A4 Stormwater Drainage Design

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A4 STORMWATER DRAINAGE DESIGN

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4.1 INTRODUCTION

The City of Sydney Stormwater Drainage Design Technical Specifications have been developed to ensure the provision of high-quality stormwater infrastructure compatible with the City's maintenance, asset management and serviceability requirements.

These Technical Specifications are output-based and define the criteria that must be satisfied by stormwater networks that are to be owned by the City or located on public land within the City's local government area. Stormwater infrastructure shall be designed by suitably qualified and experienced professionals and in compliance with these Technical Specifications and all relevant legislation, standards and current practice.

This document shall be read in conjunction with B10: Stormwater Drainage Construction, all other parts of the City's Sydney Streets Technical Specifications, and Part C: Standard Drawings.

4.2 EXCEPTIONS

Departures to the requirements stipulated in the City's Sydney Streets Technical Specifications, A4: Stormwater Drainage Design, B10: Stormwater Drainage Construction and Part C: Standard Drawings are only permitted with the written approval of the City's Principal Engineer Environment & Water.

Variations shall be requested in writing using the Drainage Standards Variation Form and a Drainage Standards Variation Approval Summary Sheet signed by the Principal Engineer Environment & Water and shall be obtained prior to construction. They are both available in Annexure B and can be downloaded from the City's website. Failure to gain approval prior to construction may result in an order to remove, redesign or reconstruct non-compliant elements.

Written approval shall be required for each instance of non-compliance and shall include a comprehensive explanation of the following:

- Description of the proposed variation
- Clauses for which variation is sought
- Justification as to why compliance is not possible.

Where the variation is sought during construction, justification as to why the variation was not reasonably foreseeable during the Construction Certificate or detailed design stages is also required.

4.3 CERTIFICATION

Stormwater infrastructure shall be designed by suitably qualified and experienced professionals and certification shall be required stating that the proposed design complies with:

- City's Sydney Streets Technical Specification A4: Stormwater Drainage Design
- City's Sydney Streets Technical Specification B10: Stormwater Drainage Construction
- City's Sydney Streets Part C: Standard Drawings
- All other relevant standards.

Certification is also required for the hydraulic and structural design of all elements. Structural certification is not required for items constructed as per City of Sydney standard drawings.

4.4 RELEVANT STANDARDS

Stormwater drainage shall be designed and constructed in accordance with all relevant standards. This includes the following standards; however, it should be noted that the following list is not exhaustive. The requirements of these technical specifications will prevail where the following standards are in conflict with it:

- Sydney Streets Technical Specifications
- Sydney Streets Technical Specification B10: Stormwater Drainage Construction
- Sydney Streets Standard Drawings
- The relevant Australian Rainfall and Runoff Projects, numbers 1 to 21 inclusive
- Australian Runoff Quality, A Guide to Water-Sensitive Urban Design, Engineers Australia, 2006
- The Constructed Wetlands Manual, Volume 1 and 2, NSW Department of Land and Water Conservation, 1998
- Condition Assessment & Asset Performance Guidelines, Practice Note 5: Stormwater Drainage, Institute of Public Works Engineering Australia
- AS 1210 Pressure vessels
- AS 1214 Hot dip galvanised coatings on threaded fasteners (ISO Metric Coarse Thread Series)
- AS 1254 Unplasticised PVC (UPVC) pipes and fittings for storm or surface water applications
- AS 1260 PVC pipes and fittings for drain, waste and vent applications
- AS 1289 Methods of testing soils for engineering purposes
- AS 1302 Steel reinforcing bars for concrete
- AS 1303 Hard drawn steel reinforcing wire for concrete
- AS 1304 Welded wire reinforcing fabric for concrete
- AS 1463 Polyethylene pipe extrusion compounds
- AS 1579 Arc-welded steel pipes and fittings for water and waste-water
- AS 1597 Precast reinforced concrete box culverts
- AS 1646 Rubber joint rings for water supply, sewerage and drainage purposes
- AS 1741 Vitrified clay pipes and fittings with flexible joints – sewer quality
- AS 1831 Ductile cast iron
- AS 2032 Code of practice for installation of UPVC pipe systems
- AS 2566.1 Buried flexible pipelines – structural design
- AS 2865 Safe working in confined space
- AS 3500 National plumbing and drainage code – compendium
- AS 3500.3 Stormwater drainage – plumbing and drainage – stormwater drainage
- AS 3600 Concrete structures
- AS 3725 Loads on buried concrete pipes
- AS 3735 Concrete structured for retaining liquid
- AS 3972 Portland and blended cements
- AS 3996 Metal access covers, road grates and frames
- AS 4058 Precast concrete pipes (pressure and non-pressure)
- AS 4139 Fibre reinforced concrete pipes and fittings
- AS 3571-1989 Glass filament reinforced thermosetting plastics (GRP) pipes – Polyester based – Water supply, sewerage and drainage applications
- AS/NZS 5065 Polyethylene and polypropylene pipes and fittings for drainage and sewerage applications
- Polyethylene pipe code 2004 3rd Edition Version 3.1– Water Services Association of Australia
- ISO 10467:2004 Plastic piping systems for pressure and non-pressure drainage and sewage – Glass

reinforced thermosetting plastics (GRP) systems based on unsaturated polyester resin.

- ISTT Trenchless Technology Guideline – Cured in place lining systems, new version August 2005
- ISTT Trenchless Technology Guideline – Close fit thermoplastic lining, new version August 2005
- ISTT Trenchless Technology Guideline – Pipe bursting and splitting, new version June 2005.

4.5 DATA REQUIREMENTS

The following information shall be provided where relevant with every detailed design or Construction Certificate that includes stormwater infrastructure:

- General Plan (services and drainage plan)
- Utilities investigation plan
- Longitudinal sections
- Drainage Details
- Relevant City of Sydney standard drawings
- Certification of Design
- Drainage Design Variation Form
- Catchment Plan
- Hydrologic and Hydraulic Design Data
- Water Quality Design Data
- Environmental Impact Assessment
- Structural Certification.

The following information shall be required for any project that requires stormwater relining works:

- A plan showing the extent of the proposed relining works including the size of the host conduit
- Details of any proposed additional structures or modification of existing structures in order to gain access to undertake the Works, including all relevant City of Sydney standard drawings
- Structural requirements for the liner, the method of relining to be undertaken and design calculations with certification of the structural capacity of the liner
- CCTV of the host conduit depicting current conditions
- Information regarding kerb outlet connections is only required on the General Plan.

The following sections provide additional detail on the requirements for each item listed above. Annexure A provides design checklists to ensure all relevant information is included with drainage designs.

4.5.1 GENERAL PLAN

A general plan of the proposed Works shall be provided at a suitable scale such as 1:200 at A3 and include the following:

- Title block, legend, north point, scale and scale bar
- Property boundaries
- Roads and road names
- Proposed development
- Existing and proposed levels, e.g. stormwater, road, footpath, other topographical features, etc.
- Relevant topographical features
- Existing stormwater network
- Proposed stormwater network
- Dimensions and/or coordinates accurately identifying the position of all stormwater assets without the need to scale positions off plans

- Stormwater pits and structures labelled from upstream to downstream using "line number/pit number" format
- Labels or schedule identifying the requisite pit or structure types, properties and relevant standard drawing or detail
- Existing and proposed pipe or conduit size
- Appropriate labels describing the proposed Works.

4.5.2 UTILITIES INVESTIGATION PLAN

A Utilities Investigation Plan shall be prepared documenting the position of all services in the vicinity of the proposed stormwater works. The plan shall be provided at a suitable scale such as 1:200, 1:250 or 1:500 at A3 and include the following:

- Title block, north point, scale and scale bar
- Property boundaries
- Road and road names
- Existing and proposed stormwater
- Location of all utilities services
- Location of potholing and surveyed service levels
- Photographs of potholed services.

Where the services investigation is large and complex, the above plan can be supplemented with a detailed service investigation report.

4.5.3 LONGITUDINAL SECTIONS

Longitudinal sections of all stormwater conduits are required for all projects where the total length of new conduit exceeds 4.8 metres.

Notwithstanding the above, longitudinal sections are not required in the following circumstances:

- Relining of existing stormwater conduits
- Replacing existing conduits like for like and there are no service intrusions in the existing conduits.

4.5.3.1 SCALE AND DATUM

Scales: 1:200 (H) 1:20 (V) at A3

1:250 (H) and 1:25 (V) at A3

Datum: AHD

4.5.3.2 TITLE BLOCK

Title block, legend, scale and scale bar shall be provided.

4.5.3.3 DIAGRAMS

The following shall be drawn on the upper portion of the longitudinal sections:

- Invert
- Obvert
- Surface
- Pits and structures
- Pit/structure labels in the form of 'Line Number/Pit Number'
- 5% AEP HGL
- 1% AEP HGL

- Position of other services crossing pipeline from survey of potholed services
- Linetype of different colours labelling service utilities with type of service and type and number of conduits.

