipe crossings at railway lines shall be designed to comply with Queensland Rail requirements. Refer Compliance with Regulations above.

6.11 Pipe Crossings at Roads

The pipe crossings at roads owned by the local council or state shall be designed to comply with their relevant requirements. Refer Compliance with Regulations above.

6.12 Pipe Crossings at Driveways and Footpaths

The Contractor shall use trenchless construction to cross driveways and footpaths.

7 DETAILED ENGINEERING

This section covers the engineering activities required for detailed design, drawings and specifications. The activities shall be detailed such that:

- There are minimal changes to scope, design and documentation.
- Variations during construction are minimal.
- The design and documents shall be detailed to minimise queries during construction.
- The designs and documents shall be based on practical and economical industry practices.

Innovative methods are to be used where it will be beneficial to the project. All documents shall be issued in draft form for Queensland Urban Utilities to review when 100% completed. The Contractor's QA documentation verifying drafting and design checks must be supplied with the design documents. The documents will be reviewed to confirm they comply with the specified requirements. They shall be revised with Queensland Urban Utilities comments and then issued as final documents. The final documents will be reviewed by Queensland Urban Utilities and then issued for construction.

The review will cover at least the following:

7.1 Water Supply

- The design reflects Queensland Urban Utilities brief for the project.
- Life cycle costs minimised.
- Minimum operating pressure is maintained at property connections.
- Maximum operating pressure is not exceeded in the system.
- Pipe class and material are suitable for the particular application.
- Maximum and minimum velocities comply with the requirements.
- Air, scour, isolation valves and other controls meet requirements.
- Layout and alignment meets requirements.
- Hydrants meet requirements.
- Connection to existing system minimises supply disruption during construction.

7.2 Sewerage Supply

- The design reflects Queensland Urban Utilities brief for the project.
- Life cycle costs minimised.
- Pipe sizes and grades meet the design requirements.
- Pipe materials are suitable for the particular application and environment.
- Sewer layout and alignment meet Queensland Urban Utilities requirements.
- Topography and environment aspects have been addressed.
- Easements as appropriate have been specified.
- Foundation and geotechnical aspects have been considered.
- Provisions for future extensions have been made as appropriate.
- Types of maintenance structures, overflows and vents meet Queensland Urban Utilities requirements.
- Location and details of bulkheads detailed.
- Property service connection locations detailed.

7.3 Design Details

The pipeline should generally follow the ground profile as plotted on plan with regard to the necessary cover being maintained over the pipe and avoidance

of buried structures and services. Longitudinal sections are required for sewerage services. The following should be noted on all detailed drawings:

- Locality plan giving the overall layout and location of the works.
- Detailed plan of the scheme.
- Location of works in relation to existing vegetation.
- Special details where Standard Drawings are not sufficient.
- Longitudinal sections.
- Position of pipe relative to property boundaries.
- Minimum cover to all types of pipe.
- Location of scours, valves, air valves, hydrants, etc. Scours shall discharge to approved locations.
- Trench widths, bedding and backfill details.
- Pipe diameter and material along a dimension line extending between chainages over which it is to be laid.
- Concrete thrust or anchor blocks details.
- Pipelines to be detailed with sockets facing up hill for ease of construction.
- Chainages on plans are derived from horizontal measurement whether the pipeline is on level ground or on a slope.
- Minimum clearance between the new pipeline and existing services must be provided.
- Locations and details of utility services.

7.4 Design Output

The design output shall include:

- Project Drawings showing pipe sizes and grades, location and types of maintenance structures, pipe materials, notes and detailed construction methods.
- Specifications that address materials, site investigation and technical matters required to for construction, testing and commissioning.

7.5 Open Trench Design

7.5.1 Design Requirements

The trench shall be designed for the installation of the designed pipe. The depth of trench shall comply with the minimum cover requirements at appropriate locations. The minimum cover shall apply to valves and fittings. The trench width and depth shall be adequate for the installation of the pipe, bedding material to support the pipe and allow use of compaction equipment. The length of the trench excavation shall be designed to allow adequate time for excavation, installation of pipe, bedding and compaction to be completed in a one day shift. The design shall allow for the trench to be excavated to a tolerance of + 0 mm and – 50 mm. The design shall show details at pipe sockets to allow a minimum clearance of 75 mm between the collar and bottom of the trench.

7.6 Trenchless Design

Trenchless design shall comply as follows.

7.6.1 Micro-tunnelling and Pipe Jacking

System Concept Design

The Contractor shall consider the following procedures as part of the concept design:

- Suitable tunnelling system with related specifications, shaft constructions, thrust wall, anchoring system, spoil removal systems and jacking forces.
- Description of the construction method, sequence of operations and type of face support.
- Location of existing underground utility services and proposed precautions and relocation if required.
- Ground monitoring equipment and methods.
- Confirmation the construction method will achieve the tolerances in line and level to requirements.
- Details of size, depth and location of access shaft, face support and work site layout.
- Method of spoil transportation from face, temporary spoil, nature of haulage equipment and disposal location.
- Programmed daily work hours and duration of the operation.
- Details of specialist subcontractors.
- Details of ventilation and lighting.
- Determine the appropriate new pipe with relevant load applications, installation method, joint details and specifications.
- Calculations of thrust forces and distribution forces during each drive including location of intermediate jacking stations.
- Perform the required surveys, site protection plans, geotechnical investigation, risk assessment and contingency planning.
- Detail each step of the process including mobilisation, excavation, rig installation, operation procedures, pilot hole drilling if required, jacking operations, depth of cover, entry angle, ground water, and other pertinent data.
- Detail drilling mitigation plan, recycling system, rates of operation, pumps, control systems and other equipment used.
- Water supply requirements for the work.
- Boring pipe description, size, grade, etc.
- Guidance and steering system including limitations and access requirements.
- Compile contingency plans comprising surface heave, impact on other utilities, loss of bursting head, etc.

