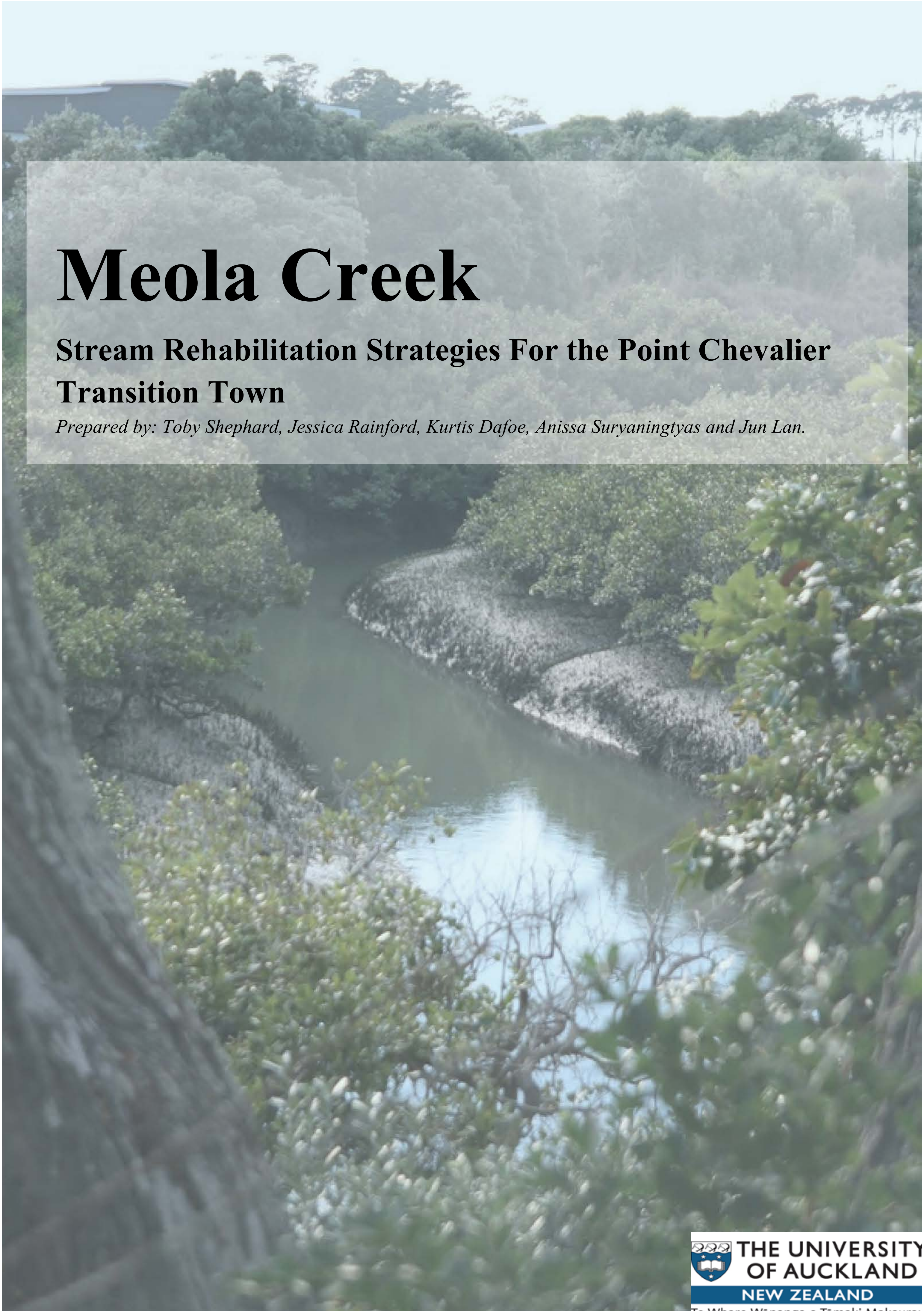

Meola Creek

Stream Rehabilitation Strategies For the Point Chevalier Transition Town

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Executive Summary

Though urban streams offer us many benefits, there are many things that can impact their health. These are closely connected with urbanisation. Impervious surfaces allow higher water flows to carry more contaminants to enter our local water bodies. Increased erosion produces more sediment to carry additional contaminants. In order to assure stream health, these types of negative inputs must be limited.

Meola Creek has the largest catchment on the Auckland Isthmus extending far beyond its mouth in Point Chevalier. There are already several community groups working to ensure the long-term health of the creek. These groups have many negative impacts to work against based on the conditions that can be seen in the creek today.

Current conditions in Meola Creek need improvement. In its upper portions, the creek is piped and channelled, which leads to the problems downstream by reducing its life-supporting capacity. There are many quality issues related to bacteria, nutrient contaminants, heavy metals, and floating debris. Several actions can be taken to help alleviate these issues.

The proposed solutions listed within this report are:
- Composting toilets
- Permeable paved surfaces
- Swales and filter strips
- Rain gardens
- Riparian planting
- Green roofs

1.0 Introduction

This report was compiled by a small group of Auckland University students following a request by the Point Chevalier Transition Town Group. The group raised the point that Meola Creek, a stream running through Point Chev and hailing from headwaters outside of their suburb, was degraded and un-swimmable. They asked of the students;

- What is the state of the stream?
- What is causing the stream's degraded state?
- What measure might improve the health of Meola Creek and indeed make it swimmable?

