

Memo

Subject Stormwater - response to authority comments
Distribution Ecove – Michael Azar
Date 30 January 2015
Project SOP site 68

Hi Michael,

We have reviewed the submissions from the Office of Environment and Heritage (OEH), Environment Protection Authority (EPA), Sydney Olympic Park Authority (SOPA), Transport for NSW (TfNSW), and Roads & Maritime Services (RMS). TfNSW and RMS did not include any comments relating to stormwater management at Site 68. The comments of OEH, EPA and SOPA are addressed below.

OEH Comments

The OEH submission (dated 15/12/2014) included the following comments:

3. Water quality treatment

OEH notes that the stormwater treatment systems on the site have been sized to ensure that waters received from the upstream catchment area will be treated as well and the treatment systems have been sized to exceed SOPA's best practice targets for the whole catchment. This will ensure that the removal of the existing water quality control pond will not have an adverse impact on the downstream receiving waters.

As such there are no stormwater issues to address for OEH.

EPA Comments

The EPA submission (dated 16/12/2014) included the following comments:

Groundwater and surface water management

The EPA notes that it is likely that groundwater and rainwater will need to be removed from excavations on site during construction and that the construction site will need to be managed to prevent off-site transport of soils and sediment and other pollutants to waterways.

The EPA recommends the following Conditions of Consent:

- Any water discharged from the site to stormwater or waterways must meet relevant ANZECC guidelines.
- Appropriate soil and water management measures that are consistent with the guidelines of the *'Managing urban stormwater: soils and construction'* publications (including *Volume 1 – Blue Book* and *Volume 2A – Installation of Services*) shall be implemented during construction.

There may be a need for ongoing groundwater discharge after project completion. The EPA notes that the issue of groundwater contamination and management has been discussed in the EIS and that the EIS identifies both the need for further assessment of groundwater and the need for further consideration of drainage requirements during detailed design.

The EPA therefore recommends that the Conditions of Consent include requirements for the further assessment of groundwater, and the ongoing management and discharge of groundwater, including contaminated groundwater.

The EPA submission recommends a condition that “any water discharged from the site to stormwater or waterways must meet relevant ANZECC guidelines”. We believe that the intent of this condition is in relation to dewatering of the excavation, not all stormwater flows through the site that enter from the upstream catchment.

We agree that dewatered groundwater should meet ANZECC guidelines, however surface water is addressed appropriately with the second condition recommended by the EPA. Therefore we recommend revising the first condition of consent to state:

Any groundwater discharged from the site during construction to stormwater or waterways must meet relevant ANZECC guidelines.

The second condition recommended by the EPA, to include soil and water management measures consistent with the Blue Book, is standard practice and included within SOPA’s stormwater guidelines, so is an appropriate condition.

SOPA Comments

The SOPA submission (dated 19 December 2014) included a number of comments relating to stormwater management, which are copied below.

Ecology

1. The Flora & Fauna assessments (FFA) shall consider off-site impacts of the development to flora and fauna, including shadowing of the tower over the habitats of Lake Belvedere and surrounding public parkland areas, and impacts of changes in stormwater flows to flora and fauna in Bennelong Pond.

Stormwater Management

1. The stormwater system is to be designed so that the discharge flow rates into Bennelong Pond meets SOPA requirements.
2. The Applicant is to revise the Stormwater & Flooding Assessment Report including the Integrated Water Management Plan (Appendix Q) to address all aspects of SOPAs Stormwater Management and Water Sensitive Urban Design (SMWSUD) Policy.
3. The Applicant be required to revise the Stormwater & Flooding Assessment Report (Appendix Q) to address the longer term ecological impacts on Bennelong Pond arising from the increased water quantity outflows from Site 68 during larger storm events (refer Table 5) and ways to manage or mitigate these impacts e.g. the high flow bypass.
4. The Applicant provide a maintenance and performance testing regime for the new treatment system prior to approval of the DA (consistent with the SOPA SMWSUD Policy).
5. DA consent conditions should address recommendations stemming from these reviews.

