MID-WESTERN REGIONAL COUNCIL

NEW SOUTH WALES

DEVELOPMENT DESIGN SPECIFICATION

D5

STORMWATER DRAINAGE DESIGN

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Amendment Record for this Specification Part

This Specification is Council's edition of the AUS-SPEC generic specification part and includes Council's primary amendments.

Details are provided below outlining the clauses amended from the Council edition of this AUS-SPEC Specification Part. The clause numbering and context of each clause are preserved. New clauses are added towards the rear of the specification part as special requirements clauses. Project specific additional script is shown in the specification as italic font.

The amendment code indicated below is 'A' for additional script 'M' for modification to script and 'O' for omission of script. An additional code 'P' is included when the amendment is project specific.

Amendment Sequence No.	Key Topic addressed in Amendment	Amendment Code	Clause No.	Authors initials	Amendment Date
1	Update for council specific information	-	Numerous	SM	17.10.12

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DEVELOPMENT DESIGN SPECIFICATION D5
STORMWATER DRAINAGE DESIGN

GENERAL

D5.01 SCOPE

1. The work to be executed under this Specification consists of the design of stormwater drainage systems for urban and rural areas.

D5.02 OBJECTIVES

1. The objectives of stormwater drainage design are as follows:

   (a) To ensure that inundation of private and public buildings located in flood-prone areas occurs only on rare occasions and that, in such events, surface flow routes convey floodwaters below the prescribed velocity/depth limits.

   (b) To provide convenience and safety for pedestrians and traffic in frequent stormwater flows by controlling those flows within prescribed limits.

   (c) Retain within each catchment as much incident rainfall and runoff as is possible and appropriate for the planned use and the characteristics of the catchment.

2. In pursuit of these objectives, the following principles shall apply: ***Design Principles***

   (a) Developments are to provide a stormwater drainage system in accordance with the "major / minor" system concept set out in Chapter 14 of Australian Rainfall & Runoff, 1987 (AR&R); that is, the "major" system shall provide safe, well-defined overland flow paths for rare and extreme storm runoff events while the "minor" system shall be capable of carrying and controlling flows from frequent runoff events.

   (b) The on-site drainage system is to be designed in such a way that the estimated peak flow rates from the site for the design average recurrence interval (ARI) of the receiving minor/major system is no greater than that which would be expected from the previous landuse.

   (c) The natural path of watercourses and flow paths shall be maintained and no development shall be permitted over them.

D5.03 REFERENCE AND SOURCE DOCUMENTS

(a) Council Specifications

C220	-	Stormwater Drainage - General
C221	-	Pipe Drainage
C222	-	Precast Box Culverts
C223	-	Drainage Structures
C224	-	Open Drains including Kerb & Gutter

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(b) Australian Standards

AS 1254	-	Unplasticised PVC (uPVC) pipes and fittings for stormwater or surface water applications
AS 2032	-	Code of practice for installation of uPVC pipe systems
AS/NZS 2566.1	-	Buried flexible pipelines, structural design
AS 3725	-	Loads on buried concrete pipes
AS 4058	-	Precast concrete pipes
AS 4139	-	Fibre reinforced concrete pipes and fittings

(c) State Authorities

RTA, NSW - Model Analysis to determine Hydraulic Capacities of Kerb Inlets and Gully Pit Gratings, 1979.

(d) Other

AUSTROADS - Bridge Design Code.

Inst. of Eng. - Australian Rainfall and Runoff (AR&R) - A guide to flood estimation. Aug 1987.

Queensland Urban Drainage Manual, Volumes 1 & 2, 1993.

Sangster, WM., Wood, HW., Smerdon, ET., and Bossy, HG.
- Pressure Changes at Storm Drain Junction, Engineering Series, Bulletin No. 41, Eng. Experiment Station, Univ. of Missouri 1958.

Hare CM. - Magnitude of Hydraulic Losses at Junctions in Piped Drainage Systems. Transactions, Inst. of Eng. Aust., Feb. 1983.

Concrete Pipe Association of Australia
- Concrete Pipe Guide, charts for the selection of concrete pipes to suit varying conditions.

Henderson, FM. Open Channel Flow, 1966.

Chow, Ven Te - Open Channel Hydraulics, 1959.

John Argue - Australian Road Research Board Special Report 34
- Stormwater drainage design in small urban catchments: a handbook for Australian practice.

Australian National Conference On Large Dams, Leederville WA.
- ANCOLD 1986, Guidelines on Design Floods for Dams.

HYDROLOGY

D5.04 DESIGN RAINFALL DATA

I-F-D Relationships

1. Design Intensity-Frequency-Duration (IFD) Rainfall - IFD relationships shall be derived in accordance with Volume 1 Chapter 2, of AR&R, for the particular catchment under consideration.

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2. The nine basic parameters read from Maps 1-9 in Volume 2 of AR&R shall be shown in the calculations submitted to Council, except where the Bureau of Meteorology provides a polynomial relationship for the catchment.

