Asset 3: Ultimo St rain gardens (Crace)

General information

Description

There are 6 rain gardens on Ultimo St in Crace. They are all built to the same design, and are located in the verge in three groups.

Each rain garden has two or three cells and two kerb inlets at each end of the rain garden. There are multiple connections at the back of the rain garden allowing footpath runoff to drain into the garden. Some rain gardens also have a connection from the property into the rain garden. The rain gardens include street trees and understorey planting.

The rain gardens are located in a street which has a row of terrace houses and a higher urban density than is typical elsewhere in Crace.

Asset type	Rain gardens (streetscape)	**Asset context**	Recent greenfield development
Year built	2011-2	**Year of handover to TAMS**	TBC
Catchment area	TBC (2,800 m^2 of road catchment plus adjacent residential)	**Catchment type**	Road runoff and some roof runoff
Filter area	Approx. 4x 30 m^2 Approx. 2x 55 m^2	**Total area**	230 m^2
Filter depth	TBC	**Construction cost**	$17,000 each (TBC) ($566/m^2)
Inlet/s	Open edge on street side	**Outlet/s**	TBC
Expected performance	TBC	**Source**	

Information reviewed to date

Information	Requested	Received	Reviewed
DA report	✓		
Design drawings		✓	

Site inspections

Site inspections have been undertaken on the following dates:

- 16 October 2014 – dry weather
- 15 November 2014 – wet weather
- 30 November 2014 – wet weather

Design objectives

The Ultimo Street rain gardens have been constructed as part of a treatment train to meet the requirements of the WSUD Code (2009).

The rain gardens are located in the middle of the catchment and are the first step in the treatment train. The rain gardens are part of the catchment which drains to the pond and recirculating wetland in the main Crace park. Downstream of the pond, stormwater is discharged from the pond into Ginninderra Creek downstream of Gungahlin Pond. Giralang Pond and Lake Ginninderra are downstream.

The rain gardens have been designed and constructed to treat the overwhelming majority of the streetscape of Ultimo St. Some roof and lot drainage is connected into the rain gardens, however it is also clear that some lots (e.g. all the battle-axe lots on the eastern side of Ultimo St) have lot drainage which is connected into a pit and bypasses the rain gardens. It was also unclear whether the rain gardens were intended to treat the runoff from private lots or only from the streetscape. There were some examples where property drainage pipes were connected into the kerb and others where property drainage connections were not visible (and presumably connected directly to the stormwater system underground).

The rain garden inlets are well located upstream of the stormwater drainage, ensuring that runoff has a chance to enter the rain garden inlets prior to entering a drainage pit.

Performance issues

At Ultimo St, construction activity including house-building has been entirely completed and the systems are no longer affected by construction sediment. The rain gardens are also considered to be in the establishment phase with vegetation coverage increasing but still not providing significant coverage of the filter media as shown in Figure 1.

Our observations of the rain gardens on Ultimo St were that:

- Most of the kerb inlets are blocked at Ultimo St and are not functioning. Runoff is completely bypassing the inlets and is draining to the standard stormwater pits
- In most cases a slight build up of debris including sediment and organics has caused blockage (refer Figure 2). In many cases after partially removing the sediment and debris and some of the mulch manually (to simulate maintenance activity), the majority of stormwater was still bypassing the systems
- In a few cases significant vegetation establishment right at the inlet is preventing water from entering the rain garden (refer Figure 3)
- Inlets from the lots are working well, with a slight area of scouring at the inlet although this is not considered a significant issue (refer Figure 4)
- Some systems are being impacted by dumping of substantial amounts of grass clippings in the rain garden, which is contributing to preventing water entering the rain garden

- In the middle western rain garden water was successfully entering one of the inlets and the inlet was able to capture the entire low flows in the gutter. Water was witnessed ponding over the surface (refer Figure 5)

- There was evidence of litter and weeds in the rain gardens, but not substantial amounts and would not take a significant effort to remove (a few minutes for each rain garden, no more than 10 minutes for the whole street)

The few rain garden cells that had functioning inlets had clear signs of deposition of sediment and debris on the rock mulch. Those systems which had blocked inlets had very clean rock mulch suggesting that flows have rarely entered these rain gardens and that only relatively small amounts of debris were required to block the inlet.

Based on site observations to date the filter media appears to be draining well. Water is only ponding on the surface for short periods after rainfall. Hence it appears that the filter and subsoil drainage are all adequate.

