PLANNING PANELS VICTORIA
MELBOURNE

Amendment C192 and C193

GREATER SHEPPARTON CITY COUNCIL

Client

EXPERT EVIDENCE OF JOHN DUNN

HEARING 24 JULY – 14 AUGUST 2017

Name and address

1 John Dunn

2 Senior Engineer/Director, Rural Works Pty Ltd, 6 Rose Street, VIOLET TOWN 3669.

Qualifications and experience

3 Qualifications: - B. E. (Civil), Grad. Dip. (Municipal Engineering & Management), Grad Cert. (Water Engineering), ME.

4 Experience: - 40 years working either as an employee of Local Government or Consulting to Local Government. The work undertaken includes: drainage design for bridges, rural roads, town urban networks; reviewing drainage proposals for developments and subdivisions for both the Greater Shepparton City Council and other Municipalities.

Area of expertise

5 Civil and structural engineering particularly in relation to local government related matters.

Expertise to make this report

6 I have been principally responsible for the assessment and review (on behalf of the Responsible Authority) of the retardation basin, storm water treatment and drainage design submitted by the Spiire.

Instructions and scope of report

7 I have been requested by Council's lawyers, HWL Ebsworth, to provide expert civil and drainage engineering evidence to the panel with regard to the plans and report – 'North Shepparton Drainage Strategy, Yakka and Hawkins Catchments' prepared by Spiire.

8 My evidence only relates to the acceptability of the Yakka Basin and Hawkins Basin designs and Drainage Plans in terms of North Shepparton Drainage Strategy.

9 My evidence is related to the basin designs in terms of the drainage of the subject land and the proposed development of the subject land.

Facts, matters and assumptions

10 The subject land is within an area that requires drainage outfall to a Goulburn Murray Water (GMW) drain.

11 GMW require that urban storm water be retarded to 1.2 l/s/ha prior to discharge to their drainage channel.

12 GMW require urban storm water to be totally retained on site for a period of time up to 24 hours following a storm event.

13 Urban storm water is to be treated to improve the quality of the stormwater prior to discharge from the site in accordance with the Infrastructure Design Manual (IDM) clause 20.3.1 General Requirements.

14 Drainage design for the subject land shall be in accordance with the IDM clause 16 Urban Drainage.

References

15 Infrastructure Design Manual.

16 MUSIC modelling of storm water treatment.

17 Rural Works Spiire Design Review Reports.

Persons carry out tests or experiments

18 Belinda MacLaughlin – Rural Works employee, who undertook the MUSIC modelling checks.

Summary of opinion

19 The co-efficient of runoff used for the drainage design has been reviewed and is in accordance with the IDM clause 16.7 Table 10 Runoff Co-efficients.

20 The catchment areas that were analysed as contributing to the basin are appropriate.

21 The design volume of storm water to be stored in the basins meets the requirement of the IDM.

22 The proposed stormwater treatment meets the requirement of the IDM clause 20.3.1 General Requirements.

23 The size and volume of the retention basins is in accordance with the IDM clause 19 On-site Detention Systems and is appropriated for the catchment.

24 The proposed basins are located to utilise the existing basins – Yakka and Hawkins basins, in order to minimise the cost of basin construction and minimise the basin footprint.

25 The proposed unground drainage, pump stations and rising mains associated with basins are in accordance with the IDM clause 16.14 Pump Stations.

26 The estimated cost for the construction of the basins, underground drainage, pump stations and stormwater treatment is appropriate.

27 The proposed method of apportionment of cost of the construction of: the basins, underground drainage, pump stations and stormwater treatment is appropriate.

28 The Spiire Report dated 7 July 2017 includes revisions and amendments to earlier versions of the Spiire Reports, in accordance with the requests detailed in the Rural Works Design Review Reports.

Provisional opinions

29 Not applicable.

Matters outside area of expertise

30 Not applicable.

Declaration

I have made all the inquiries that I believe are desirable and appropriate and that no matters of significance which I regard as relevant have to my knowledge been withheld from the Panel.

……..

John Dunn

14 July 2017

Attachment – copy of IDM clauses referenced in the Expert Evidence Statement - Note that the IDM is Reference Document in the Greater Shepparton Planning Scheme.

Clause 16 Urban Drainage

16.1 Objectives

The general objectives of urban drainage are to:

- collect and control all stormwater generated within the subdivision or development;
- collect and control all stormwater entering a subdivision from catchments outside the subdivision;
- provide an effective outlet for all collected stormwater to a natural watercourse or acceptable outfall; and
- achieve these objectives without detriment to the environment generally, surface and subsurface water quality, groundwater infiltration characteristics, adjoining landowners and landowners in the vicinity of the drainage outlet, and watercourses either upstream or downstream of the subdivision.

16.2 General

Council will expect the **Design Engineer** to design the drainage system in accordance with the relevant provisions of *Australian Rainfall and Runoff – Flood Analysis and Design 2001, Water Sensitive Urban Design Engineering Procedures* published by Melbourne Water, *Urban Stormwater Best Practice Environmental Management Guidelines 2006*, published by the CSIRO and, where relevant, *Australian Standard AS3500.3 Stormwater Drainage.*

These standards and guidelines require that the complete drainage catchment be taken into account, not just the area included in the subdivision or **Development**. **Council** will expect the **Design Engineer** to base the calculated peak flow on the full potential development of the project and the upstream areas for normal flow situations, and to consider the overland flooding caused by pipe blockages, general flooding and high water levels. Staged upgrading of the system can only be undertaken with the prior agreement of **Council**.

Prior to commencing detailed design, the **Design Engineer** should determine the possible ultimate zoning of all external catchment areas contributing to the drainage system within the **Development**. This may require consultation with the **Council's Engineering Department** and **Council's Planning Department**.

16.3 Major and Minor Drainage Systems

Council will expect the **Design Engineer** to adopt the 'major/minor' approach to urban drainage systems as outlined in *Chapter 14* of *Australian Rainfall and Runoff – Flood Analysis and Design 2001*.

The minor system typically comprises a pipeline network with sufficient capacity to collect and convey stormwater flows from nominated design storm events (see Clause 0). These pipelines prevent stormwater damage to properties and limit the frequency and quantity of surface water to a level acceptable to the community. The pipelines do not always follow the natural drainage paths and are usually aligned along property boundaries and the roadway kerbs and channels.

The major drainage system caters for the runoff from storms of higher intensity than those for which the minor drainage system has been designed. The major drainage system is designed to handle flows resulting from storms with a 1% **AEP**. These flows should follow a designated overland flow path, which will normally be a road reserve if the catchment area is small, and/or a drainage reserve when it is impractical for unsafe for a road reserve to carry the excess flows.

Council will expect the finished floor level of buildings to be at least 300mm above the 1% **AEP** flood level.

16.4 Hydrology

Council will expect the **Design Engineer** to prepare a catchment plan showing the total catchment area and sub-areas that form the basis of the design, and to submit this for approval by **Council's Engineering Department**, together with a drainage computations sheet.

Partial areas should be considered when determining peak flow sites, particularly when a catchment contains sub-areas, such as reserves, that may have relatively large time of concentration in conjunction with a small coefficient of runoff. In some instances a partial area design discharge may result in runoff that is less (or the same) than a discharge calculated at some upstream point. Careful checking of the partial area flows may be required to determine the largest flow, which **Council** will expect to be used for the design of the stormwater system downstream of the connection point.

In assessing the major drainage system, the **Design Engineer** should consider using a Unit Hydrograph or Non-Linear Run-Off Routing model. The **Design Engineer** will be responsible for determining the most appropriate methodology for each application. Various drainage tools, programs and construction methods are available to the **Design Engineer** to achieve the objectives of the drainage system. Regardless of the technique or method used, **Council** will expect detailed documentation to be submitted for review and approval.

Two separate recognised runoff estimation methods, in addition to the Rational Method, should be used for catchment areas greater than 50 hectares.

16.5 Rainfall Data

Two methods have commonly been used to describe the probability that rainfall or flood events of a defined magnitude will be experienced in the lifetime of a stormwater drainage network. These are the **Annual Exceedance Probability** and the **Average Recurrence Interval**.

Both methods are probabilistic in nature, but that fact can become obscured when the **ARI** is used to set a design event. Many people believe that, once an event with a 100-year **ARI** has occurred, no further event of that magnitude can be expected to occur for 100 years. This is not true, and the real situation is much better captured by describing the event as having a 1% **AEP** in any year. The **AEP** terminology recommended by *Australian Rainfall and Runoff* has therefore been adopted in this manual to describe events with an ARI greater than or equal to one year.

The **AEP** is related to the **ARI** by the equation: AEP=1-(1/exp(1/ARI)) where ARI is in years.

The return interval method can also be misleading for events whose average return interval is less than one year, since seasonality can become important (for example, events may be clustered in a wet season). The **EY** (events per year) terminology recommended by *Australian Rainfall and Runoff* has therefore been adopted to describe such events.

Table 8 summarises the relationship between the return interval descriptors and those now used within the manual, with **AEP** values rounded to the nearest percentage point.

Table 8 AEP Values for ARI

ARI (years)	AEP	EY
0.25	95%	4
0.50	86%	2
1	63%	1
2	39%	
5	18%	

ARI (years)	AEP	EY
10	10%	
20	5%	
50	2%	
100	1%	

Intensity/Frequency/Duration curves (IFD) are available from the Bureau of Meteorology Website: http://www.bom.gov.au/cgi-bin/hydro/has/CDIRSWebBasic

Online resources allow curves to be established for any Australian location based on its latitude and longitude.

