Queen St WW Diversion – Part 3 Construction Methodology

1. Scope / Introduction

The purpose of this high-level methodology is to inform the planning and consent teams of how Fulton Hogan (FH) intends to construct the Queen Street Wastewater Diversion project – Part 3. This methodology will be supplemented by a separate tunnel works methodology written by McConnell Dowell who will undertake the tunnel sub-trade works (refer Appendix A).

The Part 3 portion of this project includes construction of approximately 595m of tunnelled 1229 OD pipeline, three shafts with manholes and other local network connections, including connecting into the live Orakei Main Sewer (refer yellow line on Figure 1 below for Part 3 extents).

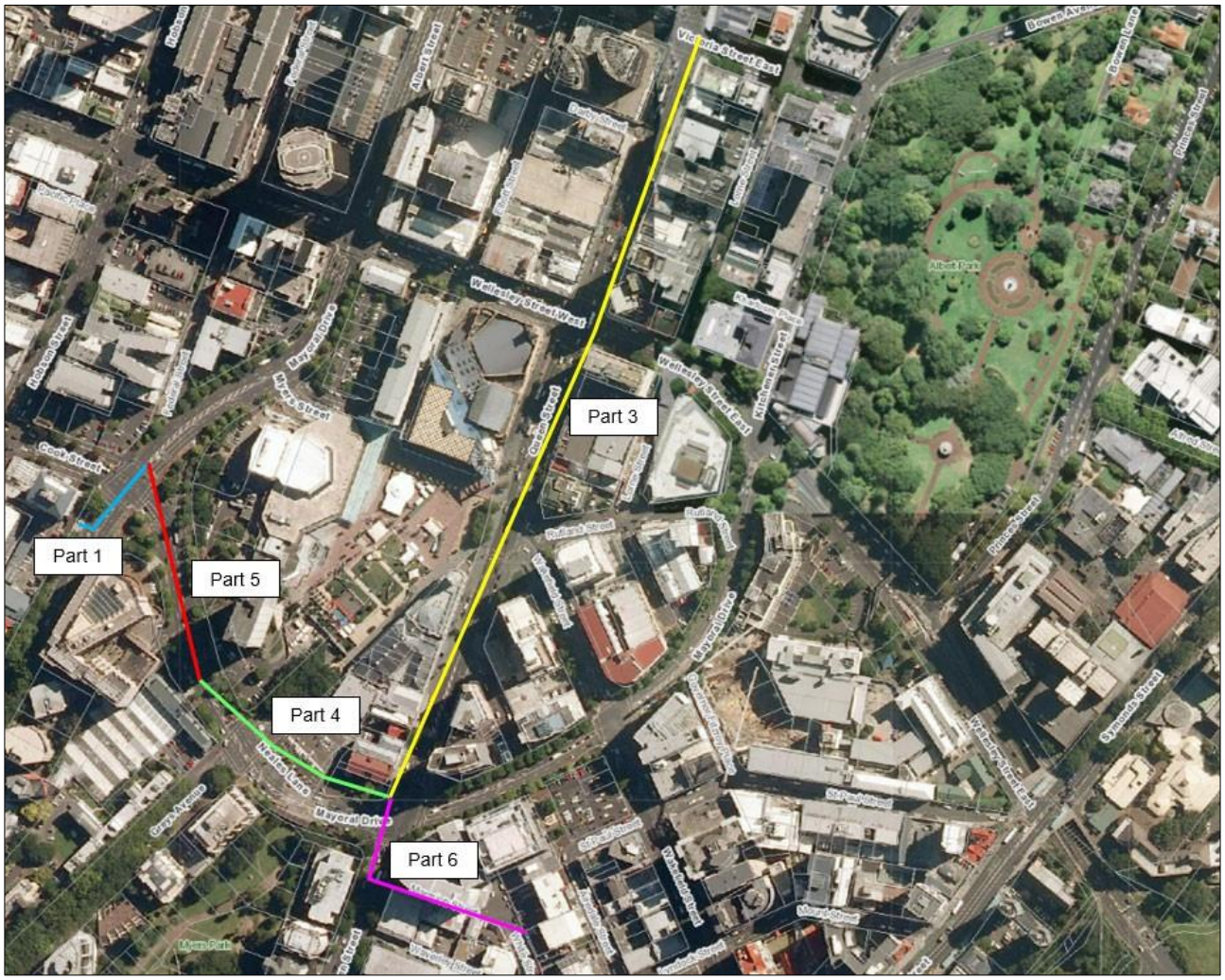

Figure 1: Part 3 Works Site Plan

This document covers the general sequencing and methodology for the construction of temporary shafts, pipelines, connections, manholes and associated works. It should be reviewed in conjunction with the FH tender construction programme.