Figure 1: Rain garden on Ultimo St, showing vegetation establishment. Large areas of the filter surface are still visible

Figure 2: Rain garden on Ultimo St, with blocked inlet caused by poor levels and a small amount of debris

Figure 3: Rain garden on Ultimo St, with significant vegetation at the inlet, and flows can be seen bypassing the inlet (flowing from left to right) directly into the stormwater drainage pit

Figure 4: Example of a rain garden with an inlet from the adjacent lot

Figure 5: Example of a kerb inlet functioning and delivering water into the rain garden. Water is flowing left to right and note the lack of water on right hand side of kerb and water ponding in the rain garden (as evidenced by darker sediment)

Key causal factors and constraints

As the rain gardens have not been constructed with a sufficient drop from the inlet to the filter surface, flows are generally not entering the rain gardens and hence are unable to pond on the surface and appear to have limited extended detention. The lack of a drop between the kerb inlet and the filter surface level is the major factor driving the failure of the system.

A secondary factor is that the inlets are relatively small. The size of the inlets makes them vulnerable to blockage. For example one plastic bag or A4 sheet sized piece of cardboard can block the inlet and prevent flows from entering the rain garden.

In these systems (unlike others at Crace) it does not appear that the construction stage has caused significant impact on the rain gardens. However this *may* become more evident once the rain gardens are working and signs of construction impacts may start to appear (e.g. clogging of the filter media etc). Matthew Frawley from CIC (pers. comm. 3 November 2014) noted that CIC has re-set some of the street scape rain gardens at Crace while they were undertaking maintenance at the site and this may potentially explain why there are no signs of construction impacts to the systems in Ultimo St.

Weeds and litter are routine maintenance issues. We understand that routine maintenance has not been undertaken since the rain gardens were handed over to ACT government, however it is noted that in these systems there is not a high prevalence of weeds or litter in the rain gardens (potentially because there is limited stormwater entering the rain gardens) and it would not require significant effort to address this.

When we are able to review the design drawings, we will be able to comment further on other aspects of the design including depths, drainage arrangement, flushing points, finished levels, etc.

It is noted that the rain gardens are significantly oversized relative to their catchments and this would have a positive impacting on the robustness of these systems in Ultimo St.

Potential improvement options

There are two key recommendations for these streetscape systems:

- Lowering of the filter surface level to allow water to enter the rain garden and to provide more extended detention in the system. At best this lowering may potentially be required only at the inlet, but it may possibly be required across the whole rain garden to function effectively. This needs to be further resolved with site survey or similar.

- Reconfiguration of the inlet, to reflect the change in levels and to promote water entering into the basin and potentially also to increase the size of the inlet to reduce the risk of blockage due to single large pieces of litter and debris

Finally it should be noted that similar systems were observed in the field on adjacent streets including Vandyke, Zanci St and Narden St and these issues were typical of the performance of these systems and these works would apply to these systems as well.

The rain gardens also need some simple routine maintenance such as weed removal, replanting and litter picking. As discussed above this would not require substantial effort.

In some cases, education of local residents could improve the performance of rain gardens. A well-informed resident should not dispose of waste in a rain garden and could even be inspired to undertake simple routine maintenance activities such as hand weeding and removing accumulated sediment from the inlet. Residents on this street have shown interest during site investigations and have asked questions about the systems during these site visits. These residents were supportive and enthusiastic about the rain gardens and were interested in how they worked.

Asset 4: Digby Circuit rain gardens (Crace)

General information

Description

There are 7 rain gardens on Digby Circuit in Crace. They are all built to the same design, and are located in the verge in 4 groups.

Each rain garden has one cell and one kerb inlet into the rain garden. The rain gardens are surrounded by a low concrete wall to take up the grade. There are no visible connections from the properties into the rain garden. The rain gardens include street trees and understorey planting.

The rain gardens are located in a street which has low density single dwellings and open space.

Asset type	Rain gardens (streetscape)	**Asset context**	Recent greenfield development
Year built	2011	**Year of handover to TAMS**	TBC
Catchment area	3,900 m^2 of catchment	**Catchment type**	Road runoff and some private lot runoff
Filter area	Approx. 10 m^2	**Total area**	70 m^2
Filter depth	TBC	**Construction cost**	TBC
Inlet/s	Open edge on street side	**Outlet/s**	TBC
Expected performance	TBC	**Source**	

Information reviewed to date

Information	Requested	Received	Reviewed
DA report	✓		
Design drawings		✓	

Site inspections

Site inspections have been undertaken on the following dates:

- 16 October 2014 – dry weather

- 15 November 2014 – wet weather

- 30 November 2014 – wet weather

Design objectives

The Digby Circuit rain gardens have been constructed as part of a treatment train to meet the requirements of the WSUD Code (2009).

