1 GENERAL

1.1 RESPONSIBILITIES

Objective
Design requirement: Provide the design drawings and specification for the construction of a sewerage system to transport sewage or effluent from properties to the treatment plant or to a defined discharge point on an existing sewerage reticulation conforming to the requirements of WSA codes and the Water Agency as documented. Provide an appropriate point of connection for each individual property to meet consumer requirements. Designer responsibilities include the following:
- Translate the planning output into a detailed system/network design. Prepare design drawings compatible with the Water Agency’s concept plan and the design parameters.
- Identify potential problems and provide appropriate solutions.
- Justify any variation from the requirements set out in this worksection or specified by the Water Agency.
- Obtain written approval from the Water Agency for any variation.

1.2 CROSS REFERENCES

General
Requirement: Conform to the following worksection(s):
- 0010 Quality requirements for design.
- 0077 Sewerage systems – pump stations (Design)

1.3 REFERENCED DOCUMENTS

The following documents are incorporated into this worksection by reference:

Standards
AS 1102-series Graphical symbols for electrotechnical documentation (Various)
AS 1214-1983 Hot dipped galvanised coatings on threaded fasteners (ISO metric coarse thread series)
AS/NZS 1260:2009 PVC pipes and fittings for drain, waste and vent application
AS/NZS 1477:2006 PVC pipes and fittings for pressure applications
AS/NZS 1554 Structural steel welding
AS/NZS 1554.6:2012 Welding stainless steels for structural purposes
AS 1579-2001 Arc welded steel pipes and fittings for water and waste-water
AS 1646-2007 Elastomeric seals for waterworks purposes (Series)
AS 2129-2000 Flanges for pipes, valves and fittings
AS 2200-2006 Design charts for water supply and sewerage
AS/NZS 2280:2004 Ductile iron pipes and fittings
AS/NZS 2566 Buried flexible pipelines
AS/NZS 2566.1:1998 Structural design
AS 2832 Cathodic protection of metals
AS 2832.1-2004 Pipes and cables
AS 2832.2-2003 Compact buried structures
AS 2865-2009 Confined spaces
AS/NZS 3500 Plumbing and drainage
AS/NZS 3500.2:2003 Sewerage
AS/NZS 3518:2004 Acrylonitrile Butadienne Styrene (ABS) pipes and fittings for pressure applications
AS 3571 Glass filament reinforced thermosetting plastics (GRP) pipes – Polyester based – water supply, sewerage and drainage applications
AS 3571.2:2009 Pressure and non-pressure water supply (ISO 10639:2004, MOD)
AS 3680-2008 Polyethylene sleeving for ductile iron pipelines
AS 3681-2008  Application of polyethylene sleeving for ductile iron piping
AS/NZS 3725:2007  Design for installation of buried concrete pipes
AS 3735-2001  Concrete structures retaining liquids
AS 3735 Supp1-2001  Concrete structures retaining liquids - Commentary (Supplement to AS 3735-2001)
AS/NZS 3862:2002  External fusion-bonded epoxy coating for steel pipes.
AS 3879-2011  Solvent cements and priming fluids for PVC (PVC-U and PVC-M) and ABS and ASA pipes and fittings
AS 3996-2006  Access covers and grates
AS/NZS 4058:2007  Precast concrete pipes (pressure and non pressure)
AS 4060-1992  Loads on buried vitrified clay pipes
AS/NZS 4087:2011  Metallic flanges for waterworks purposes
AS/NZS 4129:2008  Fittings for polyethylene (PE) pipes for pressure applications
AS/NZS 4130:2009  Polyethylene (PE) pipes for pressure applications
AS/NZS 4158:2003  Thermal-bonded polymeric coatings on valves and fittings for water industry purposes
AS/NZS 4331  Metallic flanges
AS/NZS 4331.1:1995  Steel flanges
AS/NZS 4441-2008  Oriented PVC (PVC-O) pipes for pressure applications
AS/NZS 4765:2007  Modified PVC (PVC–M) pipes for pressure applications
AS 4799:2000  Installation of underground utility services and pipelines within railway boundaries
AS/NZS 5065:2005  Polyethylene and polypropylene pipes and fittings for drainage and sewerage applications
BS EN 295 Vitrified clay pipes and fittings and pipe joints for drains and sewers
BS EN 295-1:1991  Requirements
BS EN 681  Elastomeric seals. Material requirements for pipe joint seals used in water and drainage applications
BS EN 681-1:1996  Vulcanized rubber
ISO 10467:2004  Plastics piping systems for pressure and non-pressure drainage and sewerage - Glass-reinforced thermosetting plastics (GRP) systems based on unsaturated polyester (UP) resin

Water Services Association of Australia (WSAA)
WSA 01-2004  Polyethylene Pipeline Code 2004 3rd edition Version 3.1
WSA 02-2002  Sewerage Code of Australia, 2nd Edition Ver. 2.3
          Product and material information and guidance for sewerage code of Australia WSA 02-2002
WSA 03-2011  Water Supply Code of Australia, Version 3.1
WSA 04-2005  Sewerage Pumping Station Code
WSA 06-2008  Vacuum Sewerage Code of Australia Version 1.1 Parts 0-4 and WSA 06 Standard drawings CD
WSA 07-2007  Pressure Sewerage Code of Australia Version 1.1 Parts 0-4 and WSA 07 Standard drawings (CD)
WSA 109-2011  Industry standard for flange gaskets and o-rings
WSA 113-2002  Reinforced concrete pipes with flexible thermoplastic linings

Plastics Industry Pipe Association
POP 007-2006  Metal backing flanges for use with polyethylene (PE) pipe flange adaptors

Other publications
IPWEA
IIMM-2011  International Infrastructure Management Manual

Melbourne and Metropolitan Board Works
MMBW-1989 Hydrogen Sulphide Control Manual Volume 1 and 2
1.4 STANDARDS

General
Planning and design of sewerage system: To WSA 02 Parts 0, 1 and 2.

1.5 INTERPRETATION

Abbreviations
General: For the purposes of this worksection the following abbreviations apply:
- AHBP: Allowable horizontal bearing pressure.
- CIOD: Cast iron outside diameter.
- ERS: Emergency relief system.
- FF: Full face.
- FSL: Finished surface level.
- GRP: Glass reinforced plastic.
- IBC: Inside bolt circle.
- ISO: International standards organisation.
- MH: Maintenance hole.
- NPV: Net present value.
- PN: Pressure class (number).
- SN: Stiffness class (number).
- SR: Spigot and recess.
- STEP: Septic tank effluent pump.
- TG: Tongue and groove.
- TMS: Terminal maintenance shaft.