4.5.3.4 LABELS

The middle portion of the longitudinal sections shall indicate the length of each reach and include the following information:

- Dimension/type/strength class of steel reinforced concrete pipe
- Length and grade %
- 5% AEP peak flow rate.

4.5.3.5 DATA TABLE

The lower portion of the longitudinal section shall include a data table with the following information:

- Datum
- WAE invert (blank space to be completed post construction)
- 5% AEP HGL level
- Existing surface level
- Proposed surface level
- Design invert level
- Chainage.

4.5.4 DRAINAGE DETAILS

Details shall be provided for all stormwater structures not covered by the City of Sydney standard drawings. Details shall be provided at an appropriate scale such as 1:20 at A3 and include all relevant detail to document the physical and structural features. Detail includes but is not limited to the following:

- Title block, legend, scale and scale bar
- Plan of each structure
- Sections as appropriate
- All dimensions
- Prefabricated items such as covers
- Structural steel design
- Notes and specifications.

4.5.5 CITY OF SYDNEY STANDARD DRAWINGS

Where possible City of Sydney standard drawings shall be used. A copy of all referenced City of Sydney standard drawings shall be provided with the Construction Certificate and construction drawings.

4.5.6 DRAINAGE DESIGN VARIATION FORM

The Drainage Design Variation Form and Variation Approval Summary Sheet are only required where a variation to the Technical Specifications is requested. They are both available in Annexure B of this chapter and can be downloaded from the City's website.

The purpose of the Drainage Design Variation Form is to:

- Document the proposed scope and extent of non-compliance
- Identify the elements of the Stormwater Design and Construction Technical Specifications where variance is sought

- Provide a justification for the proposed variation.

The purpose of the Variation Approval Summary Sheet is to:

- Summarise the proposed variance
- Provide written approval or refusal of the variation request.

Where a variation to the design or construction specifications is sought during the construction phase of a project, justification is required as to why the variation could not have been reasonably foreseen during the detailed design or construction certificate stages.

The following are not considered to be valid justifications for a variation:

- Failure to undertake proper services locating and potholing during the Construction Certificate or detailed design phases
- In order to avoid modifications to development consent or proposed design
- In order to avoid redesigning, removing or reconstructing elements that have already been constructed as a cost saving measure.

4.5.7 CATCHMENT PLAN

A catchment plan shall be provided at a suitable scale such as 1:500 at A3 and include the following:

- Title block, north point, scale and scale bar
- Property boundaries
- Pit and pipe layout
- Pit labels
- Sub-catchment delineation
- Label indicating catchment area
- Flow direction arrow pointing to outlet.

4.5.8 HYDROLOGIC AND HYDRAULIC DESIGN DATA

The hydrologic and hydraulic capacity of the stormwater network shall be designed in accordance with Section 4.7 of this chapter. The hydrologic and hydraulic design shall be provided to the City as either a DRAINS File and supporting information in accordance with Section 4.5.8.1 or as a comprehensive design report and design summary sheets as outlined in section 4.5.8.2.

4.5.8.1 DRAINS FILE REQUIREMENT

Where the DRAINS hydrologic and hydraulic modelling software is used for the design of the stormwater network, a copy of the DRAINS modelling file shall be provided. The modelling file shall conform to the following:

- The Catchment Plan outlined in Section 4.5.7 shall be used as a background with the modelled drainage network elements schematised in their true positions on the plan
- The stormwater network shall be schematised in the model at full scale and in its actual position on the background plan
- All required storm events and durations
- The extended hydrological parameters shall be used
- Standard Drains pit inlet capacity curves shall be used wherever appropriate
- Where non-standard pit inlet capacities are used, a supplemental report shall be provided outlining the calculation and justification for the adopted inlet capacities.

4.5.8.2 HYDROLOGIC AND HYDRAULIC DESIGN REPORT

Where the DRAINS hydrologic and hydraulic modelling software is not used for the design of the stormwater network, a comprehensive stormwater design report as well as hydrologic and hydraulic

design summary tables shall be provided.

The Stormwater Design Report shall include the following:

- A description of the hydrologic and hydraulic modelling software package used including the suitability of the software for this purpose
- The methodologies employed in the calculation of rainfall, runoff and hydraulic capacity
- The adopted pit inlet capacities
- Where non-standard pit inlet capacities are used, the calculation and justification for the adopted inlet capacities
- The hydrologic and hydraulic parameters utilised and the appropriateness of the selected values
- Description and justification of boundary conditions
- Completed hydrologic and hydraulic design summary tables as specified in Annexure C shall be provided.

4.5.9 WATER QUALITY DESIGN DATA

Water quality improvement devices shall be designed in accordance with Section 4.12 of this chapter. The water quality improvement design shall be provided to the City as either a MUSIC File and supporting information in accordance with Section 4.5.9.1 or as a comprehensive design report and design summary sheets as outlined in Section 4.5.9.2.

4.5.9.1 MUSIC FILE REQUIREMENT

Where the MUSIC water quality improvement modelling software is used for the design of the water quality improvement devices network, a copy of the MUSIC modelling file shall be provided.

4.5.9.2 WATER QUALITY IMPROVEMENT DESIGN REPORT

Where the MUSIC modelling software is not used for the design of the stormwater quality improvement devices, a comprehensive design report shall be provided.

The design report shall include all relevant information including the following:

- A description of the water quality improvement device modelling software package used, including the suitability of the software for this purpose
- The methodologies employed in the calculation of pollutant reductions
- The device bypass design arrangements
- The parameters utilised and the appropriateness of the selected values.

4.5.10 ENVIRONMENTAL IMPACT ASSESSMENT

- Where the stormwater works are to be undertaken as part of a Development Consent, the environmental impacts were assessed as part of the Development Application and further assessment is not required.
- Where the Works are to be undertaken without a Development Application, the environmental impacts of the stormwater works shall be assessed as part of a Review of Environmental Factors.

4.5.11 STRUCTURAL CERTIFICATION

Certification of the structural design is required for all stormwater structures except for City of Sydney standard drawings. The structural certificate shall be accompanied with the detailed design calculation of the structure.

All structures shall be designed to achieve 100 years' life expectancy and shall be designed in accordance with relevant Australian Standards. All concrete structures shall be designed and constructed as if they are liquid- retaining structures to minimise cracks and maximise the life expectancy of structures.

4.6 DATA HANDOVER

The following is required to be provided to the Environment & Water Team upon completion of the project:

- Marked "Works as Executed" plans
- Asset location file
- Asset data sheet
- CCTV of newly constructed conduits.

Where water quality improvement devices are created, the above information shall be accompanied by the following:

- Product specifications for all prefabricated GPT devices installed
- Operation and maintenance manual for each GPT device.

Where stormwater-relining work has been undertaken, the following information shall be provided upon completion of the project:

- Lining product specification and material data sheets
- Structural design documentation
- CCTV of host pipe prior to commencement of Works
- CCTV of host pipe with all preparations completed and ready to accept the new liner
- CCTV upon completion of lining demonstrating proper installation of liner.

4.6.1 WORKS AS EXECUTED DRAWINGS

Plans of Works-As-Executed shall be provided electronically in PDF format consisting of the design plan with red line markings indicated as-built data. The as-built data shall include the following:

- The position of all stormwater assets
- Pipe sizes and invert levels at the upstream and downstream ends of each pipe reach
- A description of all pits and structures including the type, grate, cover and kerb inlet length
- Pit and structure invert and surface levels.

4.6.2 ASSET LOCATION FILE

A shape file shall be supplied indicating the position of pipes, pits, structures and other stormwater assets. Each asset type shall be represented as outlined in **Table *1***. The positions shall be provided in the GDA2020, MGA2020 Zone 56 coordinate system. Each asset shall be provided with a unique label.

Table 1- SHAPE FILE PROPERTIES

Asset type	Feature type	Notes
Conduit	Line	Centre line of conduit
Pit	Point	Centre of grate along the kerb line. Where there is no kerb line, the centre of the pit structure shall be used
Headwall	Point	Centreline of the outlet pipe on the wall
GPT	Point	Centre of the GPT structure. Where the unit consists of multiple structures then the

Asset type	Feature type	Notes
		centre point of each structure shall be provided
Raingarden	Polygon	Polygon representing the extent of planting for each raingarden.

4.6.3 CCTV FOOTAGE

CCTV footage shall be provided for all new pipes and for all existing pipes modified. The footage shall comply with the following:

- The files shall be in MPG4 format
- File resolution shall be minimum 640 by 480 pixels, 3Mbps and 25 frames per second
- Each pipe reach (i.e. between two pits) shall be provided as a separate file
- The CCTV inspection shall be undertaken in accordance with the IPWEA Condition Assessment & Asset Performance Guidelines, Practice Note 5, Stormwater Drainage
- The speed and panning of the footage shall be sufficient to demonstrate that there are no significant cracks in the pipe and that the joints have been properly constructed
- The files shall have a name corresponding with the unique label provided in the DXF file and asset data sheet
- A summary report (*.pdf) shall accompany the data.

