STORMWATER MANAGEMENT PLANNING – A COLLABORATIVE PROCESS

S Dudson, Opus International Consultants Ltd

ABSTRACT

In recent years there has been an increasing awareness and focus on stormwater management and taking a 'big picture' point of view. Through integrated catchment management planning and use of appropriate modelling software, we are able to understand the system as a whole and build resilience into our designs.

This paper discusses the development and implementation of a stormwater strategy for Ashburton. The aim of the strategy was to understand issues with flooding, improve the resilience of the system, protect the receiving environments, accommodate future growth, support development, and is also expected to meet increased community expectations, a more stringent regulatory environment and climate change. This integrated approach to stormwater management is an example of how far stormwater management has evolved, and will optimise capital expenditure and provide better overall solutions for the Ashburton Community.

KEYWORDS

Stormwater, Stormwater Management Plan, Integrated Catchment Management Plan, Urban Development, Stormwater Levels of Service

1 INTRODUCTION

Our attitude towards stormwater is evolving. In the past, stormwater has often been dealt with reactively, largely in response to flooding. Solutions were considered in isolation due to lack of data and the complexity of interactions between pipes and watercourses, attenuation systems, infiltration systems, etc. While designing in isolation may have fixed the initial issue, the solution itself could transfer the problems elsewhere, resulting in further upstream or downstream flooding.

This paper uses the Ashburton Urban Stormwater Strategy and the development of the associated Stormwater Management Plan (SMP) to illustrate how far stormwater management has evolved current expectations. In our view, this project is a standout example of a collaborative approach to stormwater management planning.

The following sections will consider:

- Understanding the environment
- Understanding the stormwater system
- Understanding the client
- Future proofing
- Water quantity and flooding
- Water quality and ecological enhancement
- Best value investment.

2 BACKGROUND

Ashburton District Council (ADC) provides urban stormwater collection and disposal networks in Ashburton (population 31,000) and is responsible for ensuring the urban stormwater system provides an adequate level of service for the community, while protecting receiving environments and complying with current resource management legislation. ADC is reviewing their stormwater system for the Ashburton area to address current issues and prepare for future growth and needs.

The increase in development is confirmed by the Ashburton District Development Plan (2005), which identified several key issues for the township looking forward to 2021. It particular, it projected an increase in population of 6,000 people by 2021 based on recent growth trends, and the demand and impact this will have on urban resources. It also identified industry growth and a change in the nature of business to provide processing and servicing bases for land based production. These elements need to be factored in to any future planning of the stormwater network.

ADC has also had to deal with a changing legislative environment. The Natural Resources Regional Plan (NRRP) become operative and we now have the proposed Land and Water Regional Plan (pLWRP) that will supersede the relevant stormwater sections of the NRRP. As it currently stands, there is a rule (5.71) in the pLWRP that states, *"The discharge of stormwater from any community or network utility operator stormwater system…is a discretionary activity."* The requirement for a stormwater management plan is one of the discretionary matters. This essentially means that existing discharges from all community and council stormwater systems will require resource consent within a particular timeframe (likely to be within the next 2-3 years).

We have helped ADC prepare a SMP to meet the legislative requirements, support a global stormwater discharge consent application and provide an integrated approach to the management of stormwater discharges from a catchment perspective. The SMP comprises a review of existing issues and the identification of future needs. It includes the development of a hydraulic model to examine both the piped network and stream channels within the Ashburton urban catchments, providing critical information on the performance of the networks. The model also predicts the performance of the networks when future development is taken into consideration.

The SMP is intended as a living document that can be updated to reflect new development as necessary and subject to a full review every ten years to keep the document current and provide direction to ADC's Long Term Plan.

3 UNDERSTANDING THE ENVIRONMENT

The majority of stormwater runoff in Ashburton discharges to surface water, which includes the Ashburton-Hakatere River and several urban streams. There are also a number of soak pits that discharge stormwater to land where soil type and depth to groundwater are suitable (or not!).