Definitions
General: For the purposes of this worksection the following definitions apply:
- Concept plan: A package of information provided to the designer by the Water Agency to allow the appropriate planning/design of major sewerage system components to be performed. Designer: The person(s) responsible for a design output in accordance with the Water Agency’s project brief, contract or development agreement.
- Document: Record of information in written or graphical form.
- Water Agency: An authority, board, business, corporation, Council or local government body with the responsibility for planning or defining, design, construction and maintenance requirements for a water supply and/or sewerage systems. This includes Local Water Utilities (LWU).
- Septicity: The prolonged retention of sewage under anaerobic conditions, particularly during low flow periods.

2 PRE DESIGN PLANNING

2.1 SYSTEM PLANNING

Sewerage system
Sewerage system strategy: Define the processes such as the transportation subsystem and the operating units for the design of a complete system.
Planning principles: Document the following:
- Concept plan: If setting out the initial inputs of catchment area, flows, average recurrence interval (ARI), sizing, upstream controls, recommended sewer layout and any other requirements is not provided by the Water Agency, develop the concept plan to WSA 02 clause 2.2.2 and obtain approval from the Water Agency.
- Concept design: Consider factors of life cycle planning, functionality, maintainability, reliability and due diligence in conformance with WSA 07 clause 2.1 to 2.5, WSA 06 clause 2.1 to 2.7, WSA 02 clause 1.4.2, and WSA 04 clauses 2.1 to 2.17.
- Pressure network: Consider additional information requirements including collection/pump unit type, discharge point, entrapped air management.
- Catchment analysis: Calculate the anticipated total design flow of both the proposed development and any future developments. Assess the adequacy of the existing system and determine the extent and sizing of the new sewer system with sufficient capacity to cater for all existing and predicted development within the area served. Determine catchment/ sub-catchment boundaries.
- Future gauging needs: Provide flow gauge network at overflow points, pumping stations and gravity subsystem outlets.
- Terrorism: Incorporate safeguards to minimise the risk and impact of terrorist attack.

Planning parameters: Document the following to WSA 02 clause 3.3:
- Loading for each serviced property: Use average loading rates as a basis for calculating future load assessments.
- Assessment of future loads.
- Assessment of existing system loads.
- Environmental considerations: Consider the environmental impact and conform to the local government environmental and heritage requirements.
- Geotechnical investigations: Engage a geotechnical engineer to assess if any special investigation is required for ground instability and ground water infiltration.
- Operation and maintenance considerations: Locate the sewers to provide safe and easy access for maintenance and condition assessment.
- Land use both current and future.
- Analyse for NPV.

Sewage quality: Document the following factors to maintain the sewage quality:
- Septicity: Determine adequate grades for self cleaning, reducing detention periods, avoiding any unnecessary turbulence at the pressure sewer delivery point, dosing or ventilation to minimise likelihood of septicity.
- Sewage quality/Trade waste management: Determine any trade waste programs to monitor and control the waste entering the system from commercial and industrial sources.

Planning review: Review the layout to WSA 02 clause 2.5.

2.2 SUBSIDISED SCHEMES

Funding
Government grant funds: If the works form part of a contract attracting government grant funds, identify the following:
- Items which are not of the least cost option, that:
  - Are intended to have a much longer design life than the normal asset service life detailed in the Asset Management Guidelines of the International Infrastructure Management Manual.
  - Do not meet the project objectives and the requirements of the various Authorities for the least Net Present Value (NPV) but may become the preferred option for construction.
- Particular equipment which is procured without relevant competition through tendering.
- Duplication of equipment or unit processes in a system configuration.

2.3 CRITICAL INFRASTRUCTURE PROTECTION

Asset categorisation
Concept plan: Address the asset categorisation to WSA 03 clause 1.2.4.1. Provide a risk assessment of the final design for consistency with asset categorisation and the concept plan.

2.4 CONSULTATION

Council and other authorities
Approval: Obtain approval from the following public authorities:
- Consulting authority: Bellingen Shire Council

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3 DESIGN CRITERIA

3.1 GENERAL

Responsibility
Concept plan: Review the concept plan provided and make sure the data listed by WSA 02 clause 2.2.2 is available.
Conflicting requirements: If there is conflict between this specification and the Water Agency requirements seek clarification.
Requirements of design: Provide sewerage system to each property by a connection point to a pre-laid property service including the following:
- Gravity system.
- Pressurised or vacuum system.

Minimisation of life cycle costs
Design life: > 100 years without rehabilitation.
Life cycle plan: Provide an asset life cycle plan noting renovation or replacement for items. Conform to typical asset design life values to WSA 02 Table 1.1 or submit other source documentation for design life.

Catchment and upstream provision
General: Determine the area served in conformance with WSA 02 clause 2, including provision for an upstream sewer involving future loads.

Utilities services plans
Future loading: Determine the future and ultimate upstream sewer loading and make adequate allowance for such loadings.

Commissioning plan
Requirement: Provide a commissioning plan including the following:
- Pre-commissioning procedures, including schedules, record sheets for each item of equipment and checklists.
- Commissioning procedures, including procedures, schedules, notice periods for independent testing.
- Handover requirements.
- Sign-off requirements.
- Documentation requirements at handover and sign-off.
- Documentation required to operate, maintain and resource the facility including equipment technical specifications, work-as-executed drawings, risk analysis, operation and maintenance manuals, resource requirements for ongoing operation of the facility.
- Following final design, update the commissioning plan in conformance with design documentation.

3.2 SEWERAGE DESIGN

Flow estimation
Design flow estimation: Determine the design flow estimation (L/s) in conformance with WSA 02 clause 3.
Equivalent population: Determine the equivalent population in conformance with WSA 02 Appendix A.
Flow estimation for undeveloped areas: To WSA 02 Appendix B.
Flow estimation incorporating existing systems: Determine using flow modelling in conformance with WSA 02 Appendix D.
Flow estimation for partially pumped systems: Calculate in conformance with WSA 02 clause 3.2.4, where using modelling determine in conformance with WSA 02 Appendix D.
Flow schedule: Document the flow schedule.
Design flow verification: Design flow limits for pressure sewers for certification by the system supplier.

