ABSTRACT
The Sydney Catchment Authority (SCA) has developed a manual Designing and Installing On-Site Wastewater Systems to provide technical information to help design, install, inspect and assess on-site wastewater treatment and effluent disposal systems in the greater Sydney drinking water catchment.

The manual is an SCA endorsed current recommended practice developed under the Drinking Water Catchment SEPP to provide additional information regarding the design, installation and inspection of on-site systems. The aim is to reduce system failures that pose risks to water quality and human health. It provides detailed information for a variety of common systems in an easy to use form.

INTRODUCTION
The SCA is a NSW government agency established in 1999 to supply raw water to greater Sydney. The SCA’s multi-barrier approach includes the protection of water quality in the catchment, which covers almost 16,000 square kilometres across 15 local government areas. It extends from north of Lithgow, west to beyond Goulburn, south of Braidwood, east to the Kangaroo Valley and almost to Wollongong and Sutherland (Figure 1).

The SCA’s approach encompasses strategies and programs addressing on-site wastewater treatment and effluent disposal systems. There are some 15,000 on-site systems in the catchment, and approximately 300 new on-site systems are approved by councils for installation annually. On-site systems have been designed according to the ‘Silver Book’ (DLG 1998) and the Australian Standard (AS/NZS1547:2000, now replaced by AS/NZS1547:2012) in conjunction with the SCA’s own specific requirements, discussed below.

Design and/or installation faults may lead to early failure or underperformance of the treatment system, with consequent water quality and human health risks. The SCA has identified a significant number of on-site systems that have failed from their first day of operation either due to the absence of detailed design or poor installation practices.

To improve design and installation practices, the SCA has developed the Designing and Installing On-Site Wastewater Systems manual. It provides technical installation and other details to supplement information in the ‘Silver Book’ and the Australian Standard. Although the manual has been specifically developed for use in the greater Sydney drinking water catchment, incorporating specific SCA requirements and information regarding catchment climate, soils, and other characteristics, it may well have wider application.

DISCUSSION
The SEPP and current recommended practices
To support the SCA in its role in protecting water quality in the catchment, it has been provided with statutory powers to regulate development. The most recent version of the planning instrument that provides these powers is State Environmental
Planning Policy (Sydney Drinking Water Catchment) 2011 (the SEPP).

The SEPP provides a concurrence role for the SCA in control and management of all proposed development in the catchment, including on-site systems. Under the SEPP, any development in the catchment that requires council consent must have a neutral or beneficial effect (NorBE) on water quality. NorBE is satisfied if a proposed development:

- has no identifiable impact on water quality, or
- will contain any water quality impact on the development site and prevent it from reaching any watercourse, waterbody or drainage depression, or
- will transfer any water quality impact outside the site where it is treated and disposed of to standards approved by the consent authority (SCA 2011).

The SCA has developed a number of tools, models, standards and guidelines to assist in the assessment of NorBE. These include an on-line NorBE decision tool that incorporates a GIS-based, effluent plume model – the ‘wastewater effluent model’ (WEM) for developments that include on-site systems. The WEM integrates environmental constraints such as slope, soil permeability, depth, phosphorus sorption, rainfall, and the nature, size and location of on-site systems. Using this information, the WEM calculates, and provides a visual representation of the long-term extent and direction of the effluent plume generated by the on-site system.

Another requirement of the SEPP is that all developments must also incorporate current recommended practices (CRPs) or performance standards. CRPs and performance standards are best management practices that have either been endorsed or developed by the SCA to help protect water quality.

The SCA currently maintains a list of 42 CRPs, in such categories as construction earthworks, stormwater management, on-site sewage management, roads, landfill, composting, intensive livestock, horticulture, pesticides, riparian management, rural residential subdivision, as well as the preparation of environmental management plans and water cycle management studies.

Designing and Installing On-Site Wastewater Systems (Figure 2) was developed by the SCA as a CRP and published in May 2012. Hard copies of the manual have been provided to catchment councils, consultants that operate in the catchment, as well as various government agencies. An electronic version of the manual is also available on the SCA’s website at www.sca.nsw.gov.au.

![Designing and Installing On-Site Wastewater Systems](image)

**Figure 2: The new current recommended practice**

**Using the manual**

The manual identifies and describes practical solutions for specific site constraints for the most common wastewater treatment and effluent disposal systems, such as septic tanks, aerated wastewater treatment systems (AWTS), mounds, trenches and irrigation systems. Although focused particularly towards designers and installers the manual addresses the needs of a wide range of individuals involved in the design, installation, assessment, inspection and operation of on-site systems.