The request that the Flora & Fauna assessment should consider “impacts of changes in stormwater flows to flora and fauna in Bennelong Pond” is discussed under item 3 below.

The ‘stormwater management’ comments are addressed below.

1. ***The stormwater system is to be designed so that the discharge flow rates into Bennelong Pond meets SOPA requirements.***

The SOPA Stormwater Management & WSUD Policy (2013) specifies the following water quantity requirements:

Development within a Sydney Olympic Park non-stormwater harvesting catchment (shaded in orange in Map 1) must maintain a 1:5 year ARI (average recurrence interval) peak discharge to pre-development (non-urbanised) magnitude

The proposed detention tank has been designed to meet this requirement as outlined in our submission.

2. The Applicant is to revise the Stormwater & Flooding Assessment Report including the Integrated Water Management Plan (Appendix Q) to address all aspects of SOPA's Stormwater Management and Water Sensitive Urban Design (SMWSUD) Policy

The SOPA *Stormwater Management and Water Sensitive Urban Policy* includes a clause outlining that the following information is to be submitted with a development application:

- *An integrated water cycle management plan including a description of how all stormwater generated on the site will be managed and a water balance report Justification for why each element of the water sensitive urban design strategy has been selected over alternate approaches*
- *Design assumptions including design rainfall events used to size rainwater tanks and water sensitive urban design elements*
- *A site layout plan showing the location of each element of the proposed stormwater treatment train; design details of each element*
- *Monitoring and maintenance plan for all stormwater devices and other water sensitive urban design elements.*

Please refer to Appendix A of this document which outlines how all aspects of the SMWSUD Policy have been addressed. This table outlines every clause of the SOPA SMWSUD Policy and the satisfaction of those clauses by the Site 68 proposal. Note that the 'monitoring and maintenance plan' was included in the early works DA stormwater report and is provided within Appendix B of this memo for completeness.

3. The Applicant be required to revise the Stormwater & Flooding Assessment Report to address the longer term ecological impacts on Bennelong Pond arising from the increased water quantity outflows from Site 68 during larger storm events (refer Table 5) and ways to manage or mitigate these impacts e.g. the high flow bypass

The Stormwater & Flooding Assessment Report has shown that the water management strategy proposed for Site 68 will significantly reduce the stormwater pollutant load to Bennelong Pond, particularly total suspended solids (TSS) and nutrients which have caused significant issues within the pond in recent years. Thus the Site 68 project will improve the quality of the habitat within Bennelong Pond.

Disturbance to vegetation in receiving waters is predominantly impacted by frequent storm events, events up to the 1 in 2 year ARI events. As these events occur frequently if vegetation is damaged during these events, it is typically unable to recover due to the frequency of disturbance. For frequent flow events the peak flows from Site 68 are effectively managed with the detention system resulting in minimal changes to the peak velocities through Bennelong Pond. Hence there is anticipated to be no disturbance to the vegetation with the implementation of the proposed water management strategy during frequent flows.

Larger extreme flood events are typically not the events that permanently damage vegetation in a receiving water, as these events only occur rarely and vegetation can typically recover from these rare events. However our analysis has also considered these larger storm events. Two dimensional modelling of flows in Bennelong Pond has previously been carried out and the velocity of flows through the pond was modelled for extreme events. The reported *existing* 100 year ARI peak flow velocity through the central zone of Bennelong Pond is approximately 0.6 m/s. Under the proposed

Site 68 detention tank arrangements the 100 year ARI total peak flow rate through Bennelong Pond will increase (in accordance with the requirements of the SOPA SMWSUD Policy). The resulting 100 year ARI peak flow velocity through the central zone of Bennelong Pond will be approximately 0.7 m/s (a 0.1 m/s increase from the existing scenario). Established vegetation can withstand velocities up to 1.5 m/s (Fischenich, C. 2001 and QUDM 2013) and therefore it is reasoned that the proposed increased peak flow through Bennelong Pond will not create adverse impacts on Bennelong Pond.