This report includes an analysis of the conceptual context urban streams exist within and includes explanations of the factors impacting that health such as impervious surfaces, combined sewer overflow, sediment load and lack of vegetation; outlining the issues salient to urban stream rehabilitation. This section is not specific to Meola Creek and merely provides a discussion of the ideas behind stream rehabilitation.

This paper then goes on to describe other rehabilitation projects of similar scope, including projects related directly to Meola Creek.

Site analysis is also included to provide a profile for Meola Creek.

This report concludes with recommendations storm water mitigation and land use change for the Point Chevalier area in order to benefit stream health.

1.1 PURPOSE

The purpose of this report is to outline the state of Meola Creek, its water quality and surrounding land-use activities of the catchment, and to give some recommendations for improving the water body.

2.0 Conceptual Review

An appraisal of Meola Creek must first begin with an understanding of the issues facing urban streams and their rehabilitation. An appreciation of the catchment of any river is a vital concept in this process. A catchment is the drainage basin for a river; it is the land area from which surface area drains to a single exit point i.e. the mouth of the river.

Streamside property owners' landscaping and land-use decisions substantially affect stream health (Booth et al., 2004).

The knowledge those property owners have about landscaping and land-use is therefore extremely important. For example in a 2004 study, Booth et al. analysed stream sites in the Puget Sound lowlands of Western Washington State and interviewed nearby residents about their landscaping choices. Few streamside residents listed ecological considerations as the primary goal in landscape design and instead over 75% were concerned with low maintenance (Booth et al., 2004).

Unfortunately for streams, individuals do not often take individual responsibility for streamside rehabilitation (ibid). In those Puget gardens where residents did claim more ecological considerations, the study found 'ecologically minded' activities like composting but no direct stream rehabilitation efforts (Booth et al., 2004). Booth et al. (2004) therefore recommends stewardship education programmes that emphasise the importance of streamside property land uses and human behaviours in areas of heavy urbanisation where the opportunity for protection of pristine streams or indeed rehabilitation of streams has pass.

This paper aims to draw attention to those land-use practices and landscaping activities that affect urban streams and their health as water bodies to improve knowledge and bolster personal responsibility.

2.1 Urbanisation affects streams

Urban stream restoration and rehabilitation has gained popularity in the past few decades (Morris and Moses, 1999; Booth *et al*., 2001; Middleton 2001; Hillman and Brierley 2005). There is a growing need for the management of streams and their catchments that incorporates ecological and biological values.

Increasingly, evidence indicates the degradation of streams is the result of urbanisation processes and practices. Urbanisation simply means the process of making a space and its associated land-use *more urban.* This process, which includes constructing new roads, buildings, houses, and sewage and storm water pipes, creates more impervious surfaces in urban areas (Booth et al., 2001).

Impervious surfaces refer to those that cannot be penetrated by (and therefore absorb) water such as tarmac or concrete. Impervious surfaces within the catchment area are a significant problem to streams because they increase the surface runoff that reaches the stream.

The term surface runoff defines water that runs over surfaces that are either impervious, or have reached their infiltration capacity, and constitutes a major part of the water cycle. Storm water runoff is surface runoff as a result of precipitation events (rain).

The process of urbanisation can be characterised by the increase in Total Impervious Area (TIA) of a catchment and this index is often used as a proxy for urbanisation in literature. TIA is an important concept to understand in relation to the urban stream. TIA refers to built form and surface area that is presumed to absorb no water and therefore increase runoff rates within catchments. TIA is an important tool but it must also be noted that it overlooks compacted soils and soil types that might further increase impervious ratings of surface areas. Figure 1 shows that stream health declines with increased TIA for the three years of data collection at points in the Puget Sounds lowlands of Western Washington State (Booth et al., 2004).

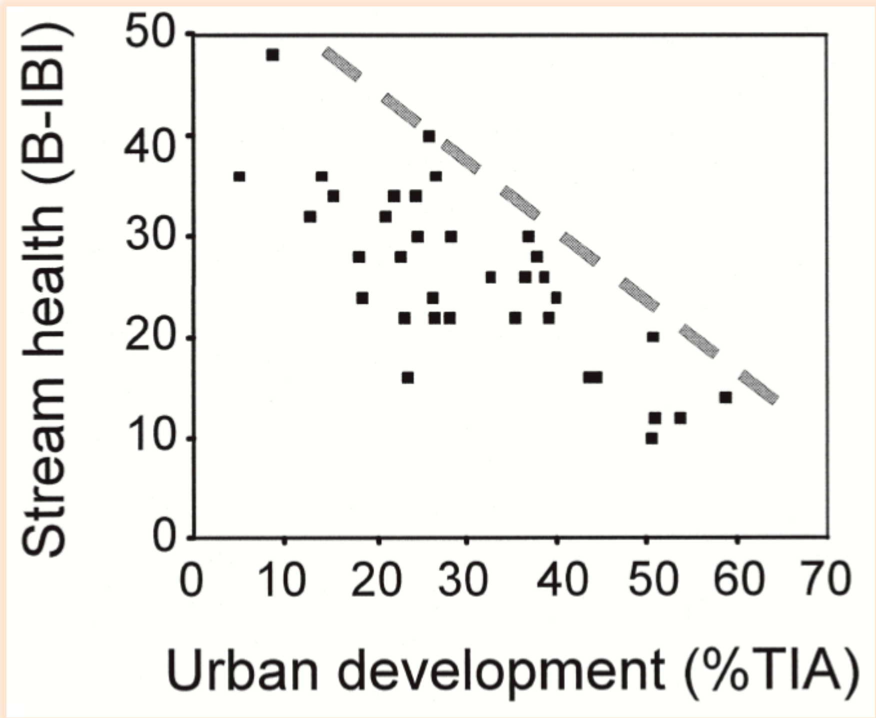

Figure 1: Stream Health against Total Impervious Area. ***Source: Booth et al 2004.***

