Emi-5 Watercourse Pollution

POINTS AVAILABLE 3

AIM OF CREDIT

To encourage and recognise developments that minimise stormwater run-off to, and the pollution of, natural watercourses and wetlands.

CREDIT CRITERIA

Up to three points are awarded independently as follows:

One point is awarded where:

- The development does not increase (pre-development) peak stormwater flows for rainfall events of up to a 1-in-2 year storm;

  AND

- The Total Suspended Solids (TSS) are reduced by 80% for the runoff volume resulting from the 1-in-2 year storm;

  AND

- Litter, oil and grease are trapped at source.

One point is awarded where:

- The development does not increase (pre-development) peak stormwater flows for rainfall events of up to a 1-in-20 year storm;

  AND

- Litter, oil and grease are trapped at source.

One point is awarded where:

- The runoff volume resulting from the 1 day rainfall, that is equalled or exceeded on average 3 times per year, is either captured and re-used on-site or infiltrated within the site;

  AND

- Litter, oil and grease are trapped at source.

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DOCUMENTATION REQUIREMENTS

Green Star SA – Design	Green Star SA – As Built
Submit all the evidence and ensure it readily confirms compliance.	Submit all the evidence and ensure it readily confirms compliance.
1. Short report 2. Tender drawing(s) 3. Extract(s) from tender documentation 4. Maintenance Plan(s)	1. Short report 2. As built drawing(s) 3. Maintenance Plan(s) 4. Extract(s) from Management Rules

Short report prepared by a suitably qualified professional that describes how the Credit Criteria have been met by:

Where the first point is claimed:

- Providing calculations of original peak stormwater flow based on pre-development site conditions;
- Providing calculations of projected peak stormwater flow based on proposed site conditions;
- Confirming that the development does not increase the peak stormwater flow for up to a 1-in-2 year storm;
- Clearly nominating the design guidelines/manuals used for the treatment system design and justification for applicability to the site, and describing the treatment system(s) for TSS reduction;
- Providing calculations of the runoff volume;
- Confirming the TSS reduction as required can be achieved and that the system is capable of achieving the treatment reduction for the runoff volume;
- Describing the system's features to trap litter, oil and grease at source; and,
- Describing the on-going maintenance for the attenuation and treatment facilities, with reference to the 'Maintenance Plan'.

Where the second point is claimed:

- Providing calculations of original peak stormwater flow based on pre-development site conditions;
- Providing calculations of projected peak stormwater flow based on proposed site conditions;
- Confirming that the development does not increase the peak stormwater flow for up to a 1-in-20 year storm;
- Describing the system's features to trap litter, oil and grease at source; and,

- Describing the on-going maintenance for the attenuation facility, with reference to the 'Maintenance Plan'.

Where the third point is claimed:

- Providing calculations demonstrating the design rainfall used;
- Providing calculations of the sizing of any stormwater storage systems (where applicable);
- Describing the infiltration areas and justification for any infiltration assumptions such as rates, slope and area over which infiltration occurs (where applicable);
- Describing the system's features to trap litter, oil and grease at source; and,
- Describing the on-going maintenance for the infiltration facility, with reference to the 'Maintenance Plan'.

Tender / As Built drawing(s) clearly demonstrating the stormwater systems included in the project design, including all landscaping stormwater mitigation initiatives.

Extract(s) from tender documentation where requirements for control and treatment of stormwater are stipulated.

Maintenance Plan(s) clearly describing the on-going maintenance requirements of the applicable infiltration, attenuation and/or treatment systems.

Extract(s) of Management Rules clearly demonstrating the commitment of the Management Entity to implement the maintenance plans for the infiltration, attenuation and/or treatment systems into the future.

ADDITIONAL GUIDANCE

Although the three credit points available in this credit can be targeted independently, achieving the Credit Criteria of one point may assist in achieving the Credit Criteria for the remaining credit points.