The rain gardens are located at the upstream end of the catchment and are the first step in the treatment train. The rain gardens are part of the catchment which drains to the pond and recirculating wetland in the main Crace park. Downstream of the pond, stormwater is discharged from the pond into Ginninderra Creek downstream of Gungahlin Pond. Giralang Pond and Lake Ginninderra are downstream.

The rain gardens have been designed and constructed to treat the part of the streetscape of Digby Cct and some of the lot runoff. Some roof and lot drainage is connected into the rain gardens, however it is also clear that some lots have drainage which is connected underground into a pit and bypasses the rain gardens. It was also unclear whether the rain gardens were intended to treat the runoff from private lots or only from the streetscape. There were some examples where property drainage pipes were connected into the kerb and others where property drainage connections were not visible (and presumably connected directly to the stormwater system underground).

Performance issues

At Digby Cct, construction activity including house-building has been entirely completed (with the exception of one lot) and the systems are no longer affected by construction sediment. While the rain gardens are still to be considered in the establishment phase, within the next 3 to 6 months, it is likely that the rain gardens will be fully established. The surface vegetation condition is shown in Figure 1.

Our observations of the rain gardens on Digby Cct were that:

- All of the kerb inlets are blocked at Digby Cct and hence the rain gardens are not functioning. Runoff is completely bypassing the rain garden inlets and draining to the stormwater drainage system

- In most cases a slight build up of debris including sediment and organics caused blockage. In many cases after partially removing the sediment and debris and some of the mulch manually (to simulate maintenance activity), the majority of stormwater was still bypassing the systems. Refer to Figure 2 for example after sediment in the inlet was removed water can be seen bypassing the rain garden.

- Some systems have been impacted by the use of sand bags which have been placed at the inlets to prevent water entering the rain garden. The fabric on the bags is deteriorating and is breaking and depositing the material from the sand bag into the rain garden. The fabric around the sand bags becomes brittle over time (refer Figure 3)

- For some rain gardens the vegetation establishment is patchy with some area establishing well and other areas not establishing as well (refer Figure 4). It is possible that different species were planted in zones and some have thrived while others have not. Most of the trees appeared to be establishing well, however one tree was observed with a pest or disease which is significantly affecting the health of the tree.

- The rain garden inlets are generally well located upstream of the stormwater drainage, ensuring that runoff has a chance to enter the inlets prior to entering a pit.

- No flushing points were visible in the rain gardens

- There was evidence of litter and weeds in the rain gardens, but not substantial amounts and would not take a significant effort to remove (a few minutes for each rain garden, no more than 10 to 15 minutes for 7 rain gardens)

Figure 1: Rain garden on Digby Cct, showing state of vegetation establishment

Figure 2: Rain garden still bypassing after manual removal of debris (flows are from left to right). The water downstream of the rain garden can be clearly seen and the small area of ponding in the rain garden is also clearly visible

Figure 3: Broken sand bag (right hand side of photo) with debris from sand bag deposited in and around rain garden)

Figure 4: Example of patchy vegetation growth in rain garden

The Digby Circuit rain gardens, unlike some rain gardens elsewhere at Crace, did not have any signs of deposition of sediment and debris on the rock mulch. The rock mulch was still very clean suggesting that stormwater is unlikely to have ever entered these systems.

It was not possible to observe the performance of the filter media as the water was not entering any of the rain gardens, however there was no sign of any ponding during rain events (from rain falling on the systems) , suggesting that water is generally freely draining through the system.

Key causal factors and constraints

As the rain gardens have not been constructed with a sufficient drop from the inlet to the filter surface, flows are generally not entering the rain garden and hence are unable to pond on the surface and appear to have limited extended detention. The lack of a drop between the kerb inlet and the filter surface level and lack of extended detention is the major factor driving the failure of the system at present. Other issues may become apparent once the issue is rectified.

A secondary factor is that the inlets are relatively small. The size of the inlets makes them vulnerable to blockage. For example one plastic bag or A4 sheet sized piece of cardboard can block the inlet and prevent flows from entering the rain garden.