Urban storm water runoff pollutes streams. A reduction in permeable surfaces that absorb and mitigate storm water runoff creates added runoff, which picks up sediments as well as pollutants (from cars, roofs, roads, chemicals) and discharges them into the nearest stream. Sediment and pollutants such as zinc, copper, nitrogen and other chemicals are discharged into urban streams at high volumes after storm and heavy rainfall events (Shaver, 2000; and van Roon and van Roon, 2009).

2.1.1 Urban stream syndrome

Urban Stream Syndrome is a term used in literature to denote the consistently observed state of ecological degradation worldwide (Collier et al., 2008; Walsh et al., 2005). Streams in urban environments experience dramatically an altered stream state because of urbanisation (Walsh et al., 2005; Booth et al., 2004; Collier et al., 2008). All these factors accumulate over time and space to degrade and pollute streams. As stream conditions and health continues to degrade, we see the increase in the need of stream rehabilitation and restoration.

Urbanisation is a multidimensional process and as such calls for a collection of responses. The "cumulative effect of the variety of human activities in urban basins profoundly influences urban streams and their biota" (Booth et al., 2004, pg 1352). Figure 2 shows the varied stressors impacting stream health. Stream rehabilitation becomes plausible by incorporating site specific responses to these stressors.

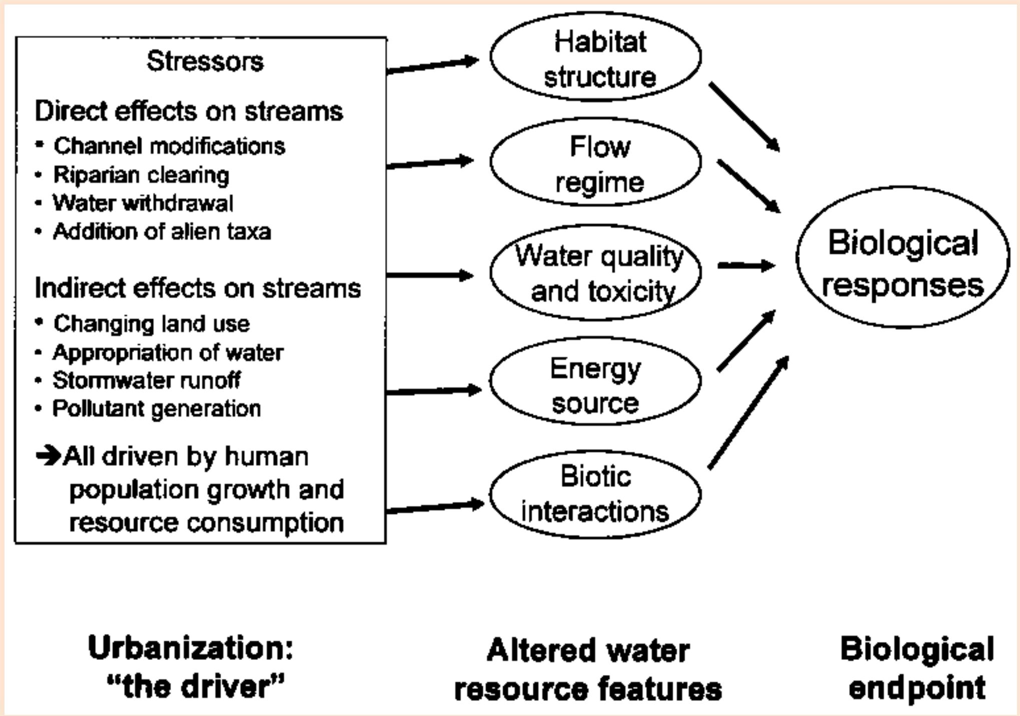

Figure 2: The Varied Impacts Resulting from Human Activity, that in turn alter Stream Health/Water Quality. ***Source: Booth et al 2004***

2.1.2 Sediment Load and pollutants

According to the United States Environmental Protection Agency (EPA 2012), sediment is the number one cause of stream pollution. In urban environments sediment loss to rivers is a significant issue. Sediment loss due to earthworks, urban developments, and farming practices are accumulating in waterways and polluting streams and other water bodies (Auckland Council 2001). High sediment loads frequently impact on urban streams negatively; they threaten stream ecosystems as well as stream biota (Shaver 2000).

Sediment of fine dimensions are easily disturbed, carried and suspended in streams. This threatens stream biota and vegetation; large amounts of sediments can reduce the amount of sunlight which is essential for in stream vegetation which produces the vital oxygen and food needed for fish and other in stream organisms, further, fine sediments can clog the gills of many fish species which can kill off entire species in streams (Shaver 2000 and Auckland Council 2001). More over, due to the fine particle size and large surface area of sediments they can carry other pollutants such as hydrocarbons, agricultural nutrients and toxic heavy metals (Auckland Council 2001).

