WYNYARD QUARTER DEVELOPMENT – PROVIDING STORMWATER SOLUTIONS IN A HIGHLY CONSTRAINED, ICONIC, URBAN ENVIRONMENT

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ABSTRACT

The Wynyard Quarter in downtown Auckland is New Zealand's largest urban renewal project. This area is being transformed from an industrial precinct into an iconic, high profile urban environment with very high emphasis on urban design.

One major challenge of the project has been integrating a comprehensive stormwater management system into the urban design, whilst avoiding some very significant engineering constraints. These included close proximity to tidal influences, contaminated soils and a very flat terrain. A combination of innovative urban design and significant engineering constraints meant conventional approaches to stormwater design would not be possible.

A key to the success of this project was the collaboration between the engineering and urban design teams and a willingness to challenge conventional stormwater management techniques. This paper will describe some of the innovative solutions that were developed for the Wynyard Quarter and discuss how they might benefit other urban renewal projects.

KEYWORDS

Stormwater, Low Impact Design, Urban Renewal, Contamination

PRESENTER PROFILE

Suman is an experienced engineer and a project manager having worked for over 19 years on a variety of major infrastructure projects in three waters, roading, infrastructure for remote communities, land development, landfill management, industrial and other civil engineering projects in New Zealand, Australia and India. Suman is highly experienced in construction management and preparation of contract documentation. Suman played key roles as a project manager in the Sewer Separation in Park Road & Grafton and as a stormwater designer in the Northern Busway Southern Sector & Esmonde Road Interchange projects. He is currently internal Opus project manager (civil engineering works) for the Daldy Street and Halsey Street Urban Design project.

1 INTRODUCTION

Auckland's waterfront, a ten kilometre public promenade from the Harbour Bridge to TEAL Park is being redeveloped. Waterfront Auckland is the newly formed Auckland Council controlled organization charged with the responsibility of overseeing this redevelopment. Waterfront Auckland is working closely with Auckland Council, Ports of Auckland, Auckland Transport and other organisations in delivering this ambitious development programme. It is an exciting time in the history of Auckland's waterfront. Twenty new places for people to enjoy: new beaches, parks and opportunities to "touch" the water.

Some of the key projects proposed for the development are:

i. New facilities to grow the cruise, marine and fishing industries. A vibrant new community at Wynyard Quarter
ii. Protection and celebration of important waterfront character and heritage
iii. Places to grow commerce.
iv. An easy walk from the downtown to the waterfront with laneways to discover and explore.

Like many cities around the globe, such as London, San Francisco, Vancouver, Toronto, Malmo, Copenhagen, Cape Town, Sydney, Melbourne and Wellington, redevelopment of previously industrial waterfront land has been undertaken for economic, social, cultural and environmental purposes. Major tourist attractions, conference centres, home to new residential populations, exemplars of design and sustainability, these regeneration projects are undertaken to drive economic growth and reinvent the cities.

Figure 1: Wynyard Quarter Location

A key goal of the waterfront redevelopment is the creation of a '*blue green*' environment. The waterfront is a critical location for sustainable urban transformation and renewal in Auckland. This will be achieved by creating:

i. a blue marine environment benefitting from improved water quality and increased aquatic habitat;
ii. a green shoreline with natural vegetation connected to the city;

iii. a place where we build sustainably, minimise environmental impact, support sustainable lifestyles, showcase green growth and recognise and respond to climate change;

iv. a place that is clean, safe and healthy with ample open space, clean air and water; a resilient waterfront that protects and enhances the natural and marine environment and demonstrates best practice in sustainable development and conservation of natural resources.

The Wynyard Quarter, otherwise known as the “Western Reclamation” or the “Tank Farm” is the 32.7 hectare area of land shaded green in figure 1. The Wynyard Quarter development is intended to establish a working and recreational waterfront linked by a sequence of engaging public spaces which will reinforce Auckland’s ‘turangawaewae’ or ‘sense of place’ and identify Auckland as a waterfront city. The project is expected to be complete by the year 2026.