7.6.2 Detail Design

The following design information shall be provided on completion of the design and before placing orders for materials and starting construction:

- Intermediate jacking stations.
- Details of Bentonite to reduce friction.
- Steering system for horizontal and vertical alignment.
- Control of surface settlement.
- Control of ground water.
- Design drawings shall include the following:
- Materials.
- Minimum internal and external diameter.
- Joint design and dimensions.
- Maximum angular deflection and draw the joint will accept under service conditions.
- The geometry and specification for packing between pipes for jacking pipes.
- The arrangement to retain the packing in position during jacking.
- Details of pipe ends to transfer jacking forces between pipes without damaging the pipe ends.
- Pipe reinforcement and cover if applicable.
- Manufacturing tolerances.
- Effective pipe length.
- Calculated mass of pipe.
- Maximum jacking force the pipes are designed to withstand reduced to account for alignment angles between adjacent pipes.
- Design failure load.

7.7 Specialist Consultants

Engage specialist consultants and contractors for advice on specialist services.

7.8 Survey

A survey is required as necessary for each water supply and sewerage project. The Contractor shall engage a licensed surveyor. The survey shall be detailed to address all design and construction requirements. It shall include DBYD and potholing of existing buried services to determine their extent and arrangement.

7.9 Geotechnical Investigation

A geotechnical investigation is required for each project. The contractor shall engage a geotechnical consultant to prepare the geotechnical investigation as part of the design.

7.10 Definitions of Rock

The Contractor shall provide written records, certified by a geotechnical engineer, for claims for rock excavation. The written records shall include geotechnical data, photographic records, extent and quantities of rock claimed as a minimum.

The following definition applies to rock material if encountered during the construction work.

7.10.1 Trenched Excavation

Rock: Comprises any material which cannot be excavated by a tracked 20 tonne or larger hydraulic excavator having a manufacturer's rating for maximum break-out force of not less than 110 kN using a 600 mm nominal width bucket.

If in the opinion of the Superintendent, the use of an excavator equal to that specified above is considered inappropriate for any reason other than the Contractor's chosen method of operation, 'Rock' shall be as defined for trenchless excavation. Otherwise, 'Rock' shall be defined as any material assessed by the Superintendent as equivalent to the definition above.

Other than Rock: Comprises all other material encountered in the excavation.

7.11 Trenchless Excavation

Rock: Comprises any material with an unconfined compressive strength greater than 7 MPa as measured by the Point Load Test in accordance with the requirements of AS 1726 and AS 4133.4.1. A factor of 24 shall apply for conversion of the Point Load Strength Index to the approximate Unconfined Compressive Strength.

Cobbles: Comprises rock fragments with a minimum compressive strength of 7 MPa and sized between 65 mm and 250 mm diameter with no more than 40% by weight passing a 53 mm size sieve.

Gravel: Comprises rock fragments with a minimum compressive strength of 7 MPa and sized between 2.6 mm and 65 mm diameter with no more than 40% by weight passing a 2.36 mm size sieve.

Other than Rock: Comprises all other material encountered in the excavation.

7.12 Horizontal Directional Drilling (HDD)

7.12.1 General

Gravity sewers must not be constructed by HDD unless approved by Queensland Urban Utilities. The construction method shall comprise fusion butt welding of individual polyethylene pipes into a pipe string and pulling into a

pre-drilled hole formed by horizontal directional drilling. The welds are to be de-beaded within the pipes.

The Contractor shall confirm that its method of handling, lifting and pulling the pipe strings does not cause it to be overstressed and shall provide calculations as part of the design.

The pipeline installation by Horizontal Directional Drilling shall be carried out in accordance with ASTM F1962-11 "Standard Guide for Use of Maxi-Horizontal Directional Drilling for Placement of Polyethylene Pipe or Conduit Under Obstacles, Including River Crossings".

7.12.2 Methodology

The methodology should include all logistical procedures that relate to each particular site together with the drilling process through to testing and reinstatement, highlighting any risk or problem. The following minimum information shall be provided by the Contractor before construction work can start:

- Detailed design calculations and drawings for installation of pipeline by the proposed method of trenchless excavation and construction methodology. Calculations shall include all design and handling stresses, including those during installation and commissioning.
- Certification from a RPEQ certifying design, drawings and specifications.

The design documentation shall address the following:

- Confirmation that HDD is possible i.e. the risks are understood and presence of and proposed proximity to existing services are known.
- Manufacturer and type of HDD equipment, operating system and equipment capability.
- Bore drilling, reaming and pull back plan.
- Bore tracking and relating equipment to be used.
- Existing underground utility services locations and any special precautions.
- Ground monitoring equipment and methods e.g. heaving, fluid loss, frac-out, etc.
- Type of existing pipe and services reconnection of joints used including their specification.
- Calculation of size and depth of exit pit required.
- Type of drilling fluid, fluid mix design plan and mud handling specification.
- Location of exit pits, trench support and work site layout.
- Method of temporary spoil storage and disposal.
- Programmed daily work hours and duration for the operation.
- Details of specialist subcontractors and applicable competency training records of personnel.
- Training and relevant experience of the personnel who will undertake the work.

- A comprehensive geotechnical investigation is carried out and used in the design.
- Liaison with the relevant authorities is complete and a system of liaison during the construction stage is developed and detailed.
- Define any third party requirements which may impact the work (e.g. ground settlement monitoring, etc.).

7.12.3 Risk Analysis

The risk analysis for HDD shall include the following as a minimum:

- Frac-outs.
- Loss of flow.
- Loss of tooling down hole.
- Ground formation changes.
- Equipment failures.
- Traffic management.
- Control of drilling fluids, cuttings and stormwater runoff from the site.

7.12.4 HDD Construction Set-Out

Prior to the start of construction work by HDD, the Contractor shall install survey marks at a maximum spacing of 2.5 m along the alignment. Each survey mark shall be labelled with a number on a nearby survey peg. The marks shall be surveyed for level and pipeline chainage. The survey mark data shall be set out in a schedule with the required depth to pipe invert shown for each mark.

The installation of the survey marks and preparation of the schedule shall be carried out by a qualified surveyor. The survey mark schedule shall be submitted to the Superintendent at least five working days prior to the start of HDD work on each pipeline drilling section.