3. Where design IFD rainfalls are provided for specific locations these are provided in Council's current Handbook of Drainage Design Criteria.

4. Design Average Recurrence Interval (ARI) - For design under the "major/minor" concept, the design ARIs to be used are given below.

Average Recurrence Intervals

5. Recurrence intervals for minor events depends on the zoning of the land being serviced by the drainage system. The minor system design ARIs are detailed below:-

- 10 years for commercial/industrial area "minor" systems
- 5 years for residential area "minor" systems
- 5 years for rural residential area "minor" systems
- 1 year for parks and recreation area "minor" systems.

6. In addition, where a development is designed in such a way that the major system flows involve surcharge across private property, then the underground system (both pipes and inlets) shall be designed to permit flows into and contain flows having an ARI of 100 years from the upstream catchment which would otherwise flow across the property. A surcharge path shall be defined for systems even where 100 year ARI flows can be maintained within the system. Easements are to be provided in private property over pipe systems and surcharge paths.

Easements in Private Property

D5.05 CATCHMENT AREA

1. The catchment area of any point is defined by the limits from where surface runoff will make its way, either by natural or artificial paths, to this point. Consideration shall be given to likely changes to individual catchment areas due to the full development of the catchment.

Catchment Definition

2. Where no detailed survey of the catchment is available, 1:4000 orthophoto maps are to be used to determine the catchments and to measure areas.

3. Catchment area land use shall be based on current available zoning information or proposed future zonings, where applicable.

4. The natural catchment boundaries are to be maintained and developments are to consider and design for flows arriving at the site from upstream catchments.

5. Where a pre-existing integrated stormwater drainage plan exists for a catchment, developers shall make relevant contributions to this system and are responsible for connecting their development into the system.

Catchment integration

6. If there is no pre-existing integrated stormwater drainage plan for the catchment and only a portion of a catchment is being developed at a particular time (staged development) the drainage strategy for the whole subdivisional catchment should be determined.

Developers are responsible for negotiating and arranging their own cost sharing arrangements with respect to stormwater drainage. Where landowners of adjoining parcels of land within the catchment area fail to communicate or agree on a drainage strategy, each developer will be required to dispose of its stormwater drainage wholly within its subdivision.

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D5.06 RATIONAL METHOD

1. Rational Method calculations to determine peak flows shall be carried out in accordance with Volume 1, Chapter 14, of AR&R and the requirements of this Specification.

2. All calculations shall be carried out by a qualified person experienced in hydrologic and hydraulic design. ***Qualified Person***

3. Co-efficients of Run-off shall be calculated as per Volume 1, Chapter 14.5 of AR&R and full details of co-efficients utilised shall be provided. ***Runoff Co-efficients***

4. Details of percentage impervious for specific locations and for individual zonings are given below. These can be used in lieu of more detailed calculations.

Development Type	% of Lot Area
• Residential R1	50
• Residential R2	40
• Residential R3	50
• Industrial	80
• Commercial	100

Runoff coefficients shall be calculated in accordance with methodology set out in AR&R.

5. The time of concentration of a catchment is defined as the time required for storm runoff to flow from the most remote point on the catchment to the outlet of the catchment. ***Times of Concentration***

6. Where the flow path is through areas having different flow characteristics or includes property and roadway, then the flow time of each portion of the flow path shall be calculated separately. ***Different Flow Characteristics***

7. The maximum time of concentration in an urban area shall be 20 minutes unless sufficient evidence is provided to justify a greater time.

8. Flow paths to pits shall be representative of the fully developed catchment considering such things as fencing and the likely locations of buildings and shall be shown for each collection pit on the catchment area plan. Consideration shall be given to likely changes to individual flow paths due to the full development of the catchment. ***Flow Paths to Pits***

9. Surface roughness co-efficients "n" shall generally be derived from information in Volume 1, Chapter 14 of AR&R. Values applicable to specific zoning types and overland flow path types are given below: ***Overland Flow Retardance***

Flow across Parks	0.35
Flow across Rural Residential land	0.30
Flow across Residential (2a)	0.21
Flow across Residential (2b)	0.11
Flow across Industrial	0.06
Flow across Commercial	0.04
Flow across Paved Areas	0.01
Flow across Asphalt Roads	0.02
Flow across Gravel Areas	0.02

D5.07 OTHER HYDROLOGICAL MODELS

1. Other hydrological models may be used as long as the requirements of AR&R are met, summaries of calculations are provided and details are given of all program input and output. ***Alternative Models***

2. Where computer analysis programs are used, copies of the final data files shall

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be provided on submission of the design to Council and with the final drawings after approval by Council.

HYDRAULICS

D5.08 HYDRAULIC GRADE LINE

Qualified Person

1. Hydraulic calculations shall generally be carried out in accordance with AR&R and shall be undertaken by a qualified person experienced in hydrologic and hydraulic design. The calculations shall substantiate the hydraulic grade line adopted for design of the system and shown on the drawings. Summaries of calculations are added to the plan and details of all calculations are given including listings of all program inputs and outputs.