The manual first outlines information particularly for designers and regulators to be considered in the land capability assessment that must be completed for each site. It includes an evaluation of the constraints - soils and climate, consideration of nutrient and hydraulic balances, sizing the effluent management area, wastewater design loadings, linear loading rates, minimum separation and setback requirements, and considerations for choosing a particular system type.

Specific SCA requirements that must be taken into account for on-site system design and installation in the catchment are also discussed which include amongst others:

- buffer distances to drainage depressions (40m), watercourses (100m) and named rivers (150m)
- design wastewater loading calculations that are made based on bedroom numbers (rather than occupant numbers)
- requirement for fixed irrigation systems (moveable surface irrigation hoses are unacceptable)
• the unsustainable nature of pump out systems as a permanent solution, rendering them unacceptable (although they may be considered in exceptional circumstances and where a location will be connected to the sewer in the near future)
• the requirement for a continuous electricity supply for some systems such as AWTSs, rendering solar power unacceptable
• the unsuitability of certain wastewater systems such as an AWTSs for intermittent wastewater loads such as from weekenders, and
• the unsuitability of surface irrigation (in winter) in sites subject to severe and prolonged frosts.

The main part of the manual is structured such that wastewater treatment systems are listed separately from effluent disposal systems. The manual uses colour-coded sections so that the user can choose the relevant treatment system (from Sections 3 to 7) and an appropriate effluent management method associated with that treatment system (from Sections 8 to 14). Table 1 shows the directory for the various treatment system types and appropriate effluent management method for each system.

Each section includes information on:
• the design requirements
• installation details (such as site layout, excavation and ground preparation, transportation and lifting, installation, connecting and sealing pipes, fittings and lids; anchoring, backfilling and revegetation)
• testing
• inspection
• operation
• common technical issues, and
• a case study to illustrate problems and identify solutions.

The manual also includes numerous detailed checklists (example Table 2) for both treatment and effluent management systems, particularly for use by installers and council inspectors.

The installation checklists enable the installer or inspector to systematically go through or identify the sequential installation and construction steps and tasks, and record technical and design details or specifications. Sound hydraulic design is required, particularly for irrigation systems. Besides enabling council inspectors to check whether installations have been carried out correctly at different stages, and whether the installed system is operating correctly, the necessary collation of information provides an important record of what has been installed for future reference e.g. for future inspections, maintenance, or decommissioning.

Separate operational checklists for treatment and disposal systems are also provided, and enable council inspectors and service agents to systematically identify the issues to be considered during inspections. These checklists also enable owners to monitor their on-site systems. While the checklists are comprehensive they can be adapted to suit site-specific requirements.

The manual also includes detailed, annotated A3-sized standard drawings (example Figure 3) that illustrate proper design, inclusions, dimensions, layout and construction details for each effluent disposal system.

Common technical issues are identified for both treatment and disposal systems. Illustrated case studies are used to demonstrate technical problems and suggest prevention or mitigation measures to avoid or minimise the risk of failure.

Case studies

An example in Section 3 of the manual (Septic Tanks) discusses the case of the installation of a septic tank and pump well on a site prone to high groundwater. After significant rain, the plastic tank lifted out of the ground (Figure 4), rupturing both the inlet and outlet pipes and resulting in the continuous discharge of primary treated effluent from the septic tank. The case study discusses how this may be fixed by anchoring the tank into the ground and providing adequate drainage.

These and other issues are identified as a series of sequential steps in the correct installation of a septic tank in this Section.

An example in Section 13 (Subsurface Irrigation) discusses the case of an AWTS and subsurface irrigation drip line installed on an unvegetated sloping site, with significant areas of exposed rock, and with a very thin soil layer overlying solid rock on other areas of the site. After the system was used for a short period of time, failure at a number of points in the system were identified.

When the installer was asked to relocate and reinstall the irrigation system in accordance with council and SCA requirements, many of the same issues recurred. The manual describes the issues and the measures that would have prevented these problems:
- Some parts of the effluent irrigation area were heavily irrigated while other areas received no effluent and remained dry. In some areas what little soil there was began to erode and wash away and expose the irrigation system, and surface ponding of effluent was observed. Also, the irrigation pump failed and the high-level alarm activated.

The irrigation area should have been divided into a number of smaller subfields to ensure even effluent distribution throughout the area, along with the installation of an automatic sequencing valve to allow subfields to be irrigated sequentially without manual owner involvement. A flushing manifold should also have been fitted to the system, and the system tested before covering with soil.