The Ashburton-Hakatere River holds Statutory Acknowledgment Area status, which reflects the significance of the river to Ngai Tahu. The Ashburton-Hakatere River is also a valued resource for recreational fishing and is an important visual landscape feature of the town, which is valued by the community. However, while high value is placed on the river, its catchment is vast (1,373 km^2) and flows are great in comparison with the potential stormwater discharges from the urban area of Ashburton. The future extent of the urban area (based on the 2012 proposed District Plan zoning maps) is estimated at 32 km^2, a mere 2.3% of the Ashburton-Hakatere River catchment. It is very difficult to measure the impacts of stormwater discharges on a water body so large; hence the smaller urban streams became the key focus.

The smaller streams that run through the urban area are much more sensitive to stormwater discharges. For this reason, an ecological assessment was carried out on the three main urban streams, to determine a baseline for water quality, sediment quality, habitat and aquatic health. The assessment highlighted that through the urban area, the streams are highly modified and in average to poor ecological health. However, this is not unusual for streams impacted by both urban and rural land uses. This is likely the cumulative result of a century of human impact comprising both urban and rural development. Urban development has inevitably led to catchments with high impervious surface area, with fences and buildings right to the edge of the stream bank in places. This has resulted in changes to the hydrological regime, bank erosion and increased inputs of pollutants associated with urban environments including heavy metals, hydrocarbons and fine sediments. No values of significance were identified.

The large rural catchment upstream of the urban area is also an important consideration for its contribution to the degraded state of the streams observed through the urban area. Nutrient loading from upstream rural activities will not be addressed by retrofit of any stormwater treatment facilities or ecological enhancement projects in the urban area.

Industrial sites can be another source of pollutants to enter stormwater systems and receiving environments if not managed properly. Site practices on the Hazardous Activities and Industries List (HAIL) are considered the highest risk if accidental spills have a pathway to the stormwater system. A separate project will identify and audit potentially high-risk sites to determine if they have appropriate management practices, containment and stormwater treatment in place.

Future development is also going to result in new contaminant sources as a result of creating more roads, more traffic and more industry. In addition, further modification of the urban streams is inevitable as development extends up the catchment. Effective management of development will be paramount to preventing any further degradation of the receiving environment (refer Section 6).

4 UNDERSTANDING THE STORMWATER SYSTEM

A decision was made early in the programme to build a hydraulic model of the urban stormwater system to help understand the stormwater systems as well as existing and/or potential issues. Modelling technology has progressed rapidly in recent years and now can now combine hydrology with both open and piped networks in a single software environment, and meant an integrated model could be built cost effectively.

The quality of any model outputs is a direct function of the quality of the data being analysed (garbage in = garbage out!). For this project, the majority of the budget was spent collecting existing information and additional investigations, to ensure the data was appropriate for its intended use and would result in the required level of confidence in the outputs.

Collection of existing data included:

- Local knowledge
- Customer complaints
- As-built information
- GIS records
- Soils, infiltration and groundwater data
- Aerial photographs
- LiDAR.

Gap analysis then identified a need for the following additional investigations:

- Site walkovers
- Topographic survey of piped network and urban watercourses
- Installation of flow monitors and rain gauges (for model calibration)
- Rainfall analysis (86 years of historic rainfall data).

An important additional step was visiting Ashburton during significant storm events to photograph and observe the level of flooding first hand. Rainfall records for these events were subsequently obtained to run in the model. This verification process showed good agreement between observed flooding and extent predicted in the model. The capabilities of the modelling software, when paired with smart use of LiDAR and infill surveying, was a powerful combination that was able to clearly overlay predicted ponding areas onto aerial photographs. This exercise was invaluable in giving ADC confidence in the data, the model and the results.

Figures 1, 2 and 3 below show several examples of observed flooding compared with the model prediction.

Figure 1: January 2009 (high intensity short duration thunderstorm)