Calculations

2. The "major" system shall provide safe, well-defined overland flow paths for rare and extreme storm runoff events while the "minor" system shall be capable of carrying and controlling flows from frequent runoff events.

Downstream Control

3. Downstream water surface level requirements are given below:-

   (a) Known hydraulic grade line level from downstream calculations including pit losses at the starting pit in the design event.

   (b) Where the downstream starting point is a pit and the hydraulic grade line is unknown, a level of 0.15m below the invert of the pit inlet in the downstream pit is to be adopted.

   (c) Where the outlet is an open channel and the design storm is the minor event the top of the outlet pipe shall be the downstream control.

   (d) Where the outlet is an open channel, the design storm is the major event and downstream flood levels are not known, the top of the outlet pipe shall be the downstream control.

   (e) Where the outlet is an open channel, the design storm is the major event and downstream flood levels are known, the downstream control shall be the 1% probability flood level.

Water Surface Limits

4. The water surface in drainage pits shall be limited to 0.150m, below the gutter invert for inlet pits and 0.150m below the underside of the lid for junction pits.

D5.09 MINOR SYSTEM CRITERIA

Gutter Flow Widths

1. The acceptable gutter flow widths in the 20% probability event is 2.5 metres maximum. Wider flow widths may be approved on roads with flat grades.

Conduit Sizes

2. Minimum conduit sizes shall be as follows:

- Pipes - 375mm diameter.
- Box culverts - 600mm wide x 300mm high.

Velocity Limits

3. Minimum and maximum velocity of flow in stormwater pipelines shall be 0.6m/sec and 6m/sec respectively.

D5.10 PITS

Spacing

1. Inlet Pits shall be spaced so that the gutter flow width is limited in accordance with this Specification and so that the inlet efficiency is not affected by adjacent inlet openings. Preference shall be given to the location of drainage pits at the upstream side of allotments.

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2. Other pits shall be provided:

- To enable access for maintenance.
- At changes in direction, grade, level or class of pipe.
- At junctions.

3. The maximum recommended spacing of pits where flow widths are not critical are given in Table D5.1 below:

	Pipe Size (mm)	Spacing (m)
Generally	less than 1200	100
	1200 or larger	150
In tidal influence	all	100

Table D5.1 - Pit Spacing

Inlet Capacity

4. Kerb inlet lengths to side entry pits are to be a preferred maximum of 3.0m, with an absolute maximum of 5.0m where the grade is 10% or more, and an absolute maximum of 4.0m where the grade is less than 10%.

5. Information on pit capacities is available in the following sources:-

- Roads and Traffic Authority's "Model analysis to determine Hydraulic Capacities of Kerb Inlets and Gully Pit Gratings", with due allowance to inlet bypass due to grade, for grade inlet pits, and recognised orifice or weir formulae for sag inlet pits.

- Pit relationships given in Volume 1, Chapter 14 of AR&R.

Allowance for Inlet Blockage

6. None of these pit charts include any blockage factors. The percentage of theoretical capacity allowed in relation to type of pit is given in Table D5.2 below:-

Condition	Inlet Type	Percentage of Theoretical Capacity Allowed
Sag	Side entry	80%
Sag	Grated	50%
Sag	Combination	Side inlet capacity only Grate assumed completely blocked
Sag	"Letterbox"	50%
Continuous Grade	Side entry	80%
Continuous Grade	Grated	50%
Continuous Grade	Combination	90%

Table D5.2 - Allowable Pit Capacities

D5.11 HYDRAULIC LOSSES

Pit Losses

1. Appropriate pressure change co-efficient "Ke" shall be determined from AR&R and relevant industry standards, such as:

Hare CM. - Magnitude of Hydraulic Losses at Junctions in Piped

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Drainage Systems. Transactions, Inst. of Eng. Aust., Feb. 1983

Roads and Traffic Authority's "Model analysis to determine Hydraulic Capacities of Kerb Inlets and Gully Pit Gratings"

Bend Losses

2. Bends may be permissible in certain circumstances and discussions with Council regarding their use is required prior to detailed design. Appropriate values of pit pressure change co-efficient at bends are to be applied.

Service Entry Losses

3. Where possible design should try to avoid clashes between services. However, where unavoidable clashes occur with existing sewer mains then appropriate pressure change co-efficient Kp shall be determined.

4. Requirements for private pipes entering Council's system are given below:-

(a) All pipe inlets, including roof and subsoil pipes, shall where possible, enter the main pipe system at junction pits. These shall be finished off flush with and be grouted into the pit wall.

(b) If a junction has to be added which is larger than 225mm then a junction pit shall be built at this location in accordance with this Specification.

(c) For smaller inlets, the drainage pipes may be broken into to allow interconnection with the main line. In this case the sideline shall be finished flush with and be grouted into the main line.

Pipe Junction Losses

5. Construction of a junction without a structure should be avoided where possible. Permission to do this is required by Council prior to detailed design. Where this is unavoidable then appropriate pressure change co-efficients Ku, for the upstream pipe and Kl, for the lateral pipe, shall be determined.

