AVON RIVER PRECINCT – THE STORMWATER CHICKEN AND THE URBAN DESIGN EGG

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ABSTRACT

This paper discusses the Avon River Precinct, a world class urban design project, with a focus on the low impact stormwater design elements of the project, the process of working in a project led by urban designers and some of the challenges along the way. The final result, is a shining example of how stormwater management can be more than a utilitarian asset, instead forming a core element of the urban design aesthetic with the added benefit of managing stormwater.

KEYWORDS

Stormwater, Urban Design, Low Impact Design

PRESENTER PROFILE

Mark Groves is an engineer with over 15 years of experience spanning both New Zealand and the United Kingdom covering infrastructure design, hydrology, hydraulic modelling, low impact stormwater design and flood risk management.

1 INTRODUCTION

This paper discusses the Avon River Precinct, the first of the anchor projects being undertaken as part of the Christchurch rebuild following the 2010 and 2011 earthquakes.

The vision is a world class urban design project in the heart of Christchurch that encompasses approximately 3.1km of the Avon River.

The project is an example of how stormwater management can be retro-fitted into an existing urban environment and be more than just a functional asset, forming part of the design aesthetic itself.

The project team consisted of a diverse team of specialists from various consultancies led by Opus International Consultants with urban designers leading the project.

This paper discusses the challenges and constraints encountered working within an existing CBD environment, the challenges of working in a diverse project team and some of the innovative drainage solutions developed.

2 PROJECT CONSTRAINTS

The project was subject to a number of constraints, some of which directly related to the prior earthquakes which forced us to consider that which previously would not necessarily have been considered. The main constraint was the project scope itself, covering only the road corridor running parallel with the river and some areas of green space. It became apparent early on there was limited space to retro-fit treatment for the larger stormwater catchments passing though the precinct, so all efforts instead focused on the road corridor itself. Other constraints included:

- Flood risk from the Avon River
- Competing need for space to accommodate areas of pedestrian movement, café spaces, cyclists, emergency vehicles, general traffic and trams
- Extensive existing infrastructure
- Protected trees, heritage structures and various other objects that could not be moved
- Potential for lateral spreading and liquefaction of the underlying soils
- Short project timescales, with civil design following development of the urban design

3 THE DESIGN PROCESS

Due to the complex nature of the project, it could not be solely led by urban designers. Engineering input was required, and at times needed to lead the way in developing solutions which in turn informed the urban design. The title of the paper references this situation; does the urban designer develop a concept and then the drainage engineer make the drainage work, or should the drainage engineer design a solution and then apply the urban design concepts? This conundrum risked a circular design process with iterative development of the overall scheme.

This element of complexity forced the technical specialists and the urban designers to work closely. The final solution was a process where all involved worked together. This resulted in group workshops where ideas could be tested, refined or compromised until a good solution was developed that met all objectives. This group approach balanced multiple needs and enable design to progress in a fast manner whilst where all involved were supportive of the outcome.

4 THE URBAN CONCEPT

In order to incorporate low impact stormwater management it was essential that stormwater was considered as an integrated part of the urban design concept, helping to inform the overall form of the landscape, but at the same, without shutting out innovation or creativity from the designers. This required closely working with the urban design specialists to help steer their ideas and concepts in the right direction and fighting to ensure your own aims and aspirations were considered.

Achieving buy in from the designers, however, did not prove an issue, as they liked the idea of a continuous ribbon of landscaping to separate the the urban landscape and the riverside walkway. Rain gardens formed the perfect tool to do this.

The result of the design process is a single pavement surface with consistent fall to a linear strip of rain gardens that drain and treat run-off from the re-developed road corridor. The pavement design allows for unrestricted fall directly into the rain gardens without obstructions like kerb’s or footpaths.

Figure1 – A photo montage of the Terraces, showing the proposed urban landscape. Rain gardens are the landscaped areas on the left of the image.

The position of the rain gardens closer to the river also ensured overland flow paths were maintained, as the river walkway could be overtopped to the river without ponding reaching the thresholds of buildings located at the other side of the pavement. It also provided a well-defined separation for those with limited vision from the trafficked section of the pavement and allowed the ecology of the river to be brought into the urban space.

The design also minimised the need for additional infrastructure for conveyance, such as slot drains, ACO drains, sumps or dish channels which was desirable for the urban designers.

