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Pr9787 - Specification for Microtunnelling and Pipejacking

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This document is only valid on the day it was printed.

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1 Purpose

The purpose of this Specification is to ensure consistency across all projects delivered by Unitywater and that the safety, quality, environmental and design objectives required by Unitywater are achieved on Microtunnelling/Pipe Jacking projects.

This Specification shall be read in conjunction with relevant project drawings (where applicable), project Scope of Works and supplementary specifications.

2 Scope

2.1 General

Microtunnelling/Pipe Jacking shall, for the purpose of this document, be defined as a trenchless construction method for installing pipelines which is:

- **Controlled:**
 - the microtunnel boring machine (MTBM) is typically operated from a control panel at the surface
 - the system will generally install pipe simultaneously as spoil is excavated and removed.
- **Guided:**
 - The guidance system shall reference fixed points in the MTBM and shall be capable of installing the pipes to the required tolerance for line and level.
- **Jacked:**
 - the process of constructing the pipeline shall be by consecutively pushing pipes and the MTBM through the ground using a jacking system for thrust
 - alternatively, the pipe can be pushed/jacked into the ground after the hole is excavated provided that the drive is in competent ground able to self-support until the pipe is installed.
- **Supported:**
 - most microtunnelling/pipe jacking drives are able to provide continuous pressure to the face of the excavation to balance ground, groundwater and earth pressures
 - however, in some instances with competent dry ground full face support is not required and the Contractor will employ a machine unable to provide pressure to the face.

To avoid confusion within this Specification the term 'microtunnelling' will be used to describe any works that include the use of a microtunnel boring machine and/or pipe jacking system for the installation of a pipeline with minimal surface disruption. For clarity the definitions of microtunnelling/pipe jacking provided in [Appendix B](#) shall be referred to.

Microtunnelling can be divided into four categories defined by the excavation technique and the material handling systems on the MTBM. The categories are listed and defined below:



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2.1.1 Slurry Microtunnelling

Slurry microtunnelling is used in water charged soils or rock ground conditions where the excavated material is cut and crushed into a slurry. This slurry is pumped out of the tunnel via pipes. This is a closed tunnelling system and has the potential to apply continuous pressure to the face.

2.1.2 Earth Pressure Balance Microtunnelling

Earth pressure balance microtunnelling is used in water charged soils or rock ground conditions where the excavated material is cut and crushed into a damp granular material. This material is removed by a screw conveyor and muck handling cars. This method is not as effective as the slurry method in high hydrostatic and high rock strength conditions. This system requires man access.

2.1.3 Pilot Tube Microtunnelling

Pilot tube microtunnelling is used in dry soils or soft rock conditions. The system drills a pilot hole from the launch pit to the reception pit. This pilot hole is then enlarged to the required size of the tunnel. As the hole is enlarged it can be lined by jacking a casing pipe or the carrier pipe into place.

2.1.4 Vacuum Microtunnelling

Vacuum microtunnelling is used in dry soil, sand or rock conditions. The system uses a guided borer head similar to EPB or slurry microtunnelling; however, spoil is removed from the bore using a vacuum system without the addition of water. The machine is advanced, and pipeline installed using the pipe jacking method. The borer head is often a retractable type that can be used to excavate blind bores without the requirements for a reception shaft/pit.

2.2 Order of Precedence

Where a discrepancy exists between the Drawings, this Specification and the other Unitywater specifications the Contractor shall seek clarification from the Superintendent.

2.3 Principal/Standard Drawings

Where the form of Contract is 'Design and Construct' the Principal Drawings are a high level concept design of the Principal's project requirements. The Contractor is to use these drawings as a guide upon which to base the preliminary and final design. The Principal Drawings will typically illustrate the following elements:

- site constraints
- an indicative trenchless alignment according to best practice
- pits, shaft or tie in locations
- approximate drive lengths
- jacking/enveloper/casing pipe and carrier pipe details.

Where the form of Contract is 'Construct only' the Principal Drawings are a prescriptive representation of exactly what is to be constructed under the Contract. These drawings will include the minimum information that the Contractor will require to build the works. Any changes required or ambiguities found must be discussed with the Principal immediately.



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3 Project Preliminaries

3.1 Approvals

Project approvals are usually obtained by Unitywater; however, in some instances approvals may be the responsibility of the Contractor. The Contractor is to refer to the Project Specific Specification for required approvals.

No work is to begin, either onsite preparation or with Microtunnelling activities, until all relevant permits and approvals have been gained and signed off by the relevant authority. The following authorities may be required to authorise the works:

- Queensland Government Department of Transport and Main Roads
- Queensland Rail and / or other rail infrastructure owners
- Local Government
- Private land owners.

The Contractor shall be required to adhere to any approval conditions that the Principal or asset owner specifies.

3.2 Design

The Contractor shall be responsible for the design and construction of all aspects of the microtunnelling works, including any temporary works and temporary pit/shaft supporting structures. All design assumptions regarding subsurface conditions, equipment requirements, groundwater and other factors are the responsibility of the Contractor and shall be fully documented.

Based on the alignment shown in the Principal Drawings, the Contractor shall design and size the excavated profile to accommodate all temporary and permanent works.

The design is to be certified by a RPEQ engineer and shall be submitted to the Superintendent for review prior to commencement of work. The Contractor shall not proceed with any work until the Contractor's design has been accepted by the Superintendent. Acceptance of the Contractor's design by the Superintendent in no way diminishes the responsibility of the Contractor for the design.

The Contractor is responsible for submitting the following design elements for approval prior to commencing work:

- The design of all temporary works associated with the trenchless construction, including but not limited to the pit/shaft support (including access ladders and pipe fixings), crane pads and access roads or laydown areas.
- Where the permanent works are to accommodate thrust arrangements, these shall be designed to ensure the permanent works are not damaged.
- The microtunnel alignment.
- Permanent microtunnel solution and shaft design to consider lateral loading from seismic events.
- Collaboratively working with the Principal's permanent infrastructure functionality and permanent design team to ensure the intent of the overall project is achieved.

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- The thrust support frame and shaft must be designed to withstand the maximum forces expected for the tunnelling system while ensuring that these forces are within the manufacturer's allowable jacking forces and deflection tolerances for the jacking pipe (if required).
- The design and execution of the microtunnelling equipment and processes.
- The design of the means of excavation to be used and the associated cutter tools.
- Verifying the suitability of the specified pipe for the methodology proposed with respect to pipe install.
- The planning and use of slurry fluids, jacking lubrication fluids, polymer drilling fluids, tunnel grout and tunnelling consumables.
- The design and use of the guidance and steering system to achieve the design alignment both horizontally and vertically.
- Theoretical settlement calculations to inform the development of an acceptable ground loss percentage:
 - The operation of the trenchless equipment is to conform to the established ground loss percentage and actual settlement shall be monitored/reported as the microtunnel advances.
- Any design amendments necessary to ensure that the construction techniques proposed are in compliance with the permanent design.