The preparation of a proper hydraulic design for the irrigation area and subfields including system components and pump should have been completed by the designer rather than the installer. The hydraulic design and the requirements of council and the SCA inform the location and installation of the irrigation area.

- Parts of the effluent irrigation area became infested with weeds, which could have been avoided by turfing with suitable grass species immediately following installation.

- The effluent distribution pipe from the tank to the irrigation area, buried just 5cm deep under an access track used by fully laden fire service tankers, was crushed, and the exposed lines and pipes (Figure 5) developed cracks and breaks as a result of UV exposure.

The proper burial of all irrigation dripper lines, manifolds and laterals, and the appropriate burial of the distribution line from the tank to the effluent irrigation area – a minimum depth of 300mm (500mm under an access track) and laid in a manner that prevents damage or deformation – would have prevented these problems arising.

- In addition, a council inspection of the installation prior to the issuance of an Approval to Operate to ensure compliance with requirements should have occurred. The installer (and property owner) must be made aware of the proposed system, the conditions of consent and their obligations to install the system in accordance with these requirements. Finally, written certification by the installer that the system was installed as designed and required must be completed.

**Designer and installer responsibilities**

Currently most on-site wastewater system reports are high-level design documents that do not provide the practical details of system design to accommodate site-specific hydraulic requirements. Such details are often ignored altogether or left to the installer, which can lead to problems such as identified above, or to installations that are inconsistent with the requirements of the consent.

The manual has sought to identify and clarify roles, responsibilities and accountabilities, particularly of the designer and the installer. Increased accountabilities and requirements for certification at the different stages of design, installation, operation and maintenance of on-site systems have also been identified.

Three templates are provided to clarify design and installation responsibilities and facilitate more effective transfer of information between the designer and the installer. The effect of these templates is to attribute full responsibility for the design of an on-site system in the context of site and other constraints to the wastewater consultant/designer. It limits the installer simply to installation, although it does not prevent liaison with the designer where problems are identified.

- **Design Producer Statement** – used by the designer to warrant the design of the effluent disposal system. The Statement may specify that an inspection by the designer is required at a particular point, and also identifies that changes to the design should be agreed by the designer to avoid invalidating the warranty.

- **System Design** – prepared by the designer to provide details of the technical and hydraulic design of the treatment and disposal systems, and is ultimately provided to the installer. It illustrates the system location, layout and configuration, together with appropriate plans, construction drawings and detailed design elements. Through the System Design, the designer certifies that if installed correctly as per the design the system will perform as expected.

- **Installation Certificate** – prepared by the installer, through which they certify that the system was installed in accordance with the System Design. A copy of the Installation
Certificate would be provided to both council and the designer, and possibly the owner. The Design Producer Statement and System Design will necessitate greater site-specific design detail in wastewater reports that go beyond the high-level design that currently largely characterises such reports. Together, these documents provide a higher level of confidence for homeowners and regulators, particularly for more constrained sites.

CONCLUSION

Designing and Installing On-Site Wastewater Systems has been developed by the SCA to help design consultants, system installers, plumbers, contractors, council officers and property owners, to ensure best practice methods are used to design and install on-site systems in greater Sydney’s drinking water catchment. It provides practical solutions in relation to specific site constraints for a range of wastewater treatment and effluent disposal systems to ensure effectively functioning system and to assist in the protection of water quality and human health. The manual also clarifies the design and installation responsibilities, provides for better communication between designer and installer, and provides a mechanism for the acceptance of these responsibilities.


ACKNOWLEDGEMENTS

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The draft manual was reviewed by a number of private consultants, the Master Plumbers Association, NSW Health, the Division of Local Government and the SCA’s Local Government Reference Panel before finalisation and publication. Other SCA staff, in particular James Caddey and Greg Greene, also provided input to the development of this manual.

NOMENCLATURE

AWTS
Aerated wastewater treatment system.

Catchment
A hydrological catchment or area of land where surface water drains through a network of drainage lines and streams to a single outlet.

CRP
Current recommended practice.

ETA
Evapotranspiration absorption.

Named rivers
The Wingecarribee River, Wollondilly River, Nattai River, Nepean River, Coxs River, Shoalhaven River, Kangaroo River, Mongarlowe River, Tarlo River for the full length of each river as defined on a topographic map, and the Mulwaree River downstream from the Braidwood Road Crossing (SCA 2011).

NorBE
Neutral or beneficial effect on water quality test.

SCA
Sydney Catchment Authority.

SEPP
State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011.