In these systems (unlike some others at Crace) it does not appear that the house construction stage has caused significant impact on the rain gardens. However this *may* become more evident once the rain gardens are working and signs of construction impacts may start to appear (e.g. clogging of the filter media etc). It appears that sand bags have been in place over the inlets of the streetscape systems which appears to have been effective in preventing significant sediment from reaching the rain garden (in conjunction with the poor arrangement of the inlet restricting the amount of water which can enter the system)

Weeds and litter are routine maintenance issues. We understand that routine maintenance has not been undertaken since the rain gardens were handed over to ACT government, however it is noted that in these systems there is not a high prevalence of weeds or litter in the rain gardens and it would not require significant effort to address this.

When we are able to review the design drawings, we will be able to comment further on other aspects of the design including depths, drainage arrangement, flushing points, finished levels, etc.

Potential improvement options

There are two key recommendations for these streetscape systems:

- Lowering of the filter surface level to allow water to enter the rain garden and to provide more extended detention in the system. At best this lowering may potentially be required only at the inlet, but it may possibly be required across the whole rain garden to function effectively. This needs to be further resolved with site survey or similar.

- Reconfiguration of the inlet, to reflect the change in levels and to promote water entering into the basin and potentially also to increase the size of the inlet to reduce the risk of blockage due to single large pieces of litter and debris

The rain gardens also need some simple routine maintenance such as weed removal and litter picking. As discussed above this would not require substantial effort. Some minor re-planting would be beneficial for a few of the systems but is not essential.

In some cases, education of local residents could improve the performance of rain gardens. A well-informed resident could be inspired to undertake simple routine maintenance activities such as hand weeding and removing accumulated sediment from the inlet.

Asset 5: Langtree Crescent rain gardens (Crace)

General information

Description

There are 31 rain gardens on Langtree Crescent in Crace. They are all built to the same design, and are located in the verge in three groups:

- Between Ettrick Street and Geegeela Street
- Near Hotspur Street
- Between Drooka Crescent and Kappakoola Street

Rain gardens include street trees and understorey planting.

Asset type	Rain gardens (streetscape)	**Asset context**	Recent greenfield development
Year built	2012? TBC	**Year of handover to TAMS**	TBC
Catchment area	TBC	**Catchment type**	Road runoff
Filter area	Approx. 31 x 6 m^2	**Total area**	186 m^2
Filter depth	TBC	**Construction cost**	$2,500 each ($417/m^2)
Inlet/s	Open edge on street side	**Outlet/s**	TBC
Expected performance	TBC	**Source**	

Information reviewed to date

Information	Requested	Received	Reviewed
DA report	✓		
Design drawings		✓	✓

Site inspections

Site inspections have been undertaken on the following dates:

- 16 October 2014 – dry weather

- 15 November 2014 – wet weather
- 30 November 2014 – wet weather

Design objectives

The Langtree Crescent rain gardens have been constructed as part of a treatment train to meet the requirements of the WSUD Code (2009).

The rain gardens are located in the upper part of the catchment and are the first step in the treatment train. However the treatment train varies for different parts of Langtree Crescent:

- The rain gardens between Ettrick Street and Geegeela Street are located upstream of the large pond at the corner of Abena Avenue and Gundaroo Drive
- The other rain gardens on Langtree Crescent are located upstream of the bioretention basin near Medhurst Crescent

Downstream of Crace, stormwater is discharged into Ginninderra Creek downstream of Gungahlin Pond. Giralang Pond and Lake Ginninderra are downstream.

It is unclear why rain gardens have only been installed in selected sections of Langtree Crescent. It was also unclear whether the rain gardens were intended to treat the runoff from private lots or only from the streetscape. There were some examples where property drainage pipes were connected into the kerb and others where property drainage connections were not visible (and presumably connected directly to the stormwater system underground).

In addition, there were several examples where stormwater inlet pits were located immediately upstream of rain gardens; therefore some had virtually no catchment area.

Performance issues

At Langtree Crescent, there is still construction activity in the catchment (house-building) and therefore most of the rain gardens are still protected by a filter sock at their inlet. Some are protected by silt fences around three sides, however most of the silt fences are dysfunctional or have been completely removed. An example is shown in Figure 1.

Our observations on Langtree Crescent were that:

- House-building is still generating significant sediment loads (refer to Figure 2), therefore it is advisable that construction stage protection measures should remain in place.
- Where construction stage protection measures have been removed, there were a number of locations where sediment-laden runoff was entering the rain gardens. An example is shown in Figure 3.
- There were a number of examples, particularly between Drooka Crescent and Kappakoola Street, where rain gardens have been so heavily impacted by construction sediment that the surface of the filter is completely clogged with a thick cover of fine clay-sized particles. An example is shown in Figure 4.
- There were also a number of examples, also concentrated between Drooka Crescent and Kappakoola Street, where construction spoil and debris has been dumped in the rain gardens, filling the extended detention zone, smothering vegetation and blocking the filter. An example is shown in Figure 5.