Other pollutants that the EPA (2012) identifies as main causes of stream pollution are bacteria (from sewage overflow – this will be dealt with in reference to Meola Creek specifically later in the report) and agricultural nutrients (from fertilisers), which often are attached to sediments and washed into streams during rainfall.

2.2 Rehabilitation steps

According to Hillman and Brierley (2005) there are two approaches to stream rehabilitation and stream management, these are the engineering paradigm and the "new approaches."

2.2.1 Engineering

Hillman and Brierley (2005) see that engineering approaches as being the most commonly used in regards to stream/river management but this approach often changes a stream's flow and hydrological mechanics and they often overlook ecological importance. Booth *et al*. (2001) also criticises engineering approaches of stream rehabilitation. Engineering approaches not only change the flow dynamics and hydrology of the stream, they further intensify the degradation of streams through channelizing and the use of culverts.

The engineering approach is usually carried out without regard to the wider environment (Hillman and Brierley 2005). Since many engineering rehabilitation projects include methods such as building and inception of channels, culverts, and pipes, as well as straightening and rerouting of streams, Kondolf (1998) argued that engineering approaches are neither the most efficient nor the most cost-effective way to achieve successful stream rehabilitation.

2.2.2 'New Approaches'

Some examples of these new approaches include:

- Community led rehabilitation projects,
- Riparian planting,
- 'Daylighting' streams,
- Low Impact Development (LID),
- Low Impact Urban Design and Development (LIUDD)
- Rain gardens,
- Green roofs,
- and storm water retention ponds for storm water mitigation

Booth et al admits that "few streams can be entirely restored" (Booth et al., 2004. Pg 1352). However rehabilitation and stewardship programmes can focus on improving the state of the stream and reducing the effects of the stressors outlined in diagram two. Booth et al., (2004) goes on to recommend an interdisciplinary approach to stream care that encompasses the streams site-specific hydrology, land-use, biology and human behaviour.

Collier et al. (2008) notes that stream rehabilitation should focus on the protection and, where removed, reintroduction of native plants. However it is also recorded that it is better to make use of plants in situ for bank stability and plant under established exotic plants (Collier et al. 2008, Hostetler 2008). Native plants can be utilised existing vegetation as a nursery until mature enough for the removal of the exotics. Species used for revegetation should aim:

- To restore the genes and species to a site which, if it were not for human intervention, might be expected to be naturally found there;

- To establish them in the appropriate landscape, in a way that replicates natural dispersal patterns. This is especially important where species are planted in a natural setting and are intended, or have the potential, to naturally regenerate.

(Department of Conservation 2013)

The "new approaches" in stream rehabilitation projects are more holistic and ecosystem-centred. They are adaptive (i.e. not a pipe in the ground we can't remove) and participatory. These "new approaches" puts emphasis on working with and restoring ecosystem values and amenities (van Roon and van Roon, 2009).

'Grass roots' and site-specific projects can give priority to community and participatory knowledge that promotes adaptive and holistic management. Holistic approaches are used worldwide to restore and rehabilitate streams and rivers (Purcell et al., 2002), as many see the benefits of holistic and adaptive management methods for stream rehabilitation. These new approaches often stimulate community engagement, more integration of ecosystem cycles and norms; which is absent in engineering methods.

2.2.3 Potential benefits of stream restoration

In New Zealand there is growing recognition of the multiple benefits that urban streams can provide (Campbell *et al.*, 2010). Many ecological functions are provided by streams such as habitat, urban drainage, flood management, public and community amenity and often cultural significance. Campbell *et al.* (2010) propose a wide variety of economic, social and environmental benefits that are linked with urban stream restoration. These are, importantly, dependent on the nature and location of restoration efforts. Table 1 shows some of these:

Table 2: Potential benefits of urban stream restoration. *Adapted from Campbell et al. 2010*.

Economic	• Improved storm water quality through use of natural systems and riparian filtering (i.e., decreasing need for storm water quality capital works). • Improved drainage and flood control. • Revitalisation, improved capital land and property value, and economic activity. • Improved demand management and reduced pollution change due to increased recognition of values of the urban water cycle leading to behavioural change.
Social	• Enhanced community character and sense of place. • Improved public amenity, potentially serving as focus point for parks or neighbourhood revitalization. • Provision of recreational open space, corridors for cycling, walking and traffic-free routes. • Serves as 'outdoor classroom' for local schools. • Buffer of green space against urban noise, dust and pollution. • Improved safety.
Environmental	• Improved storm water quality through use of natural systems and riparian filtering. • Improved aquatic and terrestrial habitat, and fish passage and wildlife movement. • Reduced storm water run-off velocity, preventing downstream erosion. • Improved temperature control through shading of streams. • Improved maintenance of base flows, flood attenuation and flow reduction.

2.3 Community engagement & private responsibility

Booth et al. (2001) believed that there are two key elements that must be present in order to achieve stream rehabilitation that would protect and enhance stream environment as well as mitigate storm water.

These are *hydrological changes* (changes to the water cycle including activities that affect surface runoff) and *individual action*. Individual action, such as spraying pesticides, littering or using fertilisers near streams, may be seen as having little impact. However, cumulatively the combination of these actions over time and space within a community can generate further degradation to their streams (Middleton, 2001). Individual action and community engagement is needed in stream rehabilitation efforts.