4.6.4 PRODUCT SPECIFICATIONS

Product specifications and all available guarantees shall be provided for all prefabricated products used such as gross pollutant traps and relining products.

4.6.5 OPERATION AND MAINTENANCE MANUAL

Where gross pollutant traps or other water-quality devices or non-standard assets (excluding raingardens) are constructed, an operation and maintenance manual shall be provided, which shall cover the following:

- Description of the asset and its components
- The design life of the asset and the individual components
- The maintenance procedures, frequency and equipment needs
- Demonstrated appropriate vehicle and equipment access
- Cost for all required maintenance activities
- A copy of the design plans, Works as Executed plans, specifications, instruction manuals and warranties for the asset.

4.7 HYDROLOGIC AND HYDRAULIC DESIGN CRITERIA

4.7.1 GENERAL STANDARDS

General standards for hydraulic design are as follows:

- Relevant Australian Rainfall and Runoff Projects, numbers 1 to 21 inclusive
- Be consistent with current industry best practice.

The requirements of these technical specifications will prevail where the above standards are in conflict.

4.7.2 HYDROLOGIC DESIGN

The hydrologic and hydraulic design shall comply with the following:

- Appropriate hydrologic and hydraulic modelling software shall be used
- Hydrology shall be determined using the ILSAX type time-area method or an appropriate storage routing model
- The use of methods such as the Rational, Advanced Rational or Probabilistic Rational methods is not permitted
- The use of hand calculations or design charts is not permitted.

4.7.2.1 DESIGN STORMS

The stormwater network shall be designed in accordance with the Major/Minor design concepts outlined in Australian Rainfall and Runoff, A Guide to Flood Estimation. Design storms shall be as follows:

- Major: 1% AEP, also referred to as 100 year Average Recurrence Interval (ARI) .
- Minor: 5% AEP, also referred to as 20 year ARI.

Simulation of additional design storms may also be required in order to comply with Section 4.7.4 and Section 4.7.5.

4.7.2.2 STORM DURATIONS

All design storms shall be simulated for the following durations:

- 5 minutes
- 10 minutes
- 15 minutes
- 20 minutes
- 25 minutes
- 30 minutes
- 45 minutes
- 60 minutes
- 90 minutes
- 120 minutes.

The worst-case duration shall be used for determining the required capacity of each structure and conduit.

4.7.3 HYDRAULIC DESIGN

Hydraulic calculations shall comply with the following:

- Appropriate hydrologic and hydraulic modelling software shall be used
- The capacity of conduits shall be calculated using hydraulic grade line analysis
- All conduits shall meet the required Minor Storm capacity without pressurisation
- Surcharging of the network is not permitted, except for the downstream reach where connecting to an existing network with capacity less than the 5% AEP
- Open-channel capacity shall be determined using appropriate open-channel hydraulic methods such as solving the energy equation using the standard step method
- Open-channel capacity shall not be determined using simplistic methods such as a single application of the Manning equation
- The use of hand calculations, design charts or monograms is not permitted.

4.7.3.1 INLET CAPACITY

Inlet capacity shall be determined in accordance with published industry data where available.

Additional information regarding the inlet capacity of certain existing inlet types commonly found in the City has been provided in Annexure E. Where available, the City's inlet capacity data shall be used.

Where non-typical inlet types are utilised and no published data is available, an appropriate relationship shall be determined. Documentation of the method used in deriving the relationship as well as a justification for the selected method shall be provided.

4.7.3.2 INLET BLOCKAGE FACTORS

Blockage factors shall be applied to all stormwater inlets as outlined in **Table *2*** below.

Table 2 - *PIT DESIGN BLOCKAGE FACTORS*

Pit type	On grade blockage factor	Sag blockage factor
kerb inlet <= 1.0 m	50%	70%
kerb inlet > 1.0 m	20%	50%
V grate or grate only	90%	90%
Strip drain or other	95%	95%

Should the pit design specifications lie outside the table above, Australian Rainfall and Runoff (ARR) Project 11 – "Blockage of Hydraulic Structures" should also be consulted and a valued derived by the ARR method adopted, subject to the approval of the Principal Engineer Environment & Water, City of Sydney.

4.7.3.3 OVERLAND FLOW LIMITS

Gutter flows and overland flow paths shall comply with the requirements in the following tables. The carriageway width indicated in the tables below shall be calculated from kerb face to kerb face ignoring parking bays. AEP is Annual Exceedance Probability.

Table 3 - *1% AEP GUTTER FLOW LIMITS FOR CARRIAGEWAYS <= 7 METRES WIDE*

Criteria	Limit
Maximum depth	100 mm
Maximum flow width	3.0 m
Maximum depth x velocity	0.6 m^2/s

Table 4 - *1% AEP GUTTER FLOW LIMITS FOR CARRIAGEWAYS > 7 METRES WIDE*

Criteria	Limit
Maximum depth	150 mm
Maximum flow width	3.5 m
Maximum depth x velocity	0.6 m^2/s

Table 5 - 1% AEP OVERLAND FLOW LIMITS FOR PEDESTRIAN AND SHARED ZONES

Criteria	Limit
Maximum depth	50 mm
Maximum flow width	1.5 m
Maximum depth x velocity	0.4 m^2/s

4.7.3.4 PIT LOSSES

Pit losses shall be determined in accordance with published 'Missouri Chart' references.

4.7.3.5 DOWNSTREAM BOUNDARY CONDITIONS

Where a network is being sized in accordance with the Minor Storm requirements, the downstream starting level for the hydraulic grade line shall be the higher of the following for the Minor Storm:

- The obvert of the pipe
- Ocean Boundary Conditions consistent with the relevant City of Sydney flood study, available on City's website.
- Hydraulic Grade Line of the downstream connection conduit
- 150mm below the surface, where the downstream conduit capacity is less than the 5% AEP.

Where the impacts of a proposed network are being analysed, the downstream starting level for the hydraulic grade line shall be the higher of the following:

- The obvert of the pipe
- The hydraulic grade line of the downstream network for the same storm event
- For flood prone land, flood levels reported in the relevant City of Sydney flood study
- Ocean boundary conditions consistent with the relevant City of Sydney flood study.

4.7.4 ADVERSE IMPACTS

Stormwater networks shall also be analysed for the 20% AEP and 10% AEP when:

- Connecting to an existing stormwater network with capacity less than the 5% AEP
- Overland flow paths are obstructed by other road features such as raised thresholds or kerb extensions
- Entry points to adjacent existing buildings are below the 5% AEP.

Stormwater shall not result in adverse impacts on private property for the 20% AEP, 10% AEP, 5% AEP and 1% AEP.

4.7.5 CONSISTENCY WITH FLOODPLAIN MANAGEMENT REQUIREMENTS

Stormwater design shall be consistent with the City's floodplain management requirements including the following:

- Interim Floodplain Management Policy
- Recommendations in the relevant Floodplain Management Plan adopted by the City.

Variations to these technical specifications can be approved under Section 4.5.6 where requirements of a site- specific flood study approved by the Environment & Water Team conflict with the specifications.

4.8 NETWORK LAYOUT

4.8.1 GENERAL LAYOUT

The general layout of the network shall comply with the following:

- The network shall be laid out in a logical fashion consistent with the topography
- Conduit capacity shall progressively increase in the downstream direction except for the existing network at the downstream connection point
- The network shall be laid out in the most hydraulically efficient manner
- Stormwater conduits shall not cross above or below other stormwater conduits
- Conduits shall be constructed in straight lines and uniform grade.

4.8.2 CONDUIT LOCATION

Stormwater conduits shall generally be located as follows:

- Below the kerb with the outside diameter of the pipe flush with the back of the kerb; or
- Centrally located within the kerbside traffic lane.
- Notwithstanding the above, conduits can be aligned in other locations in the following instances:
- Utilities or other constraints prevent installation in the preferred location
- Drainage is required to cross the road or service areas that cannot drain to the road
- Connection to existing drainage requires deviation from the preferred location.

4.8.3 PARALLEL CONDUITS

Parallel conduits shall comply with the following:

- The conduits shall be laid side by side with the minimum spacing required to achieve proper compaction of the adjoining material to achieve the required support
- The stacking of conduits is not permitted
- Conduits shall be the same size and shape except where augmentation of an existing conduit necessitates variance
- Conduits shall have the same upstream and downstream invert level except where augmentation of an existing conduit necessitates variance.

4.8.4 PROXIMITY OF OTHER STRUCTURES

Structures in the vicinity of the stormwater network shall not impose a structural load on any stormwater asset.

Structures within the 'zone of influence' shall be piered or have foundations extending below the invert level of the pipeline. The 'zone of influence' is the area that extends horizontally from the edge of the conduit by the depth to invert and extends vertically from the surface to the invert depth.

4.8.5 DRAINAGE EASEMENTS

All conduits through private land that drain public land or drain adjoining private land shall be located within drainage easements.