Contraction/ Expansion Losses

6. Going from larger upstream to smaller downstream conduits is not permitted without approval of Council prior to detailed design. In going from smaller to larger pipes benching shall be provided in pits to enable a smooth flow transition. Losses in sudden expansions and contractions must be accounted for.

Pipe Friction Losses

7. Drainage pipe systems shall be designed as an overall system, with due regard to the upstream and downstream system and not as individual pipe lengths. Drainage pipeline systems shall generally be designed as gravity systems flowing full at design discharge, but may be pressurised with the use of appropriate pits and joints. Pipe friction losses and pipe sizes in relation to discharge shall be determined using the Colebrook-White formula with the acceptable roughness co-efficients being 0.6mm for concrete pipes and 0.06mm for FRC pipes.

D5.12 MAJOR SYSTEM CRITERIA

Surcharging

1. Surcharging of drainage systems which would provide for water depth above the top of kerb will not be permitted except:

(a) Surcharging of drainage system for storm frequencies greater than 5% probability may be permitted across the road centreline where the road pavement is below the natural surface of the adjoining private property.

(b) Flow across footpaths will only be permitted in situations specifically approved by Council, where this will not cause flooding of private property.

Velocity/ Depth Criteria

2. The velocity x depth product of flow across the footpath and within the road reserve shall be such that safety of children and vehicles is considered. The maximum allowable depth of water is 0.2 metres and the maximum velocity x depth product of $0.4m^2/s$ is permitted. Where the safety of only vehicles can be affected, a maximum

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velocity x depth product of $0.6m^2/s$ is permitted. In open channels the above velocity x depth product criteria will be followed where possible or the design shall address the requirements for safety in relation to children by providing safe egress points from the channel or other appropriate methods.

Freeboard

3. Freeboard requirements for floor levels and levee bank levels from flood levels in roadways, stormwater surcharge paths and open channels are given below:

In Roadways:-

(a) A minimum freeboard of 0.3m shall be provided between the 100 year flood level and floor levels on structures and entrances to underground car parks. A higher freeboard may be required in certain circumstances.

(b) Where the road is in fill or overtopping of kerbs and flow through properties may occur a 100mm freeboard shall be provided between the ponding level of water in the road and the high point in the footpath. Driveway construction in these instances needs to consider this requirement.

In Stormwater Surcharge Paths:-

(c) A minimum freeboard of 0.3 shall be provided between the 100 year flood level and floor levels on structures and entrances to underground car parks.

In Open Channels:-

(d) A minimum freeboard of 0.5m shall be provided between the 100 year flood level and floor levels on structures and entrances to underground car parks.

Roadway Capacities

4. Flow capacities of roads should be calculated using Technical Note 4 in Volume 1, Chapter 14 of AR&R with a flow adjustment factor as given in Council's current Handbook of Drainage Design Criteria.

D5.13 OPEN CHANNELS

Safety

1. Generally, open channels will only be permitted where they form part of the trunk drainage system and shall be designed to have smooth transitions with adequate access provisions for maintenance and cleaning. Where Council permits the use of an open channel to convey flows from a development site to the receiving water body, such a channel shall comply with the requirements of this Specification.

2. Design of open channels shall be in accordance with Volume 1, Chapter 14, of AR&R. Open channels will be designed to contain the major system flow less any flow that is contained in the minor system, with an appropriate allowance for blockage of the minor system.

Channel Roughness

3. Friction losses in open channels shall be determined using Mannings "n" values given below:-

Mannings "n" Roughness Co-efficients for open channels shall generally be derived from information in Chapter 14 of AR&R. Mannings "n" values applicable to specific channel types are given below:-

Concrete Pipes or Box Sections	0.011
Concrete (trowel finish)	0.014
Concrete (formed without finishing)	0.016

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Sprayed Concrete (gunite)	0.018
Bitumen Seal	0.018
Bricks or pavers	0.015
Pitchers or dressed stone on mortar	0.016
Rubble Masonry or Random stone in mortar	0.028
Rock Lining or Rip-Rap	0.028
Corrugated Metal	0.027
Earth (clear)	0.022
Earth (with weeds and gravel)	0.028
Rock Cut	0.038
Short Grass	0.033
Long Grass	0.043

4. Where the product of average Velocity and average flow Depth for the design flow rate is greater than 0.4m^2/s, the design will be required to specifically provide for the safety of persons who may enter the channel in accordance with Volume 1, Chapter 14, of AR&R..

Side Slopes

5. Maximum side slopes on grassed lined open channels shall be 1 in 4, with a preference given to 1 in 6 side slopes, channel inverts shall generally have minimum cross slopes of 1 in 20.

Low Flows

6. Low flow provisions in open channels (man-made or altered channels) will require low flows to be contained within a pipe system or concrete lined channel section at the invert of the main channel. Subsurface drainage shall be provided in grass lined channels to prevent waterlogging of the channel bed. The width of the concrete lined channel section shall be the width of the drain invert or at least sufficiently wide enough to accommodate the full width of a tractor.