The microtunnel design shall take account of all potential impacts on all existing infrastructure and underground features, including but not limited to: impacts from ground movement, seismic activity, clearance to features, settlement/heave and any changes in the groundwater table resulting from the works, either temporarily during construction or permanently as a result of the construction.

All designs shall ensure the safe operation and use of plant, equipment and materials handling under all expected loadings such as ground pressure, superimposed loads and thrust forces.

Table 1 below outlines the minimum required design drawings for the works under the contract. It also details when RPEQ sign off is required.

Table 1 – Design Drawing Requirement

Drawing Details	Plan / Elevation	RPEQ Sign Off
Site Layout	Plan	<input type="checkbox"/>
Shaft/Pit Construction	Plan + Elevation	<input checked="" type="checkbox"/>
Shaft/Pit Layout	Plan + Elevation	<input type="checkbox"/>
Finished Microtunnel General Arrangement	Plan	<input checked="" type="checkbox"/>
Finished Microtunnel Alignment	Plan + Elevation	<input checked="" type="checkbox"/>



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3.2.1 Jacking Pipe

Prior to construction, the Contractor shall submit to the Superintendent for approval calculations showing the anticipated installation forces to be imposed on the jacking pipe. These calculations are required to take into account jacking loads, joint configuration, stress transfer, joint seal design, frictional forces, ground conditions, groundwater, angular deflection and any fluids used in the installation process.

The Contractor shall take all precautionary measures to avoid damaging the jacking pipe during the installation process. In particular, the Contractor shall ensure that the magnitude of loadings imparted onto the jacking pipe does not result in buckling, spalling or cracking of the jacking pipe and excessive deflection or improper functioning of the pipe joints. The assessment of the loads onto the jacking pipe is to be conducted in real-time and plotted against the allowable loads of the jacking pipe.

3.2.2 Carrier Pipe

The Contractor shall submit to the Superintendent for approval details showing the transportation, handling, storage, installation, any grouting required and testing of the carrier pipe. All details must adhere to the manufacturer's guidelines.

3.2.3 Design Collaboration

The Contractor and Principal shall collaboratively work to ensure that all pipeline design aspects have been adequately considered and analysed across the two key project phases: Microtunnelling Installation and the Infrastructure's Permanent Operation.

3.2.4 Safe Man Access

During the design and planning phase of the microtunnelling solution, the Contractor must consider and address safety aspects for access into the tunnel and to the machine. The size of the tunnelling pipe is one aspect that will dictate whether man access is possible and safe. Safe man access is usually facilitated at 900mm or greater diameters.

Microtunnelling system elements that will require man access include at least:

- changing cutter head tools (other than with a retractable head type MTBM)
- operating survey systems such as long and/or curved drive systems
- maintaining lubrication systems
- installing and maintaining Intermediate Jacking Stations
- outer annulus grouting.

Where man access is not appropriate (either for safety or other operational reasons) through use of the above elements, alternative solutions are to be employed in microtunnelling applications, such as using shorted drives and not curving alignments.



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3.3 Governing Documentation

As a minimum, and in addition to the documentation required in the Contract documentation, the Contractor must submit for approval the following governing documentation as outlined in Table 2, Table 3, Table 4 below.

Table 2 – Work Plans

Procedure	Submission
Settlement Monitoring Plan	4 weeks before work
Major Lift Plan(s)	4 weeks before work
Plant Suitability and Maintenance Plan	4 weeks before work
Risk and Contingency Management Plan	4 weeks before work
Microtunnelling Inspection and Test Plan	4 weeks before work

Table 3 – Work Procedures

Procedure	Submission
Site establishment	4 weeks before work
Construction of the crane support slab / pad	4 weeks before work
Pit/shaft construction (if applicable)	4 weeks before work
Fluid Design and Management (if applicable)	4 weeks before work
Casing pipe welding (or jointing)	4 weeks before work
Carrier pipe welding (or jointing) (if applicable)	4 weeks before work
Jacking wall/jacking support structure construction (if applicable)	4 weeks before work
Tunnelling/pipe installation	4 weeks before work
Tunnel access (if applicable)	4 weeks before work
Carrier pipe installation procedure (if applicable)	4 weeks before work
Annulus grouting of the overcut (if applicable)	4 weeks before work
Annulus grouting between the jacking pipe and the carrier pipe	4 weeks before work
MTBM head intervention/cutter change (under free air or compressed air)	4 weeks before work
Welding of casing/carrier pipe (steel welding, HDPE pipe welding, HDPE sheet welding)	4 weeks before work
MTBM surveying and surveying audit	4 weeks before work
Hydrostatic and Chlorination Commissioning (if required)	4 weeks before work
The demobilisation of the equipment and site	4 weeks before work

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Table 4 – Safe Work Method Statements

Safety Work Method Statements	Submission
Operation of a crane	4 weeks prior to works
Operation of the microtunnelling equipment	4 weeks prior to works
Operation of the slurry system	4 weeks prior to works
Operation of the water treatment plant	4 weeks prior to works
Work at heights	4 weeks prior to works
Work in a confined space	4 weeks prior to works
Hot works	4 weeks prior to works
Work at night under artificial light	4 weeks prior to works
Lifting	4 weeks prior to works

NOTE: These timeframes may be varied either by written agreement or nominated in the Project Scope of Works.

3.4 Risk and Contingency Plans

The Contractor shall prepare and implement an approved contingency plan dealing with the key project or microtunnelling risks identified. As a minimum the Contractor shall have defined plans complete with equipment and materials on standby to mitigate against the following microtunnelling risks:

- shaft/pit collapse
- tunnel collapse
- shaft/pit flooding
- tunnel flooding
- major MTBM mechanical failure
- settlement or heave scenarios
- serious safety or environment incidents
- high water inflows at the face of MTBM which prevents access to the pressure chamber for cutter inspection and replacement
- higher jacking forces than expected.

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3.5 Geotechnical Information and Risk

A Geotechnical Investigation will be commissioned by/carried out for the Principal for the project and the resulting information will be provided to the Contractor in the form of a Geotechnical Data Report (GDR) or complete Geotechnical Baseline Report (GBR). The level of geotechnical investigation shall be determined by, but not limited to the following inputs:

- proposed methodology
- local site geology
- local site hydrogeology
- project capital value.

The Report will cover a minimum set of requirements/criteria to aid and guide the Contractor to assess the project and specifically make informed decisions with regards to:

- equipment selection
- penetration rates
- jacking pipe selection
- carrier pipe selection
- time and cost.

The Contractor shall inform themselves thoroughly and draw their own conclusions as to the difficulty of maintaining required excavations and of undertaking other work affected by the geology and hydrogeology of the Site.

Where the Contractor considers it necessary that additional site or subsurface investigations are required, the Contractor shall bring this to the attention of the Superintendent's representative in a timely manner.

4 Procurement

4.1 Approved Suppliers

The Contractor must provide materials that have previously been approved for use as per the SEQ WS & S D & C Code Infrastructure Products and Materials (IPAM).