Detailed design
Catchment: Provide for sewers to drain the specified catchment and determine optimum depth and diameter for any future extensions.
Design accuracy: Document location and design elevations of sewer(s) with the following accuracy:
- Plan: To 0.01 m.
- Level if grade is < 0.5%: To 0.005 m.
- Level if grade is > 0.5%: To 0.01 m.
- Levels: Referenced to Australian Height Datum (AHD).
- Plan location: Referenced to local cadastral boundaries or the geodetic datum of Australia (GDA 94).

Sewer layout: Document sewer layout conforming to the natural gradient, to WSA 02 clause 4.2.3 and the following:
- Position within the street reserve in conformance with the locally applicable utilities’ allocation code or, where no code is applicable, locate clear of carriageways.
- Position within public land with the permission of the controlling Authority.
- Position within drainage reserves outside 1 in 100 year flood area.
- Position within private property parallel to front, rear and/or side boundaries.
- The final sewer alignment must conform with Water Agency and statutory requirements and any local space allocation code.

Pressure sewer layout: Provide for the pressure sewer system in conformance with WSA 07 clause 5.1.4 and 5.1.5 and the following:
- Create shut down zoning of equal size to WSA 07 clause 5.1.
- Locate in the road reserve.
- Avoid slip and unstable areas.

Environmental considerations: Conform to the following environmental requirements:
- The project Environmental impact assessment.
- Avoid sensitive areas as defined in WSA 02 clause 4.2.4.
- Vegetation: Address the following:
  - Preserve trees of significance and habitat of fauna.
  - Tree removal permits.
  - Make sure preserved and/or replacement trees are appropriate species with root systems which are not detrimental to sewerage works.
- Contaminated sites: Submit for approval from Water Agency and/or Environmental regulator, conform to the requirements in WSA 02 clause 4.2.4.4.

Tidal zones: For sewers located below high tide level, conform to WSA 02 clause 4.2.4.5.

Disused sewers: Document the treatment of disused sewers including any demolition, capping or removal.

Colour coding: If proposed sewer pipes or rising mains are located in close proximity to other service pipes or if there is the likelihood of the pipes not being recognised as sewerage pipes, document colour coded pipes as follows:
- Sewer pipes: Cream colour.

Overhead power lines and transmission towers: Do not locate pipelines under overhead high voltage (> 50 kV) power lines unless approved by the relevant authority.

Site safety plan: If pipelines under overhead high voltage power lines are approved, develop a site safety plan.

Trenchless techniques: Document trenchless methods, if appropriate, for environmentally sensitive areas, built-up or congested areas, beneath buildings or overhead power lines or at road crossings. Locate on the drawings all access pits and exit points to conform with WSA 07 clause 3.13.

Confined space risks: Design and document the technical requirements to minimise all risks associated with entry into confined space to AS 2865.

Easements
Requirement: Document easement widths, locations and placement of the sewer within the easement.

Sewers: If it is necessary to locate a sewer in locations other than dedicated public road reserves or private access way, register an easement that conforms to WSA 07 clause 3.7 and Appendix B.

Position of sewer in the easement: Conform to the following:
- 1/3 of the width into the easement on the side away from any buildings.
- Position central if there are buildings on both sides and if the easement runs through narrow walkways.
- Where there is a crossfall, position the main on the low side.

**Horizontal alignment of sewers**

**Crossings:** Conform to the following:
- Roads, creeks, drains and underground services: At right angles in conformance with WSA 02 Standard drawings SEW-1400, SEW-1401, SEW-1402, SEW-1403, SEW-1404 and WSA 07 Standard drawings PSS-1002 or PSS-1003.
- Freeways, arterial roads and other major road reserves: In conformance with WSA 02 clause 4.3.2.
- Railway reserves: In conformance with AS 4799 and WSA 02 Standard drawings SEW-1401 or WSA 07 Standard drawings PSS-1004. Submit for approval.

Public and private property: Conform to WSA 02 clause 4.3.4.

Changes in direction using MH: Maximum allowable deflection of sewer through MH to conform with WSA 02 Table 4.1 and clause 4.3.7 unless otherwise noted.

**Dead ends:** Terminate sewer end > 1.0 m past the boundary.

**Horizontal curves:** Locate and size deflection in conformance with WSA 02 clause 4.3.7.

**Obstructions and clearances**

**Sewer route:** Determine all underground obstructions and services, surface obstructions and structures and design to avoid the obstructions.

Clearances: Conform to WSA 02 clause 4.4 for the following:
- Clearances from transmission towers and power lines.
- Clearance from structures.
- Clearance from underground services in conformance with WSA 02 Table 4.2 or WSA 07 Table 3.1 or WSA 06 Table 3.1, as appropriate.

**Pipe sizing and grading**

**Sewerage design charts:** To AS 2200.

**Design:** Document pipe sizes and grades to transport the design flow and achieve a self-cleansing velocity. Conform to the following:
- Avoid excessive grades.
- Minimum grades for slime control in particular for sewers ≥ DN 300.
- Environmental protection requirements for design flow containment.
- Minimum grades for self cleansing: To WSA 02 clause 4.5.7 Tables 4.5, 4.6 and 4.7.
- Maximum grades for septicity.
- De-rate pipes for fatigue and temperature where appropriate.

**Ventilation:** Provide for sewer ventilation to conform to WSA 02 clause 4.5.3. Generally provide air space in the pipe at either peak dry weather flow or at design flow.

Minimum pipe sizes for maintenance purposes: Provide for property connections and reticulation sewers to the minimum requirements of WSA 02 Tables 4.3.