Hersha *et al.* (2012) note that an individual's behaviour, actions, and environmental values are all based on individuals' knowledge of the environment and the environmental problems that surround them. They believed that if individuals and communities are not aware or they lack the knowledge of the environmental problems that surround them, they would continue their usual practices, which would degrade streams further. This paper aims to close some of that knowledge gap and spur restoration efforts.

Hersha *et al.* (2012) and Middleton (2001) have stressed the importance of individual and community stewardship in stream rehabilitation projects. They argue that individuals and communities should invest their time and money into educating the general public about their environment and in particular their stream environment and health which would help improve their stream quality and health.

Middleton (2001) listed reasons why citizen stewardship and community engagement is worthwhile to consider in stream rehabilitation projects:

- It helps develop a community that would be more knowledgeable about their environment and environmental issues.
- It would inform the community about the direct effects of individual actions on streams or other water bodies.
- It would change the behaviours and actions of individuals towards the environment within the community.
- It would motivate community support on rehabilitation projects.
- And encourage individual participation in conservation projects e.g. riparian planting (more on this later)

Before community engagement, there must first be an educated community; a community that has been made aware of the existing or potential environmental issues and threats that surround them and their communities (Middleton 2001 and Hersha et al. 2012). Middleton (2001) notes that an educated community that encourages community participation has a vital role in stream rehabilitation. Community participation or engagement is vital in rehabilitation projects because, it would provide more human resources (man power), knowledge, funding, and planning for stream rehabilitation, collection rubbish of stream, riparian replanting and stream quality monitoring.

Community volunteer labour can be very effective towards stream restoration efforts but significant coordination methods are required. In some cases, overzealous participants neglecting to follow the plans for restoration can lead to the need for entire portions of projects to be repeated. Work with volunteers can take much longer than expected, usually due to bursts of surplus workers followed by long periods of inactivity. Therfore it is critical that at times when involvement is high, larger projects related to streams such as Meola must have deliberate coordination and planning; including ensuring that volunteers are informed on the nature and requirements of the work (Morris and Moses 1999).

Community consultation is also important. Urban drainage systems comprise pipe networks, urban streams and drainage channels that often run through private property. An integrated approach to management of these systems is therefore crucial. Campbell et al. (2010) argues that urban stream management and restoration efforts require collaboration with communities and landowners.

2.4 Urban Stream Restoration and Community Engagement: New Zealand Context

Urban development in New Zealand has disconnected neighbourhoods and communities from natural waterways. Urban streams have been modified in order to accommodate urbanisation and have been degraded significantly as a result. Table 2 includes a brief description and comparison of New Zealand Urban Stream Restoration case studies. Some lessons can be learnt from this comparison. The table shows that there are a variety of different ways that communities, councils, and private land owners can collaborate and coordinate efforts to make improvements to urban streams. It also shows that an opportunity exists for the Point Chevalier Transition Town Group to collaborate with existing communities of interest and co-ordinate future restoration efforts leading into the future (see appendix 2).

Table 3: A synthesis of four New Zealand stream restoration projects (Adapted from: Campbell et al., 2010: 1-23)

	Project Twin Streams (PTS), Waitakere City	**Bayside, Browns Bay, North Shore City**	**Waitangi Park, Wellington**	**Urban Rivers of Christchurch, Canterbury Region**
Situation	Storm water management issues including; flooding of residential properties, stream bank erosion, and pollution discharged into the Waitemata Harbour. Population pressure and climate change	Flooding, storm water quality, riparian degradation, habitat restoration, community access on private properties adjacent to reserve.	Redevelopment of urban brownfield site (cultural significance). Waitangi stream piped during reclamation of Waitangi Park. Build-up of heavy metals and hydrocarbons in marine sediments in vicinity of storm water outfall.	Poor stream health- in particular water quality. A significant proportion of the population not knowing correctly what storm water is and where it goes.
Community engagement	Council – community partnership, public and private property	Council – community partnership, public and private property	Consultation on park design as part of public consultation on the waterfront development.	Regional council led; Joint regional & city council branded project; External Advisory Group
Task	Funding: 2002-2012: Walkways & cycleways) 2002: Storm water management initiatives) 2004-2007: Sustainable Communities Project	Use community engagement strategies and social marketing tools to foster community involvement and knowledge of environment. Riparian planting and reduction of pest plant vegetation.	Waitangi Park Wetland treatment train (an engineered creation using pumps, screens, concrete and UV system in addition to natural filtration of wetland and vegetation.	To develop an awareness campaign to let the community know that the councils want to work with them towards healthier waterways.
Action	Locally based community organisations contracted by WCC to engage local communities & foster behaviour change. 70+ houses removed from floodplain and significant riparian planting.	Weed removal and control, planting, rubbish/debris removal, on-site consultations for property owners, community engagement, events and working bees, educational and activity sessions, newsletters, signage, ecological surveys and monitoring.	Design and construction of Wetland treatment system; gross pollutant trap, diversion pump, sub-surface wetland, windmill, UV disinfection, Waitangi stream wetland, Graving Dock wetland, storage pond- irrigation refuse, outlet, bio-retention treepits.	Three adverts in local print media Simplified versions installed in bus interiors, billboards. Radio advertising Ads printed as posters for schools in region. A website developed
Result	Over 17,000 volunteers and 523,323 trees planted by 2009. 550 households took part in Sustainable Households programme. International and national recognition.	6000 native plants planted by 200 community members and reduction in pest plants. Increased social cohesion and resident participation. Increase in reserve usage. .	Low impact design approach to storm water management. Raised public awareness (tours held on request). Design issues have meant that the construction, operation and maintenance of the park is not sustainable (environmentally or economically).	Greater community awareness of unhealthy state of Christchurch rivers, streams and waterways. An increase 38% in the view that they personally could do more.
Ongoing activities	Riparian planting and restoration (focus on urban areas). Investigation of methods and funding alternatives to continue past 2012.	Weed control and planting programs under-way (maintenance of partnerships with stakeholders). Community events organised as required.	Educational signs to be installed. Introduction of native freshwater species. Wellington City Council, DOC and Forest and Bird investigating future project feasibility.	There is on-going development of the general awareness campaign. Interagency group set by Environment Canterbury