2. Site Location, Working Areas and General

- The site office will be located at 48 Greys Ave within rented office space.

- Welfare facilities will be located in the Greys Avenue Car Park.
- Traffic management will be setup in advance of compound construction ensuring all agreed vehicle, pedestrian and property access requirements are adhered too.
- Site compounds will be established at the location of the three temporary shafts (refer Figures 2, 3 & 4 below for details). Exact layouts are subject to final design, traffic impact assessments and TMP's.
- Temporary steel barriers with solid/temporary fence hoardings will be constructed around the perimeter of each compound, with access gates at one or both ends. All shaft construction works will be performed from within these three compounds.
- The local WW network connection pipework and manholes will be constructed within temporary pedestrian or ATF type fencing, with all excavations handrailed to prevent unauthorised entry.
- All excavated materials and construction materials (pipes, aggregates, etc) will be removed / delivered to the site on a "just in time basis" due to very limited stockpile space.
- General site working hours will be Monday-Saturday 7am-6pm. Sunday and night work will only be carried out if required by traffic management or Watercare operational restrictions such as for tie ins/connections to existing pipe work.

Figure 2: Site compound at Queen St / Victoria St intersection

Figure 3: Site compound at Queen St / Wellesley St intersection

Figure 4: Site compound at Queen St / Mayoral Drive intersection

3. Construction Methodologies

The proposed service relocations, OMS support, temporary shaft construction, OMS support, open cut pipe laying, network connections and manhole construction methodologies are outlined below.

3.1. Service Relocations

Several existing services are required to be relocated from above the three temporary shaft locations before excavations commence. The following services need to be relocated at Mayoral Drive; electrical, comms, ATBT and stormwater; a Watermain is to be relocated at Wellesley Street. These services will be selectively relocated as and when TMP approvals permit and in advance of mobilising for the main shafts and tunnel construction. It is likely that these services will be staged in short sections to minimise traffic disruptions. The works will generally include:

- Set up TTM with site fencing
- Hydro-excavation to confirm the new diversion route is clear of other unknown services
- Open trench excavation using excavators to lay new ducts or pipework and trench shields will be used for all trenches over 1.5m in depth
- Hand cable pulling through new duct work
- Cutover periods where new diversions will be livened and old routes decommissioned

3.2. Orakei Main Sewer (OMS)

Construction of the Queen St/Victoria St shaft will not only be used to extract the TBM, but also to allow connection into the OMS. The excavation above the OMS and unloading its arch shaped blockwork structure will be carefully managed and staged to prevent an un-zipping collapse or blockage to the live flows.

The OMS will also need to be relined, however these works are to be considered under a separate scope of works.

Either before or after the relining work is complete, we will cast the stage 1 concrete on the side of the existing OMS concrete, then core through the existing concrete with a 900mm diameter core. The shaft will flood to around 700mm deep, temporarily, until the stop plate is installed to stem the flow significantly. This water will then be pumped back into the OMS.

3.3. Shaft Construction at Queen St / Victoria St Intersection

Construction methodology for the temporary shaft construction is outlined in the steps listed below:

- The shaft extents (refer Figure 6 below) will be saw cut and a 5 - 20t excavator used to remove pavement layers and other shallow level obstructions including old concrete pavements, steel tram tracks and timber piles.
- A SR-45 piling rig will be used to bore 600mm dia holes to 10m deep. This technique will deal with rubbly basalt. If competent basalt is found, the SR45 will need to be swapped for a piece of plant that has a core barrel to attempt to cut the basalt.
- If ground conditions require, the bores may be temporarily cased with steel or plastic casings.
- Steel UC posts will be lowered into each bore using a 14 - 20t excavator and the bores backfilled partially with concrete from the auger, then topped up with sand.
- The shaft extents will be excavated using an 35t excavator and a 5t excavator to feed it. A skip bin may be required on a 35t crane to finish the last bit of the excavation.
- Shaft spoil will be removed from site using 6 or 8-wheeled trucks.
- Timber lagging will be cut to fit and installed between UC posts as the excavation progresses to retaining the surrounding ground.
- At least two steel waler beams will be installed and welded together within the shaft to support the UC posts.

