TABLE 213-A: TRENCHLESS RISK DEFINITIONS AND REQUIREMENTS

	LOW RISK	MEDIUM RISK	HIGH RISK
DEFINITION	LENGTH < 25m	LENGTH > 25m, or CROSSING A LESS SIGNIFICANT WATERWAY, VICROADS RD, TRAMWAY, or WATER MAIN, SEWER OR DRAIN > DN2000	LENGTH > 100m, or SIGNIFICANT WATERWAY, RAIL or FREEWAY CROSSING
DESIGN	N/A	REF REQ.1	REF REQ.1
GEOTECHNICAL	N/A	N/A	REF REQ.2
CONSTRUCTION	REQ.3 and 4 or 5	REQ.3 and 4 or 5	REQ.3 and 4 or 5

NOTES Regarding Table 213-A:

- Significant waterways can be defined as > 10m wide (if wetlands or lakes) or > 2m (average width of river or creek).
- All other waterways (marked as a water body in the melways) can be considered to be less significant.
- Risk assessment of bored alignments also needs to consider the following risk factors:
  1. Impact on existing structures & services, ie: loading from existing structures and risk of not meeting minimum clearances.
  2. Presence of high water table & the impact on drilling techniques.
  3. Native soil physical properties and consistency.
  4. Ability of the technique to meet the positional tolerances.

TABLE 213-B: PIPELINE JOINT TYPES AND LIMITATIONS

JOINT STRENGTH	JOINT / PIPE TYPE	LENGTH LIMIT	LIMITATIONS
HIGH	JACKING PIPE. WELDED STEEL. BUTT WELDED PE or PVC. RESTRAINED JOINT DI	Ref 4.4.1 & Jacking Limit	JACKING PIPE ONLY USED FOR SLEEVES, NOT WATER MAINS. JACKING / WINCHING FORCES CANNOT EXCEED LIMIT OF PIPELINE.
MEDIUM	RRJ DI (PUSH ONLY)	<50m	ACCEPTABLE WHERE SIGNIFICANT RISK OF BORE HOLE COLLAPSE, PUSH / PULL PIPE IN BEHIND BORE HEAD.
LOW	RRJ PVC (PUSH ONLY)	<25m	REQUIRES STABLE OPEN BORE HOLE. SHALL ONLY BE INSTALLED BY HAND. PIPE SPACERS / LOCATORS SHALL ALWAYS BE USED.

REQ.1- Design Requirements for High and Medium Risk Trenchless Construction :

1. Nominate the risk level, sleeve and joint / pipe requirements.
2. Provide geotechnical information to the contractor (refer adjacent section) in high risk situations.
3. Obstructions.
   - 3.1. The risks of underground obstructions (poor ground, underground assets) shall be determined and mitigated through the obtainment of geotechnical and asset information.
   - 3.2. Consult with HDD / micro-tunneling practitioners where poor ground (eg: rocks in clay / sand / gravel or unweathered rock) conditions are present to determine whether the proposed technology is practical.
   - 3.3. Above ground items requiring protection (fauna, flora, heritage, other authority assets) shall be determined through a feature survey and investigation based on regulatory requirements.
   - 3.4. Specify a suitable alignment and installation method for the new pipeline accordingly.
4. Plan and long section design drawings are required for all >DN300 mains and any main that is non linear (has a profile to avoid obstruction(s). They shall:
   - 4.1. Indication of where obstructions and protected items are located.
   - 4.2. Method of construction (open cut / laser bore / HDD) shall be nominated for each pipe length.
   - 4.3. For micro-tunneled pipelines, indicate:
     - 4.3.1. The SN rating of jacking pipe (if jacking pipe- refer adjacent section).
     - 4.3.2. Expected size and locations of boring shafts.
       Approximate shaft sizes of 2m x 4m (DN150 to DN375), 2m x 6m (DN450 - DN900) and 4m x 8m (>DN900) may be used.
       Long dimension of shaft shall be in line with the pipe.
       Access for equipment (eg: truck access) to shaft shall be acceptable.
     - 4.3.3. Suggested method of shaft construction:
       Caisson or sheet pile perimeter (where ground conditions are weak or unstable & / or where high ground water is expected).
       Shields or soldier pile (where solid & dry ground).
     - 4.3.4. Expected location of staging area around the boring shafts.
       Sufficient space around bore shafts shall be provided for location of plant, equipment and materials.
   - 4.4. For HDD installed pipelines:
     - 4.4.1. Pipe type and SDR.
       The drilling limits of PE100 pipe is as follows:
       SDR17 -230m limit (only permitted for pipe sleeves)
       SDR13.6 -280m limit (only permitted for pipe sleeves)
       SDR11 -350m limit
       SDR9 -420m limit
       (these are linear pipe metres, not "as the crow flies" distances).
       Check that the selected SDR is able to withstand vertical loads.
     - 4.4.2. Expected size and location(s) of drilling site(s) and pipe jointing site(s).
       Typically, entry requires ~50m² and exit sites require 25m².
       Access for equipment (eg: truck access) to shaft shall be acceptable.
       Sites need to be reasonably flat, clear and well drained.
     - 4.4.3. Drill insertion point(s), angle(s) and set back(s) from maintenance shafts.
5. Groundwater management.
   The designer shall nominate the limits of discharge quality, quantity and available discharge points.
6. All necessary third party approvals and conditions shall be obtained and their conditions included in the design drawings or specifications.
   Settlement monitoring requirements and limits (if any) shall be included.