16.6 Annual Exceedance Probability

Council will expect the design of the minor drainage system to be based on the **AEP**s shown in Table 9.

Table 9 Annual Exceedance Probabilities for Minor Drainage in Urban Areas

Drainage System	Capacity
Urban Residential Areas	18% **AEP**
Commercial centres of 10 shops or less	10% **AEP**
Industrial areas or where surcharge would seriously affect private property	10% **AEP**
Drainage through Private Industrial Property	5% **AEP**
Commercial areas	5% **AEP**

The initial time of concentration from building to property boundary can normally be assumed to be six (6) minutes in urban residential areas. Special consideration may be necessary for other areas and/or circumstances.

Council will expect the **Design Engineer** to identify all overland flow pathways to be activated in 1% **AEP** events, and to demonstrate that these pathways (normally including road reserves in urban areas) have sufficient capacity to convey all excess runoff once the available capacity of the minor drainage system has been fully mobilised. Care should be taken to ensure that any adjacent properties will not suffer adverse consequences from the mobilisation of those paths .These requirements may not be applicable when pipes discharge to retarding basins, as provided for in Clause 18.5.

16.7 Runoff Coefficients

The runoff coefficient shown in Table 10 should be checked against *Australian Rainfall and Runoff – Flood Analysis and Design 2001.* For areas of special use such as schools, community centres, and sporting developments, **Council** will expect the **Design Engineer** to carry out a more detailed study of the characteristics of the area, establish the actual proportions of pervious and impervious areas, and consider the likelihood of soil permeability reducing progressively during prolonged rainfall events, in order to determine appropriate runoff coefficients.

Table 10 specifies the minimum runoff coefficients to be used in the design of drainage systems:

Table 10 Runoff Coefficients

Catchment Type	Runoff Coefficient (applies to all **AEP** for most Councils)	Runoff Coefficient (applies to 18% **AEP** for those Councils listed in Selection Table 16.7)
LDRZ – lot areas > 2 ha	0.30 See notes 1, 2 and 3	0.30
LDRZ - >1 ha to 2 ha	0.35 See notes 1, 2 and 3	0.30
LDRZ – lot areas >4000 m^2 to 1 ha	0.40 See notes 1, 2 and 3	0.35
LDRZ – lot areas >2000 m^2 to 4000 m^2	0.45 See notes 1, 2 and 3	0.35
Residential areas – lot areas >1000 m^2 to 2000 m^2	0.50 See notes 1, 2 and 3	0.40
Residential areas – lot areas >600 m^2 to 1,000 m^2	0.70 See notes 1, 2 and 3	0.55
Residential areas – lot areas >450 m^2 to 600 m^2	0.75	0.60
Residential areas – lot areas >300 m^2 to 450m^2	0.80	0.65
Residential areas – lot areas <300 m^2	0.80	0.80
Residential areas (medium density, i.e. Units, including potential unit development sites)	0.90	
Commercial zones	0.90	
Industrial zones	0.90	
Residential road reserves	0.75	
Landscaped areas	0.25	
Public Open Space	0.35	
Paved areas	0.95	

Note 1

The runoff coefficients shown in Table 10 for residential lots greater than 600m^2 in area do not include an allowance for the road reserves within these subdivisions.

Note 2

Where there is a likelihood of further subdivision occurring of allotments in new subdivisions an allowance of 10% should be added to the coefficients to avoid the need for on-site detention to be provided for these further subdivisions.

Note 3

The **Councils** listed in Selection Table 16.7 have differing coefficients of runoff for 18% **AEP** and 1% **AEP**. All other **Councils** use the coefficients listed in the first column of Table 10.

Selection Table 16.7 Differing Coefficients of Runoff

Councils That Use Differing Coefficients of Runoff for 18% AEP and 1% AEP
Greater Bendigo City Council
Greater Geelong City Council
Horsham Rural City Council
Wellington Shire Council
Yarriambiack Shire Council

16.8 Hydraulic Design

Council will expect the **Design Engineer** to use hydraulic grade line (HGL) analysis based on appropriate pipe friction and drainage structure head loss coefficients. The HGL should remain more than 150mm below the invert of the kerb for minor flows, and be less than 350mm above the invert of the kerb for major flows.

When an external area contributes stormwater to the system, the drain should be located at a depth sufficient to serve the total upstream area, and due consideration should be given to any possible upstream backwater effects.

The HGL in pipes running partially full may be assumed to follow the pipe obvert. However, the actual velocities within the pipe under such circumstances should be checked.

Pipe designs should reflect appropriate pipe parameters for either the Colebrook – White formula or Manning's formula as shown in Table 11.

Table 11 Pipe Roughness Values

Pipe Material	N	K
Spun precast concrete	0.013	0.6
UPVC	0.009	0.06
Ribbed HDPE/Polypropylene	0.010	0.25

Where **Council** has agreed that other pipe materials may be used, the manufacturer's recommendations should be adopted, having due regard to the potential for pipe roughness to increase over the service life of the system.

16.8.1 Pipe Velocities

The design pipe velocities should normally be:

- Minimum – pipe running half-full or more – 0.75 m/s

- Minimum – pipe running less than half-full - 1.00 m/s
- Maximum – 5.00 m/s

16.8.2 Minimum Pipe Grades

The preferred minimum grade of a stormwater pipe is listed in Selection Table 16.8.2. **Council** may accept flatter grades where the **Design Engineer** can demonstrate that the velocities will exceed those listed in the headings of the table.

Selection Table 16.8.2 Minimum Pipe Grades

Minimum Grade of Stormwater Pipe to be 1 in 500 subject to a Minimum Velocity of 0.7m/sec	Minimum Grade of Stormwater Pipe to be 1 in 300 subject to a Minimum Velocity of 1.0m/sec
Benalla Rural City Council	Ararat Rural City Council
Campaspe Shire Council	Ballarat City Council
Colac Otway Shire Council	Bass Coast Shire Council
Gannawarra Shire Council	Baw Baw Shire Council
Greater Shepparton City Council	Central Goldfields Shire Council
Horsham Rural City Council	Corangamite Shire Council
Mansfield Shire Council	East Gippsland Shire Council.
Moira Shire Council	Glenelg Shire Council
Wellington Shire Council	Golden Plains Shire Council
Yarriambiack Shire Council	Greater Bendigo City Council
	Greater Geelong City Council
	Hepburn Shire Council
	Indigo Shire Council
	Latrobe City Council
	Macedon Ranges Shire Council
	Mitchell Shire Council
	Moorabool Shire Council
	Moyne Shire Council
	Murrindindi Shire Council (minimum grade 1 in 200)
	Pyrenees Shire Council
	Rural City of Wangaratta
	South Gippsland Shire Council
	Southern Grampians Shire Council
	Strathbogie Shire Council
	Surf Coast Shire Council
	Swan Hill Rural City Council
	Towong Shire Council
	Warrnambool City Council

Minimum Grade of Stormwater Pipe to be 1 in 500 subject to a Minimum Velocity of 0.7m/sec	Minimum Grade of Stormwater Pipe to be 1 in 300 subject to a Minimum Velocity of 1.0m/sec
	Wodonga City Council

16.8.3 Minimum Pipe Cover

The minimum cover should be in accordance with the manufacturer's recommendations, unless otherwise provided for in Clause 16.10. Additional cover should be provided wherever crossings with large sized services are anticipated, and pipe classes should be determined having regard to the proposed cover and to the anticipated live loads.

The **Design Engineer** should discuss any proposed exceptions to the minimum cover requirements with **Council's Engineering Department** prior to submitting documents for approval of the functional layout.

16.8.4 Curved Pipelines

Curved pipelines are permitted only where they are of constant radius in the horizontal plane only, and are in accordance with the pipe manufacturer's specifications.

16.8.5 Pipe Alignments at Pits

The following considerations apply to the alignment of pipes at pits:

- Generally, when designing the pipe system under pressure, the pipe obverts should coincide at junctions, but in flat terrain, the inverts may coincide.
- Where practical, the pipes at junctions should be aligned so that the projected area of the upstream pipe is wholly contained within the downstream pipe.

16.8.6 Pit Losses

Pit losses can be calculated on the basis of:

$$K \frac{V_O^2}{2g}$$ Where Vo is the outlet velocity calculated from $$\frac{Q_O}{A_O}$$

where K is a head loss coefficient.

Values of K for various pit configurations are given in Austroads *Road Design Guidelines - Part 5 General and Hydrology Considerations* and any VicRoads Supplement to those guidelines.

16.8.7 Pit Locations

Side entry pits should be spaced so that the pits are able to deliver the design flows into the pipes, and the length of the flow channels should not exceed 80 metres. **Council** will expect the **Design Engineer** to consult inlet capacity charts or undertake specific design where any doubt exists that these criteria can be satisfied.

Side entry pits should be clear of radials, kerb crossings and driveways. Channel flow approaching an intersection should be collected before the tangent point, unless the **Design Engineer** can demonstrate that adequate capacity is available in the kerb and channel to carry water around the return.

Double side entry pits should be used where approach grades to intersections are in excess of 6% and at all low points in roads, unless the **Design Engineer** can satisfy **Council's Engineering Department** that a single side entry pit will provide sufficient inlet capacity for the pipes to operate at their required capacity.

