ADAPTIVE STORMWATER – RETROFITTING ATTENUATION AND TREATMENT IN AN URBAN ENVIRONMENT

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Abstract

Changing weather patterns and the threat of more intense storms may lead to an increase in nuisance flooding for New Zealand. The current range of Local Government Long Term Plans include significant funding for stormwater, the previously forgotten child. However are we taking an integrated approach to stormwater in our existing urban areas and are we utilising opportunities to provide mitigation?

With increasing intensification of development in existing urban areas, how can we increase permeability and treatment of stormwater? Do our current policies and standards improve the existing situation or only mitigate against further deterioration? Do our street scape upgrades maximise opportunities for soakage, detention or treatment?

This paper will look at existing retrofit and upgrading examples from New Zealand and internationally to showcase best practice and how we can adapt our thinking to enable our environment to flourish.

Key Words

Stormwater, Drainage, Best Practice, LUID, SUDS

Introduction

Stormwater management is a complex subject which has gained increased coverage in the community, politics and the media. Images of flooded communities and contaminated waterways are now a more common feature within the news, both in the press and in news bulletins.

Local Government has established key principals and standards for existing infrastructure. This has led to stricter requirements being placed on new, larger developments to integrate stormwater management into their design in order to get consent for the development. However this leaves smaller developments or public infrastructure redevelopment without the same drivers for improving stormwater management.

Key issues for stormwater retrofitting include:

Intensification of development

- Increased roading infrastructure
- Health and Safety requirements for designing out maintenance in high risk areas
- Desire for lower cost infrastructure development
- Increased density of housing
    - Less gardens
    - Increased paving
- Changing lifestyles
    - Low maintenance gardens
    - Hard standing areas in back yards
- Expectation for increased levels of service for stormwater – will the customer accept wet feet?
- Competing demands of transport networks and drainage networks.

Perceived effects of increased areas of imperviousness include:

- Less infiltration
- Increased runoff
- Increased peak flow and less detention
- Less point source treatment
- Increased carryover of pollutants into streams
- Increased downstream flooding

- Urban stream syndrome
- Change in capital/opex spend from maintenance to capital investment?

This is a complex subject with many factors to consider. This paper will focus on some areas for Local Authorities to think about where there is potential for early adoption to achieve long term benefits from minimal capital spend. It is acknowledged the private development and infilling is of ongoing concern, however this paper will focus on key public infrastructure and streetscape design, where local government have the ability to directly affect change.

Discussion

Retrofitting stormwater improvements into the urban environment is predominately completed by the local government or governing authority. Public transport routes are key contributors to urban stream degradation and ultimately contamination. This is due to the traditional design of stormwater conveyance systems to transfer stormwater as quickly as possible to the nearest receiving environment carrying with it contaminants without any form of treatment.

Retrofitting improvements to stormwater management “tools” into existing transport infrastructure requires acknowledgement of the existing issues and effects while still providing the core function of transportation. These include:

- Stormwater Quantity
- Stormwater Quality
- Socio-economic factors

Stormwater Quantity - Intensification and increased imperviousness

An example of where existing issues around intensification can be improved by changes in standard design are in Christchurch City. The Avon Stormwater Management Catchment Flood Modelling, (DHI for Christchurch City Council, 2014) identified that the existing imperviousness of the catchment was 38% impervious and with a Most Probable Development likely to be 45% impervious. This increase of 7% in impervious surfaces. The modelling consider the benefits of rain gardens and stormwater detention throughout the city. The model report identified that even stormwater devices that were intended for quality improvements only also reduced the peak runoff. These were more prevalent in smaller storms.

Stormwater Quality & Sources of contamination from Transport

The Effects of Road Transport on Freshwater and Marine Ecosystems (Ministry of Transport, 2003) identifies in Table 2.1 of the paper the key contaminant contributors for vehicles as fuel, exhaust emissions, lubricants, brake pad wear, tyre wear and road wear.

In addition to this direct contamination, there is also debris from the established urban environment such as detritus, sediment and atmospheric dust add to the contributing factors of road runoff contamination. This is combined with other factors such as material mobilised from new developments including contamination from building materials including roofing and cladding (zinc & copper).