Therefore construction-stage protection measure have not been entirely effective at protecting the rain gardens on Langtree Crescent.

Figure 1: Rain garden on Langtree Crescent, with construction-stage controls in place

Figure 2: House building still underway at Crace is causing significant sediment loads in stormwater runoff on Langtree Crescent

Figure 3: Sediment-laden runoff entering a rain garden on Langtree Crescent, 30 November 2014

Figure 4: Example of a rain garden clogged by construction-stage sediment (despite the presence of a filter sock on the street inlet – sediment has potentially run in from the footpath side)

Figure 5: Example of a rain garden on Langtree Crescent where construction spoil and debris has been dumped into the filter area

Beyond the construction stage, we also saw some issues which are likely to impact on the long-term performance of the rain gardens:

- There was no sign of any flushing points anywhere in the vicinity of the rain gardens. It is not clear whether the rain gardens have slotted under-drainage pipes or not; however assuming that they do, the lack of a flushing point will make it impossible to ever inspect or clean these pipes if they become blocked. Design drawings do not show flushing points but do show a slotted pipe in the base of the rain garden.

- Some of the rain gardens have been constructed with a reasonable drop from the inlet to the filter surface, so that flows will easily enter the rain garden and pond on the surface. However others have been constructed with no fall across the inlet and no capacity for extended detention. The design drawings show a reasonable drop from the road surface into the rain garden, including a 50 mm drop from the gutter to the edge of the garden, then a further 200 mm drop from the edge into the base of the garden (where the tree should be located). It appears that most of the rain gardens have not been constructed to these levels.

- The design drawings show a filter media depth of 600 mm, which is quite shallow for a system with a tree. However they do not show any liner around the tree pit, therefore presumably trees will be able to grow into surrounding soils.

- Several of the rain gardens had a high density of weeds

- There was significant litter in the rain gardens including some large items that were smothering vegetation and/or blocking the filter surface.

Key causal factors and constraints

Issues around the location of property drainage and the location of stormwater drainage pits immediately upstream of rain gardens are fundamental design issues which should have been resolved at the estate development stage. These basic physical features of the drainage system are virtually impossible to change now.

The construction stage issues have been caused by poor staging of the rain gardens. In our interview with industry representatives (3 November 2014) Matthew Frawley from CIC noted that staging has impacted on the rain gardens at Crace, and that it would have been preferable to complete the bioretention systems after most of the house-building was complete. However this would be an unusual process, as most assets are handed over from the developer to government much earlier in the development process. Therefore bioretention systems were completed before house-building, and simple measures were put in place to protect them from construction impacts.

Weeds and litter are routine maintenance issues. We understand that routine maintenance has not been undertaken since the rain gardens were handed over to ACT government, which explains the prevalence of weeds and litter in these rain gardens.

Potential improvement options

Construction stage issues could be rectified now by "resetting" those rain gardens where the filter has been blocked. Typically this requires

- Scraping the accumulated material and surface layer off the filter
- Checking the hydraulic conductivity of the underlying filter, to ensure it is functioning as per specifications
- Replacing the top ~100 mm of filter media
- Re-planting the filter

Where the street tree is in good health, it could potentially be left in place during this process, however it would be important to work carefully by hand around the tree. Matthew Frawley from CIC (pers. comm. 3 November 2014) noted that CIC has already re-set some of the street tree bioretention systems at Crace while they were undertaking maintenance at the site.

Resetting is also an opportunity to correct surface levels so that the final finished level of the filter media includes extended detention.

Otherwise, remaining rain gardens simply need routine maintenance such as weed removal, replanting and litter picking.

In some cases, education of local residents could improve the performance of rain gardens. A well-informed resident should not dispose of waste in a rain garden and could even be inspired to undertake simple routine maintenance activities such as hand weeding and removing accumulated sediment from the inlet.