7.12.5 Quality Assurance

The following procedures shall be included in the Quality Assurance System.

- Drilling Log Sheets - Daily "Drilling Log Day Sheet" and "Drilling Fluid Log Sheet". The Contractor is to fill out and submit the log sheets to the Superintendent at the end of each day regardless of progress made for that day.
- Pilot Hole Positioning Control Procedures.
- Sighting Trenches.
- Pipe Welding.

8 Pressure Reducing Valves (PRV) and Flow Meters

The scope of work includes detail design development, construction, and commission the PRV facility. It includes pipework, switchboard and all materials. Refer TMS61 and TMS62, and Appendix A and B.

Queensland Urban Utilities will provide the following information with the RFQ:

- A preliminary design sketch, showing property boundaries, water supply and sewerage assets and kerb alignments.
- The relative location of the proposed new assets, including connection points and isolation valves.
- Size and all other relevant details for the PRV and flow meter components.

Initial Site Feasibility Investigation

The contractor shall carry out an initial site investigation for the proposed site. This work shall include excavation of the proposed construction area to determine the depth and location of all assets and services within the proposed construction area.

The contractor shall be responsible for the accuracy and completeness of the initial site investigation.

8.1 Detailed Design

The Contractor shall proceed with detailed design based on the preliminary design provided that the initial site investigation is satisfactory. Detailed design shall generally include, but is not limited to:

- Production of construction drawings for the proposed facility.
- Identify properties, which are to have the water supply turned off and the duration of each service interruption event.

The contractor shall provide the final design documents for approval to Queensland Urban Utilities.

8.2 Construction

Construction work shall only be carried after construction drawings have been approved.

9 Products

All materials used in the infrastructure shall comply with:

- The Project Brief.
- South East Queensland Water Supply and Sewerage Design and Construction Code.
- Relevant current Australian Standards.

Specific material samples may require testing. The constructor shall arrange for the samples to be supplied, identified, stored and tested, and the results issued.

Propriety products and materials shall be used in accordance with the manufacturer's written requirements and instructions.

Comment [SS1]: This is referring to a structure. Should list section say materials used within sewer and water piping systems… and refer them to SEQcode material list, specific requirements within project briefs etc?

10 Construction

10.1 Open Trench

10.1.1 Construction Requirements

Trenching shall be carried out in a manner that will cause the least interruptions to residences and traffic. Suitable bridging must be provided at street crossings and driveways where traffic crosses open trenches. Access to properties must be maintained at all times. Spoil from the trench shall be deposited away from the excavation to allow safe installation of the pipe and to prevent the spoil falling back into the excavation. Surplus spoil shall be removed from the site to an approved location.

10.1.2 Limits of Excavation

The trench shall not be excavated wider than the designed width. Should the trench width be excavated wider than the design width, the Contractor shall recommend remedial options in the form of a stronger pipe or more effective bedding for approval by the Superintendent. Should the trench depth be over excavated, the over excavation shall be raised to the correct depth by compacted materials approved by the Superintendent.

Sharp points of rocks or other hard materials shall not protrude into the general level of the bottom of the trench. The excavation shall be taken to a greater depth and refilled with select material, compacted and finished to correct grade should sharp points of rocks or other hard material protrude in the general level of the trench. The trench must be kept free of water, loose spoil, rubbish, etc.

10.1.3 Excavation across Improved Surfaces

Paved roads, concrete footpaths, driveways and sealed areas shall be saw cut prior to excavation. The turf shall be cut neatly in squares or strips, stacked and kept moist until it is re-used. The kerb and kerb channel shall not be removed. The trench shall be tunnelled under the kerb or kerb and channel. Boring shall be done under surfaces that cannot be reinstated satisfactorily.

10.1.4 Drainage and Dewatering

The excavations shall be kept free of water. Surface water shall be prevented from entering the excavation.

11 Trenchless

11.1 Micro-tunnelling and Pipe Jacking

11.1.1 Construction

The construction sequence and program shall be completed prior to commencing any micro-tunnelling construction work. The construction sequence shall include:

- Details of the training and relevant experience of the Contractors staff.
- Confirmation of relevant geotechnical investigation.
- Site inspection and verification of existing levels, survey control points and set out points.
- Identification and location of the entry and exit pits.
- Set up jacking frame and hydraulic jacks.
- Positioning the micro-tunnelling equipment into the shaft.
- Set up guidance system.
- Tunnelling machine is capable of balancing the ground water pressure encountered during the excavation of the tunnel.
- Pipe inspection and testing.
- Disposal of slurry and spoil.
- Grout annular space between bore hole and exterior pipe.
- Procedures if an obstruction is found during construction.
- Disconnection of all laterals, and removal of concrete encasements, gibault joints, repair clamps, in-line valves and fittings from the pipe to be replaced.
- Surface settlement and heave monitoring.
- Setting up jacking mechanism.
- Confirmation of jacking forces, deviation of line and gradient and rate of advance of installed conduit.
- Confirmation that all utilities crossing within 600 mm of the alignment have soil excavated and removed to relieve pressure caused by heaving during the operation.
- Pipe testing and inspection.
- Reconnection of all laterals.
- Removal of equipment and re-instatement of site.
- Confirmation the design will withstand the maximum jacking forces the jacks are capable of and that the specified pipes will not be subjected to jacking forces that exceed their safe capacity. Confirmation all pipe lengths are on site or in store and available for installation.

11.1.2 Pipe Installation

The overcut diameter shall not exceed the outside pipe diameter by more than 2% of the pipe diameter or 30 mm whichever is smaller. The pipe installation method and equipment shall not exceed the maximum axial compressive

capacity of the pipe. The driving ends of the pipe and intermediate points must be protected against damage during the jacking process for rigid pipes. The method used to protect the joint should not impair the joints ability to close or fully seal. The Contractor shall transport, handle and store the pipes and fittings in accordance with the manufacturer's recommendations.