All drainage easements shall comply with the following:

- Easement terms shall be in accordance with the standard terms for a Drainage Easement under the Conveyancing Act 1919 (NSW)
- Where the conduit drains public land, the easement shall be in favour of the City of Sydney
- Where the conduit does not drain any public land, the easement shall be in favour of the private land that drains through the conduit
- In all cases, authority to modify or extinguish the easement shall be vested in the City of Sydney
- Easement widths shall be in accordance with **Table *6***.

Table 6- EASEMENT WIDTHS

Criteria (Conduit diameter/width and depth to invert)	Width
375 mm <= Diameter/width < 750 mm	1.8 m
750 mm => Diameter/width < 1200 mm	2.2 m
1200 mm => Diameter/width < 1500 mm	3.0 m
Diameter/width => 1500 mm and depth <= 3 m	Diameter/width plus 2 m
Diameter/width => 1500 mm and depth > 3 m	Diameter/width plus 4 m

4.8.6 PROXIMITY OF OTHER UTILITY SERVICES

The minimum separation between the stormwater network and other utility services shall be the greater of the following:

- The requirements of the other service utility authority
- 100mm.

4.8.7 PIT LOCATIONS

General requirements for pit locations are as follows:

- Stormwater pits within the wheel tracks on vehicle traffic lanes shall be avoided where practical
- The maximum conduit length between two pits shall not exceed the length specified in **Table 7**
- All pipe connections shall be via accessible pit structures and the direct connection of one drainage line to another shall not be permitted.

Stormwater pits with surface inlets shall be required at the following locations:

- All low points within the kerb and gutter
- All other low points in the public domain
- At sufficient intervals along kerb and gutter and other overland flow paths to collect runoff meeting the requirements of Section 4.7.3.3.

Stormwater pits shall be required where there is a change in any of the following conduit properties:

- Cross-sectional shape
- Size or dimension
- Grade
- Direction
- Material type

- Joint type.

Table 7 - MAXIMUM PIPE LENGTH BETWEEN STORMWATER PITS

Criteria (conduit diameter/width)	Maximum distance between pits
375 mm <= Diameter/width < 750 mm	40 m
750 mm => Diameter/width < 1500 mm	60 m
Diameter/width => 1500 mm	100 m

4.9 STRENGTH CLASS

4.9.1 PROXIMITY OF PITS TO VEHICLE AND PEDESTRIAN CROSSINGS AND INTERSECTIONS

Stormwater inlet pits are not permitted on the kerb and gutter at the following locations:

- On the radius within intersections
- Within the bounds of a signalised pedestrian crossing
- Within kerb ramps at non-signalised pedestrian crossings
- Within vehicle crossings.

Where there are existing kerb inlet pits at proposed vehicle or pedestrian crossing sites, the following modifications shall be made:

On grade pits:

- An additional kerb inlet pit or pits shall be provided to ensure equivalent inlet capacity is retained
- New kerb inlet pits shall be provided on the upstream side
- Where site constraints prevent installation on the upstream side, it is permitted to install new kerb inlet pits on the downstream side
- Where possible, the existing pit shall be removed; however, if site constraints prevent removal, the pit shall be modified as follows:
  i. If the existing pit is in a driveway crossing and is to be retained, a grated cover shall be provided
  ii. If the existing pit is in a pedestrian crossing and is to be retained, a solid infill cover shall be provided.

On sag pits:

- An additional kerb inlet pit or pits shall be provided to ensure equivalent inlet capacity is retained
- Kerb inlet pits shall be provided on both sides of the crossing
- The pedestrian crossing shall be regraded towards the adjacent inlet pit and the existing pit shall be removed. Where site constraints prevent removal of the existing pit, a solid infill cover shall be provided on the pit.
- A sag without a kerb inlet pit or grate-only pit is not acceptable.

4.9.2 CONDUIT ANGLES AT PITS

The acute angle between each inflow pipe and the outlet shall be no less than 95 degrees. Conduits shall not connect at the corner of a pit (i.e. birdsmouthing).

4.9.3 PROXIMITY TO TREES

Where practical, stormwater infrastructure within the drip line of trees shall be avoided. Where trees are unavoidable, an arborist's report shall be required. Additional investigations of tree roots may be required.

4.9.4 INTEGRATION WITH PUBLIC DOMAIN

The overall integration of the stormwater network with the public domain shall be considered including the proximity to footing for poles, street furniture, and the like.

4.9.5 OUTLET STRUCTURES

The number of outlet structures discharging into the harbour, watercourses or water bodies shall be minimised. Land adjoining these areas shall be drained through existing outlet structures where permitted by topography.

Outlet structures shall comply with the following:

- Designed in accordance with relevant standards and best practice for the type of structure and the relevant water body
- Comply with all planning and legislation requirements
- Minimise the potential for scouring or erosion
- Ensure the long-term stability of the receiving area and adjoining structures.

4.9.6 OTHER STORMWATER AUTHORITIES

Portions of the stormwater network within the City are owned by other government authorities such as Sydney Water, Place Management NSW and Transport for New South Wales.

Connections to the stormwater assets of other government authorities shall be undertaken with the approval of and in accordance with the requirements of the relevant authority.

Variations to these technical specifications, in order to avoid connection to other public authorities' stormwater assets, shall not be permitted.

4.10 CONDUIT DESIGN

4.10.1 CONDUIT TYPE

Stormwater conduits shall comply with the following:

- Steel reinforced precast concrete stormwater pipes with standard rubber ringed belled socket joints shall be used for all pipes located in the public domain or owned by the City
- Steel reinforced precast concrete stormwater pipes with rubber ring flush joints can be used where cover or utility constraints prevent the use of belled socket joints
- Fibre reinforced precast concrete pipes with rubber ring flush joints can be used where a pipe is to be fully encased in concrete
- All concrete pipes shall be rated for a Class 4 load (minimum)
- Steel reinforced precast concrete box culverts may also be used for all box culverts located in the public domain or owned by the City
- Steel reinforced precast concrete box culverts shall be rated for direct traffic loadings with no cover
- Cast in situ conduits or other material types shall not be used in the public domain or for City-owned conduits
- Irrespective of the above requirements, the base of box culverts shall be cast in situ steel reinforced concrete.

- A minimum 20mm deep V drain shall be cast into the base slab of culverts.

4.10.2 MINIMUM CONDUIT SIZE

The minimum size of City-owned conduits shall be as follows:

- Pipelines – 375mm nominal diameter
- Box culverts – 450mm width by 300mm height nominal.

Where box culverts are used, the width shall not exceed four times the height.

4.10.3 PERMITTED GRADES

The grade of conduits shall comply with the following:

- The conduit grade shall be within the range specified in Table 4.10.3-1 below
- The grade of a conduit can be reduced to an absolute minimum of 0.5 per cent where topography, existing stormwater or utility services prevent installation of a conduit within the preferred range
- Drop pits shall be used to ensure the maximum grade specified in
- Table 8 is not exceeded
- Vertical pipelines shall not be permitted.

Table 8 - PERMITTED GRADE

Criteria (Conduit diameter/width)	Minimum grade	Maximum grade
375 mm <= diameter/width < 1200 mm	1%	10%
Diameter/width => 1200 mm	1%	5%

4.10.4 INVERT LEVELS

Invert levels of conduits shall comply with the following:

- Invert levels shall be no lower than mean high tide
- The fall within pipes shall be in the downstream direction
- Reverse grades are not permitted
- Charged conduits are not permitted
- Submerged outlets are not permitted.

4.10.5 STRUCTURAL DESIGN

Conduit structural design shall be in accordance with all relevant Australian Standards and shall consider the anticipated loadings over the entire life of the asset.

Conduits shall be designed for the SM1600 series vehicle loads (minimum).

Notwithstanding the above, all conduits in the public domain or owned by the City shall be a minimum Class 4.

4.10.6 CONDUIT COVER

Where possible, conduits shall have a minimum cover of 600mm. Where this cannot be achieved due to site constraints such as utility services or connections to existing drainage, the minimum cover permissible is as follows:

- Pipes – 150mm

- Box culverts – 100mm

Pipes shall be concrete encased where the cover is less than or equal to 300mm.

Pipes with cover less than 600mm and more than 300mm shall be assessed to ensure the structural integrity of the pipe is not compromised under expected loads specified in Section 4.10.5 and the pipe shall be concrete encased if necessary.

Concrete encasement shall comply with the following:

- Minimum encasement thickness shall be 150mm mass concrete surrounding the entire conduit
- Where the cover is less than 200mm, a 50mm asphalt surface shall be maintained and the balance of the cover shall be concrete encasement with steel reinforcement
- Subject to the calculated service loads, steel reinforcement within the encasement may be required to ensure structural strength
- Where the concrete encasement above the pipe is less than 150mm, steel reinforcement shall be required over the top of the pipe
- Where it is proposed that stone kerb be placed on top of the pipe, a minimum of 100mm concrete encasement with steel reinforcement is required between the pipe and the stone kerb
- Where it is proposed that concrete kerb and gutter are to be placed on top of the pipe, a construction joint shall be required to separate the concrete encasement from the kerb and gutter, and steel reinforcement shall be required in the gutter.
- Conduit cover shall not exceed 2 metres.