If the Contractor proposes to utilise non pre-approved products these are to be submitted to the Superintendent's Representative for consideration.

4.2 Principal Supplied Materials

The Contractor shall document the receipt of any Principal supplied materials formally with the Superintendent's Representative. The receipt of materials by the Contractor accepts the suitability of these products for inclusion in the Works.

All Principal supplied materials shall be handled strictly in accordance with the manufacturer's written instructions at all times.

4.3 Storage and Security of Materials

The Contractor shall provide security for the Site and Works including the construction facilities, plant and equipment. Materials shall also be secured by the Contractor to prevent their removal by unauthorised personnel.

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4.4 Personnel

Appropriately trained and experienced personnel are required for the delivery of the Works. Table 5 (refer to following page) summarises the minimum training and experience required for key personnel. Details of key personnel experience shall be provided to the Superintendent's Representative for approval before the works commence.

A site supervisor who is thoroughly knowledgeable of the equipment and microtunnelling procedure shall be present at the job site at all times. The site supervisor shall be present to immediately address microtunnelling concerns, health and safety and environmental issues.

Table 5 – MTBM Personnel Experience

Microtunnelling Role	Training / Qualification	Experience in Role (Years)
Project Manager	Minimum Higher Education Diploma	5
Microtunnelling Supervisor	Relevant Industry Experience	5
MTBM Operator	MTBM Operation Experience	3
Microtunnelling Engineer	Minimum Higher Education Diploma	2
Microtunnelling Surveyor	Registration on the SBQ, Underground Surveying Experience	4
Separator Operator	Recognised supplier or industry fluid training	1

4.5 Plant

All microtunnelling construction operations shall be performed using the appropriate specialist equipment.

All plant must be of a good standard and the Superintendent shall be permitted to inspect the proposed plant.

All plant must pass the Principal's equipment assessment/inspection criteria prior to site mobilisation. The key Principal's equipment assessment/inspection criteria is listed below:

- plant is required to be in good safe working order
- plant is required to have a good service history
- plant is required to be fit for purpose
- plant is required to have suitable noise attenuation when working in urban environments to ensure compliance with the *Environmental Protection Regulation 2019* and *Environmental Protection (Noise) Policy 2019* is achieved (refer to Pr9825 - Specification for Shafts).

The Contractor's management plans must detail a system for daily checking and resolving of issues with the supplied plant and equipment. The Contractor must supply key critical spares to ensure that the all equipment achieves a 90% working availability target.

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4.5.1 Microtunnel Boring Machine (MTBM)

The MTBM and ancillary equipment must be suitable for all local conditions, geological and hydrogeological conditions expected.

The design and selection of the MTBM and ancillary equipment is the sole responsibility of the Contractor.

The MTBM shall be robust with adequate safety margins for the anticipated duty, designed and manufactured to comply with all relevant safety standards and legislation.

The external diameter of the machine shall be designed to produce minimum overcut and the necessary clearance between the outside of the jacking pipe and excavated ground.

The overcut of the tunnelling shield shall not exceed 30 mm or more than 2% of the pipe OD (whichever is smaller).

The Contractor shall ensure the leading edge of the jacking pipe is protected when connected to the MTBM.

Wherever possible hydraulic piping shall be of rigid metal tubing, the use of flexible hose shall be kept to a minimum.

Hydraulic equipment shall be designed to operate at up to twice the working pressure.

Arrangement for extraction, transport and disposal of spoil shall be appropriate for the material to be handled.

All operating functions of the MTBM, including rate of advancement, shall be in the control or direction of the MTBM operator.

The MTBM and/or procedures must be capable of withstanding unexpected water ingress at the face to ensure face stability.

4.5.2 Microtunnel Boring Machine Characteristics

The preferred methodology is a sealed tunnelling system with the ability to balance the earth/water pressure at the face with the use of compressed air, tunnelling conditioning agents or slurry.

Control shall be such that the pressure can be adjusted to suit changing face conditions and can be maintained at all times within 10 % of the required pressure.

The Contractor is responsible for selecting the suitable cutter head, tools and tunnelling conditioning agents for the anticipated geological conditions.

The jacking wall and jacking frame shall be designed to take the additional forces required to propel the MTBM forward with the face pressurised.

Tail seals shall be designed to withstand the maximum hydrostatic pressure at the tunnel invert, plus additional pressure from propulsion and slurry, with an adequate safety margin. The tail seals shall prevent ingress of water, slurry and other materials into the finished lining.

The MTBM as a minimum is to be fitted with the following instruments and controls:

- face pressure gauges
- cutter head rotation speed, direction, torque and thrust gauges
- slurry flows and pressure gauges (slurry machine)
- screw rotational speeds and pressure drops (earth pressure balance)

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- electrical power
- advance rates
- a means of measuring and recording the volume of material excavated per pipe
- cutter head door aperture status (where fitted).

Any deviations from the aforementioned machine requirements will need to be approved by the Principal.

4.5.3 Jacks

Each set of jacks in the launch pit shall be fitted with suitably calibrated pressure gauges in good working order and such that actual jacking forces can be read at any time during the jacking operation.

The load from one ram or combination of rams shall be limited to avoid damage to the lead pipe. The jacking load shall be transferred to the jacking pipe through a jacking ring, which shall be sufficiently rigid to ensure even distribution of the load.

The jacks are to measure jack thrust pressures, stroke position and stroke speed.

4.5.4 Separation Plant

The Contractor shall design an appropriate slurry recycling system capable of:

- handling the volume rates, types and quantities of materials anticipated
- balancing the removal of solids from suspension with slurry MTBM advance rate
- re-circulating the processed slurry and providing means of re-conditioning and replacing lost slurry as required
- increasing slurry density to counter slurry loss and to prevent face collapse.

The Contractor's separation plant shall adopt one or more of the following systems to adequately reuse the slurry:

- coarse screen shaker (+440 microns)
- desander (+100 microns)
- fine screen shaker (44-74 microns or larger)
- mud cleaner (44-77 microns or larger)
- desilters (15 microns or larger)
- centrifuge (4-8 microns and smaller).

An alternative to a separation system that may be employed by the Contractor is a series of weirs and storage tanks which enable the excavated solids to sink to the bottom of the tanks. These tanks then need to be cleaned for disposal at the approved facility.

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4.5.5 Slurry Feed and Discharge Lines

The Contractor is required to design slurry lines, valves and pumps to resist abrasion to the fullest extent practical from the available ground condition. This shall include:

- intermediate pumps along each tunnel reach which shall be sufficient to provide slurry flow rate and pressure needed for required Active Support Pressure
- intermediate pumps on the slurry discharge line to enable the removal of cuttings at minimal face support pressure
- slurry discharge compatible with the anticipated maximum MTBM advance rate and length or tunnel
- a minimum of two abrasion resistant pressure sensors along the slurry charge (feed) line and two additional abrasion resistant pressure sensors along the slurry discharge line. Sensors shall be capable of being replaced under operating conditions.