Hydraulic Jumps

7. Transition in channel slopes to be designed to avoid or accommodate any hydraulic jumps due to the nature of the transition.

D5.14 MAJOR STRUCTURES

1. Hydraulic calculations for major structures shall generally be carried out in accordance with AR&R and shall be undertaken by a qualified person experienced in hydrologic and hydraulic design.

Afflux

2. All major structures in urban areas, including bridges and culverts, shall be designed for the 100 year ARI storm event without afflux. Some afflux and upstream inundation may be permitted in certain rural and urban areas provided the increased upstream flooding is minimal and does not inundate private property.

Freeboard

2. A minimum clearance of 0.3m between the 100 year ARI flood level and the underside of any major structure superstructure is required to allow for passage of debris without blockage.

3. Certified structural design shall be required on bridges and other major culvert structures and may be required on some specialised structures. Structural design shall be carried out in accordance with the Specification for STRUCTURES BRIDGE DESIGN.

Culverts

4. Culverts (either pipe or box section) shall be designed with due regard being given to inlet and exit losses, inlet and outlet control and scour protection.

D5.15 DETENTION STORAGES

1. Detention storages shall be located above ground and preferably integrated into landscaping.

Critical Storm

2. For each ARI a range of storm events shall be run to determine the peak flood level and discharge from the retarding basin. Storm patterns shall be those given in

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Volume 1, Chapter 11 of AR&R. Sensitivity to storm pattern should be checked by reversing these storm patterns. ***Duration***

3. The critical storm duration with the basin is likely to be longer than without the basin. A graph showing the range of peak flood levels in the basin and peak discharges from the basin shall be provided for the storms examined.

4. Flood Routing should be modelled by methods outlined in AR&R. ***Routing***

5. The high level outlet to any basin shall have capacity to contain a minimum of the 100 year ARI flood event. Additional spillway capacity may be required due to the hazard category of the structure. The hazard category should be determined by reference to ANCOLD. ***High Level Outlet***

6. The spillway design shall generally be in accordance with the requirements for Open Channel Design in this Specification.

7. Wherever practicable and certainly in areas known to be affected by high water tables and/or salinity of groundwater, retarding basins shall be designed to be water retentive so that surface drainage water does not leak to the subsurface, recharging groundwater. ***Salinity Prevention***

8. Pipe systems shall contain the minor flow through the detention basin wall. Outlet pipes shall be rubber ring jointed with lifting holes securely sealed. Pipe and culvert bedding shall be specified to minimise its permeability, and cut off walls and anti-seepage collars installed where appropriate. ***Low Flow Provision***

9. The low flow pipe intake shall be protected to prevent blockages.

10. Freeboard - Minimum floor levels of dwelling shall be 0.5m above the 100 year ARI flood level in the basin. ***Freeboard at Dwellings***

11. Public Safety Issues - Detention storage design is to consider the following aspects relating to public safety. ***Safety Issues***

- Side slopes are to be a maximum of 1 in 6 to allow easy egress. Steeper side slopes may be considered in difficult circumstances. Side slopes of greater than 1 in 4 may require handrails to assist in egress.
- For basins, water depths shall be, where possible, less than 1.2m in the 20 year ARI storm event. Where neither practical or economic greater depths may be acceptable. In that case the provision of safety refuge mounds should be considered.
- The depth indicators should be provided indicating maximum depth in the basin.
- Where detention storage is being provided in landscape areas, depth of ponded water shall be less than 0.6m. Where detention storage is being provided in carparking/paved areas, depth of ponded water shall be less than 0.2m.
- Protection of the low flow intake pipe shall be undertaken to reduce hazards for people trapped in the basin.
- Signage of the spillway is necessary to indicate the additional hazard.
- Basins shall be designed so that no ponding of water occurs on to private property or roads.
- No planting of trees in basin walls is allowed.

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- No basin spillway is to be located directly upstream of urban areas.
- Submission of design Drawings to the Dam Safety Committee is required where any of these guidelines are not met or Council specifically requires such submission.

12. Detention basins shall be topsoiled, turfed and landscaped.

STORMWATER DETENTION

D5.16 STORMWATER DETENTION

1. Installation of Stormwater Detention is required to maintain post- development flows to at or below predevelopment flows.

2. Location of basins for stormwater detention, stormwater treatment or sedimentation purposes shall avoid areas that are known to be permanent or seasonal groundwater discharge areas. This action reduces the likelihood of recharge into the groundwater. ***Salinity Prevention***

INTERALLOTMENT DRAINAGE

D5.17 INTERALLOTMENT DRAINAGE

1. Interallotment Drainage shall be provided for every allotment which does not drain directly to its frontage street or a natural watercourse.

2. Interallotment drainage shall be contained within an easement not less than 1.0m wide , and the easement shall be in favour of the upstream allotments.

