UPPER PARRAMATTA RIVER

CATCHMENT TRUST

On-site Stormwater Detention Handbook

Third Edition

December 1999

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This Handbook is published in accordance with the Upper Parramatta River Catchment Trust's On-site Stormwater Detention Policy. This policy was developed in conjunction with the four local councils in the catchment:

- Baulkham Hills Shire Council
- Blacktown City Council
- Holroyd City Council
- Parramatta City Council

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[i] Amended to include GST in third edition

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[i] Simpler checklists added in third edition

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List of Revisions to the Third Edition

Date	Page	Changes
Jan 2001	i	Revision 1 added
Jan 2001	viii	New page with revisions table
Jan 2001	3-4	Clarified OSD requirements for residual lots and rural areas
Jan 2001	4-13	Fig 4.5 amended
Jan 2001	4-14	Private courtyard area clarified, clarification of design parameters added
Jan 2001	4-15	Private courtyard definition added, clarification of design parameters added
Jan 2001	4-16	Note added regarding free standing timber walls, confined space requirements added
Jan 2001	6-1	Private courtyards defined in Table 6.1
Jan 2001	7-29 to 7-33	Fig 7.9 added and following pages renumbered
Jan 2001	7-32	Dwelling 1 summary sheet added
Jan 2001	B3-6	Deleted repeated page
Jan 2001	C1	Title changed and notes on confined space warning sign added
Jan 2001	C3	Confined space warning sign added
Jan 2001	D-2 to D-6	Amendments to structural details
Jan 2001	E-1 to E-3	Revised lists of manufacturers and maintenance contractors
Jan 2001	I-1	Winner and highly commended for 2000 added
Jun 2004	i	Revision 2 added
Jun 2004	ii	Note adjusted for revision 2
Jun 2004	iii	GST added to price of Handbook
Jun 2004	iv	New 2.7 added to contents
Jun 2004	v	New 4.2.9 added to contents and numbering changed
Jun 2004	vi	Checklists added to Appendices B8-10
Jun 2004	viii-x	Revisions table extended
Jun 2004	1-1	Introductory comment about WSUD added
Jun 2004	1-2	Rainwater tank section added to relevant groups
Jun 2004	1-2	Comment about WSUD added
Jun 2004	1-3	Revision 2 major changes listed
Jun 2004	1-5 to 1-7	New words added to glossary
Jun 2004	2-4	New section 2.7 on Water Sensitive Urban Design
Jun 2004	3-1	Link between Water Sensitive Urban Design (WSUD) and OSD noted in policy
Jun 2004	3-1	Need for integration of OSD and WSUD
Jun 2004	3-3	Clarification of application of OSD policy with WSUD
Jun 2004	3-6	Mainstream flood storage in lieu of OSD added
Jun 2004	3-7	Holroyd City Council position on SCP
Jun 2004	3-7	Deferral of OSD in subdivisions clarified
Jun 2004	3-9 & 3-10	Holroyd City Council position on SCP
Jun 2004	3-10	Approved plans to be sent to designer
Jun 2004	4-1 to 4-29	All pages renumbered as new material added
Jun 2004	4-1	Deferral of OSD in subdivisions clarified
Jun 2004	4-1	Holroyd City Council position on SCP clarified
Jun 2004	4-1	OSD and site water management including WSUD

Date	Page	Changes
Jun 2004	4-2	Links between OSD & WSUD added
Jun 2004	4-3	WSUD and water management added to flow chart
Jun 2004	4-4	Relationship between OSD and WSUD required
Jun 2004	4-5	Change to minimum allowed to by pass OSD facility
Jun 2004	4-6 to 4-8 & 4-10	Providing designers with an approved copy of plans
Jun 2004	4-6	OSD to complement WSUD
Jun 2004	4-7	Integration of OSD and WSUD
Jun 2004	4-7	Weir calculations required
Jun 2004	4-7	Storages wholly within the property
Jun 2004	4-10	Weir calculations
Jun 2004	4-12 & 4-13	Changed mesh code
Jun 2004	4-15	OSD deferral for small subdivisions
Jun 2004	4-15	Storages within property
Jun 2004	4-16	Freeboard
Jun 2004	4-16	Storages within property
Jun 2004	4-17	Pool fencing of storages in play areast
Jun 2004	4-18	Storages within property
Jun 2004	4-19	Clarification of grate spacing
Jun 2004	4-20	New section 4.2.9 on rainwater tanks
Jun 2004	4-21	Renumbered Overflow
Jun 2004	4-21	Renumbered Maintenance Schedule
Jun 2004	4-23	Designer supervision of construction
Jun 2004	4-25	Rainwater tank issues
Jun 2004	4-26	Clarification of top water level
Jun 2004	4-26	Confirmation required when rainwater tanks used as part of OSD storage
Jun 2004	4-26	Certification of maintainability
Jun 2004	4-28	Freeboard on weir flow
Jun 2004	4-29	Deferral of OSD in small subdivisions cross referenced
Jun 2004	5-1	Change to minimum allowed to by pass OSD facility
Jun 2004	5-8	Note regarding bypass area added above Design Summary Sheet
Jun 2004	6-1	No OSD storage in small courtyards
Jun 2004	7-7,7-13,7-20, 7-23,7-32,7-33	Note regarding bypass area added above Design Summary Sheet
Jun 2004	8-1	Additional references addded
Jun 2004	B1-1	Design Summary Sheet altered
Jun 2004	B4-1	New sub appendices created & chapter renumbered
Jun 2004	B4-2	Plan reference on restriction on title
Jun 2004	B4-4 & B4-5	Blacktown City Council recital added in new sub appendix
Jun 2004	B5-3	Plan reference on restriction on title
Jun 2004	B7-1	Deferral for small subdivisions clarifed
Jun 2004	B8-1	Additional notes on initial page
Jun 2004	B8-1 to B8-4	New front page, new SCP checklist and following pages renumbered
Jun 2004	B8-3	References to new SCP checklist on original SCP checklist
Jun 2004	B8-4	Change in undrained portion of site
Jun 2004	B9-1 to B9-7	New front page, new Detailed Design checklist and following pages renumbered

Date	Page	Changes
Jun 2004	B9-4	References to new design checklist on original design checklist & weir calculations clarified
Jun 2004	B9-5	Change in undrained portion of site
Jun 2004	B9-7	Overflow depth calculation requirement clarified
Jun 2004	B10-1 to B10-7	New front page, new WAE checklist and following pages renumbered
Jun 2004	B10-2 to B10-7	New WAE checklist added and following pages renumbered
Jun 2004	B10-4	References to new WAE checklist on original WAE checklist
Jun 2004	B11-1	Maintainability added to hydraulic compliance certificate
Jun 2004	B12-1	Maintainability added to list of outstanding works
Jun 2004	C-1	New OSD sign
Jun 2004	C-4	OSD sign details added
Jun 2004	E-1	Signs added to two suppliers
Jun 2004	E-2 & E-3	Revised list of maintenance contractors added
Jun 2004	F-1	Clarification of contact s at Blacktown City Council
Jun 2004	I-1 & I-2	Award winners for 2001 to 2004 added
Jun 2004	J-1 & J-2	Additional entries in index

1.0 Introduction

On-site Stormwater Detention (OSD) involves the temporary storage and controlled release of stormwater generated within a site. Without adversely affecting the property, it relies on thoughtful design and passive engineering during site development to achieve significant reductions in downstream flooding. OSD is required to ensure that the change in stormwater runoff from a site due to development does not increase flooding problems downstream except in very severe events. OSD systems must be properly maintained to make sure that stormwater flows from the site are regulated for the life of the development.

OSD is only one aspect of the management of the water cycle on a site. In recent years the Trust has begun to broaden its focus to include the complete water cycle affecting developments. Under the heading of Water Sensitive Urban Design (WSUD), water management now needs to consider the opportunities to better mimic the natural water cycle by addressing issues such as the potable water supply, re-use of grey water, the installation of rainwater tanks, the use of infiltration (where appropriate), the quality of stormwater runoff and the impact of more frequent storms on natural creeks and watercourses.

The Trust and the four catchment councils support the philosophy of WSUD and are currently working with a range of other groups to better understand the processes involved and the opportunities to implement better water management as part of the development process. Nonetheless, the role of OSD in ensuring that new developments do not worsen existing flooding problems remains critical. While sympathetic consideration will be given to WSUD features, these cannot be treated as a trade off against the requirement to provide OSD. In many cases more research will be required to demonstrate whether WSUD proposals such as water retention (eg. for infiltration or rain gardens) can be partly, or completely, offset against the volume of OSD storage required. In the case of rainwater tanks, for example, the Trust has had research undertaken by the University of Newcastle based on local rainfall data and predictive usage rates which now allows part of the volume of rainwater tanks to be offset against the OSD storage required. (See section 4.2.9 for more details)[i]

This Handbook has been principally prepared for experienced OSD designers. In the upper Parramatta River catchment design and certification of OSD systems will only be accepted from persons having acceptable professional accreditation. The following are considered to be acceptable accreditation for the purpose of OSD design and certification:

- NPER in Civil Engineering (Institution of Engineers, Australia);
- Surveyors Certificate of Accreditation in On Site Detention and Drainage Design (Institution of Surveyors NSW and the Association of Consulting Surveyors NSW);
- Stormwater Register (Association of Hydraulic Services Consultants Australia)
- Accreditation as a certifier under the Environmental Planning and Assessment Act 1979 in the relevant discipline.[ii]

OSD can be provided most efficiently and effectively when it is considered as early as possible in the development process. The system is most easily maintained when owners have a clear idea of the location and function of the components of the system. For these reasons, this Handbook has wider application for architects, engineers, builders, developers, property owners and managers, local government officials or staff and concerned citizens who each have a role to play in the successful application of OSD in the Upper Parramatta River Catchment.

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[i] Introduction of WSUD added for third edition
[ii] Professional accreditation requirements added for third edition.

The format of the Handbook is set out in Section 1.2, but the following table provides a guide to those areas of the Handbook likely to be of most use to different groups within the community.[i]

PROFESSION/GROUP	RELEVANT SECTIONS OF HANDBOOK
OSD Designers	Sections 3 - 7 and Appendices
Architects	Sections 1, 3 and 4
Solicitors and Conveyancers	Sections 1.3, 2.5, 4.3.6, Appendices B2-B7
Developers	Sections 1-3, 4.1 and 4.3.6
Owner Builders	Sections 1-3, 4.1, 4.3.6,4.2.9-11[ii], 6.6, Appendices B2-B7
Owners/Tenants/Property Managers	Sections 1, 4.2.1, 4.3.6, Appendix B2
Local Council Officials	Sections 1-3, 4.2.9, 4.3.6, Appendix B2
Local Council Staff	Sections 1-7 and Appendices
Concerned Citizens	Sections 1, 2, 3.4, 4.2.7, 4.3.6 and 6.2

The OSD policy and the Handbook are primarily intended for use within the upper Parramatta River catchment. However, the catchment councils generally require OSD in other catchments too. Appendix F provides the relevant parameters for those areas while Appendix G shows how the methodology can be adapted to other areas. The application of WSUD principles is dependent on a range of local factors, such as soil types, rainfall intensities and land uses, and reference should be made to the local council for advice in other catchments[iii].

1.1 General

There are two key components to the Upper Parramatta River Catchment Trust's flood mitigation effort. The first aims to reduce and eventually eliminate the present flood threat. This will involve public expenditure of more than $50M on projects such as retarding basins, channel improvements and levees to protect some 2200 properties threatened by mainstream and trunk drainage flooding.

The second component aims to prevent growth of the already substantial flooding problem caused by increasing development of the catchment. This is achieved through planning and development controls of which OSD is the most important element.

Since the publication of the first edition in September 1991, the Handbook has been purchased by over 500 OSD practitioners. The second edition in November 1994 was released to take advantage of the considerable body of practical experience which had been developed, as well as including the results of several Trust-sponsored research projects.

The second edition incorporated:

- a reorganisation of the Handbook to better reflect the development process
- a requirement for OSD designers to be involved in the initial site layout through the preparation of the Stormwater Concept Plan
- an increased emphasis on designer supervision of the construction of OSD systems.
- generic dimensions for in-situ and precast discharge control pits

[i] Quick reference guide added for third edition.
[ii] Section on rainwater tanks added where appropriate in third edition.
[iii] Comment on WSUD added for third edition

- a reduction in the minimum orifice diameter of discharge control pits
- increased attention to construction practices.

The third edition[iv] reflects the experience gained by council staff and consultants in the practical application of OSD. The format has been retained as closely as possible to provide continuity for both council staff and designers. The changes focus on improvements to make the policy and its application more robust, and include:

Revision 1:

- revised covenants;
- an index;
- references for all three editions;
- revised discharge control pit;
- accreditation of designers;
- alterations to suit new planning legislation;
- promoting larger common storages;
- removing deferral of OSD;
- change in minimum development area;
- freeboard specified;
- access covers;
- authority to release plans to future owners;
- limiting storage in private courtyards;
- safety fences and
- check lists.

Revision 2:[v]

- simpler checklists added;
- reduction in the area of site not draining to the OSD storage;
- the use of rainwater tanks;
- consideration of Water Sensitive Urban Design;
- clarification of freeboard;
- calculations required for weirs and other overflows;
- clarification of deferral of OSD in small subdivisions;
- clarification of Holroyd City Council's position on Stormwater Concept Plans;
- providing OSD designers with an approved copy of the plans;
- OSD storages including wall footings to be wholly within property;
- Pool fencing of storages in play areas;
- Clarification of spacing of entry grates to underground storages;
- Maintainability added to Hydraulic Compliance certificate;
- Additional references added;
- Design Summary Sheet altered to address flow from off site;
- Reference to plan numbers added to restrictions on title;
- Copy of Blacktown City Council's recitals for covenants and restrictions on use;
- List of maintenance contractors revised; and
- OSD Award winners updated.

Using commercially available products to reduce the number of items that have to be purpose-built is the key to reducing OSD costs. To assist designers, this revision includes details of manufactured products that are available to meet OSD requirements on development sites. (See Appendix E)[vi]

[iv] List of changes added for third edition.
[v] Major changes in revision 2 of third edition listed
[vi] Appendix E added for third edition.

To continue the improvement of OSD, the Trust welcomes suggestions, comments, design hints and examples of successful OSD designs for inclusion in subsequent editions of the Handbook.

1.2 Handbook format

The Handbook is divided into seven main sections and seven appendices. The first two sections contain background information on the general principles of OSD. The next two sections cover policy and application of the policy. The final three sections provide the technical information required to prepare an effective and functional OSD system

Section 1 - outlines the development and format of the Handbook and includes a glossary of terms and abbreviations used.

Section 2 - presents the concepts and principles of a catchment-based OSD policy.

Section 3 - defines the policy, the catchment area, the developments to which it applies and the method of implementation.

Section 4 - details the approval process, the minimum information required at each stage and important issues to be considered.

Section 5 - covers the hydrologic and hydraulic design of the storage and discharge control pit.

Section 6 - provides technical advice on the integration of the storage into a site, effective site drainage techniques and related issues.

Section 7 - presents a number of case studies.

1.3 Glossary of terms

AEP - Annual Exceedance Probability - probability of a given discharge or rainfall being equalled or exceeded within a period of one year.

ARI - Average Recurrence Interval - average or expected value of the period between exceedances of a given discharge or rainfall.

Certificate of Hydraulic Compliance - a certificate prepared by the OSD designer and submitted to the relevant council on completion of the OSD system. The certificate verifies that the works have been carried out in accordance with the approved design.

DCP - Discharge Control Pit - a chamber that receives the majority of stormwater from the site and discharges it to the gutter or drain at a controlled rate not exceeding the PSD.

Development Area - the area of a property to be affected by the construction/reconstruction of buildings, structures, sealed surfaces, landscaping, driveways and car-parks.

Floodways - surface drainage systems that cater for major concentrated flows from upstream catchments.

Flowpath – See Overland Flowpath.

Grey Water – Waste water from non-toilet plumbing systems such as handbasins, washing machines, showers and baths. Grey water is differentiated from black water, which is wastewater from toilets[vii]

HED - High Early Discharge - method for ensuring that the discharge from a DCP approaches the PSD early in the storm event. Also, the discharge from a DCP when overflow first occurs to the storage.

Infiltration – the vertical movement of water through a permeable substance, such as sand or soil. The rate at which the flow occurs is dependent on the properties of the substance and the relative volume of voids (air spaces) it contains. In the case of the clay soils typical of Western Sydney, infiltration rates are extremely slow whereas in sandy soils or fissured rock the rate of infiltration may be much faster[viii].

Maintenance Schedule - set of operating instructions for prospective property owners or occupiers setting out the routine maintenance necessary to keep the OSD system working properly.

Orifice – A circular hole with sharp edges machined to 0.5 mm accuracy in a corrosion resistant steel plate which controls the rate of discharge from the Discharge Control Pit.[ix]

OSD - On-site Stormwater Detention - temporary storage of stormwater generated within the site so as to restrict the discharge leaving the site to a pre-determined rate.

Outlet – The pipe conveying the stormwater discharge from the Discharge Control Pit downstream of the orifice.[x]

[vii] Definition added for third edition
[viii] Definition added for third edition
[ix] Definition added for third edition.
[x] Definition added for third edition

Overland Flowpath – surface drainage system that caters for minor flow from an upstream catchment. Also the drainage system that caters for surcharges from the OSD storage in events larger than the 100 year ARI flow or when a blockage occurs.

Permeable – a property of a porous material that allows a liquid to flow through it[xi].

Positive Covenant/Restriction-as-to-use - legal protection placed on a property title requiring owners to repair and maintain the OSD systems.

Potable – fit for drinking. Potable water may be used, without further treatment, for drinking. Kitchen sinks, basins, showers and baths are considered to be potable uses because of the chance of water being ingested, especially by the young.[xii]
PSD - Permissible Site Discharge - the maximum allowable discharge leaving the site in litres/sec/hectare (l/s/ha), or in litres/sec (l/s) when applied to a specific site.

Rain Garden — a combination of an infiltration and filtration device. Water is directed to a local hollow where it soaks into a organic filter medium such as topsoil or compost. Some water soaks into the ground while the remainder is collected and piped to the stormwater drainage system. Components of a rain garden include a grass pre-treatment area, temporary ponding, planting soil, sand mixing with the soil, an organic layer, and plant material. Infiltration can be a component depending on soil conditions)[xiii]
Retention – (as defined by Argue, 1986) refers to procedures and schemes whereby stormwater is held for considerable periods causing water to continue in the hydrological cycle via infiltration, percolation, evapotranspiration, and not via direct discharge to watercourses. This description can be expanded to include rainwater tanks of various types[xiv]

SCP - Stormwater Concept Plan - conceptual layout of the OSD system submitted with the development or subdivision application. **Note**: Holroyd City Council do not accept SCPs (See Section 4.1)[xv]

SSR - Site Storage Requirement - the minimum volume (in m^3/hectare or in m^3 when applied to a specific site) required for a storage to ensure that spillage will not occur when the outflow is restricted to the PSD.

Storage – an area where water is stored temporarily to achieve OSD. The area may be divided into Primary, Secondary or Tertiary Storage. Primary storage caters for frequent storm events, Secondary storage caters for intermediate events and Tertiary storage caters for major events.[xvi]

Structural Storage - a storage system, generally below ground level, where the volume is contained within a closed structure.

Sump - space between the DCP invert and the outlet, used to prevent silt and debris blocking the outlet.

Surface Storage – a storage system, generally above ground, where the volume is contained within an open area.[xvii]

Sustainable – capable of being maintained at length without interruption, weakening, or loss of power or quality.[xviii]

[xi] Definition added for third edition
[xii] Definition added for third edition
[xiii] Definition added for third edition
[xiv] Definition added for third edition
[xv] Clarification of HCC position in third edition
[xvi] Definition added for third edition.
[xvii] Definition added for third edition

Water Cycle – the natural cyclical process whereby atmospheric water falls as rain, flows as stormwater or groundwater to receiving waters and is then evaporated back into the atmosphere. At various stages of the process, water may also be released into the atmosphere (transpired) by living things[xix].

Water Sensitive Urban Design – a process of urban design for development or re-development that seeks to mimic the natural water cycle so as to create a sustainable development in terms of its treatment of water, wastewater and stormwater[xx].

Work-as-Executed Plans – plans showing the levels, dimensions and location of what is constructed. In the context of this Handbook the plans refer to the OSD system and must be prepared by a Registered Surveyor or the OSD designer.

WSUD – See Water Sensitive Urban Design

[xviii] Definition added for third edition
[xix] Definition added for third edition
[xx] Definition added for third edition

2.4 Why so much storage is required

The 470 m^3 /ha of storage required under the upper Parramatta River catchment OSD policy is approximately three times greater than the volumes required under former council policies. While this volume may at first appear excessive, the former policies only aimed at controlling 5 year or 20 year storm flows for one particular storm duration.

However, the flood standard adopted in this catchment, and generally throughout New South Wales, is the one in 100 year event. This standard is widely used for both the design of flood mitigation schemes and for defining flood plain limits. (Even though the draft Floodplain Management Manual redefines as floodprone all land below the Probable Maximum Flood level, development constraints are likely to apply mostly to land below the 100 year ARI event.)[i]

As the catchment OSD policy deals with storms of all durations up to 100 year ARI events, it must detain much greater volumes of runoff. If the policy aimed only at controlling, say, the 30 minute - 20 year ARI storm, only 260 m^3 /ha would be required.

Another point of concern is that the 80 l/s/ha corresponds to the 5 year ARI - 2 hour storm duration runoff from a fully developed site calculated using the Rational Method. For longer duration storms the runoff is even less. Is it reasonable, some have asked, to limit the 100 year ARI runoff to the 5 year magnitude or less?

The confusion is understandable because early OSD policies focussed only on the peak discharge. It needs to be appreciated that, even if OSD limits the post-development peak discharge to the pre-development rate, the overall post-development volume of runoff is still greater. As a result the post-development stormwater discharge after the peak (on the hydrograph 'tail') will be greater. Moreover, by maintaining outflow at the PSD rate for some time, OSD further increases these discharges.

The Rational Method OSD procedures necessarily ignore the cumulative downstream implications of these increased 'tail' discharges. However, with a catchment hydrologic model, it is seen that the accumulation of increased 'tail' discharges can (and does) result in greater flood discharges at some points further downstream. It is to avoid this that the PSD must be less than that required merely to avoid increasing peak discharges at some specific site.

2.5 Legal basis of the Policy

Legal advice obtained by the Upper Parramatta River Catchment Trust states that local councils have the power to impose a condition on development consent or building approval requiring the construction of OSD systems on the development site.

OSD also satisfies the test of 'reasonableness'. New developments should not be allowed to add to downstream flooding and drainage problems. Without OSD or other compensatory flood storage, the cost of dealing with additional stormwater runoff from a new development is passed onto downstream residents in the form of increased flood damage and distress, or onto the local authorities which must upgrade the drainage system or construct additional flood mitigation works.

OSD is also consistent with, and supports, urban consolidation. One of the principal arguments against urban consolidation is that the stormwater drainage system cannot cope with the increased stormwater runoff. By ensuring there is no increase in peak runoff from urban consolidation sites under all circumstances, OSD completely overcomes this objection.

[i] Reference added for third edition.

2.6 Better water quality

The primary function of an OSD system is to control runoff quantity. However, downstream water quality is also improved as a result of storage outlet screening which:

- traps visible pollution such as trash and litter and prevents it being discharged into receiving waters
- prevents leaves and grass clippings and other organic matter from entering receiving waters where decomposition decreases dissolved oxygen levels and threatens aquatic life.

2.7 Water Sensitive Urban Design

Current trends in urban development seek to address the issue of creating a more sustainable urban environment. Global warming and climate change are now seen as issues to be addressed in the present not just the future. Droughts and dry land salinity have highlighted the need to review our national approach to water usage, while the increasing population in major cities has focussed attention on the supply of potable water and the disposal of wastewater. Water supply authorities are reviewing the appropriateness and cost implications of using treated, potable water for domestic or industrial uses which are predominantly non-potable.

As the driest continent in the world, Australia must conserve water, which is one of its most precious resources, if the country is to prosper in the long term. Action now will give future generations an opportunity to enjoy the quality of life we currently enjoy. Failure to act could create enormous problems within the next generation.

Water Sensitive Urban Design (WSUD) is a process by which a development is designed so as to mimic the natural pre-development water cycle. In an undeveloped site rainwater may fall on vegetation or pervious ground surfaces. Typically there will be some infiltration into the topsoil, ponding on flat areas from where the water may evaporate and absorption by vegetation. Any overland flow that results is likely to be sheet flow over a vegetated surface which means that velocities are low and the stormwater may take a considerable time to reach the nearest watercourse. This extended period of flow to watercourses reduces the risk of flooding because a significant portion of the rainfall takes a long time to reach the watercourse. Rainwater which has infiltrated into the topsoil may also find its way to local watercourses but this takes much longer again. This water may also flow into ground water if the subsoil is sufficiently pervious.

After development however there is less vegetation, more impervious area and a more efficient means of collecting and transporting flows off site. This increases the volume of flow into the watercourses and reduces the time taken to reach the waterway. This leads to greater flow depths in the creek and the likelihood of flooding. OSD is one way that stormwater can be temporarily detained close to where the rain falls to help overcome the quickening of flows to the creek systems. The same volume of stormwater will reach the waterway but at least it takes several hours longer which, in this catchment, helps reduce the risk of flooding downstream[i].