- Dewatering will be required; a 2-inch submersible pump and hose will be used to remove water from excavations. The water will be pumped into clarifying tanks/containers for treatment, if required, before discharging to stormwater. Permits will be obtained to discharge the treated water. The pumps will be powered by a hybrid diesel generator which will run continuously while the trench is open, dependent on water ingress rates. Noise mitigation will be provided by the solid hoarding at the shaft.
- Forced air ventilation will be required using a fan at surface level with ventilation ducting into the shaft.
- It is expected that solid basalt will be found within this shaft at approximately 5.5m below road level.
- The basalt layer will be broken out using coring, cutting and rock splitting techniques to avoid generating vibration above 2.5mm/s at the Farmers Building.
- Broken basalt will be removed from the shaft using the 35t excavator.
- 4-6 unreinforced concrete piles will be required at the tunnel entry to enable breakthrough of the MTBM.

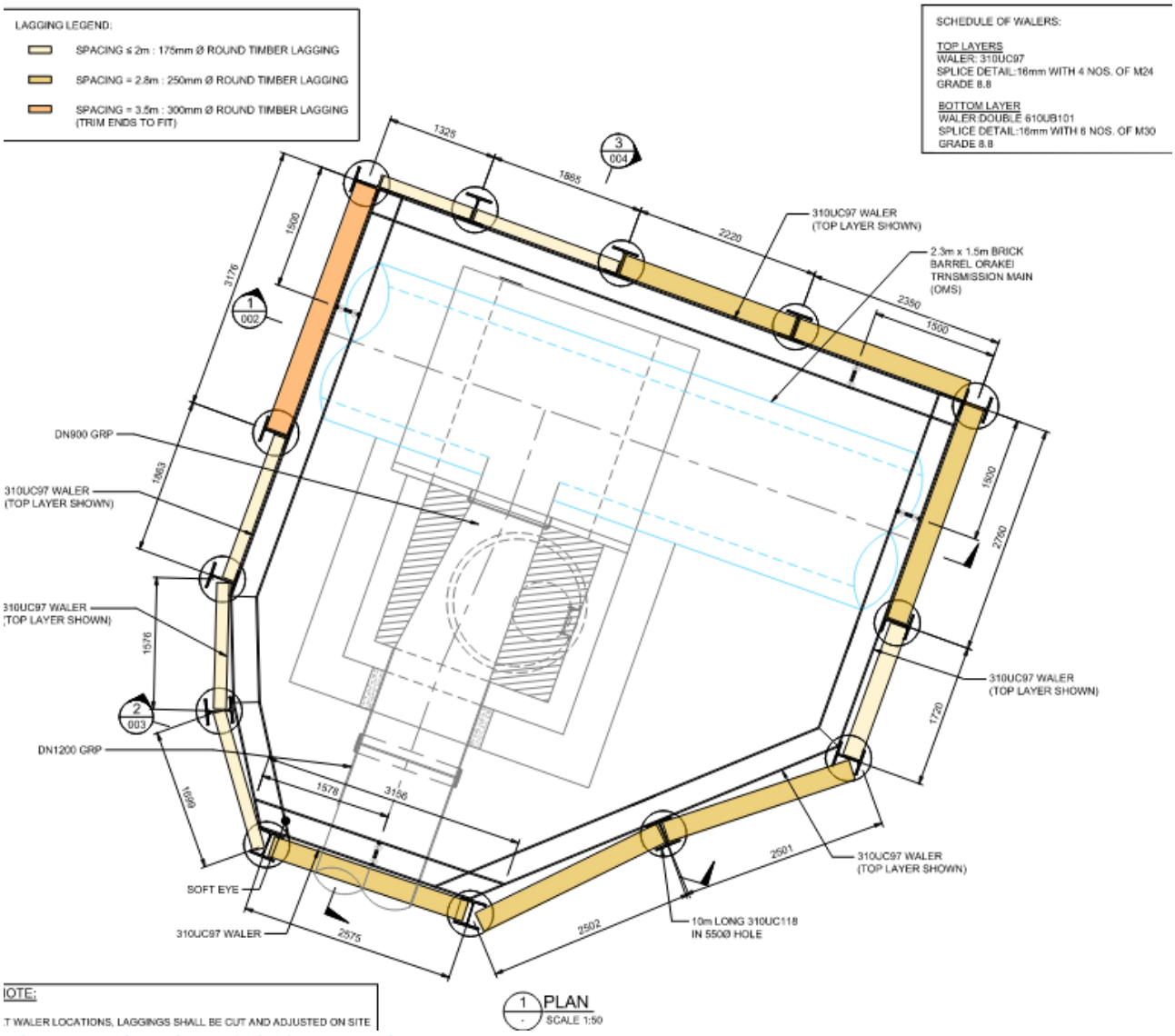

Figure 5: Plan view of shaft excavation

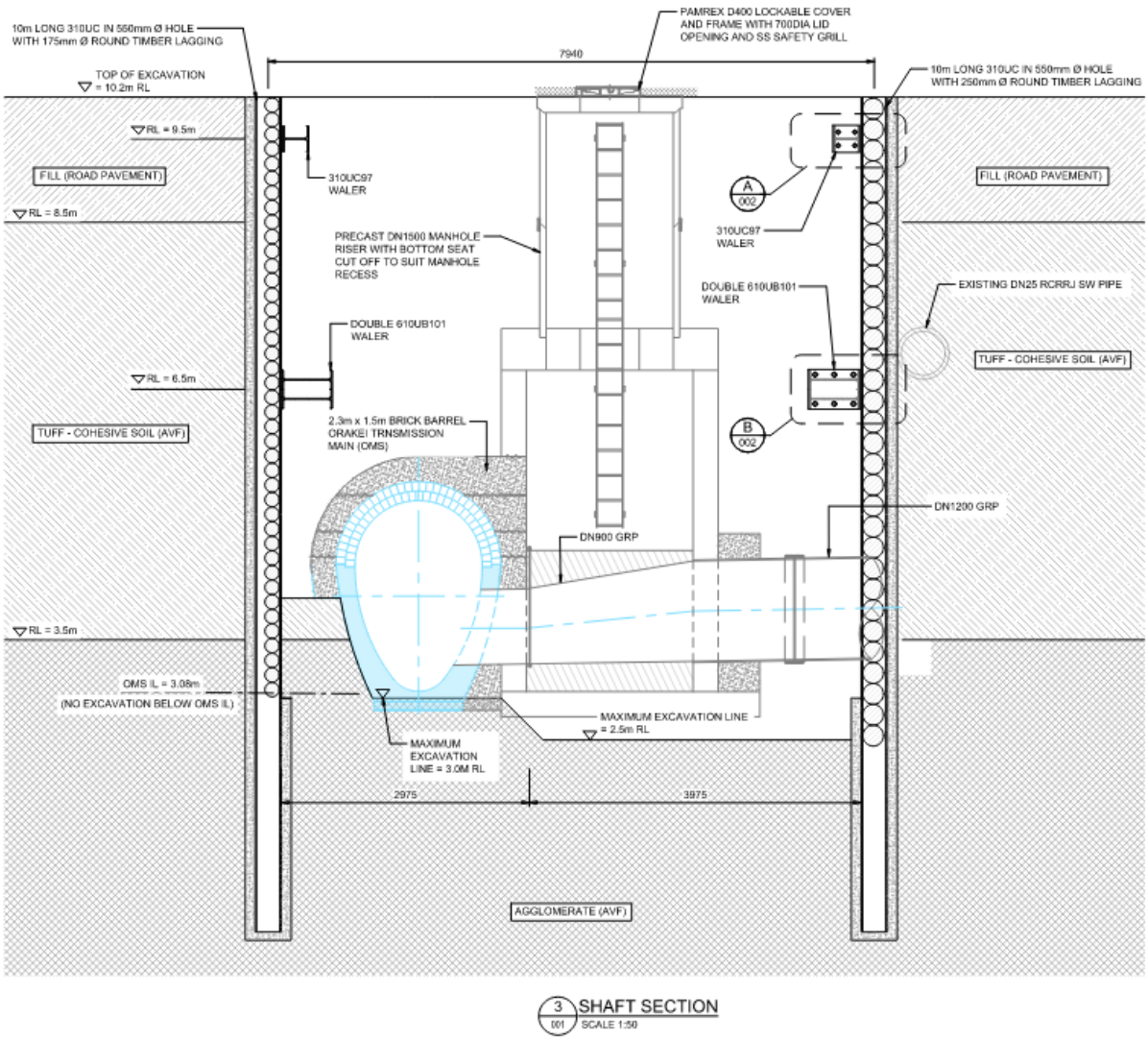

Figure 7: Section view of excavated shaft and exposed OMS

- The OMS connection collar will be formed and poured with concrete using a concrete skip and a 35t crane at road level or boom pump.