4.6 Materials

Permanent materials are to fully comply with this specification and the documents referenced herein. The Contractor shall prepare and submit supplier's certificates for all permanent materials to be included in the works.

4.6.1 Jacking Pipe

Table 6 and Table 7 below describe the typical uses of jacking pipe in the water industry.

Table 6 – Jacking pipe type and usage

Type	Casing/Carrier Pipe	Permanent Uses (usually gravity)
GRP (Glass Reinforced Plastic)	Casing or Carrier Pipe	Storm Water/Trunk Main/Sewer
Steel	Casing Pipe	N/A
Concrete	Casing or Carrier Pipe	Storm Water/Trunk Main
Polymer	Casing or Carrier Pipe	Storm Water/Trunk Main/Sewer
HDPE Lined Concrete	Casing or Carrier Pipe	Storm Water/Trunk Main/Sewer
Vitrified Clay	Casing or Carrier Pipe	Storm Water/Trunk Main/Sewer

The Contractor is to source and use jacking pipe to the appropriate standard as outlined in Table 7 below.

Table 7 – Jacking Pipe Standards

Type	Standard
GRP (Glass Reinforced Plastic)	DIN 16869 & DIN 19565
Steel	To achieve temporary works loadings
Concrete	AS / NZS 4058
Polymer Concrete	DIN 54815-1 & DIN EN14636-1
HDPE Lined Concrete	AS / NZS 4058
Vitrified Clay	EN 295

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For tunnels 900mm in diameter or greater, lubrication ports are required every 15 m. The lubrication ports are to be spaced evenly around the jacking pipe circumference at 120 degrees and be complete with a sealed one way valve.

The Contractor shall appropriately choose a jacking pipe jointing and packer system to suit the pipe's purpose and the tunnel alignment (allowable joint deflection). The Contractor shall handle the jacking pipe as per the corresponding specifications and manufacturers guidelines.

4.6.2 Intermediate Jacking Stations

Under certain circumstances it may be necessary to provide one or more intermediate jacking stations within a single jacked length between the launch and reception pits. Such a station shall consist of a pair of modified jacking pipes.

In order to protect and form the joint between these pipes, the Contractor shall provide fit for purpose cylindrical steel sleeves of suitable wall thickness and of such a length that they overlap the pipes for a distance of at least 150 mm on either side of the joint. The design of the sleeves shall be RPEQ certified.

The intermediate jacking station must be complete with seals to prevent ingress of pressurised ground and water.

Intermediate jacking pipes are fitted out from within the tunnel and therefore are only used in tunnel diameters of 900 mm or greater.

The Contractor is to allow an Intermediate Jacking Stations every 100 m of the drive length, unless justified and approved by the Superintendent's Representative.

4.6.3 Microtunnelling Consumables

The Contractor shall use materials in a safe and responsible manner. All materials used in the microtunnelling operation are to be approved by the Superintendent's Representative.

The Contractor shall ensure that chemicals and hydrocarbons are used according to Unitywater's accepted environmental practices complete with control measures to mitigate risk.

The Contractor shall ensure that the tunnelling fluids and chemicals that have the potential to come into contact with the ground are biodegradable, safe to water bodies and fire resistant.



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5 Project Execution

The Contractor shall maintain control of site operations at all times.

5.1 Site Setup

The Contractor is to set the launch and reception sites up in accordance with the approved site layout drawing which as a minimum must cover the following key aspects:

- perimeter fencing in the allowed location
- site topsoil stockpile complete with erosion and sediment control
- entry and exit points
- pedestrian walkways and appropriate exclusion zones around cranes or moving plant
- equipment locations and movement zones
- any underground or overhead power lines and the appropriate exclusion zone
- shaft/pit location
- traffic guidance systems.

5.2 Existing Services

- The Contractor shall note the presence of overhead and underground services on the works site. Special care shall be taken in the vicinity of electricity services.
- The locations of some underground services are indicated on the drawings and are based on information supplied by the respective Authorities where such information is available.
- It is emphasised that information supplied regarding these services is tentative only with respect to both details of services shown and the existence of other services not shown.
- Neither the Principal nor the Superintendent warrant the completeness or accuracy of the information given and the Contractor is required to make enquiries into the presence and location of underground services with the relevant Authorities.
- The attention of the Contractor is drawn to the fact that private underground and overhead services and individual services to premises from public utility mains are not shown on the drawings.
- The Contractor shall verify the position of each underground service before commencement of excavation. The Contractor shall pre-locate the services as to depth, alignment and extent or size, so as to ensure such services are not adversely affected. Hand excavation may be necessary to close proximity to services until the exact location is determined.
- Trenches containing underground services shall be backfilled so that the subgrade is restored as nearly as possible to its original state of compaction.
 - Where selected backfill has been placed by other utilities and has had to be removed, it shall be replaced by the same type of selected material.
 - All backfill shall be carefully deposited in the trench and around the utility service in layers and adequately compacted by proper hand rammers and tampers or by use of effective mechanical equipment.

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- Extra care shall be taken by the Contractor to re-compact excavations near existing underground pipework, so that foundations of that pipework are restored and more especially when re-compacting in the vicinity of low flexibility pipework.
- The Contractor shall be held responsible for any damage caused to existing overhead or underground services.
 - In case of failure or damage, the Contractor shall immediately notify the relevant service provider and arrange for repairs to be undertaken.
 - If there is any delay, the Superintendent will arrange for repairs to be carried out by the Principal or others and the full cost of such repairs shall be borne by the Contractor.
 - If, in the opinion of the Superintendent, the failure or damage causes an emergency situation, then remedial action will be taken by the Principal and the full cost of such action shall be borne by the Contractor.
- Only those persons qualified to undertake repairs on the relevant services shall be permitted to perform the work with the prior approval of the service authority.
- Where it is necessary to carry out alterations to existing overhead or underground services, this work will be arranged by the Contractor unless otherwise specified.
- The Contractor shall allow to co-ordinate and work around service authorities where relocations are necessary during the Contract.
- The Contractor shall promptly advise the Superintendent of any services affecting the works which were not shown on drawings so that appropriate action can be taken.

5.3 Dilapidation Reports

The Contractor is responsible for all pre-construction and post-construction property assessments. These assessments shall be a means of determining whether and to what extent, damage has resulted from the Contractor's operations during the Works. Any damage identified shall be made good at the Contractors expense.

As a minimum the dilapidation reports shall capture:

- all work sites and any surrounding area likely to be impacted by the construction activities, including heavy vehicle traffic
- a minimum distance of 3 x the depth of any shaft measured radially from its perimeter
- a minimum distance of 2 x the depth to invert level measured from the centreline of any pipe installed by trenchless methods
- any area within the settlement trough or zone of influence as defined by the Contractors prediction of ground settlement
- the report must capture the condition of all aspects of the natural and built environment within the nominated areas, including but not limited to inside buildings, public utilities and plant, roadways and landscaping.