[i] Water Sensitive Urban Design note added in third edition

3.0 On-site Stormwater Detention Policy

3.1 Policy statement

The overall aim of the catchment OSD policy is to ensure that new developments and redevelopments do not increase peak stormwater flows in any downstream area during major storms up to and including 100 year ARI (1% AEP) events.

The OSD solution should create a sustainable solution for peak stormwater flow management, which complements any WSUD aspects of the development. However, there should be no reduction in the volume of storage provided,nor increase in the site discharge to the downstream drainage system. (Section 4.2.9 details the volumes of rainwater tanks which can be offset against the OSD storage.)[i]

3.2 Objectives

The objectives of the OSD policy are to:

- prevent any increase in downstream peak flows resulting from new developments or redevelopments by temporarily storing on-site the additional and quicker runoff generated

- prevent increases in downstream flooding and drainage problems that could:

    - increase flood losses
    - damage public assets
    - reduce property values
    - require additional expenditure on flood mitigation
    - drainage works.

- encourage integration of OSD systems into the architectural design and layout of the development so that adequate storage areas are included in the initial stages of the site design

- encourage integration of the OSD facilities into a sustainable overall water management plan for the site[ii]

- require construction supervision of OSD systems by the OSD designer to improve construction standards.

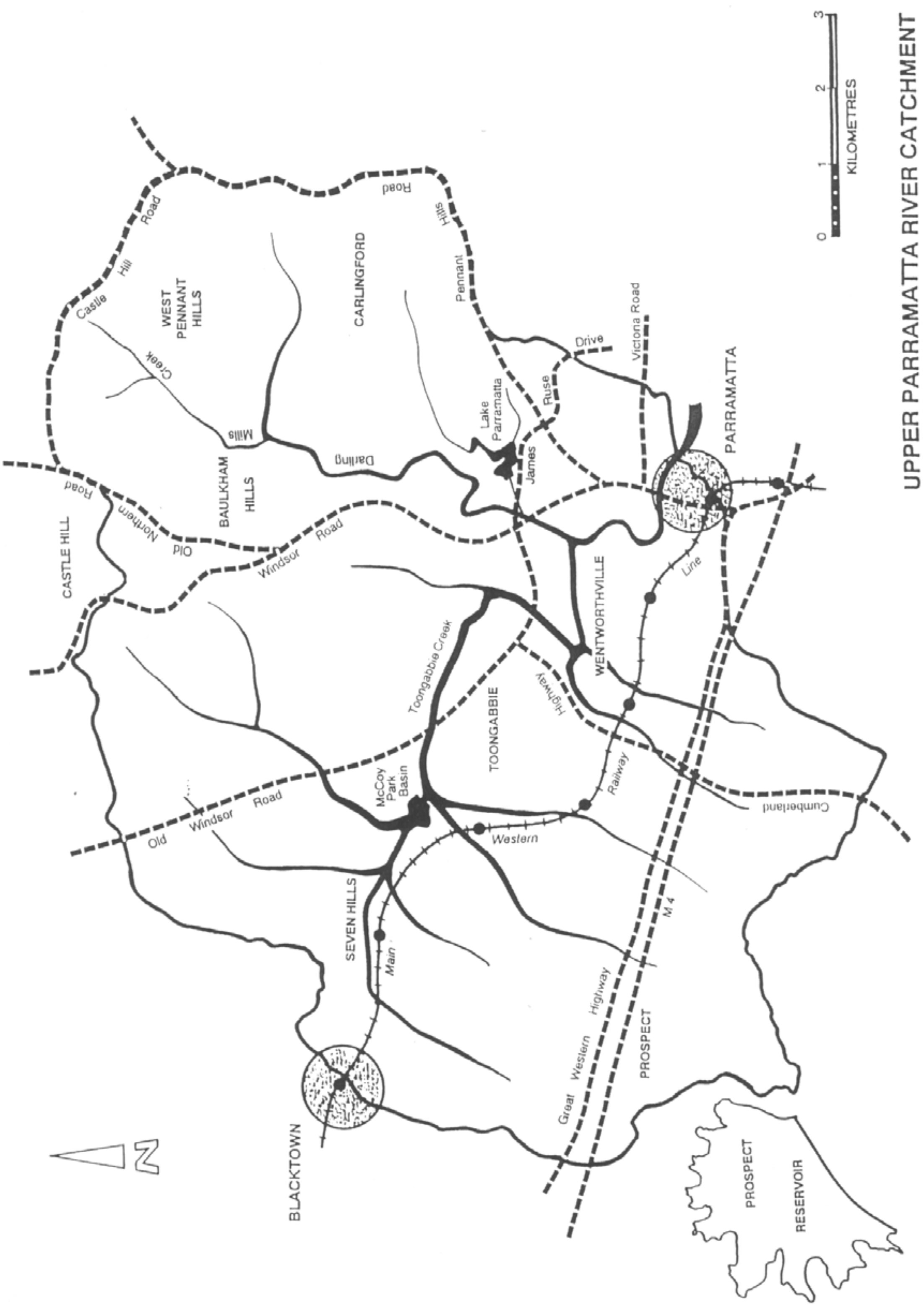
3.3 The Catchment area

The policy, control standards, procedures and approval processes detailed in this Handbook apply throughout the 110 km^2 of the upper Parramatta River catchment. The four local councils, Baulkham Hills, Blacktown, Holroyd and Parramatta have adopted the common OSD policy for those areas within the catchment. The catchment boundaries are shown in Figure 3.1.

For areas outside the catchment, interested parties should contact the relevant local council. An approximate procedure for applying the methodology outside the catchment is given in Appendix G[iii] and the parameters for the design of OSD systems in other catchments within the four councils are given in Appendix F[iv].

[i] Impact of WSUD added in third edition
[ii] Need for integration added in third edition
[iii] Previously Appendix C.
[iv] Appendix F added for third edition.

Figure 3.1


UPPER PARRAMATTA RIVER CATCHMENT
KILOMETRES
PARRAMATTA
WEST PENNANT HILLS
CARLINGFORD
BAULKHAM HILLS
CASTLE HILL
WENTWORTHVILLE
TOONGABBIE
SEVEN HILLS
BLACKTOWN
PROSPECT
PROSPECT RESERVOIR
McCoy Park Basin
Lake Parramatta
Toongabbie Creek
Castle Hill Road
Pennant Hills Road
Darling Mills Creek
Old Northern Road
Windsor Road
Old Windsor Road
James Ruse Drive
Victoria Road
Cumberland Highway
Great Western Highway
M 4
Main Western Railway Line

3.4 Policy application

On-site Stormwater Detention (OSD) systems temporarily detain stormwater on a site, in order to limit the discharge leaving the property to a pre-determined rate which will ensure that the development does not increase downstream flood discharges for storms up to the 100 year ARI event.[v]

OSD is applied as a condition of development consent by Council under the Environmental Planning and Assessment Act 1979. Any existing obligation to provide and maintain an OSD system will be found in the development consent applicable to the property or on the property title itself. In the case of a proposed development, the guidelines given below in sections 3.4.1 and 3.4.2 show whether OSD will be necessary.

For residential subdivisions, OSD was not generally required on lots created by subdivision until 1991 when the common OSD policy was adopted by the four councils in the upper Parramatta River catchment. However, all lots created after that date have a requirement for OSD applied as a condition of development consent for the subdivision.

3.4.1 Developments to which OSD applies

OSD requirements generally apply to all types of development and redevelopment on both flood liable and flood-free sites. These include the following:

- subdivisions (including residential) approved after 1991;
- single dwellings on lots created by a subdivision approved after 1991, unless a communal OSD system was constructed as part of the subdivision;
- all commercial, industrial and special-use developments and buildings;
- town houses, villas, home units, duplexes;
- dual occupancies;
- semi-detached residential/commercial and residential/industrial properties;
- tennis courts;
- roads, car parks, paths and other sealed areas;
- public buildings;
- buildings, car parks and other sealed areas of public sport and recreational facilities;
- single dwellings, extensions and additions (in the Parramatta City Council area only) where the proposed development involves an increase in impervious area greater than 150m^2 and the land is designated as Grey or Grey Hatched on Council's Flood Prone Land Map;
- sites which include WSUD and water re-use. Consideration will be given to variations to the PSD or SSR only where it has been proved conclusively that infiltration/recycling or reuse will invariably reduce the site stormwater discharge for the full range of storm events.[vi]

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[v] Definition added for third edition.
[vi] Integration with WSUD added to third edition

3.4.2 Developments to which OSD does not apply

OSD policy does not apply to:

- single dwellings, extensions, additions and improvements on single residential lots created before November 1991 (when the OSD policy was adopted), except where OSD is required as a restriction on the property title or in the case of local drainage problems in the City of Parramatta as noted in Section 3.4.1;

- the residual lot containing an existing dwelling which is excised as part of a subdivision of a lot created prior to 1991, provided that flows from the excised portion are directed away from the OSD system; (**Note:** OSD is required for the new lots created.) Subsequent single residential building/additions on the residual lot will also not be required to provide OSD;

- the residual lot containing an existing industrial or commercial development which is excised as part of a subdivision of a lot created prior to 1991, provided that there is no significant development proposed on the residual lot and that flows from the residual lot are directed away from the OSD system; (**Note:** OSD is required for the new lots created.);

- dual occupancy residences on a lot with an existing residence involving less than 150[i] m^2 of development area;

- sub-divisions of existing dual occupancies where no changes to the buildings or site are proposed;

- boundary adjustments and consolidations of allotments where no additional lots are created;

- one-off minor developments, minor additions and repairs where the proposed development area is less than 150 m^2 (subsequent minor developments or additions shall require OSD). This exclusion is aimed principally at small areas within large commercial or industrial sites. It does not apply to any developments where the development area is greater than 150 m^2 nor to dual occupancies[ii];

- change of use where no physical changes to the outside of the property are proposed;

- areas within large properties (usually commercial or industrial but may be residential) not covered by the development application or construction certificate;

- new developments in subdivisions where OSD has already been provided for the entire subdivision;

- buildings in Rural/Non-urban areas;

- the grassed playing field and vegetated area of public sports and recreational facilities which are not part of a development.

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[i] Minimum area increased for third edition.
[ii] Explanation added for third edition.

3.4.3 Area of the site to which OSD applies (Previously Section 4.1.5)[i]

Generally, OSD applies to the entire site, but there may be exceptions in certain circumstances.

Additions & extensions

On an already-developed property, the OSD requirements apply only to the area of the new development, provided runoff from previously developed areas can be excluded from the OSD storage.

Dual occupancies

Where an additional dwelling is proposed on a lot with an existing dwelling, the OSD requirements will relate to the additional dwelling and a curtilage for anticipated paths, driveways and paved areas. In the absence of details on the plans, the curtilage will be taken as 10% of the area of the proposed second dwelling. Where two or more dwellings are constructed on the same lot at the same time, the OSD requirements will be applied to the entire site.

Subdivision of an existing residential property

When an existing residential property is subdivided to create a single additional lot[ii], the OSD requirements will relate only to the area of the new allotment. The OSD storage facilities may be located on the remainder of the original property, provided the combined peak discharge (from both lots) is no greater than if the OSD systems were located on the new lot.

Subdivisions creating new public or private roads and paths

The OSD requirements apply to the whole development area including roads and paths, not just the individual lots. The best solution will normally be for the detention storage to be located on one lot for the whole subdivision. However, if individual storages are provided on each lot, the discharges should be adjusted to provide the equivalent storage for the area of roads or paths.

Undeveloped portions of a lot

Portions of large lots which are unaffected by the development may be excluded from the area to be controlled by the OSD systems, provided flows from these areas can be diverted around the OSD system. Council approval must be obtained before excluding portions of a lot from the OSD requirements.

Floodways (See Section 4.1.3)

Creeks, waterways and drainage swales that carry major concentrated flows around the storage area are defined as floodways. The area of the floodway can be excluded from the site area for the purpose of calculating the site storage requirements, provided that the area is protected from development by an appropriate covenant or easement.
Note: Overland flowpaths, which cater for minor flows cannot be excluded from the site area for the calculation of OSD.

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[i] Section number changed for third edition.
[ii] Clarification added for third edition.

New development or redevelopment

Where the proposed development is of a vacant site or a complete redevelopment of an already-developed property, the OSD requirement will relate to the whole property.

Battle-axe blocks

The access driveway to battle-axe blocks shall be included in the site area used for calculation of the site storage requirements.

3.4.4 Policy variations (Previously Section 3.4.3)

Each council will, in consultation with the Trust, consider requests to vary control standards or provide/contribute to alternative storage facilities in accordance with the procedures outlined in Appendix A. For equity reasons, where OSD is waived for a particular site, an equivalent expenditure on measures providing environmental and/or community benefits from the development, such as water quality improvements, will be required.[i]

In some situations, where the site is flood prone and the watercourse flows through the site, the council may accept the provision of additional mainstream flood storage in lieu of OSD. In these cases, the storage must be available over the full range of storm events and allow for the fact that mainstream flood levels will tend to decrease over time. As the storage is on-line and the site discharge has not been restricted, the additional storage required is a minimum of 25% greater than the site's OSD storage requirement.[ii]

3.5 Control standards

3.5.1 Permissible Site Discharge (PSD)

The maximum PSD is 80 l/s/ha. This will need to be adjusted in accordance with the procedures set out in Section 5.1 when the entire site cannot be drained to the storage.

3.5.2 Site Storage Requirements (SSR)

The minimum SSR for an off-line OSD storage that has a DCP which achieves the full PSD early in the storm event is 470 m^3/ha. This will need to be adjusted where either full high early discharge (HED) is not achieved or the permissible site discharge is reduced according to Section 5.1.

3.5.3 Minimum outlet size

To reduce the likelihood of the DCP outlet being blocked by debris, the outlet opening shall have a minimum internal diameter or width of at least 25 mm and shall be protected by an approved mesh screen.

3.5.4 Ponding depths

Guidelines to assist in determining depths and frequencies of ponding for different classes of storages are given in Table 6.1. It is emphasised that these are general guidelines that will be varied according to the nature of the development and the location of the storage. The maximum depth of ponding in above ground storages is 600 mm. Council may approve deeper ponding in individual cases where the applicant demonstrates that safety issues have been adequately addressed. For example warning signs and or fencing should be installed where the depth exceeds 600 mm or adjacent to pedestrian traffic areas.

[i] Community benefit requirement formalised in third edition.
[ii] Mainstream storage equivalent defined in third edition.

3.5.5 Safety Fences[iii]

Surface storages should be constructed so as to be easily accessible, with gentle side slopes permitting walking in or out. A maximum gradient of 1:4 (ie 1 vertical to 4 horizontal) will be required on at least one side to permit safe egress in an emergency. Where steep or vertical sides are unavoidable, due consideration should be given to safety aspects such as the need for fencing, both when the storage is full and empty.

Balustrades (fences) must comply with the Building Code of Australia (See Section D2.16 of the Code), while safety fences should comply with the Swimming Pool Act 1992.

3.5.6 Internal drainage system (Previously Section 3.5.5)[iv]

The stormwater drainage system (including surface gradings, gutters, pipes, surface drains and overland flowpaths) for the property must::

- be able to collectively convey all runoff to the OSD system in a 100 year ARI (1% AEP) rainfall event with a duration equal to the time of concentration of the site
- ensure that the OSD storage is by-passed by all runoff from neighbouring properties and any part of the site not being directed to the OSD storage, for storms up to and including the 100 year ARI event.

3.6 Policy implementation

3.6.1 Development approvals for Subdivisions.[v]

In general, the OSD requirements are imposed at the subdivision stage, in the following manner:

- Development Application - submission and approval of a conceptual layout of the OSD system. (Stormwater Concept Plan) Except at Holroyd City Council where detailed design required with development application[vi].
- submission of Engineering Plans - submission and approval of the detailed design, including calculations and construction plans and details
- release of Subdivision Certificate/Linen Plans - submission and approval of work-as-executed drawings, certificates of hydraulic compliance[vii], and legal instruments on property titles protecting the OSD system.

Note: The OSD system must be constructed at the time of subdivision and not deferred until the construction of the individual dwellings except where the subdivision is up to seven lots, if it is proven there are site restrictions. (See Section 4.0)[viii]

Refer to Figure 3.2.

[iii] New section added in third edition.
[iv] Numbering altered for third edition.
[v] Wording changed in third edition to reflect changes to Environmental Planning & Assessment Act 1979.
[vi] Holroyd City Council position clarified in third edition.
[vii] "Hydraulic" added to clarify certificate terminology in third edition.
[viii] Deferral of OSD clarified for small subdivisions in third edition.

3.6.2 Development approvals and construction certificates[ix]

When the OSD requirements are implemented through the development approval and construction certificate process, the approval is in three stages:

- Development Application - submission and approval of a conceptual layout of the OSD system (Stormwater Concept Plan) Except at Holroyd City Council where detailed design required with development application;[x]

- Construction certificate - submission and approval of the detailed design, including calculations and construction plans and details;

- Final Approval - submission and approval of work-as-executed drawings, certificates of hydraulic (and structural, if required) compliance and legal instruments protecting the OSD system.
  Note: If the OSD system was constructed at the subdivision stage, the system may need to be re-certified at final approval to ensure it will still function as designed.

The various steps involved are set out in Figure 3.2.

[ix] Wording changed in third edition to reflect changes to Environmental Planning & Assessment Act 1979.
[x] Holroyd City Council position clarified in third edition

Figure 3.2
OSD APPROVAL PROCESS

Proposal	Determine if OSD is required (Section 3.4)
Yes ↓	
Preliminary Lot Layout	Have a contour survey prepared Involve OSD Designer in site/lot layout
Prepare Stormwater Concept Plan (SCP)	OSD Designer prepares SCP SCP submitted with development application (Section 4.1) Note: Holroyd City Council requires detailed OSD design with development application.[1]
Development Approval	Council approves development/subdivision with OSD conditions
Detailed Design	OSD Designer addresses consent conditions and prepares maintenance schedule. Calculations, maintenance schedule, plans & details submitted with application for Construction certificate. Plans forwarded to Council or private certifier. Applicant should include a letter authorising Council/private certifier to send a copy of the approved plans to the designer.(Section 4.2)[2]
Construction Certificate/ Engineering Plan Approval	Council or private certifier issues approval
Construction	OSD Designer supervises construction (Section 4.3.2)
Finalisation	Work-as-Executed drawings prepared. Positive Covenant prepared & attached to Linen plan/ subdivision certificate. OSD Designer certifies hydraulic performance of construction. (Section 4.3.4)
After Approval Release of subdivision certificate/Linen Plan	Certificate of Hydraulic Compliance & Work-as-Executed Plan submitted to Council. Positive covenant registered. (Section 4.3.6)

[1] Holroyd City Council position clarified in third edition
[2] Copy of plans to designer added to third edition

4.0 The approval process

This section[i] sets out the steps in the approval process from the Stormwater Concept Plan through the detailed design to the construction and final approval.

OSD is best considered as early as possible in the development process, particularly where the proposal includes WSUD principles[ii], so that the most efficient and effective system can be designed and installed. There are a number of issues to be addressed at the conceptual stage which will have a significant impact on the final solution:

- in multi lot subdivisions, a common OSD system should be constructed on one lot rather than a separate system on each individual lot;
- every attempt should be made to use surface storage for the OSD system. Underground storages should be the option of last resort. The use of surface storage reduces the cost of the system and improves accessibility for maintenance (See Section 4.2.6 and Appendix H;
- overland flows from upstream must be diverted past the OSD storage unless the storage volume is increased to cater for the upstream catchment;
- the OSD system is to be constructed at the time of subdivision and not to be deferred until the building is constructed without specific Council approval. Council approval will only be considered for subdivisions of up to 7 lots where there are demonstrable site restrictions. Any easements or inter allotment drainage cannot be deferred and must be created/installed at the time of subdivision.[iii]

- the site should be shaped to ensure all flows are directed to the storage even if blockages or larger storm events occur;
- development of flood prone sites must be carried out without any net loss of flood storage.

4.1 The Stormwater Concept Plan

A Stormwater Concept Plan (SCP) is required to support all development applications covered by the OSD Policy (see 3.4.1). The purpose of a SCP is not to provide a detailed design, but to identify the drainage constraints and to demonstrate that the OSD system can be integrated into the site's overall water management and proposed layout. The steps involved in preparing a SCP are summarised in Figure 4.1. It should be noted however, that Holroyd City Council no longer accept SCPs in conjunction with the development application and require a detailed OSD design because in many parts of the City, detailed levels are required to show that the OSD facility will function correctly.[iv]

An OSD system is an integral part of the entire development and can be expensive to retro-fit once the site layout has been established. The control of stormwater flows through the OSD facility may facilitate the provision of water quality improvements on sites where these are required by the development consent. Treatment of the stormwater will often be easier once the discharge has been controlled by the OSD facility. Developers and architects should involve their OSD and WSUD designer(s) in developing the initial site layout.

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[i] Key considerations compiled for third edition.
[ii] Reference to WSUD added in third edition
[iii] Deferral of OSD clarified in third edition
[iv] Clarification of Holroyd City Council's position on SCPs added to third edition

4.1.1 Objectives

The objectives of the Stormwater Concept Plan are to:

- emphasise that the OSD and drainage requirements need to be considered, as part of an overall site water management plan,[i] in the initial planning stages of the development
- simplify the detailed design by identifying adequate storage areas in the planning stage and showing how the OSD design complements the WSUD components of the proposal[ii]
- reduce project costs by maximising the use of proposed landscape and architectural features as part of the OSD system
- allow the cost of development consent conditions relating to OSD to be determined at the planning stage
- assist in addressing the concerns of local residents regarding drainage and flooding issues.

[i] Reference to site stormwater management added to third edition
[ii] Relationship to WSUD added to third edition

Figure 4.1 Preparation of typical Stormwater Concept Plan

Note: Holroyd City Council do not accept SCPs with development applications[iii]

Site Inspection

Identify Drainage Constraints

- external flows entering the site
- potential discharge points
- potential storage areas
- catchment of any external flows entering the site
- Opportunities/requirements for water reuse and water quality treatment

↓

Site Survey and Contour Plan

- location and levels on council/inter allotment drainage system
- sufficient levels to ensure a contour plan can be prepared with contours extending into adjoining properties where necessary
- any other constraints (e.g. easements and services)

↓

Discuss Site Layout With Architect/Developer

- estimate storage volume required (refer Section 4.1.5)
- estimate external flows entering the site (refer Section 4.1.3)
- establish building and site layout
- start negotiations for inter allotment drainage easements (if required)
- Identify any WSUD/water quality proposals[iv]

↓

Prepare Stormwater Concept Plan

- locate estimated storage volume
- determine areas unable to drain to storages
- estimate levels of storage and assess the available discharge points
- treat overland flowpaths/floodways
- identify emergency spillways

↓

Review Architectural, Landscape Plans

- check other plans submitted with Development Application for any anomalies or conflicts with the SCP
- fill out SCP checklist (Appendix B).

↓

Submit SCP with DA

[iii] Holroyd City Council position clarified in third edition

[iv] Reference to WSUD and water quality added to third edition

4.1.2 Minimum data requirements

The minimum information to be included in a SCP is:

- an estimate of the volume of OSD storage required
- the relationship between OSD and any WSUD proposals for the site[v]
- calculations of the maximum 100 year ARI flow rate for flowpaths and floodways
- a plan which includes:
    - the development/site boundaries and area
    - contours and spot levels (which reflect the site gradings and extend into adjoining properties)
    - the extent and area of any upstream catchment for external flows entering the site
    - the location and extent of detention storages
    - the location and levels of discharge points for the storages
    - the layout of the site, including location of all buildings, roadways and landscaped areas
    - the location and approximate extent of any floodways or flowpaths through the site
    - the location and area of any portion of the site unable to drain to the storages.

An SCP Checklist is provided in Appendix B.8[vi]

4.1.3 Assessment of external flows

An OSD storage is designed to deal with stormwater runoff from only a particular area. If external flows enter the storage, it will fill more quickly, causing a greater nuisance to occupiers and it will become ineffective in terms of reducing stormwater flows leaving the site. The OSD design must therefore cater for external flows which can enter the storage. This is done by either increasing the size of the storage, or by diverting the external flows around the storage.

If upstream flows cannot be diverted around the storage, the storage size must be increased to cater for the additional catchment with the PSD remaining at 80 l/s/ha.[vii]

Where the storage is not sized to detain runoff from the entire upstream catchment, a floodway/overland flowpath must be provided to ensure that the 100 year ARI runoff from outside the site by-passes the OSD storage. It is important to ensure that the by-pass flow is directed to a suitable outlet point and not directed onto an adjoining property.[viii] The diversion drainage should be designed to cater for the 100 year ARI flow for the upstream catchment, which may well have a longer time of concentration than the site. It is preferable if the diversion drainage can be designed to avoid unnecessarily concentrating the flow and in some instances it may be possible to respread the flow to sheet flow. The diversion may be achieved with a grass swale or raised garden bed in many instances. This will provide a

[v] Relationship to WSUD added in third edition
[vi] Checklist added for third edition.
[vii] Clarification added for third edition.
[viii] Design hint added for third edition.

softer solution than a concrete drain or piped system and may be easier to respread to sheet flow. In addition, the use of a landscaped solution will often be more attractive and cheaper.