4. The Applicant provide a maintenance and performance testing regime for the new treatment system prior to approval of the DA (consistent with the SOPA SMWSUD Policy)

The SOPA SMWSUD Policy states:

“Monitoring and maintenance plan for all stormwater devices and other water sensitive urban design elements” is to be submitted with a development application, under clause 5 (‘Information to be submitted with a development application’).

A preliminary monitoring and maintenance regime is provided in Appendix B below, as provided in the Early Works DA stormwater report.

The SOPA SMWSUD Policy also states:

“An establishment, handover and operation and maintenance plan must be developed and implemented for all water sensitive urban design assets for the life of the asset. A copy of this plan, and evidence of a maintenance contract covering at least the first two year period, should be included in any application for an Occupation Certificate [underline added]. Copies of the plan and maintenance contract must be provided to the Authority” under clause 10 (‘Asset Maintenance’).

A complete ‘establishment, handover and operation and maintenance plan’ will be provided in the application for an Occupation Certificate.

5. DA consent conditions should address recommendations stemming from these reviews

It is considered that the responses above should satisfy the requests of SOPA and additional conditions are not required.

Please contact me if you have any queries regarding the above.

Regards,

Andrew McMillan

APPENDIX A

SOPA STORMWATER MANAGEMENT AND WATER SENSITIVE URBAN DESIGN POLICY	POLICY REQUIREMENT MET?	NOTES
Policy Requirements		
To properly meet the requirements of this Policy, development within Sydney Olympic Park must meet the following requirements:		
1. Maximise harvest and reuse of roof-water.		
o All non potable water demand shall be met by non-potable water sources (eg roof water, recycled water) where connection to the Park's recycled water supply is available.	Yes	A connection to the recycled water network and recycled water reticulation is shown on the building services engineers drawings
o Locally-harvested rainwater shall be the primary source of non-potable water for developments located within a Sydney Olympic Park non-stormwater harvesting catchment (shaded orange on Map 1). Where practicable, at least 90% of nonpotable demand shall be met from this source, which may be supplemented by recycled water as a back-up if harvested rainwater is insufficient to meet demand. Where non-potable demand within a development site is low, alternative uses for roof water such as landscaping, roof gardens, as well as offsite re-use, should be considered so as to minimise the volume of stormwater discharged to local waterways.	Yes	Roofwater harvesting is proposed for site irrigation demands. (90% of all non-potable demands met by rainwater harvesting is not practicable for a high rise tower building where there is a very small roof catchment and significant internal non-potable demands.) Internal non-potable demands will be met by recycled water.
2. Minimise volume and frequency of stormwater discharge from hardstand areas such as paving, driveways and car parks, and maximise quality of any stormwater discharged.		
Design of landscaped and paved areas must incorporate water sensitive urban design elements and pollution control devices including but not limited to:		
o Appropriate stormwater management measures as detailed in Master Plan 2030 (section 4.9.1) <i>The applicable portion of the SOPA Master Plan 2030 is included below: Stormwater Management for Open Space</i> <i>To minimise the impact of stormwater from communal open space on the health and amenity of nearby waterways:</i> <i>21. Retain stormwater on site by:</i> <i>- collecting and storing water from roofs and hard surfaces maximising porous surfaces and deep soil</i> <i>- draining paved surfaces to adjacent vegetation.</i> <i>22. Protect stormwater quality by providing for:</i> <i>- sediment filters, traps or basins for hard surfaces</i> <i>- treatment of stormwater collected in sediment traps on soils containing dispersive clays.</i>	Yes	Refer Sections 3 and 4 of Stormwater and Flooding Assessment. Stormwater is retained on site by harvesting of roofwater, treatment of flows from the upstream catchment in the bioretention system, and by the provision of deep soil areas. Stormwater quality treatment will exceed SOPA's requirements.
o Retaining a minimum of 20% of the site's open space area as deep soil. Areas included as deep soil are to have a minimum dimension of two metres. Consolidate areas of deep soil within sites and between adjacent sites to increase the benefits.	Yes	The landscape architect's design report confirms that more than 20% of open space is provided as deep soil areas.
o Minimising impervious areas that are directly connected to the stormwater system. Runoff from impervious areas such as driveways, paving and rainwater tank overflows should be directed onto landscaped areas designed to accept such flows	Yes	Wherever possible runoff from impervious areas is directed to the bioretention system (first flowing into the tank)
o Removal of gross pollutants, sediments and nutrients prior to stormwater discharge to the trunk drainage system, through use of devices such as bioswales, sand filters, gross pollutant traps, and litter baskets	Yes	A sediment basin (within the tank) and bioretention treatment system is provided to remove gross pollutants, sediments and nutrients prior to stormwater discharge to the trunk drainage system
o Installation of appropriately-designed bioswales or other stormwater harvesting systems within surface carparks that have more than ten spaces, such that water flows meet the relevant water quality and quantity targets for the catchment (Attachment 1)	N/A	No surface carpark with more than ten spaces is included in the project
o Installation of oil and grease traps in surface and basement carparks	Yes	Building services engineers drawings include 'stormwater pollution control device' to basement drainage system
o Using wetland plant species native to the Sydney region in water sensitive urban design features and associated landscaping, to avoid spread of weed propagules to downstream wetlands	Yes	All species used in the bioretention system will be native to the Sydney region
3. Water conservation		
o Connect all new development to Sydney Olympic Park's recycled water system for all approved uses of recycled water	Yes	Refer building services engineer report
o All residential development must comply with the Building Sustainability Index (BASIX). Mixed use development must comply with the requirements detailed in Master Plan 2030.	Yes	Refer building services engineer / sustainability consultant
o Individual water metering must be provided where possible to all residential units within a development.	Yes	Refer building services engineer report