REQ.2- Geotechnical Information Required for High Risk Trenchless Construction:

The designer shall engage a geotechnical consultant to undertake bore hole analysis and report on ground conditions as follows:

1. Bore holes required as follows:
   - 1.1. Bore holes shall be undertaken on both sides of a waterway crossing, within a few metres of the waters edge.
   - 1.2. This testing shall be undertaken even in difficult to access locations.
     Dispensation is required where required bore holes cannot be completed.
   - 1.3. Bore holes shall be to a depth at least 5m below the expected water main level.
   - 1.4. Existing bore hole data in close proximity to required bore holes may be acceptable in lieu of new bore hole excavation(s).
   - 1.5. Where cobbles or boulders are present, large diameter bore holes (>300) or test pits shall be excavated to determine the size and spacing of these larger items.
2. Bore hole information (vs depth / elevation) shall include:
   - 2.1. X, Y co-ordinates and surface elevation.
   - 2.2. Blow count.
   - 2.3. Grain size distribution.
   - 2.4. Plasticity of cohesive soils.
   - 2.5. Stabilized (24 hour) groundwater level.
   - 2.6. In rock:
     - 2.6.1. Compressive strength of rock.
     - 2.6.2. Jointing and fracturing (RQD).
     - 2.6.3. Structural complexity (folding & faults)
     - 2.6.4. Degree of weathering.
     - 2.6.5. Mineralogy.
3. Boring risks shall be assessed and reported, focusing on:
   - 3.1. The stability of any open bore hole.
     - 3.1.1. Unstable formations which may collapse into the bore hole.
     - 3.1.2. Risk of high plasticity clays swelling to partially or completely block the bore hole.
       Where the risk to bore hole stability is moderate to high, HDD should not be selected as the construction method unless this risk can be controlled.
   - 3.2. Loss of drilling fluid or lubricant to surface (eg: frac out).
   - 3.3. Formations which may stop or deflect the boring head.
   - 3.4. Location of aquifers and the implications for boring.
   - 3.5. Optimum depth and alignment for trenchless construction which minimizes the above risks.

Jacking Force Calculation (Pipe Sleeves Only):

1. Jacking force (F) = Fp + Ff
   - 1.1. Fp= penetration resistance. This is the "back force" of the boring head against the earth during boring.
   - 1.2. Ff = frictional resistance. This is the force required to overcome the friction of the jacking pipe in the bore hole.
2. $Fp = 8 \times D^3 P$ (kN)
   - 2.1. D = pipe external diameter (m).
   - 2.2. P = face resistance:
     - 2.0.1. P = 50 for soft materials (soft clay and sand)
     - 2.0.2. P = 60 for mid stiffness materials (stiff clay and mixed gravel & sand)
     - 2.0.3. P = 70 for hard materials (rock)
3. $Ff = 10 \times \pi$ D L Q (kn)
   - 3.1. L = jacking distance (pipe length in m)
   - 3.2. Q = a + 0.4D
     a = 0.15 for stiff clays and rock
     a = 0.24 for sands
     a = 0.34 for soft clay and mixed gravel & sand
4. In summary: $F = 8 D^3 P + 30$ D L (a + 0.4D)

SN Rating of Jacking Pipe:

1. Size the ID of the water pipe or sleeve.
2. Estimate jacking force required to install this pipe (using the left method).
3. Select preliminary SN rating of jacking pipe.
   - 3.1. Look up supplier catalogue.
   - 3.2. Select the minimum SN rating which can withstand the estimated jacking force.
4. Review need for intermediate jacking stations (which would reduce jacking force).
   - 4.A. Review required when the jacking length is > 150m or the required SN is > 100,000.
   - 4.B. Assess the jacking forces required if intermediate jacking station(s) were to be used.
   - 4.C. Assess the additional cost of the intermediate jacking stations (consult with laser boring contractor) vs the savings in pipe (due to lower SN rating).
5. Finalise SN rating of jacking pipe.
   Select the lowest cost jacking and pipe system.
6. Check that the SN rating of the pipe will also meet vertical loadings.