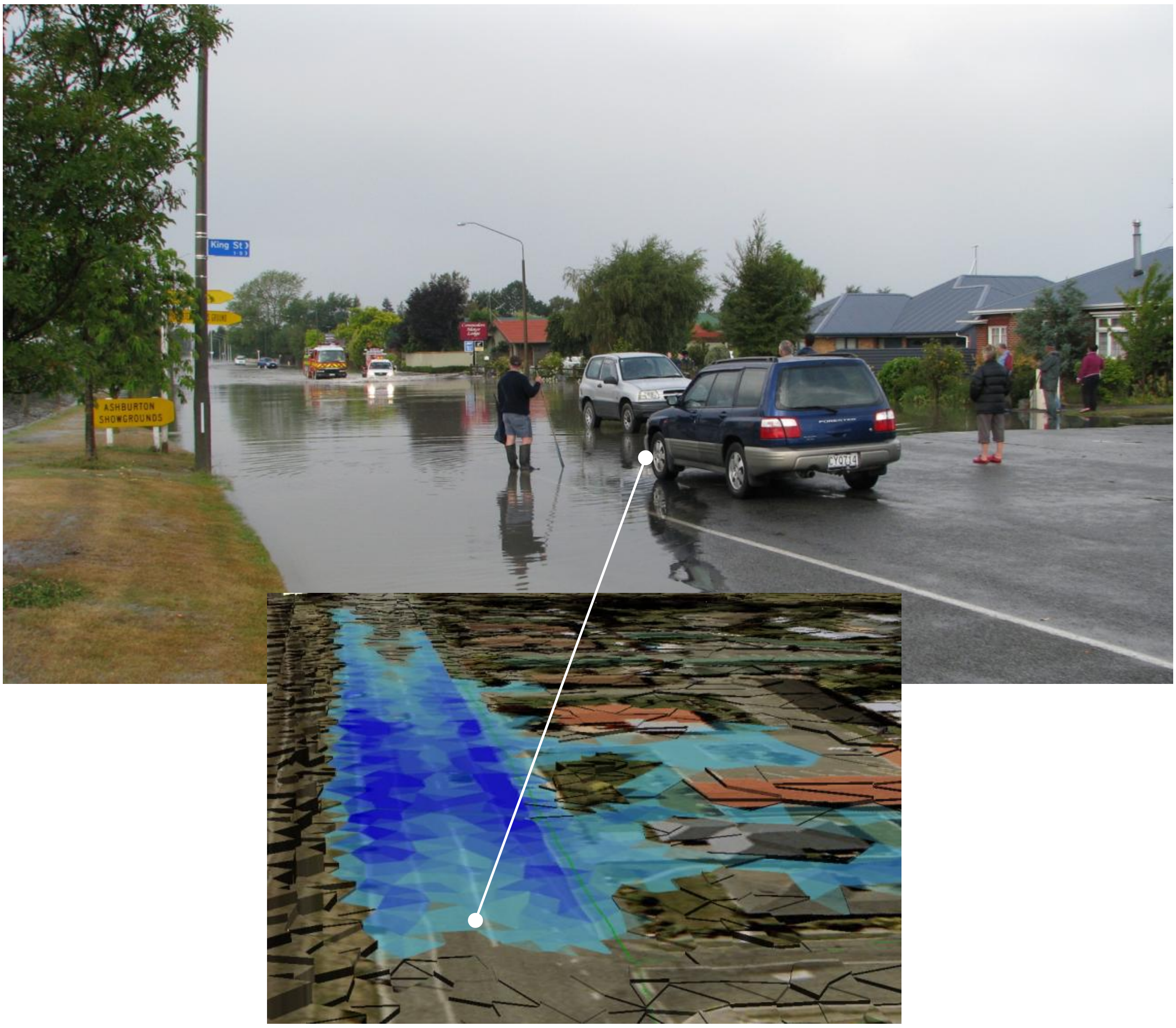

Figure 2: August 2012 (long duration low intensity event)