For the purposes of the OSD policy, the external flows can be divided into two categories: overland flowpaths and floodways.

Overland Flowpaths

These are surface drainage systems which cater for relatively minor sheet flow from upstream properties and convey it around the storage or allow it to pass across the site without interference (eg. dish drain, grass swale). The area of the flowpath must be included in the site area when determining the site storage requirements.

Floodways

These surface drainage systems convey relatively major concentrated mainstream, surface or surcharge flows from an upstream catchment around the storages (eg. overbank flow, natural gully or surcharge path for a drainage line). The area of the floodway can be excluded from the site area for the purpose of calculating the site storage requirements, provided that the area is protected from development by an appropriate covenant or easement. Where an existing easement is insufficient to cater for the 100 year ARI flow from the upstream catchment, it may need to be widened to cater for the flow. This would reduce the area for calculating the storage requirements.[ix]

There are a small number of situations where part of the external flow would not enter the storage. This portion of the flow need not be collected nor diverted. For example:

- dual occupancies where a second dwelling is proposed on a lot with an existing dwelling;
- (OSD is required for the area of the additional dwelling plus a curtilage to cover paths and paved areas. Runoff from the remainder of the lot need not be directed to the OSD storage nor is it necessary to divert external flows affecting this portion of the lot.)
- large properties where only a small area is being developed.
- (OSD applies only to the area covered by the development application, generally the building/paved area plus curtilage. Here again external flows affecting the undeveloped areas need not be diverted.)

4.1.4 Areas not directed to the OSD storages

(See also Section 3.4.3 where the development affects only part of a site)[x]

Where possible, the drainage system should be designed to direct runoff from the entire site to the OSD system. Sometimes, because of ground levels, the receiving drainage system or because of other circumstances, this will not be feasible. In these cases up to 15% of the site area may be permitted to bypass the OSD systems, provided that as much as possible of the runoff from impervious site areas is drained to the OSD system. Calculations based on the standard design storm for this catchment, indicate that 15% of the site without OSD will generate a site discharge of 80 l/s/ha which means that no runoff at all could be permitted from the remaining 85% of the site.[xi]

For areas not draining to an OSD storage, the storage volume is still calculated on the entire site area while the PSD is adjusted downwards according to procedures in Section 5. This makes sure the storage is fully used in the design storm.

4.1.5 (This section has now become Section 3.4.3)

[ix] Clarification added for third edition.
[x] Cross-reference added for third edition.
[xi] Bypass area reduced in third edition

4.1.6 Estimating storage volumes

The Site Storage Requirement (SSR) will vary depending on the efficiency of the discharge control device. It can be shown that if an OSD storage has a discharge control pit that achieves the PSD immediately flow is generated from the site, the SSR is 470 m^3/ha. In practice this does not occur and an adjustment to the storage volumes is necessary after the discharge characteristics have been fixed.

It is not necessary to select the discharge control device or accurately determine the SSR for the SCP. A storage rate of 500 m^3/ha can be used to approximate the required storage volume. This approximate volume is refined at the detailed design stage.

4.2 Detailed design

From 1 May 1999[xii], design and certification will only be accepted from persons having acceptable professional accreditation. The following are considered to be acceptable accreditation for the purpose of OSD design and certification:

- NPER in Civil Engineering (Institution of Engineers, Australia);
- Surveyors Certificate of Accreditation in On Site Detention and Drainage Design (Institution of Surveyors NSW and the Association of Consulting Surveyors NSW);
- Stormwater Register (Association of Hydraulic Services Consultants Australia)
- Accreditation as a certifier under the Environmental Planning and Assessment Act 1979 in the relevant discipline.

A detailed design submission is required to support an application for a construction certificate or the engineering plans of a development. The specific site drainage constraints will have been identified and addressed conceptually in the SCP, thereby simplifying the detailed design.

The purpose of the detailed design submission is to finalise the design of all components of the OSD system, provide a set of plans and details for construction of the system, and detail the maintenance procedures necessary to ensure the long-term effectiveness of the system. The steps involved in a typical detailed design submission are outlined in Figure 4.2.

One of the concerns raised by OSD designers is that they may not see the approved OSD plans if they are not the applicant. Council may not be entitled to send a copy to the designer unless the applicant gives permission. If the applicant authorises release of a copy of the plans, this will allow designers to adjust future designs to better suit the council's requirements. It will also ensure that the designer has the approved plans if engaged to provide the hydraulic certification for the OSD facility[xiii].

4.2.1 Objectives

The objectives of a detailed OSD design are to:

- ensure that all components of the OSD system are functional
- ensure that the OSD design complements the WSUD proposals for the site
- simplify construction of OSD systems by providing detailed design plans
- increase owner awareness and improve maintenance standards by simply outlining the necessary maintenance practices
- encourage consideration of accessibility and maintainability of storages.

[xii] Accreditation requirement added in third edition.

[xiii] Plans to designer added to third edition

4.2.2. Minimum data requirements

The following information must be included in a detailed design submission:

- calculations for each storage, finalising the storage volumes and discharge
- Where WSUD components are proposed, calculations and details of both the OSD and WSUD components are required which clearly demonstrate that the designer has integrated the systems so as to allow for the impact of each on the design of the other. For further information on the details to be submitted for the WSUD components please contact the local council. Additional information is also available in the Final Draft Water Sensitive Urban Design Technical Guidelines dated October 2003 prepared for the Trust by URS Australia Pty Ltd. Copies of the report or the final report which supersedes it) will be available from the Trust web site (www.uprct.nsw.gov.au) and the Water Sensitive Urban Design in the Sydney Region website (www.wsud.org).[xiv]
- rates in accordance with procedures in Section 5
- calculations verifying that the overflow from the DCP to the storage, flowpaths/floodways, internal drainage systems and any overflow weirs have sufficient capacity
- design plans and details which include the:
  - location and extent of each storage with each storage wholly within the property.
  - locations and details of each discharge control device
  - catchment area draining to each storage
  - maximum water surface levels in each storage
  - overflow structures and surcharge paths
  - levels and location of the discharge points for each storage
  - internal drainage system
  - existing contours and final design levels
  - final site/lot layout
  - location and extent of any floodway/flowpath
- cross-sections through the storages
- a maintenance schedule that simply sets out:
  - what maintenance is required
  - how will the maintenance be done
  - who should carry out the maintenance
  - when the maintenance will be done
- structural certification for components of the OSD system (if necessary).
- completed Detailed Design checklist (See Appendix B.9)[xv]
- a letter authorising Council to forward a copy of the approved plans to the designer

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[xiv] Clarification of relationship between OSD and WSUD clarified in third edition

[xv] Checklist added in third edition.

Figure 4.2 PREPARATION OF A TYPICAL DETAILED DESIGN SUBMISSION

Preparation	• Obtain copies of: -approved SCP(where available) -development consent conditions -landscape & architectural plans
↓ Select Discharge Control Device/Finalise Storage Volumes	• Select discharge control device • Establish levels of outlet and ensure free outfall if possible • Finalise required storage volume
↓ Design of Storage in Detail	• Distribute final storage volumes to minimise nuisance to property owners • Check underground storages for - access - maintainability • Determine maximum water surface levels • Ensure sufficient weir capacity for excess flows
↓ Design Internal Drainage	• Ensure 100 year flows are conveyed to basin for areas designed to drain to storages • Check flowpaths and floodways have adequate capacity to ensure external 100 year discharges routed around basin
↓ Prepare Final Drawings	• Detail to sufficient standard to allow builders/plumbers to construct system under supervision • Specify materials and dimensions
↓ Prepare Calculation Sheet & Maintenance Schedule	• Prepare calculation sheet for each basin • Prepare maintenance schedule outlining necessary maintenance practices
↓ Review	• Review other DA/Construction Plans for anomalies or conflicts with the OSD/drainage plans • Check all relevant OSD consent conditions have been satisfied • Fill out Detailed Design checklist (Appendix B)
↓ Submit	• Include a copy of a letter authorising Council/private certifier to send a copy of the approved plans to the designer.[xvi]

[xvi] Plans to be available for designer added in third edition

4.2.3 Discharge Control Pit (DCP)

The DCP is the key feature in regulating discharge from the site. Hydraulic model tests conducted on behalf of the Trust by Manly Hydraulics Laboratory established a set of generic design parameters for DCPs incorporating HED, screens and orifice control.
Proprietary products or in-situ devices meeting these guidelines are not required to provide a laboratory-determined head-discharge relationship. Other forms of discharge control are commercially available and can be used in the catchment provided that:

- the hydraulic characteristics of a prototype have been determined and certified by a recognised hydraulics laboratory
- the risk of the device becoming blocked by debris is minimal
- the device can be readily inspected
- the device can be accessed for cleaning
- there is minimal risk of the system being tampered with.

<u>Orifice Controlled High Early Discharge Pits</u>

A typical discharge control pit with an orifice control is shown in Figure 4.3.
The minimum orifice diameter is 25 mm.

The following minimum pit dimensions will achieve predictable hydraulic characteristics:

- minimum width =3d (symmetrical about the orifice)
- minimum design head =2d (centre of orifice to top of overflow)
- minimum screen clearance =1.5d (orifice to upstream face of screen)

where d is the internal diameter of the orifice.

These dimensions can be increased to allow greater screen sizes or improve access.

Orifice plates are to have the following characteristics:

- orifice plates are to be manufactured in corrosion-resistant 3 mm thick stainless steel plate, or 5 mm thick plate where the orifice exceeds 150 mm, with a circular hole machined to 0.5 mm accuracy.
- orifices fashioned in material other than stainless steel will be subject to the specific approval of the Trust. In determining whether an orifice is suitable, it will be necessary to demonstrate:
  - the discharge characteristics are constant and predictable
  - the material is durable
  - the machined hole is to retain a sharp edge
  - the plate is to be permanently fixed to the pit wall with no gaps between the plate and the wall.

High early discharge (HED) is important in minimising the storage volume required. In order that HED can be assumed:

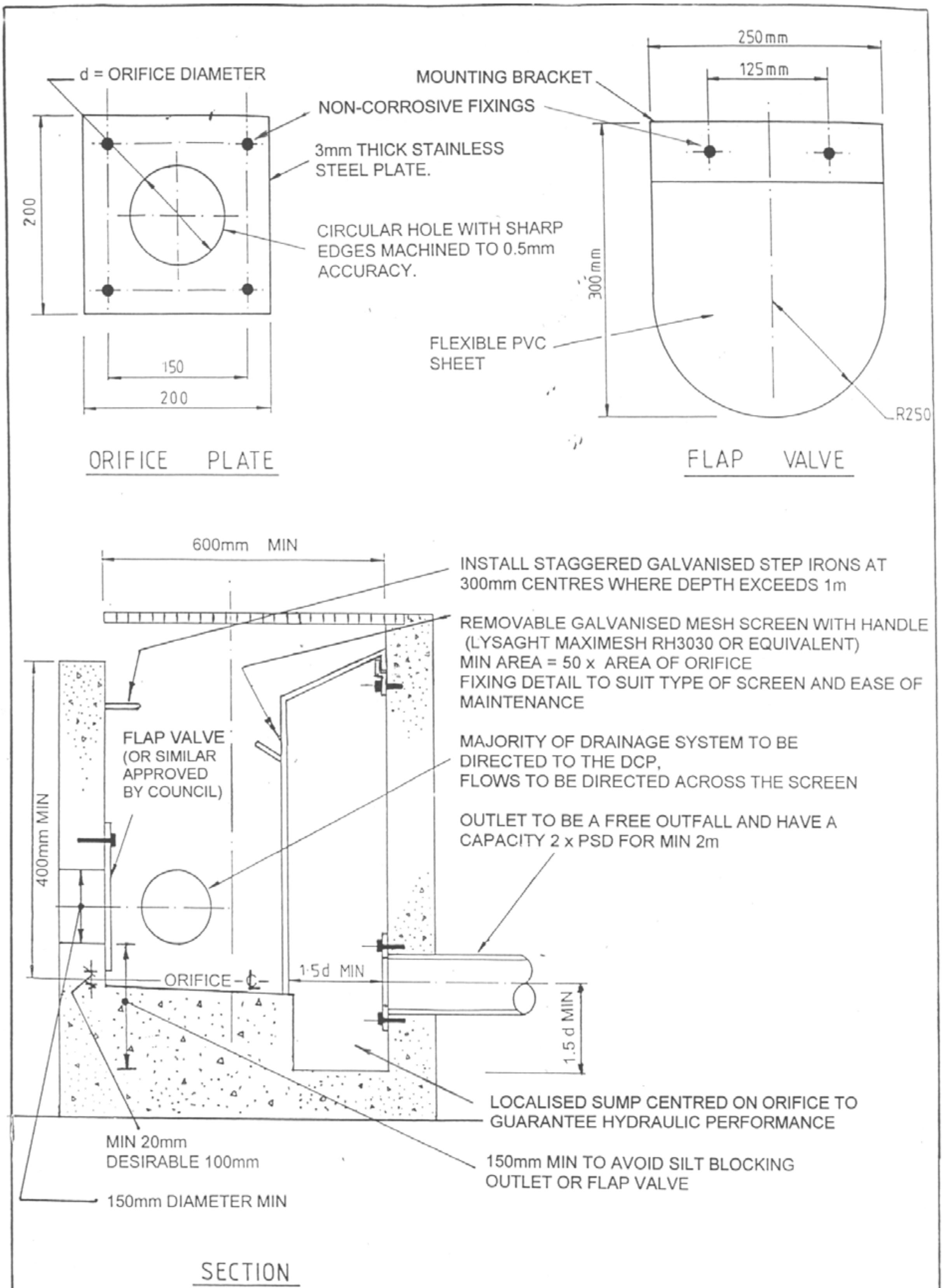
- the discharge to the storage is to commence at a minimum of 75% of the PSD;
- the overflow structure from the DCP to the storage (weir, pipe, grate etc.) must be able to convey the maximum 100 year flow to the DCP less the initial HED through the orifice and sufficient calculations are to be provided to demonstrate this;[i]
- the majority of the site drainage system is to be connected to the DCP; and
- the volume of the DCP is to be small in comparison to the volume of the storage.

The Discharge Control Pit will need to be maintained regularly. To assist with inspecting and cleaning, the minimum internal dimensions of the DCP should be[ii]:

- 600x600 mm for up to 600 mm deep
- 900x900 mm for greater than 600 mm deep

For sites with multiple owners/tenants the DCP, and as much of the storage as possible, should be contained in the common areas rather than on private lots. This means that inspections and maintenance are simpler and remain the responsibility of the joint owners rather than an individual.[iii]

[i] Calculations for weir flow spelled out in third edition
[ii] Pit dimensions altered for third edition.
[iii] Use of common areas added in third edition.



TYPICAL DISCHARGE CONTROL PIT

DCP DESIGN MAY NEED TO BE ADJUSTED FOR VERY FLAT SITES CONSULT COUNCIL ENGINEER

FIGURE 4·3

4.2.4 Free discharge from a DCP

The orifice discharge equation is:

$$Q=CA\,(2gh)^{1/2}$$

where Q is the discharge in m^3/sec

C is the coefficient of discharge

A is the orifice area in m^2

g is the acceleration due to gravity

h is the depth of water above the centre of the orifice in metres.

This equation relies on:

- a circular sharp-edged orifice and
- free discharge from the orifice.

To ensure that free discharge is maintained the outlet needs to be well ventilated and the outlet pipe needs to be large enough to prevent submergence. As a guide, designers should try to ensure that the outlet from the DCP has a just-full capacity of twice the PSD. The orifice should be centred in the outlet pipe to avoid edge effects.[i] Free discharge is not achieved when the outlet from the DCP is affected by tailwater levels in the downstream drainage system. See Section 6.5.

4.2.5 Screens

DCPs must be fitted with an internal screen. The screen needs to:

- protect the orifice from blockage
- create static conditions around the orifice which helps to achieve predictable discharge co-efficients
- retain litter and debris which would degrade downstream waterways.

<u>Screen type</u>

A small aperture-expanded steel mesh, such as Maximesh Rh3030, is recommended for orifices less than 150 mm in diameter. This type of screen retains relatively fine material (eg. cigarette butts and grass clippings) while maintaining the performance of the orifice under heavy debris loading. For orifices larger than 150 mm, the screen area necessary for a fine mesh screen can make it difficult to fit in a DCP.

A grid mesh, such as Weldlok A40/203,[ii] may be used for these larger orifices. Where the grid mesh is used, a fine mesh screen should be installed upstream of the DCP, for areas likely to collect litter or debris.

[i] Design hint added in third edition.
[ii] Code number of mesh updated in third edition

Screen area

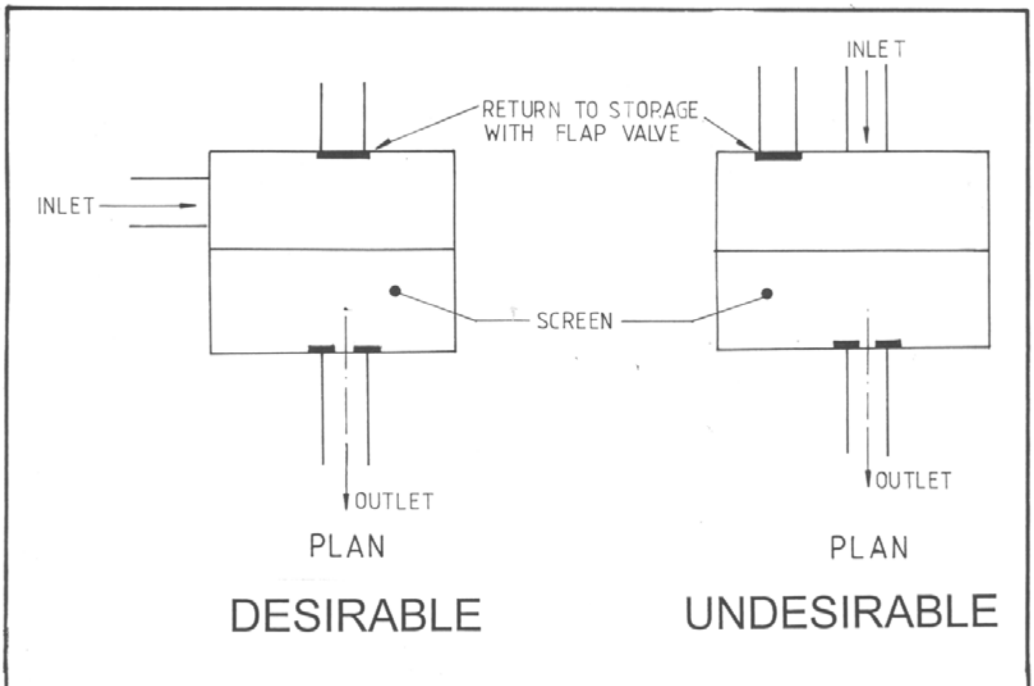
The minimum recommended area (including blocked area) for an internal screen in a DCP is:

- 50 times the orifice area where a fine mesh screen is used (eg. Maximesh Rh3030)
- 20 times the orifice area where a grid mesh is used (eg. Weldlok A40/203).

Screen orientation

The inlet pipe to a DCP should direct inflows parallel (or at a small angle) to the screen. Perpendicular inflows drive debris into a mesh screen making it difficult to dislodge. When inflows are directed parallel to the screen, the debris is layered on the screen but is blown off when the inflow exceeds approximately 2-3 times the PSD. This arrangement is illustrated in Figure 4.4. The performance of the orifice and screen is influenced by the orientation of the screen.

To assist in shedding debris, the screen should be positioned as close to vertical as possible. This allows debris to fall off once the water level in the DCP drops. However, the screen must fit securely to the pit to avoid debris floating over or around the screen and blocking the orifice.[iii] The screen should be placed no less than 60 degrees to the horizontal.



ORIENTATION OF DCP INLETS FIGURE 4·4

[iii] Design hint added in third edition.

General

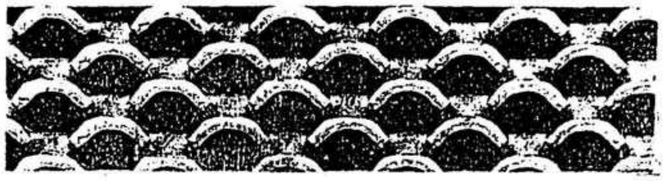
To prevent blockages, Maximesh screens must be positioned so that the long axis of the oval shaped holes is horizontal, the protruding lip is uppermost and above the hole and the screen is tilted downstream. (See Figure 4.5)[i]. Blockages can occur if the screen is accidentally placed upside down. Fitting a handle to the screen not only reduces the chance of incorrect placement but also makes removal for cleaning easier. Fixings need to be selected to suit the screen and to promote easy removal for maintenance.

Reducing the screen size also facilitates cleaning by reducing the weight. Proprietary screens may be considered to achieve this end. A list of current suppliers of screens (and other OSD products) is given in Appendix E.

After being cut to size, Maximesh screens need to be 'hot dipped' galvanised to prevent corrosion.

All mesh screens deflect under high inflows and heavy debris loading and should be braced to stop debris being carried around the screen.

MAXI-MESH
RH3030



Viewed from upstream

FIGURE 4.5

4.2.6 Storages[ii]

The selection of the most appropriate type of storage for the site is critical to the quality, effectiveness and cost of the OSD design. Every attempt should be made to provide the majority of the volume as surface storage rather than below ground. Not only will this be generally cheaper to construct (savings of \$100-150/m^3 for storages between 20m^3 and 100m^3 were identified by a survey commissioned by the Trust and the NSW Department of Housing in 1996)[iii], but greater flexibility is usually achieved in siting the storage. Also, maintenance is simpler and generally safer. Designers should be aware, however, of the increased risk of subsequent alteration to the storage by future occupants and should try to provide a finished landscaping product which needs no further improvement. It may be necessary to provide primary storage below ground to reduce the chance of ponded water causing problems for occupiers of the site. However, innovative design can reduce the volume of below ground storage required.

[i] Clarification and Fig 4.5 added in third edition.
[ii] Additional comments added in third edition.
[iii] *On-Site Stormwater Detention System Cost Survey* dated January 1997 prepared by Bewsher Consulting Pty Ltd. (See Appendix H for further details).

Designers should also seek to provide larger common storages in multi-owner developments or subdivisions. This removes the need for a large number of smaller storages which will have increased design, construction and maintenance costs. Particular problems have been experienced in multi-lot subdivisions where OSD storages on individual lots have proved to be considerably more costly to install than a single OSD storage would have been. Care should also be taken with the use of private courtyards (considered to be yards less than 60 m^2 in area) for storage for safety reasons. OSD storage in these courtyards will not be permitted if the area is less than 25m^2 and Council's specific approval will be required for courtyards whose area is

between 25 and 60m^2. Recommendations for allowable depths and the frequency of ponding are given in Table 6.1.[iv]

OSD storages for subdivisions must be constructed prior to the release of the Linen Plan rather than deferred until the construction of the dwelling because of the problems faced by owners in deferred construction.[v] The only exception to this requirement is the case of a subdivision of up to 7 lots where there are demonstrable site restrictions. Deferral still requires the written approval of Council.[vi] The construction of a single storage provides more flexibility in the design and siting of houses on the individual lots.

The walls of each storage must be entirely within the property so as to avoid possible disputes with adjoining land holders if the common boundary fence was used as part of the storage.[vii]

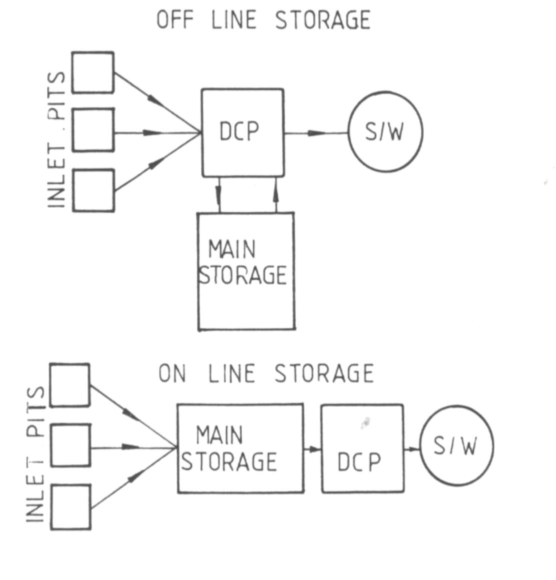
Off-line – On-line storages

The relative location of the DCP and the storage is an important design consideration. As shown in Figure 4.6, an OSD system with the storage and the DCP in series is defined as an on-line system. In this case, the discharge from the DCP is dependant on the characteristics of both the DCP and the storage. The design processes outlined in section 5 of this Handbook are generally not applicable for on-line storages. On-line systems will need to be designed using a calibrated hydrologic/hydraulic model.

There are some specialised discharge control devices, such as float controlled discharge regulators that have different discharge characteristics. These may be used on-line and still achieve HED and discharge rates independent of the shape of the storage. The characteristics of these devices should be checked with the manufacturer and verified with the Trust prior to preparation of a detailed design.

Where the majority of the stormwater passes directly to the DCP, and the storage fills by spillage from the top of the DCP, the OSD system is defined as off-line (See Figure 4.6). Here the DCP discharge and the storage volume is independent of each other. On-line storage systems require more storage volume than off-line storages. In the upper Parramatta River catchment, the difference can be in the range of 10-20%.