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5.4 Monitoring and Reporting

During the microtunnelling works the Contractor is to provide records as listed in Table 8 below.

Table 8 – Microtunnelling/Pipe Jacking Record/Report

Microtunnelling Record/Report	Details
Shaft and tunnelling records	Daily
Geological records	Daily
Ground support records (if applicable)	Daily
Tunnelling data – jacking pressures, rotation pressure, slurry flow rates, rotation velocity, line, level, advance rates, shove pressures and earth pressures.	Daily
Quantities of consumables used	Weekly
Plant used	Weekly
Labour used	Weekly
Materials used	Weekly
Gas monitoring details	Daily and immediately if there is a problem
Environmental details (water treatment, noise, dust and sediment controls)	Weekly and immediately if there is a problem
The diameter and type of pipe and pipe joints used	Weekly
Individual pipe identification by location	Weekly
Delivered jacking pipe dimension and damage checks	Weekly

5.4.1 Surface Settlement

The Contractor shall provide information on the permissible subsidence or heave at the ground surface, considering the use of the area, structures and systems in the sphere of influence of the microtunnelling project and taking into consideration the subsoil and groundwater conditions and the depth of cover.

5.5 General Earthworks

General earthworks requirements shall conform to the requirements of Unitywater's Specification for Civil and Earth Works (Pr9902).

5.6 Microtunnelling

5.6.1 Construction of Entry and Exit Seals

The Contractor shall install entry and exit seals on the launch and reception walls for the launch and reception of the machine. These seals shall be designed to withstand hydrostatic and slurry pressures during the launch and reception, throughout the tunnelling operations and once the tunnelling has been completed.

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5.6.2 Microtunnelling Set-up

The Contractor is to verify that the jacking cradle and MTBM are set online, grade and level prior to launching the machine.

5.6.3 Microtunnelling

During microtunnelling the Contractor shall ensure that the following conditions are met:

- jacking forces are within the allowable loads accepted by the jacking pipe manufacturer and the design checks of this specification
- the jacking pipe joint deflections are within the allowable angles stipulated by the jacking pipe manufacturer
- tunnel and MTBM access is conducted as per the documentation, specifications and standards
- the tunnel excavation does not exceed an acceptable ground loss percentage in line with calculations
- the tunnel and MTBM follows the designed alignment within the tolerances specified in Section 5.6.6 below
- the tunnel only commences when there is adequate jacking pipe available
- the Contractor will conduct the microtunnelling operation according to the Guide to Best Practice for the Installation of Pipe Jacks and Microtunnels published by the Pipe Jacking Association (UK).

5.6.4 Lubrication

Should outer annulus lubrication of the pipe be shown to be required in the thrust calculations, pipe lubrication shall be carried out by injecting a suitable, pressurised lubricant through preformed holes in the jacking pipe or at the cutting edge of the microtunnel boring machine.

Drilling fluids used shall be biodegradable.

Outer annulus lubrication is only employed when man access is possible. It is preferred that the lubrication system employed is automatic and it operates to a set volume or set pressure.

5.6.5 Tunnelling Guidance

The MTBM shall have an appropriate guidance and steering system to ensure the alignment is achieved to the design requirements and acceptable tolerances as detailed in Table 11 below. The tunnelling guidance system shall provide the following information at a minimum frequency of two second intervals:

- MTBM distance from the launch shaft/pit
- MTBM roll
- MTBM inclination
- MTBM attitude across the articulated section of the machine.

Details of the proposed guidance and steering system shall be forwarded to the Superintendent's Representative, for approval, prior to works commencing.



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There are typically three MTBM guidance systems to choose from in the survey of a microtunnelling operation. These guidance systems and the criteria that the Contractor is to choose the appropriate system as described in Table 9 below.

Table 9 – MTBM Guidance System

Drawing Details	Drive Length	Drive Type	Minimum Tunnel Diameter	Survey Technique	Requires Man Access
Laser Target System	< 200m	Straight	Any	Conventional	No
Theodolite based Survey System	> 200m	Straight or Curved	900mm	Conventional	Yes
MTBM Gyro System	> 200m	Straight or Curved	900mm*	Non-Conventional	Yes

* Curved microtunnels of diameter <900mm may be possible using a gyro based system however recommendations for alignment design and equipment selection should be sought from specialist trenchless engineers.

The accurate survey and guidance of the MTBM and the tunnel is paramount to the success and end use of the tunnel. The Contractor is to employ experienced tunnel surveyors to ensure the best results. The Contractor shall employ a tunnel survey audit as described in the Table 10 below.

Table 10 – Microtunnelling Survey Audit Requirements

Microtunnelling Survey Conditions		Audit Requirements		
Tunnel Length	Man Access	Survey Technique	Audit Type	Frequency & Location
< 200m	No	Conventional	Surface and Pit Checks of Survey Control	1 mid drive
< 200m	Yes	Conventional	Surface, Tunnel and Pit Checks of Survey Control	1 mid drive
200 – 400m	Yes*	Non-Conventional	Gyro Campaign	1 between 100-120m of drive start
> 400m	Yes*	Non-Conventional	Gyro Campaign	1 between 120-170m of drive start and 100m from finish of drive

* For tunnels with man access, but insufficient space for a successful gyro campaign to audit the TBM guidance (typical diameters 900mm to 1500mm) then the Contractor shall document within the Survey and Guidance Management Plan a method for maintaining and auditing the accuracy of the TBM based guidance system.

Construction control points shall be established sufficiently far away from the work so as not to be affected by ground movement caused by the construction operations. Such control points shall be checked regularly against permanent benchmarks to ensure the accuracy of the tunnelling is not compromised by ground movement.



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5.6.6 Alignment Tolerances

- The location of the MTBM shall be checked and recorded at least twice per installed pipe and the position recorded against the design grade on the tunnelling shift report. This information shall be provided to the Superintendent's Representative on a daily basis.
- Where the microtunnel is found to be out of alignment based upon the tolerances tabulated below, excavation is to stop immediately. The excavation shall not recommence until directed by the Superintendent's Representative.
- The Contractor is responsible for all corrective works and associated costs needed to correct the alignment of the proposed tunnel.
- Under no circumstances shall the Contractor take corrective action without the approval of the Superintendent's Representative. The jacked pipe shall be installed in conformance with the horizontal and vertical alignment as shown on the drawings subject to the allowable construction tolerances as listed in Table 11 below unless otherwise detailed in the Project Job Specification.

Table 11 – Allowable Construction Tolerance

Activity	Limits / Tolerance	Comments
Horizontal	± 50 mm	N / A
Vertical	± 30 mm	N / A
Tunnel grade	± 0.25%	No back fall and no ponding

5.6.7 Spoil Removal and Separation

- The excavation of cut ground and disposal arrangements shall be capable of dealing with the full range of materials expected. Generally, the disposal system shall accommodate material produced by the MTBM.
- The Contractor shall ensure that the spoil removal system does not become clogged, jammed or damaged by materials delivered from the tunnelling operation.
- Approval by the Superintendent's Representative must be sought if the Contractor doesn't propose to use a separation plant.
- The disposal of the excavated material in solid or liquid form is the responsibility of the Contractor.
- The Contractor shall be aware of any contamination present, including Acid Sulphate Soils, and have in place the appropriate testing, handling, treatment and disposal procedures.