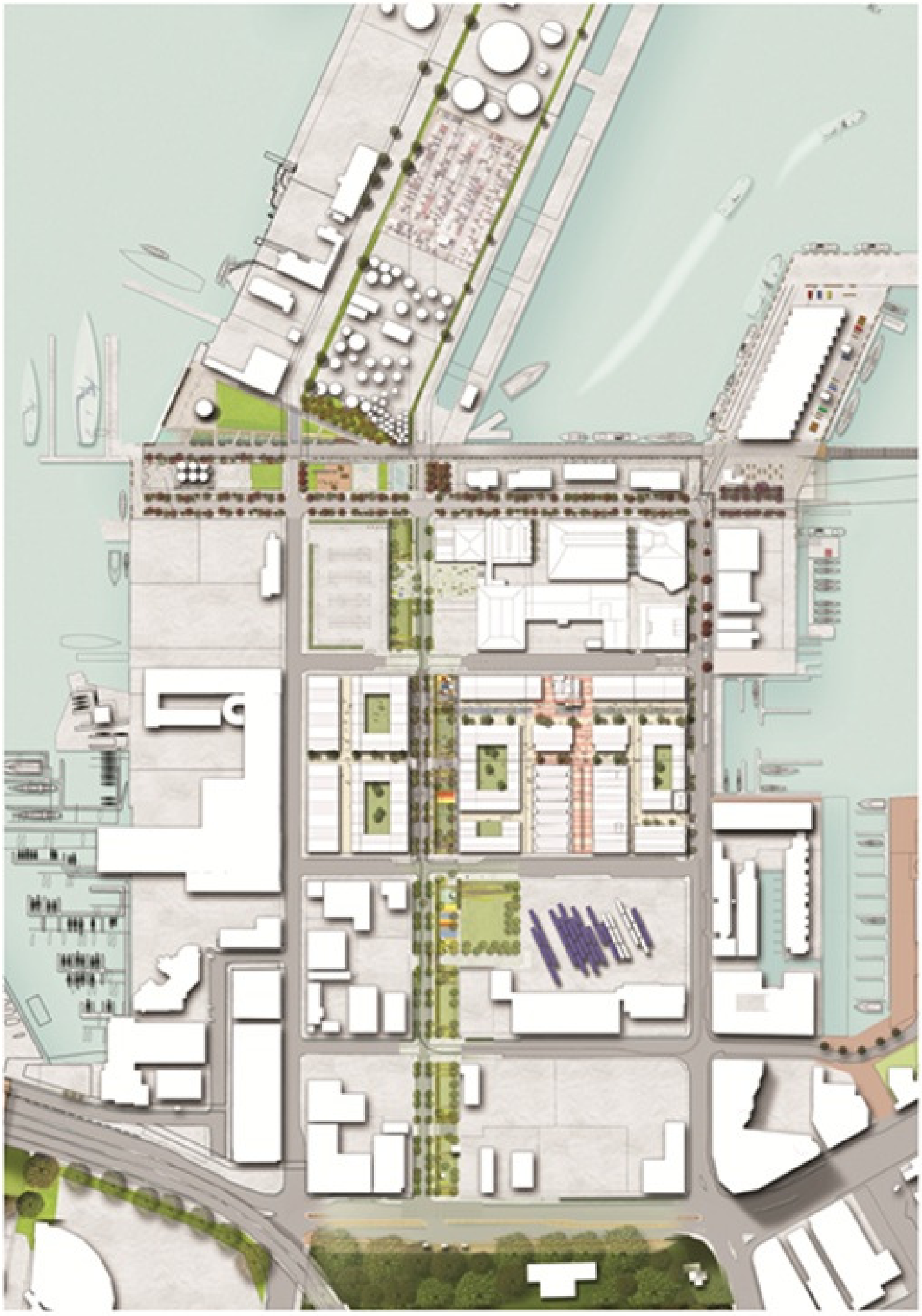

Figure 2: Wynyard Quarter Master Plan

The Wynyard Quarter is expected to employ approximately 6,000 people, provide apartment accommodation for up to 6,000 people and have daily visitor numbers of approximately 5,000 people using the public spaces, retail and entertainment precincts. Approximately 10 ha out of the 32.7 ha of the Wynyard Quarter is being developed as a Public Open Space.