3.0 Contextual Review of Meola Creek

3.1 The Meola Creek catchment

Catchment: Urbanised and degraded

Meola creek catchment is a highly urbanised environment, which has adverse health implications for the health of the stream. The catchment comprises some 20km^2 and includes Pt. Chevalier, Mount Albert, Mount Eden, Epsom and Three Kings (see Appendix 3). It is the largest single catchment in Auckland City and covers 10% of the surface area of the isthmus (Sinclair Knight Merz, 2002).

The character of the catchment, and in turn the stream, has been highly modified over 800 years of human activity; particularly in the 19th and 20th centuries (ibid). Meola Creek was piped in the upper catchment and the wetlands were drained; no original vegetation remains and the habitats of native fauna have been completely devastated (ibid). 60% of the Creek is lined with concrete or basalt blocks and 25% has been culverted; however the stream remains close to a natural state within the Pt. Chevalier area (ibid).

Various water quality and stream health testing has been undertaken in Meola Creek. Findings indicate that the upper catchment may be considered the most degraded (Sinclair Knight Merz 2002). According to Sharman (2012) the lower Meola Creek below the Alberton Culvert has a higher ecological value than the upper Meola. It has higher dissolved oxygen and lower temperatures due to increased baseflow from aquifer inputs. The upper section of Meola is subject to regular combined sewer overflow discharges and when baseflows are low, does not provide life-supporting capacity. The upper catchment area is outside Point Chev towards Mount Albert and Three Kings but affects Meola Creek in Point Chev nonetheless.

Sharman and Clarke (2012) note that although Meola Creek has highly modified riparian margins, it still retains areas that provide good shading to the stream and stability to the banks. There are the patches of mixed vegetation that cover the basaltic lava flows along the length of the open sections, therefore existing well vegetated areas were considered in all conceptual options to be maintained through weed removal and minor enhancement plantings (Sharman and Clarke 2012).

Poor water quality

Poor water quality in Meola creek is a result of wastewater and storm water discharges into the water body (Sinclair Knight Merz, 2002). This has damaging effects downstream in Meola Bay, where micro-invertebrate populations are adversely affected by pollutants (Sinclair Knight Merz, 2002).

- Wastewater contributes the majority of bacterial and nutrient contaminants in the creek – phosphorus and nitrogen.
- Storm water overflow carries heavy metals and suspended solids.

Combined sewers

Combined sewers provide for approximately 40% of wastewater disposal within the drainage system for the Meola creek catchment (Sinclair Knight Merz 2002). While separated wastewater and storm water systems exist within the catchment, their prevalence is limited. The design standard for the combined sewers is generally well below that specified by Metrowater and Auckland City Council; 50% of the system has insufficient capacity for peak flows (Sinclair Knight Merz 2002). In fact, discharge from 26 wastewater overflow structures contributes significantly to overall stream flow; in 1992 it was estimated to have comprised 34% of the total surface creek flow (Sinclair Knight Merz 2002).

This is vitally important to an understanding of the health of Meola creek: untreated wastewater in overflow events is contributing, drastically, to water volume and therefore water quality.

Overflows

During 2002, 283 overflows were recorded for the Meola catchment in the Metrowater database. A 1992 model shows overflow volume for the entire catchment (Sinclair Knight Merz, 2002). Of the 26 combined sewer overflows, the major ‘culprits’ lie in the Mount Albert area. However of note to this study are the overflows at:

- 58 Walmer Road, Pt. Chevalier: 101377m^3/year: 6^{th} of 26
- 76 Premier Avenue, Pt. Chevalier: 30569m^3/year: 9^{th} of 26
- 213 Meola Road, Pt. Chevalier: 16038m^3/year: 11^{th} of 26
- 252 Meola Road, Pt. Chevalier: 10645m^3/year: 12^{th} of 26
- 53 Premier Avenue, Pt. Chevalier: 5895m^3/year: 14^{th} of 26
- 79 Moa Road, Pt. Chevalier: 4822m^3/year : 15^{th} of 26

Figure 3 shows an overflow point at Lyon Avenue after twenty minutes of rain. Lyon Avenue is situated above the Point Chevalier portion of the catchment but is relevant because it illustrates the effect of impervious urban surfaces on an urban stream as well as drawing attention to the condition of the upper catchment. After one hour of rain, the overflow from Lyon Avenue has impacts on Meola Creek (Sheffield 2012).