- A hole will be formed into the OMS using stitch coring and the opening will be temporarily plugged.
- After TBM extraction, a precast concrete manhole will be installed using a 90t mobile crane at road level.
- Precast concrete riser manhole sections will be installed using a 90t crane at road level.
- The shaft will be backfill with compacted GAP65 or low strength concrete using the 90t crane and skip.
- The temporary works will be progressively removed using a gas axe and 90t crane.
- Road pavements (GAP65 and AC) will be reinstated using a 14 – 20t excavator, 400kg plate compactor and static drum roller.

3.4. Shaft Construction at Queen St / Wellesley St Intersection

Construction methodology for the temporary shaft construction is outlined in the steps listed below:

- The shaft extents will be saw cut and a 20t excavator used to remove pavement layers and the cast iron watermain.
- A trench will need to be dug to remove the 4m deep redundant overflow pipe that runs across the shaft. This may need grouting to prevent pile integrity or stormwater contamination issues.
- A concrete guide beam will be formed a poured to assist with managing pile placement and verticality.
- 26No. unreinforced 600mm diameter secant piles will be installed to 14.4m deep.
- The shaft will be excavated using a clam shell excavator or drilled out using an SR45 drill rig.
- Shaft spoil will be removed from site using 6 or 8-wheeled trucks.