**Maximum EP for reticulation sewers:** Conform to WSA 02 Table 4.4.

**Downstream sewer sections:** Do not reduce pipe size.

**Additional requirements for pressurised sewer systems:** Conform to the following:
- Property discharge lines: ≥ DN 40 where 1 or 2 pumps are connected to any property discharge.
- Pressure reticulation sewers: ≥ DN 50 for residential, industrial and commercial zones unless smaller size required for WSA 07 clause 4.5.3.4.
- Internal pipe diameters for PE pipes: To WSA 07 Table 10.2.
- Head loss due to air entrapment: To WSA 07 Appendix A.
- Hydraulic roughness value: To WSA 07 clause 4.5.3.3.
- Grinder pump pressure sewers: Minimum flow velocity of 0.6 m/s at least every 24 hours.
- **STEP systems:** Minimum flow velocity of 0.3 m/s at least every 24 hours.
- **Grinder pump pressure sewers and STEP systems:** Maximum flow velocity of 3.5 m/s.
Vertical alignment of sewers
Design: Document the vertical alignment of sewers in conformance with the topography, minimum pipe size and grade to transport the design flows. Include the following:
- Adequate depth to service property connections by gravity.
- Adequate depth to achieve clearances from utility services and obstructions.
- Adequate grade for self-cleansing and slime stripping.
- Allowance for losses through maintenance structures affecting the hydraulic grade line.
- Minimum cover over sewers.

Long section design plan: Document longitudinal sections and provide a level schedule in conformance with WSA 02 Standard Drawing SEW-1101. Provide levels at each side of any road crossing, at crossings of existing and proposed creeks, drains, cables, pipes, at changes in grade including MS and vertical bends, at regular intervals on vertical curves.

Minimum cover: Document minimum cover measured from the top of the pipe to finished surface to conform to WSA 02 Table 4.8 and WSA 07 Standard drawings PSS-1000. If minimum cover is not achievable, document protective measures.

Lot servicing requirements and control: Conform to WSA 02 clause 4.6.4 for all service area requirements for residential, industrial, commercial, partial and basement servicing.

Minimum depth of sewer connection point: Determine controlling factors of soffit and physical losses in conformance with WSA 02 clause 4.6.5 and document depth requirements.

Grading through MHs: Document the grades through the MHs in conformance with WSA 02 clause 4.6.6.

Vertical and compound curves: Document vertical and compound curves as required and in conformance with WSA 02 clause 4.6.7 and 4.6.8.

Property connection
Levels and vertical risers: Document the levels of property connections and requirements for vertical risers providing a property connection point for each existing and proposed property serviced by a network. Conform to the methods of property connection in WSA 02 clause 5.3.

Limitation of connection to sewers: Make property connections to reticulation sewers only, not on branch and trunk sewers, unless otherwise approved and suitable provisions are made in conformance with WSA 02 clause 5.2.

Maximum depth of property connection: ≤ 2.5 m below FSL.

Number of property connections: One connection per single or multiple occupancy lot in conformance with WSA 02 clause 5.5.

Undeveloped and developed lots: Document the location of the connection points in conformance with WSA 02 clause 5.6 and Standard drawings SEW-1401 and SEW-1105. Provide Y connections as approved.

Length of property connection sewers: Design the lengths in conformance with WSA 02 clause 5.8.

Pressure sewer laterals: Provide isolation valves and pipework in conformance with WSA 07 clause 8.2 and 8.3.

Depth of pipework: Minimum and maximum depths of service connection pipework in conformance with WSA 07 Standard Drawing PSS-1000.

Surface boxes: Provide all buried assemblies, valves and clean-outs with surface boxes with removable watertight lids.

Corrosion protection
Internal corrosion: Document protection against hydrogen sulphide (H2S) and conform to MMBW Hydrogen sulphide control manual volume 1 and 2.

External corrosion: Document protection by selecting corrosion resistant material, coatings, sealed conduits and fittings, refer to AS 3735 and AS 3735 Supplement 1.

Sewage quality
Septicity: Design the system in conformance with WSA 07 clause 3.15 and the following:
- Adequate velocities for self-cleansing and slime control to WSA 07 clause 4.5.3.4.
- Minimal detention times and low sewage age to WSA 07 Table 3.2.

Pressure system discharging to a gravity sewer: Provide for all of the following:
- Avoid any unnecessary turbulence at the discharge point.
- Adequately ventilate the gravity sewer (natural and forced) downstream of the discharge point.
- Provide a Water Agency approved coating to the inside of the discharge maintenance hole.

Odour control: Design to minimise sewerage odours generally found in pressure sewers, collection tanks, valve pits and maintenance/relief structures. Detain sewerage in the sewer for the minimum time, reduce turbidity and provide for ventilation or dosing.

Detention time: Determine allowable detention time of fresh sewerage for the catchment based on average flows with consideration given to temperature, occupancy profile (e.g. residential versus commercial) and lot density.

Odour control dosing: Determine the locations required for dosing to control odour in conformance with WSA 07 Table 3.2 and MMBW Hydrogen sulphide control manual volume 1 and 2.

Trade waste management: Document any requirements for trade waste management for industrial or commercial developments.

**Provision for condition monitoring, sampling and maintenance**

Monitoring: Provide for condition monitoring and maintenance of the system in conformance with the following requirements:

Flushing points and scours: Provide all dead ends to pressure sewers with an end flushing point if the number of connections on a branch line exceeds 5.

In-line flushing points: Provide as follows:
- Downstream of isolating valves, except where there is a downstream flushing point within 100 m.
- Where there is more than one upstream connecting line.
- At intervals not exceeding 500 m.

Document size and location: Locate flushing points in pits with appropriate covers.

Sampling points and flow meters: Provide sampling points and flow meters in conformance with WSA 07 clause 5.6.3 and 5.7.

Chambers: Locate flushing and sampling points in chambers with appropriate clearances, drainage or water tight cover. Provide permanent signage.

### 3.3 PRESSURE SEWERAGE

**Application of pressure sewerage**

Pressure sewer design: Consider the application of pressure sewerage in conformance with WSA 07 clause 1.2.2. Choose the system dependent on cost, downstream treatment and available space for installation of on-lot facilities. Address the following in the pressure system design:

- Pressure network configuration.
- Locations for the discharge point.
- Locations for the collection/pump units.
- System characteristics including design flows, flow velocities, pressure and discharge capacity, collection/pump type, emergency storage volume (hours), pressure sewer and appurtenances, lateral pipe and property boundary assembly, locations of cleanouts, flushing points, isolation valves, property discharge line and appurtenances, collection tank and collection sump volumes, operating levels, size(s) of pipes for each length of the proposed pressure system to meet the concept plan requirements, appropriate pipeline material type(s) and class(es) in conformance with concept plan.
- Sewer layouts and alignments including route selection, topography and environmental aspects, easements, foundation and geotechnical aspects, provision for future extensions, types and locations of cleanouts, isolation valves and air release valves, types and locations of pressure monitoring stations and flow meters, delivery pipe connection locations.
- Document all assumptions and the requirement to review assumptions during construction.
- Unforeseen ground conditions arising during construction.