It must be evident that the Management Entity is committed to the maintenance of the infiltration, attenuation and/or treatment systems into the future. The Management Rules must clearly demonstrate the requirement for maintenance in accordance with the 'Maintenance Plan' for the infiltration, attenuation and/or treatment systems.

Pre-development site condition

For the purposes of peak stormwater flow calculation in Green Star SA, the 'pre-development' site condition is considered as the condition of the site in its natural state prior to any development on the site. For refurbishments or brownfield developments, the pre-development site condition is not the condition of the existing landscape and hardscape, but of the site prior to any development (i.e. greenfield condition).

Peak Flow Control

Where a system is designed to control the flows from the site for events up to both the 1-in-2 year and the 1-in-20 year storms, two or more outflow controls are likely to be required.

Consideration should also be made of what will happen when the design storm is exceeded (e.g. overland escape routes).

TSS reduction

For the purposes of Green Star SA, a stormwater management system that is designed, constructed and maintained to specific guidelines as deemed appropriate by the design team will be accepted to reduce TSS as outlined in those guidelines, based on existing field data. Guidelines should be selected to ensure relevance to the site's physical characteristics (e.g. climate, soil, vegetation, slope etc.). Recommended stormwater design guidelines/manuals include, but are not limited to;

- Georgia Stormwater Management Manual (2001);
- Municipal Stormwater Management 2nd Ed. (2003);
- Virginia Stormwater Management Handbook (Vol. 1 & 2) 1st Ed. (1999); and,
- Melbourne Water WSUD Engineering Procedures: Stormwater (2005).

Please see References & Further Information for full details.

Shared stormwater services

If an attenuation/retention pond or other strategy is shared between sites or projects it must be demonstrated how this provides sufficient attenuation/treatment and achieves the applicable credit criteria for the Green Star SA project and all other sites/projects linked to the same pond (i.e. the applicable Credit Criteria must be met for all sites served by the shared/district system). It is not required that Project Teams submit Credit Interpretation Requests (CIR) for this scenario.

Watercourses and wetlands - definitions

The following definitions of watercourses and wetlands from the National Water Act, 1998 (Act No. 36 of 1998) (NWA) are adopted by the GBCSA with regards to the Green Star SA rating tools:

Watercourses: The NWA includes wetlands and rivers into the definition of the term watercourse as follows:

- A river or spring;
- A natural channel in which water flows regularly or intermittently;
- A wetland, lake or dam into which, or from which, water flows; and,
- Any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse.

A reference to a watercourse includes, where relevant, its bed and banks.

Wetlands: Defined as "land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil."

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Design Rainfall Depth

Daily rainfall data for locations across South Africa may be obtained from the South African Weather Service, where a site-specific record does not exist. A minimum of three complete years' data should be used, and ideally five years or more. The correct design rainfall depth should be calculated in accordance with the guidance provided below:

1) Obtain rainfall data

Daily rainfall data specific to the site (with justifications) should be sourced for a minimum of 3 complete years, however if longer records are obtainable, they should be used. For example, daily rainfall data obtained from 1st January 1999 to 31st December 2003 represents five (5) full years of data (i.e. N = 5)

2) Determine Relevant Daily Rank

The relevant daily rank can be determined by multiplying the number of years of data (i.e. N) by the desired annual frequency that the 1 day rainfall is equalled or exceeded per year. For the purposes of Green Star SA and this credit, this frequency is 3. Hence; *Relevant Daily Rank = 3*N (e.g. 3 x 5 = 15)*

3) Rank data

Using a data processing software package such as Microsoft Excel, the daily rainfall data obtained in Step 1 must be ranked based on daily rainfall from highest (i.e. heaviest rain event) to lowest (i.e. least intense rain event, or no rain) including the days where no rain was recorded. For this example, this is simulated below:

Original Data			**Ranked Data**	
Date	Rainfall (mm)	Rank	Date	Rainfall (mm)
01/01/1999	0	1	23/01/2003	205.5
02/01/1999	4	2	07/01/2003	198
03/01/1999	0	3	08/02/2000	102.9
04/01/1999	3.9	4	12/01/2000	80.1
05/01/1999	0	5	09/02/2000	75.5
06/01/1999	0	6	12/09/2001	73.1
07/01/1999	28.5	7	07/02/2000	52
08/01/1999	0	8	01/02/1999	50.6
09/01/1999	0	9	25/10/2001	46.2
10/01/1999	0	10	21/10/1999	40
11/01/1999	14.6	11	02/03/2000	36
12/01/1999	0	12	10/02/2000	35.6
13/01/1999	0	13	01/03/2000	34.2
14/01/1999	0	14	18/09/2000	32.1
15/01/1999	0	**15**	**16/11/2001**	**31.8**
16/01/1999	0	16	24/01/2002	31
17/01/1999	0	17	18/03/2003	30.9
…	…	…	…	…
…	…	…	…	…
26/12/2003	14	1821	23/12/2003	0
27/12/2003	0	1822	27/12/2003	0
28/12/2003	0	1823	28/12/2003	0
29/12/2003	0	1824	29/12/2003	0
30/12/2003	0	1825	30/12/2003	0
31/12/2003	0	1826	31/12/2003	0

4) ***Determine design rainfall depth***

To determine the design rainfall depth to use in calculations to demonstrate compliance with the Credit Criteria, simply take the relevant daily rank (determined in Step 2) and count backwards from highest intensity rain event as ranked in the data set (i.e. the 15th ranked rain event). On the basis on the worked example, the rainfall depth to use is therefore **31.8mm**.

BACKGROUND

Stormwater in South Africa has traditionally been channelled away from sites as rapidly as possible to the nearest watercourse, wetland or coastline without much consideration for quality. The necessity to deal with both the quantity and quality of runoff is now recognised through the encouragement of groundwater recharge through infiltration, and for storage and reuse of runoff.

Stormwater quantity

From an ecosystem perspective it is the high frequency of smaller floods that cause the most cumulative damage. In its natural state, a landscape will absorb the rainfall from normal rainfall and minor storm events. The high surface area of the leaves of trees, shrubs and grasses holds a large percentage of a light rain shower before the rainfall even reaches the soil. Often this moisture on the leaves will evaporate before the next shower.

During heavier or longer rainfall events once the leave’s surfaces are saturated, the rainwater begins to soak into the soil. The amount of rainfall that will soak into the soil depends on how deep it is and its structure (clay to sandy). The water in the soil will be drawn up and lost through evaporation and evapotranspiration. The remaining water will continue to percolate downwards to recharge the water table or deeper still to recharge aquifers. The ground water, once it reaches an impermeable layer, will move laterally to re-emerge as a seep either on the hillside or adjacent to the water course where it slowly and continuously discharges into the watercourse. The vegetation along the watercourses which protects the soil against erosion has adapted to these conditions.

Only after a number of showers in close succession or a period of extended rainfall will the soil reach saturation point and excess rainfall move across the surface as runoff. The surface runoff is constantly dispersed and the energy dissipated by the vegetation cover until it reaches the watercourse or wetland. Damage to vegetation on the slopes and along the water course is usually limited and can recover between excessive storm events. In natural conditions it is normally only the infrequent large flood events that cause extensive damage to vegetation and soil. The vegetation recovers in the years between these events.

In developed areas the scenario changes. Rainfall is collected on impervious surfaces, roofs, roads and parking areas and immediately concentrated into stormwater pipes or surface channels. There is no vegetation to absorb the light showers, the surface is impermeable and there is no infiltration into the soil. Runoff is channeled to the nearest watercourse in a concentrated stream of high energy water. This means that every rainfall event results in a flood which results in damage to vegetation along the watercourse and soil erosion. Since every rainfall event results in a damaging flood within the watercourse there is no time for vegetation to recover and it is systematically removed and the exposed soil eroded. This damage is evident for some distance below the storm water discharge point until the vegetation along the watercourse eventually dissipates the energy.