[iv] Design requirement added in third edition.
[v] Design requirement added in third edition.
[vi] Deferral of OSD clarified for small subdivisions in third edition
[vii] Boundary issue added to third edition



ON LINE & OFF LINE OSD SYSTEMS
FIGURE 4·6

4.2.7 Surface storage systems

There are few absolute requirements when designing a surface storage. These guidelines have been framed to allow the designer maximum flexibility when integrating the storage in the site layout. A discussion of the general principles of storage design is included in Section 6. However the desirable minimum design parameters for surface storage systems are set out below.

<u>General</u>

The floor levels of buildings adjacent to surface storage areas should have a suitable freeboard to avoid the risk of water entering the building in storms more severe than the design storm or in the event of system blockage. The free board is to be calculated from the top water level including the depth of flow over the overflow weir. (See Section 4.2.9).[viii] The required freeboard is:

- 200 mm for habitable buildings
- 100 mm for garages.

A similar freeboard should be provided for flowpaths adjacent to buildings.

The walls creating each storage must be entirely within the property so as to avoid possible disputes with adjoining land holders if the common boundary fence was used as part of the storage.[ix]

[viii] Freeboard requirement clarified in third edition
[ix] Boundary issue added to third edition

Landscaped storages

- The desirable minimum surface slope is 1.5% for the base.
  The absolute minimum surface slope is 1.0% for the base.

- Side slopes should be a maximum of 1V to 6H where possible. (See also Section 3.5.5)

- Sub-soil drainage should be provided around the outlet to prevent the ground becoming saturated during prolonged wet weather.

- Where the above ground storage is located in the same area as the children's play equipment, pool type fencing, including a child proof gate, must be provided to ensure that young children can only enter the area under supervision. Water levels can rise quickly in the basin and pictorial signage such as that shown in Appendix C must be installed to reinforce to need to leave the area when it rains.[i]

- Where the storage is located in an area where frequent ponding could create maintenance problems or personal inconvenience to property owners, the first 10%-20% of the storage should be provided in an area able to tolerate frequent inundation such as:

  - a paved outdoor entertainment area

  - a small underground tank

  - a permanent water feature

  - a rockery or rock garden.

- If using private courtyards for OSD storage, the area of courtyard must be between 25 and 60m^2 and specific Council approval must be obtained. In this Handbook, private courtyards are considered to have an area of 60 m^2 or less. Areas greater than that are treated as gardens. The storage should generally not commence ponding more frequently than once every 5 years. Provision should also be made for the future installation of garden sheds and the like by leaving an area of the courtyard above the storage depth.[ii] Refer to Table 6.1 for depths and frequency of ponding.
- The maximum depth of storage should be limited to 600 mm unless otherwise approved by Council and the area must be designed to allow safe egress as the storage fills with water[iii].

- The structural adequacy of retaining walls must be checked, including the hydrostatic loads caused by a full storage.
- Free standing timber log retaining walls should not be used to create a storage, but timber can be satisfactory as part of an earth retaining wall which prevents any significant leakage.

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[i] Fencing of OSD storage in playgrounds added in third edition
[ii] Design requirement added for third edition.
[iii] Maximum ponding depth added in third edition.

Driveway and car-park storages

- To avoid damage to vehicles, depths of ponding on driveways and car-parks should not exceed 200 mm under design conditions.
- Transverse paving slopes within storages areas should not be less than 0.7%.
- Where the storage is to be provided in a commonly used area where ponding will cause inconvenience (eg. a car-park), the area should only flood once every year, on average. This will require approximately the first 15% of the storage to be provided in a non-sensitive area.

4.2.8 Structural/underground storages

The use of underground storages for total storage volumes should be avoided where at all possible[i]. However, locating a small proportion of the required storage underground can often enhance a development by limiting the frequency of inundation of an open storage area. In very difficult topography, the only feasible solution may be to provide all or most of the storage volume underground. However the designer should recognise that underground storages:

- are more expensive to construct than surface storage systems
- are difficult to inspect for silt and debris accumulation
- are difficult to maintain
- can be dangerous to work in and may be unsafe for property owners to maintain.

The optimal solution will generally be a system where the property owner is able to carry out the routine maintenance. Where the structure cannot be maintained by the property owner or occupier, this must be clearly identified in the maintenance schedule. When preparing a design for underground storage, designers should be aware of the provisions of AS 2865-1995 *Safe Working in a Confined Space.* Where practicable, the design should eliminate the need to enter the confined space for maintenance or other purposes[ii]. A sign indicating that the storage is a confined space and that entry should be restricted to trained personnel should be fixed to each opening into the underground storage. A typical sign is included in Appendix C.

The walls of each storage must be entirely within the property so as to avoid possible disputes with adjoining land holders if the tank or underground storage encroaches onto their land.[iii]

[i] Design requirement added for third edition.
[ii] Design hint added for third edition.
[iii] Boundary issue added to third edition

Important design considerations

- Residents/owners must be able to inspect critical parts of the storage from the surface without having to remove heavy access covers. Concrete covers are to be avoided for this reason[i].

- Openings must be wide enough to allow easy entry to a storage[ii], ie:
  - 600 x 600 (storages up to 600 mm deep)
  - 900 x 900 (storages greater than 600 mm deep)

- A continuous fall on the floor of the storage of at least 1% must be provided to the storage outlet to minimise ponding in the storage.

- The minimum clearance height for accessible tanks is 900 mm[iii]. Where this cannot be achieved due to level or other constraints, the following internal heights can be considered:
  - Commercial/Industrial developments 750 mm
  - Residential developments 500 mm.

  provided that :
  - All grates accessing the tank shall be a minimum of 900 mm x 900 mm, and a maximum lifting weight of 20kg;
  - Grates to be placed at the extremities of the tank with a maximum distance of 3m from any point in the tank to the edge of the nearest grate. This should allow any point in the tank to be reached with a broom or similar implement without the need to enter the tank;[iv]
  - The base of the tank is shaped with a 2% crossfall to a V drain and with a 2% longitudinal slope along the V drain;
  - Tanks less than 750 mm high must be precast to avoid difficulties with removing formwork.

- To minimise the risk of silt and debris blocking the storage outlet or flap valve, the floor of the DCP should be a minimum of 150 mm below the return pipe to the storage, and the return pipe to the storage should be at least 150 mm in diameter.

- Where all the storage is provided in an underground structure, a large storm could be stored even with a totally blocked outlet. The storage should be designed to overflow and pond in a very visible part of the property so that the ponding will be noticed and the outlet blockage cleared before another storm event.

- All surface inlet drains upstream of the DCP and the storage must be designed so that there is no overflow before the storage is full.

- The build-up of noxious odour in storages without a grated access can create problems. If the storage is sealed, vents should be provided.

- In addition to checking that the storage is structurally adequate for the normal earth, traffic and hydrostatic loads generated by a full storage, the structure should be checked for flotation. Depending on the surrounding soil conditions, the soil around the tank can become saturated during a storm. The underground tank will empty soon after the storm is finished, while the soil will remain saturated for much longer. Sub-soil drainage, weep-holes and wall drainage may be needed to equalise hydrostatic pressures.

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[i] Design hint added for third edition.
[ii] Pit dimensions changed for third edition.
[iii] Design requirements added in third edition.
[iv] Cleaning requirement clarified in third edition

4.2.9 Rainwater Tanks[v]

In the past the four local councils and the Trust have always refused to allow rainwater tanks to be considered as part of an OSD facility because of the probability that the tank would be full at the start of a major rainfall event. In recent years it has been argued, however, that a rainwater tank will not always be full at the start of a storm if its water is used inside and outside the dwelling for non-potable purposes - toilet flushing, hot water, garden watering.

To resolve this matter, the Trust engaged Peter Coombes and Associate Professor George Kuczera of the University of Newcastle to carry out a study to find what proportion of the volume of a rainwater tank can be counted as part of the site's OSD volume – assuming its water was used both inside and outside the dwelling. A 1000-year rainfall record was generated based on a 53-year pluviograph record at West Ryde. This was applied to water-use models of different types of residences - a single dwelling, a duplex, a town house and an apartment building. The results of repeated simulations with different typical sizes of rainwater tanks (5, 10 and 15 m^3) showed that the average percentage of rainwater tank volume that can be counted as part of the site's OSD volume ranges from 32% to 50% if the tank has no air space, and 51% to 72% if there is 50% air space. The full set of percentages is set out in the table below.

These results should be considered as an interim answer. The study only looked at individual sites and it will be necessary to also investigate the cumulative impact on peak discharges from groups of dwellings with rainwater tanks. (This is the subject of a separate study for the Trust being undertaken by Dr Allan Goyen of Cardno Willing. The results of that study will be available at the next revision of this Handbook.) The West Ryde 100-year rainfall intensities are significantly higher than corresponding intensities in the middle of the upper Parramatta River catchment, so the study results may understate the effectiveness of rainwater tanks for OSD. It should also be noted that, in this catchment at least, with rainwater tanks typically 5 or 10 m^3 in capacity, the volume allowed (1.5 m^3 to 7 m^3) would be quite small relative to the total OSD volume required on most developments.

The specified percentages of a rainwater tank's volume shown in the table below can be counted as part of a site's OSD storage (the Site Storage Requirement) provided that:

- the development is residential, or its water usage can be considered to approximate that of a residence;
- the rainwater tank volume is between 5 and 15 m^3 (or 20 m^3 for apartment blocks);
- the rainwater tank is plumbed into the household water supply system so that its water is automatically used for non-potable purposes;
- the design is in accordance with Section 3.5 of the study report by Coombes et al and AS/NZS 3500.1.2: *Water Supply – Acceptable Solutions* (provides guidance for the design of rainwater tanks with dual water supply (rainwater and mains water)); and
- all overflows from the rainwater tanks are directed into the OSD discharge control pit.

The average percentage of rainwater tank volume that can be counted as OSD site storage is in the table below for each allotment scenario.

	Volume of rainwater tank counting as OSD storage (%)	
Scenario	**No airspace in tank**	**50% airspace in tank**
Allotment	42	65
Duplex	50	72
Townhouses	40	53
Walk up apartments	32	51

The report by Coombes et al can be viewed and downloaded from the Trust's web site at:

http:/www.uprct.nsw.gov.au/sustainable_water/publications/list.htm

[v] New section 4.2.9 added in third edition

4.2.10 Overflow[i]

Provision needs to be made in the design of a storage for storms more severe than the design storm or for blockages in the system. With most storages, it is relatively easy to provide a weir capable of passing the entire discharge from a very large storm event with only a few centimetres depth of water over the weir.

The following design method should be used to check the adequacy of overflow structures, such as weirs or spillways, and freeboards to finished floor levels. Overflow and weir flow calculations must be included in the detailed design information submitted to the consent authority.

- Assume the outlet is blocked and the storage full.
- Calculate the approximate maximum 100 year ARI event discharge to the storage (a Rational Method approximation will be adequate).
- Calculate the maximum depth over the spillway/weir assuming the entire 100 year ARI event discharge passes over the spillway/weir.
- Check the floor levels of any buildings upstream of the storage to ensure that these buildings are not inundated. (Refer 4.2.7 for suitable freeboards)
- Overflows should be directed to a flowpath through the development so that buildings are not inundated nor are flows concentrated on an adjoining property.

4.2.11 Maintenance schedule[ii]

As part of the detailed design submission, a maintenance schedule is to be prepared. The maintenance schedule is a simple set of operating instructions for future property owners and occupiers. It should be clearly and simply set out and should be accompanied by a simplified plan showing the layout of the OSD system. (See sample plan in Figure B2.2) The designer's consent to release of this plan to subsequent owners/occupiers should be provided to facilitate long term maintenance of the facility.[iii]

<u>What must be done?</u>

The maintenance schedule needs to set out simply and clearly the routine maintenance necessary to keep the OSD system working. Some of the issues that will need to be addressed are:

- where the storages are located
- which parts of the system need to be accessed for cleaning and how access is obtained
- a description of any equipment needed (such as keys and lifting devices) and where they can be obtained
- the location of screens and how they can be removed for cleaning.

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[i] Section renumbered in third edition
[ii] Section renumbered in third edition
[iii] Plan and release requirements added in third edition

Who should do the maintenance?

The majority of OSD systems, particularly those where a large proportion of the storage is located above ground, will be able to be maintained by property owners, residents or handymen. Larger underground systems, particularly those with limited access and/or substantial depth, may require the owner to engage commercial cleaning companies with specialised equipment.

How often should it be done?

The owner should be provided with advice on how frequently the system needs to be inspected and approximately how often it will require cleaning. The frequencies of both inspections and maintenance will be highly dependant on the nature of the development, location of the storage and the occurrence of major storms. Suggested frequencies are:

- Residential
  - -inspect system every six months and after heavy rainfall
  - -clean system as required, generally at least once a year.
- Commercial/Industrial
  - -inspect system every three months and after heavy rainfall.
  - -clean system as required, generally at least once every six months.

4.3 Construction/final approval

The last stage in the approval process involves making sure that the system has been built correctly and that appropriate legal protection is in place to ensure long-term performance of the system. The design effort involved in preparing a concept plan or a detailed design submission is wasted unless the OSD system is built correctly and maintained. The constructed system should conform exactly to the approved design plans and particular attention is required to ensure that all critical levels are achieved.[iv] Figure 4.7 summarises the procedure for supervising and constructing and certifying an OSD system.

4.3.1 Objectives

The objectives of the construction supervision and certification arrangements are to:

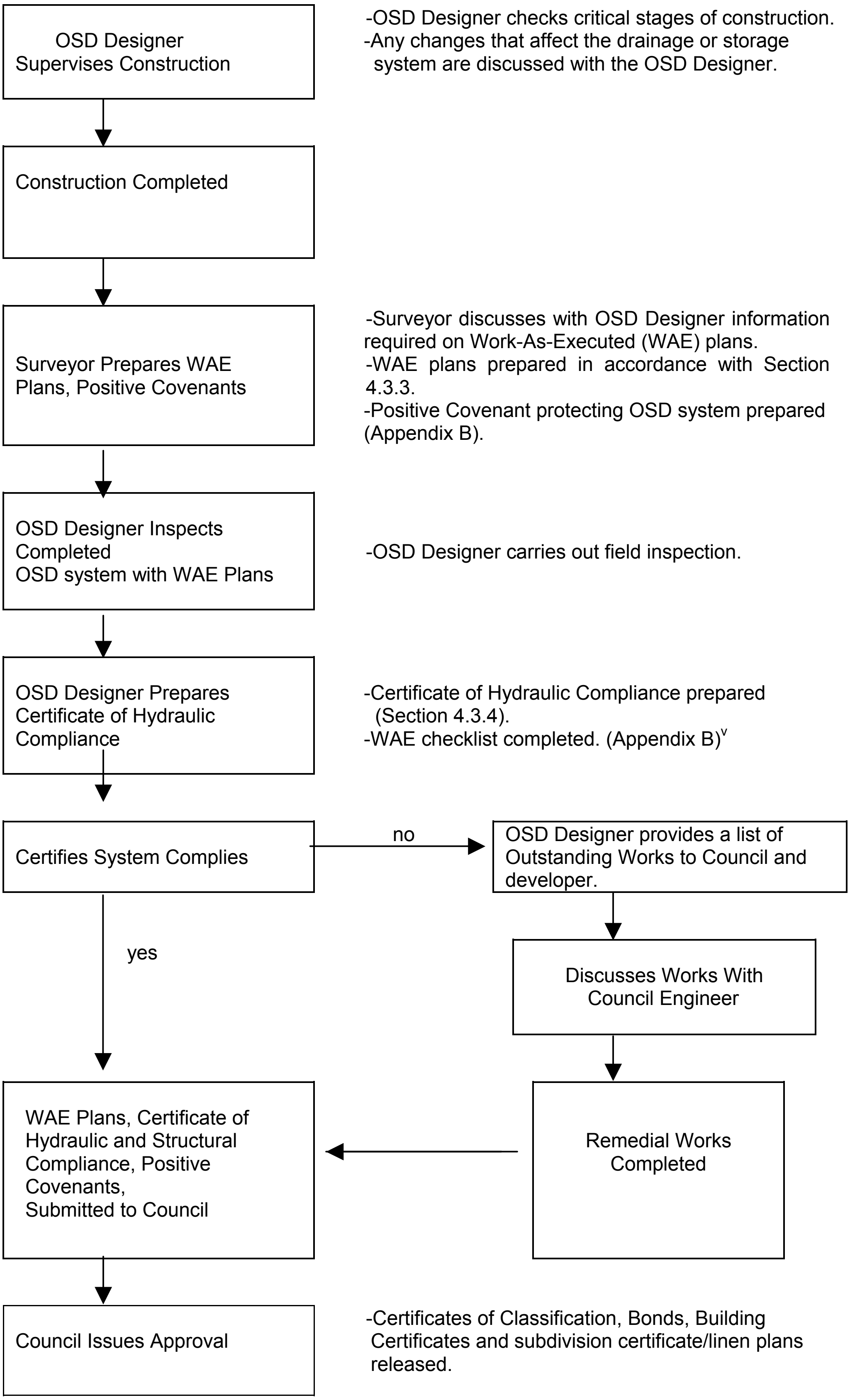
- encourage supervision of critical stages of construction by the OSD designer to improve construction standards,
- minimise delays and additional expenditure on rectification works by ensuring adequate construction supervision,
- increase community acceptance of OSD by eliminating nuisances created by poor construction, and
- enable local Councils to inspect and insist on essential maintenance of the system.

[iv] Design requirement added in third edition.

4.3.2 Construction supervision

Construction supervision is essential in achieving a properly working OSD system. OSD construction is often multi-disciplined with many tradesmen (such as bricklayers, landscapers and concrete finishers,) who may be unfamiliar with stormwater drainage, being responsible for constructing critical features of the system. OSD systems require closer attention to set-out and levels than a conventional drainage system. Without adequate supervision during construction (preferably by the designer or someone very familiar with the design intent), expensive and time consuming rectification works are often necessary before a Certificate of Hydraulic Compliance can be issued by the OSD designer.

Figure 4.7 Construction, certification and final approval



[v] Checklist added in third edition.

4.3.3 Work-as-Executed Plans

Work-as-Executed (WAE) plans prepared by a Registered Surveyor or the OSD designer must be submitted. A general set of guidelines for preparation of WAE plans is provided below. However in some projects there will be site-specific features which will require additional details. The OSD designer should therefore be consulted before preparing these plans. It is important that the WAE plans provide the OSD designer with sufficient information to certify that the as-constructed system will function in accordance with the approved design. Note that any changes to the top water level in the storage or depth of storage may alter the required orifice diameter. Calculations should be submitted to show that the orifice diameter is correct if the approved design water level has been changed.[vi]

<u>Discharge Control Pit</u>

The following information on the discharge control pit (DCP) should be included:

- internal pit dimensions
- the diameter of the orifice plate and verification that it has been fitted correctly
- verification that a screen has been fitted, as well as its location, dimensions and the minimum distance from the orifice
- verification that an appropriate flap valve has been fitted (if specified)
- levels on the top and invert of the pit
- internal diameter of the outlet pipe.

<u>Storage</u>

The following details of the OSD storage should be provided:

- type of storage - roof, above ground, below ground, rainwater tank[vii] or combination
- detailed calculations of the actual volume achieved for each storage
- level and location of any overflow structures (eg. spillways, weirs)
- sufficient levels and dimensions to verify storage volumes – as a minimum, WAE plans should give the constructed level of all design levels shown on approved plans.[viii]
- any changes to storage depth or top water level and whether the orifice size is affected.[ix]
- Where rainwater tanks have been installed as part of the OSD storage, the volume of the tank and the % used for OSD with certification that the tank is plumbed in for non-potable internal and external uses.[x]

[vi] Design requirement added in third edition.
[vii] Rainwater tank added in third edition
[viii] Design requirement added in third edition.
[ix] Design requirement added in third edition.
[x] Certification of rainwater tank characteristics added in third edition

Internal drainage

The following information on the internal drainage system is to be included:

- pit surface levels
- invert levels and diameters of pipes
- location and levels of any floodways and/or overland flowpaths
- sufficient spot levels to show site gradings and extent of areas not draining to the storage(s).

Freeboards

The finished floor levels of adjacent structures on the property, such as garages and dwellings, are to be shown to ensure they are sufficiently above the maximum storage water surface levels and overland flowpaths. As stated in Section 4.2.7, a freeboard of 200 mm should be provided for habitable dwellings and a freeboard 100 mm for garages. The top water level should take into account the depth of water over the overflow weir. (Section 4.2.9).[xi]

4.3.4 Certificates of Hydraulic Compliance

Certificates of Hydraulic Compliance are required by all councils within the catchment to confirm that the drainage and On-site Stormwater Detention (OSD) works have been carried out in accordance with the approved design. From 1 May 1999,[xii] design and certification will only be accepted from persons having acceptable professional accreditation. The following are considered to be acceptable accreditation for the purpose of OSD design and certification:

- NPER in Civil Engineering (Institution of Engineers, Australia);
- Surveyors Certificate of Accreditation in On Site Detention and Drainage Design (Institution of Surveyors NSW and the Association of Consulting Surveyors NSW);
- Accreditation as a certifier under the Environmental Planning and Assessment Act 1979 in the relevant discipline; and
- Stormwater Register (Association of Hydraulic Services Consultants Australia)

To avoid delays in obtaining certification, developers and builders are encouraged to have the OSD designer supervise the construction of these systems. Defects are expensive to repair once the development is completed.

Certificates of Hydraulic Compliance are to be attached to the Work-As-Executed plans and submitted to council prior to the release of linen plans, certificates of occupation and/or final approval. A separate structural certification will be required for any structural elements. The Certificate of Hydraulic Compliance needs to:

- state that the system will function and can be maintained[xiii] in accordance with the approved designs, subject to satisfactory maintenance;
- state what percentage of any rainwater tank contributes to the OSD storage and document that tank has been plumbed for non-potable uses inside and outside[xiv].
- identify any variations from the approved design, and state that these variations will not impair the performance of the OSD system.

[xi] Weir calculations clarified in third edition
[xii] Accreditation requirements added in third edition.
[xiii] Maintainability added in third edition
[xiv] Certification of rainwater tank characteristics added in third edition

Alternatively, where variations are identified that impair the performance of the OSD system, the OSD designer will need to complete an Outstanding Works form. This form lists the variations from the approved design and the required remedial works. Where significant remedial works are necessary, discussions should be held with the relevant council officers and arrangements made to have these works carried out prior to the issue of a Certificate of Hydraulic Compliance by the OSD designer or final approval by council.

The Certificate of Hydraulic Compliance is the principal means by which adequate construction standards are ensured and certification needs to be conducted in a professional manner. Whilst the Certificate will be based on the work-as-executed plans, the OSD designer will need to inspect the site to check critical design features.

Some of the important considerations to be addressed when certifying hydraulic compliance are that for:

<u>Discharge Control Pits</u>:

- a plate with a sharp-edged orifice of the correct diameter and the specified material has been securely fitted;
- the discharge control pit (DCP) dimensions satisfy minimum parameters, eg. width, design head, and clearance from screen;
- the orifice is screened and the screen is properly fixed, located and able to be removed for cleaning;
- outlet pipes from the DCP are the correct size, level and grade to ensure there is free discharge through the orifice;
- the levels of the top water surface, storage invert and DCP are such that the design discharge from the storage is achieved;
- where the design assumes 'high early discharge', runoff from sufficient areas of the site is directed to the DCP to ensure that the design PSD is achieved soon after the commencement of heavy rainfall; and
- the flap valve, if specified, is fitted correctly.

<u>Storage</u>:

- actual storage volumes achieved are adequate;
- the actual top water surface level of the storage will not cause either unintended surcharge of the internal drainage system or inundation of/or inadequate freeboards to finished floor levels; nor will it alter the storage depth sufficiently to impact on the required orifice size;
- the base of the storage is well graded and drains to the DCP; and
- spillways and overflow paths are the correct level and free from obstructions.

Internal drainage

- site gradings are correct;
- the internal drainage lines are of a sufficient size, level and grade to convey flows to the storage;
- if a blockage occurs or the internal drainage lines cannot convey all runoff in a 100 year rainfall event, the site is graded to direct surcharging flows to the storages;
- storages cannot be by-passed by overflows from the internal drainage system or by overflows from any surface area designed to drain to the storages;
- flowpaths designed to divert upstream flows around the basin have been properly constructed and will function as designed; and
- general workmanship is adequate to prevent long-term failure of the system.

Freeboards

- the levels of structures (such as garages, factories, offices and dwellings) are sufficiently above the as-constructed maximum water surface levels in the storage (including the calculated depth of any weir overflow) and flowpaths; and
- an emergency spillway or overflow path is provided to ensure that surcharge of the drainage system and storage (even in the event of an extreme storm or accidental blockage of pits, pipes etc.) will not cause stormwater to enter buildings where significant damage would occur.

Standard Certificate of Hydraulic Compliance Forms and Outstanding Works forms are included in Appendix B.

4.3.5 Structural certification

Due to loadings, certain OSD storage components may require specific structural certification for design and construction. The following list is typical but not exhaustive. This certification should be provided by a qualified, practising structural engineer, except where the components match the standard designs provided in Appendix E.[xv]

Free standing walls

These are subject to hydrostatic loads when a storage is full or filling. The significance will depend on the maximum ponding depth.