Maximum system operating pressure: 120 m head.

**Valves for pressure systems**

Valves design and location: Document the location, type, class, end connections and arrangement for all valves in conformance with WSA 07 clause 5.3 and WSA 07 Standard Drawing PSS-1005.

Isolation valves: Locate isolation valves in conformance with WSA 07 clause 5.4.2 and the following:
- At intervals < 500 m or 30 service connections whichever is the lesser.
- At both ends of bridge crossings.
- At both sides of areas of unstable ground.
- On the branch (riser) of each tee immediately adjacent to an air release and vacuum break valve.
- Document covers and surrounds including the permanent marking of boxes.

Air release and vacuum break valves: Document in conformance with WSA 07 clause 5.5, WSA 07 Standard Drawing PSS-1006 and the following:
- Investigate whether air release or vacuum break valves are required for all high points.
- On-line cleaning and maintenance or replacement without having to shut down the sewer.
- Use air release valves suitable for use with pressure sewers.
- Do not use manually operated air release valves.
- Avoid major roadways and areas subject to flooding. Locate above flood level.
- Provide vacuum break valves, if negative pressure of 10 m head occurs.
- Provide permanent access for maintenance.
- Provide covered concrete chambers with adequate ventilation and permanent signage. Eliminate any odour issues and provide appropriate drainage for a water tight environment.

Verification: Verify that the depth of the pressure main accommodates the height of any specified air release or isolating valve.

**Collection/pump units for pressure sewerage**

Design flow: Provide the collection/pump capacity and overflow storage time based on minimum design flow in conformance with WSA 07 clause 7.1.

Design: To [0077 Sewerage systems-pump stations (Design)].

### 3.4 MAINTENANCE STRUCTURES

**General**

Location: Document the locations of all maintenance structures in conformance with WSA 02 clause 6.2 and 6.4 and Table 6.1.

Spacing of maintenance structures: Design the maintenance structures and spacing to allow access to every part of a sewer by using equipment installed on a service vehicle parked near to the boundary of the nearest road or readily accessible public land in conformance with WSA 02 clause 6.3.

Connections of new to existing sewer: Document the connection method and any necessary construction details.

**Maintenance holes (MHs)**

Design: Document the construction requirements and any proprietary items for the MH in conformance with WSA 02 clause 6.6 and WSA 02 Standard drawings SEW-1300 to SEW-1308. Including the following:
- Property connections into MHs.
- Diameters of MHs.
- MH base layout, including channels.
- Flotation.
- Ladders, step irons and landings.

Access covers: Document the details, crossfall and location of covers in conformance with AS 3996 and WSA 02 clause 6.6.9.

**Maintenance shafts (MSs), Terminal maintenance shafts (TMSs) and Inspection shafts (ISs)**

Design: Document location, depth and riser shafts for MSs, TMSs and ISs in conformance with WSA 02 clause 6.7. Document the tolerance for verticality so that the grade of the incoming sewer is within design tolerance.

### 3.5 ANCILLIARY STRUCTURES

**General**

Water seals, boundary traps and water-sealed MHs: Document location and type of water seal, boundary trap and/or water sealed MHs in conformance with WSA 02 clause 7.2 and WSA 02 Standard drawings SEW-1409, SEW-1410 and SEW-1411 and AS/NZS 3500.2.
Gas check MHs: Document the location and type of gas check MHs and provide for easy accessibility for maintenance in conformance with WSA 02 clause 7.3.

Vertical and near vertical sewers: Document location and construction details for vertical and near vertical sewers including any safety measures and access structures to WSA 02 clause 7.4.

Ventilation: Document location, type, materials and construction details for vents including any additional structures, equipment and protection measures, conform to WSA 02 clause 7.5 and WSA 02 Standard drawings SEW-1408 and SEW-1407.

Vortex inlets and water cushions: Document the location, type, materials and all the necessary structures, equipment and protection measures in conformance with WSA 02 clause 7.7.

Inverted syphons: Document the location, hydraulic capacity, driving head and the additional items listed in conformance with WSA 02 clause 7.8.2.

Overflows and emergency relief structures (ERS): Document the location and construction details in conformance with WSA 02 clause 7.9 and WSA 02 Standard drawing SEW-1412.

Flow measuring devices: Document the location, type, materials and all necessary equipment details for installation and testing of flow measuring devices, including any additional measures relating to recording and transmission of data in conformance with WSA 02 clause 7.10, Appendix B and Appendix C.

Wet weather storage: Determine and document the requirements for wet weather storage in conformance with WSA 02 clause 7.11, including the following:
- Capacity: Submit calculations for approval.
- Proposed method of releasing stored flows back into the system.
- Proposed cleaning and washing arrangements.
- Proposed ventilation arrangements.
- Proposed alarm devices for linkage to the remote monitoring system to alert when flow into the storage facility occurs.

Near horizontal boreholes
Near horizontal boreholes: Document the location, type, materials and construction details including any additional structures, features, equipment and protection measures in conformance with WSA 02 clause 7.6. Design for maintenance requirements as follows:
- Provide silt traps to conform with WSA 02 Table 7.2.
- Provide seamless, light coloured pipe liner keyed into wall of portal access or silt trap hole.
- Provide all weather access to the silt trap.

Maximum limits of deviation from level (vertical) and from line (horizontal): Do not exceed the greater of the following:
- Numerical value of the design grade (mm), providing no backfall > WSA 02 Table 6.1 at any point.
- Dn ≤ 1000:
  - Vertical deviation mm/100 m length: ± 30 (± 0.03%).
  - Horizontal deviation mm/100 m length: ± 50 (± 0.05%).

3.6 STRUCTURAL DESIGN

General
Design: Determine pipelines to resist structural failure and conform to AS/NZS 2566.1, AS/NZS 3725 or AS 4060 as relevant.

Structural considerations: Design pipelines to suit the following criteria:
- Site conditions.
- External forces: Including:
  - Trench fill loadings (horizontal and vertical due to the earth loading).
  - Surcharge.
  - Impact loads.
  - Groundwater effects.
  - Dead weight DN ≥ 1000.
  - Traffic loads.
  - Pipe stiffness.
Embarkment compaction strength of native soil live loads.