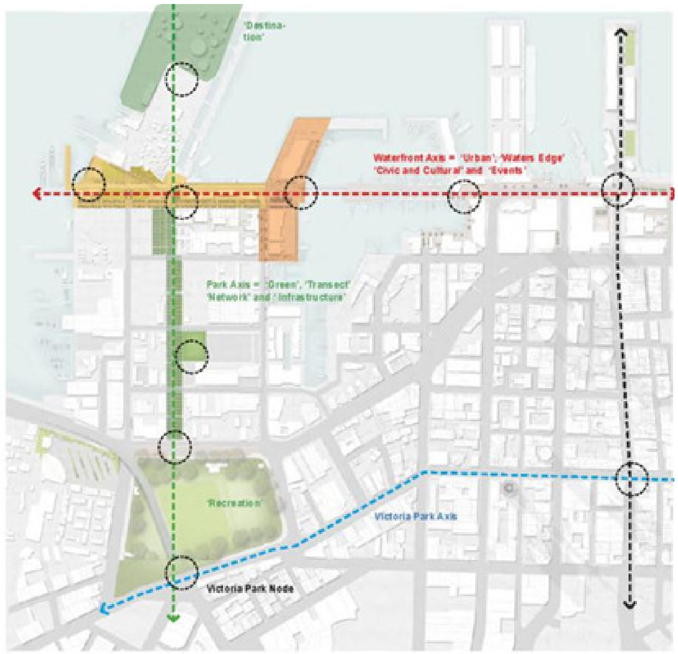

Figure 3: The Park Axis and the Waterfront Axis

The framework for the Wynyard Quarter establishes following four key urban concepts that will integrate the site into its unique waterfront and CBD setting:

i. the Waterfront Axis establishing the waterfront spine;

ii. the Park Axis creating a landscape network;

iii. the Wharf Axis connecting land and sea;

iv. the Waterfront Precincts developing areas of distinct character.

Daldy Street development that includes the Daldy Street Linear Park is one of the key projects along the Park Axis. This development will create a strategic route for passenger transport, pedestrian and cyclist through the Wynyard Quarter as well as recreational and social space. The park and street will be activated by adjacent retail and commercial activity within the Wynyard Quarter.

Figure 4: Daldy Street Concept Design

Daldy Street is one the most iconic and constrained developments within the Wynyard Quarter. Opus International Consultants Ltd (Opus) is working closely with MPM Projects, Architectus, Design Flow, Traffic & Transportation Engineers, Tonkin & Taylor, Bentley & Co and WT Partnership in delivering this project for Waterfront Auckland. Opus is providing the civil engineering design for the Daldy Street and Halsey Street development which is being implemented in two stages. The first stage of the development extends from Jellicoe Street to Pakenham Street West. The second (future) stage extends from Pakenham Street West in the north to Fanshawe Street in the south.

The Daldy Street development project is used here as the example to describe how a comprehensive stormwater management system has been integrated into the urban design, whilst avoiding some very significant engineering constraints.

2 URBAN DESIGN OBJECTIVES

The Daldy Street proposal establishes the first section of the 'park axis' – a future continuous connection between Victoria Park and the Headland Park. The vision for Daldy Street as described in the Wynyard Quarter Urban Design Framework (UDF) states: "Daldy Street Linear Park will be established by extending the Daldy Street axis between Fanshawe Street and Point Park. The park will provide a strategic route for passenger transport, pedestrians and cyclists through the Wynyard Quarter as well as recreational and social space. The park and street will be activated by adjacent retail and commercial activity within the Wynyard Quarter." Coupled with this is the goal from the Waterfront Plan of 'A blue green waterfront', demonstrating best practice in sustainable design.