The result of frequent minor and major floods along the watercourse is excessive ongoing scouring of the base of the watercourse to form erosion gullies and deeply incised watercourses. The water table either side of the watercourse drops to the lower level of the watercourse and deprives the riparian vegetation along the banks of the necessary water which is then replaced by terrestrial vegetation. The deeper cross section of the channels with no vegetation to dissipate the energy of the storm water means that storm water is further accelerated and does more damage further downstream.

Stormwater quality

The contaminants in stormwater can be grouped according to their water quality impacts:

- **Oils, grease and surfactants:** Rubber from tyres and oil and grease washed from road surfaces, domestic and industrial sites, plus surfactants from detergents used for washing vehicles, materials or surfaces are common sources of toxic pollutants in stormwater.
- **Litter:** This includes organic waste matter, paper, cigarette buds, plastics, glass, metal and other packaging materials from paved areas in urban catchments.
- **Total Suspended solids:** Suspended solids have two main constituents: organic, primarily from sewage, and inorganic, primarily from surface runoff. Turbidity from suspended solids reduces light penetration in water, affecting the growth of aquatic plants. When silts and clays settle, they may smother bottom dwelling organisms and disrupt their habitats. Since metals, phosphorus and various organics are adsorbed and transported with these particles, sediment deposits may lead to a slow release of toxins and nutrients in the waterway.
- **Nutrients:** Potential sources of nutrients are:
  - Sewage overflows;
  - Industrial discharges;
  - Animal wastes;
  - Fertilisers;
  - Domestic detergents; and
  - Septic tank seepage.

  Excessive amounts of nutrients, such as nitrogen and phosphorous, can promote rapid growth of aquatic plants, including toxic and non-toxic algae. This excessive growth and oxygen depletion can cause fish and aquatic organisms to die.
- **Oxygen demanding materials:** Sources of oxygen-demanding materials are biodegradable organic debris, such as decomposing food and garden wastes, and the organic material contained in sewerage. Biological and chemical oxygen-depleting substances can cause water-borne diseases and present serious health risks.
- **Micro-organisms:** Bacteria and viruses found in soil and decaying vegetation, and faecal bacteria from sewer overflows, septic tank seepage and animal waste, are common contaminants in stormwater after heavy rain. Pathogens and micro-organisms, including bacteria, viruses and faecal coliforms, cause water-borne diseases. These can present

serious health risks from cholera, typhoid, infectious hepatitis and a range of gastrointestinal diseases.

- **Toxic organics:** These include garden pesticides, industrial chemicals and landfill leachate. They may cause long-term ecological damage and threaten human health. Organochlorine pesticides, herbicides and insecticides can be accumulated in organisms and persist in the environment over long periods.
- **Toxic trace metals:** Industrial chemicals can enter stormwater from a number of sources including sewerage overflows, illegal dumping and accidental spillages. Dust from brake and clutch linings of motor vehicles coupled with waste from degrading roadways and water pipes can inject ammonia, hydrogen sulphide and heavy metals (mercury, cadmium, lead and zinc) into the stormwater system.

Effects of good stormwater design and treatment

Recent research and demonstration projects in the USA have shown that stormwater can be exploited in a cost effective and environmentally sensitive manner for new urban developments. A well-designed stormwater system will control peak flows and reduce a variety of contaminants. Designs that reduce TSS typically provide additional water quality benefits, which are less easy to quantify.

In this context:

- Water reclamation can reduce potable water demand considerably;
- Properly managed stormwater flows can prevent the increase in flood risk and watercourse erosion typically caused by urbanisation and provide important flow return to streams, offsetting the environmental impact of upstream water supply diversions and reducing the need for costly in-ground stormwater infrastructure;
- The enhanced use of natural drainage corridors and depressions can provide open space, landscaped and recreational areas and conservation benefits increasing the amenity of new urban developments (multiple use corridors); and
- Treatment of stormwater closer to source minimises uncontrolled discharge of water containing high suspended solids, nutrients and organic material.