5.6.8 Pipe Damage

- The Contractor shall stop all work, notify the Superintendent's Representative, and investigate the damage when there is any indication that the installed pipe has sustained damage.
- The Superintendent's Representative will within 72 hours approve or determine if the pipe installation is not in compliance with the specifications.

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5.6.9 Interventions

Man access to the tunnel and MTBM can be summarised into two cases: under normal atmospheric conditions and under compressed air conditions.

In normal atmospheric conditions, the Contractor is to access the tunnel according to the *Confined Space Code of Practice* (2021) Workplace Health and Safety Queensland, Queensland Government.

When compressed air access is required the Contractor is to adhere to AS 4774 *Work in Compressed Air and Hyperbaric Facilities*.

5.6.10 Outer Annulus Grouting

Outer annulus grouting is undertaken to ensure a uniform contact between the casing pipe and the excavated ground and to prevent the surrounding ground settling over time to fill the void. In conjunction with the Principal, the Contractor shall determine whether annulus grouting is required. In determining if grouting is required the following elements must be assessed:

- surface settlement
- pipe buckling from ground and hydrostatic loads
- drill path erosion and drainage
- resistivity
- heat transfer
- permanent operation.

If outer annulus grouting is deemed necessary then grout used shall reach a minimum strength of 1Mpa at 48hrs. Previous performance of the grout mix design shall be demonstrated to the Superintendent's Representative before use.

The Contractor shall install the outer annulus grouting until one of the following conditions is met:

- the installed grout volume has equalled the theoretical annulus volume between grout ports (15m)
- the installed grout pressure exceeds the theoretical hydrostatic ground pressure plus 0.5 bar, and
- the installed grout is visible at the next inbye open crown (or upper) grout ports.

A secondary examination should be undertaken to prove that grout surrounds the pipe (a selection of crown (or upper) grout ports are opened and inspected for grout). This would ordinarily be performed by the Superintendent's Representative.

5.6.11 Carrier Pipe Installation

Upon completion of the tunnelling works, the Contractor shall undertake carrier pipe installation as a separate operation where required.

Generally, the Contractor shall install the pipes in pretested lengths utilising an excavator, crane or other suitable lifting equipment. The carrier pipe shall be centralised in the bore using casing spacers at a minimum of 1.5 m intervals or as specified by the manufacturer to support the weight of the pipe.

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Pipe installation shall be generally carried out using the following procedures:

- pit/shaft made safe either using shoring box, structural support or by benching and battering
- ensure suitable area is available for trench and pipe string
- suitable length trench to be excavated on line and level required for installation of pipe
- pipe launch cradle to be installed in the pit to assist in pipe alignment
- site specific lift plan to be developed prior to pipe installation commencing
- pipe to be lifted into trench using suitably sized equipment
- casing spacers to be installed onto carrier pipe at manufacturer recommended spacing
- pipe to be loaded into casing pipe using suitably sized equipment
- the pipe is to be tested and accepted in line with Section 6 - Testing and Commissioning prior to grouting the carrier pipe in place.

5.6.12 Grouting of Carrier Pipe Annulus

Once the carrier pipe is installed, centred and tested, the Contractor shall grout the inner annulus of the casing pipe.

- The grout shall be an approved minimum 1 MPa mix which has been submitted to the Superintendent for approval. The mix shall have historical laboratory testing to confirm its suitability. The product choice must consider:
 - heat of hydration
 - potential environmental effects (e.g. aquifers, polymer vs. cementitious, hydrophilic), and
 - likelihood of fracture.
- The gap between the casing pipe and the carrier shall be sealed at each end of the casing pipe.
- A breather pipe shall be installed at each end with the end of the breather pipes at least 1 m above the lowest obvert of the pipe.
- Grouting shall commence from the downhill end of the pipe.
- Grout shall be added into the void, under gravity pressure or by pump, through the pipe until grout is visible and bleed water is expelled from the breather pipe at the upper end.
- The quantity of injected grout shall be recorded on a concrete pour card and that quantity shall be compared to the calculated theoretical volume. Discrepancies shall be recorded in the project completion documentation (refer to section 8).

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5.6.13 Settlement Monitoring

The Contractor shall monitor the effects of tunnelling construction at the surface, including all ground movements and the effects on all structures influenced by the works under the Contract.

The survey shall be carried out by a surveyor in accordance with the Settlement Monitoring Plan (requested in Section 3.3).

The tunnelling method shall be suitable for achieving limited movement at the surface directly above the tunnel alignment. Surface movement either up or down should not exceed 5mm beneath existing services including roads and 10 mm beneath undeveloped land unless otherwise specified in the Project Job Specification.

The Contractor shall be fully responsible for any damage to nearby structures; equipment or infrastructure resulting from the tunnelling works and shall take all reasonable steps to ensure that such damage does not occur.

Daily movement monitoring shall include as a minimum the following components:

- Installation of monitoring points along and perpendicular to the tunnel alignment:
 - each set of surveying points shall have one point located on the centre line and 2 either side at an offset distance of 5m and 10m from the centre line
 - the survey points shall be at intervals along the centreline of maximum 30m to monitor and interpret actual movements.
- Movement monitoring shall be undertaken daily within a plan distance of 30m (each way) of the tunnel face whilst the tunnel is advancing, unless specified otherwise by the tunnel designer.
- In the event that instability of the surface is observed (a breach of the 5mm / 10mm thresholds), advancement of the pipe tunnelling operation shall be suspended and the Superintendent's Representative shall be immediately informed.
- Monitoring shall be referenced to stable survey stations located outside the zone of influence of the works and not subject to ground movement.

When passing under road or rail the Contractor will need to conform to the relevant authority's settlement requirements.

6 Testing and Commissioning

6.1 Hydrostatic Testing

The Contractor is required to conduct the hydrostatic test of each carrier pipe within the works under the Contract **prior** to grouting operations taking place.

The Contractor shall engage a NATA accredited testing authority to conduct the hydrostatic testing.

The test must conform to the relevant Unitywater specification, either the Specification for Pressure Pipe Construction (Pr9904) or the Specification for Non-Pressure Pipeline Construction (Pr9875).

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6.2 Leakage Testing

For specific leakage testing requirements refer to the requirements identified in the specific Scope of Works. This may include vacuum testing.

6.3 Chlorination

When chlorination testing is required, the test shall be undertaken in accordance with Unitywater's Procedure for the Determination of Acceptance of New Mains (Pr9032)

7 Project Completion and Handover

Throughout the construction of the project the Contractor shall complete and submit all records mentioned in the above sections of this document. In addition to these documents the Contractor shall submit the as-built package in hard copy and electronic format.