11.1.3 Settlement and Monitoring

The Contractor shall carry out dilapidation surveys along the pipe alignment. The Contractor shall:

- Take all care and precautions to protect existing structures, utilities and services.
- Identify and protect services that cross the construction activities.
- Monitor ground movement directly above and three metres either side of the utility intersection. Surface or ground monitoring points shall be recorded at a minimum of 30 m intervals or at least three locations per tunnel drive.
- Surface settlement monitoring readings shall be taken:
- Prior to active excavation reaching that point.
- When the tunnel face reaches that point.
- When the zone of active excavation has passed and no further movement is detected.

11.1.4 Performance Requirements

The Contractor shall maintain comprehensive site records of micro-tunnelling and pipe jacking loads, line and level measurements, the distance moved and the relationship between them. The Contractor shall submit all the site data records in electronic format within 48 hours of the operation to the Superintendent.

11.2 Horizontal Directional Drilling (HDD)

The Contractor's method of handling, lifting and pulling the pipe strings shall not over-stress the pipe material. Calculations shall be submitted by the Contractor demonstrating this requirement.

11.2.1 Construction Methodology

The Contractor's method of handling, lifting and pulling pipe strings shall not overstress the pipe material. The space between the pipe and the excavated hole shall be filled with an approved lubricant at a pressure that will support the adjacent ground. The space between the pipe and the excavated hole shall be filled by displacing the lubricant with grout. The drilling fluid, water and cuttings shall be disposed of in an approved manner.

The Contractor shall follow the following recommended drilling and pipe installation procedures:

- Verify the capacity and capability of the HDD equipment before commencing drilling.
- Drilling fluid and recycled fluid design plan established and agreed with the Superintendent.
- The Contractor shall ream the bore hole on completion of the pilot hole. The bore hole diameter shall be a minimum of 25% larger than the pipe outside diameter.
- The Contractor shall pull the pipe through the bore hole during the last step of reaming. The pipe shall be attached with a swivel connector. The pull back operation must continue without interruptions until the pipe is completely pulled though the reamed hole. The Contractor shall not apply more than the maximum safe pipe pull force specified by the pipe manufacture.
- The installed pipe shall be homogenous throughout and shall be free of visible marks, holes and other faults.
- The Contractor shall transport, handle, store and assemble the pipes and fittings in accordance with the manufacturer's requirements.
- The pipe shall be allowed to cool and relax after installation to the manufacturer's recommended amount of time. However, this shall not be less than four hours. Sufficient extra length of pipe shall protrude on the inlet and exit pits to allow for cooling, relaxation and axial contraction.

11.2.2 Settlement and Surface Heave

The Contractor shall take all care and necessary precautions to protect the existing structures, utilities and services. All potential affected work areas shall be visually inspected to assess and documented prior to commencing construction. The Contractor shall cease work in the event monitoring points indicate surface movement in excess of agreed specifications.

11.2.3 Equipment

The Contractor shall provide HDD equipment of sufficient capacity and capability to undertake and complete the work within the contract period based on the design. The equipment shall have spare capacity to the degree appropriate to findings of its risk analysis. The equipment shall include standby units, spare parts and consumables required for the duration of the work.

All equipment monitoring devices, including pressure gauges, flow meters and drilling head control/location equipment shall be in good condition, easily accessible, legible and calibrated in accordance with the manufacturer's specifications. The Contractor shall maintain monitoring maintenance and calibration registers on site.

11.2.4 Construction Set-Out

Survey marks shall be placed along the alignment at a maximum spacing of 2.5 m. Each survey mark shall be labelled with a number on a nearby survey peg. The survey marks shall be surveyed for level and chainage of the pipeline. The survey mark data shall be set out in a schedule with the required depth to pipe

invert shown on each survey mark. The installation of the survey marks and preparation of the schedule shall be carried out by a qualified engineering survey. The survey mark schedule shall be submitted to the Superintendent at least five working days before starting HDD works on each drilling section. Tolerances in the gradient and alignment of the final installation shall comply with the Project Drawings.

11.2.5 Pilot Hole Positioning Control

The Contractor shall use, as a minimum, wire-line and surface sensing equipment to accurately monitor and control the drilling of the pilot hole to the design alignment and tolerances. The line and level position of the drilling head shall be checked at each survey mark at a maximum spacing of 2.5 m. If the drilling head is found to have moved outside the construction tolerances at any survey mark, the drill string shall be retracted to a position within tolerance, and drilling recommenced along the correct alignment.

At no time throughout the pilot hole drilling should blind drilling be undertaken if a loss of control signal occurs. Should there be a loss of signal, the Contractor shall suspend drilling until control signals are re-established.

11.2.6 Sighting Trenches

Sighting trenches shall be used during HDD pipe installation works to check the level of the drill head near critical services. The Contractor may utilise sighting trenches at other locations if required. The Contractor shall excavate additional sighting trenches if instructed by the Superintendent to confirm clearance to an existing service or confirmation of construction line and level tolerances.

11.2.7 Preparation of Pipe

The Contractor shall string out, butt weld, remove internal weld beading, inspect for defects and support the pipe where required on rollers to prevent damage during installation.

11.2.8 Drilling Fluid

The design and construction shall confirm that the drilling fluid and cuttings do not discharge at the surface i.e. frac-out. If discharge occurs, drilling shall cease and not recommence until suitable remedial work has been completed. The drilling fluid shall be suitably contained at all times and shall not enter the stormwater drainage system.

11.2.9 Down Hole Tooling

The Contractor's knowledge and experience will determine the most appropriate tooling configuration suitable for the ground conditions. The down hole tooling should be well maintained and in excellent working condition. Changes or alterations to the down hole tooling during construction shall be notified to the Superintendent.

11.2.10 Pipeline Placement

The pipeline shall be sealed at both ends and weighted by filling with water, if necessary, to suit the assumptions inherent in the Contractor's design calculations after forming the pipe string. The Contractor shall confirm that during the pulling operation, pulling forces or hole cave-in does not damage the pipeline. Pulling forces shall not exceed safe tensile loads as specified by the pipe manufacturer.

The pipeline string shall be supported on rollers at appropriate spacing to confirm that the pipeline is not over-stressed or damaged by scratching during placement.