Control and treatment of stormwater and surface runoff from developments can be achieved through a variety of technologies and strategies, including for example:

- **Petrol, oil and sediment arresters** can have different design and operating dynamics, ranging from plate separators, to vortex, swirl and dynamic separators. Such separators are often sited in car parks and other points of high traffic density;
- **Sand filters**, grassed swales and porous pavements, can be effective treatment techniques, especially in car parks, commercial and industrial sites. Roof runoff, which is predominantly clean, can be directly infiltrated into the soil near a building by connecting the downpipe to a subsoil drain system with an overflow for large events, providing that there is a ‘first flush’ diverter or catchment system to filter out the initial flow of roof runoff;
- **Swales** are open, grass-lined channels that receive runoff from roads and other impervious surfaces. Small check dams can be added to slow velocities and increase

pollutant removal, but a sequence of swale sections with proper growing medium and planting is necessary to properly filter and confine pollutants;

- **Permeable paving materials**, such as porous asphalt or porous concrete, are surfaces that mimic natural infiltration. Permeable surfaces can also be designed with a turf cell reinforcement structure or open-celled pavers, and concrete or plastic grids with voids that are filled with topsoil, growing medium or aggregate to ensure that vehicle or foot traffic can still use the area securely whilst surfaces remain permeable;
- **Constructed pollution control ponds**, or wet detention basins, are largely open water bodies of several metres depth; mosquitoes may become a problem if their prevention or deterrence is not factored into the design, and health and safety regulations must be observed for depths of water in publicly-accessible locations;
- **Constructed wetlands** resemble local natural wetlands and provide a balanced and productive ecosystem. When a constructed ecosystem is productive, it means that there is a significant biomass of plants and microscopic algae that take up nutrients, and provide habitat and food for animals. Note that birds are often attracted to constructed wetlands and can themselves increase the nutrient and pathogen levels in these systems. The problem can be limited by ensuring that roosting sites for large flocks (e.g. cormorants, ibis etc.) are not incorporated in the design.
- **Rainwater harvesting** for on-site uses will help to attenuate peak flows;
- **Roof gardens** can absorb significant amounts of rainfall, helping to attenuate peak flows. Super-imposed loads on the roof structure, plus retained rainwater, means that the roof needs to be designed to the extra loading;
- **Bio-Basins** are planted and shaded infiltration basins which trap polluted stormwater. The basin surface appears ‘dry’ as its surface is gravel and there are no ponds for mosquitoes to breed. The Bio-basin contains specialised wetland plants that act upon the water pollutants in much the same way they do in natural wetlands. Larger detained pollutant particles settle out to allow the natural bacteria processes to occur. Bio-Basins are easier to maintain and manage than constructed wetlands, but must be protected from fine sediment loads which could eventually clog the system;
- **Vegetated Filter Strips (VFS)** can also be used to help remove pollutants from stormwater; these are strips of grasses or plants placed across stormwater flow paths which filter stormwater runoff and minimise speed of stormwater discharge by encouraging a longer, more winding flow, especially where sheet flow rather than concentrated flow is intended; and,
- **Floating treatment systems** have rooted, emergent macrophytes growing on a floating artificial mat on the surface of the water. They are capable of surviving water depth fluctuations that typically occur in stormwater systems, without the risk of the plants becoming inundated or desiccated and stressed. The roots floating beneath the structure support a diverse microbial population which aide uptake of dissolved nutrients.

All of the above stormwater treatment technologies require careful and specific maintenance steps to be taken in order to ensure their on-going efficacy. Failure to undertake required maintenance will ultimately result in more costly repairs or even full replacement of the system.

Landscaping also plays an integral role in the design of most stormwater treatment systems, offering opportunities for their aesthetic incorporation in the surrounding area. The use of particular plants species is important since some species will be more effective in treating stormwater and better suited for surviving the ambient conditions. Co-ordination between stormwater engineers, landscapers and nurseries/growers is advised to ensure that the required plants are available for planting at the correct stage in the project.

REFERENCES & FURTHER INFORMATION

South African Weather Service
http://www.weathersa.co.za/web/

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