REQ.3-General Construction Requirements:

- Comply with requirements of Table 213-B. Comply with the pipe manufacturers instructions with respect to the suitability and conditions of use of the pipe for the selected construction method.
- Ensure metallic pipe coatings (ie: Di & MS pipe) are protected from damage (eg: use slippers or lubricant layer).
- Annular Space (space between bore hole and sleeve (if sleeved) or between bore hole and carrier pipe (if not sleeved)) and Grouting:
  - 1.1. Grouting between sleeve and carrier pipe is generally not required.
  - 1.2. It is preferred that the overcut diameter not exceed 30mm.
  - 1.3. When annulus > this limit, grout the annulus as per WSA03 MRWA edition (ie: use a flowable grout, eg: liquafill or bentonite).
  - 1.4. Grouting should commence as soon as possible after pipe installation (to prevent material falling into the annulus).
    It should occur within 4 hours of completion (weak ground) or 24 hours (stable ground).
  - 1.5. Ensure grouting pressures do not exceed the buckling capability of the sleeve / pipe when empty.

REQ.4- Construction Requirements for Laser Boring / Microtunneling:

1. Shafts.
   Shafts are to be prepared in close consultation with the boring contractor. Issues to address include:
   - 1.1. Preparation of the thrust area.
     How is the strength of the native ground behind the thrust block to be maintained.
   - 1.2. Depth of shaft.
     Sufficient clearance below the invert of the water main is required to enable the jacking frame to be correctly set (0.5m to 1.2m extra depth typically required).
   - 1.3. Preparation of shaft base (type & size of concrete pad).
   - 1.4. Location of props and bracing which may impede access of materials and equipment into the shaft.
   - 1.5. Type of shaft support (sheet pile, shield, solder set, caisson).
   - 1.6. Method of managing any weak ground.
   - 1.7. Method of groundwater management.
   - 1.8. Stabilisation / sealing of the bore entry point to prevent slurry or lubricant from coming back into the shaft.
2. Settlement / subsidence.
   The contractor shall monitor and control the settlement of road and railway crossings to the satisfaction of the controlling agency.
3. Requirements for intermediate jacking stations (IJSs).
   - 3.1. At least one IJS for drives exceeding 150m.
   - 3.2. At least two IJSs for drives exceeding 250m.
   - 3.3. As required to keep jacking forces within 70% capacity of the:
     - 3.3.1. Jacking pipe, and
     - 3.3.2. Jacking frame, and
     - 3.3.3. Thrust block.

REQ.5- Construction Requirements for Horizontal Directional Drilling (HDD):

1. Construction risks shall be adequately identified and controlled by the contractor. This assessment and control plan shall at least indicate the preventative and remedial actions for:
   - 1.1. Loss of drilling fluid (frac out).
   - 1.2. Loss of circulation of drilling fluid (indicating frac out).
   - 1.3. Drilling mud seepage (spillage) onto land or into a waterway.
   - 1.4. Collapsed hole.
   - 1.5. Washout of cavity and collapse of the surface.
   - 1.6. Stuck or deflected drill stem.
   - 1.7. Swelling of high plasticity clays which may partially or completely block the bore hole.
   - 1.8. Lost tools.
   - 1.9. Pedestrian safety.
   - 1.10. Traffic hazards.
   - 1.11. Damage to flora, fauna and assets.
   - 1.12. Site security.
   - 1.13. Pull back force exceeding the tensile limit of pipe.
   - 1.14. Unsatisfactory pipe jointing.
   - 1.15. Damage to pipe (during pull back).
2. To ensure bore hole blockage and fluid losses are detected and addressed, monitoring and reporting shall be undertaken which at least:
   - 2.1. Strictly monitors drilling fluid volumes,
   - 2.2. Monitors annular pressure.
   - 2.3. Monitors cutting returns.
   - 2.4. Monitors the ground and waterways within 400m of boring.
   Any loss of drilling fluid or drilling mud shall be contained and immediately reported to the water agency.
3. The pipe shall not be bent beyond the minimum radius of the pipe (refer PIPA document POP202).
4. The installed pipe shall be allowed to relax and cool for at least 12 hours before it is restrained at either end.
5. The location of the drill stem (& therefore pipe) shall be monitored and recorded in the as constructed documentation (to ensure pipe can be located in future).
6. Settlement / subsidence.
   The contractor shall monitor and control the settlement of road and railway crossings to the satisfaction of the controlling agency.

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