11.2.11 Drilling Through Rock, Cobbles or Gravel

If drilling conditions change, possibly indicating the presence of additional rock, cobbles or gravel, the Contractor must notify the Superintendent. The Superintendent must be able to verify and quantify any claims of variations for drilling through rock, cobbles or gravel.

No claim pertaining to the ground formation will be considered where:

- The Contractor has failed in the Contractor's obligation to complete and submit Drilling Log Day Sheet and Drilling Fluid Log Sheet.
- The Contractor's gauges and measuring devices are found to be faulty or inoperative.
- It is found that the Contractor has failed in the Contractor's obligations to provide access to all gauges and measuring devices throughout the course of the project.
- The Contractor has failed to give adequate notice to the Superintendent of a change to down-hole tooling and to allow for inspection by the Superintendent prior to the tooling going down hole.
- The Contractor fails to give adequate notice of down hole tooling exiting the hole to allow for inspection by the Superintendent.
- The Contractor fails to maintain adequate flow and viscosity of drilling fluid.

11.2.12 Acceptance of Installed Pipelines

An additional 3 m length of pipeline shall be butt-welded to the leading end of the pipe string prior to placement. After the pipeline has been pulled through sufficiently to expose the additional 3 m length, the Superintendent and the Contractor shall jointly examine it.

If the pipe length is significantly damaged, as defined below, complete replacement of the pipeline will be required. Significantly damage is defined as:

- Scratches deeper than 10% of the pipe wall thickness are evident.

Any evidence of plastic failure of the pipe due to tensile forces (e.g. necking or reduction in outside circumference compared with the supplied pipe).

11.2.13 As Constructed Alignment Survey

The Contractor shall survey the pipe's horizontal and vertical alignment using a gyroscope based probe or similar (DuctRunner DR HDD or approved equivalent). The probe shall have a maximum accuracy tolerance of 0.25% in the X, Y and Z directions. This shall be done after the installation of the pipe and before its connection to the adjoining sections.

11.3 Pipe Bursting – Specialist System

11.3.1 System Concept Design

The Contractor shall consider the following procedures as part of the concept design:

- Determine the appropriate pipe bursting method for each particular application.
- Determine the appropriate replacement pipe with particular consideration of the exterior finish and flush joint connections.
- Perform the required surveys, site protection plans, geotechnical investigation, risk assessment and contingency planning.
- Detail each step of the process including mobilisation, winch installation, pipe bursting operations, existing pipe specifications.
- Confirm bursting winch specifications include adequate anchoring system, pull forces and required torques.
- Water supply requirements for the work.
- Compile replacement pipe specification.
- Compile contingency plans comprising surface heave, impact on other utilities, loss of bursting head, etc.

The equipment design and capacity should be adequate to:

- Pull the bursting head through the existing pipe, destroy it and displace the fragments outwards.
- Pull the new pipe into the bore hole created by the bursting head.

11.3.2 Methodology

The following minimum information shall be provided by the Contractor before construction work can start:

- Detailed design calculations and drawings for installation of pipeline by the proposed method of pipe bursting and construction methodology. Calculations shall include all design and handling stresses, including those during installation and commissioning.
- Certification from a RPEQ certifying design, drawings and specifications.

The Contractor shall submit design documentation which shall address the following:

- General description of the construction method and sequence of operations.
- Type of existing pipe and service connection joints.
- New piping type, connection details and equipment used.
- Manufacturer and type of bursting equipment, operating system proposed and capability of equipment chosen.
- Confirm pipe bursting is possible and the presence and proximity to existing services is known and the risks understood.
- A comprehensive geotechnical investigation is carried out and used in the design.
- Existing underground utility services locations and any special precautions.
- Ground monitoring equipment and methods e.g. heaving.
- Type of existing pipe and services reconnection of joints used including their specification.
- Calculation of size and depth of exit pit required.
- Hydraulic calculations for by-pass pumping.
- Location of exit pits, trench support and work site layout.
- Method of temporary spoil storage and disposal.
- Programmed daily work hours and duration for the operation.
- Details of specialist subcontractors and applicable competency training records of personnel.
- Training and relevant experience of the personnel who will undertake the work.
- Liaison with the relevant authorities is complete and a system of liaison during the construction stage is developed and detailed.
- Define any third party requirements which may impact the work (e.g. ground settlement monitoring, etc.).
- Method of temporary spoil storage and disposal.

11.3.3 Construction

The construction sequence and program shall be completed prior to commencing any pipe bursting construction work. The construction sequence shall include:

- Site inspection and verification of existing levels, survey control points and set out points.
- Identification and location of the entry and exit chambers including access chambers for services disconnection and utility crossings.
- Procedures if an obstruction is found during construction.
- Disconnection of all laterals, and removal of concrete encasements, gibault joints, repair clamps, in-line valves and fittings from the pipe to be replaced.
- By-pass flow pumping arrangement.
- Surface settlement and heave monitoring.
- Setting up pulling mechanism.

- Confirmation of pull forces, deviation of line and gradient and rate of advance of installed conduit.
- Confirmation that all utilities crossing within 600 mm of the existing bursting pipe have soil excavated and removed to relieve pressure caused by heaving during the bursting operation.
- Pulling bursting head and replacement pipe from entry to exit chambers.
- Pipe testing and inspection.
- Reconnection of all laterals.
- Removal of equipment and re-instatement of site.

11.4 Working in and around Asbestos Cement Pipes

Some of the existing pipes in water and sewer systems may include pipes manufactured from asbestos cement (AC). The Contractor shall comply with the relevant safety requirements and regulations when working in and around AC pipes. Handling of AC pipes shall be carried out in accordance with Queensland Urban Utilities ASBESTOS SWMS 10.

The Contractor shall check and comply with local council requirements where AC pipe is to be replaced and or repaired.

11.5 CCTV Surveys

The Contractor shall undertake colour CCTV surveys of the sewer at the following stages:

- An initial CCTV survey of the sewer undertaken immediately upon completion of all rehabilitation works (this CCTV survey shall be undertaken on the same day as rehabilitation works are complete and there should not be any flow through the pipe).
- A second CCTV survey of the sewer undertaken after cleaning at the end of the defects liability period. This shall constitute the final CCTV survey should this survey find nil defects.