3. Pipe Capacity - The interallotment drain shall be designed to accept concentrated drainage from buildings and paved areas on each allotment for flow rates having a design ARI the same as the "minor" street drainage system.

4. In lieu of more detailed analysis, the following areas of impervious surface are assumed to be contributing runoff to the interallotment drain:- ***Impervious Area***

Development Type	% of Lot Area
• Residential R1	50
• Residential R2	40
• Residential R3	50
• Industrial	80
• Commercial	100

5. Pipes shall be designed to flow full at the design discharge without surcharging of inspection pits.

6. Interallotment drainage pits shall be located at all changes of direction. Pits shall be constructed of concrete, with 100mm thick walls and floor and have a minimum 600 x 600 internal dimensions. Pits shall be with a 100mm concrete lid finished flush with the surface of works. Depressed grated inlets are acceptable. ***Pits***

7. Pipes - Minimum Grade - The interallotment drainage shall have a minimum longitudinal gradient of 0.5% . ***Grade***

8. Interallotment Drainage Pipe Standards - The interallotment drainage shall be ***Pipe Type***

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constructed from rubber ring jointed pipes of either fibre reinforced concrete drainage pipe, reinforced concrete pipe, or UPVC pipe which shall conform respectively to the requirements of AS 4139, AS 4058 and AS 1254. In public road and recreation reserves where vehicle loads may be encountered, reinforced concrete pipe only, shall be used.

9. Interallotment Drainage Pipe - Relationship to Sewer Mains - Where interallotment drainage and sewer mains are laid adjacent to each other they are to be spaced 1.5 metres between pipe centrelines (where the pipe inverts are approximately equal). ***Sewer***

10. Where there is a disparity in level between inverts the spacing is to be submitted for approval.

11. Where sewer mains are in close proximity to interallotment drainage lines they are to be shown on the interallotment drainage plan.

DETAILED DESIGN

D5.18 CONDUITS

1. Conduits and materials shall be in accordance with the acceptable industry standards. ***Materials***

2. Pipe bedding and cover requirements for reinforced and fibre reinforced concrete pipes shall be determined from the Concrete Pipe Association "Concrete Pipe Guide" or AS 3725. For uPVC pipes, the requirements shall be to AS 2032. ***Bedding and Cover***

3. Drainage lines in road reserves shall generally be located behind the kerb line and parallel to the kerb. Drainage lines in easements shall generally be centrally located within easements. ***Location***

4. Bulkheads shall be designed on drainage lines where the pipe gradient exceeds 5 per cent. The design details shall address the size, and position in the trench as well as spacing along the line. ***Bulkheads***

D5.19 PIT DESIGN

1. Pits shall be designed with benching to improve hydraulic efficiency and reduce water ponding. Pit designs and other pit design requirements are to be in accordance with accepted industry standards. Safety and safe access are important considerations in pit design. Step irons shall be detailed where required and grates shall be of “bicycle safe” design.

D5.20 STORMWATER DISCHARGE

1. Stormwater discharge shall be located so as to avoid recharging groundwater and creating or worsening salinity degradation of adjacent land. Stormwater discharge shall be located to avoid areas with high groundwater tables, groundwater discharge areas or salt-affected land. The Designer shall meet requirements of the appropriate land and water resources authority with regard to the salinity levels of discharge to natural watercourses. ***Salinity Prevention***

2. Scour protection at culvert or pipe system outlets shall be constructed in accordance with guidelines set down in *The Blue Book - Managing Urban Stormwater:: Soils and Construction* unless outlet conditions dictate the use of more substantial energy dissipation arrangements. ***Scour Protection***

3. Kerb and gutter shall be extended to drainage pit or natural point of outlet. Where outlet velocity is greater than 2.5m per second or where the kerb and gutter ***Kerb & Gutter Termination***

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discharge causes scour, then protection shall be provided to prevent scour and dissipate the flow.

4. At points of discharge of gutters or stormwater drainage lines or at any concentration of stormwater from one or on to adjoining properties, either upstream or downstream, Council will require the Developer to enter into a Deed of Agreement with the adjoining owner(s) granting permission to the discharge of stormwater drainage and the creation of any necessary easements with the cost of the easement being met by the Developer. ***Easements, Adjoining Owners***

5. Where the drainage is to discharge to an area under the control of another statutory authority eg, Public Works, the design requirements of that Statutory Authority are also to be met. ***Other Authorities' Requirements***

For site developments, an overland flowpath shall be provided through the site to cater for the 100 yr ARI event flows from the upstream catchment plus those from the site developed. These flows must be safely conveyed through the site to Council's road and/or drainage system and discharged via a road or pathway system in preference to the use of easements. ***Overland Flow Paths***

6. The minimum drainage easement width shall be 3.0m for drainage systems to be taken over by Council. The overall width of the easement in Council's favour will be such as to contain the full width of overland flow or open channel flow in the major system design event. ***Council Easement***

7. Piped stormwater drainage discharging to recreation reserves is to be taken to a natural watercourse and discharged in an approved outlet structure or alternatively taken to the nearest trunk stormwater line. ***Recreation Reserves***

D5.21 TRENCH SUBSOIL DRAINAGE

1. Subsoil Drainage shall be provided in pipe trenches as follows:

   In cases where pipe trenches are backfilled with sand or other pervious material, a 3m length of subsoil drain shall be constructed in the bottom of the trench immediately upstream from each pit or headwall. The subsoil drain shall consist of 100mm diameter agricultural pipes, butt jointed with joints wrapped with hessian, or slotted PVC pipe. The upstream end of the subsoil drain shall be sealed with cement mortar, and the downstream end shall discharge through the wall of the pit or headwall.