Retaining walls

In addition to the normal earth and hydrostatic loadings, it may be necessary to consider the possibility of saturated sub-soil conditions.

Underground storages

These may be subject to a combination of earth pressures, hydrostatic loadings, traffic loadings and buoyancy forces.

[xv] Certification requirement clarified in third edition.

4.3.6 Legal protection of OSD systems[xvi]

OSD systems are structures intended to control site discharges over the entire life of the development. To guarantee the system's continued operation, it needs to be protected from alteration and regularly maintained.

Prior to the issue of final approval (eg. Building Certificate under Section 149 of the Environmental Planning and Assessment Act 1979 and/or the release of any subdivision certificate/linen plan) the OSD system and associated floodways and flowpaths need to be legally protected. This is achieved by applying a restriction on the use of the land and a positive covenant over the lot in favour of the local council. These can be imposed either by submitting a suitable Request Form to the Land Titles Office or in conjunction with the registration of a plan showing the new lots to be created. An explanation of the process involved, sample instruments, standard terms and conditions, a copy of the Land Titles Office Information Bulletin 14 and sample forms 13PC and 13RPA, are included in Appendix B, and as listed below.

B.2 Explanatory notes on the preparation and registration of Positive Covenants and Restrictions on Use of Land.

B.3. Forms for use under Section 88E(3) of the Conveyancing Act where there is no subdivision of land involved and the covenant and restriction on use are being imposed on an existing parcel of land.

B.4 Terms and conditions for Restriction on Use of Land and Positive Covenant.

B.5 Sample Restriction on Use of Land and Covenant where a deposited plan is being registered together with a Section 88B instrument.

B.6 A copy of Information Bulletin No 14 (dated September 1998), prepared by the Land Titles Office, *A Guide to the Preparation of a Section 88B Instrument to:*

- *Create Easements, Profits à Prendre, Restrictions on the Use of Land or Positive Covenants*
- *Release Easements or Profits à Prendre*

B.7 Sample Covenant used where a deposited plan is being registered together with a Section 88B instrument and construction of the OSD system is being deferred. **Note**: Council will only permit deferral of the construction of the OSD systems in exceptional circumstances. (See Section 4.0)[xvii]

[xvi] Section expanded to include current Land Titles Office information and clarify process.
[xvii] Cross reference added in third edition

5.0 The Design Process

This section explains the calculations which will normally be undertaken to determine the OSD parameters. (Reference should also be made to Section 4.0 for issues which affect the design concept.)

A simplified hydraulic/hydrological design method has been prepared for use within the catchment provided that the OSD system has:

- high early discharge (HED), and
- off-line storage.

Where this is not the case, the discharge will be dependant on the shape of the storage and the design will need to be prepared using a calibrated hydraulic/hydrological model acceptable to the Trust. It will be necessary to discuss the project with the relevant council before preparing a design on this basis.

5.1 The OSD design process

5.1.1 Determination of basic parameters

Assuming the proposed OSD system will have HED and an off-line storage:

- measure the total site area (where exclusions apply refer 4.1.3 & 4.1.5);
- calculate the preliminary storage requirement based on a rate of 470 m^3/ha; and
- determine the preliminary PSD assuming a rate of 80 l/s/ha.

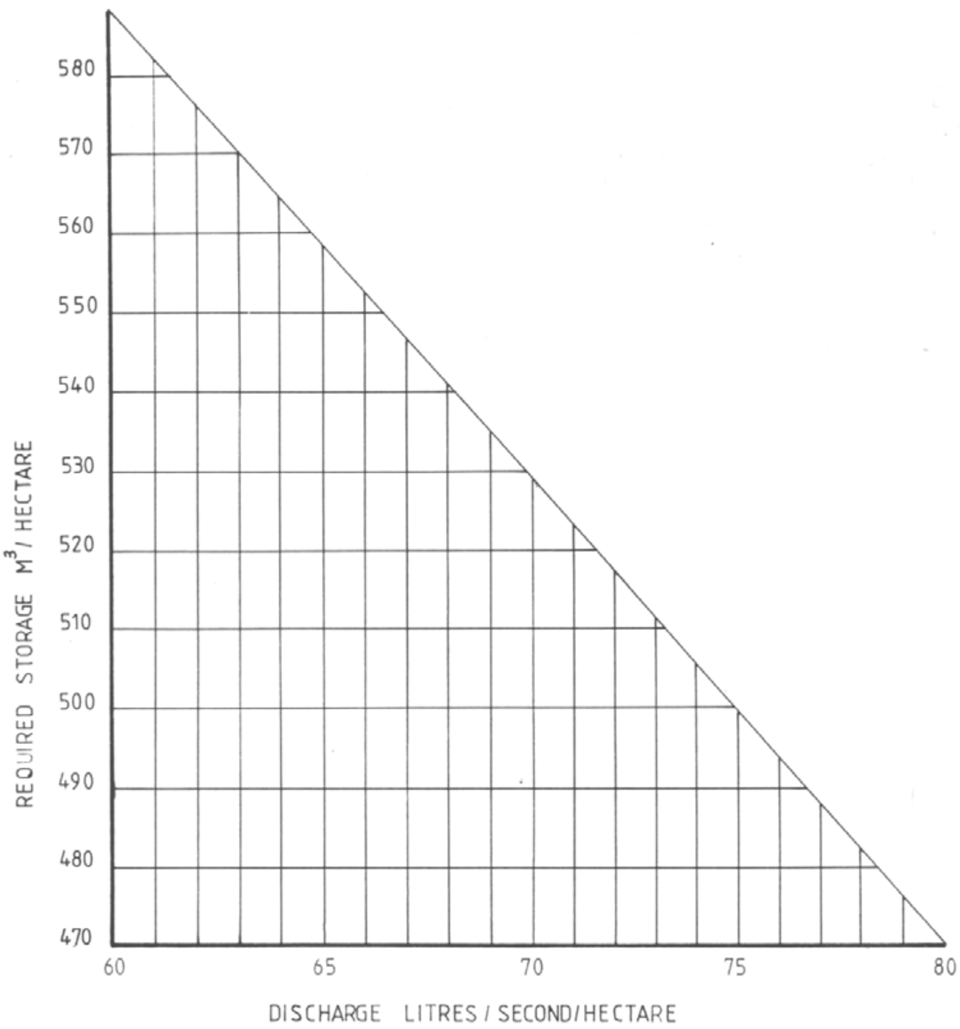
5.1.2 Adjustment for areas unable to drain to storage

In some cases, it will be impractical for runoff from all of the development site to drain to the OSD storage. In these cases the PSD is adjusted as follows:

- measure the area of the site unable to drain to the storages;
- check that this amount does not exceed 15%[i] of the total site area, and
- maintain the basic storage requirement, but adjust the PSD downwards according to the volume/PSD adjustment chart (Figure 5.1). This adjustment ensures the storage is fully utilised during the 100 year ARI event.

Where the area of site unable to be drained is greater than 15%, the rate of site discharge from that area will exceed the PSD of 80 l/slha for the standard design storm. This means that no discharge would be permitted from the remainder of the site. As this is not feasible, designers should discuss the possible options with council to reduce the area not drained through the OSD facility.[ii]

[i] Percentage bypassing OSD reduced to 15% in third edition
[ii] Explanation of reduced bypass area added in third edition



The graph is a straight line approximation of the equation

$$SSR = 74.66 \times PSD^{-0.731}$$

Where: SSR is the Site Storage Requirement in m^3/ha

PSD is the Permissable Site Discharge in m^3/s/ha

UPPER PARRAMATTA RIVER CATCHMENT TRUST

VOLUME / PSD ADJUSTMENT CHART

FIG. 5·1

Adjustment for HED

- HED = PSD x $\sqrt{h^{min}/h^{max}}$

  = 6.35 x $\sqrt{(0.5/0.591)}$
  = 5.84 l/s

  where HED= discharge in l/s when first flow to storage occurs
  PSD= final PSD in l/s
  h^{min} = height above centre of orifice at first flow to storage
  h^{max} = maximum height above centre of orifice

- check this exceeds 75% of the PSD

- mean discharge = (5.84 + 6.35)/2
  = 6.1 l/s

- mean discharge per hectare = 6.1/0.09 = 67.8 l/s/ha

- calculate SSR (read off value from PSD\Volume Adjustment chart using PSD of 67.8 l/s/ha)

  SSR = 540 m^3/ha

- calculate storage volume needed

  Final SSR = 540 x 0.09

  = 48.6 m^3

Distribute Storage to Minimise Nuisance

A paved outdoor seating area is to be provided for storms up to the 1 year frequency to prevent the landscaped storage becoming saturated frequently. The storage volume required to meet this criteria is set out below:

- using (Figure 5.2) the storage frequency selection chart enter the graph at 1 year ARI and read off the percentage of the total storage

  0.16 x 48.6 = 7.8 m^3.

  The architect and property owner have asked that the frequency of ponding on the driveway be specified, 40m^3 of storage has been provided in the landscaped and paved outdoor seating area and 8.2m^3 over the driveway.

- percentage of total storage in the outdoor paved and landscaped area

  40/48.6 = 0.83
  ie. 83%

- enter Figure 5.2 with 83% of total storage and read off frequency as 1 in 45 years. Therefore ponding will occur on the driveway on average once every 45 years.

Note: Area drained to site storage must now be 85% not 75% as shown in this example.[i]

DRAINAGE DESIGN SUMMARY **SUB/DA No.**__________

Project: WORKED EXAMPLE 5.2 Location: __________

Designed by: __________ Company: __________ Phone: __________

SITE AREA 0.1 ha *See Section 4.1.5 for dual occupancy			[A]
Basic storage volume	470 x [A] 0.1	= 47 m³	[B]
Basic discharge	= 0.08 x [A] 0.1	= .008 m³/s	[C]
Area of site drained to storage (Must be as much as possible and not be less than 75% of the total site without written Council approval).		= .09 ha	[D]
[D/ [A] + [0.09]/[0.1] x 100		= 90 %	[E]
Storage per ha. of contributing area = [B]/[D]	47/0.09	= 522	[F]
Enter *volume/PSD adjustment chart* (Fig 5.1} using [F], and Read new PSD in litres/second/ha.		= 70.6 l/s/ha	[G]
Determine PSD =[G] x [D] 70.6 x 0.09		= 6.35 l/s	[H]
Maximum head to orifice centre		= 0.591 m	[K]
Weir flow to storage	$Q^{Weir} = CL(H^{Weir})^{1.5}$ $\therefore H^{Weir}$	= 0.091 m	[I]
Selected orifice diameter: $d = (0.464 \times Q / \sqrt{h})^{0.5} = (0.464 \times [H]/\sqrt{[K]})^{0.5}$		= 0.062 m	[J]
Maximum discharge		= 6.35 l/s	[L]
Head for high early discharge		= 0.50 m	[M]
High early discharge {[L] x √[M] / [K] } (min 75% of [L])		= 5.84 l/s	[N]
Approximate mean discharge = ([L)] + [N]) /2		= 6.1 l/s	[P]
Average discharge/ha = [P] / [D] = 6.1 / 0.09		= 67.8 l/s/ha	[Q]
Enter *volume/P.S.D. adjustment chart* (Fig 5.1) using [Q] And read off final storage volume per hectare		= 540 m³/ha	[R]
Determine final SSR = [R] x [D] = 540 x .09		= 48.6 m³	[S]
Primary storage proportion	= [S] x 16 %	= 7.8 m³	[T]
Secondary storage proportion	= [S] x 67 %	= 32.6 m³	[U]
Tertiary storage proportion	[S] x 17 %	= 8.2 m³	[V]
Check [T] + [U] + [V] = [S]		= 48.6 m³	

SIGNATURE:__________ **DATE:**__________

[i] Area draining changed in revision 2 of third edition

6.0 Technical Discussion

6.1 Frequency Staged Storage

Generally the most challenging task of the OSD designer is locating and distributing the storage (s) in the face of the following competing demands:

- making sure the system costs no more than necessary
- creating storages that are attractive and complementary to the architectural design
- avoiding unnecessary maintenance problems for future property owners
- minimising personal inconvenience for property owners/residents.

These demands can be balanced by providing storage in accordance with the frequency staged storage approach. Under this approach, the depth of inundation and extent of area inundated increase with the storm magnitude so that the greatest inconvenience to owners/occupiers occurs very infrequently. The approach recognises that people are generally prepared to accept flooding which causes inconvenience, but no damage, provided it does not happen too often. Conversely, the less the personal inconvenience, the more frequently the inundation can be tolerated. Where use of private courtyards for storage is unavoidable, safety issues must be addressed and provision should be made to warn occupants and also to maintain a dry area for sheds or similar structures. Private courtyards which are less than 25 m^2 in area are not to be used for OSD storage nor for flood storage on flood prone sites.[i]

Recommendations for depth and frequency for inundation of different classes of storages are given in the Table below. It is emphasised that these are provided for guidance only and should not be considered prescriptive. The maximum depth of ponding for above ground storages should be limited to 600 mm, and appropriate safety precautions should be made.[ii] This should include the provision of warning signs and fencing where depths exceed 600 mm near pedestrian traffic areas.

Table 6.1 SUGGESTED FLOOD FREQUENCIES FOR STORAGE AREAS

STORAGE AREA	SUGGESTED DEPTH	FREQUENCY OF INUNDATION
pedestrian areas	50 mm beginning to pond	once in 100 years once in 20 years
parking & driveways	200 mm 100 mm beginning to pond	once in 100 years once in 20 years once in 10 years
gardens	600 mm 400 mm 200 mm beginning to pond	once in 100 years once in 10 years once in 2 years once a year
Private courtyards[iii] (where the area is between 25 and 60 m^2)	600 mm 300 mm beginning to pond	once in 100 years once in 20 years once in 5 years
Paved recreation in common areas	beginning to pond	6 times per year

[i] Design requirements added in third edition.
[ii] Maximum storage depth specified in third edition.
[iii] Private courtyards added in third edition

6.2 Site drainage techniques

A number of simple techniques can be employed to increase the efficiency of the OSD system, whilst reducing the impact on the site.

- Grade the site for surface drainage so that when the pipe system fails no serious consequences will occur. The surface flows on many sites are so small that there is no need for any underground drainage system, except for the roof drainage.
- Avoid filling the site with pits that are not needed. Pits rarely get any maintenance. As well, increased pit head loss through the drainage system can cause drainage failure due to blockage.
- Direct as much of the site as possible to the storage. A frequent failing of storage systems is that the driveways either discharge directly to the street or a grated drain on the boundary. These drains rarely perform adequately. A better approach is to introduce a speed hump or threshold which will more effectively divert surface flows to a storage or contain flows when the driveway forms part of the storage system. Figure 6.1 shows three profiles suitable for diverting driveway flows to a storage.
- When OSD storage is provided in a garden area, avoid placing the DCP in the centre where it will be an eyesore. Alterations to the grading of the floor of the storage will generally allow the DCP to be located unobtrusively in a corner next to shrubbery or some garden furniture. Allow for future garden sheds in determining the area available or storage.[i]
- Try to retain some informality in garden areas used for storage. Rectangular steep-sided basins unbroken by any features maximise the volume, but detract from the appearance of the landscaping. Steep sided basins also require safety issues to be addressed (See Section 3.5.5)[ii]

6.3 Overflows to a structural storage

Several OSD systems recently examined have had the overflow weir to the structural storage screened to prevent the accumulation of litter and debris in the storage. Screening the overflow weir greatly increases potential for blockage. When the screen becomes blocked, the DCP surcharges and the OSD system fails. Screening the overflow weir is generally impractical because the screen area necessary to maintain the full discharge to over the weir is so large. A better solution is shown in Figure 6.2. In this DCP, a basket is provided within the structural storage to collect litter and debris without interfering with flows into the storage.

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[i] Allowance for sheds added in third edition.

[ii] Cross-reference added in third edition.

Note: Area drained to site storage must now be 85% not 75% as shown in this example[i]

DRAINAGE DESIGN SUMMARY **SUB/DA No.**________________

Project: CASE STUDY 7.1 Location: ______________________

Designed by: ________________ Company: ____________________ Phone: _________

SITE AREA 0.135 ha *See Section 4.1.5 for dual occupancy			[A]
Basic storage volume	470 x [A] .135	= 63.5 m^3	[B]
Basic discharge	= 0.08 x [A] .135	= .0108 m^3/s	[C]
Area of site drained to storage (Must be as much as possible and not be less than 75% of the total site without written Council approval).		= .135 ha	[D]
[D/ [A] + [.135]/[.135] x 100		= 100 %	[E]
Storage per ha. of contributing area = [B]/[D]		= 470	[F]
Enter *volume/PSD adjustment chart* (Fig 5.1} using [F], and Read new PSD in litres/second/ha.		= 80 l/s/ha	[G]
Determine PSD =[G] x [D] 80 x .135		= 10.8 l/s	[H]
Maximum head to orifice centre		= 0.925 m	[K]
Weir flow to storage	$Q^{Weir} = CL(H^{Weir})^{1.5}$ $\therefore H^{Weir}$	= 0.058 m	[I]
Selected orifice diameter: $d = (0.464 \times Q / \sqrt{h})^{0.5} = (0.464 \times [H]/\sqrt{[K]})^{0.5}$		= 0.072 m	[J]
Maximum discharge		= 10.8 l/s	[L]
Head for high early discharge		= 0.575 m	[M]
High early discharge	$\{[L] \times \sqrt{[M] / [K]}\}$ (min 75% of [L])	= 8.5 l/s	[N]
Approximate mean discharge = ([L)] + [N]) /2		= 9.65 l/s	[P]
Average discharge/ha = [P] / [D] = 9.65 / 0.135		= 71.5 l/s/ha	[Q]
Enter *volume/P.S.D. adjustment chart* (Fig 5.1) using [Q] And read off final storage volume per hectare		= 520 m^3/ha	[R]
Determine final SSR = [R] x [D] = 520 x .135		= 70.2 m^3	[S]
Primary storage proportion	= [S] x 16 %	= 11.2 m^3	[T]
Secondary storage proportion	= [S] x 23 %	= 16.3 m^3	[U]
Tertiary storage proportion	[S] x 61 %	= 42.7 m^3	[V]
Check [T] + [U] + [V] = [S]		= 70.2 m^3	

SIGNATURE: ________________________________ **DATE:** ____________

[i] Area draining changed in revision 2 of third edition

7.2 A site with full coverage and no spare floor space

The proposed office development is on a very tight remnant site from which the maximum utility has been achieved without prior consideration being given to OSD. The site falls to the street where there is immediately adjacent drainage. Conventional drainage from the pitched roof would deliver runoff from the entire catchment to the street system in under two and a half minutes at essentially 100% runoff.

See Figure 7.4 for the site layout and storage calculations. A completed Drainage Design Summary sheet also follows.

Solution

Primary storage is to be provided in a galvanised steel tank suspended beneath the ceiling of the upper parking level, hard against the rear boundary. The provision of $8m^3$ is needed to limit ponding frequency of the secondary storage to slightly in excess of 1 in 5 years.

Secondary storage is to be provided on a deck which is lowered between upstanding beams to retain general clearance on this part of the upper parking level at the proposed under beam clearance under beams shown on architecturals.

Overflow can be provided by setting the edge beam adjacent to the residential driveway 75 mm below the office threshold level. With the weir length available, this would allow many times Q_{100} to overflow without affecting the offices.

Volumes

Tank: $8m^3$ required.
Building with inside structure 9.4 m, so 9.3 m long tank is feasible.
Tank width say 1.2 m.

so depth = 8.0/(9.3 x 1.2) = 0.72 m.

The tank can use airspace at the extreme rear of the building where suspended services are not a problem. Clearances for the tank need to be checked against the Australian Standard *AS 2890.1 Parking Facilities - Off-Street Parking*.[ii] There is no problem in this case although there is a minor nuisance in that access to the boot (or bonnet) of cars using the four spaces affected would not be possible without moving the vehicles.

Deck: 9.9 m^3 required.
Upturning of edge-beams and depressing the deck provides a potential pond 300 mm deep below office floor level with a surface area of 9.4 x 5.7 metres.

So depth for 1% AEP storm = 9.9/(9.4 x 5.7) = 0.185 m.

Slab will require surfacing as a recreation space and the provision of some fall to drainage. 'Fullgoes' on a line just inside the suspended tank at 3m centres will allow a general 0.5% fall with only 20 mm level variation over the deck area. A further 20 mm is allowed for surfacing the slab.

so freeboard to office floor = 0.300 - 0.185 - 0.040

= 0.075 m

[ii] Reference to standard added in third edition.

Note: Area drained to site storage must now be 85% not 75% as shown in this example[i]

DRAINAGE DESIGN SUMMARY **SUB/DA No.**__________

Project: CASE STUDY 7.2 Location: __________

Designed by: __________ Company: __________ Phone: __________

SITE AREA 0.038 ha *See Section 4.1.5 for dual occupancy				[A]
Basic storage volume	470 x [A] ·038	= 17.9	m³	[B]
Basic discharge	= 0.08 x [A] ·038	= 3.0	m³/s	[C]
Area of site drained to storage (Must be as much as possible and not be less than 75% of the total site without written Council approval).		= ·038	ha	[D]
[D/ [A] + [·038]/[·038] x 100		= 100	%	[E]
Storage per ha. of contributing area = [B]/[D]		= 470		[F]
Enter *volume/PSD adjustment chart* (Fig 5.1} using [F], and Read new PSD in litres/second/ha.		= 80	l/s/ha	[G]
Determine PSD =[G] x [D] 80 x 0.038		= 3.0	l/s	[H]
Maximum head to orifice centre		= 1.25	m	[K]
Weir flow to storage	$Q^{Weir} = CL(H^{Weir})^{1.5}$ $\therefore H^{Weir}$	= 0.038	m	[I]
Selected orifice diameter: $d = (0.464 \times Q / \sqrt{h})^{0.5} = (0.464x[H]/\sqrt{[K]})^{0.5}$		= 0.035	m	[J]
Maximum discharge		= 3.0	l/s	[L]
Head for high early discharge		= 0.85	m	[M]
High early discharge	$\{[L] \times \sqrt{[M] / [K]}\}$ (min 75% of [L])	= 2.5	l/s	[N]
Approximate mean discharge = ([L)] + [N]) /2		= 2.75	l/s	[P]
Average discharge/ha = [P] / [D] = 2.75 / ·038		= 72.4	l/s/ha	[Q]
Enter *volume/P.S.D. adjustment chart* (Fig 5.1) using [Q] And read off final storage volume per hectare		= 512	m³/ha	[R]
Determine final SSR = [R] x [D] = 512 x ·038		= 19.5	m³	[S]
Primary storage proportion	= [S] x 41 %	= 8	m³	[T]
Secondary storage proportion	= [S] x 59 %	= 9.9	m³	[U]
Tertiary storage proportion	[S] x ___ %	= —	m³	[V]
Check [T] + [U] + [V] = [S]		= 17.9	m³	

SIGNATURE:__________ **DATE:**__________

[i] Area draining changed in revision 2 of third edition

7.3 A flat site

The site is assumed to have no fall, but the adjacent council road has normal crossfall and is drained in a way which allows free discharge to the kerb. Although underground drainage may be present, it is assumed to be fully charged with the hydraulic grade line at the surface level.

As a starting condition for the assessment of OSD the proposal must be arranged so that it can be effectively drained by conventional methods and rendered flood free to normal standards (5%AEP).

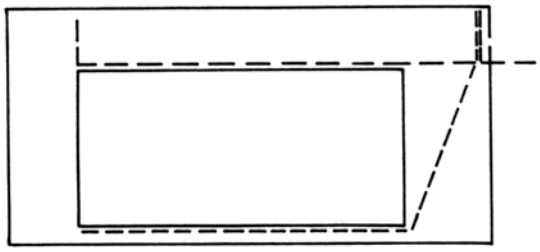
The site has an area of 0.1 ha and a residential development is proposed to cover 50% of the land exclusive of driveways, parking and a paved drying area. Two significant sections of garden space are proposed.

The site layout and discharge control pit details are shown in Figure 7.5.

Conventional drainage

With such a flat site, it would be preferable to use two stormwater drains running from the rear corners of the building to the kerb. However, Council insists upon a single discharge point. Therefore, allow the network suggested below.

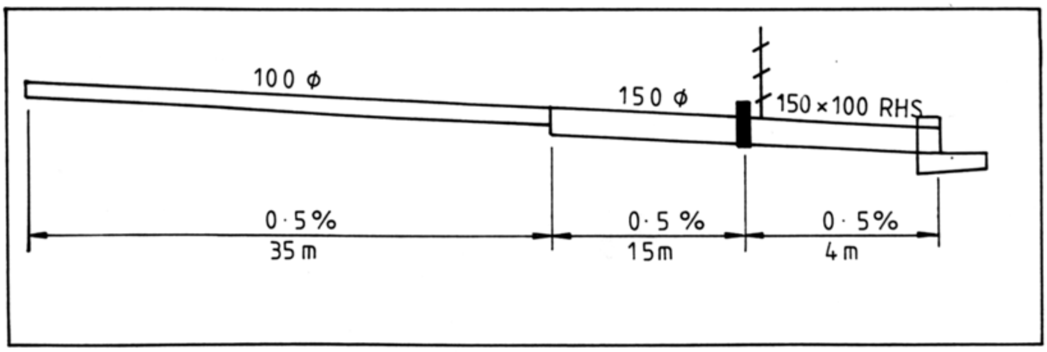
The driveway is collected only at a grated drain just inside the boundary.