4.10.7 DECOMMISSIONING OF REDUNDANT CONDUITS

Conduits not in use shall be decommissioned. Decommissioned conduits shall be removed where possible. Where site constraints prevent the removal of a decommissioned conduit, the conduit may remain in the ground, provided the following:

- The conduit is disconnected from the live stormwater network at the point where the conduit connects to the live network
- Where the decommissioned conduit was connected to a live stormwater structure or box culvert at the downstream end, the live structure or culvert shall be properly repaired and sealed with a concrete wall
- Where the decommissioned conduit was directly connected to a live pipe at the downstream end, the live pipe shall be repaired by replacing the unsealed conduit length
- The downstream end and all upstream inlets to the decommissioned conduit are sealed with mass concrete plugs
- The conduit shall be backfilled with a sand slurry.

4.11 STORMWATER STRUCTURE DESIGN

4.11.1 STANDARD STRUCTURES

The City provides a suite of standard design cast in situ reinforced concrete structures. Stormwater structures shall comply with the following:

- All stormwater structures shall be cast in situ reinforced concrete
- All stormwater structures shall include suitable maintenance access from the surface
- Where possible, standard City of Sydney structures shall be utilised.

4.11.2 NON-STANDARD STRUCTURES

4.11.2.1 GENERAL REQUIREMENTS

Where City of Sydney standard structure designs cannot be used, a non-standard structure shall be specified subject to the following:

- The structure shall be cast in situ reinforced concrete
- The structure shall as far as possible comply with the features of the most similar City of Sydney standard drawing
- The structure shall comply with all requirements in these technical specifications and the City's construction specifications
- All stormwater structures shall be designed to an appropriate loading capacity to suit the loading capacity of the specified grate (Class 'D' for trafficable areas and Class 'C' for areas only subjected to pedestrian activity). The loading criteria shall comply with AS3996 and the ultimate-limit state design load shall be the same as the ultimate-limit state design load for the specified loading classification of the grate (240 KN for Class 'D' and 150 KN for Class 'C' Grates).
- If grates are supported by suspended slab, the thickness of the concrete slab shall not be less than 125mm at the thinnest location under the grate.

4.11.2.2 MAINTENANCE ACCESS

Maintenance access requirements for non-standard structures shall comply with the following:

- The access grate or cover shall be a minimum of 900mm rectangular or 600mm circular.
- The access shafts shall be a minimum of 900mm by 900mm square where the depth is less than 2m.
- The access shafts shall be a minimum of 1200mm by 1200mm square where the depth is greater than 2m, and the access cover shall be precast within a concrete surround.

4.11.3 EXTENDED KERB INLET LINTELS

4.11.3.1 GENERAL REQUIREMENTS

All extended kerb inlet lintels shall be precast concrete to the relevant Australian Standard with permitted nominal lengths as follows:

- 2.4 m
- 1.8 m
- 0.9 m

The longest permitted kerb inlet lintel length that can be accommodated by site constraints shall be used.

Extended kerb inlet lintel heights shall comply with the following:

- The top of the kerb inlet lintel shall be flush with the top of the kerb
- The minimum opening height is 125 mm
- The maximum opening height is 200 mm

Kerb-only and grate-only pits are not permitted on roads; however, due to the number of such existing pits in use, inlet capacity information has been provided in Annexure E for hydraulic analysis purposes.

The approved stone kerb inlets listed in Annexure E are also permitted.

4.11.3.2 EXISTING TRACHYTE KERB INLETS

Existing trachyte kerb inlets shall be retained or re-used where possible provided that a bicycle safe grate is also used.

Pit inlet capacity shall be analysed as per Annexure E for 100 mm kerb heights, the grate-only inlet capacities in Annexure E shall be used.

Should the existing trachyte kerb inlets provide insufficient inlet capacity, additional kerb inlet pits shall be provided in the vicinity in order to provide the requisite inlet capacity.

4.11.4 GRATES AND COVERS

The preferred covers are circular and shall comply with the following:

- The word "Stormwater" is embedded into the cover material and will remain visible for the life of the cover
- Sewer covers or covers with the word "Sewer" inscribed on the cover shall not be used
- Covers shall be bolted down with a minimum of three bolts
- Covers shall be a minimum strength Class D
- Alternatively, rectangular covers can be used subject to compliance with the following:Infill covers shall have a surface material matching the surrounding surface Covers shall be bolted down with a minimum of four bolts
- Where grates and covers are within a landscaped/grassed area, the main chamber of the pit shall be recessed (200 mm minimum depth) below ground and an access shaft provided to surface level with a concrete mowing strip (150mm minimum width) around the grate or cover
- Covers shall be a minimum strength Class D.

4.11.5 TRAPPED GULLIES

Trapped gullies are legacy assets from combined stormwater/sewer systems.

Trapped gullies shall be demolished, completely removed and replaced with standard stormwater pits in accordance with these technical specifications, except for networks where combined stormwater/sewer systems remain or on systems where there is no downstream gross pollutant trap.

Prior to the removal of trapped gullies, site investigations shall be undertaken to confirm that there are no sewer connections to the stormwater in the vicinity of the Works.

4.11.6 BRICK OR MASONRY STRUCTURES

Brick and masonry structures are legacy assets no longer supported and are not to be modified or refurbished. Where it is necessary to undertake work on brick or masonry structures, they are to be removed and replaced with modern reinforced cast in situ concrete structures complying with the requirements of these technical specifications.

Notwithstanding the above, a brick or masonry structure can be retained and modified or refurbished in these circumstances:

- The scope of modification is limited to replacing the lintel, grate or cover
- The structure is an integral part of an existing brick or masonry conduit
- The structure is within a heritage area and forms part of a heritage item.

4.11.7 DECOMMISSIONING OF REDUNDANT STRUCTURES

Where a stormwater structure is no longer required such as in Section 4.11.7 of these technical specifications, the structure shall be decommissioned.

All decommissioned stormwater structures shall be completely demolished and removed.

4.12 STORMWATER QUALITY IMPROVEMENT DEVICES

4.12.1 RAINGARDENS

4.12.1.1 GENERAL REQUIREMENTS

Raingardens shall be designed in accordance with the following general requirements:

- Prior to design of the raingardens, a full catchment analysis shall be undertaken to ensure the raingarden does not have any negative impact on floodplain or the impact is negligible
- When the raingardens are built in a floodway, the designer shall ensure that impact of the raingarden on the flood storage capacity is negligible
- The raingardens shall be modelled using MUSIC and the results shall be submitted to the City for approval
- The planting area of an individual raingarden shall be no less than 8 square metres
- The raingarden shall be designed in such way to have negligible negative impact on the floodway capacity

4.12.1.2 STORAGE CAPACITY

- Raingarden ponding capacity shall be equivalent to the volume of the rainfall created by a 25 minute 3 months storm. When this volume cannot be achieved, a minimum volume of three cubic meters shall be provided in the raingarden.
- Depth of the storage in the raingarden shall not be less than 150mm and not more than 280mm. The depth of the raingarden's storage capacity shall be measured from the lowest point that water can enter or exit the raingarden.
- Any pit chambers or other structures in the raingarden are not allowed. If any pits are in the raingarden, the area and volume of these structures and pit chambers shall not be included in the storage volume calculation.

4.12.1.3 IN-FLOW

- In no circumstances shall the raingarden be utilised as the surface run-off collection device
- Where possible raingardens shall be designed as off-line systems with an appropriate bypass at upstream. Where drainage network is in the proximity, the bypass shall consist of a surface run-off collection device which is connected to the stormwater network.
- Where connection to the stormwater network is not possible, an overland flow path can be designed as bypass. The overland flow path shall be designed to have minimum interference with traffic and pedestrian activities.
- The raingarden inlet shall be designed to allow all surface run-off caused by minor rainfall events to flow freely to the raingarden
- The raingarden inlet device shall be designed to allow the entrance of a maximum 50% AEP surface

run-off into the raingarden, calculated for the critical time of concentration of the catchment. Regardless of the catchment size, the flow entering the raingarden shall not exceed 30 litres per second.

- The level at the raingarden's entry shall be 50mm lower than the level of the bypass
- The bypass shall be designed in such way that it is activated when:
  - the flow exceeds maximum entry flow specified in the clauses above
  - the raingarden is full.
- Appropriate erosion control and energy dissipation shall be provided at the entry to the raingardens that ensures planting is not damaged by erosive forces
- A gross pollutant trap/device, as per the City's standard drawings, shall be incorporated within the raingarden's inlet device, immediately upstream of the raingarden to intercept gross pollutants and sediment.
  - The size of the mesh shall be 50 mm x 50 mm stainless steel mesh where installed within the inlet pit
  - An inlet restriction plate shall be installed at the entry point to the raingarden. The plate shall be installed flush with the top and face of the kerb. The maximum opening size in the plate shall be 50mm and the plate shall be installed at 50mm distance from the invert of the kerb.