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DOCUMENTATION

D5.22 DRAWINGS

1. Catchment Area Plans shall be drawn to scales of 1:100 or 1:200, unless alternative scales are specifically approved by Council and shall show contours, direction of grading of kerb and gutter, general layout of the drainage system with pit locations, catchment limits, how the proposed stormwater system is integrated with the proposed landscape and any other information necessary for the design of the drainage system. The extent and area (in plan) of any upstream catchment for external flows entering the site and the proposed catchment and sub-catchment areas layout of the subject site shall be shown

Catchment Areas

2. The Drainage System Layout Plan shall be drawn to a scale of 1:500 and shall show the major and minor systems with drainage pipeline location, drainage pit location and number and road centreline chainage, size of opening and any other information necessary for the design and construction of the drainage system.

Drainage System Layout

3. The plan shall also show all drainage easements, reserves and natural watercourses. The plan may be combined with the road layout plan.

4. Survey of the development site and surrounding areas, to provide sufficient information in order to assess the Application, which includes lot boundaries, contours/spot levels, buildings, easements, services, landscaped areas, site area, roadways etc.

Survey

Note: For plans submitted for construction certificate stage, sufficient contours and spot levels must be shown on the plan to enable a proposal's construction. It is insufficient to show arrows to indicate a fall in the pavement. All levels to be related to AHD.

4. The Drainage System Longitudinal Section shall be drawn to a scale of 1:500 horizontally and 1:50 vertically and shall show pipe size, class and type, pipe support type in accordance with AS 3725 or AS 2032 as appropriate, pipeline and road chainages, ground levels, services, invert levels, calculated flows, velocity, pipeline grade, hydraulic grade line and any other information necessary for the design and construction of the drainage system.

Longitudinal Section

5. The location and extent of any floodways, flowpaths, stormwater concentrations or proposed overland flowpaths must be shown with information to include contours of the land within which the floodway, flowpath, stormwater concentrations or overland flowpath path will be located, the capacity of it, details of any bed reinforcement and the proposed point of discharge.

Overland flowpaths

6. Open Channel Cross Sections shall be drawn to a scale of 1:100 natural and shall show the direction in which the cross sections should be viewed. Reduced levels are to be to Australian Height Datum (AHD), unless otherwise approved by Council where AHD is not available. Cross sections may alternatively be provided in digital format able to be viewed in Excel or text files or where HEC-RAS has been used, in this format.

Open Channels

7. Details including standard and non-standard pits and structures, dimensions, pit benching, open channel designs and transitions shall be provided on the Drawings to scales appropriate to the type and complexity of the detail being shown. This includes for on-site detention storage, weirs, outlet structures, scour protection, etc.

Details

8. Written agreement from downstream property owners to provide an easement to drain water if applicable.

Easement

2. Where on-site detention is proposed, the following additional information will be required:

On-site detention

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(a) The location and extent of the detention storage.

(b) The location and levels of discharge points for the storage.

(c) Preliminary estimates on the Site Storage Requirement and Permissable Site Discharge values.

(d) The location and area of any portion of the site unable to drain to the storage.

(e) The final disposal point, where the runoff from the site is unable to drain to the storage, together with justification that this runoff will not cause any adverse effects to the development site or neighbouring properties.

9. The flood study / drainage report prepared in accordance with relevant standards. The report will detail all assumptions and results and must demonstrate that stormwater runoff from the site is not increased beyond the existing undeveloped state up to and including a 100 year ARI. All stormwater detention details including analysis shall be included with the drainage report. ***Report***

7. Work-as-Executed Drawings shall be submitted to Council upon completion of the drainage construction and prior to the issue of the subdivision certificate. The detailed Drawings may form the basis of this information, however, any changes must be noted on these Drawings. ***Work-as-Executed Drawings***

D5.23 EASEMENTS AND AGREEMENTS

1. Evidence of any Deed of Agreement necessary to be entered into as part of the drainage system will need to be submitted prior to any approval of the engineering Drawings. Easements will need to be created prior to the issue of the subdivision certificate.

2. Where an agreement is reached with adjacent landowners to increase flood levels on their property or otherwise adversely affect their property, a letter signed by all the landowners outlining what they have agreed to and witnessed by an independent person shall be submitted prior to any approval of the engineering Drawings.