The Contractor shall keep records of all trenchless operations, and all such data as directed by the Superintendent. These records will form part of the As-Constructed data. As-Constructed information shall be prepared in accordance with the SEQ WS&S D&C Code – Asset Information Specification.

All records are to be approved by the Superintendent and submitted in accordance with Unitywater specifications listed within the contract documentation.

7.1 Documentation Submittals

The Contractor shall liaise closely with the Superintendent during the documentation of survey work and shall provide the Superintendent with adequate opportunity to verify any measurement or detail the Contractor considers necessary prior to the commencement of reinstatement operations.

7.2 Post-Construction Dilapidation Report

The Contractor is responsible for all pre-construction and post-construction property assessments. These assessments shall be a means of determining whether, and to what extent, damage has resulted from the Contractor's operations during the Works.

8 Typical Microtunnelling Inspection and Test Plan (ITP)

The Contractor shall prepare and submit for approval by the Principal at least four (4) weeks prior to the commencement of microtunnelling works, an Inspection and Test Plan (ITP) for the works in accordance with the requirements of the relevant specifications.

Below details the typical activities that trigger a visual inspection, witness point verification or hold point release. This list is to be used as a minimum guide for the Contractor to develop their ITP. The Contractor must provide the Principal at least 8 hrs notice of a required visual inspection, witness point verification or hold point release.

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Table 12 - Inspection and Test Plan

Project Elements	Activity	Contractor Responsibilities			Principal Responsibilities		
		Visual	Witness	Hold	Visual	Witness	Hold
Project Documentation	Company HSEQ System	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	Project Safety Plan	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	Project Environmental Plan	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	Project Quality Plan	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	Dilapidation reports (pre- and post-construction)	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	Site Establishment Plan	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	Settlement Plan	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	Tunnelling Procedure	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	Pipe Installation Procedure	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	Grouting Procedure	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	Lift Plans (MTBM, pipes)	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	Commissioning Procedure	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Design Documentation	Crane Pad	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	Pit/Shaft	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	Jacking Frame/Thrust Wall	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	MTBM (airlock, head)	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	Settlement Calculations	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Project Execution	Site Set Up To Plan	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Crane Pad Installation To Design	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Shaft Mark Out To Design	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Shaft Built To Design	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
	Jacking Pipe Built To Design	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	Jacking Frame And Jacking Wall Block Set Out	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
	MTBM Entry Seal Built To Design	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
	Settlement Monitoring and Review	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>

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Project Elements	Activity	Contractor Responsibilities			Principal Responsibilities		
		Visual	Witness	Hold	Visual	Witness	Hold
	MTBM Commissioning (Mechanical, electrical and hydraulics)	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
	MTBM and Lead Pipe Alignment Checks	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	Jack Commissioning	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
	MTBM Guidance Calibration and Commissioning	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
	MTBM Overcut Checks	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
	Ongoing Jacking Pipe Checks (Damage, joints and packing)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Ongoing Jacking Forces	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Ongoing Face Loss Control	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Ongoing MTBM Alignment Checks	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Ongoing Tunnel Survey Audit	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	MTBM Exit Seal Built To Design	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
	Annulus Grouting Checks	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
	Tunnel Clean	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Commissioning and Hand Over	Hydrostatic Testing - if required (NATA)	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	Leakage Testing - if required (NATA)	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	CCTV Inspection - if required	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	Red Line Drawing	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	As Constructed Survey	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	Submission of all Project Records/SEQ WS&S D&C Handover Deliverables	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

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Appendices

Refer to following pages.

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Appendix A – Definitions, Acronyms Abbreviations

The following definitions, abbreviations and acronyms are used throughout this specification.

Definitions

Term	Definition
Act	The <i>Work Health and Safety Act 2011</i> (QLD)
Carrier Pipe	Permanent pipe installed inside a casing/enveloper pipe.
Casing Pipe	Installed using trenchless methods to provide initial support to the excavated bore, prior to installation of the carrier pipe. May also be installed to provide additional protection to the permanent carrier pipe.
Contract	The legally binding agreement between two or more parties for doing or not doing something specified.
Contractor	An organisation that is bound to carry out and complete the works under the Contract.
Contingency Plan	A plan to mitigate the risk of an activity. The plan usually allows for backup procedures, emergency response and post-disaster recovery.
Drawings	Drawings prepared by the Designer(s) for the purpose of illustrating the design requirements for the works under the Contract.
Designer	A professional engineer (RPEQ) who is appointed by the Contractor to carry out design and to issue instructions regarding standards, specifications and techniques to be observed in the construction of this project.
Design Documentation	Drawings, specifications and other design documentation (including design standards, design or durability reports and calculations) in computer readable and written forms prepared by the Designer for the purposes of the Trenchless works under the Contract.
Enveloper Pipe	Refer to “Casing Pipe”.
Geotechnical Baseline Report (GBR)	The GBR describes the ‘Ground Reference Conditions’ at the location (alignment as shown in the GBR) of the proposed alignment. The Baseline Conditions presented in GBR represent what is assumed to be encountered for the purpose of defining ‘indications of the Contract’. The provision of a baseline in the Contract is not a warranty that the baseline conditions will, in fact, be encountered. It is therefore not appropriate for the Principal or Contractor to conclude that baseline statements are warranties.
Geotechnical Data Report (GDR)	The GDR describes the factual ground conditions at the locations nominated in the GDR. Typically these are close to the proposed trenchless alignment. The conditions presented in the GDR represent what observed during field investigations by the suitably experienced geotechnical engineer engaged by the principal. The provision of this information is not a warranty that the conditions will, in fact, be encountered. It is therefore not appropriate for the Principal or Contractor to conclude that the geotechnical statements made are warranties.



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Term	Definition
Ground Loss	Ground loss is defined as the volume of material that has been excavated in excess of the theoretical design volume of excavation.
Gyro	A non-conventional surveying instrument used to determine the orientation of true north by locating the meridian direction.
Gyro Campaign	The use of a gyro instrument to determine the position of the MTBM and the alignment of the tunnel relative to true north.
Jacking Pipe	Pipe specifically designed and manufactured for the purpose of being jacked into its final position.
Launch pit or shaft	An excavation at the commencement point of a jacked section of pipeline, in which the jacking structure and other equipment is installed and from which the microtunnelling operations are carried out.
Lift (shaft / pit)	The incremental construction height completed as the shaft / pit progresses downward.
Microtunnelling	Method for installing an underground service pipe (pipeline) to a high accuracy using a microtunnel boring machine (MTBM) without disturbing the surface. The pipeline is installed behind the MTBM via a pipe jacking operation.
Open Shield System	A mechanised tunnelling system having no capacity to create a pressurised area forward of the machine for ground support or groundwater control.
Operator	Suitably trained or qualified person who operates machinery, an instrument or other equipment.
Permit	A document that controls an activity that is considered high and not able to be commenced without completing important requirements.
Pipe Jacking	Method for installing an underground service pipe by jacking to a high accuracy behind a microtunnel boring machine (MTBM) or open-shield system without disturbing the surface.
Principal	
Principal Drawings	Drawings issued to the Contractor forming part of the Contract. These drawings are owned by the Principal and are to be used to guide or govern the work under the contract.
Project Manager	A person nominated by the Contractor responsible for the construction of the contract.
Red Line Drawings	Original, as constructed drawings marked up in red detailing the as-built data.
Safe Work Method Statement	A document summarising the work required for an activity. This document summarises the hazards and the required measures to control and minimise safety risks.
Scope of Work	A document summarising the works to be completed under the Contract.