4.12.1.4 DESIGN

- The raingardens' media layers shall be designed in accordance with the City's standard drawings
- Unlined raingardens shall be limited to the following suburbs:
  - Rosebery
  - Waterloo
  - St Peters
  - Beaconsfield
  - Zetland
  - Alexandria.
- Unlined raingardens shall only be used where ground conditions permit infiltration and there is sufficient distance from buildings and structures to ensure these structures will not be adversely impacted by the raingarden.
  - Ground infiltration rate shall be more than 100 mm/hour
  - The highest predicted underground water table shall be 1500 mm lower than the levels of theraingardens.
- Infiltration rates and the underground water table shall be determined prior to design by an accredited experience geotechnical engineer.
- Partly lined raingardens shall be used where ground conditions permit infiltration and protection is required for adjoining buildings or structures
- All other raingardens shall be lined.

4.12.1.5 MAINTENANCE

All raingardens and associated components shall be designed in accordance with Sections 4.6.4 and 4.11.2.2

All submissions for raingarden design shall include a maintenance schedule addressing maintenance activities, access, frequency, type, amount of resources and annual cost.

4.12.1.6 PLANTING

The raingarden shall be located in a position that provides a minimum of six (6) hours of sunlight daily. Planting of the raingarden shall be approved by the City's Greening & Leisure Team.

Some of the species which are allowed in the raingarden are listed below:

- *Callistemon sp*
- *Westringia sp*
- *Dianella sp*
- *Lomandra sp*
- *Carpobrotus glaucescens*
- *Hibbertia scandens*
- *Doryanthes excelsa*
- *Banksia robur.*

4.12.2 GROSS POLLUTANT TRAPS

4.12.2.1 DESIGN REQUIREMENTS

The design should also be in accordance with the other criteria outlined in the Technical Specifications and in particular those detailed below:

- Devices shall have a diversion chamber with a fixed weir and a high flow bypass
- The device shall have separate access shaft provision to the diversion chamber, treatment area and storage area for inspection, maintenance and cleaning
- The device shall treat the three-month ARI design flow rate with high flows bypassing the device
- The device storage shall be sized for a six-month cleaning interval
- The device shall have off-line storage
- Surcharging of devices onto roads as a bypass method shall not be permitted and devices shall not at any time cause surcharging
- The device shall be fitted with suitable lifting lugs to allow for installation (where appropriate).

4.12.2.2 DEVICE PERFORMANCE

The performance of the device shall comply with the following:

- The device shall be designed to achieve 100 years life expectancy
- The device shall remove no less than 70% of all particles between 0.125mm and 5mm in size and 90% of particles greater than 5mm in size
- The device shall remove 30% of Total Phosphorus
- The device shall treat the three-month ARI design flow rate with high flows bypassing the device
- The device shall be sized for a six-month cleaning interval
- Devices shall have non-blocking self-cleaning screens
- Total pollutant storage volume per device shall not exceed 3 cubic metres and shall not be less than 0.7 cubic metres
- Devices shall have a high flow bypass
- Surcharging of devices onto roads as a bypass method shall not be permitted and devices shall not at any time cause surcharging
- Devices shall be designed in a manner that minimises blockage of the device or remobilisation of pollutants.

4.12.2.3 CLEANING AND MAINTENANCE REQUIREMENTS

In order to facilitate cleaning operations, devices shall comply with the following:

- The device shall be designed to facilitate a suitable, easy and safe cleaning process. Access openings shall be provided directly over the inlet pipe, the outlet pipe and the pollutant collection area
- The device shall be designed to have screens that can be easily removed to enable cleaning behind the screens or sufficient room between the wall and screen to allow cleaning in a safe manner
- Devices shall be designed to avoid the need for cleaning personnel to enter confined spaces
- Devices shall be designed to minimise the contact of cleaning personnel with pollutants
- Devices shall be designed with consideration of the access necessary to replace internal components of the device
- Access and working platforms shall be provided to the device suitable to permit the required cleaning process as well as accommodate the required cleaning equipment
- Pollutant storage areas shall be enclosed with public access to pollutants limited by covers.

4.12.2.4 ACCESS AND WORKING PLATFORMS

Access and working platforms for cleaning activities shall comply with the following:

- Sealed working platforms shall be provided to accommodate eductor trucks for cleaning
- Driveways and working platforms shall be designed to permit cleaning vehicles to park adjacent to the device with the device located at the rear of the vehicle or on the left (passenger) side of the vehicle
- The road itself could be used as a working platform if it is a low traffic road and there is sufficient width to allow the safe passing of traffic around the cleaning truck, cleaning operations will not damage the road, and there are no other safety issues that necessitate off-road working platforms
- Suitable working platforms and areas shall be provided off road where access to a device is required via a high traffic road
- Access to devices shall be from either a public road or a sealed driveway accessible via a public road
- Driveway access from high traffic roads shall permit cleaning vehicles to enter and exit in the forward-facing direction
- Where driveway access is proposed on low traffic roads, it is preferred that the driveway be designed to permit vehicles to exit in the forward-facing direction
- Sufficient separation shall be provided from pedestrian walkways and cycleways to ensure maintenance operations do not conflict with pedestrian and cycle movements.

4.12.2.5 DEVICE AND MATERIAL TYPES

The design of custom devices or the selection of a proprietary product shall be undertaken in consultation and with the approval of the City's Environment & Water team. The device once installed shall be designed to take traffic loadings of maintenance vehicles such as eductor trucks.

The devices shall consist of the following material types:

- Reinforced concrete structure
- Stainless steel or heavy galvanised mild steel screening components
- Access covers can be mild steel, ductile iron or cast iron to a minimum strength Class D.

4.13 RELINING

General requirements for relining are as follows:

- Relining shall be undertaken for the entire length of a pipeline between its upstream and downstream pit
- Stormwater pits at the upstream and downstream end shall be modified to facilitate the relining if required
- Any buried pits, blind pits or significant bends along the length of Works shall be replaced with standard junction pits
- The liner shall be designed to withstand all loads anticipated over the life of the liner assuming the host pipe is fully deteriorated with no remaining strength
- The deteriorated host pipe and its surrounding embedment shall be considered to support the liner but no bonding or composite action shall be assumed between the liner and the host pipe
- Where a pipeline is located outside a road reserve, beneath a building or is subject to a point load, a structural analysis shall be provided calculating the likely loads that will be imposed on the liner.

4.14 FOOTPATH DRAINAGE

4.14.1 GENERAL REQUIREMENTS

Where possible footpaths shall be graded towards the kerb and gutter, raingardens or garden beds to as much as possible avoid the need for stormwater infrastructure.

Where stormwater drainage within the footpath cannot be avoided:

- Footpath drainage shall comply with the requirements of these technical specifications that are applicable to all other road drainage
- All surface inlets shall be grated sump drains
- Grates shall be heel proof in high pedestrian traffic areas and pedestrian proof in low or medium pedestrian areas
- Footpath drainage shall be connected to the underground stormwater network.

4.14.2 CENTRAL SYDNEY PRECINCT

Footpath drainage within the Central Sydney planning precinct shall comply with Section 4.14.1 and the following requirements:

- Notwithstanding Section 4.10.2, the minimum size of a pipe on the footpath can be reduced where utility services constraints do not permit the use of a 375 mm diameter pipe
- The pipe size shall be as large as can be accommodated by the site constraints but no less than 150mm diameter
- Notwithstanding Section 4.10.1, a uPVC pressure pipe, minimum Class 12 to AS1477, can be used for 150mm diameter pipes
- The minimum pit length and width shall be 300 mm by 300 mm
- The minimum cover for a 150mm diameter pipe shall be 100 mm with the pipe concrete encased.

4.14.3 TRENCH GRATES OR STRIP DRAINS

4.14.3.1 PERMITTED USE

The use of trench grates or strip drains is generally not permitted. However, it is accepted that in certain circumstances, it is not possible to drain a site using alternative methods.

Where no other alternative is possible, trench grates or strip drains can be used in the following locations:

- At the top of stairways or stairway landings
- Across accessible ramps
- Across an opening to a private property where it is not possible to drain away from the property boundary
- As a gutter bridge as per Section 4.14.4.

4.14.3.2 GENERAL REQUIREMENTS

Trench grates and strip drains shall comply with the following:

- The length shall be minimised
- Notwithstanding Section 4.10.2, the minimum dimensions shall be 300 mm wide by 300 mm deep
- Shall withstand a Class D loading
- Shall be embedded in a minimum of 150 mm thick mass concrete
- Grates shall be bolted down
- Heel-proof grates shall be used in high pedestrian traffic areas and pedestrian-proof grates in low or medium pedestrian areas.

4.14.4 GUTTER BRIDGES

4.14.4.1 PERMITTED USE

Where a low point within a gutter need to be drained, gutter bridges shall be used in the following circumstances:

- There is no existing piped drainage within a reasonable distance of the low point to permit the connection of a below ground stormwater network
- Utility constraints prevent the installation of a conduit to the minimum size specified in Section 4.10.1
- To connect adjoining raingardens across a pedestrian footpath.