16.9 Main Drains

Pipes of ∅750mm or greater should be designed as main drains, and large direction changes through standard pits should be avoided. Consideration should be given to using special pit geometries, and/or introducing additional pits and/or bends at significant changes of direction.

The **Design Engineer** should discuss the design criteria for main drains with **Council's Engineering Department** at the earliest possible stage in the design process.

16.10 Pipes

16.10.1 Pipe Type

16.10.1.1 Reinforced Concrete Pipes

Reinforced concrete pipes with spigot-and-socket profile and rubber ring joints, manufactured to meet the requirements of *AS/NZS 4058-2007 Precast concrete pipe (pressure and non-pressure)*, and designed and installed in accordance with Clause 16.10.3, are accepted by all Councils. Flush-jointed reinforced concrete pipes with external bands, manufactured, designed and installed to the above standards, may be used for culverts and other specific applications, subject to the prior agreement from **Council's Engineering Department**.

16.10.1.2 Ribbed Polypropylene or High-Density Polyethylene Stormwater Pipes

Ribbed polypropylene or high-density polyethylene stormwater pipes, designed and installed in compliance with Clause 16.10.3, may be used as an alternative to reinforced concrete pipes where a Council has indicated its acceptance of such use in Selection Table 16.10.1 Ribbed Polypropylene or High Density Polyethylene Stormwater Pipes.

Selection Table 16.10.1 Ribbed Polypropylene or High Density Polyethylene Stormwater Pipes

Accepted for use	Accepted for use except under road pavements
East Gippsland Shire Council	Ballarat City Council
Greater Geelong City Council	Baw Baw Shire Council
Greater Shepparton City Council	Campaspe Shire Council
Surf Coast Shire Council	Colac Otway Shire Council
Wangaratta Rural City Council	Glenelg Shire Council
Warrnambool City Council	Golden Plains Shire Council
	Greater Bendigo City Council
	Greater Bendigo City Council
	Horsham Rural City Council
	Indigo Shire Council
	Macedon Ranges Shire Council

Accepted for use	Accepted for use except under road pavements
	Murrindindi Shire Council
	Wellington Shire Council
	Yarriambiack Shire Council

16.10.1.3 Other Profiles and/or Materials

Prior agreement in writing from **Council's Engineering Department** is required for all other pipe profiles and/or materials. These include ribbed polypropylene or high density polyethylene stormwater pipes for those Councils not listed in Selection Table 16.10.1 Ribbed Polypropylene or High Density Polyethylene Stormwater Pipes.

Council recognises that sustainable material alternatives, including recycled plastics and concretes containing recycled aggregates or fibre reinforced concretes, can demonstrate similar hydraulic performance to that of conventional materials, but will require that the **Design Engineer** provides additional evidence on the structural integrity and durability of proposed pipe profiles and materials. The information provided should include:

- details of any Australian or overseas Standards covering the design and installation of the pipeline;
- the manufacturer's recommendations for type, class , loading, cover, and installation procedures;
- details of where, by whom, and for what purposes similar pipes have previously been accepted;
- details of testing and inspection proposed to be undertaken; and
- other details as required by the **Council**

16.10.2 Pipe Diameters

The minimum pipe diameter is generally 100mm UPVC for property inlets serving a single dwelling and 150mm UPVC for property inlets serving two dwellings. **Councils** may require larger diameter property inlets where the runoff being generated from the property so dictates.

Pipes that are or will become **Council** assets, and are not required to convey runoff from a road or street, should have a minimum diameter of 225mm. Pipes that are or will become Council assets, and do convey runoff from a road or street, should have a minimum diameter of 375mm, to reduce the risk of blockage.

The **Design Engineer** may apply in writing to **Council's Engineering Department** for agreement to vary the above minimum sizes. Such applications should be accompanied by computations to show that the required minimum flow velocities have been achieved, and the pipe capacities are adequate for the intended purpose. The application should explain how blockages are to be avoided when the pipes in question are required to convey runoff from a road or street.

16.10.3 Standards for the Design and Installation of Pipes

16.10.3.1 General

Council will only accept pipes which have been manufactured designed and installed according to the relevant Australian Standards. When selecting the type and class of pipe to be used, due regard should be had to the external loading, the pipe characteristics and the construction techniques to be used. The pipe embedment materials and procedures should comply with any specific recommendations published by the pipe manufacturer, and all relevant controls should be applied to plant and compaction techniques when required for a particular type and class of pipe.

Pipeline designs should consider both dead and live loads. In addition to the live loads imposed by normal traffic movements, **Council** will expect the **Design Engineer** to have regard to the transient live loads associated with construction equipment, heavy service vehicles and emergency vehicles.

When pipelines are located within road reserves or public spaces, or may otherwise be subjected to significant live loads, **Council** may require the **Design Engineer** to provide specific calculations, based on the live loads specified in *AS 5100.2 Bridge design*, to confirm the adequacy of the proposed type and class of pipe, rather than relying on generic recommendations by manufacturers.

Where any departures from these provisions are proposed, **Council** will expect the **Design Engineer** to seek agreement for those departures at the earliest possible stage in the design process, and to provide detailed justification for their proposals.

Note: *The **Design Engineer** should ensure that any commercially available software package relied upon in performing such calculations uses the live load distribution ratios specified in Clause 6.2 of AS 5100.2.*

16.10.3.2 Reinforced Concrete Pipes

Reinforced concrete pipes, as specified in Clause 16.10.1, should be designed and installed in accordance with *AS/NZS 3725-2007 Design for installation of buried concrete pipes*. The **Design Engineer** should have regard to the recommendations in *AS/NZS 3725-2007 Supplement 1 (Commentary),* particularly in situations where a buried pipeline may be required to carry significant live loads.

Note: *Table B2 of AS 3725-2007 does not reflect the live load distribution ratios specified in Clause 6.2 of AS 5100.2, and should not be relied upon when submitting specific calculations for pipelines to be located within road reserves or public spaces.*

16.10.3.3 Ribbed Polypropylene or High Density Polyethylene Stormwater Pipes

Ribbed Polypropylene or High Density Polyethylene Stormwater Pipes, as specified in Clause 16.10.1, should:

- be designed to comply with *AS/NZS 2566.1-1998 Buried flexible pipes – structural design;*
- be installed as required by *AS/NZS 2566.2-2002 Buried flexible pipes – installation*;
- comply fully with any additional technical recommendations provided by the manufacturer;
- when installed behind mountable or semi-mountable kerb, have a cover of at least 750mm;
- when installed in easements subject to occasional traffic, have a cover of at least 600mm; and
- when installed within a Bushfire Management Overlay, have a cover of at least 450mm.

When particular pipe materials and/or systems are not specifically covered in AS/NZS 2566.1-1998, Council may require the Design Engineer to provide evidence that the testing and quality control regimes applied, and the design parameters recommended, by the manufacturer are equivalent to, or more stringent, than those specified in the standard.

16.10.3.4 Alternative Bedding and Backfill Materials

Aggregate specifications for these purposes depend on the pipeline material, the depth of embedment, and the nature of the overlying infrastructure. **Council** will expect the material being considered to meet grading, plasticity and other criteria outlined in the relevant specifications. **Council** recognises that recycled materials may provide a sustainable alternative to natural gravels and sands or crushed rock, but will normally expect the **Design Engineer** to provide evidence that such materials will meet consistent performance standards, equivalent to those of conventional materials, and have been used

successfully in comparable situations elsewhere in Australia. Where such evidence is not readily available, advice may be sought from the manufacturer of the pipe units as to the suitability of the proposed alternative material.

16.11 Structures

16.11.1 Drainage Structures

Council will expect drainage structures to comply with the applicable standard drawings. Where modifications are required or special structures are to be constructed or installed, the **Design Engineer** should submit full details with the detailed design documentation. Normal good practice should be observed in determining the pit layouts, and shallow intersection angles between drainage lines at pits will not be permitted.

Murrindindi Shire Council requires floors of pits shown in the Standard Drawings to be shaped to suit the pipe radius and change of pipe lower inverts, unless otherwise agreed by the **Council**.

Junction pits at the back of kerb within intersections should be avoided wherever possible.

16.11.2 Minimum Drops at Pits

Minimum drops at pits are required to provide sufficient slope along the pit inverts to clear debris, and to provide tolerance in setting pipe invert levels. Generally the minimum drop through pits is 20mm. However, in circumstances where changes in direction occur, several pipes enter one pit, large inlet and outlet velocity differences exist or grated or side-entry pits are used, hydraulic losses become significant and should be carefully considered in the analysis and design of the network.

16.11.3 Maximum Drops at Pits

Council will expect the **Design Engineer** to design drop pits with a level difference greater than 2m between an incoming pipe and the pit outlet pipe in accordance with the Austroads *Road Design Guidelines - Part 5 – General and Hydrology Considerations* and any VicRoads Supplement to those guidelines.

16.11.4 Side Entry Pits and Grated Pits

Pit functions and capacities should be in accordance with Austroads *Road Design Guidelines - Part 5A Drainage – Road Surfaces, Networks, Basins and Subsurface* and any VicRoads Supplement to those guidelines. Unless otherwise agreed by **Council**, pit construction or installation should be in accordance with the relevant Standard Drawings, and with the manufacturer's recommendations where appropriate.