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4. Riparian protection		
o Development within 40 metres of a creek, river, lake or estuary must have regard for the 'Guidelines for riparian corridors on waterfront land' (dated July 2012, or subsequent revisions) issued by NSW Office of Water. Any necessary approvals required under the NSW Water Management Act 2000 must be obtained.	N/A	The proposed development is not within 40 metres of a creek, river, lake or estuary.
5. Information to be submitted with a development application:		
Submit the following minimum information with a development application:		
o An integrated water cycle management plan including a description of how all stormwater generated on the site will be managed and a water balance report	Yes	Refer Section 3 of Stormwater and Flooding Assessment.
o Justification for why each element of the water sensitive urban design strategy has been selected over alternate approaches	Yes	<p>This item was included with the Site 68 Early Works DA report, and is repeated below</p> <p><u>Alternative WSUD approach</u> - Leave a portion of the existing SWQCP to the site area not utilised by tower <u>Reason that approach was not pursued</u> - Unacceptable urban design outcomes, as the wetland would be significantly deeper than the surrounding areas.</p> <p><u>Alternative WSUD approach</u> - New treatment wetlands to the future plaza area <u>Reason that approach was not pursued</u> - Treatment wetlands are not as efficient for pollutant removal as bioretention, and the footprint required for a treatment wetland to meet SOPA's water quality targets could not be accommodated within the plaza zone.</p> <p><u>Alternative WSUD approach</u> - Relocate treatment to Bennelong Pond 'forebay' zone <u>Reason that approach was not pursued</u> - Bennelong Pond is considered as a receiving water rather than a treatment zone. The Bennelong 'forebay' already provides an important role in stormwater management for Bennelong Pond and Site 68 was seen as an opportunity for additional upstream treatment. There is insufficient space to provide sufficient volume for detention.</p> <p><u>Alternative WSUD approach</u> - Direct Site 68 stormwater to Lake Belvedere <u>Reason that approach was not pursued</u> - There is insufficient information to adequately assess this inter-catchment transfer and there would be likely impacts on flooding. Removing freshwater flows from Bennelong Pond would make it more saline. The new stormwater drainage line would also need to cross several buried high voltage transmission lines and trench through a remediated land.</p>
o Design assumptions including design rainfall events used to size rainwater tanks and water sensitive urban design elements	Yes	Refer Section 4.2.1 of Stormwater and Flooding Assessment.
o A site layout plan showing the location of each element of the proposed stormwater treatment train; design details of each element	Yes	Design plans have been provided, and design details for the bioretention are included within the Stormwater & Flooding Assessment (Section 4.4)
o Monitoring and maintenance plan for all stormwater devices and other water sensitive urban design elements.	Yes	This item was included with Site Early Works DA report. Included in Appendix B of submissions reponse memo
6. Development that does not meet policy requirements	N/A	
Development that does not meet policy requirements must:		
o Fully justify why requirements cannot be met		
o Provide a detailed Water Sensitive Urban Design Strategy that includes the information specified at clause 5 of this policy, as well as a report prepared by a suitably qualified professional such as a registered civil engineer with a minimum of five years demonstrated professional experience in the field of stormwater management, and where relevant, a suitably qualified professional with a minimum of five years demonstrated professional experience in the field of constructed wetlands management. The report shall be based on modelling using an appropriate urban stormwater modelling tool (ie MUSIC or equivalent) and:		
i. Demonstrate the water quality and stormwater flow improvements achieved by the proposed Strategy, with regard to the stormwater quality and quantity targets specified in this policy (Attachment 1)		
ii. Assess the impact of flows on the receiving environment, the capacity of downstream infrastructure to manage such flows, and any required enhancement works proposed to be implemented		