The overall urban design objective is to deliver a high quality urban streetscape that realises the physical and spatial expression of the Auckland 'sense of place' and to provide a catalyst and a benchmark for adjoining private development adjoining while meeting the budget and time constraints.

Figure 5: Artistic Impression of the Urban Design Objective

The proposed public open space and road environment involves the provision of the following elements:

i. Landscaping (street furniture and trees), land and park areas
ii. Multi-functional paved areas including ancillary structures
iii. Transportation infrastructure and associated structures

iv. The ‘Dockland Tramway’ within the road reserve
v. Stormwater infrastructure within the road reserve
vi. Street lighting

3 STORMWATER ISSUES

3.1 GENERAL CONSTRAINTS

Delivering a sustainably designed street within an urban setting offers specific challenges and opportunities. The use of raingardens and swales to treat stormwater runoff is typically and arguably easier to deliver in suburban street settings where the competition for space is less fierce. In urban settings the competing demands for street space make the provision of the significant space required for stormwater treatment more difficult. The competing elements include the urban design requirements for generous footpaths and good crossing points, space for cycle transport, outdoor dining, public seating, artworks, street trees and good public transport and the transport planning requirements for space for private vehicle transport and parking.

A core commitment of Waterfront Auckland is to deliver *sustainable* streets within the development. This creates a need to negotiate through these conflicts, balance divergent needs for space and develop innovative approaches to design. Jellicoe Street, a previous stage of Wynyard Quarter development along the Waterfront Axis, completed in 2011 clearly demonstrated this approach and achievement. The response of users to this heavily planted urban street was been uniquely positive. People love the extent of ‘green’, the kerbless low speed traffic environment, the generous public seating and the sustainability values inherent in the design.

3.2 ENGINEERING CONSTRAINTS

The topography of the area is generally flat and lies at an elevation of between approximately RL +3m to +5m. The lowest finished floor levels (FFLs) set for all future buildings in the developments is 3.45m RL with one of the existing buildings having a floor level of 3.05m.

3.2.1 DESIGN TIDAL LEVELS

Mean High Water Springs (MHWS) in the Waitemata Harbour is reported to be 1.57m RL. The available published information suggest that by 2050 the MHWS will increase by 0.25m and by 2100 0.50m. A 100 year storm surge of 0.90m is also predicted for the area. Based on the above information, existing and future MHWS and Still Water Levels for the Port of Auckland area, including the Wynyard Quarter, are as below:

- Current SWL (MHWS + 100 year storm surge) = 2.47m RL
- 2050 SWL (MHWS 2050 + 100 year storm surge) = 2.72m RL
- 2100 SWL (MHWS 2100 + 100 year storm surge) = 2.97m RL

With the proposed FFLs set at 3.45m RL, the freeboard available for the 2100 SWL is 0.48m. This is slightly less than the standard freeboard of 0.5m recommended by Auckland Council Standards, but given the uncertainty in the figures, is considered satisfactory.

The Wynyard Quarter development has one existing lowest floor level at 3.05m RL (future floor levels will be above 3.45m RL). Based on the Auckland Regional Council Technical Report 1131, tsunami inundation at Wynyard Quarter could be to ~3.53m (MSL

0.03m RL plus 3.5m). In this case the street level and a small number of ground floors of developments would be at risk of shallow inundation.

3.2.2 CONTAMINATION

Historically, Wynyard Quarter has been occupied by port-related industry. In more recent years the marine industry has also established a presence to service the port and Westhaven Marina. Initial use for the area was timber trading, and then in the 1930s use for bulk petrochemical storage, particularly in the northern section, commenced. Other land uses have also included a variety of commercial and industrial activities including shipping, ship maintenance/building, bulk cement storage and distribution, fish processing and general engineering and warehousing facilities. As such, the entire development site is classified as contaminated.