Note the following CCTV surveys may be additionally required where appropriate:

- Where post installation defects of the rehabilitation system have been identified and rectified (after authorisation from Queensland Urban Utilities or the Superintendent) both pre and post repair CCTVs are required.

The final CCTV survey shall show that the system has been correctly installed and that all property connections are completely open to the sewer.

11.6 Laser Profiling

Post installation laser profiling shall be undertaken with no-flow in the pipe. Up to a maximum of 20% flow can be allowed in the pipe for pre-installation laser profiling. The sewers have to be cleaned and all debris removed before the laser profiling is undertaken.

11.7 Property Connections

The Contractor shall determine the number, size, type and location of property connections. The Contractor shall locate and reconnect only live property connections after the main has passed the compliance tests. Property connections will be completed with the open cut trench method. The internal surface of the main and the property connection shall be smooth and free from defects that may affect the flow at the connection.

The Water Supply property connections shall comply with South East Queensland Water Supply and Sewer Design and Construction Code .

The Sewerage Supply property connections shall comply with South East Queensland Water Supply and Sewer Design and Construction Code.

11.8 Connections to Existing Mains

All work on the existing reticulation system (water supply and sewerage supply) shall be considered as "live work" and will be constructed by the Contractor. The Contractor will require accreditation from Queensland Urban Utilities to perform this work.

12 PIPES

12.1 Polyethylene Pipe (PE)

Polyethylene pipe shall comply with the Water Industry Association of Australia Standard Polyethylene Pipeline Code WSA 01 2004.

12.1.1 Pipe Laying

Installation of PE pipelines shall be in accordance with AS 2566.2. The installation of PE pipes shall be for pipes that have been joined by butt welded and/or electro fusion connections of individual pipes into strings. The pipeline may be constructed by trenching or may be constructed by Horizontal Directional Drilling. Pipes and fittings shall be examined for damage immediately before jointing. Pipes and fittings with a scratch or other damage penetrating in excess of 10% of the pipe wall thickness shall not be used. Pipe connections shall be performed in environmentally controlled conditions enclosed areas to exclude dust, water and other contaminants.

Pipes strings shall be assembled on pipe rollers. The method of handling and installing the pipe strings shall not overstress the pipe structure.

Pipe installation and backfilling, as appropriate, shall be carried out in the early morning whenever practical. This is to minimise pipe contraction on cooling. Particular care shall be exercised when installing the pipe in the vicinity of tees or other fittings which require to be positioned at a precise chainage on the pipeline.

12.1.2 Trenching Method

The pipeline may be constructed by assembling on the side of the trench, and lowered into position with lifting slings. Marker tape shall be laid above the pipe and the communications conduits. The tape shall be on top of the PE pipe. The tape shall be 150 mm above the communications conduits. A tracer system shall be laid continuously with the pipeline and adequately secured to valves and fittings.

Changes to direction shall be achieved by bending the pipe to a minimum radius of 50 times the nominal size (or as per the manufacturer's guidelines) where bends are not detailed on the Project Drawings. The ambient temperature shall be above fifteen degrees Celsius. The pipe to be positioned centrally in curved trenches with the use of temporary packing during backfilling. The temporary backfilling shall be removed when the degree of backfilling is sufficient to restrain the pipe in the correct position. The pipe must not be bent around stakes.

12.1.3 Flange Backing Rings

Steel backing rings for PE pipe flanges shall be stainless steel Grade 316 and comply with the details in AS 4087 Table B7 Class PN 16. Flange bolts shall be Grade 316 stainless steel. Bolt threads shall be treated with an anti-galling compound. Nuts shall be tightened evenly in diametrically opposite pairs using a torque wrench set to the manufacturer's recommended torque for PE flanges. Jointing compound shall not be used with gaskets. Gaskets may be secured temporarily to one flange face by a minimum quantity of clear rubber solution for vertical joints.

12.1.4 Pipe Position

The position of the internal face of any pipe shall not deviate from that indicated on the Project Drawings or as directed by the Superintendent.

12.1.5 Bedding, Side Filling and Overlay

The ability of PE pipe to resist external loads is dependent fundamentally on adequate compaction of the side fill. The degree of compaction for bedding, side filling and compaction shall be detailed on the Project Drawings.

Granular bedding material shall be used by spreading and compacting over the full length of the pipe trench. The bedding material shall be trimmed and levelled to provide continuous support to the pipe. The side fill material shall be placed equally on each side of the pipe in layers. Compaction of the side fill material shall be by hand ramming. The pipe shall be restrained against lifting as required during this operation. This work shall be done progressively and in sequence with the removal of trench supports, as necessary, so that the specified degree of compaction is attained to the side fill. Overlay shall be formed by placing and compacting the granular material to the height shown on the Project Drawings. Vibrating plate compactors shall not be used until the overlay has been placed.

12.1.6 Pipeline Anchors

Anchorages at bends, tees, reducers and dead ends shall be provided to resist the axial forces where the jointing system does not have sufficient axial strength capability.

12.2 Mild Steel Cement Lined (MSCL)

Mild steel cement lined pipe should normally be used for water trunk and distribution mains. The pipes shall comply with AS 1579 – Arc-welded Steel Pipes and Fittings for Water and Waste-water. The pipes shall have an internal cement lining complying with AS 1281 – Cement Mortar Lining of Steel Pipes and Fittings. The pipes shall have an external coating installed for above ground or below ground applications. The type of coating will vary in accordance with the design environment. Polyethylene coatings shall comply with AS 4321 – Fusion Bonded Medium Density Polyethylene Coatings and Linings for Pipes and Fittings. Rubber rings for pipe joints shall comply with AS 1646 – Elastomeric seals for Waterworks Purposes. The pipeline shall incorporate the following:

- All flanged branches, scours and air valves shall have insulated bolts.
- All insulated flanges, scours and air valves must be tested before backfilling.
- Catholic protection test point details shall be provided.
- All exposed metalwork such as branches, anchors, flanges or dead plates shall be coated with an insulating material before being backfilled or concrete encased.
- Reinforcement shall not be welded to or make contact with the pipe.
- Reticulation branches shall be fitted with valves.

