Level 2, 50 Customhouse Quay
Wellington
New Zealand
holmesgrouplimited.com

PAERATA CULVERT REPLACEMENT – IMPROVING WATER QUALITY OUTCOMES THROUGH WATER SENSITIVE DESIGN

E. Grigg (Holmes NZ)

ABSTRACT

Auckland Council is undertaking a restoration project for the Whangapouri Stream and Paerata Road culvert in Pukekohe. Whangapouri Stream is an urban stream in Pukekohe which is bridged by an existing culvert on Paerata Road. The project is seeking to remove the existing culvert and replace it with a new bridge as the existing crossing has the potential to flood upstream during large storm events.

Adjacent to this culvert, there are two existing stormwater discharges to the stream that convey the runoff from the surrounding high use roads. Auckland Council faced a challenge with these discharges, as during rainfall events contaminants generated from vehicular traffic are washed from the road surface and make a major contribution to stormwater pollution. This runoff contains a variety of organic and inorganic pollutants that contaminant the receiving water bodies and are potentially toxic for aquatic species. The existing stormwater management system provided no attenuation or treatment of these stormwater discharges. As part of the rehabilitation, our scope included the realignment and upgrade of the existing stormwater discharges to the stream.

This presented the opportunity to upgrade the existing stormwater management system. To meet the treatment requirements outlined in the Auckland Unitary Plan, and to improve the water quality of the stormwater discharges, we have proposed to install treatment for the discharges. With the aim of aligning with tangata whenua values, our design seeks to improve the natural environment instead of simply meeting minimum treatment requirements. This led to a stormwater design based on the following principles:

- Protection and restoration of the Whangapouri Stream as taonga by providing stormwater treatment.
- Use of green infrastructure where practicable instead of using cartridge treatment.

- Mimicking natural systems as much as possible by treating stormwater by passing it through land or rock before discharging to the receiving water body.

PROJECT BACKGROUND

There are two catchments which discharge to Whangapouri Stream adjacent to the culvert. Catchment A is located to the south of the culvert and is comprised of high use roads. Runoff for the catchment is collected via two double sumps in the nearby roundabout and discharges directly to Whangapouri Stream. The total area for catchment A is 4,960m2, of which approximately 49.1% is comprised of trafficable areas.

Catchment B is located to the north of the culvert and is comprised of high use roads, and several commercial properties. The total catchment area for area B is 3,690m2, of which approximately 65.6% is comprised of trafficable areas.

The two existing stormwater discharges are located adjacent to the existing culvert on Paerata Road crossing the Whangapouri Stream. Both existing discharges are elevated approximately 1 – 1.5m above the normal stream level, creating the opportunity for plunge pools to form and erosion of the stream bank during larger storm events. This has the potential to impact the stability of the stream slope.

Both the peak runoff and first flush volumes for the pollution generating areas were calculated using TP108 Guideline for Stormwater Runoff Modelling in Auckland Region and GD01 Stormwater Management Devices in the Auckland Region guidelines respectively. The first flush volume was based on 10mm rainfall for the trafficable areas of catchment A and B. This equates to a water quality flow (WQF) of 6.43 L/s for both catchments.

PROPOSED DEVELOPMENT

To construct the proposed bridge and to tie the road into the existing levels, the culvert and surrounding road is to be demolished and redeveloped. The total area of road redevelopment for the site is approximately 500m^2. Instead of treating the redeveloped runoff, we proposed to treat the runoff from catchment A and B instead. The proposed area of treatment is significantly larger than the area of redevelopment. Therefore, treating the catchments will provide a substantial improvement in treatment—rather than just treating the redeveloped area. The proposed bridge has been designed to match existing hydrological conditions and contours. Therefore, there are negligible changes to the existing catchments.

Providing treatment for the outlets had several constraints. Primarily, the restricted space for the treatment, steep slopes adjacent to the site, and clashes with the proposed bridge infrastructure.

For Outlet A, a publicly owned landscape area of approximately 50m^2 was identified as a suitable location for treatment. As Outlet B crosses private land before immediately discharging to the stream, no suitable space was identified for low impact design (LID) treatment. Therefore, we decided that both outlets would be pre-treated using a gross pollutant trap (GPT), and only Outlet A would receive additional treatment.