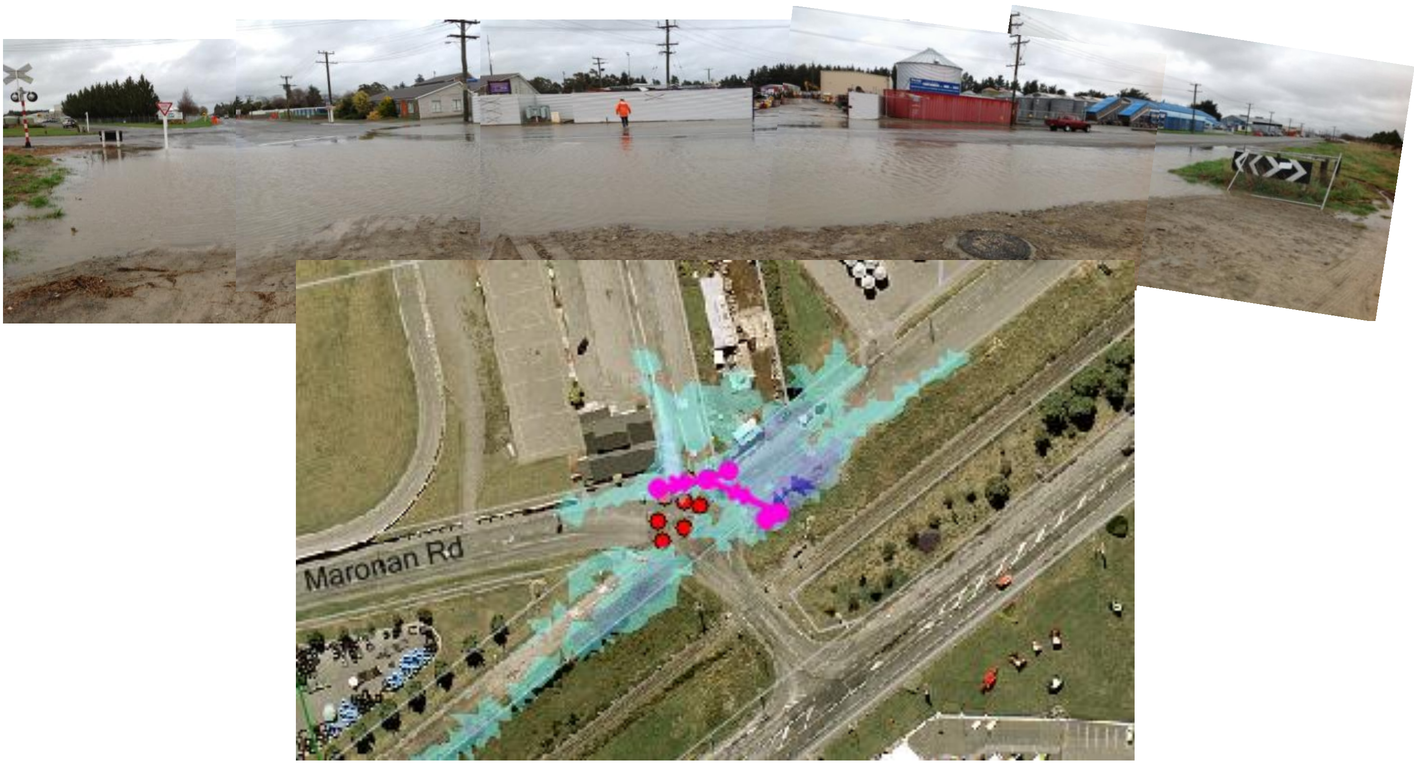

Figure 3: June 2013 (220mm rainfall over 8 days)

The model has been a critical tool, helping to identify a number of water quantity issues with the Ashburton stormwater system, the most significant being limited network capacity. The existing piped network does not provide a full reticulated service to all streets in Ashburton. Much of the stormwater network is conveyed via deep-dish channels for considerable distances before being intercepted and discharged into a pipe. Combined with the intensification of the urban area over time, we now have large flow rates draining to single catch-pits in certain areas, leading to significant water ponding or the catch-pits being by-passed altogether.

When rainfall events coincide with high water levels in the urban streams, this can create a backwater effect that further reduces the ability of the network to drain effectively. In larger events, the urban streams can exceed channel capacity.

While urban flooding is a frequent occurrence during rain events, Ashburton is flat (approx. 0.5%) so runoff in excess of the network capacity has a large area over which to spread out. Resultant ponding is generally static, shallow (less than 300mm) and is rarely sufficient to enter habitable buildings or cause property damage. Natural overland flow paths are not clearly defined and are easily manipulated through subdivision development and the construction of new roads.

During the process we were able to identify three critical storm durations:

1. 10 min – isolated flooding caused by localised capacity issues with existing piped network.

2. 2 hour – time of concentration for the urban area. Flooding caused by restrictions in existing piped network and high water level observed in urban streams as a result of urban discharges.

3. 48 hour – time of concentration for the rural catchment resulting in highest observed water levels in the urban streams. Combined with poorly drained soils, soil saturation, high groundwater, and lack of overland flow paths, long duration storm events (48 hour and above) results in the most extensive flooding.

Given the current flooding issues, there is no spare capacity in the existing system to accept additional flows from further development or intensification. If not managed effectively, future development will only exacerbate these issues.