12.2.1 Joints

Welded steel pipes may have rubber ring joint, spherical slip-in joint, ball and socket joint, plain butt joint, butt joint with collar, flange joint or any combination of these end types.

Flanged joints shall comply with AS 4087 – Metallic Flanges for Waterworks Purposes. The flanges shall be raised face steel flanges. Flanges shall comply with AS 4087 Figure B.7 unless connecting to existing pipe where the connecting flange shall match existing. The pipe barrel and exposed parts of the flange shall be coated with an epoxy painted coating. The surface shall be blast cleaned to AS 1627.4 Class 3 and painted with a two coat system of two pack high build, solvent free cycloaliphatic amine cured epoxy coating to a dry film thickness of 500 microns. The application shall comply to the manufacturer's requirements. The joint between the coatings shall be covered with a UV stabilised heat shrink sleeve.

The joint detail shall comply with the design life of the pipe line with corrosion protection at the joint compatible with remainder of the pipe coating system.

Welded joints with internal and external welds shall be checked with a pneumatic test of the weld integrity. An air nozzle shall be attached to the pipe plate in the air space between the welds. The annulus pressured to 100 kPa and the welds checked for leaks.

12.2.2 Gaskets

Gaskets shall be full face elastomeric solid EPDM rubber 3 mm thick. Jointing compound shall not be used with gaskets. Gaskets may be secured temporarily to one flange face by a minimum quantity of clear rubber solution for vertical joints.

12.2.3 Pipeline Anchors

Anchors shall be provided to all unanchored flexible joints at changes of diameter, direction, tees, valves and blank ends. The anchors shall be able to resist the thrust developed by the internal operating pressure, any transient pressures associated with the operation and field test pressure.

12.2.4 Installation

12.2.4.1 Trenches

Trenches shall be excavated to the lines and levels shown on the Project Drawings. Over excavation in the bottom of the trench must be filled with selected material, compacted and graded. Where sharp points of rock or other hard material project above the general level of the bottom of the trench, the excavation shall be deepened and refilled with selected material, well compacted and finished to grade. The trench must be kept free of water, rubbish, etc. and in a proper condition for pipe laying.

Bell holes should be excavated in the trench base for rubber ring joints to prevent the socket from bearing on the foundation.

The trench should be locally enlarged to facilitate welding and coating reinstatement for welded joints.

12.2.4.2 Bedding

The backfill for haunch support, side support and overlays shall be well compacted between the sides of the pipe and the trench. Particular care must be taken to compact the material under the haunches of the pipe. The backfill shall be built up in layers evenly on both sides of the pipe. The depth of backfill shall not exceed 150 mm unless detailed otherwise on the Project Drawings. Backfilling in layers should proceed until 150 mm above the top of the pipe or as detailed on the Project Drawings.

The material used should be non-cohesive native soil with no particles larger than 25 mm, or imported sand or gravel of nominal size not larger than 20 mm with the maximum size not to exceed 25 mm. The material should not be too high in electrical resistivity where catholic protection is used.

A compacted zone of 50 mm below the pipe should comprise of non-cohesive soil, imported fill or sand such that the maximum particle size is does not exceed 13.2 mm. This zone is required to prevent damage to the coating system.

Bedding shall be restored where the trench has been over excavated for pipe welding, etc. Cross trench dams shall be constructed to prevent erosion of backfill and bedding where trench water flow is possible.

12.2.4.3 Trench Fill

The material used for back filling shall be replaced such that no cavities or voids are left. Large pointed stones or other hard unyielding material must not be placed immediately above the overlay. The trench fill shall be compacted in layers to achieve the relative density for pavement support. The extent of compaction should be to minimise future surface settlement.

12.2.4.4 Compaction

Layers not exceed 225 mm in depth shall be placed and compacted. Compaction shall comply to a minimum of 95% of Standard Maximum Dry Density to AS 1289.1.1 or 70% density index to AS 1289 E6.1 Density Index Method for a cohesionless material as applicable before any additional fill is placed. Road pavement of a depth and quality equal to the original pavement shall be supplied and compacted to a minimum 95% of Modified Maximum Dry Density to AS 1289.5.2.1.The Contractor shall arrange compaction tests at the rate of one test per 100 m of pipeline. Testing shall be done by a NATA registered laboratory.

12.3 Ductile Iron Cement Lined (DICL)

Ductile iron cement lined pipes shall be spigot and socket rubber ring joined pipes and comply with AS 2280 – Ductile Iron Pipes and fittings. DICL pipes shall be internally lined with cement mortar to AS 2280 Table 7.1. DICL pipes shall be bitumen coated externally to AS 2280 Section 7. DICL pipes shall be protected from corrosion by being sleeved in polyethylene. The pipe protection shall comply with:

- AS 3680 - Polyethylene Sleeving for Ductile Iron Piping.
- AS 3681 –Application of Polyethylene Sleeving for Ductile Iron Piping.

- The pipes shall be joined using elastomeric seals. The elastomeric seals shall be natural rubber with a minimum volume of polymer in the elastomeric compound of 70% complying with AS 1646.

- The spigot and interior of the socket shall be thoroughly cleaned. The seal cleaned and flexed to the manufacturer's requirements, and placed in the socket with bulb leading. The groove in the seal must be located on the retaining bead in the socket, and the retaining heel of the gasket firmly bedded in its seat so that the heel of the gasket is not proud of the mouth pipe. The lubricant for the seal shall be a water main bactericidal pipe jointing lubricant suitable for potable water and complying with AS 3855.

The assembly of the pipes shall be in accordance with the manufacturer's requirements.

- Pipes shall be cut either by power driven abrasive wheel cutter or special cutters made for ductile iron. Pipes shall be cut through the ductile iron and mortar lining to achieve a smooth unbroken end to the lining. Cut end shall be chamfered similar to the original spigot.