OUTLET A

Several options were considered for the stormwater treatment of Outlet A, including a selection of LID treatments:

- Swales
- Conventional raingarden
- Proprietary raingarden/green infrastructure device
- Cartridge treatment

With the aim of developing a water sensitive design, we determined that the amenity and maintenance of a LID treatment or propriety green device was significantly better than utilising a treatment cartridge and provided better alignment with tangata whenua values. Therefore, we decided that either LID treatment or propriety green device was the preferred option.

The available treatment length is approximately 10m at the longest point. Therefore, we discarded swales as a treatment option as the minimum length of swale required or retention time could not be achieved with the space available.

Using GD01 guidelines we calculated a conventional raingarden would need to be 49m^2, for WQF treatment only. Additionally, we liaised with suppliers of proprietary stormwater treatment devices, Stormwater360 and SPEL, to identify and size potential treatment options. From these discussions we identified that the best devices for the site were Stormwater360's Filterra and SPEL's SPELBasin. Both devices are modular bioretention devices with significantly reduced footprints compared to traditional bioretention, with a required treatment area for the devices of 12.96m^2 and 11.2m^2 respectively.

With the required footprint of 49m^2 for the conventional raingarden, available space of only 50m^2, and the combination of the steep ground towards the stream, we determined the initial preferred raingarden option was not feasible.

However, by using the proprietary devices we could greatly reduce the footprint of the treatment area and concluded the preferred option was to use a proprietary treatment device. This option still aligned with tangata whenua values to improve the natural environment beyond minimum treatment requirements and by treating the runoff by passing it through land before discharging.

Of the two devices considered, both provided similar levels of treatment, and maintenance frequency. After deliberation we chose the Stormwater360 Filterra device as the preferred treatment device as the shape of the device fit the available space better than the SPEL device. To meet the required treatment flows two 6.48m^2 Filterra devices were required. We proposed the preferred optioning and reasoning to the Healthy Waters project manager who accepted this approach.

To distribute the flow between the two devices, a planted distribution channel was placed between the treatment devices to slow the flow velocity and to equally distribute the flow to each device. While the channel was not designed to achieve any treatment requirements, it will increase the hydraulic residence time of the treatment compared to discharging directly to the devices. This will reduce the peak flow rate into the Whangapouri Stream, reducing flood and scour risk.

Pre-treatment of the runoff is required prior to discharge to the treatment devices to remove sediment and larger pollutants such as litter. Pre-treatment for the devices will be achieved via a gross pollutant trap (GPT) cartridge in the manhole prior to the distribution channel. This will help prevent clogging, increase the lifespan, and reduce maintenance frequency of the devices.

OUTLET B

There is severely limited available space for LID treatment for Outlet B. Therefore, only pre-treatment via a GPT will be provided for the outlet before discharging to the stream. As the existing discharge has no treatment, this will still have an improved impact on the water quality of the discharge.

Both outlet A and B will be lowered so that the level of the discharge is closer to the normal stream level to prevent the formation of plunge pools and scour of the stream embankment. This included a riprap apron at each outlet to further reduce scour, reduce flow velocity, and protect the stream bed.

CONCLUSION

Previously, there was no stormwater treatment for discharges into the Whangapouri Stream. As per Auckland Unitary plan, treatment is required for redeveloped areas to improve the water quality of the stormwater discharges and prevent contamination of receiving water bodies. Therefore, a stormwater treatment system has been developed for the discharges to increase the water quality of the runoff entering the stream.

We proposed to treat a significantly larger catchment area than the redevelopment—and will provide considerable improvements in treatment. Healthy Waters accepted our approach to the treatment as it will deliver a better impact in the water quality. Due to difficult site constraints treatment was achieved using a mix of proprietary green infrastructure and pre-treatment devices. Thus, protecting and restoring the Whangapouri Stream as taonga, providing a design solution above and beyond minimum requirements, and aligning with tangata whenua values.

KEYWORDS

Water quality, stormwater treatment, water sensitive design, tangata whenua