Council may accept the use of prefabricated pits, but may require the **Design Engineer** or **Construction Engineer** to provide full technical details of the proposed pits, including material, specification, dimensions, and product data sheet, and to give careful consideration to any advantages or disadvantages of using such pits in the proposed location. **Council** may also require that a certificate be provided by a **Qualified Engineer** to confirm the structural integrity of the pits in the specific application, having regard to the nature of the pipes to be used and the dead and live loads to be sustained.

16.11.5 Pit Covers

Pit covers should have a clear opening of sufficient dimension and orientation to comply with OH&S and confined space entry requirements. Heavy duty covers or plastic lock-down covers may be required in high risk areas such as Public Open Spaces, recreation reserves, school areas etc. Elsewhere, covers should be installed with class rating in accordance with potential traffic loadings.

Approved trafficable load-bearing covers should be provided on all side entry pits in exposed kerb areas, particularly at intersections, and on all pits located within industrial **Developments**. The drainage network should be designed to locate pits away from exposed kerb areas wherever possible

16.12 Litter Collection Pits

Council will expect the **Design Engineer** to provide acceptable gross pollutant traps towards the end of any drainage line that discharges to a watercourse and/or drainage basin, located so that comfortable access by maintenance vehicles is achieved. Where the pit is located in a road reserve, drainage reserve or other area with public access, all vehicle travel should be in a forward-only direction.

For design purposes, the default period for the cleaning of litter collection pits should be assumed to be 6 months.

16.13 Outfall Structures and Energy Dissipators

Council will expect outfall structures or discharge points for floodways at receiving waters to be designed in accordance with the requirements of the responsible authorities for the relevant land and receiving waters. Energy dissipators for pipes should normally be of the impact type.

16.14 Pump Stations

Small pumped systems, serving catchments up to 2,000m^2 in area in cases where stormwater cannot be conveyed by gravity to a legal point of discharge, may be designed to comply with Section 9 of AS/NZS 3500.3. With that exception, Council will expect all pumped systems to be designed by a **Qualified Engineer**, having regard to the principles that all pump stations should be:

- constructed above the 1% AEP flood level;
- screened so as to minimise the likelihood of blockage by sediment and debris;
- configured so that failure of a single pump will not result in failure of the system;
- provided with sufficient storage capacity to accommodate power supply outages;
- capable of being quickly and effectively isolated from the drainage network;
- designed so that all major components can readily be removed and replaced;
- designed so that emergency power supplies can readily be connected;
- equipped with suitable telemetry, including warning and remote control systems; and
- supplied with detailed operation and maintenance manuals.

Further guidance can be found in *Hydraulic Engineering Circulars 22 (Urban Drainage Design)* and *24 (Stormwater Pump Station Design)* published by the US Department of Transportation.

16.15 Subsoil Drainage

Council will expect the **Design Engineer** to provide appropriate sub-surface drainage where groundwater or overland flows may adversely affect the performance of areas set aside as Public Open Space or Reserves. All sub-surface drainage should be installed in accordance with Section 702 of the *Vic Roads Standard Specifications for Road Works and Bridge Works* and include flushing points at the remote end from the outlet pit.

The desirable minimum grade for sub-surface drainage for pavements is 1: 250 with an absolute minimum of 1:300.

Typically, circular 100mm rigid wall or flexible UPVC Class 400 slotted pipe, including geotextile sock where required, is installed under each concrete pavement edging to a minimum depth of subgrade level.

Council will expect the **Design Engineer** to submit details of all sub-surface drainage to be used in the **Development, including groundwater discharge systems from sewerage trenches,** to **Council's Engineering Department** for approval.

16.16 Property Drains

In a greenfield development, no property drainage may discharge to kerb and channel without the written agreement of **Council's Engineering Department**. Connection should be made directly to a stormwater pit unless there is an existing pipe in the road reserve adjoining the property to which the property drain can be connected using a standard 'jump up' as shown in the **Council's** Standard Drawings. Where these requirements cannot be met but there is an existing barrier kerb, then the connection may be made to the barrier kerb.

In in-fill urban residential and commercial **Developments** where connection to underground drains is impractical, two (2) kerb adaptors per 20m of frontage should be provided at the time of development. Unless otherwise agreed by Council, kerb adaptors should be located clear of all driveway crossings and at least 1m from kerb crossings.

Generally galvanised steel or UPVC adaptors are acceptable unless there is a specific **Council** requirement as detailed in Selection Table 16.16.

Selection Table 16.16 Kerb Adaptors

Galvanised Steel Kerb Adaptors	UPVC Kerb Adaptors
Baw Baw Shire Council	Bass Coast Shire Council
Campaspe Shire Council	Ballarat City Council
Colac Otway Shire Council	Greater Bendigo City Council
Glenelg Shire Council	Mildura Rural City Council
Golden Plains Shire Council	Wellington Shire Council
Greater Geelong City Council	Yarriambiack Shire Council
Greater Shepparton City Council	
Horsham Rural City Council	
Macedon Ranges Shire Council	
Mildura Rural City Council	
Mount Alexander Shire Council	
Surf Coast Shire Council	
Swan Hill Rural City Council	
Wangaratta Rural City Council	

Council will expect the **Design Engineer** to provide easement drains to all allotments that fall to the rear, and to ensure that such drains are deep enough to serve the entire allotment. A property inlet, as per **Council's** Standard Drawings, should normally be constructed at the low corner of each allotment. The minimum fall towards the underground drainage outlet along the low side of allotments should be 1:200.

16.17 Major Drainage Requirements

Council will expect the **Design Engineer** to ensure that the major drainage system has sufficient capacity to collect the excess runoff from a catchment in a 1% **AEP** rainfall event once the available capacity of the minor drainage system has been fully mobilised, and to convey that runoff to the receiving waters with minimal nuisance, danger or damage. The major drainage system should be so designed and constructed as to ensure a reasonable level of safety and access for pedestrian and vehicular traffic, limit flooding of private and public property and minimise the inflow of pollutants to the receiving waters. The design of major drainage systems should take into account the potential use of wetlands, gross pollutant traps and sediment interception ponds, particularly immediately downstream of urban areas.

Major drainage in railway reserves should be limited to cross track drainage rather than longitudinal drainage. **Council** will expect the **Design Engineer** to obtain written consent from the relevant authority for all **Infrastructure** proposed to be located in railway reserves before seeking detailed design approval from **Council's Engineering Department**. The **Developer** will be required to pay all associated costs for such drainage works, including the licence fees (for a period of at least 10 years) specified by the relevant authority.

The normal minimum requirements of the major drainage system are as follows:

- **Council** will expect the design of major drainage systems to be based on the critical 1% **AEP** storm with some consideration being given to the impact of a rarer storm event. Best practice requires that the critical storm be determined by routing storms of varying duration until the peak flows are identified. **Council** will expect two recognised flow estimation methods (runoff routing computer models) in addition to the Rational Method to be used for comparative purposes when urban catchments or sub-catchments are greater than 50 Ha in area.

- Hydraulic Grade Line analysis should be used for the design of floodways, low-flow pipes and retarding basins. **Council** will expect the **Design Engineer** to demonstrate that the dimensions of major floodways are sufficient both to meet hydraulic requirements and to facilitate maintenance (including mowing), and that street drainage in urban areas will not be directed into easement drains.

- The depth of overland flows in urban areas should be controlled by freeboard to properties or by the upper limits of surface flow depth/velocity consistent with public safety, as detailed in Austroads *Road Design Guidelines Part 5A Drainage – Road Surfaces, Networks, Basins and Subsurface* and any VicRoads supplement to those guidelines.

16.18 Floodways

Major floodways generally comprise engineered open waterways, and often involve roadways, trapezoidal channels and sometimes sheet flow through open spaces. Major floodways are generally located within road reserves, drainage reserves or Public Open Space. **Council** will not accept major floodways through easements on private land in urban situations, and will expect the computed peak discharge to be contained entirely within reserves.

Where a **Development** will have a significant impact on overland flows or flood-storage, **Council** will expect the **Design Engineer** to design and construct appropriate compensatory works.

Where active floodways are present **Council** will not accept development without hydraulic modelling and analysis. The **Design Engineer** may also be requested to submit a risk assessment report including details of the measures proposed to be taken to ensure that the potential for loss of life, risk to health and damage to property is minimised, and flood conveyance or storage accommodated.

Council will expect hydraulic modelling to be undertaken by a suitably qualified person or organisation, to identify works that will ensure that adjacent landholders are not detrimentally affected, and to identify the extent, velocities and depth of overland flood flows through the development and downstream.

Council will generally view alteration to existing wetlands as a last resort, to be considered only after all other options have been reviewed and found wanting. The function of a floodplain is to convey and store flood water and preserve the inherent values of wetlands.