3.2.3 GEOTECHNICAL CONDITION

The geology of the area is comprised of reclaimed land built between 1905 and 1917 over marine mud. The reclamation fill is derived primarily from sandstone and mudstone from local Waitemata Group cliffs, but also includes various other materials including volcanic rubble and gravels. Some grab and bottom dumping of dredged materials is also thought to have occurred and hydraulic filling utilising marine sediments has also been undertaken. All of the soils can be generally described as weak and variable. The groundwater level is typically shallow at about 1-1.5m below ground level and likely influenced, to an unknown extent, by the tide.

4 THE STORMWATER MANAGEMENT SYSTEM

The Daldy Street project builds on the successes and learning's from the Jellicoe Street project, providing all that Jellicoe Street has and more. In particular it builds on the importance of providing for pedestrian thoroughfares within the design and the opportunities for additional capacity in the stormwater treatment to treat runoff from adjacent future developments.

An existing 2.75m stormwater pipeline that conveys stormwater from a catchment that extends far beyond Wynyard Quarter runs along Daldy Street discharging flows into the Waitemata Harbour at the Jellicoe Street Wall. Due to capacity limitations of this pipeline, an independent overall stormwater management system was developed for the Wynyard Quarter area between Jellicoe Street and Fanshawe Street before finalising a system for Daldy Street.

4.1 DALDY STREET ZONE

The street zone of Daldy Street was designed to comprise the following:

i. 4m wide footpaths adjacent to the eastern and western building frontages

ii. A 2.5m wide zone for street furniture, bio-retention tree pits and street trees either of the carriageway alternating with intended carparking bays

iii. Two 3.5m wide carriageways for buses and private vehicles with the north bound land accommodating the tram route

iv. A 4m wide pedestrian walkway along the park edge which provides opportunities to 'move', 'occupy' and cross laterally between adjacent park and street spaces, this zone will be available for recreational cycle use and eventually connect to cycle routes west to harbour bridge Park and East to Tamaki Drive

v. Typically a 4m wide linear raingarden *zone* along the park edge which provides treatment of stormwater and also accommodate the overland flows

vi. A second 1-1.5m wide meandering path between the raingarden and park zones for slow circulation and occupation via integrated seating opportunities

vii. Typically 12-14m of park space with a combination of lawn areas, tree planting, tree groves and paved urban areas.

These ‘zones’ were clearly identified early in the design process through consultation between the various design teams to promote integration of Urban and Engineering designs. Conventional design practices could not be applied and innovative solutions, careful planning and early coordination were required to meet the stormwater treatment and conveyance requirements.

Figure 6: Street zone design for Daldy Street

4.2 STORMWATER CATCHMENT

The overall catchment between Jellicoe Street and Fanshawe Street was divided into three individual catchments with three separate outfalls through reticulation design instead of the topography. The individual catchments were configured to minimise pipe diameters, run lengths and depths. Minimising these aspects also minimized the depth in contaminated land and groundwater. Dividing the catchments also provided the ability to stage construction of the development. The stormwater system designed for each of the three catchments consists of treatment devices, a primary pipe reticulation system and a secondary overland flow path.