Foundation design and ground water control: Document special design details or construction details as required to mitigate difficult foundations and/or groundwater.

Piling: Provide structural support for buried pipelines if there is settlement potential.

Flotation: Provide resistance to flotation of empty pipe in water charged ground.

Trench design: Document minimum trench widths in conformance with SEW-1201, AS/NZS 2566.1 or AS/NZS 3725.

Pressure sewers: Do not use shared trenching for pressure sewers without approval.

**Geotechnical considerations**

Geotechnical assessment: To WSA 02 clause 8.6.

Sewers in engineered or controlled fill: Document to support the predicted settlement and the capacity of the pipeline to accommodate the movement in conformance with WSA 02 clause 8.6.2.

Sewers in non-engineered fill: Engage a geotechnical specialist to design the support and foundation remediation.

Construction of an embankment: Engage a geotechnical specialist to design the construction of an embankment, trench and bedding. Determine the relevant construction requirements in conformance with WSA 02 clause 8.6 and WSA 02 Standard drawings SEW-1203, SEW-1204 and SEW-1205.

Unforeseen ground conditions: If unforeseen ground conditions are encountered, review the structural design and make appropriate amendments.

**Sewers in unstable ground**

Avoid: Make all attempts to avoid construction of sewers through unstable ground including mine subsidence areas and slip areas.

Mine subsidence areas: Submit for approval by the Mine subsidence regulator any design for mains located in mine subsidence areas Conform to WSA 02 clauses 8.6.5 and 8.6.6, include the following:

- The expected strains on the pipeline resulting from potential subsidence.
- Use area specific ground strains available from the Mines subsidence regulator.
- Notate and endorse approved design.
- Jointing system.

Slip areas: Engage a geotechnical specialist to design the construction of sewers in slip areas. Minimise all potential for damage to a sewer caused by movement of unstable ground.

Water charged ground: Engage a geotechnical specialist to analyse the support and anchorage systems, pipe material and jointing methods.

**Above ground crossings**

Above ground pipelines: Document the pipeline supports and loading protection including for vandalism, exposure conditions, impact loading from traffic and external corrosion. Conform to WSA 02 SEW-1404, SEW-1405, SEW-1406.

**Bulkheads and trenchstops**

Design: Document bulkheads and trenchstops in conformance with WSA 02 clause 8.10,Table 8.1 and SEW-1206, SEW-1207.

Drainage: Provide details for trench drainage where required.

**Pipeline anchorage for pressure/vacuum sewerage**

Design: Document and detail pipeline anchorage required at all changes in direction, tees, valves, tapers and termination points exceptions include restrained joints and welded pipelines. Consider all horizontal and vertical forces arising from maximum allowable operating pressure.

Thrust blocks: Document the design for the thrust blocks including:

- Calculation of unbalanced thrust and resultant thrust.
- Temporary thrust blocks to conform to the permanent thrust blocks requirements.
- Size.
- Location: Must not protrude beyond the space allocation for the main.
- Where required use puddle flanges to transfer thrust.
- Timber and recycled plastics.
Anchor blocks design: Document to resist the unbalanced thrust due to the greater of the design pressure or test pressure to be imposed at the anchorage location and prevent movement of pipe bends in a vertical direction consisting of sufficient mass concrete to prevent pipe movement.

Restrained joint ductile iron water mains: Document the details including locations and any special construction techniques required. Conform to manufacturer’s recommendations for restrained jointing systems.

Design restraint requirements for special situations: Document any special requirements such as above ground mains with unrestrained flexible joints, buried steel mains with welded joints, above ground steel mains with welded joints, ductile iron and steel mains with flanged joints, PE mains.

**Mechanical protection of pipelines**

Requirement: Protect pipeline located under major infrastructure by design and documenting in conformance with WSA 07 clause 3.10, WSA 06 clause 3.10 and the following:

- Concrete encasement: Document encasement and connections. If concrete encasement is proposed, submit for approval and include the following:
  - Design as a beam to withstand external loadings where encased length of pipelines incorporated joints or the AHBP < 50 kPa.
  - Do not encase cast iron, wrought iron, AC pipe, lead joints, flanged joints, riveted pipe, sections of any main containing a service connection or valve (including air valves).

- Bored encasing pipe.
- Service pipe inside a carrier pipe.

### 3.7 MATERIALS

**General**

Products and materials: Conform to *Product and material information and guidance for sewerage code of Australia WSA02-2002, WSAA Product specifications* and Water Agency product catalogues.

**PVC non-pressure**

Standard: To AS/NZS 1260 and WSA 02 Table 10.1.

Detail: Document the sizes and configuration of pipeline systems including the following:

- Nominal diameter.
- Pipe pressure classification (SN).
- Material classification number (as necessary).
- Length of pipes.
- Types, materials and classes of fittings.
- Internal and external corrosion protection.

**Vitrified clay (VC) non-pressure**

Standard: To BS EN 295-1 and WSA 02 Table 10.1.

Elastomeric joints: To BS EN 681-1.

Detail: Document the sizes and configuration of pipeline systems including the following:

- Minimum crushing strength.
- Nominal diameter.
- Pipe pressure classification.
- Joint type.
- Length of pipes.
- Types, materials and classes of fittings.
- Internal and external corrosion protection.

**Ductile iron gravity or pressure sewers**

Standard: To AS/NZS 2280 and WSA 02 Table 10.1.

Detail: Document the sizes and configuration of pipeline systems including the following:

- Nominal diameter.
- Pipe series (CIOD or ISO).
- Pipe pressure classification (PN).
- Joint type.
- Length of pipes.
- Types of fittings.
- Internal and external corrosion protection.
- Restrained joint seals.

Sleeving: PE sleeving to bituminous coated DI pipes to AS 3681.

Flange class DI pipes: Fully support flange in the installed condition. Include instructions for preventing loading of the flange during installation.

Flanged joints to AS/NZS 4087: Document the type of flange gasket and the tightening sequence.

Corrosion protection: Document one of the following on the drawings:
- Cement mortar lining: To AS/NZS 2280, or
- Thermal-bonded medium density polyethylene: To AS/NZS 4158.
- Epoxy coating: To AS 3862.

Polyethylene sleeving: To AS 3680.