The minimum requirements that apply to design and treatment of floodways, and open unlined drains, are as follows:

- The depth of floodways should be kept to a minimum (generally less than 1.2m).
- The desirable maximum batter slope is 1:8; the absolute maximum slope is 1:5.
- The desirable minimum cross-fall for inverts is 1:40, and the minimum bed width 2.5m.
- The maximum permissible longitudinal grades for major floodways will be governed by the need to minimise flow velocities in order to avoid scour and secure public safety.
- The desirable minimum longitudinal grade for major floodways is 1:200 to minimise the likelihood of ponding and siltation. The absolute minimum grade is 1:300.
- Flexible structures, utilising rock gabions, rock mattresses and geotextile fabric are preferred for grade control structures, minor energy dissipaters and major erosion/scour protection measures.
- Floodways utilising a low-flow pipeline should be sized to convey the entire 1% **AEP** design flow based on the assumption that the low-flow pipeline is fully blocked during major storms. Low-flow pipes should be designed in accordance with the following:
    - The desirable minimum cover for low-flow pipes is 450mm and the absolute minimum cover is 350mm. Appropriate pipe classes should be adopted with due consideration being given to construction and maintenance loads.
    - Low-flow pipes providing outlet drainage for retarding basins should be designed with invert levels of adequate depth to command the pipes located within the basin.
    - Low-flow pipes should be designed to convey the runoff associated with a 95% AEP rainfall event.
    - The minimum grade of low-flow pipes should be sufficient to generate self-cleansing velocities.
    - The minimum size of low-flow pipes should be ∅375mm.
    - The maximum spacing of pits on straight sections of low-flow pipes should be 80m.
    - Low-flow pipelines, including pits and other structures, should be designed to minimise hydraulic losses unless there is a specific need to incorporate energy dissipaters such as drop pits.
    - Major floodways that cannot accommodate a low-flow pipeline due to flat longitudinal grades or level constraints should have a low-flow invert or trickle-flow channel. Subsurface drainage should be provided where feasible.
- Pipes discharging into major floodways should be connected to the low-flow pipeline, with surcharge pits being provided as necessary.

16.19 Drainage Reserves

Drainage reserves incorporated into **Developments** should be at least 10m wide. Reserve widths should be sufficient to accommodate a drain able to convey the runoff associated with a 1% **AEP** rainfall event. All-weather access tracks may be required on both sides of the drains where batter slopes exceed 1:8. Pump stations, electrical supplies, and water-quality treatment **Infrastructure** should be sited so as to provide sufficient room for construction and maintenance vehicle to turn at an appropriate location, refer to Clause 18.4.8.

Wherever possible drainage reserves should be sited to abut Public Open Space, but will only contribute to the provision of Public Open Space in accordance with requirements of Clause 18.2. **Council** will expect the **Design Engineer** to consider increasing the reserve width for conservation and landscaping purposes.

Where drainage **Infrastructure** within the drainage reserve does not comply with the standards for public access, the reserve should be fenced to prohibit public access. **Council** will expect the **Design Enginee**r to submit a landscaping plan and fencing details for approval, with all fencing and landscaping being completed at the full cost of the **Developer**.

16.20 Building Over Council Drainage Easements

Consent from **Council** is required to construct a building or structure over a **Council** drain.

16.21 Urban Drainage Easements

In urban areas, easements for drainage only should be at least 2m wide. Easements intended to accommodate drainage and sewerage should be at least 3m wide. The easement width may be further increased by the relevant authority having regard to the depths at which sewer pipes are to be installed. Where practicable, easements should be matched and aligned with those existing on adjacent properties to provide continuity for utility services and to ensure that the proposed use for which the easement is created can be achieved.

Clause 18 Retardation Basins

18.1 Objectives

- To protect property and **Infrastructure** from flooding occurring from a nominated rainfall event by the provision of retardation basins.
- To limit, as much as possible, the number of retardation basins servicing an area in order to reduce **Council's** future maintenance expenditure.
- To ensure that standalone retardation basins drain completely within a reasonable time following each rainfall event and, wherever practicable, are constructed so that the area can be used for passive or active recreation or other uses such as car parks as determined by **Council**.
- To incorporate stormwater treatment and litter traps into the retardation basin design where practical and required by **Council**.
- To protect existing stormwater drainage assets, owned by Council or by other drainage authorities, from overloading as a result of works carried out by **Council** or **Developers** that are or will become the property of **Council**.
- To protect the public from risk of injury or death.
- To standardise the type and operation of pumping systems and outfalls associated with retardation basins.
- To improve the quality of stormwater runoff being discharged from a particular development using **WSUD** principles.
- To ensure that retardation basins are so designed and constructed as to:
    - be aesthetically pleasing,
    - have regard to the area in which they will be located,
    - avoid any adverse impact on amenity in the surrounding areas.

18.2 The Use of Drainage Basins for Public Open Space Purposes

Developers and **Design Engineers** need to satisfy the requirements of clause 56.05-2 of the relevant planning scheme and in particular Standard C13. The provision of Public Open Space should be:

- Suitably dimensioned and designed to for the intended use, buffer areas around sporting fields and passive open space.
- Appropriate for the intended use in terms of quality and orientation.
- Located on flat land (or land which can be cost-effectively graded).
- Located with access to, or making provision for, a recycled or sustainable water supply.
- Adjoin schools and other community facilities where practical.

- Where not designed to include active open space, local parks should be generally be greater than 1 hectare in area and be suitable dimensioned and designed to provide for their intended use and to allow easy adaption in response to changing community preferences

In addition to satisfying the conditions of Clause 56.05-2 of the relevant planning scheme and, in particular, Standard C13, in order to be accepted as Public Open Space the relevant portion of any proposed retardation basin should:

- be at least 10m wide; and
- incorporate the construction of shared walkways; and
- have a cross-fall within a 10m wide corridor around any path; and
- be linked to other public open space being provided in the area; and
- not be inundated during any event up to and including a 18% **AEP** event; and
- unless otherwise agreed by **Council**, not be inundated during a 1% **AEP** event.

The design events for various kinds of POS proposed for use as a retardation basin should be:

- Regional Parks and Sports Fields 2% AEP
- Local Parks 5% AEP
- Linear Parks 10% AEP

18.3 General

Council will expect the detailed design and documentation of drainage basins and/or similar detention facilities to be carried out by a **Qualified Engineer**, and to demonstrate that any required storm water retardation or detention systems can be integrated into the drainage system.

The facility should normally be located and designed in accordance with a relevant **Development Plan, Council Strategy,** or **Stormwater Management Strategy**. Where the necessary policy framework is not in place, **Council** will expect the **Design Engineer** to seek specific agreement for the siting of any proposed retardation basins prior to proceeding with the design of the minor and major drainage system. Catchment boundaries may be increased only if written consent is obtained from the relevant drainage authority.

Council will expect any design to be consistent with this **Manual**, and to meet all the requirements of the local Catchment Management Authority (CMA) and Irrigation and Drainage Authority. For example, retarding basins with outfall to relevant authority drains are required to be designed for the 1% **AEP** storm event of 24-hour duration, with a no-outfall condition, and with a maximum discharge rate to the drainage system as specified by the authority (typically 1.2 lit/sec/ha).

Land that has been identified for storm water retardation basins to be maintained by **Council**, whether existing or proposed, must be shown on a Plan of Subdivision as a Municipal Reserve for drainage purposes and be vested in the **Council**. In circumstances where retarding basins are not to be maintained by **Council** and are located within land that is common property, **Council** is unlikely to be a member of the Owners Corporation corporate. In such instances, **Council** will expect a Section 173 Agreement to be placed on each benefiting allotment to ensure that **Council** drainage networks are not compromised by any act, or omission by the Owners Corporation.

When a retardation basin is required for any **development**, the basin and any overland flow paths should normally be constructed as part of the first stage of the works. Where the **Design Engineer** considers that the retardation basin is not required to service that stage, **Council** will expect them to submit plans, computations, and approvals from the relevant authorities demonstrating that satisfactory temporary provisions can be made for storage and outfall.

18.4 Retardation Basin Design Requirements

18.4.1 Location

Retardation basins cannot be located in areas zoned as Urban Floodway Zone, or on land affected by a Flood Overlay. Locating basins within an area affected by a Land Subject to Inundation Overlay will require specific prior agreement from **Council** and all other relevant authorities.

Council will expect that where a retardation basin poses potential risk to lives, buildings or infrastructure downstream its design will comply with the Australian National Committee on Large Dams (ANCOLD) guidelines.

Retardation basins may need to be protected from unrelated overland flows entering the basin and therefore, apart from the above limitations, should not be located in an area designated on the floodplain maps maintained by the Department of Environment, Land and Planning as an active floodway. Council will expect appropriate works to be carried out to minimise erosion and maintenance resulting from overland flows. The location of basins should have regard to:

- The physical dimensions required for storage.
- Access for maintenance to the bed and batters.
- Pre-development catchments.
- Existing developed catchments.
- Existing drainage including piped, swale drains, or flow paths.
- Existing and proposed drainage easements.
- Ground water depth and seasonal fluctuations.
- Subsoil characteristics.
- Location and point of discharge.
- Soil type and seepage rate.
- Land uses and zoning.
- Effect of overland flows external to the catchment.
- Potential risk or effect on people, fauna and flora.
- Amenity of the area.
- Benefiting landholder issues.
- Provision of a suitable discharge method based on:
    - a pump station with appropriate telemetry situated in public view; or
    - gravity; or
    - a combination of gravity and a pumped outfall.
- Availability of mains electricity, and provision for emergency power supply.
- Maintenance issues and all weather access.
- Water quality.
- Whether or not the retarding basin is proposed to be used or included in the calculation for Public Open Space.
- The location of overland flows into the basin and the treatment(s) to minimise erosion.

- Inlet velocity and the need to install energy dissipation structures.
- 1% flood level or highest recorded flood level information.

18.4.2 Design Criteria

Council will expect retarding basins to be designed for the critical 1% **AEP** storm, and those with established areas downstream, and no clear and safe overland flow paths, to be designed with due consideration to less probable events.