12.3.1 Bedding

The bedding shall be placed in the trench and compacted before pipes are laid. Bedding material shall be compacted to a density index of not less than 65% measured in accordance with AS 1289.E6.1. The bedding shall be placed to a level of not less than one quarter of the pipe diameter above invert and then recessed to accommodate the pipe barrel. The bedding shall be excavated at the pipe sockets to relieve the sockets of any loads. The pipes shall be brought to line and grade with minimum disturbance to the bedding material. The bedding material shall not be built up under the pipe after the pipe has been laid. The surround material shall be placed around the pipe without disturbing the pipe's line and grade.

Vibrating plate compactors or flooding shall not be used for compacting surround or side support material. Hand tamping tools shall be used to achieve the required compaction.

12.3.2 Backfilling

Selected compacted fill shall consist of material excavated from the trench and capable of achieving the required compaction. Selected fill shall be free of vegetable matter and generally uniform in nature. It shall not contain large rock fragments, large clay particles or silt. Material used for backfilling shall be replaced such as not to leave any cavities or voids. Large pointed stones or other hard and unyielding material shall not be placed immediately above the embedment material. The finished backfilled surface in natural ground shall be left in such a condition that it will not erode as the result of surface water runoff over it.

12.4 MPVC Pressure Pipe

MPVC pipes and fittings shall comply with AS 1260. Handling and storage of pipes and fittings shall comply with AS 2032.

12.4.1 Bedding

The bedding shall be placed in the trench and compacted before pipes are laid. Bedding material shall be compacted to a density index of not less than 65% measured in accordance with AS 1289.E6.1. The bedding shall be placed to a level of not less than one quarter of the pipe diameter above invert and then recessed to accommodate the pipe barrel. The bedding shall be excavated at the pipe sockets to relieve the sockets of any loads. The pipes shall be brought to line and grade with minimum disturbance to the bedding

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12.5 Disinfection for Water Supply

Tapping points for the injection of chlorine and for taking bacteriological samples shall be provided. These are to be at approved locations at each end of the main and installed during construction. The Contractor shall take samples for bacteriological testing. Testing to be done by a NATA registered testing facility. The Contractor shall carry out disinfection using an agreed method approved by the Superintendent.

13 FLOW CONTROL

13.1 Water Supply

13.1.1 Water Shut Plan

On the request for a Network Access Permit by the Contractor, a Water Shut Plan is triggered pending the impact on the network. Queensland Urban Utilities is responsible for the creation of the Water Shut Plan, which will be issued to the Contractor for implementation during construction.

The Contractor is responsible for the operation of all valves associated with the shut plan, by a Queensland Urban Utilities accredited valve operator.

A trial shut needs to occur to confirm the operational status of valves to be operated during an actual shut down event.

13.1.2 Bypass Water Supply Arrangements

It is the Contractor's responsibility to ensure water supply is maintained to all affected customers by a bypass arrangement or tanker supply, where loss of

supply extends beyond a single 8 hour period, or where approved otherwise by Queensland Urban Utilities.

13.2 Sewerage

13.2.1 General

The Contractor is responsible for flow control which shall be planned to confirm that there are no overflows of sewage. Should an overflow occur the Contractor shall be responsible to:

- Notify the Superintendent immediately the Contractor becomes aware of the overflow.
- Take immediate action to stop or mitigate the overflow.
- Report the overflow in accordance with the requirements of Department of Environment & Heritage Protection (DEHP).

Undertake all necessary clean up, restoration or remedial actions ordered by the Superintendent or the (DEHP).

13.2.2 Flow Control Plan

The Flow Control Plan shall detail the proposed methodology to maintain sewerage services to affected occupiers and prevent overflow from the sewerage system for all components of the work. The flow control plan shall provide double isolation/safety measures following a detailed risk assessment for each segment of the work.

The Flow Control Plan shall demonstrate ability to achieve the following requirements:

- The Flow Control Plan shall demonstrate the capability to fully bypass a minimum of three times ADWF. RFQ will specify any specific flow control requirements.
- Monitoring of weather forecasts shall be in place for the duration of the work.
- The system used to control flow must be certified by a Registered Professional Engineer Queensland for the intended purpose and with demonstrated relevant experience in the water services industry and sewer rehabilitation.
- Should temporary alterations to sewerage assets be required to facilitate the Flow Control Plan then remediation and making good of the assets shall be undertaken.

13.2.3 Temporary Stopping of Flow to Discharge Maintenance Holes

The Contractor shall plan and coordinate flow control measures with the Superintendent where required. The Contractor shall submit a request to the Superintendent at least fourteen working days before he requires the sewage pumping station(s) to be switched off. The Superintendent shall nominate the

period of time that the pumping station(s) can be switched off. This will only be undertaken in and following a period of dry weather

14 PROPERTY CONNECTIONS

The Contractor shall determine the number, size, type and location of property connections from the documents and inspections.

The Contractor shall test and confirm property connections which are live. The locations of all live and dead property connections shall be recorded for accurate reinstatement. All live property connections shall be reconnected after the conduit has been completed and has passed the compliance tests.

The internal surface of the conduit, and the junction between a property connection and the conduit, shall be smooth and free from defects that may affect the flow from the property connection.

14.1.1 Reinstatement of Property Connections

The Contractor shall allow sufficient time for the installed conduit to stabilise before commencing cut outs for the property connections. This shall include movements caused by shrinkage, thermal contraction, stress recovery, mechanical adjustments in material properties during installation, curing, etc. The junction reinstatement system shall be capable of forming a seal with any installed conduit.

The cutting equipment:

- Shall be able to reinstate cut sloping or square connections.
- Leave a smooth bevelled edge free of any protrusions.
- The cut out shall be flush with the inside surface of the property connection line.
- Shall leave no discontinuity between the conduit hole and the property connection line.

The Contractor shall confirm:

- That each hole cut by the equipment and reinstated will not inhibit flow from the property connection.
- Cause any constrictions.
- Will not catch solid materials.

14.1.2 Rehabilitation of Property Connection Service Lines

Rehabilitation of property connection service lines may be required on some systems.

Appendix A - Scrutiny Checklist for Water Reticulation

Appendix B - Sewer Reticulation Projects, Drawings Checklist for Site Plans