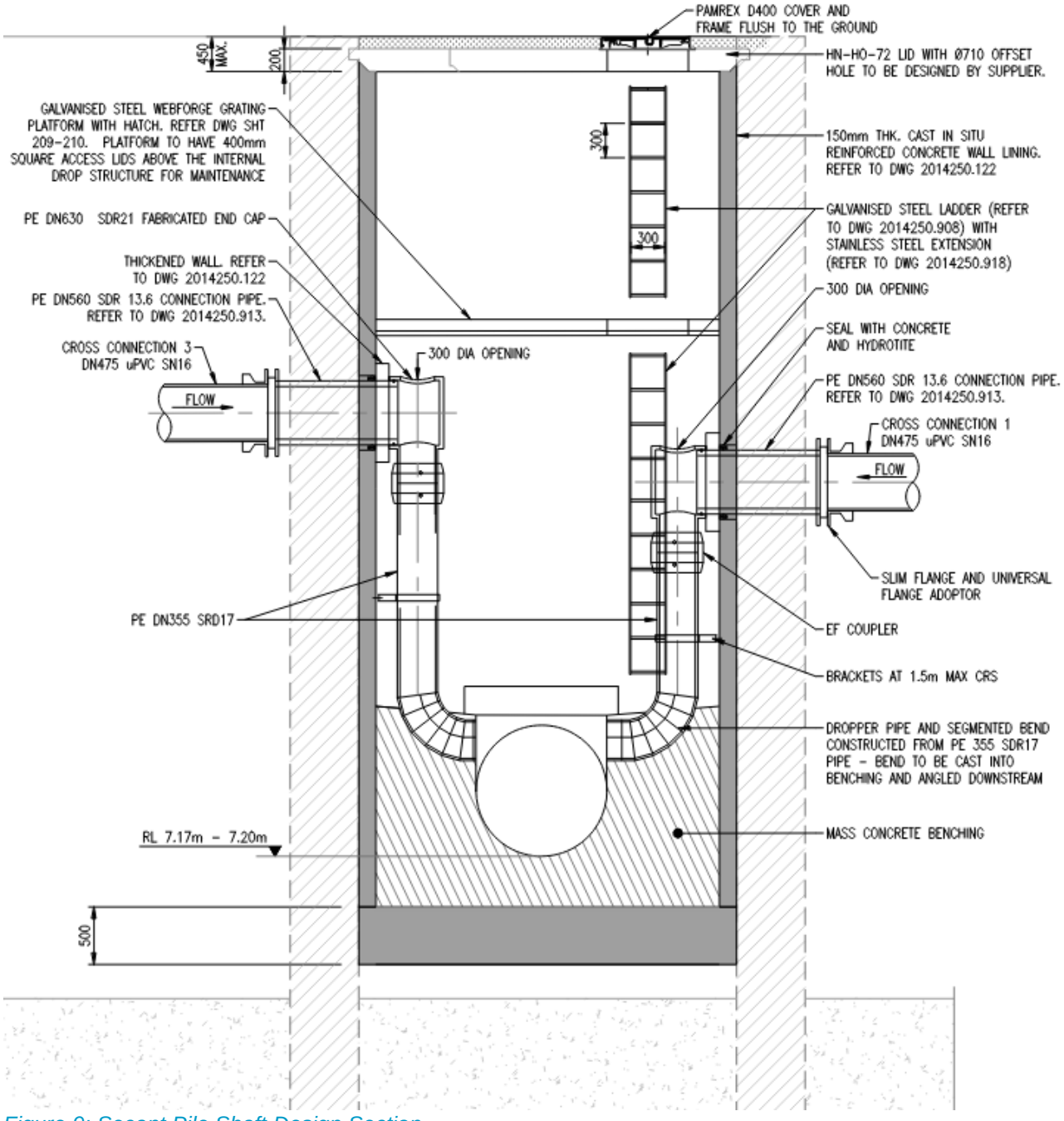

Figure 9: Secant Pile Shaft Design Section

3.5. Temporary Shaft Construction at Queen St / Mayoral Drive Intersection

Construction methodology for the temporary shaft construction is outlined in the steps listed below:

- The shaft extents (refer Figure 10 below) will be saw cut and a 14-20t excavator used to remove pavement layers and other shallow level pavement layers.
- A SR-45 CFA Drill Rig will auger 600mm diameter holes to 18m deep.
- The CFA auger will be replaced with concrete as it extracts to surface level, this should prevent the earth collapsing into the pile.
- Hard piles will either be reinforced with helical reinforcing cages or steel UC posts. These will be plunged into the fresh concrete pile immediately after the auger is fully extracted.
- The shaft extents will be excavated using a combination of a 3T excavator (mining regulations compliant) and a larger 20-35T excavator, Once the shaft is past 5.5m deep, the larger excavator will change to a 20T telescopic-boom excavator.
- Shaft spoil will be removed from site using 6 or 8-wheeled trucks.
- There will be 4 layers of 610 UC walers, waler level 1 will be a single UC, walers levels 2-4 will be a double UC as the excavation progresses. These will control mechanical settlement outside of the shaft.
- Dewatering will be required, a 2-inch submersible pump and hose will be used to remove water from excavations. The water will be pumped into clarifying tanks/containers for treatment, if required, before discharging to stormwater. Permits will be obtained to discharge the treated water. The pumps will be powered by a hybrid diesel generator which will run continuously while the trench is open, dependent on water ingress rates. Noise mitigation will be provided by the solid hoarding at the shaft.
- Forced air ventilation will be required using fans at surface level with ventilation ducting into the shaft.
- Refer to Victoria shaft above for manhole and shaft backfill details.