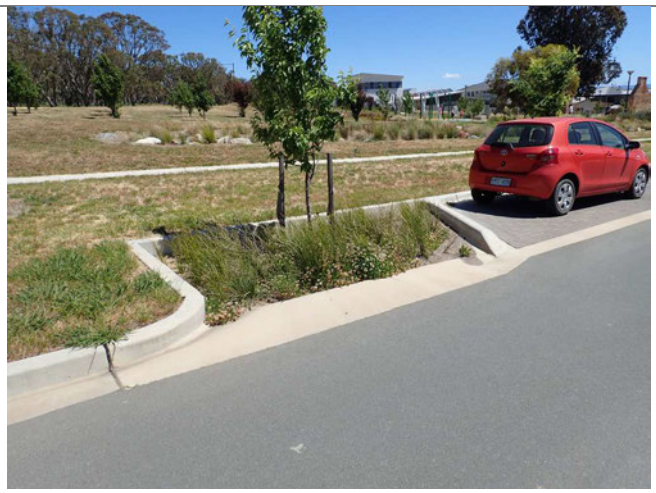
Asset 7: Turbayne Crescent rain gardens (Forde)

General information

Description

Three rain gardens on Turbayne Crescent in Forde. Rain gardens mark the ends of car parking bays at the southern end of Turbayne Crescent, adjacent to a small park.

Rain gardens include street trees and understorey planting.



Asset type	Rain gardens (streetscape)	**Asset context**	Recent greenfield development
Year built	2013? TBC	**Year of handover to TAMS**	TBC
Catchment area	~560 m^2	**Catchment type**	Road runoff
Filter area	Approx. 3 x 9 m^2	**Total area**	27 m^2
Filter depth	TBC	**Construction cost**	TBC
Inlet/s	Open edge on street side	**Outlet/s**	Slotted pipes
Expected performance	TBC	**Source**	

Information reviewed to date

Information	Requested	Received	Reviewed
DA report	✓		
Design drawings	✓		

Site inspections

Site inspections have been undertaken on the following dates:

- 2 November 2014 – dry weather
- 16 November 2014 – wet weather

Design objectives

The Turbayne Crescent rain gardens have been constructed as part of a treatment train to meet the requirements of the WSUD Code (2009).

The rain gardens are located in the upper part of the catchment and are the first step in the treatment train. Downstream is:

- A small swale, which takes any overflows from the rain gardens
- A vegetated waterway along Mulligan's Flat Road
- Yerrabi Pond on Ginninderra Creek

Performance issues

The key performance issue at Turbayne Crescent is the design of the street as a whole, which directs most stormwater runoff past the rain gardens and directly into the swale. This is illustrated in Figure 1. Figure 2 shows flows entering the upper rain garden and Figure 3 shows flows bypassing the lower rain garden. Bypassing occurs in the same fashion at the middle rain garden.

In the upper rain garden where flows were able to enter the rain garden, the system was working reasonably well:

- Water was ponding across part of the rain garden (refer to Figure 4). There was only a small volume of functional extended detention, however many streetscape systems effectively have no extended detention, therefore this is a comparatively good outcome
- Water stored in the extended detention drained away quickly after stormwater inflows eased, indicating that the filter is draining freely