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iii. justify how the development meets policy objectives		
iv. provide suitable offset proposals that meet policy objectives.		
7. Public domain infrastructure and hard paving (including roads, footpaths and carparks)		
o Provide a detailed Water Sensitive Urban Design Strategy that includes the information specified at clause 5 of this policy, and a report, prepared by a suitably qualified professional such as a registered civil engineer, with a minimum of five years demonstrated professional experience in the field of stormwater management, and where relevant, a suitably qualified professional with a minimum of five years demonstrated professional experience in the field of constructed wetlands management. The report shall be based on modelling using an appropriate urban stormwater modelling tool (ie MUSIC or equivalent, and:	Yes	
i. Demonstrate how the development meets stormwater quality and quantity targets specified in this policy (attachment 1)	Yes	Refer Section 4 (water quality) and Section 5 (water quantity) of Stormwater and Flooding Assessment.
ii. Assess the impact of flows on the receiving environment, the capacity of downstream infrastructure to manage such flows, and any required enhancement works proposed to be implemented	Yes	Assessment of flows on the receiving environment has shown that the water management strategy proposed for Site 68 will significantly reduce the stormwater pollutant load to Bennelong Pond. Refer to Sections 4 & 5 of the Stormwater & Flooding Assessment. The capacity of the existing downstream infrastructure is currently inadequate and is proposed to be upgraded as part of the project. Refer to Section 5.4 of the Stormwater & Flooding Assessment.
8. Modelling tool inputs		
o Where the MUSIC (Modelling Urban Stormwater Improvement Conceptualisation) tool is used, inputs must be consistent with the Draft NSW MUSIC Modelling Guidelines (Sydney Metropolitan Catchment Management Authority 2010)	Yes	Refer Section 4.2.1 of Stormwater and Flooding Assessment.
o Data from a Bureau of Meteorology rainfall station that is representative of the long-term rainfall at Sydney Olympic Park (Bureau of Meteorology stations 66195 / 66217) is to be used in modelling.	Yes	Rainfall data from these stations is not appropriate as they do not include 6 minute pluviograph data which is required for water quality modelling. BOM station 66195 only includes rainfall data from 1996 - 2010 with data gaps. BOM station 66212 only includes rainfall data from 2011 - 2014 with data gaps. These data periods are not sufficient for long-term modelling.
9. Construction management		
o Development applications must include a draft management plan addressing the requirements set out in Table 1. The final Plan must be submitted with an application for a construction certificate.	Yes	Refer civil engineers drawings
10. Asset maintenance		
o An establishment, handover and operation and maintenance plan must be developed and implemented for all water sensitive urban design assets for the life of the asset. A copy of this plan, and evidence of a maintenance contract covering at least the first two year period, should be included in any application for an Occupation Certificate. Copies of the plan and maintenance contract must be provided to the Authority.	N/A	The establishment, handover and operation and maintenance plan is to be included in the application for an Occupation Certificate.
i. The plan must include routine checking, cleaning and servicing of all devices in accordance with the manufacturers recommendations. Records of all maintenance activities undertaken must be kept and provided to the Authority annually by 30 June each year, or at other times upon request.		
ii. The pollution retention efficiency of structural stormwater treatment measures must be maintained up to the design discharge and must not decrease with build-up of materials		
iii. Where necessary system components become unavailable, an alternative system is required to be retrofitted into the development to achieve an equivalent pollutant reduction outcome.		