Where the **Design Engineer** can demonstrate that a 1% **AEP** storm event will be irrelevant due to cross-catchment storm flows and overland flows swamping the catchment and/or the basin, **Council** may consider a design based on a more probable storm event and with reduced storage capacity.

Council will expect the minimum freeboard within the basin following a 1% **AEP** event, under no outfall conditions, to be 300 mm for earth structures and 200 mm for hard structures, and peak basin water level to be lower than the lowest kerb invert level in the catchment area. **Council** will also expect the **Design Engineer** to ensure that:

- the peak water level in the retarding basin resulting from the minor drainage storm event detailed in Table 12 remain below the invert of the lowest inlet pipe discharging to the basin; and
- the overland flow path for a major storm has been designed with no minor system contribution to flow capacity; and
- for storage calculations, the volume of storage in pits and pipes in the minor system has been ignored.

18.4.3 Inlet Structures

Council will expect any inlet to a basin to have an acceptable inlet drainage structure with a low-flow pipe, where practicable, connected to the pump station, and capable of a flow (not under head) equal to the maximum pump discharge rate.

Council will expect any inlet pipe to the basin to be fitted with a headwall designed to allow debris to escape and to impede the entry of children or animals, and all headwalls to be fitted with an acceptable post and rail barrier to prevent falls and to identify their location.

18.4.4 Low-Flow Pipes

Retardation basins should incorporate a low-flow pipe system with a minimum pipe diameter of 300mm. The low-flow pipe system should be designed to match the outflow capacity when this is less than a 18% **AEP** storm event.

18.4.5 Overflow Systems

A suitable overflow system must be provided to cater for rarer storm events than what the system has been designed for and to provide for a blockage in the system. All overflows are to be directed away from buildings, adjoining properties and associated **Infrastructure**. The overflow system must be designed to cater with a 1% AEP storm event.

The minimum depth of overland flow must be designed so that it is no higher than 300mm below the lowest floor level of any dwelling impacted by the overflow.

18.4.6 Depth of Retardation Basins

Significant areas of municipalities listed in Selection Table 18.4.6 are subject to shallow ground water tables and **Councils** will expect excavations to be limited to 0.5m above the water table.

Selection Table 18.4.6 Shallow Groundwater Tables

Municipalities Affected by Shallow Groundwater Tables
Bass Coast Shire Council
Campaspe Shire Council
East Gippsland Shire Council
Gannawarra Shire Council
Glenelg Shire Council
Greater Shepparton City Council
Horsham Rural City Council
Moyne Shire Council
Warrnambool City Council
Wellington Shire Council

In such circumstances, **Council** will expect the **Design Engineer** to ensure that retardation basins have an impervious lining, or other acceptable treatment**,** to prevent the ingress of groundwater, and that any structures which penetrate the groundwater zone, such as footings and drainage lines, are appropriately treated to prevent possible damage caused by extended contact with groundwater.

Groundwater may be able to be extracted and used, subject to the requirements of the relevant authority.

If the use of the land changes from that of agricultural production, any former grants for subsoil/groundwater pumps may be required to be refunded. Any development that does not retain an irrigation right will be required to finalise any outstanding debts or annual maintenance charges for ground water pumps. **Council** will not accept any future charges in this regard unless prior written agreement has been obtained

The depth of all retardation basins with public access will be determined having regard to the safety of persons who may fall into or enter the basin during times of operation. To allow for this possibility, inside batters should have a maximum slope of 1:8, which will determine the maximum practicable depth of many basins.

18.4.7 Batter Slopes in Earthen Basins

Where public access is to be provided, the desirable maximum batter slope for retardation basins is 1:8 for both cut and fill situations. The absolute maximum batter is 1:5 in both situations, and prior **Council** consent will be required where such steep slopes are proposed. The desirable minimum bed cross-fall is 1:400, graded to the outlet point.

Council will expect the **Design Engineer** to determine the batter slopes for securely fenced retardation basins having due regard to the following factors:

- soil type.
- erosion.
- maintenance.
- safety and minimisation of risk.

18.4.8 Access Requirements

Council will expect all weather access to be provided to the retarding basin and any associated structures and pumps to enable maintenance to be carried out, with the access being designed so that maintenance vehicles do not need to reverse at any time.

To ensure that maintenance of any portion of the basin and its associated works can be safely carried out, a 5m wide reserve should be provided around the perimeter of any retardation basin, unless the **Council** has given prior written consent for alternative arrangements.

18.4.9 Risk Analysis

Council will expect the **Design Engineer** to prepare a risk assessment report for all drainage structures, including basins and associated structures. The risk assessment should be undertaken in accordance with the principles of *AS/NZS 31000, 2009 Risk Management.*

Additionally, if the retardation basin poses a high risk when assessed using the Australian National Committee on Large Dams (ANCOLD) guidelines then Council will expect that the structure will be designed, and the construction to be supervised and approved, by a qualified engineer with specific expertise in the field.

The **Design Engineer** will be responsible for deciding on the action required in response to the risk assessment report and its recommendations, but should consult with **Council** if the recommendations are complicated, require community involvement, or may involve significant ongoing maintenance issues.

Council will expect the **Design Engineer** to include a copy of the risk assessment report, with recommendations and associated works, when submitting the detailed design documentation for review and approval.

18.4.10 Fencing and Security

Council will expect the **Design Engineer** to ensure that retardation basins which are not accessible to the public are fenced and secured against casual entrance, unless prior written consent has been obtained from the **Council**.

Where the risk assessment determines that the retardation basin complex should be securely fenced, **Council** will expect a 1.8m high chain-mesh fence to be installed around the entire perimeter, with access for maintenance purposes being by lockable gates.

18.4.11 Landscaping

Council will expect the **Design Engineer** to submit a detailed landscape plan for all retardation basins for acceptance.

18.4.12 Maintenance

Council will expect a heavy duty grate or cover to be provided for each pit located in the wheel path of vehicles. In other circumstances, light duty grates and covers may be sufficient. Access covers and grates should be designed to facilitate the use of a lifting system acceptable to **Council**.

Council will expect any large pipe inlets into the basin to be grated in a satisfactory manner to prevent entry. The grates should be designed so that they can easily be maintained and will not cause blockages during storm events. Pits, pipes and screens that require regular cleaning and maintenance should be readily accessible, with the geometry of openings allowing for cleaning and removal of debris and silt accumulations.

Clause 19 On-site Detention Systems

19.1 Objectives

The objectives of small on-site detention systems are as follows:

- To ensure that the capacity of existing drainage **Infrastructure** is not exceeded as a result of **Developments** that increase the volumes and peak rates of stormwater runoff beyond the capacities for which the **Infrastructure was** originally designed;
- To ensure that the cumulative impact of future **Developments** will not exceed the capacity of the existing drainage system;
- To reduce total stormwater volumes and peak flows from urban and rural **Developments** into receiving waters;
- To minimise the development costs of drainage **Infrastructure** by reducing peak outflows
- To ensure that on-site detention systems can be effectively maintained by landowners and provide a cost effective method of meeting the other objectives of this section.

19.2 General

19.2.1 Types of Developments requiring on-site detention

The following types of development typically require on-site detention:

- Multi-unit development in newer residential areas where no specific provision for such development was made in the design of the drainage system for these areas.
- Multi-unit development in older residential areas where the drainage system was designed to handle a peak discharge significantly lower than that predicted by applying the runoff coefficients defined in Clause 16 to a 18% **AEP** event.
- Industrial development in areas where the drainage system was designed to handle a peak discharge significantly lower than that that predicted by applying the runoff coefficients defined in Clause 16 to a 10% **AEP** event
- Major commercial development in areas where the drainage system was designed to handle a peak discharge significantly lower than that predicted by applying the runoff coefficients defined in Clause 16 to a 5% **AEP** event**.**
- Low-density residential development within or adjacent to urban or rural township areas.
- On-site detention will not usually be required in rural locations when lot sizes exceed 2ha, unless specific measures are required to protect streams or constructed waterways from erosion associated with increased peak flow rates.

19.2.2 Methodology

This **Manual** provides a simplified method for **Design Engineers**, builders and owners to estimate the requirements for on-site detention to limit discharges into the existing drainage system to the actual capacity of that system. Note that specific calculations carried out by a **Qualified Civil Engineer** will be required when the peak discharge rates nominated by **Council** differ significantly from those assumed in the simplified method.

The primary objective of this section is to ensure that existing minor drainage networks continue to meet current needs and expectations as more intensive development takes place. Situations will also arise in which the impact of a proposed development on major drainage networks should be considered. Unless flooding problems are already evident, the basic principle should be to limit the peak outflow from any site in a 1% **AEP** rainfall event to pre-development levels. The volume of on-site storage required to achieve that outcome may be greater than that required to ensure that the capacity of the minor drainage network is not exceeded. **Council** will expect the relevant designs and calculations to be prepared by a **Qualified Civil Engineer** and submitted for review and approved by **Council's Engineering Department**.

19.3 Requirements

19.3.1 General Requirements

Where on-site detention is required in order to discharge into the existing drainage system, **Council** will expect the **Design Engineer** to provide computations that demonstrate how the permissible rate of discharge and the volume of on-site detention required have been determined and show that the existing drainage system will not be adversely impacted by the **Development**.

19.3.2 Basic Principles and Limitations

Where the development site in question discharges to an established minor drainage network, **Council** will expect the permissible site discharge [PSD] to be based on the actual network design capacity rather than the peak discharge prior to development.