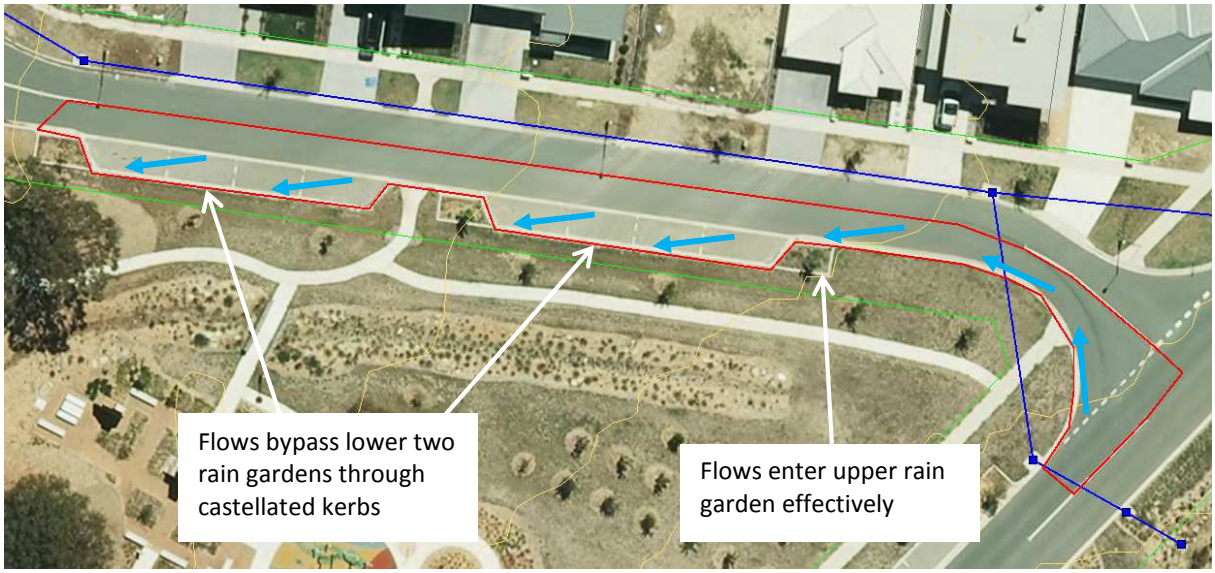


Figure 1: Catchment area and flowpaths observed at Turbayne Crescent

Figure 2: Flows entering upper rain garden

Figure 3: Flows bypassing the lower rain garden into a small swale

Figure 4: Water ponding in the extended detention in the upper rain garden (16 Nov 2014)

However even in the upper rain garden, there were some minor issues which affect the system's performance (or will cause performance issues over time):

- Slotted under-drainage pipes have been installed with a geotextile filter sock around the pipe. While this is commonplace where slotted pipes are installed behind structures, it is not recommended in rain gardens as the filter sock tends to clog under the higher hydraulic loading in these systems. In rain gardens, if appropriate filter media, transition and drainage media are used, then a filter sock is not required.

- Flushing points have been installed at grade in the rain gardens, with no cap (refer to Figure 5). This means they are easily buried out of sight and they easily become clogged. It also means that if water is able to enter the area of the rain garden where the flushing point is installed, it would simply bypass the filter media directly into the drainage pipe.

Figure 5: Flushing point in the lower rain garden (photo taken after shifting leaf litter which was covering the pipe)

Key causal factors and constraints

The key factor which has caused poor performance of the Turbayne Crescent rain gardens is their design.

Stormwater flows which bypass the rain gardens still receive treatment in swales, vegetated waterways downstream of the development and regional ponds, however the rain gardens themselves are relatively ineffective.

If the streetscape is modified to bring the lower two rain gardens online, the following constraints need to be considered:

- Layout and levels of structures such as kerb and gutter
- Existing vegetation within the rain gardens, including trees

Potential improvement options

A basic re-design of the streetscape could direct flows to the lower two rain gardens:

- Castellated kerb should be replaced with a solid kerb
- At the low point in each parking bay, adjacent to the rain gardens, an inlet should be made into the rain gardens

Unfortunately at this stage it would be virtually impossible to replace the under-drainage system and remove the filter sock without also replacing the trees within the rain gardens. However there is a risk that blockage occurs over time. Therefore options here are:

- Undertake this work now and replace the trees before they become large established street trees. An arborist could advise about whether the individual trees could actually be removed and replaced successfully
- Leave the filter sock in place, bearing in mind the risk of future blockage and a potential need to undertake this work some time in the future.

A riser and cap on the flushing point could be installed relatively easily from the surface.

Asset 8: Zakharov Avenue rain gardens (Forde)

General information

Description

There are 61 rain gardens on Zakharov Avenue in Forde. They are all built to the same design, and are located between car parking bays in the roadway.

Rain gardens include street trees and understorey planting.

Asset type	Rain gardens (streetscape)	**Asset context**	Recent greenfield development
Year built	2009? TBC	**Year of handover to TAMS**	TBC
Catchment area	TBC	**Catchment type**	Road runoff
Filter area	Approx. 61 x 4 m^2	**Total area**	244 m^2
Filter depth	TBC	**Construction cost**	TBC
Inlet/s	Open edge on street side	**Outlet/s**	Slotted pipes
Expected performance	TBC	**Source**	

Information reviewed to date

Information	Requested	Received	Reviewed
DA report	✓		
Design drawings		✓	✓

Site inspections

Site inspections have been undertaken on the following dates:

- 2 November 2014 – dry weather
- 16 November 2014 – wet weather

Design objectives

The Zakharov Avenue rain gardens have been constructed as part of a treatment train to meet the requirements of the WSUD Code (2009).

The rain gardens are located in the upper part of the catchment and are the first step in the treatment train. Downstream are:

- Two ponds located within the suburb of Forde
- Yerrabi Pond on Ginninderra Creek

Performance issues

The key performance issue at Zakharov Avenue is the fact that in most of the rain gardens, the finished levels allow very little (if any) water to enter the rain garden. There are a few exceptions where water can pond to a shallow depth over the filter media, however most of the rain gardens are almost fully bypassed.

Figure 1 shows a typical example where there was no water entering the filter area. Figure 2 shows an example where there was minimal water entering the filter area and Figure 3 shows an example where there was some water entering the filter area and ponding across part of the surface.