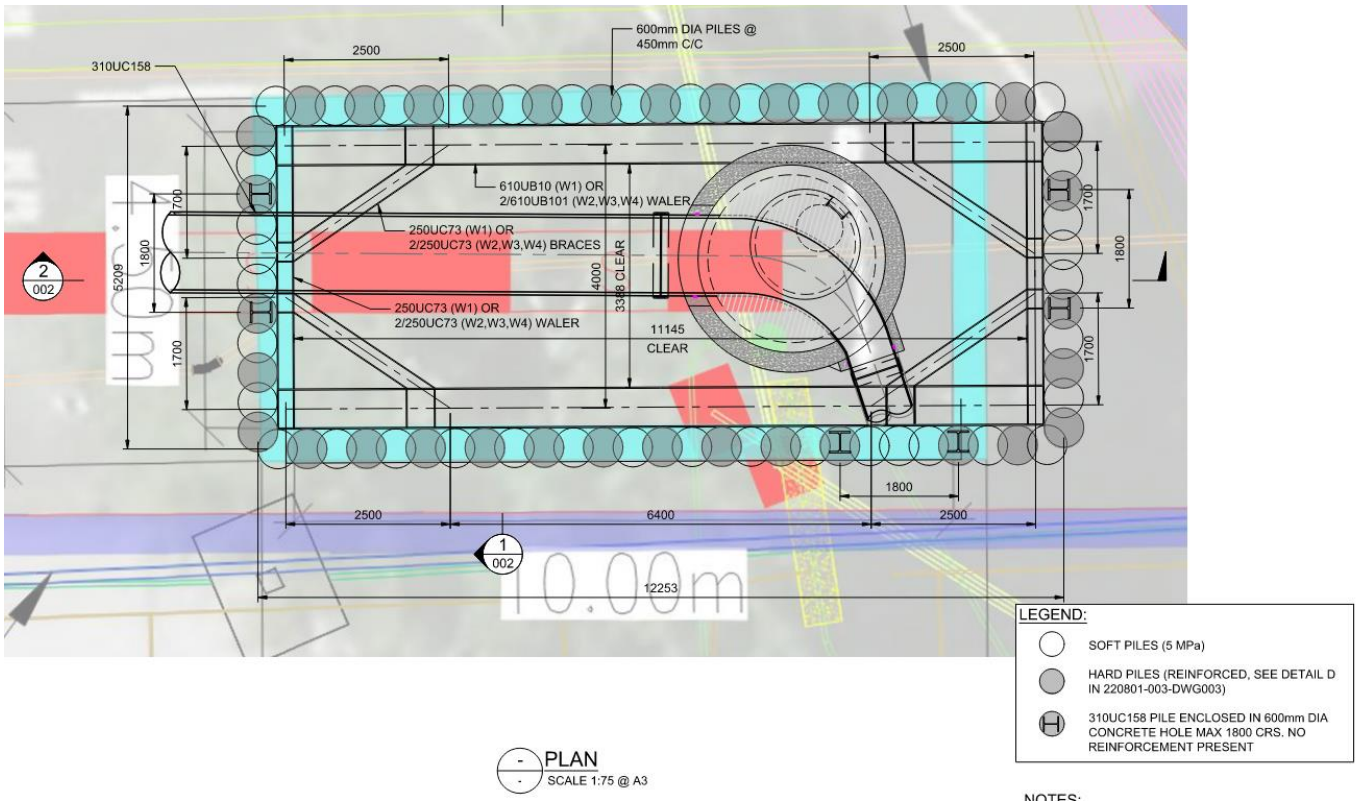

Figure 1: Plan view of Mayoral Drive Shaft Design

3.6. Open Cut Pipe Laying for Local Connections

Local wastewater connections will be required into the Wellesley shaft / manhole.

Construction methodology for the open cut pipe laying and manholes is outlined in the steps listed below:

- Traffic management will be setup in accordance with approved TMP's which will likely be staged to incorporate all open-cut trenches.
- Trench shields will be used for all trenching over 1.5m depth, which will be most connections. Approximately 20 to 30m of trench will be open at any one time. Open earthworks would be up to 300m3.
- Pipe lengths and precast manholes will be delivered to side on flatbed trucks and unloaded within the site using HIAB or excavators.
- A leading excavator will be used to trench to the required depths and install trench shields as the excavations advances. Wider trench boxes will be provided at manhole locations.
- Excavated materials will be cut to waste as clean, managed or contaminated fill dependent on contamination testing results.
- Dewatering may be required; a 2-inch submersible pump and hose will be used to remove water from excavations. The water will be pumped into clarifying tanks/containers for treatment, if required, before discharging to stormwater. Permits will be obtained to discharge the treated water. The pumps will be powered by a hybrid diesel generator