Discharge in each line is from half roof. For the whole roof:
A = 36.2 x 14.3 =.052 ha.

Q_{20} = FCIA = .00278 x 0.95 x 180 x .052 = 0.025 m^3/s

Using sewer grade uPVC the last section of pipe in each run upstream of the grated drain must be 150 mm diameter for gravity flow, as shown in the schematic long section below.



Calculate orifice diameter.

$$d = (0.464 \times Q / \sqrt{h})^{0.5}$$

$$\left(\frac{0.464 \times 0.0008}{\sqrt{0.58}}\right)^{0.5}$$

$$= 0.070 \text{ m}$$

High early discharge $= 8 \times \sqrt{h_{min} / h_{max}}$

$$= 8 \times \sqrt{0.515 / 0.58}$$

$$= 7.54 \text{ l/s}$$

So, Q_{mean} is 7.77 l/s or 77.7 l/s/ha.

Enter Volume Adjustment Chart (Figure 5.1) with 77.7 l/s/ha and read off required volume as 484 m^3/ha.

For 0.1 ha site volume is 48.4 m^3.
The available 48 m^3 is therefore acceptable.

In summary

Sites are rarely this flat and there is usually a little fall to work with. Fall had to be created here by raising the block levels to provide a notional grade of 0.5% to the street. There is nearly always some fall available so the exercise will normally be a little easier.

Costing is interesting. The driveway must be built anyway, whether it is for water storage or not. The landscaping at the front of the property costs approximately the same per m^2 whatever level it is put at, and the trivial quantity of earthwork would not be identifiable in site costs. The brick wall, common enough for such a development, needs no special attention provided it is heavy enough to function as a gravity wall. It should cost no more than the usual fencing cost.

There remains only the outlet arrangement. The footpath crossing can be smaller than that normally required and the discharge control pit cost is comparable to that of the grated drain and junction pit normally located at the boundary. The only additional cost of OSD in a case like this probably lies in supervising the work to make sure the plans are understood and the levels specified are achieved. Even this cost is one which should already be put into making sure conventional drainage is installed so that it will work and ensure the owner gets value.

Note: Area drained to site storage must now be 85% not 75% as shown in this example[i]

DRAINAGE DESIGN SUMMARY **SUB/DA No.**__________

Project: CASE STUDY 7.3 Location: __________

Designed by: __________ Company: __________ Phone: __________

SITE AREA 0.1 ha *See Section 4.1.5 for dual occupancy				[A]
Basic storage volume	470 x [A] 0.1	= 47	m^3	[B]
Basic discharge	= 0.08 x [A] 0.1	= .008	m^3/s	[C]
Area of site drained to storage (Must be as much as possible and not be less than 75% of the total site without written Council approval).		= 0.1	ha	[D]
[D/ [A] + [0.1]/[0.1] x 100		= 100	%	[E]
Storage per ha. of contributing area = [B]/[D]		= 470		[F]
Enter *volume/PSD adjustment chart* (Fig 5.1} using [F], and Read new PSD in litres/second/ha.		= 80	l/s/ha	[G]
Determine PSD =[G] x [D] 80 x 0.1		= 8	l/s	[H]
Maximum head to orifice centre		= 0.58	m	[K]
Weir flow to storage	$Q^{Weir} = CL(H^{Weir})^{1.5}$ $\therefore H^{Weir}$	= 0.065	m	[I]
Selected orifice diameter: $d = (0.464 \times Q / \sqrt{h})^{0.5} = (0.464x[H]/\sqrt{[K]})^{0.5}$		= 0.070	m	[J]
Maximum discharge		= 8	l/s	[L]
Head for high early discharge		= 0.515	m	[M]
High early discharge {[L] x $\sqrt{[M] / [K]}$ } (min 75% of [L])		= 7.54	l/s	[N]
Approximate mean discharge = ([L)] + [N]) /2		= 7.77	l/s	[P]
Average discharge/ha = [P] / [D] = 7.77 / 0.1		= 77.7	l/s/ha	[Q]
Enter *volume/P.S.D. adjustment chart* (Fig 5.1) using [Q] And read off final storage volume per hectare		= 484	m^3/ha	[R]
Determine final SSR = [R] x [D] = 484 x 0.1		= 48.4	m^3	[S]
Primary storage proportion	= [S] x 19.3 %	= 9.25	m^3	[T]
Secondary storage proportion	= [S] x 37.5 %	= 18.0	m^3	[U]
Tertiary storage proportion	[S] x 43.2 %	= 20.8	m^3	[V]
Check [T] + [U] + [V] = [S]		= 48	m^3	

SIGNATURE:__________ **DATE:**__________

[i] Area draining changed in revision 2 of third edition

Note: Area drained to site storage must now be 85% not 75% as shown in this example[i]

DRAINAGE DESIGN SUMMARY **SUB/DA No.** ______________

Project: CASE STUDY 7·4 Location: FLAT ROOF TOWER

Designed by: ______________________ Phone: ____________

SITE AREA 0·09 ha *See Section 4.1.5 for dual occupancy				[A]
Basic storage volume	470 x [A] 0·09	= 42.3	m^3	[B]
Basic discharge	= 0.08 x [A] 0·09	= 0·0072	m^3/s	[C]
Area of site drained to storage (Must be as much as possible and not be less than 75% of the total site without written Council approval.)		= –	ha	[D]
[D / [A] = [ ]/[ ] x 100		= 100	%	[E]
Storage per ha. of contributing area = [B]/[D]		= –		[F]
Enter *volume/PSD. adjustment chart* (Fig 5.1) using [F], and read new PSD in litres/second/ha.		= –	l/s/ha	[G]
Determine PSD =[G] × [D] ________ × ________		= 7·2	l/s	[H]
Maximum head to orifice centre		= 0·955	m	[K]
Selected orifice diameter	$d = (0.464 \times Q / \sqrt{h})^{0.5}$	= 0·0585	m	[J]
Maximum discharge		= 7·2	l/s	[L]
Head for high early discharge		= 0·900	m	[M]
High early discharge. $\{[L] \times \sqrt{[M]/[K]}\}$ (min 75% of [L])		= 7·0	l/s	[N]
Approximate mean discharge = ([L] + [N]) /2		= 7·1	l/s	[P]
Average discharge/ha = [P] / [D] = 7·1 / 0·09		= 78·9	l/s/ha	[Q]
Enter *volume/P.S.D. adjustment chart* (Fig 5.1) using [Q], and read off final storage volume per hectare		= 477	m^3/ha	[R]
Determine final SSR = [R] x [D] = 477 x 0·09		= 42·9	m^3	[S]
Primary storage proportion = [S] x _____%		=	m^3	[T]
Secondary storage proportion = [S] x _____%		=	m^3	[U]
Tertiary storage proportion = [S] x _____%		=	m^3	[V]
Check [T] + [U] + [V] = [S]		=	m^3	

SIGNATURE: ______________________ DATE: ____________

COMPANY: ______________________

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[i] Area draining changed in revision 2 of third edition

7.5 Duplex Site

Total site area = 841.2 m^2

dwelling No. 1 - 502.2 m^2 dwelling No. 2 – 339 m^2.

A storage for each dwelling is proposed. The storage area available for dwelling No. 2 is limited, but the grassed rear boundary and side landscaping are being used as an overland flowpath and will not drain to the storage. These areas therefore can be added to the storage area for dwelling No. 1. Overland flowpaths are needed to drain 0.03 ha of upstream catchment flowing across the rear boundary and 0.1 ha across the side boundary.

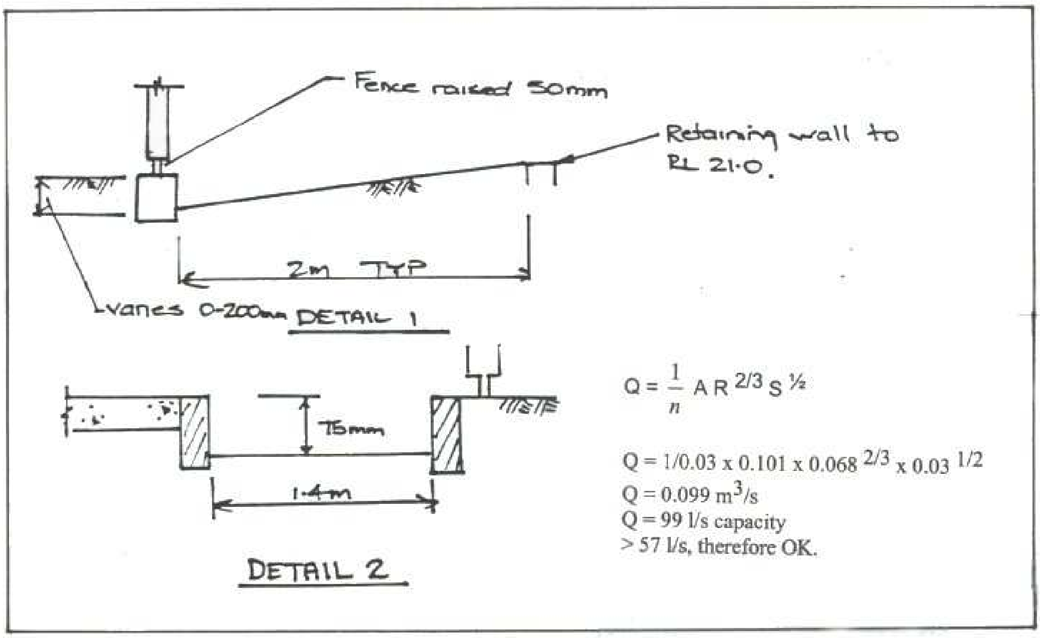
Cross sections of the proposed water storage are shown in the following details. (Figures 7.8 and 7.9)
Details of the 2 discharge control pits are also shown in Figures 7.10 and 7.11.

<u>Treating overland flow</u>

Calculate total overland flow

$$Q = CIA/360$$
$$= 0.7 \times 227.3 \times 0.13/360$$
$$= 0.057\ m^3/s$$
$$Q = 57\ l/s$$

The rear of dwelling No. 2 and the courtyard are in cut and even small catchments can cause flooding if the area is not property graded. A sensible precaution would be to raise the retaining wall above the existing surface and regrade the rear yard to fall to the north-east. As the rear boundary is essentially flat, it will be necessary to create a fall. This could simply be achieved using railway sleepers on some other garden edging, as shown below. This will serve as the flowpath.



The driveway downstream of the speed hump will need to be shaped to discharge the overland flowpath via the driveway to the street.

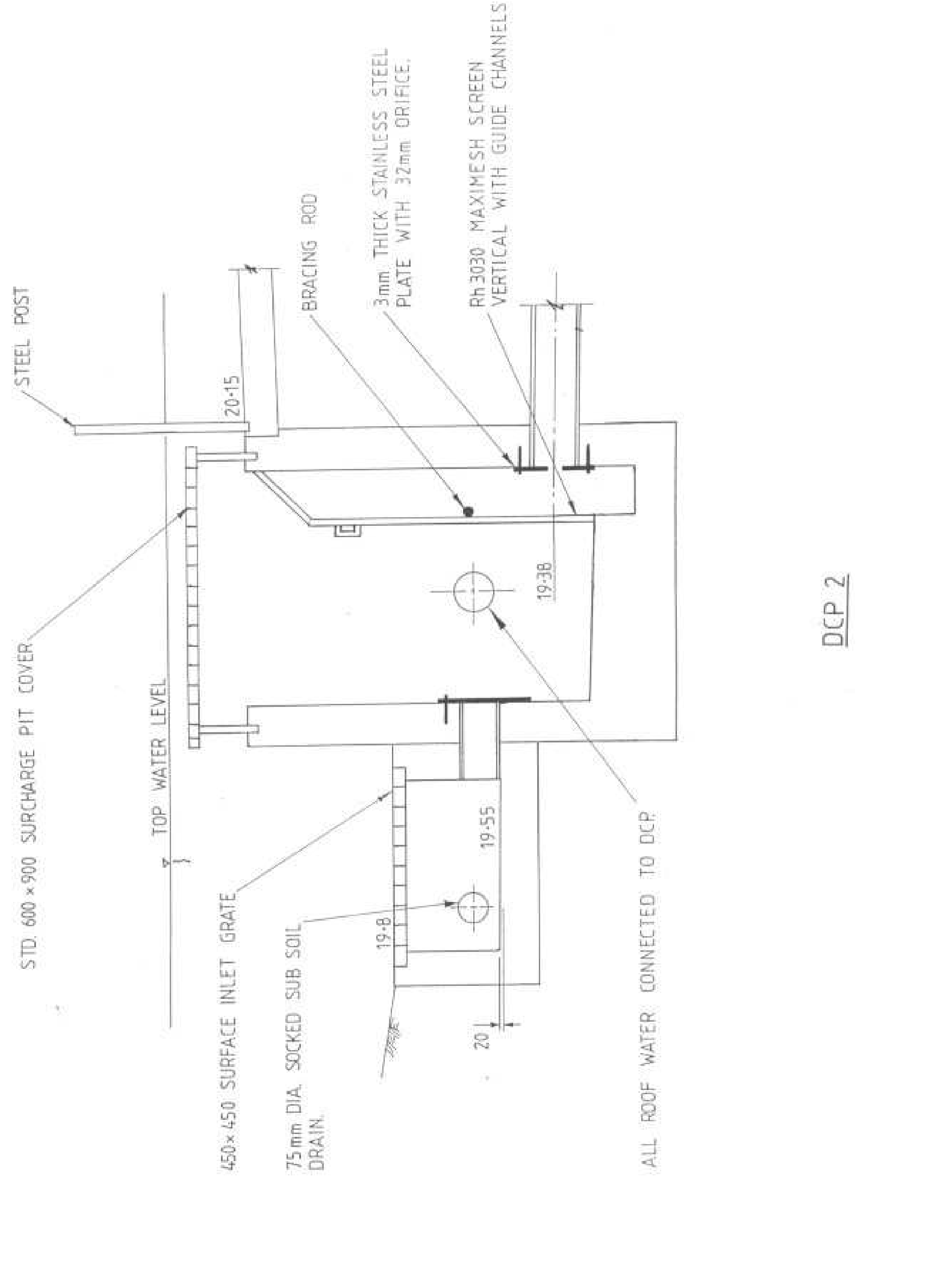

STEEL POST
BRACING ROD
3mm THICK STAINLESS STEEL PLATE WITH 32mm ORIFICE.
Rh3030 MAXIMESH SCREEN VERTICAL WITH GUIDE CHANNELS
20·15
19·38
STD. 600 × 900 SURCHARGE PIT COVER
TOP WATER LEVEL
450 × 450 SURFACE INLET GRATE
75mm DIA. SOCKED SUB SOIL DRAIN.
19·8
19·55
20
ALL ROOF WATER CONNECTED TO DCP.
DCP 2

FIGURE 7·11

Note: Area drained to site storage must now be 85% not 75% as shown in this example[i]

DRAINAGE DESIGN SUMMARY **SUB/DA No.** ____________

Project: CASE STUDY 7·5 Location: DWELLING No.1
Designed by: ____________ Phone: ____________

~~SITE~~ CAT AREA 0·0574 ha *See Section 4.1.5 for dual occupancy				[A]
Basic storage volume	470 x [A] 0·0574	= 27.0	m^3	[B]
Basic discharge	= 0.08 x [A] 0·0574	= 0·0046	m^3/s	[C]
Area of site drained to storage (Must be as much as possible and not be less than 75% of the total site without written Council approval.)		= 0·0436	ha	[D]
[D / [A] = [436]/[574] x 100		= 76	%	[E]
Storage per ha. of contributing area = [B]/[D]		= 619		[F]
Enter *volume/PSD. adjustment chart* (Fig 5.1) using [F], and read new PSD in litres/second/ha., – extended using eq'n		= 55·5	l/s/ha	[G]
Determine PSD =[G] × [D]	55.3 × 0·0436	= 2·4	l/s	[H]
Maximum head to orifice centre		= 0·70	m	[K]
Selected orifice diameter	$d = (0.464 \times Q / \sqrt{h})^{0.5}$	= 0·035	m	[J]
Maximum discharge		= 2·3	l/s	[L]
Head for high early discharge		= 0·75	m	[M]
High early discharge. $\{[L] \times \sqrt{[M]/[K]}\}$ (min 75% of [L])		= 2·2	l/s	[N]
Approximate mean discharge = ([L] + [N]) /2		= 2·25	l/s	[P]
Average discharge/ha = [P] / [D] =	2.25 / 0·0436	= 51·4	l/s/ha	[Q]
Enter *volume/P.S.D. adjustment chart* (Fig 5.1) using [Q], and read off final storage volume per hectare – extended using eq'n		= 654	m^3/ha	[R]
Determine final SSR = [R] x [D] =	654 x 0·0436	= 28·5	m^3	[S]
Primary storage proportion	= [S] x 77 % 1 in 25 y	= 21·8	m^3	[T]
Secondary storage proportion	= [S] x ____%	= 6·9	m^3	[U]
Tertiary storage proportion	= [S] x ____%	=	m^3	[V]
Check [T] + [U] + [V] = [S]		= 28·7	m^3	

SIGNATURE: ____________ DATE: ____________

COMPANY: ____________

[i] Area draining changed in revision 2 of third edition

Note: Area drained to site storage must now be 85% not 75% as shown in this example[i]

DRAINAGE DESIGN SUMMARY **SUB/DA No.** ______

Project: CASE STUDY 7-5 Location: DWELLING No2
Designed by: ______ Phone: ______

~~SITE~~ CAT AREA 0.02708 ha *See Section 4.1.5 for dual occupancy				[A]
Basic storage volume	470 x [A] 0.02708	= 12.7	m^3	[B]
Basic discharge	= 0.08 x [A] 0.02708	= 0.0022	m^3/s	[C]
Area of site drained to storage (Must be as much as possible and not be less than 75% of the total site without written Council approval.)		= –	ha	[D]
[D / [A] = [ ]/[ ] x 100		= 100	%	[E]
Storage per ha. of contributing area = [B]/[D]		= –		[F]
Enter *volume/PSD. adjustment chart* (Fig 5.1) using [F], and read new PSD in litres/second/ha.		= –	l/s/ha	[G]
Determine PSD =[G] × [D] ______ × ______		= 2.2	l/s	[H]
Maximum head to orifice centre		= 0.970	m	[K]
Selected orifice diameter	$d = (0.464 \times Q / \sqrt{h})^{0.5}$	= 0.032	m	[J]
Maximum discharge		= 2.2	l/s	[L]
Head for high early discharge		= 0.770	m	[M]
High early discharge. $\{[L] \times \sqrt{[M]/[K]}\}$ (min 75% of [L])		= 2.0	l/s	[N]
Approximate mean discharge = ([L] + [N]) /2		= 2.1	l/s	[P]
Average discharge/ha = [P] / [D] = 2.1 / 0.02708		= 75.7	l/s/ha	[Q]
Enter *volume/P.S.D. adjustment chart* (Fig 5.1) using [Q], and read off final storage volume per hectare		= 495	m^3/ha	[R]
Determine final SSR = [R] x [D] = 495 x 0.02708		= 13.4	m^3	[S]
Primary storage proportion = [S] x 41 %	1 in 54	= 5.5	m^3	[T]
Secondary storage proportion = [S] x ____%		= 8.5	m^3	[U]
Tertiary storage proportion = [S] x ____%		=	m^3	[V]
Check [T] + [U] + [V] = [S]		= 14	m^3	

SIGNATURE: ______ DATE: ______

COMPANY: ______

[i] Area draining changed in revision 2 of third edition

8.0 References[i]

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Upper Parramatta River Catchment Trust (1999). *On-site Stormwater Detention Handbook. Third Edition Revision 1*

[i] Additional references added in third edition

Form B1[i] **DRAINAGE DESIGN SUMMARY SUB/DA No.______________**

Project:______________________Location: ______________________________________

Designed by: _________________Company:______________________Phone:_________

SITE AREA _____________ha *See Section 3.4.3 for dual occupancy [A]

Upstream catchment draining through site =__________ ha [AA]
See Section 4.1.3 for assessment of external flows.
Basic storage volume 470 x [A]_________ =__________ m^3 [B]

Basic discharge = 0.08 x [A]_________ =__________ m^3/s [C]

Area of site drained to storage =__________ ha [D]
(Must be as much as possible and not be less than 85% of the total site without written Council approval).

[D/ [A] + [ ]/[ ] x 100 =__________ % [E]

Storage per ha. of contributing area = [B]/[D] =__________ [F]

Enter *volume/PSD adjustment chart* (Fig 5.1} using [F], and Read new PSD in litres/second/ha (l/s/ha). =__________ l/s/ha [G]

Determine PSD =[G] x [D] _________ x _________ =__________ l/s [H]

Maximum head to orifice centre =__________ m [K]

Weir flow to storage $Q^{Weir} = CL(H^{Weir})^{1.5}$ $\therefore H^{Weir}$ =__________ m [I]

Selected orifice diameter: $d = (0.464 \times Q / \sqrt{h})^{0.5} = (0.464\text{x}[H]/\sqrt{[K]})^{0.5}$ =__________ m [J]

Maximum discharge =__________ l/s [L]

Head for high early discharge =__________ m [M]

High early discharge $\{[L] \times \sqrt{[M] / [K]}\}$ (min 75% of [L]) =__________ l/s [N]

Approximate mean discharge = ([L)] + [N]) /2 =__________ l/s [P]

Average discharge/ha = [P] / [D] = _________/__________ =__________ l/s/ha [Q]

Enter *volume/P.S.D. adjustment chart* (Fig 5.1) using [Q]
And read off final storage volume per hectare =__________ m^3/ha [R]

Determine final SSR = [R] x [D] = _______x ________ =__________ m^3 [S]

Primary storage proportion = [S] x ______% =__________ m^3 [T]

Secondary storage proportion = [S] x ______% =__________ m^3 [U]

Tertiary storage proportion [S] x _______% =__________ m^3 [V]

Check [T] + [U] + [V] = [S] =__________ m^3

SIGNATURE:___________________________________ DATE:______________

[i] Revised for third edition to include flow from upstream and revised by pass flows

B4 Terms and conditions for Restriction on Use of Land and Positive Covenant[i] .

Appendix B4A contains standard recitals for the Terms and Conditions to be applied in Restrictions on Use of Land and or Positive Covenants in relation to OSD systems. Appendix B.5 contains a sample instrument which shows how these terms and conditions are applied.

Both the Restriction on Use and the Positive Covenant will normally be required, however in cases where only the Positive Covenant is used, the definition of the OSD system and the details of the Council file number (given in clause 1 of the Restriction on Use) should be included in the Positive Covenant.

Appendix B4B contains the OSD related recitals for use in the City of Blacktown. Council also has a booklet of Standard Recitals for Terms of Easements, Covenants and Restrictions Commonly Imposed by Instrument under Section 88B of the Conveyancing Act, 1919 as Amended.

[i] Council file number and Blacktown City Council recitals added for third edition.

B4A[ii] Restrictions on Use of Land for OSD Systems

1. The registered proprietor shall not make or permit or suffer the making of any alterations to any on-site stormwater detention system which is, or shall be, constructed on the lot(s) burdened without the prior consent in writing of ……………………………………..(*Insert name of Council)* . The expression "on-site stormwater detention system" shall include all ancillary gutters, pipes, drains, walls, kerbs, pits, grates, tanks, chambers, basins and surfaces designed to temporarily detain stormwater as well as all surfaces graded to direct stormwater to the temporary storage[iii]. The on-site stormwater detention system is detailed on the plans approved by …………….. as Construction Certificate No…………. on ……………..,. (Include the following for privately certified Construction Certificates only:) A copy of this Construction Certificate is held on Cvouncil file No. …………………………….

   Any on-site stormwater detention system constructed on the lot(s) burdened is hereafter referred to as "the system".

   Name of Authority having the power to release, vary or modify the Restriction …………….. referred to is ……………………………………..(*Insert name of Council).*

2. The registered proprietor shall not erect or suffer the erection of any dwelling house or other structure on the lot(s) hereby burdened unless the registered proprietor has first constructed or has made provision for the construction of an on site stormwater detention system on the said lot(s), in accordance with the design, construction and/or provision requirements of the ……………………………………..(*Insert name of Council)* and to the satisfaction of the …………………………………… (*Insert name of Council)*. The expression "on-site stormwater detention system" shall include all ancillary gutters, pipes, drains, walls, kerbs, pits, grates, tanks, chambers, basins and surfaces designed to temporarily detain stormwater as well as all surfaces graded to direct stormwater to the temporary storage.

   Note: Clause 2 is only necessary when construction of the OSD system is being deferred, which will only be permitted by Council in exceptional circumstances.

Positive Covenants

1. The registered proprietor of the lot(s) hereby burdened will in respect of the system:

   (a) keep the system clean and free from silt, rubbish and debris

   (b) maintain and repair at the sole expense of the registered proprietors the whole of the system so that if functions in a safe and efficient manner

   (c) permit the Council or its authorised agents from time to time and upon giving reasonable notice (but at any time and without notice in the case of an emergency) to enter and inspect the land for the compliance with the requirements of this covenant

   (d) comply with the terms of any written notice issued by the Council in respect of the requirements of this covenant within the time stated in the notice.