In most cases it appears that the original constructed levels were inappropriate, with the filter located above the gutter invert level. In some cases it appears that levels within the filter have probably built up over time as vegetation has established and sediment and mulch have accumulated in the filter.

Figure 1: Typical example of a Zakharov Avenue rain garden where stormwater runoff completely bypasses the filter

Figure 2: Typical example of a Zakharov Avenue rain garden where stormwater runoff can only enter a small area at the inlet. Extended detention is minimal

Figure 3: Isolated example of a Zakharov Avenue rain garden where stormwater runoff is able to pond to approximately 30 mm across part of the filter surface

There were also some other fundamental issues with the design of rain gardens at Zakharov Avenue, which limit their potential to treat stormwater:

- Some rain gardens are located immediately downstream of stormwater pits, therefore they effectively have no catchment area (refer example in Figure 4)

- It did not appear that any property drainage was connected into the rain gardens, therefore they are only able to treat runoff from the roadway

Figure 4: Stormwater pit located immediately upstream of a rain garden

Beyond these fundamental issues, a few other minor issues were also noted at Zakharov Avenue:

- Slotted under-drainage pipes have been installed with a geotextile filter sock around the pipe. This is how it was specified on the design drawings. While this is commonplace where slotted pipes are installed behind structures, it is not recommended in rain gardens as the filter sock tends to clog under the higher hydraulic loading in these systems. In rain gardens, if appropriate filter media, transition and drainage media are used, then a filter sock is not required.

- Design drawings show no drainage layer. Drawings actually include no details on the depth of the filter and therefore it is not known what has been installed.

- Flushing points have been installed by leaving a section of flexible slotted pipe protruding from most of the rain gardens (refer to Figure 5). The design drawings do not show flushing points at all, therefore the construction contractor appears to have had no direction on this element. These pipes are easily damaged and also provide a pathway for water to short-circuit the filter media via the drainage pipe. Flushing points should generally be constructed from solid PVC with a PVC cap.

- There were several examples of rain gardens where the understorey vegetation has died (refer to Figure 2). A rain garden without this understorey vegetation is more prone to clogging and less effective in terms of nutrient removal, as densely-rooted vegetation plays a very important role maintaining the porosity of the filter media and taking up pollutants.

- There were several examples of rain gardens with garden waste such as lawn clippings and leaf litter dumped in the rain garden. In some cases the quantity was sufficient to smother vegetation in the rain garden (refer to Figure 6)

Figure 6: Garden waste dumped in a rain garden on Zakharov Avenue

Figure 5: Flushing point in a Zakharov Avenue rain garden

These rain gardens' theoretical and actual treatment performance cannot be quantified in MUSIC until we have more details of its catchment area and dimensions from design drawings.

Key causal factors and constraints

Issues around the location of property drainage and the location of stormwater drainage pits immediately upstream of rain gardens are fundamental design issues which should have been resolved at the estate development stage. These basic physical features of the drainage system are virtually impossible to change now.

The issue with finished levels and lack of water entering the rain gardens at Zakharov Avenue appears to have arisen at the design stage. The design drawings show no vertical dimensions, however suggest relatively flat levels across the rain garden surface. They do not show any extended detention in the rain gardens and do not show enough detail on which to base the finished levels.

The flushing point and slotted pipe details, as noted above, are also due to inadequate or incorrect details provided at design stage.

Where vegetation has died, it appears that this is due to weed spraying. TAMS has noted that organic mulch has washed away at Forde and weeds are becoming a big problem. Weed treatment is via spraying, which tends to impact on all of the vegetation within the filter (it is also counter-productive to add chemicals to a stormwater treatment system).

In some cases, education of local residents could improve the performance of rain gardens. A well-informed resident should not dispose of garden waste in a rain garden and could even be inspired to undertake simple routine maintenance activities such as hand weeding and removing accumulated sediment from the inlet.

Potential improvement options

Improvement options are limited at Zakharov Avenue due to constraints associated with the physical configuration of the drainage system and existing trees within the rain gardens (most of which are in good health and have been in place for 5 years).

An opportunity for substantial redesign is therefore not likely to arise until street trees need replacing and/or the road needs resurfacing many years in the future.

The best option here may be to leave existing rain gardens in place and allow them to function simply as garden beds. If there is a desire to restore the expected stormwater treatment outcome, then new rain gardens could be retrofit to the street in separate locations (e.g. adjacent to existing rain gardens) if reduced availability of on-street parking is acceptable.