Joints: Elastomeric seal to AS 1646.

Protection: Provide wrapping for unprotected joints in the trench with an approved petrolatum tape system or approved alternative.

Bolts and nuts: To AS 2129 and galvanized to AS 1214 or stainless steel to ASTM A276.

**Glass reinforced plastic (GRP) non-pressure**

Standards: To AS 3571.2 and WSA 02 Table 10.1.

Detail: Document the sizes and configuration of pipeline systems including the following:
- Nominal diameter.
- Pipe series.
- Pipe pressure classification (PN).
- Pipe stiffness classification (SN).
- Joint type.
- Length of pipes.
- Types of fittings.

Pressure sewers: GRP pipe to ISO 10467.

**PVC pressure/vacuum sewer**

Standard: Conform to WSA 02 Table 10.3 and the following:
- PVC-U: To AS/NZS 1477.
- PVC-M: To AS/NZS 4765 series 2.
- PVC-O: To AS/NZS 4441 series 2.
- Vacuum pipes and fittings: To WSA 06 clause 9.5.2.

Detail: Document the sizes and configuration of pipeline systems including the following:
- Nominal diameter.
- Pipe series (1 or 2).
- Pipe pressure classification (PN).
- Material classification number (as necessary).
- Length of pipes.
- Types, materials and classes of fittings.
- Internal and external corrosion protection.

**Steel pipeline systems**

Detail: Document the sizes and configuration of pipeline systems including the following:
- Nominal diameter: To AS 1579 Appendix C.
- Rated pressure.
- Joint type: To AS 1579 Appendix E.
- Length of pipes.
- Types of fittings: To AS 1579 Appendix D.
- Internal and external corrosion protection including cathodic protection if appropriate.
- Flanged joints, class of flange, type of flange gasket and the tightening sequence: To AS/NZS 4087. Steel water mains: Submit for approval by the Water Agency for use in reticulation systems. Gasket types: Document full face (FF), inside bolt circle (IBC), tongue and groove (TG), spigot and recess (SR), single flat sheet, laminated ply or moulded. Insulated flanged joints: Document if steel pipes, fittings and other steel appurtenances are jointed to flanges and/or flange backing plates of dissimilar metals such as copper, copper alloys, galvanized steel and stainless steel. Insulated flanged joints are not required where joining to wrought iron flanges, grey cast iron flanges or ductile cast iron flanges. Pipe jointing: Document one of the following on the drawings:
  - Elastomeric seal jointed with seals conforming to AS 1646.
  - Butt welded, welded spigot and socket, or welded using a welding collar and with the application of a polyethylene heat shrunk sleeve over the weld, or wrapped.
  - Flanges: To AS/NZS 4087.
Protection: Provide wrapping for unprotected joints in the trench with an approved petrolatum tape system or approved alternative.
Bolts and nuts for flanged joints: To AS 4087 clause 3.2.

**PE pipeline systems**

PE pipeline: To WSA 01.
Detail: Document the sizes and configuration of pipeline systems including the following:
  - Nominal diameter.
  - Pipe pressure classification (PN).
  - Material class (PE80 or PE100).
  - Length and form of pipes (straight lengths or coils).
  - Types, materials and classes of fittings.
  - Internal and external corrosion protection.
Jointing: In conformance with WSA 01.
Mechanical couplings: Self restraining.
Stub flanges and backing rings: Conform to POP 007.
Flanges: Conform to AS 2129, AS/NZS 4331.1 and AS/NZS 4087.
Polyethylene (PE) pipe: To AS/NZS 4130 and WSA 02 Table 10.2.
PE Fittings: To AS/NZS 4129.
Bending: To AS 2033.
Vacuum pipes and fittings: Conform to WSA 06 clause 9.5.3.

**Polypropylene (PP) non-pressure**

Standard: To AS/NZS 5065 Type B ID series and conform to WSA 02 Table 10.2.
Pipe stiffness class: SN 10.
Elastomeric joint seals: To AS 1646.
Detail: Document the sizes and configuration of pipeline systems including the following:
  - Nominal diameter.
  - Length of pipes.

**ABS pipes and fittings**

Acrylonitrile butadiene styrene (ABS) pipes and fittings: To AS 3518 and joined in conformance with the manufacturer’s recommendations using solvent cement to AS 3879.
Pipe class: Provide for cyclic loading.

**Reinforced concrete (PVC lined)**

Standard: To AS/NZS 4058 and WSA 113.
Testing: To AS/NZS 4058 Appendix A including crack load, ultimate load, hydrostatic pressure, dimensional accuracy, cover, joint assembly.
Detail: Document the sizes and configuration of pipeline systems including the following:
  - Nominal diameter.
  - Pipe load class.
- Configuration of bends.
- External coatings for aggressive soils.
- Lifting holes if required.
- Any additional cover.
- Length.
- Types, materials and classes of fittings.
- Internal and external corrosion protection.

**Protection against degradation**

Detail: Document measures to protect all pipeline system items (e.g. pipes, fittings, appurtenances, elastomeric seals) including the following:

- Eliminate contact between dissimilar metals to prevent galvanic corrosion.
- Protective coatings for some metallic components and concrete structures, suitably designed for various corrosivity levels of soil and groundwater.
- Fully sealed conduits for plastic pipes and fittings in contaminated ground.
- Fully sealed conduits for all elastomeric seal jointed pipes and fittings in contaminated ground.
- Control trench fill and pipe embedment materials.
- Mitigate stray current or other effects on buried steel pipelines.
- Cathodic protection for buried steel pipelines to AS 2832.1 and AS 2832.2.

Protection against damage to coatings: Provide for more than one thickness of PE sleeving between coated fittings, valves and other appurtenances and thrust and anchor blocks.

Stainless steel: Grade 316 or 316L, welding requirements to AS/NZS 1554.6 and threaded component details.

Protection against contaminated ground: Fully welded externally coated or wrapped steel pipeline. Submit alternatives for approval by the Water Agency.

Bolted galvanized connections: An encapsulating system using priming paste wrapped with petrolatum tape or PE sleeving.

**Valves**

Isolation valves: Conform to WSA 07 clause 5.4 and the following:

- Minimum PN 16.
- Clockwise closing.
- Waterway internal diameter > 90%.
- ≥ DN 80: Flange or restrain-joint socketed resilient seated gate valve.
- < DN 80: Resilient seated ball valves.
- Anchor valves ≥ DN 80 if not flanged or restrained-joint socketed.
- Flange gaskets: > 3 mm thick full face NBR or EPDM rubber to WSA 109.
- Capable of being locked in the open and closed positions.