D5.24 SUMMARY SHEETS

1. A copy of the Hydrological Summary Sheets providing the minimum information set out in Appendix A is required. ***Hydrology***

2. A copy of the Hydraulic Summary Sheets providing the minimum information set out in Appendix B is required. ***Hydraulics***

D5.25 COMPUTER PROGRAM FILES AND PROGRAM OUTPUT

1. Computer program output may be provided as long as summary sheets for Hydrological and Hydraulic calculations in accordance with this Specification are provided with plans submitted for checking and with final Drawings.

2. Copies of final computer data files, for both hydrological and hydraulic models shall be provided for Council's data base of flooding and drainage information in formats previously agreed with Council.

3. It is preferably that stormwater pipe network design be undertaken in the DRAINS model format.

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APPENDIX A

HYDROLOGICAL DESIGN SHEETS

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PIPED URBAN STORMWATER DRAINAGE **HYDROLOGICAL DESIGN SHEET 1** Sheet …… of ……

Job …… Reference ……..

(1) Pit	(2) Land Use Type	(3) Flow Length (m)	(4) Slope (m/m)	(5) 'n'	(6) Time (min)	(7) Total Time (min)	(8) Intensity I (mm/h)	(9) Runoff Coeff. C	(10) Area A (ha)	(11) CA (ha) [9]x[10]	(12) ΣCA (ha)	(13) Q=CIA (l/s) [8]x[12] /0.36	(14) Bypass Flow (l/s) from Pit( )	(15) Adopted Flow rate (l/s) [13]+[14]	(16) Gutter Slope (m/m)	(17) Flow Width (m)	(18) Inlet Type	(19) Inflow (l/a)	(20) Bypass Flow (l/s) to Pit ( )	(21) Remarks
FLOW TIMES															PIT INLET					

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HYDROLOGICAL DESIGN SHEET 2

PIPED URBAN STORMWATER DRAINAGE

Job ..... Reference .....

(1) Pipe	(2) Time to (min)	(3) Intensity I (mm/h)	(4) ΣCA (ha)	(5) Q= CIA (l/s) [3]x[4] /0.36	(6) Time to (min)	(7) Intensity I (mm/h)	(8) ΣCA (ha)	(9) Q=CIA (l/s) [7]x[8] /0.36	(10) Adopted Flow Rate (l/s) Greater of [5] &[9]	(11) Remarks
	FULL AREA				PARTIAL AREA					

Designer ..... Date ..... Checked .....

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APPENDIX B

HYDRAULIC DESIGN SHEETS

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Piped Urban Stormwater Drainage

HYDRAULIC DESIGN SHEET

Job _____ Sheet _____ of _____ Reference _____

[1] Pipe	[2] Length L (m)	[3] Design Flow Rate Q (l/s)	[4] Trial Pipe Diameter (m)	[5] Full Pipe Vel. V (m/s)	[6] $\frac{V^2}{2g}$ (m)	[7] U/S Surface Level (m) AHD	[8] U/S Pit Water Level Limit * (m)	[9] Pit Pressure Change Coeff. Ku or Kw	[10] $k_u\frac{V^2}{2g}$ (m) [9]x[6]	[11] HGL at U/S Pit (m) [8]-[10]	[12] HGL Slope S_f (m/m)	[13] Pipe Friction Loss $S_f L$ [12]x[2]	[14] HGL at D/S Pit (m) AHD [11]-[13]	[15] D/S Pit Surface Level (m) AHD	[16] D/S Pit Water Level Limit** (m)	[17] Hydraulic [11]-[14]	[18] Cover [7]-Cover, Wall thickness	[19] U/S Pipe [23] Drop	[20] Adopted Lowest of [17],[18] and [19]	[21] Hydraulic [16]-[4]	[22] Cover [15]- Cover	[23] Adopted Lowest of [21] and [22]	[24] Pipe Slope S_f [20]-[23] [2]	[25] Remarks
																U/S Invert Levels (m)				U/S Invert Levels (m)				

* Lower of :[7] - freeboard
or lowest HGL level in [14] for pipes entering U/S pit.

** Lower of : [14]
or [15] - freeboard

Designer _____ Date _____ Checked _____

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HYDROLOGICAL CHECKING SHEET

PIPED URBAN STORMWATER DRAINAGE

Job ..... Reference .....

(1) Pipe	(2) Length L (m)	(3) Design Flow-Rate Q (l/s)	(4) Pipe Dia-meter (m)	(5) Full Pipe Vel. V (m/s)	(6) $\frac{V2}{2g}$ (m)	(7) D/S HGL Level (m) AHD	(8) Pipe Friction Loss S L (m)	(9) HGL just below U/S Pit (m) [7]+[8]	(10) Obvert Level At Upper End of Pipe (m)	(11) Pit Pressure Change Coeffs. K Or K	(12) $\frac{K.V2}{2g}$ (m) [11]x[6]	(13) Adopted U/S Pit Water (or HGL) Level* (m)	(14) U/S Surface Level (m) AHD

* (higher of [9] and [10] +[12])

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