Figure 2 – A 3D rendering of the proposed urban landscape (Terraces) showing rain gardens on the left.

5 RAIN GARDEN DESIGN

Given the importance and high visibility of the rain gardens, their design not only included hydraulic assessment, but assessment of soil performance including drought resistance which as these impacted the available plant palette and irrigation requirements.

There was a desire from Council initially to include European specimen trees in the rain gardens, however, the project team pushed for the use of smaller evergreen or semi-evergreen natives such as Cordyline and Sophora. These would provide a locally distinctive, more diverse palette and compliment the river.

Prior research has also indicated that inclusion of trees within rain gardens could aid fixation of nutrients, which was important given the proposed rain garden soil mix would have a high organic content for moisture retention and plant health.

Figure 3 – Antigua to Durham, showing the rain gardens as a key design element

The rain garden sizes were determined by the urban design team, based on the scale they deemed appropriate. This generally resulted in rain gardens larger than would conventionally be required. This had a four-fold benefit; it did not compromise the designer's vision; being oversized should reduce maintenance frequency; it further reduces discharge rates to the Avon and saved the project money, as the pavement was more expensive per m^2 than the rain gardens.

The general design approach was 150mm of depression storage with full capture (100% live storage) of at least a 15mm rainfall, which in Christchurch is equivalent to a 93%ile rainfall event. This is a more conservative approach than now adopted by Council, but was feasible given the generous space available.

This approach also allowed adoption of a lower permeability soil media for improved drought resilience (given the Christchurch climate) and did not require a specific infiltration rate to avoid early by-passing of flows. So long as the depression storage could drain within 24 hrs. (a minimum infiltration rate of 6mm/hr) the soil media would be adequate.

Figure 4 – East Frame, showing the rain gardens as a key design feature

In order to provide confidence in performance, Opus worked with LivingEarth to develop three trial soil mixes which aimed to balance soil moisture retention with acceptable infiltration rates. Opus than carried out testing on the three mixes to determine infiltration performance and drought resilience so that the best performing mix could be taken forwards for use.

The final mix selected consisted of approximately 50% organic compost obtained from CCC's composting facility (re-use of Christchurch green waste), 40% sharp sand and 10% locally sourced silt loam. LivingEarth were approached due to their prior Auckland experience developing rain garden specific soil mixes and as they could provide large batches of a consistent quality controlled product, which was important given the emphasis put on being able to use a wider plant palette than conventionally used without irrigation.

The mixture selected had a saturated hydraulic conductivity of 300 – 9mm/hr, dependent on soil compaction levels, with 9mm/hr representing the worst case situation (well compacted wet soil). With a 150mm of depression storage, even at 9mm/hr, the rain garden could drain down in under 17 hours which is quite acceptable in an urban environment.

However, it was also found during testing that poor handling of several soil mixes trialed could result in almost impervious soil under the right conditions (this included local topsoil). This highlighted the risk of poor performance if overly compacted when saturated and the need for good construction management.

Only one sample had high enough sand content to avoid this issue and guarantee hydraulic performance, but it also carried the risk of being too dry in summer requiring regular irrigation, something the designers were clear they did not want to see.

6 TREE PITS

Tree pits located upstream of rain gardens were designed to be slightly depressed below the adjacent pavement. Whilst not designed as a stormwater drainage or treatment feature specifically, this helped to reduce run-off volumes from the pedestrianized areas, particularly during small events, whilst increasing the amount of water (and nutrients) reaching the tree pits. This was a cost effective approach, given tree pits were proposed regardless.

7 PAVEMENT DRAINAGE

Good surface drainage of the pavement was essential, given the high profile of the project. Finished surface levels were modelled using AutoDesk Civil 2013. A 3D model of the proposed urban streetscape was created, which formed the basis for ensuring adequate falls were achieved. The Civil3D modelers, engineers and the urban designers then worked closely to develop a clutter free street scape with clean lines whilst also achieving desired drainage. This was achieved through a series of design workshops where ideas were put forward and tested to arrive at an outcome all were satisfied with.

In key areas, to check the proposed drainage would function, a Digital Elevation Model surface was exported from Civil3D and imported into the hydraulic modelling software InfoWorks ICM (Integrated Catchment Modeling) to generate a 2D mesh. Rain-on-Grid analysis was then carried out to assess flow depths and potential ponding areas.