5 UNDERSTANDING THE CLIENT

A significant part of the developing a successful SMP was an understanding of what was important to ADC and the Ashburton community.

We initiated consultation with key stakeholders to identify issues the community has regarding stormwater and stormwater management prior to preparation of the SMP or any other any actions of the stormwater strategy being executed. Stakeholders included:

- ADC staff
- Developers
- ECan
- Fish and Game
- Iwi
- New Zealand Transport Agency.

A mail-out with feedback forms was followed up with a telephone call and meetings. The three most common issues identified by respondents were:

1. Attenuation and treatment needed prior to discharge of stormwater to creeks and rivers.
2. A need to consider a variety of innovative techniques to manage stormwater including rain gardens, water reuse, swales, naturalising of open drains and creating riparian margins with public access and amenity value.
3. Lack of control of flood waters with overland flow currently an issue.

As the SMP has developed, working closely with ADC across many departments was essential. A series of presentations, workshops and meetings have been held with Council staff and councillors, including representatives from:

- Water services
- Asset management
- Roading
- Building consents
- Parks and reserves
- Planning.

The responsibility for and impacts of stormwater has grown and now overlaps all these council departments. It was important for ADC staff to understand the far-reaching effects of stormwater, from sumps in the road to buried pipelines, from amenity areas created by the use of grassed basins and wetlands, to land use restrictions and inspection of on-site drainage such as soak pits for building consent compliance.

The workshops were hugely successful at working through the process of developing the SMP once we had completed the baseline investigations. The first workshop prioritised the stormwater management issues and discussed the general management approach and potential targets for improvement. The second workshop looked at options for what the future stormwater system for Ashburton might look like, considering both the existing issues and management options for future developments. The third workshop looked at the implementation of the SMP and the additional processes and resourcing required in order for ADC to authorise new discharges under their global stormwater discharge consent. Overall, this project has strengthened our relationship with ADC and the level of trust we share. The culture of open and honest communication we have created with them has helped to streamline the SMP process.

We also held workshops with the councillors and Mayor of Ashburton. In addition to informing the councillors of progress on the stormwater strategy, the purpose of these workshops was to confirm the appropriate targets to commit to in the SMP and global consent application, what to do with the flood maps and an appropriate public consultation plan going forward.

Stakeholders were sent additional letters updating progress during the development of the SMP. In addition, meetings and on-going open dialogue with ECan consents staff has proved invaluable to ensuring the SMP will meet all their requirements. The next phase of consultation will be during the notification period of the global consent application. The key stakeholders will be given an opportunity to inspect the SMP document and attend follow-up meetings to discuss any concerns. The intention is also to hold a community open day to explain the SMP to the public and how stormwater management is likely to affect them. This proactive approach to consultation will assist in the consent process running smoothly.

The last phase will be public consultation on how much is allocated to future stormwater management funding and how best to spend it. This phase will follow lodgement of the SMP and global consent application with ECan.

6 FUTURE PROOFING (STORMWATER GUIDELINES FOR DEVELOPMENT)

Ashburton has experienced significant growth in recent years, which is expected to continue, with an additional 450 ha impervious area if the updated land use zoning in the partially operative District Plan (2012) is fully realised. If not managed properly the increased runoff volumes and generation of contaminants from the development of these greenfield catchments will have a detrimental effect on the receiving waterways and will exacerbate flooding in existing urban areas.

ADC elected not to invest in off-site catchment wide solutions for new developments. Instead, stormwater management for new developments will remain the responsibility of the developer. Stormwater Design Guidelines are being written which set out what a new development must achieve in order to be granted authorisation from ADC to discharge stormwater under ADC's global stormwater discharge consent. Development that occurs in line with these guidelines will also help ADC meet their stormwater objectives.

The focus of the guidelines is management of stormwater close to source, to mimic as close as possible what naturally happened in the pre-developed 'natural' system. On-site stormwater management is encouraged, utilising rainwater tanks, raingardens or soak pits for roof and hardstand runoff as appropriate. Where a site is located over free draining gravels, the expectation will be the use of soakage based systems to discharge stormwater to ground. Where a site is located in an area of poorly drained soil and high groundwater, there should be an allowance for ponding of runoff in detention systems. The main objective relating to stormwater quantity is to manage stormwater such that post developed flows do not exceed pre developed flows for events up to and including 2% AEP 48 hour duration events.