Figure 3: Lyon Avenue after 20 minutes of rain (left) and Meola Creek after 1 hour of rain (right). ***Source: Sheffield 2012***

Combined Sewer Central Interceptor

The planned 800 million dollar Central Interceptor (CI) will remove 80% of the overflow volumes at over 120 discharge points in Meola, Motions, Whau and Oakley creeks (Sheffield, 2012). The flow will be conveyed to the Mangere Waste Water Treatment Plant for treatment before discharge into Manukau Harbour (Sheffield, 2012). This is of direct benefit to the Meola catchment because the waste water overflow contribution to the Meola Creek and Meola Reef/Waitemata Harbour will be reduced greatly. However the CI will be complete and operational only by 2025 and will make no impact on storm water reduction for point chev. Here we can see the potential for storm water mitigation techniques (described later in this report) at the neighbourhood and residential level will be called for.

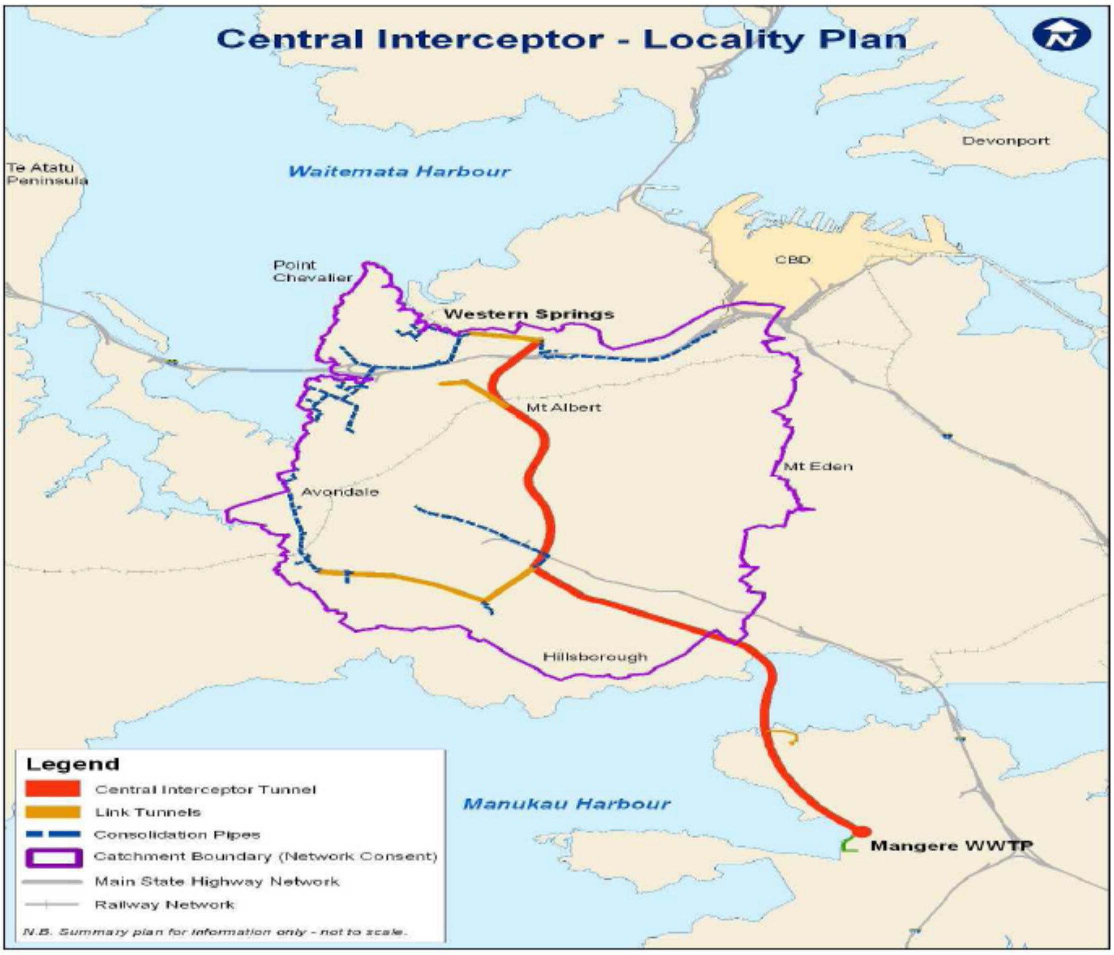

Figure 4 Proposed Central Interceptor which would pipe sewage away from Western Springs and surrounding suburbs to Mangere for treament.