REFERENCES


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<th>System Checklist No.s</th>
<th>Select Effluent Management Method</th>
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<td>6.1, 6.2</td>
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<td><strong>Section 14</strong></td>
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<tr>
<td>Emerging Technologies</td>
<td>-</td>
<td>Various technologies to assist in effluent disposal</td>
<td>-</td>
<td>-</td>
</tr>
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</table>

**Notes**

1. Treatment should be accomplished either in two, three, or four separate beds. Each percolating bed's volume should be equal to the effluent volume. Percolating beds should be designed to ensure a maximum effluent flow rate of 1 inch per day. In general, the percolating bed's volume should be equal to the effluent volume to ensure effective treatment.

2. The length of each percolating bed should be equal to the width of the treatment area. The width of the treatment area should be equal to the depth of the percolating bed. The depth of the percolating bed should be equal to the width of the treatment area.

3. The length of each percolating bed should be equal to the width of the treatment area. The width of the treatment area should be equal to the depth of the percolating bed. The depth of the percolating bed should be equal to the width of the treatment area.

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11. The length of each percolating bed should be equal to the width of the treatment area. The width of the treatment area should be equal to the depth of the percolating bed. The depth of the percolating bed should be equal to the width of the treatment area.

**Standard Drawing 10B - Absorption Trench / Bed (not to scale)**

Figure 3: Example of a Standard Drawing
### Table 2: Example of a Checklist

#### Checklist 10.1 Installation of trenches and beds for use by plumbers / installers and Council inspectors

<table>
<thead>
<tr>
<th>Type of system:</th>
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</thead>
<tbody>
<tr>
<td>Method of application</td>
</tr>
<tr>
<td>Configuration</td>
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<tr>
<td>Pre-construction considerations</td>
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<tr>
<td>Is the soil moisture too wet for construction?</td>
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<tr>
<td>Site preparation</td>
</tr>
<tr>
<td>Trench / bed area marked according to site plan / conditions of consent including buffer and setback distances</td>
</tr>
<tr>
<td>Trenches / beds positioned according to design requirements for contours</td>
</tr>
<tr>
<td>Trench or bed dimensions</td>
</tr>
<tr>
<td>Number of trenches / beds</td>
</tr>
<tr>
<td>Width: mm</td>
</tr>
<tr>
<td>Trench / bed dimensions consistent with council’s consent</td>
</tr>
<tr>
<td>Confirm all system elevations</td>
</tr>
<tr>
<td>Stake trench / bed boundaries with elevations</td>
</tr>
<tr>
<td>Method of excavation:</td>
</tr>
<tr>
<td>Trench / bed bottom graded to specifications</td>
</tr>
<tr>
<td>Inspection ports</td>
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<tr>
<td>Type:</td>
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<tr>
<td>Perforations</td>
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<tr>
<td>Grade (1) from tank to trench</td>
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<tr>
<td>Media</td>
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<td>Gravel</td>
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<tr>
<td>Media size and source: Cleaned and graded</td>
</tr>
<tr>
<td>Total media depth: mm</td>
</tr>
<tr>
<td>Distribution system</td>
</tr>
<tr>
<td>Gravity distribution device</td>
</tr>
<tr>
<td>Type</td>
</tr>
<tr>
<td>Description of header:</td>
</tr>
</tbody>
</table>
Distribution system access

- None (surface)
- Riser
- Other (give details):

Valve type (where applicable)

Alternating / sequencing valve (describe):

Field sequencing

- Globe
- Gate ball
- Other

Installation access

- In valve box in the field
- In bedding material
- In dosing tank

Pressure manifold

Specification:

Laterals feed configuration

- End
- Top
- Centre
- Bottom
- Other (give details):

Type

- Diameter: mm
- Length: mm

Orifices specifications / spacing / size / orientation (describe):

Access / protection

- Yes
- No

Describe:

Laterals

Specification:

- Type:
- Diameter: mm
- Spacing: mm
- Length: mm

Installation

Geotextile fabric cover placed over media

- Yes
- No

Final topsoil cover

- Depth of topsoil: mm

Imported material needed

- Yes
- No

Nature of material (describe; should be clay loam – sandy loam):

Stormwater diversion berm / drain where needed

- Yes
- No

Grass vegetation cover established over site:

Service provider:

Contact number:

Comments, action or repairs needed: (Where a response in the above Checklist needs extra information or action, specify the action plan and/or the process to fix the problem, or specify an alternative that is being offered)

Name / title of inspector:

Signature: Date:

(1) Grade must be consistent with 'PCA 2004 Plumbing Code of Australia'.