Brownfield development will be subject to the same requirements for any additional impervious areas, the exception being where less than 30% of the existing site will remain the same. In this case the scale of re-development is considered sufficient to make achieving an overall reduction in stormwater volume feasible.

The main premise of the guidelines from a stormwater quality point of view is the requirement for first flush (18mm rainfall depth) treatment, stormwater management close to source and a preference for natural systems (raingardens, swales, wetlands, infiltration basins) over proprietary devices. Providing treatment for all new trafficked hardstand areas will be expected for Brownfield developments.

The stormwater model will be an extremely useful tool check compliance with the guidelines. The effectiveness of proposed stormwater designs for new developments can be tested prior to granting authorisation for the discharge. The model also allows us to test future scenarios and the impact on existing infrastructure of any new connections to the existing network.

The Stormwater Design Guidelines are designed to be simple for both developers and ADC to understand and implement, reducing the need for specialist technical input in a lot of cases. They are driven by in-depth knowledge of the systems and an aims to reduce the risk of ADC inheriting poor designs. The SMP and Stormwater Design Guidelines are living documents and are designed to be adaptive when new development areas are identified and as technology and best practice evolve.

7 WATER QUANTITY AND FLOODING

The stormwater model was a crucial tool in considering options to manage existing flooding issues. Changes to the stormwater network, such as increasing pipe sizes and adding new stormwater infrastructure, were tested to see what impact the upgrades would have on the extent and frequency of ponding and associated costs.

One of the outcomes of the first workshop with ADC staff was existing flooding problems were the highest ranked issue. A 10% AEP level of service was set as a target for upgrading stormwater infrastructure as this is the consistent with the level of service requirements for new infrastructure as stated in NZS 4404 (adopted by ADC). Using the model, the existing stormwater network was progressively upgraded until no ponding was predicted in any events, up to and including 10% AEP.

A key part of the solution was to reduce discharges to the urban streams by diverting stormwater to the Ashburton-Hakatere River. As discussed in Section 3, the Ashburton-Hakatere River catchment is so large in relation to the Ashburton urban area that urban stormwater discharges are unlikely to coincide with peak flows in the river, or result in any measurable increase in base flows. By diverting stormwater to the Ashburton-Hakatere River, capacity is freed up so that pipelines can be upsized to discharge more stormwater and relieve upstream flooding problems. This solution also includes several detention basins (necessary to buffer the increased flows to the urban streams once the pipes and outfalls are upgraded) and stormwater treatment where cost effective.

The total cost of stormwater upgrades to achieve a 10% AEP level of service for the existing urban area is in the order of $100M, comprised of new infrastructure, upgrades to existing infrastructure and allowance for engineering fees and a large contingency. $100M is an unaffordable investment for a problem that to date hasn't cost the community any significant damages. Especially as this does not allow for any future intensification which would mean a portion of the cost could be attributed to developer contributions. We were also able to use the model to also compare the cost of providing a reduced 20% AEP level of service ($90M) and reducing flooding to less than 300mm ($60M).

In addition to the infrastructure upgrades identified using the model, there are other options to reduce the stormwater quantity. The majority of Ashburton streets are 100% impervious, so there is opportunity for significant reduction in stormwater runoff volumes by reducing imperviousness of the existing streetscape. This is consistent with the vision for Ashburton streetscapes, which is to increase use of greenspace and reduce carriageway and footpath widths. As this will be an expensive exercise, it is considered an aspirational goal that will be achieved slowly over many years. There will be a typical template the utilises raingarden planted areas to capture and treat stormwater that can be rolled out when streets come up for renewal, or for replacement of deep dish channel with traditional kerbs.

8 WATER QUALITY AND ECOLOGICAL ENHANCEMENT

There are two ways to enhance the quality of receiving environments. One is through the stormwater devices themselves and the other is through enhancing the natural systems and habitats that receive the waters from the stormwater system, which can offset the effects of stormwater discharges.

Retrofitting stormwater treatment into the existing Ashburton stormwater system is difficult for two reasons. Firstly, there is little land available for installation of treatment systems as the existing urban area is well developed, right up to the point of discharge into the receiving waterways. Secondly, the stormwater network is very flat so the addition of any treatment devices runs the risk of worsening upstream flooding due to the additional head required to operate them.