Economic, Social and Cultural aspects of improving stormwater quality

The report on Value-for Money: Stormwater Treatment Standard for State Highway Infrastructure (NZTA, 2009) identified that the adoption of a stormwater standard (now the Stormwater Treatment for Road Infrastructure, 2010) would only result in an increase of 1% cost for stormwater management but would achieve better environmental outcomes.

The report ‘Banking on Green: A look at How Green Infrastructure Can Save Municipalities Money and Provide Economic Benefits Community Wide’ recognises the economic benefits to ‘green’ stormwater management. It identifies that economic benefits to green stormwater infrastructure can be attributed to energy efficiency from urban cooling and from reduction in pumping costs due to stormwater ingress and infiltration. It also identifies that key areas of reduction can help to reduce possible spend on Combined Sewer Overflow reductions through taking an integrated 3 Waters approach. The report also identifies where considering detention as an alternative to upgrading pipe capacity can have additional economic benefits.

Bringing Benefits Together: Capturing the Value(s) of Raindrops Where They Fall, (Wise, 2007) identified that addressing localised point source stormwater on an incremental basis provided less debt servicing for the implementation of solutions. Further to that it noted that one of the key factors in enabling this was to re-address the design and function of urban streets and parking lots, hardscape surfaces, making parts of the problems become the solutions. In the presentation of the report it identifies some key case studies including the Seattle SEA Streets program which implemented vegetated strips with no kerbs, resulting in 11% reduction in impervious surfaces and a 90% runoff reduction along with 25% cost savings compared to conventional design. Another case study highlighted in the report is the Portland Green Streets Program which produced 40% cost savings compared to conventional design and 80-85% reduction in Combined Sewer Overflow peak flow reduction.

Operational maintenance of stormwater systems is often consider to be a high cost when looking at 'green' infrastructure. However this is implying that all options for improving stormwater management include high maintenance solutions. There are multiple techniques for managing stormwater that require minimal maintenance when compared to a standard stormwater conveyance system.

The Health and Safety at Work Act 2015 which comes into force on 4 April 2016, may have an impact on the consideration for stormwater treatment maintenance. The consideration of plantings and the ability to maintain them in the central berm will have require further consideration. It is important to ensure that in establishing Safety in Design into the stormwater management does not eliminate the potential for stormwater treatment within the roading corridor.

The urban community has turned its attention to the degradation of urban waterways and streams. Often the community wants to support the rehabilitation of urban streams and waterways, yet does not fully understand their own impacts on water quality. There is a national resurgence both through community will, media and political support in the acknowledgment of social benefits to improving urban waterways. This translates to urgency to do 'something' without fully understanding the costs, benefits or the effectiveness of the projects.

Stormwater quality and quantity issues are of particular concern to Tangata Whenua. The desire for Mahinga Kai or food gathering from waterways is of considerable cultural significance. There is also a recognition that the urban waterways will never return to their original state but there is a desire that they return to their original intent as a place of food gathering.

Examples of current policies and standards from Design Codes and Practises

Improving stormwater management will require policies and standards to be aligned. Most Council policies will mentioned the need for stormwater treatment and quality improvements however they do not always translate into design standards. The follows are examples of design standards for council roading infrastructure.

NZS 4404:2010 identifies the need for new developments and subdivisions to control peak flows and pollutant removal. This means that for future developments best practice will be implemented, but this does not necessarily apply to retrofitting existing infrastructure.

‘3.3.19 Road Run Off

Stormwater management for a subdivision needs to integrate the control of stormwater from the proposed roading network with the overall stormwater system for the land development phase and final subdivision layout. Such planning needs to integrate the control of stormwater peak flows and pollutant removal as set out in Section 4 of this Standards with the aim of minimising downstream negative effects and mitigating road instability and erosion problems. Some guidance is set out in NZTA Stormwater treatment standard for state highway infrastructure.’