[ii] Space for Council file number added in third edition

[iii] Surface grading requirement added in third edition.

2. Pursuant to Section 88F(3) of the Conveyancing Act 1919 the Council shall have the following additional powers:

   (a) in the event that the registered proprietor fails to comply with the terms of any written notice issued by the Council as set out above the Council or its authorised agents may enter the land with all necessary materials and equipment and carry out any work which the Council in its discretion considers reasonable to comply with the said notice referred to in part 1(d) above

   (b) the Council may recover from the registered proprietor in a Court of competent jurisdiction:

      (i) any expense reasonably incurred by it in exercising its powers under sub-paragraph (i) hereof. Such expense shall include reasonable wages for the Council's employees engaged in effecting the work referred to in (i) above, supervising and administering the said work together with costs, reasonably estimated by the Council, for the use of materials, machinery, tools and equipment in conjunction with the said work.

      (ii) legal costs on an indemnity basis for issue of the said notices and recovery of the said costs and expenses together with the costs and expenses of registration of a covenant charge pursuant to section 88F of the Act or providing any certificate required pursuant to section 88G of the Act or obtaining any injunction pursuant to section 88H of the Act.

Name of Authority having the power to release vary or modify the Positive Covenant ………………….. referred to is ………………………………………(*Insert name of Council).*

B4B Standard recital for Use in the City of Blacktown[iv]

Terms of Restriction on Use of Land

1. For constructed works

The registered proprietor(s) covenant as follows with the Authority benefited in respect to the on-site stormwater detention system (hereinafter referred to as "the system") constructed on the burdened lot(s) that they will not, without the prior and express written consent of the Authority benefited:

a. Do any act, matter or thing which would prevent the system from operating in a safe and efficient manner.
b. Make or permit or suffer the making of any alterations or additions to the system.
c. Allow any development within the meaning of the Environmental Planning and Assessment Act 1979 to encroach upon the system.

This restriction shall bind all persons who are or claim under the registered proprietor(s) as stipulated in Section 88E(5) of the Conveyancing Act 1919.

For the purposes of this restriction, "the system" means the on-site stormwater detention system constructed on the land as detailed on the plans approved by ………… as Construction Certificate No. ………… on …………, including all ancillary gutters, pipes, drains, walls, kerbs, pits, grates, tanks, chambers, basins and surfaces designed to temporarily detain stormwater, as well as all surfaces graded to direct stormwater to the temporary storage. *(Include the following for Private CC's only)* A copy of this Construction Certificate is held on Council File No. ……………….

2. For deferred works

This following version is only used when construction of the OSD system is being deferred, which will only be permitted by Council in **exceptional** circumstances.

"The registered proprietor shall not erect or suffer the erection of any dwelling house or other structure on the lot(s) hereby burdened unless the registered proprietor has first constructed or has made provision for the construction of an on site stormwater detention system on the said lot(s), in accordance with the design, construction and/or provision requirements of, and to the satisfaction of Blacktown City Council.

The expression "on-site stormwater detention system" shall include all ancillary gutters, pipes, drains, walls, kerbs, pits, grates, tanks, chambers, basins and surfaces designed to temporarily detain stormwater as well as all surfaces graded to direct stormwater to the temporary storage."

[iv] Blacktown City Council recital added for third edition.

Terms of Positive Covenant………

1. The registered proprietor(s) covenant as follows with the Authority benefited in respect to the on-site stormwater detention system (hereinafter referred to as “the system”) constructed on the burdened lot(s), that they will:
   a) Keep the system clean and free from silt, rubbish and debris

   b) Maintain and repair at the sole expense of the registered proprietor(s) that part of the system contained within the registered proprietor’s own lot, so that it functions in a safe and efficient manner, in accordance with the “On-Site Detention Maintenance Schedule” as approved by …………………. on ……………., a copy of which is held on Council File ……………….. A copy of this Schedule is available to all owners and occupiers of the burdened lot(s)

   c) For the purpose of ensuring observance of this covenant, permit Blacktown City Council or its authorised agents (hereinafter referred to as “the Council”) from time to time and upon giving reasonable notice (but at any time and without notice in the case of an emergency) to enter the land and inspect the condition of the system and the state of construction, maintenance or repair of the system, for compliance with the requirements of this covenant

   d) Comply with the terms of any written notice issued by the Council to attend to any matter and carry out such work within the time stated in the notice, to ensure the proper and efficient performance of the system and to that extent Section 88F(2)(a) of the Conveyancing Act 1919 (hereinafter referred to as “the Act”) is hereby agreed to be amended accordingly.

2. Pursuant to Section 88F (3) of the Act the Council shall have the following additional powers pursuant to this covenant:
   a) In the event that the registered proprietor fails to comply with the terms of any written notice issued by the Council as set out above, the Council may enter the land with all necessary equipment and carry out any work considered by Council to be reasonable to comply with the said notice referred to in 1(d) above.
   b) The Council may recover from the registered proprietor in a court of competent jurisdiction:

      I. Any expense reasonably incurred by it in exercising its powers in sub-paragraph 2(a) above. Such expense shall include reasonable wages for employees engaged in effecting, supervising and administering the said work, together with costs, reasonably estimated by Council, for the use of materials, machinery, tools and equipment used in conjunction with the said work.

      II. Legal costs on an indemnity basis for issue of the said notices and recovery of the said costs and expenses together with the costs, charges, and expenses of registration of a covenant charge pursuant to Section 88F of the Act or providing any certificate required pursuant to Section 88G of the Act or obtaining any injunction pursuant to Section 88H of the Act.

3. This covenant shall bind all persons who are or claim under the registered proprietor(s) as stipulated in Section 88E(5) of the Act.

For the purposes of this covenant, “the system” means the on-site stormwater detention system constructed on the land as detailed on the plans approved by ………. as Construction Certificate No. ………… on …………, including all ancillary gutters, pipes, drains, walls, kerbs, pits, grates, tanks, chambers, basins and surfaces designed to temporarily detain stormwater, as well as all surfaces graded to direct stormwater to the temporary storage. *(Include the following for Private CC’s only)* A copy of this Construction Certificate is held on Council File No. ……………….

PART 2[i]

TERMS OF RESTRICTION ON USE …………………………………………….. REFERRED TO IN THE ABOVE-MENTIONED PLAN

The registered proprietor shall not make or permit or suffer the making of any alterations to the on-site stormwater detention system which is constructed on the lot(s) burdened without the prior consent in writing of ……………………………………(*Insert name of Council.* The expression "on-site stormwater detention system" shall include all ancillary gutters, pipes, drains, walls, kerbs, pits, grates, tanks, chambers, basins and surfaces designed to temporarily detain stormwater as well as all surfaces graded to direct stormwater to the temporary storage[ii]. Any on-site stormwater detention system constructed on the lot(s) burdened is hereafter referred to as "the system". The on-site stormwater detention system is detailed on the plans approved by …………….. as Construction Certificate No…………. on ……………….,. (Include the following for privately certified Construction Certificates only:) A copy of this Construction Certificate is held on Cvouncil file No. ……………………………

Name of Authority having the power to release, vary or modify the Restriction …………….. referred to is ……………………………………(*Insert name of Council).*

PART 2 (Continued)

TERMS OF POSITIVE COVENANT ……………………………..…………..REFERRED TO IN THE ABOVE-MENTIONED PLAN

1. The registered proprietor of the lot(s) hereby burdened will in respect of the system:

   (a) keep the system clean and free from silt, rubbish and debris

   (b) maintain and repair at the sole expense of the registered proprietors the whole of the system so that if functions in a safe and efficient manner

   (c) permit the Council or its authorised agents from time to time and upon giving reasonable notice (but at any time and without notice in the case of an emergency) to enter and inspect the land for the compliance with the requirements of this covenant

   (d) comply with the terms of any written notice issued by the Council in respect of the requirements of this covenant within the time stated in the notice.

[i] Space for council file number added to third edition.
[ii] Surface grading requirement added in third edition.

INSTRUMENT SETTING OUT TERMS OF RESTRICTION ON THE USE OF LAND AND POSITIVE COVENANT INTENDED TO BE CREATED PURSUANT TO SECTION 88E OF THE CONVEYANCING ACT 1919.

(Sheet .. of … sheets)

Plan: Subdivision of Lot …….D.P…………….
Covered by Council Clerk's
Certificate No. ………………..
Of ………………………………

Full name and address ……………………………………………
Of proprietor of the land ……………………………………………
……………………………………………

2. Pursuant to Section 88F(3) of the Conveyancing Act 1919 the Council shall have the following additional powers:

(i) in the event that the registered proprietor fails to comply with the terms of any written notice issued by the Council as set out above the Council or its authorised agents may enter the land with all necessary materials and equipment and carry out any work which the Council in its discretion considers reasonable to comply with the said notice referred to in part 1(d) above

(ii) The Council may recover from the registered proprietor in a Court of competent jurisdiction:

(a) any expense reasonably incurred by it in exercising its powers under sub-paragraph (i) hereof. Such expense shall include reasonable wages for the Council's employees engaged in effecting the work referred to in (i) above, supervising and administering the said work together with costs, reasonably estimated by the Council, for the use of materials, machinery, tools and equipment in conjunction with the said work.

(b) legal costs on an indemnity basis for issue of the said notices and recovery of the said costs and expenses together with the costs and expenses of registration of a covenant charge pursuant to section 88F of the Act or providing any certificate required pursuant to section 88G of the Act or obtaining any injunction pursuant to section 88H of the Act.

Name of Authority having the power to release vary or modify the Positive Covenant ………………………………….. referred to is …………………………………(*Insert name of Council).*

B8 STORMWATER CONCEPT PLAN SUBMISSION[i]

The following checklists have been provided to assist designers to confirm that all necessary issues have been addressed. The first Stormwater Concept Plan (SCP) checklist (B8A) is a shorter version of the second. The first list is to be completed by the stormwater consultant and submitted to Council together with the plan/s and any necessary attachments.

The second more comprehensive checklist (B8B) may be used by less experienced designers as an aid to ensure that all relevant information has been provided. It may be submitted to Council instead of the shorter form if desired.

Note:

Holroyd City Council does not accept SCPs and a detailed OSD design is to be submitted with the development application. Council also requires consultants to complete a detailed design checklist, which is available from Council, which incorporates both the SCP checklist (Appendix B8A) and the Detailed Design checklist (Appendix B9A).

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[i] Shorter SCP checklist added in third edition

B8A OSD STORMWATER CONCEPT PLAN SUBMISSION

This form is to be completed by the stormwater designer and submitted to Council together withthe plan/s and any necessary attachments.

PROJECT ADDRESS: ____

OSD DESIGNER DETAILS:

Company Name:____

Address: ____

Telephone No.: ____________________ **Fax No:** ____________________

Accreditation Organisation: ____________ **Accreditation Reference:** _______

Name of designer: __________________________ **Date:** ____________________
(Print Name)

Council Reviewer's Name: __________________________ **Date:** ________________

CHECKLIST

	Complies with Handbook Yes	Complies with Handbook No	Council agrees Yes	Council agrees No
1. Flooding:				
Is the site (whole or partly) below the 1 in 100 year flood level?	☐	☐	☐	☐
If yes, does the OSD system reflect the flood affectation?	☐	☐	☐	☐
Have floodplain issues been addressed (eg storage, obstructed flow etc)?	☐	☐	☐	☐
2. External catchment: (refer section 4.1.3)				
Is there an external catchment draining into the site?	☐	☐	☐	☐
If Yes, have calculations of 100 year ARI flow been submitted & full area of catchment shown?	☐	☐	☐	☐
3. OSD Storage : (refer Sections 4.1.4,4.1.6 & 6.5)				
The storage volume has been estimated with calculations	☐	☐	☐	☐
The area to be drained has been shown on plan and is more than 85%?	☐	☐	☐	☐
Is there free discharge at the outlet or provision made for drowned outlet?	☐	☐	☐	☐
Has the storage been located at the lowest point of the site to collect surface & roof gutter overflow?	☐	☐	☐	☐
4. Site information:				
The following information has been shown on the plans: - scaled site layout showing all buildings, roadways and landscaped areas	☐	☐	☐	☐
- spot levels and contours (including adjoining properties)	☐	☐	☐	☐
- location, dimensions and extent of detention storages	☐	☐	☐	☐
- location of any floodways or flowpaths through the site	☐	☐	☐	☐
- location of any other constraints, e.g. easements, sewer & other services or Water Sensitive Urban Design (WSUD) features	☐	☐	☐	☐

B8B STORMWATER CONCEPT PLAN SUBMISSION[ii]

This form may be completed by the stormwater consultant and submitted to Council together with the plan/s and any-necessary attachments if form B8A is not used.

PROJECT ADDRESS: ____

PROJECT APPLICANT:____

STORMWATER DESIGNER DETAILS:

Company Name:____

Address: ____

Telephone No.: ______________________ **Fax No:** _____________________

Accreditation Organisation: ____

Accreditation Reference: _____________________

Name and signature of designer: _____________________________________

(Print Name)

____________________________________ **Date:** __________

(Signature)

Items submitted: **

Stormwater Concept Plan — Yes / No

Stormwater Concept Plan Checklist — Yes / No

- – Attachment A: Flood Affectation Information — Yes / No
- – Attachment B: External Catchment Assessment — Yes / No
- – Attachment C: OSD Value Assessment — Yes / No
- – Attachment D: Outlet Hydraulic Assessment — Yes / No

COUNCIL REVIEW DETAILS:

Council Review Officer's Name: _____________________________________

Review officer's comments: ____

____

Signature of Review Officer: ________________________**Date:**______________

** The above items are to be submitted in a single bound form — a 'loose leaf' format is unacceptable.

[ii] Form number changed to reflect new shorter checklist in third edition.

STORMWATER CONCEPT PLAN CHECKLIST

ITEM	DESIGNER		COUNCIL REVIEW	
	YES	NO	YES	NO
1. Is the site (whole or partly) defined as floodprone?				
If YES, see Plan No .... and reference flood level information in Attachment A.				
2. Is there an external catchment draining into the site?				
If YES, see Plan No .... and calculations of 100 year ARI flow in Attachment B				
2. Plan No .... has been prepared in accordance with Section 4.1.2 showing:				
- site layout showing all buildings, roadways and landscaped areas				
- site spot levels and contours (with extensions into adjoining properties)				
- location, levels and extent of detention storages				
- location and levels at collecting stormwater system				
- location and approximate extent of any floodways or flowpaths through the site (based on flows defined in Attachment B)				
- location and area of any portion of the site unable to drain to the storages				
- location of any other constraints, e.g. easements and services				
- datum and scale				
4. The storage volume has been estimated (refer Section 4.1.6)				
If YES, see calculations in Attachment C.				
5. The area of the site to be drained has been determined, (refer Section 4.1.4)				
If YES, see Plan No				
If YES, the undrained percentage is ......% (to be not more than 15%[iii], refer Section 4.1.4).				
6. The approximate dimensions of the storage area, including invert level, are provided				
If YES, see Plan No.				
7. Invert level of storage is not less than ground level (or top of kerb) at point of connection to external stormwater system, (refer Section 6.5)				
If YES, see Plan No.				
If NO, see calculations in Attachment D				

[iii] Undrained percentage of site reduced in third edition

B9 OSD DETAILED DESIGN SUBMISSION[i]

The following checklists have been provided to assist designers to confirm that all necessary issues have been addressed. The first detailed Design checklist (B9A) is a shorter version of the second. The first list is to be completed by the stormwater consultant and submitted to Council together with the plan/s and any necessary attachments.

The second more comprehensive checklist (B9B) may be used by less experienced designers as an aid to ensure that all relevant information has been provided. It may be submitted to Council instead of the shorter form if desired.

Note:

Holroyd City Council requires consultants to complete a detailed design checklist which is available from Council and which incorporates both the SCP Checklist (Appendix B8A) and the Detailed Design Checklist (Appendix B9A).

[i] Shorter detailed design checklist added in third edition

B9A OSD DETAILED DESIGN SUBMISSION[ii]

This form is to be completed by the stormwater consultant and submitted to Council/Principal Certifying Authority (PCA) together with the plan/s and any necessary attachments.

PROJECT ADDRESS: ____

STORMWATER DESIGNER DETAILS:

Company Name:____

Address: ____

Telephone No.: _________________________ **Fax No:** _________________________

Accreditation Organisation: ___________________**Accreditation Reference:** ___________

Name of designer: __________________________

_____________________ (Print Name) _____________________

Reviewer's Name: ___________________________________ **Date:**____________________

[ii] Shorter checklist added in third edition

DETAILED DESIGN SUMMARY CHECKLIST			COUNCIL AGREES:	
	Yes	No	Yes	No
1. **Stormwater Concept Plan (SCP):** (refer Section 4.1)				
Has a SCP been approved previously? If not please submit SCP checklist	☐	☐	☐	☐
Is the detailed design consistent with the approved SCP?	☐	☐	☐	☐
Is this design consistent with all conditions of development consent affecting the OSD design (eg trees to be retained)?	☐	☐	☐	☐
2. **Design information:**	☐	☐	☐	☐
Do the plans show all information required by Section 4.2.2 of the Handbook? (Including calculations for weir and by-pass flows, final site/lot layout, etc)	☐	☐	☐	☐
Does the entire drained area grade to the storage, including roof gutter overflows?	☐	☐	☐	☐
If No, do drainage all components have 100 year ARI capacities?	☐	☐	☐	☐
3. **OSD System:**	☐	☐	☐	☐
Is the catchment for each OSD storage clearly shown on the plans?	☐	☐	☐	☐
Has a drainage design summary sheet (Form B1) been submitted for each OSD system?	☐	☐	☐	☐
Is the Discharge Control Pit consistent with the principles in section 4.2, Fig. 4.3 and Council's design standards?	☐	☐	☐	☐
4. **OSD Storage:**	☐	☐	☐	☐
Does depth of storages comply with Table 6.1 & Section 4.2.6 to 4.2.10?	☐	☐	☐	☐
Has a cross-section of the storage been provided?	☐	☐	☐	☐
Is there the required freeboard for all buildings on site?	☐	☐	☐	☐
Have structural details been provided?	☐	☐	☐	☐
Have access/ maintenance issues been addressed (eg. Section 4.2.8)?	☐	☐	☐	☐
) Are any walls and footings of the storage completely within the property? (Section 4.2.6 to 4.2.8	☐	☐	☐	☐

B9B. OSD DETAILED DESIGN SUBMISSION[iii]

This form may be completed by the stormwater designer and submitted to Council/Principal Certifying Authority (PCA) together with the design plan/s and any necessary attachments if form B9A is not used.

.

PROJECT ADDRESS: ____

PROJECT APPLICANT:____

OSD DESIGNER DETAILS:

Company Name:____

Address: ____

Telephone No.: _________________________**Fax No**: _____________________

Accreditation organisation: ____

Accreditation Reference: _______________________

Name and signature of designer: ____________________________________
(Print Name)

__________________________________ **Date**: ____________________
(Signature)

Items submitted: **

- OSD Design Plan/s — Yes / No
- OSD Detailed Design Checklist — Yes / No
  - – Attachment A: Flood Affectation Information — Yes / No
  - – Attachment B: External Catchment Assessment — Yes / No
  - – Attachment C: On-line System Calculations — Yes / No
  - – Attachment D: Weir, Overflow and Surcharge Pathway Calculations — Yes / No
  - – Attachment E: Site Drainage Calculations — Yes / No
  - – Attachment F: Outlet Hydraulic Assessment — Yes / No
  - – Attachment G: Site Storage Details — Yes / No
  - – Attachment H: Drainage Design Summary Sheet — Yes / No

COUNCIL REVIEW DETAILS:

Council Review Officer's Name: ______________________________________

Review officer's comments: ____

____

____

____

Signature of Review Officer: ____________________ **Date**:__________________

** The above items are to be submitted in a single bound form — a 'loose leaf' format is unacceptable.

[iii] Form number changed to reflect new shorter checklist in third edition

OSD DETAILED DESIGN CHECKLIST

ITEM	DESIGNER		COUNCIL REVIEW	
	YES	NO	YES	NO
1. A Stormwater Concept Plan (SCP) has been approved previously (refer Section 4.1)				
2. The site (whole or partly) is defined as floodprone in a 100 year event				
If YES, see Plan No .... in Attachment A				
2(a) Has any floodplain storage been lost?				
If YES, see Plan No .... in Attachment A				
2(b) Has the floodprone area been excluded from the OSD calculations?				
2(c) Is the OSD system performance adversely affected by the 100 year flood level?				
3. Is there an external catchment draining into the site?				
If YES, see Plan No .... and calculations of 100 year ARI flow in Attachment B				
4. The location and extent of any floodway/flowpath has been determined, (refer Sections 4.1.3 & 4.2.2)				
If YES, see Plan No ....and accompanying 100 year event hydraulic calculations in Attachment B. Buildings are not inundated (and have the required freeboard) nor are flows concentrated on an adjoining property (refer Sections 4.1.3, 4.2.7 & 4.2.9)				
5. The detailed design submission is consistent with the approved SCP				
6. Are there any conditions on the development approval that may affect the drainage design (for example, trees to be retained)?				
7. The detailed design submission addresses the drainage-related conditions of the development approval				
8. A site layout plan with accompanying ground levels/contours which extend into adjoining properties is submitted				
If YES, see Plan No.				
9. Have other constraints, e.g. easements, services, been defined?				
If YES, see Plan No.				
10. How many OSD storage systems are there?.......................				
-				
11. Are the storage system/s off-line (refer Section 4.2.6)?				
If NO, see alternative calculations included in Attachment C				
12. State the type of discharge control device (i.e. orifice or………………..? Where the device is not an orifice, has specific Trust approval been obtained?				
13. The area of the site to be drained by each OSD storage has been determined, (refer Section 4.2.2)				
If YES, see Plan No.				
If YES, the uncommanded site percentage is ......% (to be less than 15%, refer Section 4.1.4 unless specific approval has been granted).				
14. The plan/s identify the maximum water levels, and the levels and locations of each storage's discharge point (refer Section 4.2.2)				
If YES, see Plan No				
15. The location of overflow structures and surcharge pathways have been determined, (refer Sections 4.2.2 & 4.2.9)				
If YES, see Plan No .... and calculations in Attachment D				
Buildings are not inundated nor are flows concentrated on an adjoining property (refer Sections 4.2.7 & 4.2.9)				
16. The drainage plans have been checked for consistency against the Architectural and landscaping plans				
17. A maintenance schedule has been prepared (ref Section 4.2.10)				

Where there is more than one OSD system, Questions 18 to 26 are to be answered separately for each OSD storage system.

OSD Storage system identifier...

ITEM	DESIGNER		COUNCIL REVIEW	
	YES	NO	YES	NO
18. The design explicitly shows how all the drained area grades to the storage, including roof gutter overflows (refer Section 6.2)				
If YES, see Plan No				
If NO, see calculations in Attachment E showing how all drainage system components (including all roof gutters, downpipes, collecting pits and pipe systems, etc) have 100 year ARI capacities with 50% blockage factor				
19. The invert level of storage is not less than ground level (or top of kerb) at point of connection to external stormwater system				
If YES, see Plan No.				
If NO, see explanatory notes in Attachment F				
20. The discharge control pit design is consistent with the principles shown in Figures 4.3, 7.10 and/or 7.11				
20(a) The DCP has an open grating type lid (for ease of inspection)				
20(b) The DCP minimum dimensions are consistent with Section 4.2.3				
20(c) The floor of the DCP has a localised sump adjacent to the orifice with level at least 150 mm below the return pipe, (refer Section 4.2.8)				
20(d) The return pipe from the storage is at least 150 mm in diameter (refer Section 4.2.8)				
20(e) The return pipe flap valve is consistent with Figure 4.3				
20(f) If an orifice control is specified, is it consistent with the requirements set out in Section 4.2.3?				
If YES, see: Plan No. .... for stainless steel plate specification, thickness and fixing to pit wall				
20(g) The overflow weir is fitted with a basket (refer Section 6.3).There is a surface grate above the basket to facilitate inspection and maintenance				
20(h) The high early discharge (HED) characteristics are consistent with the requirements set out in Section 4.2.3 including calculations for overflow depth to storage[iv].				
If YES, see: Plan No. .... for height of discharge to storage relative to permissible site discharge (PSD)				
Accompanying weir calculations in Attachment E				
Plan No .... showing majority of site drainage system connecting to the DCP & the volume of the DCP is small compared to the volume of the storage				
20(i) The screen design is consistent with Section 4.2.5				
If YES, see: Plan No............. for screen type, area and orientation				
Plan No............. for fabrication note re aperture orientation				
Plan No............. for fixing and handle details				
Plan No............. showing how all inflows to the DCP are on the upstream side of the screen protecting the orifice				
20(j) The outlet pipe from the DCP has a capacity at least twice the PSD (refer Section 4.2.4)				
If YES, see calculations in Attachment E				

.