Air release and vacuum break valves: Conform to WSA 07 clause 5.5 and the following:

- Combination air release valves with a large orifice and small orifice in a single unit preferred at the high points.
- Large orifice minimum size: ≥ DN 50 for installation on pressure sewers ≤ DN 280.

Division valves on vacuum sewers: Conform to WSA 06 clause 9.6.

Vacuum interface valves: Conform to WSA 06 clause 10.2.

### 3.8 VACUUM SEWERAGE ADDITIONAL REQUIREMENTS

**Application of vacuum sewerage**

Vacuum sewerage design: Consider the application of a vacuum sewerage system in conformance with WSA 06 clause 1.5.3. Address the following in the vacuum system design:

- Vacuum and gravity configuration.
- Locations for vacuum station and discharge point.
- System characteristics including head, vacuum and discharge capacity, generator and pump type, pressure main and pipe work requirements, vacuum interface valve type, vacuum tank, collection chamber and collection sump volumes, operating levels.
- Size(s) and grades of sewers throughout the relevant portion of the proposed vacuum system to meet concept plan requirements.
- Material type(s) and class(es) in conformance with the concept plan.
- Sewer layouts and alignments including route selection, topographical and environmental aspects, easements, foundation and geotechnical aspects, provisions for future extensions, types and locations of maintenance structures, overflows and vents, property service connection locations.
- Document all assumptions and review assumptions during construction.
- Unforeseen ground conditions arising during construction.

**Detailed design**

Vacuum sewer design flows: Conform to WSA 06 Tables 5.1, 5.2 and 5.3 for PVC-U, PVC-M and PE80.

Air to liquid ratios: Relate to the longest vacuum sewer in conformance with WSA 06 Table 5.4.

Vacuum station design: Conform to 0077 Sewerage systems-pump stations (Design).

**Vacuum sewer design**

Sewer layout: Document the sewer layout to conform with WSA 06 clause 9.2 and the following:
- Main routes: Select to minimise lift and length, equalise flows on each vacuum main, provide adequate access for operation and maintenance and efficiently connect to properties.
- Split catchments into appropriate zones.

Headloss: Determine headloss to conform with WSA 06 clause 9.3 including the available vacuum, friction loss and static lift loss.

Sewer profiles: Level grade, upgrade and downgrade profiles to conform with WSA 06 Figures 9.2 and 9.3. Lift pitches and lift heights to conform with WSA 06 Table 9.1. Profile design to conform with WSA 06 clause 9.4.2.

Connections: Conform with the following:
- Connection to vacuum vessel: Conform to WSA 06 Figure 9.4.
- Connecting sewers: Conform to WSA 06 clause 9.4.5.
- Bends: Conform to VAC-1100 and VAC-1102.
- Waterlogging: Conform to clause 9.4.7.

Pumping system and pump discharge pipework: Conform to 0077 Sewerage systems-pump stations (Design)

### 4 DOCUMENTATION

#### 4.1 GENERAL

**Design**

Design review: Demonstrate compliance with the concept plan and WSA 02 clause 9.1.

Project design documentation: Provide project-specific information including the following:
- Detailed drawings including location of all relevant obstructions.
- Specifications for products, materials, site investigation, excavation/trench details, size pressure class, jointing methods, corrosion protection measures and other technical matters.
- Design assumptions and constraints.

Asset categorisation:
- Risk assessment of final design for consistency with asset categorisation of concept plan.
- Surge analysis and design for surges.
- PN of system components.
- Operations and maintenance training manuals.

**Specifications**

Construction documentation: Provide project specific completed specification 1361 Sewerage systems – reticulation (Construction).

**Design certification**

Requirement: Provide a signed and dated design certificate.
4.2 DRAWINGS

General
Design drawings: Provide design drawings to WSA 02 clause 9.2, WSA 04 clause 15.2, WSA 06 clause 19.1 and 19.2 and include the following:
- Pipeline acronyms: Use the WSAA acronym's provided at www.wsaa.asn.au.

Drawing scale, size and format
Drawing scale:
- Detail plans scale: 1:500.
- Longitudinal sections.
- Horizontal scale: 1:1000.
- Vertical scale: 1:100.
Drawing size: Consultation with the relevant Water Agency.
Drawing format: Provide in electronic form after consultation with the relevant Water Agency.
Symbols: Conform to AS 1102.
All wires and terminals: Numbered.

Drawings content
Requirement: Provide design drawings to include the following:
- Plan:
  - Lot boundaries and lot numbers.
  - Location and chainage of all maintenance holes, junctions and dead ends.
  - MH types.
  - Location and size of all gravity and rising mains and pump stations.
  - Location of pipelines, valves and vents.
  - Sewer main number and maintenance hole number.
  - Existing sewer mains, junctions and maintenance holes.
  - For level lots, spot levels at the lot extremities to show that at least 90% of the area of the lot can be connected to the sewer by gravity.
  - Hatching to show the area of any lot not serviced.
  - Site contours.
  - Existing and proposed features and services.
  - North point and scale bar.
  - Easement location.
  - Arrangement of other utilities.
- Longitudinal section:
  - Reduced levels for natural surface and design surfaces at all changes in grade.
  - MH locations and type.
  - MH numbered in conformance with the Sewer Authority’s Asset Register.
  - Invert levels for maintenance holes inlet and outlet.
  - Size, type, class and grade of pipe.
  - Location, invert level and size of all drainage lines, water mains, and other utility services crossing the main.
  - Notation regarding all joining lines.
  - Property ownership.
  - Note ‘In road’ trench conditions.
- Pipe protection: Details of corrosion protection required for pipes and fittings.
- Trenchless installation: Areas designated for trenchless pipe installation.

Asset register
Maintain: Provide asset schedules and drawings in a form consistent with the existing or proposed Asset Register after consultation with the Water Agency.
4.3 WORK-AS-EXECUTED

Work-as-executed drawings
General: Provide additional set of final construction drawings for the purpose of recording the work-as-executed by the Contractor.
Requirements for recording: Document the requirements for recording work-as-executed drawings including the GPS coordinate points.