APPENDIX B

1 Monitoring and Maintenance

1.1 Monitoring

A monitoring programme is recommended to ensure the proposed treatment systems perform in accordance with the design intent and to guide any corrective actions, adaptive management responses or maintenance requirements. Monitoring is broadly split into two parts:

- WSUD infrastructure monitoring to ensure the systems are performing as designed and not exhibiting problems.
- Construction phase water quality monitoring.

The following sections outline the proposed monitoring requirements. The monitoring will occur in a co-ordinated manner and deliver meaningful information which can be used to interpret the performance of the treatment systems and guide adaptive management measures within Site 68.

1.1.1 Bioretention water quality

Baseline water quality monitoring on a single bioretention system is recommended. This will focus on water quality monitoring to provide a record of water quality exiting the filter media of the bioretention system.

Methodology: Collection of water samples exiting the filter media immediately following a rainfall event and analysis by laboratory.

Frequency: Quarterly, following rainfall events greater than 10mm

Period: 1 year

Location: Outlet of a single bioretention system

Parameters (samples for lab): TSS, TN and TP

1.1.2 Bioretention permeability

In-situ hydraulic conductivity testing of the filter media is recommended during the maintenance period within all the bioretention systems, to provide a record of hydraulic conductivity of the filter media over time as the bioretention basin establishes.

Methodology: In-situ constant head or falling head testing within bioretention system filter media.

Frequency: 6 monthly

Period: 1 year

1.1.3 Construction

For the construction phase of the development, discharges from the sedimentation basins or other control devices is to be monitored to provide an ongoing record of water quality discharged to Bennelong Pond and provide a basis for undertaking remedial and adaptive management activities where required.

Methodology: In-situ monitoring with probe or visually for some parameters and samples collected and analysed by laboratory for others (see below for details).

Frequency: Weekly or as required for discharges from site.

Period: Ongoing.

Location: Sedimentation basins

Parameters (in-situ): pH, oil & grease, flow rate

Parameters (samples for lab): TSS (monthly only)

Target Values: Target values that are considered appropriate for discharges from sediment basins are listed in the table below.

- <i>Total suspended solids</i>	<i><50mg/litre</i>
- <i>pH</i>	<i>pH 6.5 – 8.5</i>
- <i>Oil & Grease</i>	<i>No visible sheen on released waters</i>
- <i>Flow rate</i>	<i>As approved by SOPA and dependent upon the nature of the receiving waters and design of the outlet structure</i>

Where the criteria above are not met then the following corrective actions are to be implemented, as a minimum:

- Investigate the cause of the water quality problem and develop a strategy to address the problem and to ensure that the problem does not recur. This may require consultation with the designers of the stormwater strategy and/or other environmental consultants.
- Where possible, minimise the propagation of the problem by preventing discharge from the sediment basin where the incident has occurred.
- Inspect all sediment and erosion control (particularly if there are other active construction sites) and WSUD elements in the catchment that drains to Site 68 and determine whether any of these elements require remedial maintenance.