The simplest stormwater quality and ecological improvements can be achieved in existing detention areas and open drains. With appropriate planting and design, stormwater devices can provide for enhanced ecology and landscape values by designing flow-rates, margins and batter-slopes to optimise ecological buffers and diverse plant communities. As the vision for Ashburton streetscapes is realised, the reduction in impervious surfaces through the increased use of greenspace and reduction in carriageway and footpath widths will also help to reduce the production and transport of contaminants.

As far as natural system enhancement goes, riparian planting has a number of ecological enhancement advantages. It creates shade for fauna, provides cover for fish, keeps the water temperature cooler, filters nutrients, stabilises the stream banks and can improve the visual landscape. Planting diverse species from a similar ecotone and in a structure that replicates habitat niches within a plant community e.g. root zones, litter layers, herbaceous plants, understory shrubs, canopy plants and emergent trees.

Community engagement and education is a key aim of the SMP. As such we are hoping to initiate a community based enhancement program of a representative area, which focuses on improving water quality values and its associated ecology. The aim would be for the community to select an area they valued on one of the creeks and restore it as close to its natural state as possible, including riparian planting, animal and plant pest management, creating fish friendly instream habitat and enhancing landscape values. The project could be used as an education tool for the community who may well choose to apply the techniques if they have a stream or creek running adjacent to or through their own land.

Whilst increasing stormwater discharges into the Ashburton River is not an issue from a volume perspective, it will be important to incorporate Tikanga Maori principles into design in respect of the river's Statutory Acknowledgement status. The design of water systems should acknowledge and potentially interpret values of Takata Whenua including favoured plant varieties for cultural harvest, potential food sources, kaitiakitanga (stewardship) and mauri (life force/spiritual health). There is a preference for treating stormwater (restoring its mauri) by passing it through land before it is released into natural waterways, as is avoiding the mixing of waters from different sources.

9 BEST VALUE INVESTMENT

Given the large cost associated with increasing the level of service in the existing urban area, it is important to reflect on the issues and the outcomes we are trying to achieve. The model is such a powerful tool for looking at different options it can be easy to get carried away with solutions.

The next task will be to use the model to break down the 10% AEP upgrades into discreet projects, starting first with the solutions to ponding greater than 300mm deep. Each project will be costed and considered against the four wellbeings (social, cultural, economic and environmental) and the objectives of the SMP. This will enable the projects to be ranked in order of best overall outcomes. The same process will be carried out for stormwater treatment and ecological enhancement projects.

Solutions should be outcomes based so ecological enhancement projects may end up higher priority than pipe upgrades. Such projects are a lot more visual to the community and have wider benefits (social, cultural and environmental as well as engineering) for a relatively small financial investment.

Due to the overall high expenditure required to achieve the objectives, and subsequent impact on rates, a large focus will be placed on community consultation to help inform the decision making process and likely programme of expenditure.

10 CONCLUSIONS

Stormwater is no longer just about drainage and simplified runoff calculations; it's a lot more exciting. Computer modelling has become an increasingly powerful tool, able to seamless integrate piped networks, attenuation, soakage systems, surface and channel flows. Effective stormwater management now requires multi-disciplinary teams made up of engineers, modellers, ecologists, planners and landscape architects. Not to mention the diverse range of stakeholders and changing regulatory environment.

Effective management of this integrated, collaborative approach, paired with an in depth understanding of the system, the environment, the client and the community was the key to the success of stormwater management planning for Ashburton.

ACKNOWLEDGEMENTS

I'd like to acknowledge Ashburton District Council for their active participation in the workshops and their permission to present this study.

REFERENCES

Ashburton District Council (2005) *Ashburton District Development Plan*

Ashburton District Council (2012) *Proposed District Plan: Decision Version*

Environment Canterbury Regional Council (2011) *Guidelines for the development of Stormwater Management Plans*

Environment Canterbury Regional Council (2011) *Canterbury Natural Resources Regional Plan*

Environment Canterbury Regional Council (2012) *Proposed Canterbury Land and Water Regional Plan*

Opus International Consultants Limited (2007) *Ashburton Urban Stormwater Issues and Options Study*, prepared for Ashburton District Council

Opus International Consultants Limited (2009) *Ashburton Urban Stormwater Strategy*, prepared for Ashburton District Council