The basic principle behind on-site detention is that, unless there are particular reasons to believe the contrary to be the case, and **Council** has declared a specific PSD for the development, the original drainage network design should be assumed by the **Designer** to have been carried out properly by the standards of the time. Where, as is often the case in established urban areas, the site and the upstream catchment are relatively small in extent and uniform in character, the rational method should be used to calculate a site PSD based on the rainfall intensity at the design recurrence interval and the concentration time (Tc) for the upstream catchment. The reason for using the catchment, rather than site, concentration time is that the former time would have governed the original site discharge on which the network design was based.

Most methods for determining the storage volume needed to achieve a calculated or specified PSD assume that the relevant rainfall event can be represented by a symmetrical triangular (trapezoidal when the event duration exceeds double the concentration time) site discharge hydrograph. The modified rational method allows for the discharge fall time to exceed the initial rise time, and delivers a somewhat more conservative assessment of required storage.

When a storage device is drained under gravity via a control mechanism, the outflow is assumed to increase in a linear manner from zero at the start of the event until the discharge entering the device, after reaching and passing the peak value, decreases to the PSD. The required storage is then assumed under the Boyd Method to be equal to the difference between the overall volumes flowing into and out of the device. Similar considerations apply to pump drawdown, save that the outflow remains constant over the time interval between the inflow initially reaching the PSD and then, after reaching and passing the peak, decreasing again to the PSD.

With certain adjustments, methods based on these assumptions are appropriate for developments up to ~5ha in area, and upstream catchments to ~50ha in area. Beyond these limits, volumetric runoff-routing methods should be used. Within the above limits, however, the main errors in the procedure arise from the assumption that the storage drawdown rates under gravity increase linearly with time. The actual relationships between head and discharge, and between head and device capacity, are markedly nonlinear. When a linear response has been assumed, a better estimate of the required storage volume is achieved by reducing the nominal PSD by 25% for storage in tanks or basins whose plan shape is basically constant with increasing depth, or 40% for storage in pipes or horizontal cylindrical tanks. A better approach, however, is to use the Swinburne Method, which makes soundly-based adjustments to compensate for both the above nonlinearities.

19.3.3 Design Parameters

When the development location so requires, or when the existing drainage infrastructure is known to be unable to accept the peak discharge flows estimated by the rational or modified rational method, **Council's Engineering Department** may specify the permissible site discharge and/or may require that the **Design Engineer** carry out specific calculations to establish the appropriate storage volume for any **Development**.

The **Design Engineer** may calculate the on-site detention requirements by any recognised method, appropriate to the nature and scale of the development and the upstream catchment, acceptable to **Council's Engineering Department**. Unless the **Design Engineer** can demonstrate that other values would be more appropriate, calculations should be based on the following parameters:

- Annual exceedance probability for the original design event — 63%
- Annual exceedance probability for the current design event — see Section 16.8 of this Manual
- Coefficients of runoff — see Section 16.7 of this Manual

For the reasons set out in Clause 16.5 of this Manual, the **AEP** terminology recommended by *Australian Rainfall and Runoff* has been adopted to describe events with an average return period greater than or equal to one year, and reference should be had to Table 8 as required to confirm the equivalence between these measures.

19.3.4 Simplified Design Method for Small Developments

The provisions of this sub-clause only apply to residential, industrial or commercial developments where the total site area does not exceed ~1ha, and where the permissible site discharge has not been specified by Council.

Table 13 provides guidance on the allowable discharge rates and storage volumes for the most common types of small **Developments** within the ambit of this sub-clause taking place within municipalities across regional Victoria.

Table 13 Storage Volumes and Discharge Rates for Small Detention Systems

TYPE OF DEVELOPMENT	ORIGINAL AND REQUIRED DESIGN PARAMETERS	ALLOWABLE DISCHARGE RATE (litres/sec/ha)	STORAGE REQUIRED (litres/ m²)	
			VERTICAL (Tank/ Basin)	HORIZONTAL (Pipe)
Multi-unit development (newer residential areas)	C=0.5 for an 18% **AEP** to C=0.8 for an 18% **AEP**	65	8	10
Multi-unit development (older residential areas)	C=0.5 for a 63% **AEP** to C=0.8 for an 18% **AEP**	37	12	14
Industrial development	C=0.5 for a 63% **AEP** to C=0.9 for a 10% **AEP**	37	15	18
Industrial development	C=0.9 for a 63% **AEP** to C=0.9 for a 10% **AEP**	65	11	13
Commercial development	C=0.9 for a 63% **AEP** to C=0.9 for a 5% **AEP**	65	14	17

The storage requirements in any given case should be calculated having regard to the proportion of the stormwater runoff from the developed site to be directed to each category of storage device. For example, for a multi-unit development on a 750m² site in an older area, if 60% of the total runoff can be directed to conventional rainwater tanks and 40% has to be directed to underground pipes, the table would require that the following storage volumes be provided:

Rainwater Tanks 0.6 x 750 x 12 = 5,400 litres

Underground Pipes	0.4 x 750 x 14 = 4,200litres

The allowable discharge rates set out above have been calculated based on a concentration time of 20 minutes for the upstream catchment served by the relevant minor drainage network, and reflecting the annual exceedance probability used when the latter network was originally designed. The Swinburne Method has been applied to determine the required on-site storage volume.

Council's Engineering Department may waive the requirement for on-site detention where it can be shown that there are no adverse impacts resulting from the increased rate and volume of stormwater from the development and that the level of service adopted by the **Council** will not be compromised.

19.3.5 Specific Design Requirements

A suitable overflow system should be provided to cater for **AEP** events, up to and including 1% **AEP** events, less frequent than those which the system has been designed to handle, and appropriate provision must be made for network blockages during such events.

Where stormwater discharge is to be controlled by an orifice or tube located on the downstream face of a pit, **Council** will expect the **Design Engineer** to consider and address the consequences of device blockage in a design storm. Options might include providing a safe overland route conveying surplus flows from the location where the detention system will surcharge to an acceptable destination, installing sufficient storage to retain the flows on-site, or using dual-chamber pits with the controlled flow passing through an internal weir wall.

Any overflows should be directed away from buildings, adjoining properties and associated **Infrastructure**, and **Council** will expect the **Design Engineer** to demonstrate that the maximum water surface level will remain at least 300mm below the lowest floor level of any residence within the overflow zone.

Council will expect the **Design Engineer** to ensure that all pipes conveying water within a detention system are at least 90mm in diameter, unless they form part of a proprietary system acceptable to **Council**, or contribute directly to the restriction required to achieve the design PSD.

When specific calculations are carried out, **Council** will expect the **Design Engineer** to estimate the concentration times for the relevant catchment and from the top of the catchment to the development site using recognised methods, and to submit the following additional information for review and approval:

- Plans showing the invert levels of all pipes at or above 100mm in diameter.
- Plans showing the designed finished surface level of all driveways, car parking areas, landscaping areas and lawns.
- Plans showing the floor levels of all buildings, existing or proposed.
- Plans showing the locations of storage devices, pipes and pits, pervious and impervious areas, buildings, driveways and other relevant infrastructure.
- Evidence that, when the detention system relies on surface storage, all floor levels in habitable buildings will be at least 300 mm above the peak water level in the storage area at design capacity.
- Evidence that, where depressed driveways are used to provide storage, they are bounded by kerbs not less than 100 mm in width, cast integrally with the main slab unless otherwise agreed by **Council**.
- Cross-sections of each storage device or devices.
- Existing surface levels on at least a 10 metre grid in the subject property and adjoining properties.
- One copy of the drainage computations.
- One copy of the structural computations for any underground storage tanks.

- Three copies of the final engineering plans.

19.3.5.1 Acceptable Systems

The most commonly acceptable systems are as follows:

- Conventional rainwater storage tanks.
- Driveways bounded by kerbs of not less than 100 mm in width.
- Underground pipes and tanks of various configurations.
- Underground pipes and tanks with pumped outfalls.
- Lined, in-ground storage basins with pumped outfalls.
- Excavated earthen dams with gravity outfalls (in low-density residential Developments).

Typical outflow control arrangements are for gravity drawdown to take place through a pipe (with no provision to vary the flow capacity), an orifice plate, or a proprietary multi-cell unit. When a site is located below street level, and no network drainage is available along the rear boundary, pumping may become the only viable option.

19.3.5.2 Maintenance of On-Site Detention Systems

Council will require to inspect on-site detention systems from time to time to ensure that landowners are operating and maintaining the relevant devices in accordance with **Council** specifications, and that the systems remain effective.

Council and the **Developer** may therefore enter a Section 173 Agreement binding future landowners to maintain their on-site detention systems in satisfactory working condition, and to provide reasonable access to enable authorised Council officers to inspect the systems. The Agreement may also require landowners to pay an annual inspection fee as set by **Council** from time to time.

Clause 20 Stormwater Treatment

20.1 Objectives

- To ensure that stormwater discharged to natural watercourses and drainage networks belonging to other drainage authorities meets the requirements of the *Environment Protection Act 1970* and the water quality performance objectives for individual drainage catchments as provided in the State Environment Protection Policies (SEPP).
- To implement the design requirements of the **Council's** Stormwater Management Plan.
- To ensure that all designs incorporate consistent best practice **WSUD** measures and principles.
- To ensure that treatment methods and **Infrastructure** are cost-effective from a maintenance and operational perspective and that the risk to the public is minimised as far as practicable.
- To protect and enhance natural water systems within urban environments.
- To integrate stormwater treatment into the landscape, while maximizing the visual and recreational amenity of **Developments**.
- To improve the quality of water draining from urban **Developments** into receiving environments.