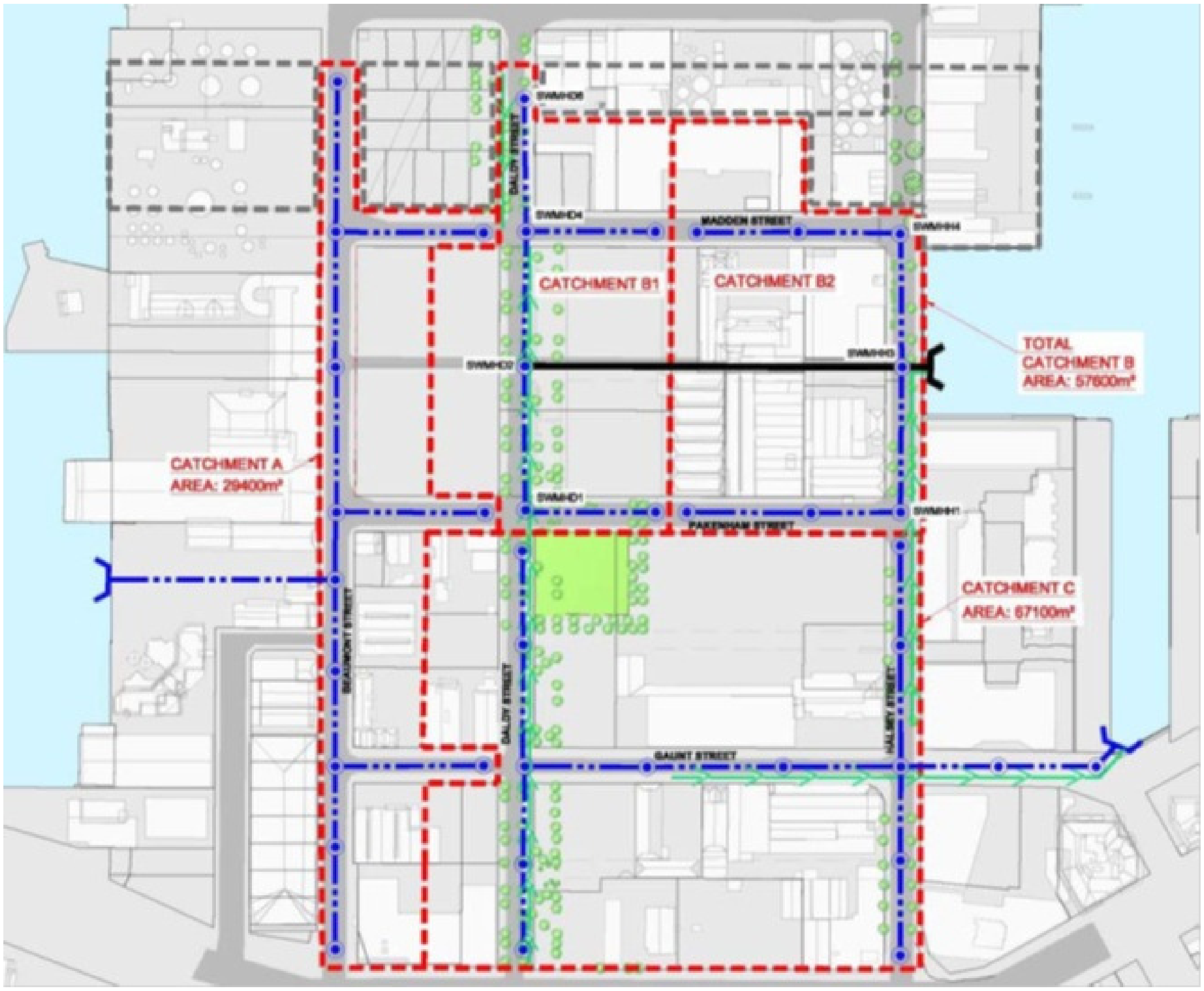

Figure 7: Catchment Areas for the Wynyard Quarter

4.3 PIPE NETWORK DESIGN CRITERIA

The primary pipe network has been designed to convey the 5% AEP event flows as per Auckland Council standards. As the site topography is virtually flat and the development high profile, the overland flow paths are designed for 1% AEP flows in excess of the primary reticulation capacity. The overland path is designed to be situated along the park edge coinciding with the linear raingarden so as to provide additional treatment of stormwater in addition to accommodating the overland flows.

Incorporating a meandering path and integrated seating along the park edge allowed for lowering the ground contours to form the overland flow path.

Figure 8: Overview of the Daldy Street Stormwater Management System

The various branches of the primary network and the overland flow path combine at a 'collection point' between Madden and Pakenham Streets. As no overland flows exit is available from the Linear Park, the outfall into the Waitemata Harbour at the Lighter Quay Basin is designed to take 1% AEP flows from the catchment via a pipe that takes overland flows from adjacent catchments too.