4.14.4.2 GENERAL REQUIREMENTS

General requirements for gutter bridges are as follows:

- The design shall comply with the City's standard drawing for gutter bridges
- Notwithstanding Sections 4.10.2 and 4.14.3.2, the minimum internal dimensions of a gutter bridge are 100mm high by 450mm wide
- Access points shall be provided either along the entire length or at changes in direction
- The surface material of the gutter bridge shall be consistent with the surrounding surface material
- Suitably slip-resistant and heel-proof grates can be used
- Notwithstanding Sections 4.11.4 and 4.14.3.2, a Class C cover or grate can be used where surface constraints prevent vehicle traffic from mounting the kerb and traversing the gutter bridge
- A gutter bridge is permitted to discharge directly into a stormwater pit or back to a kerb
- Kerb inlets and outlets shall be designed to withstand vehicle loads and impacts.

4.15 PRIVATE CONNECTIONS

4.15.1 STORMWATER DRAINAGE CONNECTION APPROVAL APPLICATION

All private stormwater connections require approval prior to construction. Applications for private connections shall be undertaken using the Private Connection Application Form available from the City's website.

4.15.2 KERB OUTLETS

4.15.2.1 OUTLET CONFIGURATION

Kerb outlets shall comply with the following:

- Discharge to the kerb and gutter
- A single discharge point shall be provided for each property at the most appropriate location
- Where a property fronts multiple roads and/or it is not physically possible to utilise a single discharge point then an additional discharge point can be provided on alternative road frontages
- The number of discharge points shall be minimised
- The number of discharge points from a property to the kerb shall not exceed three (3)
- The minimum spacing between discharge points from the same property is six (6) metres
- Conduit crossings shall take the shortest route to the kerb and shall be generally straight grade with minimal bends. All bends shall be manufactured with a maximum of 45° bend. Conduit crossings shall not cross the frontage of another property without the approval of the City's Representative.
- A maximum of three (3) parallel conduits are permitted at any single discharge point
- Parallel conduits shall have a minimum 300mm separation between centrelines
- Conduits shall not be directly connected to a stormwater pipe or conduit (see Section 4.15.3 for direct connection requirements).

Acceptable conduits are as follows:

- 90 mm uPVC pressure pipe Class 12
- 150 mm wide by 10 0mm high, mild steel, heavily galvanised channel provided the wall thickness is a minimum of 5mm
- 150mm wide by 50mm high, mild steel, heavily galvanised channel can be used for granite paved footpath, 100mm high kerbs or roll over/mountable kerbs provided the wall thickness is a minimum of 5mm.

Where there is no kerb and gutter, the following shall be undertaken:

- Kerb and gutter shall be provided
- Directly connect to the stormwater network as per Section 4.15.3

4.15.2.2 DISCHARGE LIMITS

- The maximum permitted discharge from any property is 25 litres per second for storms up to and including the 5% AEP
- Groundwater, dry weather flows and base flows shall not discharge to the kerb and gutter
- Where property discharge exceeds the maximum permitted kerb outlet discharge or includes groundwater, base flows or dry weather flows, the property shall be directly connected to the stormwater network as outlined in Section 4.15.3.

4.15.2.3 BASEMENT DISCHARGES

- All basements shall connect directly to the stormwater network as outlined in Section 4.15.3.

4.15.3 DIRECT CONNECTIONS

4.15.3.1 GENERAL REQUIREMENTS

Private stormwater drainage shall connect to the public stormwater network at the following locations:

- An existing stormwater inlet pit on the kerb along the property frontage
- An existing stormwater junction pit on a public stormwater network that traverses the property.

Where there is no existing public stormwater network through the property or along the road frontage of the property, the following shall be undertaken:

- A stormwater kerb inlet pit and pipe network shall be provided on the road along the property frontage and connected to the existing public stormwater network
- The new network shall be designed and constructed in accordance with the City's requirements, service the public land and be dedicated to the City
- The private network shall connect to the public network at a kerb inlet pit.

4.15.3.2 CONDUITS

Private conduits on public land connecting to the public stormwater system shall comply with the following:

- The conduits shall not drain public land and shall remain in private ownership
- Conduits shall traverse public land in a straight line from the property boundary to the connection point on a public stormwater pit
- No private stormwater structures are permitted on public land
- Conduits greater than 150mm nominal diameter shall be reinforced concrete
- Conduits less than or equal to 150mm nominal diameter can be uPVC pressure pipe Class 12.

4.15.3.3 BACKFLOW PREVENTION AND SURCHARGING

Where a connection is greater than a single 150mm diameter conduit, backflow prevention shall be provided.

A non-return valve shall be provided within the private property immediately prior to discharge to ensure that the public network does not surcharge into the property.

A surcharge point shall be provided within the property, immediately upstream of the non-return valve, to permit the property to discharge via the surface in situations where the public network capacity is exceeded.

4.15.3.4 OTHER STORMWATER AUTHORITIES

Where a direct connection is proposed to another public authority's network, such as Sydney Water or the Roads and Maritime Service, the direct connection shall comply with the requirements of the other authority in addition to compliance with the City's requirements.

4.15.3.5 POSITIVE COVENANT

All properties with a direct connection to the public stormwater network shall include a positive covenant on the property title.

4.16 ON-SITE DETENTION

4.16.1 REQUIREMENTS

- Compliance is required with the Sydney Water on-site detention requirements
- In addition to Sydney Water requirements, the City may impose on-site detention requirements only if required under section 4.15.2.2.
- Where on-site detention is provided, the City requires a positive covenant to be registered on the property title to ensure proper maintenance and functioning of the on-site detention.

4.17 REVISION REGISTER

Revision	Clause	Description of Revision	Authorised By	Date
Rev. 6	Overall	Reference to Water Asset chance to "Environment & Water"	SA	Aug-23
	Overall	References to 5 year ARI, 10 year ARI, 20 year, 100 year ARI changed to 20% AEP, 10% AEP, 5%, 1% AEP respectively		
	4.6.2	Reference to DXF file changed to shape file		
		Updated to MGA2020		
	4.11.2	Grate loading classification Changed to 240 kN from 210 kN		
	4.12.1.4	Section deleted		

ANNEXURE-A - DESIGN CHECKLIST

Drainage Design Checklist	
General Plan	☐ Yes
Catchment Plan	☐ Yes
Long sections	☐ Yes
Relevant City standard drawings	☐ Yes
Drainage Details or All structures are as per City standard drawings	☐ Yes or ☐ Yes
Utilities Investigation Plan and additional investigation report if required	☐ Yes
Drainage Design Variation Form or No variations from the City's Stormwater Design and Construction Technical Specifications are proposed and any variations discovered post-construction will be rectified prior to asset handover	☐ Yes or ☐ Yes
Statement of Environmental Effects or Development consent already obtained	☐ Yes or ☐ Yes
DRAINS file depicting hydraulic design or Hydraulic Design Report and Hydraulic Design Summary Sheet	☐ Yes or ☐ Yes

ANNEXURE-B - DRAINAGE DESIGN VARIATION FORM AND DRAINAGE VARIATION APPROVALSUMMARY SHEET

DRAINAGE VARIATION APPROVAL SUMMARY SHEET

Item	Clause	Variation Description	Approval*
1			☐ Approve or ☐ Refuse
2			☐ Approve or ☐ Refuse
3			☐ Approve or ☐ Refuse
4			☐ Approve or ☐ Refuse
5			☐ Approve or ☐ Refuse
6			☐ Approve or ☐ Refuse

* To be completed by Environment & Water team

Date

Principal Engineer – Environment & Water
City Infrastructure & Traffic Operations

DRAINAGE DESIGN VARIATION FORM

Item 1
Clause where variation is sought:
Description of variation:
Justification for variation:
*Decision:
☐ Approve or ☐ Refuse
*Notes or conditions:

* To be completed by Environment & Water team

Environment & Water Team

City Infrastructure & Traffic Operations

ANNEXURE-C - HYDROLOGIC AND HYDRAULIC DESIGN SUMMARY TABLES

HYDROLOGIC DESIGN SHEET

Name: ____________ Description: ____________ Page(s): ____________

Job No: ____________ Date: ____________ AEP: ____________

Pit/Structure	Hydrology							Pit / Structure				Overland Flow							
	Area	Impervious / Pervious	Flowpath length	Slope	Additional Time	Total Time	Total Flow	Junction Pit	Grade / Sag	Grate Size	KI Length	Approach Flow	Slope	Flow Depth	Flow Velocity	Velocity X Depth	Inflow	Bypass Flow	Remarks
	(ha)	(%)	(m)	(m/m)	(min)	(min)	(L/s)	(Y / N)	(G / S)	(L m / W m)	(m)	(L/s)	(m/m)	(m)	(m/s)	(m^2/s)	(L/s)	(L/s)	