20.2 General

Council will expect all **Developers** to make provision for the improvement of water quality leaving the **Development** site by works located close to the nominated point of discharge for the **Development**. The **Developer** will be responsible for maintaining these works, to the satisfaction of the **Council**, until the end of the maintenance period.

All urban **Developments** should meet the requirements of the *Urban Stormwater Best Practice Environmental Management Guidelines 1999*, the *Water Sensitive Urban Design Engineering Procedures 2005* and the *Water Sensitive Urban Design Guidelines South Eastern Councils 2011* prepared by Melbourne Water.

The storm-water treatment methods which may be considered, subject to **Council** agreement, include:

- Bioretention swales.
- Bioretention basins.
- Vegetated swales.
- Underground sand filters.
- Sedimentation basins.
- Constructed wetlands.
- Pond system with edge vegetation.
- Water tanks.
- Gross pollutant traps.
- Litter traps.

Council will expect the **Design Engineer** to develop appropriate strategies for addressing these goals, and may require that land be set aside and works constructed within a **Development** or subdivision for the specific purpose of treating stormwater to ensure appropriate water quality at the point of discharge into the receiving waters.

The **Design Engineer** may be required by **Council** to demonstrate to Council that the proposed method of treatment is the most cost-effective and sustainable for **Council** having regard to the whole of life costs of the treatment elements.

Melbourne Water publication "Water Sensitive Urban Design Life Cycle Costing Data" can assist the **Design Engineer** to determine the maintenance and renewal costs of the various elements of stormwater treatment.

20.3 Requirements

20.3.1 General Requirements

The following are general requirements for the provision of stormwater treatment:

- **Developments** should comply with principles and recommendations of *Water Sensitive Urban Design Guidelines 2009, Urban Stormwater – Best Practice Environmental Management Guidelines* and **Council's** Stormwater Management Plans to achieve the following water quality standards:
    - 80% retention of the typical urban annual load for Total Suspended Solids (TSS).
    - 45% retention of the typical urban annual load for Total Phosphorus (TP).
    - 45% retention of the typical urban annual load for Total Nitrogen (TN).
    - 70% retention of the typical urban annual load for gross pollutants (litter).
- Discharges for an average 63% **AEP** should be maintained at pre-development levels for stormwater treatments.
- **Council** will expect the **Design Engineer** to select the most suitable treatment types for the **Development**, and to submit designs for review and approval by **Council's Engineering Department** demonstrating that **Council** standards for maintenance, ongoing costs, and stormwater quality can be achieved.
- Where **Council** has constructed whole-of-catchment treatment facilities**, Developers** of industrial estates within such catchments will be required to contribute to treatment costs within those facilities, and may also need to install pre-treatment facilities in those estates in accordance with the requirements of **Council's** Stormwater Management Plan. Where whole-of-catchment treatment is not available, **Council** will expect **Developers** to provide separate treatment facilities within the **Development**.
- **Council** will expect the **Design Engineer** to consider the staging and construction of **Developments**. Treatment facilities should normally be commissioned only when sufficient runoff is available to keep plants alive, and **Council** may bond the value of the plantings in preference to have planting proceed at an inappropriate time.
- **Council** will expect the **Design Engineer** to ensure that cleaning and maintenance of structures and equipment associated with stormwater treatment can be achieved without manual handling, and that routine maintenance does not require access to confined spaces.
- **Council** will expect the **Design Engineer** to undertake a full risk assessment for all treatment sites, taking into account fencing, grates across drains, wetlands, retarding basins, pumping stations, and other structures, and to submit the assessment and recommendations for review and approval by **Council's Engineering Department**.
- **Council** will expect the **Developer's Representative** to submit comprehensive operational documentation and manuals for treatment sites prior to the commencement of Defects Liability Period.
- Where constructed wetlands are being provided to serve a staged development the Developer will be expected to maintain the wetlands at his cost until the defects liability period is completed for the last stage of the development.

20.3.2 Gross Pollutant Traps

Council will expect the **Design Engineer** to apply the following criteria in designing gross pollutant traps [GPT]:

- The following design flows should be used, depending upon the degree of hydraulic effectiveness required:
    - 95% AEP design flow typically has a hydraulic effectiveness exceeding 97%
    - 86% AEP design flow typically has a hydraulic effectiveness exceeding 98.5%
    - 63% AEP design flow typically has a hydraulic effectiveness exceeding 99%

- Selecting a design flow rate will require the **Design Engineer** to balance the cost and space requirements of the device (a higher design flow will usually require a larger facility with additional costs) and the volume of water that could bypass the unit and avoid treatment. The minimum design flow should be 95% **AEP**. **Council** will expect the **Design Engineer** to provide all-weather access to all treatment sites, permitting crane access to GPT units, which should be assumed to require cleaning every six months. In new **Developments** or public areas, **Council** will expect maintenance vehicles to be able to travel in a forward direction at all times.
- **Council** will expect the **Design Engineer** to ensure that the quality of the water being discharged will meet the requirements of the relevant drainage authority, and to submit supporting evidence to **Council's Engineering Department** for review and approval.

20.3.3 Bioretention Swales

Bioretention swales are not accepted for use in any municipality unless the relevant **Council** has provided specific written consent for their use. The design requirements for such swales are as follows:

- Bioretention swales are best suited to situations where longitudinal grades are between 1% and 4% or velocities during major storm events do not exceed 2m/s. Where steeper grades are identified as a constraint, check dams may have to be introduced to reduce velocities to the above level.
- Water ponding at entry points to the swale should not occur for longer than 1 hour after the cessation of rainfall, as prescribed in Clause 56.07-4 of the VPP.
- Grassed swales requiring mowing should have batter slopes less than 1:4.
- The design details should otherwise be in accordance with the guidelines set out in Chapter 5 (Clause 5.3) of the *Water Sensitive Urban Design Engineering Procedures: Stormwater Manual (Melbourne Water, 2005).*

20.3.4 Bioretention Basins and Rain Gardens

The design requirements for bioretention basins and rain gardens are as follows:

- Water ponding at entry points to the swale should not occur for longer than 1 hour after the cessation of rainfall, as prescribed in Clause 56.07-4 of the VPP.
- The design details should otherwise be in accordance with the guidelines set out in Chapter 6 (Clause 6.3) of the *Water Sensitive Urban Design Engineering Procedures: Stormwater Manual (Melbourne Water, 2005).*
- Selection Table 20.3.4 provides details of the location and other criteria under which **Councils** will be prepared to consider accepting bioretention basins and rain gardens as part of the stormwater treatment systems within the municipalities concerned.

Selection Table 20.3.4 Bioretention Basins and Rain Gardens

Permitted in Private Property and Drainage Reserves	Permitted in Nature Strips	Permitted Except in Unsuitable Locations for Access, Permanent Subsurface Flow Conditions, Etc.	Not Permitted Under Any Circumstances
Ararat Rural City Council	Murrindindi Shire Council	Ballarat City Council	Horsham Rural City Council
Baw Baw Shire Council		Bass Coast Shire Council	Latrobe City Council
Benalla Rural City Council		Corangamite Shire Council	Pyrenees Shire Council
Buloke Shire Council		Glenelg Shire Council	
Campaspe Shire Council		Golden Plains Shire Council	
Mansfield Shire Council		Greater Bendigo City Council	
Moira Shire Council		Greater Geelong City Council	
Mount Alexander Shire Council	Mount Alexander Shire Council	Greater Shepparton City Council	
Rural City Of Wangaratta		Indigo Shire Council	
Strathbogie Shire Council		Macedon Ranges Shire Council	
Towong Shire Council		Mildura Rural City Council	
Wodonga City Council	Wodonga City Council	Mitchell Shire Council	
		Moorabool Shire Council	
		South Gippsland Shire Council	
		Southern Grampians Shire Council	
		Swan Hill Rural City Council	
		Warrnambool City Council	
		Wellington Shire Council	
		Yarriambiack Shire Council	

20.3.5 Vegetated Swales, Grassed Swales, and Buffer Strips

The design requirements for vegetated swales, grassed swales and buffer strips are as follows:

- Swales are most efficient when longitudinal grades are between 1% and 4%. Flatter grades tend to cause swales to become waterlogged and/or have stagnant pooling, while steeper grades may lead to high velocities, with potential risks of erosion and damage to vegetation. Check banks (small porous walls) may be constructed to distribute flows evenly across the swale.

- Batter slopes are typically 1:9. Grassed swales requiring mowing should have batter slopes less than 1:4.

- The design details should otherwise be in accordance with the guidelines set out in Chapter 8 (Clause 8.3) of the *Water Sensitive Urban Design Engineering Procedures: Stormwater Manual (Melbourne Water, 2005)*.

- Subject to road reserve width and service locations, **Councils** other than those identified in Selection Table 20.3.5 will consider approving vegetated swales, grassed swales and buffer strips for use in open space reserves within normal or low-density residential zones and/or in central median strips on roads.

- Selection Table 20.3.5 also provides details of the circumstances under which **Councils** will be prepared to consider accepting vegetated swales, grassed swales and buffer strips located within nature strips as part of the stormwater treatment systems within the municipalities concerned.