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Term	Definition
Specification	This document, that specifies, in a complete, verifiable manner, the requirements, design, behaviour, or other characteristics of a system, component, product, result, or service and, often, the procedures for determining whether these provisions have been satisfied.
Superintendent	An individual appointed by the Principal to perform two functions: Be the Principal's agent for the works under the Contract. Administer the Contract fairly and perform certain certifier requirements.
Superintendent's Representative	A person nominated by the Superintendent, to act on behalf of the Superintendent.
Trenchless Construction	Installation of new, or replacement of, underground infrastructure with minimal disruption to surface environment, traffic, business and other activities.

Abbreviations and Acronyms

Acronym	Description
ASTT	Australasian Society for Trenchless Technology
AS / NZS	Australian / New Zealand Standard
ASS	Acid Sulphate Soils
AS	Australian Standard
BYDA	Before You Dig Australia https://www.byda.com.au/
CCTV	Closed Circuit Television
GBR	Geotechnical Baseline Report
GDR	Geotechnical Data Report
GRP	Glass Reinforced Plastic
HDPE	High Density Polyethylene Pipe
ID	Inside Diameter
IFC	Issued for Construction
ISO	International Standards Organisation
ITP	Inspection and Test Plan
MTBM	Microtunnel Boring Machine
NATA	National Association of Testing Authorities
N/A	Not Applicable
OD	Outside Diameter
QA	Quality Assurance
RPEQ	Registered Professional Engineer Queensland

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Appendix B – References

General

All work carried out under this Specification shall comply in all aspects (i.e. in design, construction, testing and performance) with the latest relevant Australian (AS), British (BS) and IEC Standards and standards in the following sections.

Reference to specific clauses of the various codes is intended to highlight those points and shall not be taken to imply a lesser importance for all other applicable clauses.

All the works shall conform to the Rules and Regulations of the Statutory Authorities having jurisdiction over the Site.

If the requirements of this Specification do not comply with the minimum requirements of the statutory regulations and standards, the latter shall apply. If the requirements of this Specification are more exacting than the minimum requirements of the statutory regulations and standards, the former shall apply.

All Materials, fittings, accessories and equipment supplied by the Contractor shall be new and the best obtainable of their kind and shall comply in all respects with the requirements of the relevant Standards Australia specifications.

All works shall be completed in accordance with this Specification, the Job Specification and stated supplementary specifications.

The Contractor shall undertake their own assessment as to the type of material to be excavated and sub-surface conditions and shall allow for any dewatering, timber shuttering and shoring that may be required.

Unless otherwise specified, the equipment covered by this Specification shall be designed, manufactured, installed and tested in accordance with the following, listed in order of precedence:

- the Project Contract documents
- requirements of the Statutory Authorities having jurisdiction over all or part of the manufacture, installation or operation of the plant
- the SEQ WS&S D&C Code
- all relevant Australian and governing Queensland standards where applicable
- Water Services Australia (WSAA) national codes.

In the absence of relevant SEQ WS&S D&C Code, WSAA or Australian codes or standards, relevant industry, international (ISO), European or British standards shall be followed. International standards shall take precedence over European or British standards. The Contractor shall obtain approval from the Superintendent prior to using any non-Australian standards not nominated in the equipment specifications, schedules, datasheets or associated drawings.

Where local or international standards do not exist, the manufacture and installation of equipment shall be in full compliance with the manufacturer's own recognised standards. Manufacturer's standards, where used, shall be submitted to the Superintendent by the Contractor for review and acceptance shall be obtained by the Contractor from the Superintendent prior to commencement of manufacture.

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All equipment shall comply with relevant Federal and State Acts, Regulations and Codes including, but not necessarily limited to, the following:

- [Work Health and Safety Act 2011 \(Qld\)](#)
- [Work Health and Safety Regulation 2011 \(Qld\)](#)
- [Work Health and Safety Queensland Codes of Practice.](#)

The version of any applicable standard or regulation shall be the revision in place at the date of invitation of contract packages.

The Contractor shall have in place a dedicated quality system that conforms to ISO 9001.

Quality control procedures for management, inspection, review and evaluation of all materials, manufacture, workmanship and testing of all products shall be planned and implemented by appropriately skilled and qualified persons to ensure that requirements of the quality procedures are met and that high quality is maintained.

The Contractor shall ensure that all equipment supplied/installed under this Specification is the product of a manufacturer who is fully experienced, reputable, qualified and regularly engaged for at least five years in the manufacture of the equipment to be supplied/installed.

Applicable Legislation and Regulation

At least the following legislation and related regulation shall apply:

- [Work Health and Safety Act 2011 \(Qld\)](#)
- [Work Health and Safety Regulation 2011 \(Qld\)](#)
- [Water Supply \(Safety and Reliability\) Act 2008 \(Qld\)](#)
- [Environmental Protection Act 1994 \(Qld\)](#)
- [Queensland Building and Construction Commission Act 1991 \(Qld\)](#)
- [Professional Engineers Act 2002 \(Qld\).](#)

Codes of Practice (ratified by Legislation)

SEQ Water Supply and Sewerage Design and Construction Code

The requirements of the South East Queensland Water Supply and Sewerage Design and Construction Code (SEQ WS & S D & C Code) shall supersede the requirements of this specification where advised in the Job Specification. In this case the requirements of this specification shall only apply where no requirement is provided in the SEQ WS & S D & C Code.

If the Job Specification does not reference SEQ WS & S D & C Code, the requirements of SEQ WS & S D & C Code shall apply where no requirements are stated in this specification.

Other [Codes of Practice](#) that apply to works carried out under this Specifications are:

- Workplace Health and Safety Queensland Code of Practice, Managing noise and preventing hearing loss at work 2021
- Workplace Health and Safety Queensland, Confined Space Code of Practice 2021
- Workplace Health and Safety Queensland, Scaffolding Code of Practice 2021.

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Codes of Practice (not ratified by Legislation) and Industry Guidelines

The following Codes of Practice and industry guidelines apply to works carried out under this Specification:

- Safe Work Australia, Guide for Tunnelling Work (November 2013)
- Australasian Society for Trenchless Technology, Guidelines for Horizontal Directional Drilling, Pipe Bursting, Microtunnelling and Pipe Jacking (Rev 1, February 2010)
- Pipe Jacking Association (UK), Guide to Best Practice for the Installation of Pipe jacks and Microtunnels (1995).