A4 STORMWATER DRAINAGE DESIGN

HYDRAULIC DESIGN SHEET

Name: Description: Page(s):

Job No: Date: AEP:

Pipe	Branch	Length (m)	Flow rate L/s	Pipe Diameter (mm)	Full Pipe Velocity (m/s)	$V^2/2g$	Upstream Surface Level (m AHD)	Downstream Water Limit (m AHD)	Upstream Water Limit (m AHD)	Upstream Pit Coefficient K_u	$K_uV^2/2g$	User HGL at Downstream Pit (m AHD)	HGL at Downstream Pit (m AHD)	HGL Slope Sf (m/m)	Pipe Friction Loss Sf.L (m)	User HGL at Upstream Pit (m AHD)	Remarks

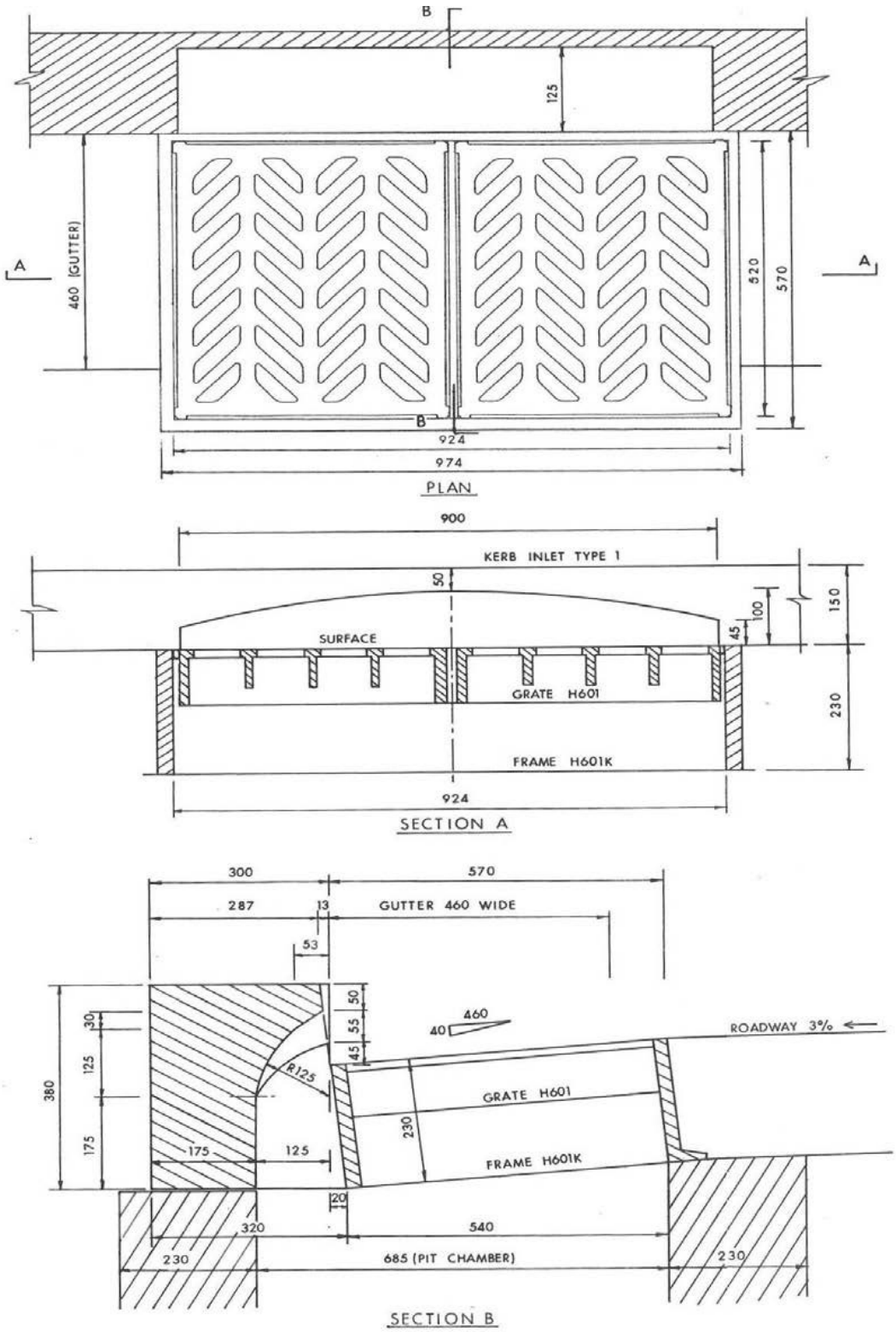
A4 STORMWATER DRAINAGE DESIGN

ANNEXURE- D - ASSET DATASHEETS

ASSET DATA SHEETS ARE AVAILABLE FROM THE CITY OF SYDNEY WEBSITE IN EXCEL FORMAT.

ANNEXURE E - APPROVED STONE KERB INLETS

TRACHYTE KERB INLETS



TYPICAL DETAIL FOR TRACHYTE KERB INLET PIT

Existing trachyte kerb inlets can be re-used provided that a bicycle safe grate is also provided. Pit inlet capacity shall be as per the following tables. For 100mm kerb heights, the grate-only inlet capacities shall be used.

Kerb-only and grate-only pits are not permitted on roads; however, due to the number of existing pits in use, inlet capacity information has been provided below for hydraulic analysis purposes.

CoS trachyte kerb inlet with bicycle-safe grate on 150mm high kerb

0% Longitudinal Fall	
Approach Flow (l/s)	Inlet Capacity (l/s)
0	0
11	11
20	20
25	25
38	38
60	57
82	73
100	83
117	92
140	102
148	105
155	107
226	124

1% Longitudinal Fall	
Approach Flow (l/s)	Inlet Capacity (l/s)
0	0
10	10
29	29
41	41
59	57
81	70
95	76
116	84
146	92
178	101
210	109

3% Longitudinal Fall	
Approach Flow (l/s)	Inlet Capacity (l/s)
0	0
12	12
30	29
45	42
60	53
83	67
97	73
119	83
150	96
209	107

5% Longitudinal Fall	
Approach Flow (l/s)	Inlet Capacity (l/s)
0	0
15	15
33	30
47	39
63	50
85	65
100	72
123	79
152	82
180	86
225	90

7% Longitudinal Fall	
Approach Flow (l/s)	Inlet Capacity (l/s)
0	0
12	12
30	25
55	41
123	70
162	75
197	81

Sag	
Depth (mm)	Inlet Capacity (l/s)
0	0
140	60
155	80
187	125
233	175
253	257
275	295

CoS trachyte kerb inlet only on 150mm high kerb

0% Longitudinal Fall	
Approach Flow (l/s)	Inlet Capacity (l/s)
0	0
100	49
145	57
160	59
227	70

1% Longitudinal Fall	
Approach Flow (l/s)	Inlet Capacity (l/s)
0	0
81	34
95	37
120	43
149	46
181	51
214	56

3% Longitudinal Fall	
Approach Flow (l/s)	Inlet Capacity (l/s)
0	0
85	28
100	32
123	37
153	41
212	45

5% Longitudinal Fall	
Approach Flow (l/s)	Inlet Capacity (l/s)
0	0
15	7
33	12
47	16
63	20
85	26
103	31
125	34
155	36
180	36
225	38

7% Longitudinal Fall	
Approach Flow (l/s)	Inlet Capacity (l/s)
0	0
12	6
30	11
55	15
123	27
162	32
195	33

Sag	
Depth (mm)	Inlet Capacity (l/s)
0	0
145	60
165	80

CoS bicycle-safe grate only

0% Longitudinal Fall	
Approach Flow (l/s)	Inlet Capacity (l/s)
0	0
100	82
140	98
155	99
225	115

1% Longitudinal Fall	
Approach Flow (l/s)	Inlet Capacity (l/s)
0	0
80	62
93	66
115	72
145	80
180	88
210	92

3% Longitudinal Fall	
Approach Flow (l/s)	Inlet Capacity (l/s)
0	0
85	59
99	63
120	70
150	77
209	84

5% Longitudinal Fall	
Approach Flow (l/s)	Inlet Capacity (l/s)
0	0
15	14
33	26
47	33
63	42
85	53
100	58
123	64
153	66
175	68
225	72

7% Longitudinal Fall	
Approach Flow (l/s)	Inlet Capacity (l/s)
0	0
12	10
30	22
55	34
123	55
162	60
198	67

Sag	
Depth (mm)	Inlet Capacity (l/s)
0	0
140	60
155	80
195	125
205	175
275	257
337	295

Data derived from physical modelling outlined in the document: Manly Hydraulics Laboratory; Hydraulic Model Studies of Grate, Lintel and Modified Gully Pit Designs for Pyrmont Redevelopment; Draft Report MHL690; Public Works Report No. 94018; July 1994; ISBN 0 7310 2740.

Stone kerb inlet pits

Approved stone kerb inlets shall be in accordance with standard drawings 1.1.12 and 1.1.13.