4.4 DEVELOPMENT FEATURES

The 'folly' is a traditional landscape device and usually takes the form of a non-functional building erected to enhance or provide a landmark within the landscape. Along Daldy Street, tank 'follies' inspired by the industrial character of the site are proposed. One such above ground water tank is planned at the 'collection point'. A chamber to be built in association with the tank 'folly' will harvest stormwater for local use.

Another feature will be a 'water play' facility located within the urban zone to the south east of the Daldy and Madden Street intersection. This will provide an opportunity for 'play and discover' within the park. The location is so chosen to allow integration of the feature with the adjacent water tank 'folly' and the local stormwater infrastructure.

4.5 TREATMENT REQUIREMENTS

The Sustainable Development Framework for the projects sets an aspirational target of 80% reduction in annual TSS loads. The stormwater treatment system was designed with the objective of providing at least 75% reduction in TSS loads for the entire site.

Catchment areas and expected annual loads of TSS are estimated using the Model for Urban Stormwater Improvement Conceptualization (MUSIC, Version 4). The catchment areas including building allotments were assumed to be 95% impervious for modelling purposes and are estimated to produce 20,600 kg of sediment in stormwater per year. An assessment of pollutant reductions shows the reduction of TSS is 17,700 kg from the

20,600 kg generated in the Daldy Street catchment. This represents an 86% reduction in annual TSS loads which exceeds the objectives for treatment.

4.6 TREATMENT

The limited surface grade and proximity to the coast meant it would be difficult to 'daylight' any pipes downstream of the area prior to entering the tidal zone. Therefore to treat stormwater after flow has entered pipes would require either an underground installation or a pumped system to return flows to the surface. Neither of these options was considered favourable because of costs, maintenance issues and lack of integration of stormwater into the landscape.

One of the driving philosophies for Daldy Street was to create a 'Green and Local' environment. Urban designers and engineers adopted a Low Impact Design (LID) approach to treatment of stormwater flows. Treatment is to be provided 'at source' before stormwater reaches the underground stormwater network. Starting from the earliest concept stages of design, the urban designers and Engineers sought to integrate the aesthetic landscape features and functional treatment requirements.

The design involves creating a number of smaller sub-catchments that link together through multiple treatment systems in a 'treatment train' effect. This option was considered rather than the entire site being treated with a more traditional 'end-of-pipe' solution. By combining landscape and engineering requirements into single devices we were able to reduce the space requirements for treatment devices whilst still maintaining the pollutant removal targets. This in turn helped to ensure the multiple urban design features did not have to be compromised in order to satisfy the Engineering requirements.

4.6.1 BIORETENTION SYSTEMS

The main bioretention system incorporated into the urban design is commonly known as raingardens. An important characteristic of the Wynyard Quarter raingardens is that infiltration to in-situ soils has not been included in the design. Due to the soil contamination, the systems have been isolated using liners to protect the downstream environment from the harsh petrochemical contamination in the underlying soils.

The devices operate by allowing surface flows to filter through the surface soil media which removes sediment and nutrients. Flows are transferred into perforated pipes which then convey flows to an outlet pit before being discharged into the piped conveyance system.

The estimated annual load reduction for TSS is 17,700 kg from the 20,600 kg generated in the Daldy Street catchment. This represents an 86% reduction in annual TSS loads which exceeds the objectives for treatment which is only 75%.

Two variations in the type of raingardens are proposed:

4.6.2 ROOF WATER RAINGARDENS

The 2.5m wide zone to the west of Daldy Street is designed to accommodate street furniture and bioretention tree pits. These tree pit raingardens treat flows from the allotments on the western side of Daldy Street. Roof runoff will be conveyed by private drains to the 'bubble up' pits in the raingarden to direct flows to the surface. These raingardens also collect all surface flows form the footpath and the paved areas between parking bays along the western edge of Daldy Street.