Wellington City Council has identified the need for stormwater management in road and sets out Performance Criteria to have regard to ‘limit the on-going maintenance costs of assets’ and to ‘provide for stormwater drainage and utility services’. It enables that ‘provided the previous criteria are met, alternative, low impact design solutions, including permeable paving and swale use, may be proposed with appropriate engineering detail that will enable the Council to assess the viability of the proposal.’

Dunedin City Council ‘Dunedin City-Code-of-SubdivisionDevelopment-Aug-2010’ uses NZS 4404 as a standard and requires in additional that there is provision for ‘low maintenance’ formalised stormwater drainage that also provides ‘appropriate stormwater treatment’. The roading following clause has been added:

‘3.3.21 Road drainage – add before clause 3.3.21.1

The road design shall include provision for a low maintenance formalized stormwater drainage system which ensures that all trafficable areas, parking areas or pedestrian walkways are kept free of surface water in accordance with the Stormwater Performance Criteria and maintain a safe operating surface. The drainage system shall include measures to adequately mitigate the effects of stormwater runoff, by controlling peak discharges and providing appropriate stormwater treatment.

Local Government has in general set out policies that enable retrofitting of stormwater management devices such as swales. However does not go as far as requiring the installation of these devices as standard practice.

Case Studies of Good Practice:

City of Portland Oregan- Street Kerb Extensions

The City of Portland has enabled the design of street kerb extensions, there the existing kerb lines are extended out to provide a traffic calming measure. This kerbs are cut down to enable stormwater flows into a vegetated swale behind the kerb. In some instances this will also enable infiltration into the ground and will help to remove some of the first flush contaminants before it enters the stormwater system.

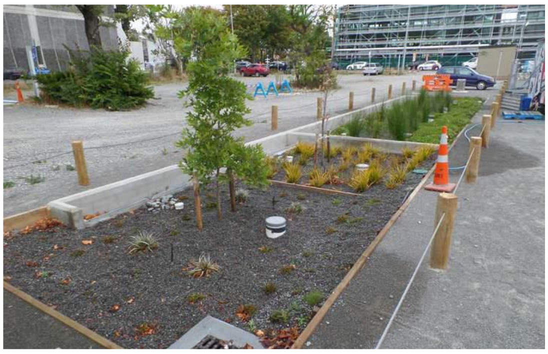
City of Portland, North East Siskiyou

Christchurch City Council – Rain Gardens

These devices are becoming more common in New Zealand with an example below from Christchurch City Council in Dorset Rain Garden.

Dorset Street Rain Garden, Christchurch City Council

The Christchurch City Council Stormwater Management Plan, (Christchurch City Council 2015) has set a standard in considering potential retrofitting locations for stormwater management. The plan identifies key priority areas for stormwater treatment improvements. This also provides key designs for swales, tree pits and other small scale treatment devices.



Christchurch City Council Rain gardens, Christchurch City Council.

Moving towards Permeable Pavement

Auckland Council has released a Permeable Pavement Construction Guide which outlines best practice for the inclusion of permeable paving into infrastructure including construction sequences.

Auckland Council Permeable Pavement Construction Guide

Conclusion

Street renewals and landscaping will occur over the next 100 years. We as a community cannot afford to retrofit drainage designs in roads within a short period. However by changing the principals of road drainage design now we enable the progressive upgrading of our roading infrastructure to include for green drainage techniques.

The issue is recognised by all councils and there is community desire to see improvements to urban design standards with reference to stormwater improvements of both quantity and quality. Stormwater management principles, policies, plans and technical designs are available to provide for sustained improvement and outcomes.

This paper highlights the need for a coordinated approach to stormwater management between roading and drainage asset classes, led by local government. Local government should look to change current standards and practices to include for retrofitting stormwater management as the standard rather than as the exception.

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Author Biography & Photograph

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Chris is also currently Project Manager for the delivery of Canterbury local government infrastructure projects for MWH where he regularly works with technical specialists in multi-office teams across New Zealand and Australia. He is a past Chairman of the Institution of Professional Engineers Canterbury Branch (2013). Chris was winner of the 2015 IPWEA Hynds Paper of the Year.