This additional check identified some potential ponding areas that were difficult to identify otherwise and was therefore a valuable exercise. The exercise itself was also quick, being able to import the DEM, define the 2D zone on screen and run the model all within 10 minutes, with the run itself taking seconds. The output (generated on-screen) allowed for instant visualization of results.

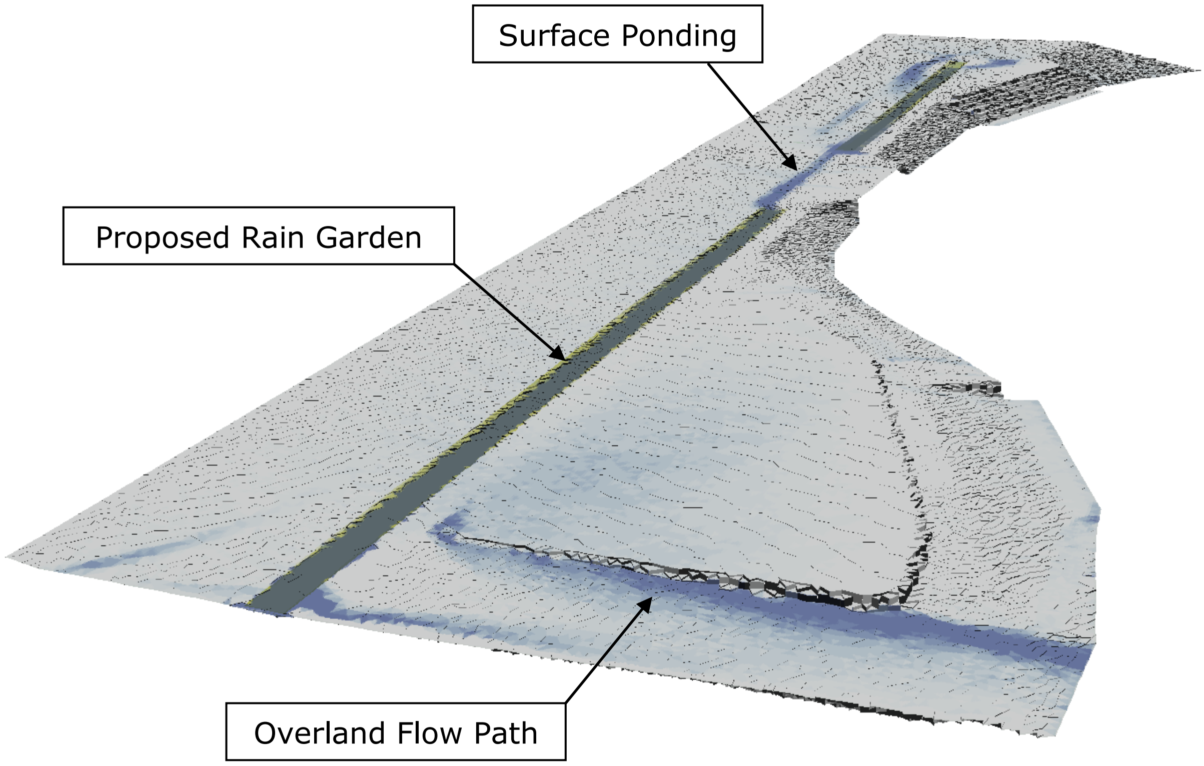

Figure 5 – 3D view of the Terraces with areas of blue indicating ponding or flowing stormwater.

8 CONCLUSIONS

The Avon River is a modern example of how urban design and stormwater drainage can meet. The result is a highly visual and attractive amenity space that forms a core feature of the urban landscape, which also happens to drain the space and treat the run-off.

Group design workshops between the various technical specialists and urban designers where concepts were tested and developed were key to progressing the design under tight timescales and avoiding circular design processes.

Design of the pavement surface around the rain gardens also ensured a clean street environment with minimal drainage infrastructure. Rain gardens were key to this; they work well in the shared space street environment due to the lack of kerb lines and having single consistent fall. They also provide an attractive landscaped 'ribbon' that buffers the river walk and brings the ecology of the river into the urban environment.

The Avon River Precinct is a shining example of how stormwater management can also be a core feature of urban design that is more than just a drainage asset.

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