4.6.3 STREET WATER RAINGARDENS

A 4.5mwide raingarden in the shape of swale is located along the park edge, or the eastern edge, of Daldy Street. These raingardens are mainly a linear system integrated into the boulevard. They collect flows from either side of the street including parking bays, the carriageway and footpaths and hard paved areas along the east side. Treated flows will be conveyed via stormwater pipes running north south. Being in the form of a swale, they double up as overland flow paths to convey secondary flows during major storm events.

4.7 CONVEYANCE

4.7.1 PRIMARY CONVEYANCE SYSTEM

Stormwater conveyance is via a piped reticulation system that runs along the Daldy Street Raingardens. All raingardens are designed with an overflow/outlet chamber. The treated water from the base of the raingarden and overflows from top of the raingardens will be collected in these chambers and conveyed through a shallow pipe before discharging into main stormwater pipes running north south along the eastern edge of Daldy Street. All Building Raingardens are designed with and inlet chamber. These are 'bubble up' pits to convey roof runoff from adjoining allotments to the surface of the raingardens. Daldy Street is a kerbless road, the runoff from the carriageway and other paved areas drain directly into raingardens as sheet flows. To facilitate drainage of surface runoff into the raingarden, Daldy Street is also designed with a one-way crossfall. As such the raingardens themselves double up as inlet structures into the primary piped conveyance system.

The outlets from raingardens to the primary conveyance system have been spaced and sized to retain the flow depths within the raingarden during storm events of up to and including the 5% AEP events. This ensures that for the 5% AEP event there is no flooding of the footpath or carriageway.

The primary conveyance pipeline runs along the Daldy Street Raingardens to a 'collection point' between Madden and Pakenham Streets. The overland flows from the secondary flow paths also converge at this point.

Figure 9: *Artistic View of Daldy Street Raingarden, Overland Flow Path & Tank Folly*

4.7.2 SECONDARY OVERLAND FLOW PATHS

The 4.5m wide Daldy Street Raingardens located along the park edge of Daldy Street function as the main overland flow paths in major storm events in addition to providing stormwater treatment. The overland flow path/raingarden is expressed as a sinuous edge that reinforces the sense of movement through the park.

The overland flow path has been designed to accommodate the full combined 1% AEP flow in excess of the primary conveyance system capacity to again avoid flooding the main carriageway. To accommodate the required flows, the eastern edge of the raingarden is formed into a 1-1.5m wide path and a raised in-situ linear seating wall that is integrated with the street furniture elements of the park. This arrangement provides the opportunity to 'move', 'occupy' and 'cross' laterally between adjacent park and street spaces. During a 1% AEP storm event, the overland flows raise up to a maximum of 3.2m RL flooding the adjacent footpath to east and the tree pit raingardens along the eastern edge of Daldy Street but without flooding the main carriage way. With the lowest finished floor level (FFL) set to 3.45m RL buildings remain protected.

The Daldy Street linear raingarden and the overland flow path were established such that they are aligned with the landward historic Waiatarau Stream (meaning 'the reflecting waters'). Through the engineering and urban design of this functional stormwater management element, we were able to symbolically extend the historic stream into the development.

4.8 GROUNDWATER

Construction of a substantial section of the stormwater management system required earthworks below the watertable which is typically 1-1.5m below ground level. To restrict mobilisation of soil contaminants through groundwater infiltration, the stormwater system will be separated from groundwater by a combination of blockwork wall for raingardens, clay liners and mudcreting (cement stabilised soil backfill) for pipelines. The stormwater pipes will be rubber ring joint type with petrochemical resistant rubber selected.

5 CONCLUSIONS

With some minor compromises on design standards, we were able deliver a satisfactory and functional stormwater system. By identifying the issues very early in the project and through collaborative working between various design teams, we could include stormwater facilities as key features of urban design. Through Urban and Engineering designs, the stormwater management facilities could be isolated from underlying soil contaminants.

Integration of urban design and stormwater management is possible provided we start early in the project.

Figure 9: Artist's Impression of Daldy Street

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Opus Design Team

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