which will run continuously while the trench is open, dependent on water ingress rates. Noise mitigation will be used such as barrier screens for overnight dewatering if required. We do not anticipate the need to dewater in one location for more than 3 weeks.
- Pipe bedding material will be carted to the worksite directly from source in 6 or 8-wheeled trucks, spread into the trench using an excavator and compacted using 40-400kg plate compactors.
- Excavators will be used to lift 2.4m pipe lengths into the trench.
- Side haunch, overlay bedding and hard fill to pavement level will be constructed as per pipe bedding material (refer item above).
- The pavement layer will be stepped out from trench excavation to provide keys into the existing pavement layers. The pavement aggregates will be spread using excavators and compacted using drum rollers, unless the trench is within 15m of a heritage structure.

4. Sequence of work & Programme Durations

- Refer high level construction programme in Appendix B.

5. Revision History

Rev.	Date	Author	Description
01	31/03/2023	Jeremy Gordon	Issued for Information
02	04/04/2023	Jeremy Gordon / Derek Austin / Paul Cooper	MCD tunnel methodology (Appendix A) and MCD review comments included
03	05/06/2024	Dominic Wakeland	Updated FH Section to support consent specialists' assessment of changes.

Appendices:

Appendix A – McConnell Dowell tunnel methodology

Appendix B – High level construction programme