[iv] Weir calculations clarified

ITEM	DESIGNER		COUNCIL REVIEW	
	YES	NO	YES	NO
21. If an above ground/landscaped storage is specified, answer Q21(a) to Q21(g), otherwise move to Q22.				
21(a) The first 10%-20% of storage is provided in an area able to tolerate frequent inundation(refer Section 4.2.7)				
21(b) Where the depth of ponding exceeds 600 mm, consideration has been given to whether there are steep drops, and/or a need for steps or 'walk-in' 'walk-out' batters, etc. when deciding if fencing and/or warning signs are required (Refer Sections 4.2.7 & 6.2)				
21(c) The landscaping treatment within the storage area is such that it does not limit storage volumes or provide a significant source of debris loading				
21(d) The minimum surface slope is consistent with Section 4.2.7				
21(e) Subsoil drainage is provided in areas subject to frequent ponding and around the outlet (refer Section 4.2.7)				
21(f) If the design includes a retaining wall, has it been structurally checked ?				
21(g) Does the system have the correct storage?				
If YES, see stage-storage calculations in Attachment G				
22. If a driveway/car-park storage is specified, answer Q22(a) to Q22(c), otherwise move to Q23				
22(a) The maximum depth is less than or equal to 200mm (refer Section 4.2.7)				
22(b) The minimum transverse slope is 0.7% (refer Section 4.2.7)				
22(c) The system has the correct storage				
If YES, see stage-storage calculations in Attachment G				
23. If a structural/underground storage is specified, answer Q 23(a) to Q 23(f), otherwise move to Q24				
23(a) The dimensions of openings are consistent with Section 4.2.8				
23(b) The storage floor has a minimum slope of 0.7% (refer Section 4.2.8)				
23(c) There are sufficient access points for flushing purposes (refer Section 4.2.8)				
23(d) There are sufficient grated openings for ventilation purposes (refer Section 4.2.8)				
23(e) All access points have light weight covers				
23(f) The system has the correct storage				
If YES, see stage-storage calculations in Attachment G				
24. The distribution of storage minimises inconvenience (refer Section 5.1.4)				
25. The Drainage Design Summary sheet has been completed (refer Appendix B1)				
If YES, see completed sheet in Attachment H				
26. The Drainage Design Summary sheet details are consistent with the design plans				

B10. OSD WAE SURVEY AND CERTIFICATION SUBMISSION[ii]

The following checklists have been provided to assist designers/surveyors to confirm that all necessary information has been provided to confirm the as built OSD facility complies with the design. The first WAE checklist is a shorter version of the second. The first list (B10A) is to be completed by the stormwater consultant and submitted to Council together with the plan/s and any necessary attachments.

The second more comprehensive checklist (B10B) may be used as an aid to ensure that all relevant information has been provided. It may also be submitted to Council instead of the shorter form if desired.

[i] Shorter checklist added in third edition

B10A OSD WAE SURVEY AND CERTIFICATION SUBMISSION[ii]

This form is to be completed and submitted to Council/Principal Certifying Authority (PCA) together with the plan/s and any necessary attachments.

PROJECTADDRESS: ______________________________

WAE PLAN DETAILS:

Company Name:______________________________

Name of surveyor: ____________________ **Date of WAE Plan:** ___________

Telephone No.: ____________________ **Fax No:** ____________________

Items submitted:	**Yes**	**No**	**NA**
• Signed WAE Plans	☐	☐	
• Certificate of Hydraulic Compliance (Form B11)	☐	☐	
• Certificate of Structural Compliance	☐	☐	☐
• OSD WAE Volume Calculations	☐	☐	

COUNCIL REVIEW DETAILS:

Reviewer's Name: ______________________________ **Date:**____________________

[ii] Form number changed to reflect new shorter checklist in third edition

OSD WAE & CERTIFICATION CHECKLIST	Yes	No	COUNCIL AGREES Yes	COUNCIL AGREES No
1. WAE Plans: (Section 4.3.3)				
Are there any major variations from the approved plans?	☐	☐	☐	☐
If so, is a Section 96 (EP&A Act) modification required?	☐	☐	☐	☐
Is the WAE plan superimposed on an approved design plan in red ink?	☐	☐	☐	☐
Has a WAE level boxed in red ink been shown at each design level?	☐	☐	☐	☐
Have WAE dimensions been shown adjacent to design dimensions?	☐	☐	☐	☐
Do the WAE plans show the following information:	☐	☐	☐	☐
• finished floor levels of dwellings and garages	☐	☐	☐	☐
• levels of overland flow paths	☐	☐	☐	☐
• area and flows from external catchment or reason why its ignoredt	☐	☐	☐	☐
For the Discharge Control Pit (DCP):	☐	☐	☐	☐
• internal pit dimensions	☐	☐	☐	☐
• diameter and centre line of orifice	☐	☐	☐	☐
• location, dimensions, distance from orifice for fitted screen	☐	☐	☐	☐
• levels of top and invert of pit	☐	☐	☐	☐
• levels of maximum water level and water level at HED	☐	☐	☐	☐
• Internal diameter of outlet pipe	☐	☐	☐	☐
For each storage:	☐	☐	☐	☐
• type of storage (roof, above ground, below ground, etc.)	☐	☐	☐	☐
• sufficient levels and dimensions to verify storage volumes	☐	☐	☐	☐
• calculations of actual volume achieved	☐	☐	☐	☐
• level, dimensions and location of overflow between DCP and storage	☐	☐	☐	☐
• site gradings and areas draining to or bypassing the storage(s)	☐	☐	☐	☐
2. Certification: (Section 4.3.4 & 4.3.5)	☐	☐	☐	☐
Has revised design summary sheet (Form B1) based on WAE been submitted?	☐	☐	☐	☐
Have upstream flows been ignored, and if so Why?	☐	☐	☐	☐
Are WAE calculations sufficient to show storage & PSD are satisfactory?	☐	☐	☐	☐
Does the WAE volume agree with design volume for each storage?	☐	☐	☐	☐
Does OSD system function correctly?	☐	☐	☐	☐
Have structural certificates been submitted?	☐	☐	☐	☐

B10B. OSD WAE SURVEY AND CERTIFICATION SUBMISSION[iii]

This form may to be completed by the stormwater designer and submitted to Council/Principal Certifying Authority (PCA) if Form B10A is not used.

PROJECT ADDRESS: ____

DEVELOPER:____

OSD DESIGNER DETAILS:

Company Name:____

Address:

____

Telephone No.: _____________________**Fax No**: ______________________

Accreditation Organisation: ____

Accreditation Reference: ___________________

Name and signature of designer: ____________________________________
(Print Name)

____ **Date**: _____________
(Signature)

Items submitted: **

- WAE Plan/s Yes / No
- Certificate of Hydraulic Compliance Yes / No
- Certificate of Structural Compliance Yes / No / NA
- WAE Survey and Certification Checklist Yes / No
  - -- Attachment A: OSD Volume Calculations Yes / No
  - -- Attachment B:OSD WAE Dimensions, etc. Yes / No

COUNCIL REVIEW DETAILS:

Council Review Officer's Name: _____________________________________

Review officer's comments: _______________________________________

____
____
____
____
____
____

Signature of Review Officer: ______________________ **Date**:_____________

** The above items are to be submitted in a single bound form — a 'loose leaf' format is unacceptable.

[iii] Form altered to reflect shorter checklist in third edition

OSD WAE & CERTIFICATION CHECKLIST

ITEM	DESIGNER		COUNCIL REVIEW	
	YES	NO	YES	NO
1. The WAE plan/s has/have been prepared				
If YES, see Plan No/Nos .... prepared by ....………… and dated				
1(a) The WAE plan or Attachment B provides the following information about each discharge control pit, DCP (refer Section 4.3.3)				
- internal pit dimensions				
- diameter of fitted orifice plate				
- location, dimensions, distance from orifice for fitted screen				
- levels of top and invert of pit				
- Internal diameter of outlet pipe				
1(b) The WAE survey provides the following information about each storage (ref Section 4.3.3)				
- type of storage (roof, above ground, below ground, etc.)				
- sufficient levels and dimensions to verify storage volumes				
- calculations of actual volume achieved, see Attachment A				
- level, dimensions and location of overflow structure between - DCP and storage				
1(c) The WAE plans provide the following information on internal drainage (ref Section 4.3.3)				
- pit lid types and surface levels				
- invert levels and diameters of pipes				
- location, dimensions and levels of any floodways and/or overland flowpaths				
- sufficient spot levels to show site gradings and extent of areas draining and not draining to the storage(s)				
1(d) The WAE plan provides finished floor levels of dwellings and garages (refer Section 4.3.3)				
2. The following drainage-related structural elements have been constructed in accordance with the design (refer Section 4.3.5)				
2(a) Free standing walls (see certificate of structural compliance)				
2(b) Retaining walls (see certificate of structural compliance)				
2(c) Underground storages (see certificate of structural compliance)				

Final site inspection details: By……………………………………………Date:……………………

ITEM	DESIGNER		COUNCIL REVIEW	
	YES	NO	YES	NO
3(a) Each discharge control pit complies with the following requirements (refer Section 4.3.4). See also Attachment B				
- DCP dimensions and levels comply with design parameters				
- material, thickness, diameter and sharp edge of fitted orifice plate				
- the orifice plate is securely fitted				
- the orifice is screened and the screen is properly fixed, located and able to be easily removed				
- outlet pipe is the correct diameter, level and grade (to ensure there is free discharge through the orifice)				
- the levels of the top water surface, storage invert and DCP are such that the design discharge from the storage is achieved				
- in design cases of 'high early discharge', runoff from sufficient areas of the site is directed to the DCP				
- the specified flap valve is fitted correctly				
3(b) Each storage complies with the following requirements (refer Section4.3.4), see also Attachment B				
- the actual volume achieved is adequate				
- the actual top water level will not result in either unintended surcharge of the internal drainage system and/or inundation or inadequate freeboard to finished floor levels				
- the base of the storage is well graded and drains to the DCP				
- Spillways and overflow paths are constructed to the correct levels and are free from obstructions				
3(c) The internal drainage complies with the following requirements (refer Section 4.3.4)				
- site gradings are in accordance with the design expectation (regarding areas to be commanded by each storage)				
- the internal drainage lines are of a sufficient size, level and grade to convey the flows to the storage				
- storages cannot be by-passed by overflows from the internal system or by overflows from any surface area designed to drain to the storages				
- floodways and/or overland flowpaths designed to divert flows around the basin have been properly constructed and will function as designed				
- general workmanship is adequate to prevent long-term failure of the system				
3(d) The finished levels of structures (e.g. dwellings, garages) are sufficiently above the as-constructed maximum water surface levels in the storage and flowpaths (refer Section 4.3.4)				
3(e) An emergency spillway or overflow path has been provided so that surcharge will not cause stormwater to enter buildings where significant damage would occur				
3(f) All drainage pits, pipes, storages are in a clean condition and free of building materials,				

ATTACHMENT B: OSD WAE DIMENSIONS, ETC.

DESCRIPTION	APPROVED	WAE	CERTIFIER'S COMMENTS
DISCHARGE CONTROL PIT:			
(a) Orifice diameter (mm)			
(b) Orifice plate material			
(c) Pit width (m)			
(d) Pit breadth (m)			
WEIR:			
(a) Reduced level			
(b) Width			
(c) Height (mm)			
DCP invert level			
Access grate dimensions			
STORAGE:			
(a) Top water level			
(b) Storage volume (m^3)			
(c) Freeboard to F.F.L. (mm)			
(i) Habitable area			
(ii) Garage			
Maximum depth of water (mm)			

CERTIFIER'S NAME: ……………………………………………….

SIGNATURE: ……………………………………………………...

DATE: ………………………………………………………………

FORM B.11
UPPER PARRAMATTA RIVER CATCHMENT TRUST

ON-SITE STORMWATER DETENTION SYSTEM

CERTIFICATE OF HYDRAULIC COMPLIANCE

BAULKHAM HILLS/BLACKTOWN CITY/HOLROYD CITY/PARRAMATTA CITY COUNCIL

(delete not applicable)

JOB NO: ________________ **DA NO:** ________________ **BA NO:** ________________

PROJECT: ____

LOCATION: ____

DESIGNED BY: _________________________ **CONSTRUCTION CERTIFIED BY:**______________________

QUALIFICATIONS: ______________________ **TELEPHONE:** ________________________

1.0 WORKS CONSTRUCTED IN ACCORDANCE WITH DESIGN. (Delete if not applicable)

I _____________________ of ______________________ (accredited professional being competent to practice in the field of stormwater drainage design) have inspected the above on-site stormwater detention system and certify that the works have been constructed and can be maintained[i] in accordance with the approved design details for the above mentioned project.

Signature: ____________________ **Date:** _________

2.0 CONSTRUCTION VARIATIONS NOT AFFECTING DESIGN PERFORMANCE. (Delete if not applicable)

I _____________________ of ______________________ (accredited professional being competent to practice in the field of stormwater drainage design) have inspected the above on-site stormwater detention system and certify that the works have been constructed and can be maintained in accordance with the approved design details for the above mentioned project, except for the variations listed below which do not affect the performance of the system, subject to satisfactory maintenance.

Variations:
____

____

____

Signature: ____________________ **Date:** __________

3.0 AUTHORITY TO RELEASE PLANS TO FUTURE OWNERS OF THE PROPERTY
As the copyright owner of the drainage plans, I hereby authorise release of the approved plans/attached sketch plan to future owners of the property to assist in the maintenance of the On-site Stormwater Detention system.

Signature: ____________________ **Date:** __________

Name: ______________________________(Print)

[i] Maintainability added for third edition

FORM B.12

UPPER PARRAMATTA RIVER CATCHMENT TRUST

ON-SITE STORMWATER DETENTION SYSTEM

LIST OF OUTSTANDING WORKS
BAULKHAM HILLS/BLACKTOWN CITY/HOLROYD CITY/PARRAMATTA CITY COUNCIL

(delete not applicable)

JOB NO: _______________ **DA NO:** _______________ **BA NO:** _______________

PROJECT:

____

LOCATION:

____

DESIGNED BY: ________________________ **CONSTRUCTION CERTIFIED BY:** ________________________

QUALIFICATIONS: _____________________ **TELEPHONE:** ________________________

1.0 CONSTRUCTION VARIATIONS AFFECTING DESIGN PERFORMANCE.

I ____________________ of _____________________ (accredited professional being competent to practice in the field of stormwater drainage design) have inspected the above on-site stormwater detention system and the following variations to the approved design. The listed remedial works will be necessary to make the system function and/or be maintained according to the approved design.

Variation	Remedial Work Necessary

Signature: ___________________ **Date:** _________

Appendix C - Signs

OSD Warning Sign[i]

Signs are only required for OSD systems where deemed necessary by Council because of the depth and/or location of the storage.

The size of the sign will depend on the individual situation. The following guidelines are suggested:

- 600 mm x 450 mm Open areas or large developments.
- 400 mm x 300 mm Restricted areas.

Confined Space Sign

Signs are required at each entry into confined spaces, such as deep pits or underground storages. Signs may be made of metal or a durable synthetic material.

The size of the sign will depend on the individual situation, but the following sizes are suggested as a guide:

- 300 mm x 450 mm Large entries (such as doors)
- 187.5 mm x 250mm Small entries (such as manholes)

OSD Sign[ii]

These signs should be located in or near the OSD facility to alert future owners of their obligations to maintain the facility.

[i] Sign name changed in third edition
[ii] New sign added in third edition

OSD Warning Sign

Colours:

Triangle and “WARNING”	Red
Water	Blue
Figure and other lettering	Black

Confined Space Warning Sign

Colours:

"DANGER" and background	White
Elliptical area	Red
Rectangle containing elipse	Black
Other lettering and border	Black

OSD Sign

SIZE: 110 mm x 80 mm
CORNERS: Square
COLOUR: Etched and filled Black Legend on Natural Silver Background
MATERIAL: Aluminium 0.9mm Mill

Appendix E – Lists of Manufacturers of Proprietary and Other OSD Products and Maintenance Contractors

Manufacturer	Address	Products
ACO-Polycrete Australia	185 Briens Road NORTHMEAD 2152 Tel: (02)9630 2788	Precast discharge pits.
Barrys Signs	180 Targo Rd GIRRAWEEN NSW 2145 Tel: (02)9631 1351	Warning signs
BCP Precast Pty Ltd	Pacific Highway CHARMHAVEN 2263 Tel: (0243) 923 300	Reinforced concrete storage and precast discharge control pits.
De Neefe Signs Pty Ltd	13 James Ruse Drive GRANVILLE NSW 2142 Tel: (02)9637 0218	Warning signs
Everhard Industries	3 Jumal Place SMITHFIELD 2164 Tel: (02)9604 5955	Screens, flap valves, orifice plates, concrete and plastic discharge control pits, concrete storages.
Hu-Tech Metal Products	37 Anzac Street GREENACRE 2190 Tel: (02)9790 0100	Screens, flap valves, orifice plates and tailwater discharge compensators, confined space sign and OSD sign[i].
Ingal Civil Products	127-141 Bath Road SUTHERLAND 2232 TEL: (02)9521 2711	Buffa-tank storage systems.
Mascot Engineering Group	45-51 Clapham Road REGENTS PARK 2143 Tel: (02)9644 1044	Discharge control pits, light weight lids, screens, orifice plates.
Signs Of Safety	74 Fitzwilliam Road TOONGABBIE 2146 Tel: (02)9636 8813	Warning signs.
Wilmac Pty Ltd	40 Burrabogee Road PENDLE HILL 2145 Tel: (02)9631 0957	Screens, flap valves, precast pits, orifice plates, confined space sign and OSD sign[ii].
RMS Roadsigns	2 Cawarra Road TAREN POINT NSW 2229 Tel: (02)9540 4400	Warning Signs
Safetyman Signs Pty Ltd	17 Commercial Road KINGSGROVE NSW 2208 Tel: (02) 9502 2300	Warning Signs

[i] Additional products added in third edition
[ii] Additional products added in third edition

OSD Maintenance Contractors

The Trust sought updated expressions of interest in April 2004[i] from companies or individuals able to maintain OSD facilities . The following companies responded and have provided details of their maintenance capability. The list is provided to assist owners to maintain OSD facilities on their properties. No attempt has been made to check the credentials of the listed firms, nor are any specifically recommended by the Trust.

The selection of a suitable maintenance contractor and agreement on the works to be undertaken are matters for individual owners. The Trust will not be liable for any losses incurred by either the owner or the contractor.

COMPANY	CONTACT DETAILS	STATED MAINTENANCE CAPABILITY
Australian Wastewater Management Strategies Pty Ltd Suite 1/191 Blues Point Road, NORTH SYDNEY NSW 2060	Mr Armen Mesrobian (02) 9460 2020 (ph) (02) 9460 2121 (fax) AWMS1@bigpond.com (email)	-General repair and maintenance -Envirocell Sewage treatment systems
Beachs Fencing 82 Ulundri Drive CASTLE HILL NSW 2154	Mr Robert Beach (02) 9680 3247 (ph) 0408 470 783 (mob)	-General maintenance
Collex Industrial Services PO Box 4574 MILPERRA DC NSW 1891	Ms Carol Smith (02) 9709 3011 (ph) (02) 9709 3411 (fax)	-Stormwater, Gross Pollution Traps and Sewer maintenance services -Confined space trained staff
D-CO Plumbing and Drainage P/L PO Box 3350 ROUSE HILL NSW 2155	Mr Keenan Di Francesco (02) 9836 5654 (ph) 0419 126 166 (mob) (02) 9636 3120 (fax)	-Plumbing and Draining -General cleaning and maintenance
BR Durham& Son Pty Ltd Lot 103, Curtis Road MULGRAVE NSW 2756	Mr Denis Durham, Mr Charles Durham (02) 4587 7011 (ph) (02) 4587 7069 0418 861 977 (Denis) 0418 202 094 (Charles) sales@durham.com.au	-Suppliers of civil drainage products -Maintenance of drainage systems including Full Vacuum Pump cleanout (for road use)
Ecosol Wastewater Filtration Systems Unit 29/56 O'Riordan Street ALEXANDRIA NSW 2015	Mr Andrew Middleton (02) 9669 6000 (ph) (02) 9669 6100 (fax) 0427 013 355 (mob) info@ecosol.com.au (email)	-Design, supply, installation, cleaning and maintenance of solid pollutant filters.
Envirocivil (NSW) P/L PO Box 158 LANE COVE NSW 1595	Mr Peter Day (02) 9418 9601 (ph) (02) 9418 3498 (fax) 0412 232 859 (mob) peterday@netspace.net.au (email)	-General cleaning and maintenance

[i] Revised list added for third edition

COMPANY	CONTACT DETAILS	STATED MAINTENANCE CAPABILITY
James Plumbing Services 7/143 Coreen Avenue PENRITH NSW 2750	Mr Steve James, (02) 4722 9698 (ph) (02) 4722 8481 (fax)	-Plumbing and drainage installation, repair and maintenance
Storm Water Systems PO Box 96 PYRMONT NSW 2009	Mr Anto Pratten (02) 9555 8744 (ph) (02) 9555 8766 (fax) 0419 419 478 (mob) antopratten@stormwater.com.au (email)	-Supply and install floating booms, end of line traps and pit inserts -Vacuum eductor truck -Cleaning and maintenance of pits and pollution devices
Sydney Wide Pipe Cleaning Pty Ltd PO Box 506 BLACKTOWN NSW 2148	Mr Jeff Field (02) 9627 7133 (ph) (02) 9627 7144 (fax) 0417 924 993 (mob) sydwide@bigpond.com.au (email)	-OSD cleaning & maintenance -High velocity water jetting -CCTV pipeline inspections -Rootcutting -Grease trap cleansing -Liquid waste transport
Transpacific Industrial Solutions Pty Ltd PO Box 20 CARRINGTON NSW 2294	Mr Ian Wellsmore (02) 4967 6600 (ph) (02) 4967 3337 (fax)	-maintenance, cleaning and service of stormwater and waste water infrastructure -facilities maintenance -drain cleaning -CCTV inspections

Appendix F – OSD Parameters Outside Upper Parramatta River Catchment[i]

Baulkham Hills Shire Council (BHSC), Holroyd City Council (HCC) and Parramatta City Council (PCC) have adopted the principles of the Trust policy for other catchments in their local government areas. The parameters to be used for the other catchments are given in the table below.

Blacktown City Council (BCC) requires OSD in identified drainage problem areas outside the upper Parramatta River catchment. Contact Council's Drainage[ii] Engineers for further information

Local Government Area	Catchment	Site Slope *BHSC only	PSD (l/s/ha)	SSR (m3/ha)
BHSC	Hawkesbury River	>15%	136	298
BHSC	Hawkesbury River	10% to 15%	115	336
BHSC	Hawkesbury River	6% to 10%	104	362
BHSC	Hawkesbury River	3% to 6%	92	396
BHSC	Hawkesbury River	0% to 3%	87	412
HCC	A'Becketts Creek		140	300
HCC	Duck Creek		140	300
HCC	Prospect Creek		140	300
PCC	A'Becketts and Duck River/Creek		80	470
PCC	Claycliff Creek		235	215
PCC	Devlins Creek		210	250
PCC	Parramatta River – North Side - Charles St to Vineyard Creek		208	235
PCC	Parramatta River – North Side – East of Vineyard Creek		280	190
PCC	Parramatta River –South Side –		80	470
PCC	Ponds/Subiaco Creek		130	330
PCC	Terrys Creek		210	250
PCC	Vineyard Creek		160	285

Additional notes for BHSC

The OSD policy applies to the Hawkesbury River catchment within the shire except in :

- the Rouse Hill Development Area (including Norwest Business Park) defined as the gazetted River Management Area.
- Bingara Drainage Catchment and Barina Downs North Precinct as defined in Section 94 Contribution Plan No 3 – Crestwood.

[i] Parameters for other areas of catchment councils added in third edition.
[ii] Clarification of contact point at BCC added in third edition

Appendix I. Stormwater Industry Association On-site Stormwater Detention Excellence Award Winners And On-site Stormwater Detention Regional Environment Award Winners[i]

Note: The Trust sponsored the national Stormwater Industry Association (SIA) OSD Excellence Awards in 1999-2001. That sponsorship was refocussed on the SIA's Educational Excellence Award from 2002, and the Award for OSD Excellence for design or construction was incorporated into the Regional Environment Awards sponsored by the Trust and the four catchment councils. Projects for the Regional Environment Awards must be located within one of the Cities of Blacktown, Holroyd or Parramatta or the Shire of Baulkham Hills.

Year	Winner	Highly Commended
1999	Haddad Khaicy Partners 80 Weston Street, Harris Park NSW Tel: 9687 9222	
2000	D S Agencies Pty Ltd PO Box 7027 Cloisters Square WA 6850 Tel: (08) 9322 3090	• Haddad Khaicy Partners 80 Weston Street, Harris Park NSW Tel: 9687 9222 • Rammy Associates PO Box 280, Pendle Hill NSW 2145 Tel: 9896 6116
2001	Tweed Shire Council Tumbulgum Road Murwillumbah NSW 2484 Tel: (02) 6670 2400	
2002	*Messrs Steve Arraj and Giorgio Bucci* *of* Dincel & Associates Level 3, 7K Parkes Street, Parramatta NSW 2150	
2003		*Mr Steve Arraj* *of* Haddad Khaicy Mance Arraj Partners 1/142 James Ruse Drive Rosehill NSW 2150
2004	*Messrs Steve Arraj and Giorgio Bucci* *Of* Haddad Khalil Mance Arraj Partners 1/142 James Ruse Drive Rosehill NSW 2150	

[i] Winners names updated in third edition

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