Other corrective actions that are deemed appropriate responses to the specific incident should also be implemented.

1.2 Maintenance

WSUD infrastructure such as bioretention systems require ongoing inspection and maintenance to ensure they establish and operate in accordance with the design intent. Potential problems associated with WSUD as a result of poor maintenance include:

- Decreased aesthetic amenity;
- Reduced functional performance;
- Public health and safety risks; and
- Decreased habitat diversity (dominance of exotic weeds).

The following sections summarise the maintenance requirements of the WSUD systems.

It is recommended that the personnel who are to undertake the operation and maintenance of the bioretention systems be briefed and trained on procedures and protocols prior to commencement. Keeping

and maintaining records on the condition of the systems and all maintenance works required will be important to inform and schedule future maintenance works.

Importantly the most intensive period of maintenance is during the plant establishment period (initial one to two years) when weed removal and some replanting may be required. The WSUD designs developed for the Site 68 development will seek to minimise maintenance requirements during this period by incorporating a provision to isolate the majority of the 'vegetated' areas of the WSUD systems from inflows during the construction and establishment phase (i.e. by taking it offline). This greatly reduces the risk of plants becoming smothered by sediments resulting from construction activity (a common cause of early plant mortality and filter media clogging) and importantly also reduces the weed seed load being deposited in the basins during the period when the plants are establishing and least able to compete with (shade out) weed species. Therefore it is expected that the vegetation in the bioretention systems will become well established prior to bringing them online – which will occur at least 12 months after planting (i.e. at least one growing season such that root/rhizome establishment and foliage density are well developed).

1.2.1 Sediment basin and pump maintenance

Typical maintenance of the sediment basin and pumps during operation will involve:

- Routine inspection of the sediment collection zone.
- Routine inspection of the pump control panels for any fault alarms.
- Removal of sludge from sediment basin by eductor truck
- Removal of debris from the outlet trash rack
- Servicing of pumps (by qualified pump service technician)
- Irregular and corrective maintenance such as repairing pumps (e.g. repairs to seals, motor, bearings, casings)
- Long term maintenance will include eventual pump replacement (pumps are expected to have a 10 year life)

1.2.2 Bioretention maintenance

Typical maintenance of bioretention systems during operation will involve:

- Routine inspection of the bioretention system profile to identify any areas of obvious increased sediment deposition, scouring from storm flows, rill erosion of the batters from lateral inflows, damage to the profile from vehicles and clogging of the bioretention system (evident by a 'boggy' filter media surface).
- Routine inspection of inflows systems, overflow pits and under-drains to identify and clean any areas of scour, litter build up and blockages.
- Removal of sediment where it is smothering the bioretention system vegetation.
- Where a sediment forebay is adopted, removal of accumulated sediment.
- Repairing any damage to the profile resulting from scour, rill erosion or vehicle damage by replacement of appropriate fill (to match onsite soils) and revegetating.
- Tilling of the bioretention system surface, or removal of the surface layer, if there is evidence of clogging.
- Regular watering/ irrigation of vegetation until plants are established and actively growing.

- Removal and management of invasive weeds (herbicides should not be used).
- Removal of plants that have died and replacement with plants of equivalent size and species as detailed in the plant schedule.
- Pruning to remove dead or diseased vegetation material and to stimulate growth.
- Vegetation pest monitoring and control.

Maintenance should only occur after a reasonably rain free period when the soil in the bioretention system is dry. Inspections are also recommended following large storm events to check for scour and other damage.