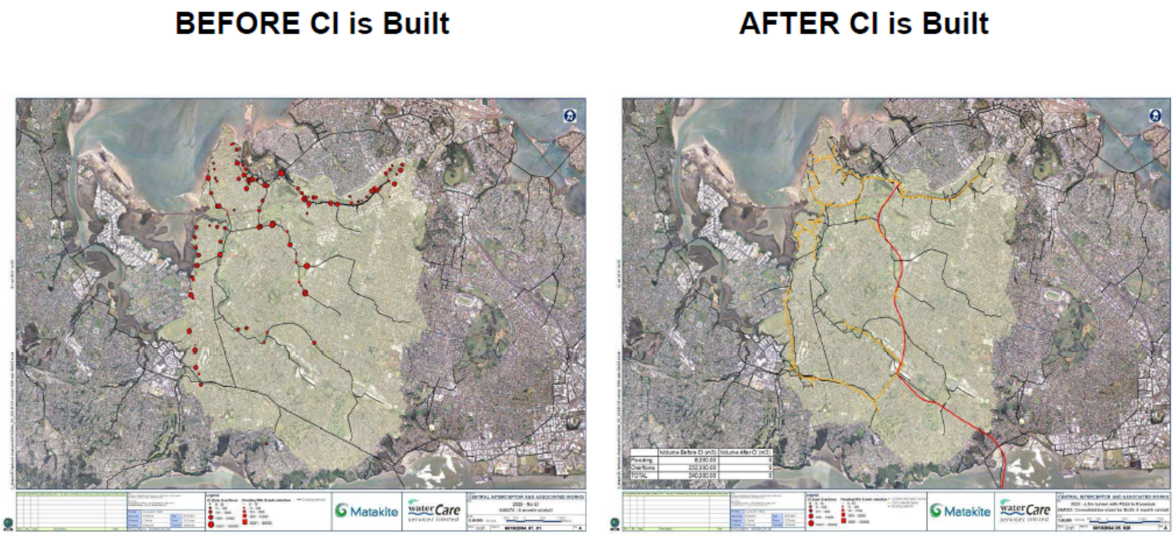

Figure 5 Overflows monitored before Central Interceptor built vs estimated overflows after Central Interceptor competion.

4.0 Proposed actions/ Recommendations (Results)

4.1 Composting toilet

Waterless composting toilets are waste facilities that operate outside of the sewerage system, preventing human waste from entering into the wastewater process. They have the potential to dramatically reduce water use and redistribute waste from the sewerage system and into agriculture. Usually, urine is separated for dry composting. GHD (2003) and Salmon (2004) estimated that the adoption of dry composting toilets would reduce domestic sewerage discharge volume by as much as 28%.

Based on the impact of wastewater overflows on the health of Meola Creek (34% of total stream flow was estimated as combined sewer overflow; Sinclair Knight Merz, 2002); composting toilets present a practical option. Toilets can be fitted inside and do not smell (Williams, 2012). It must be noted also that in addition to a reduction in wastewater volume, composting toilets can offer community resilience in a crisis that might damage sewerage infrastructure.

Composting toilets occupying an interesting legal space:

- Section G19 of the NZ Building Code outlines approved solutions for wastewater; it does not list composting toilets (Salmon et al., 2004).
- Section G13 specifies that where a sewer connection is available, wastewater disposal is to via a connection to a sewer (Salmon et al., 2004).
- This means that a Local Authority (in this case Auckland Unitary Council) would need to waive the relevant restrictions within the Building code in order to approve a composting toilet within an area where sewer connection is available (Salmon et al., 2004).
- AS/NZS (Australia and New Zealand Standards) 1547 qualifies the use of composting toilets by consideration of health and nuisance.

4.2 Storm water Control Methods

The main benefits to the health of Meola Creek from controlling storm water are the reduction of street level contaminants that would have entered the stream as runoff and the reduction of reticulated flow which can carry combined sewerage and produce water velocities that destroy the Creek's vegetation and natural pollutant control capacities. In other words, by reducing storm water runoff volume and speed, we can protect the health of Meola creek.

The following methods can all be used as a storm water treatment train extending from where the rain falls to where the runoff enters Meola Creek. The recommended measures aim to greatly reduce the velocity of surface runoff to accommodate higher levels of natural filtration, as well as to increase the rate of infiltration in the catchment in order to reduce the volume of water artificially directed to the Creek.

In a functioning treatment train, rain falls on **permeable surfaces** and **green roofs** being immediately slowed and infiltrated, before continuing through **swales** and **rain gardens**. Between these primary and secondary mechanisms and streams, **riparian planting** and **retention ponds** could be used as a last line of defence.

4.2.1 Permeable Paved Surfaces

"One of the most effective means of ameliorating rapid storm water runoff is to minimise hard surfaces and to use permeable materials when needed for hard wearing or vehicle standing" (Hostetler et al 2008).

With a city like Auckland, where many of the rainfalls are light, the ability for paved surfaces to infiltrate only several centimetres an hour will avoid surface runoff from all but the largest of storms. There are many ways to ensure that paved surfaces remain as permeable as possible. Though there have been technical documents produced by the Council to support some of these strategies (as well as the strategies to follow), because the uptake of many has been slow, communities must strongly propose their implementation whenever road upgrades are scheduled to happen. It is completely likely that there will become a time when the Council requires these types of technologies, so showing that they can save money by combining it with existing planned work is a good way to promote them.

One of the most agreeable methods is simply to use pavement which is permeable: asphalt without the smallest aggregate components looks and functions as conventional asphalt would in terms of vehicle conveyance but is able to infiltrate large amounts of water which falls on it. Curb-cuts are a second method which can be combined with permeable pavement or by itself only conventional streets. Instead of having a continuous curb which focuses all runoff to reticulated drainage systems (with associated problems of combined sewerage outflows), a more effective method is to cut the curbs at regular intervals so that water can infiltrate uniformly to structures such as swales and rain gardens next to the paved surface. Though curb-cuts are important, an even better related method is to simply eliminate the curb altogether and only resort to curb cuts where traffic and roadside parking conditions require a curb.

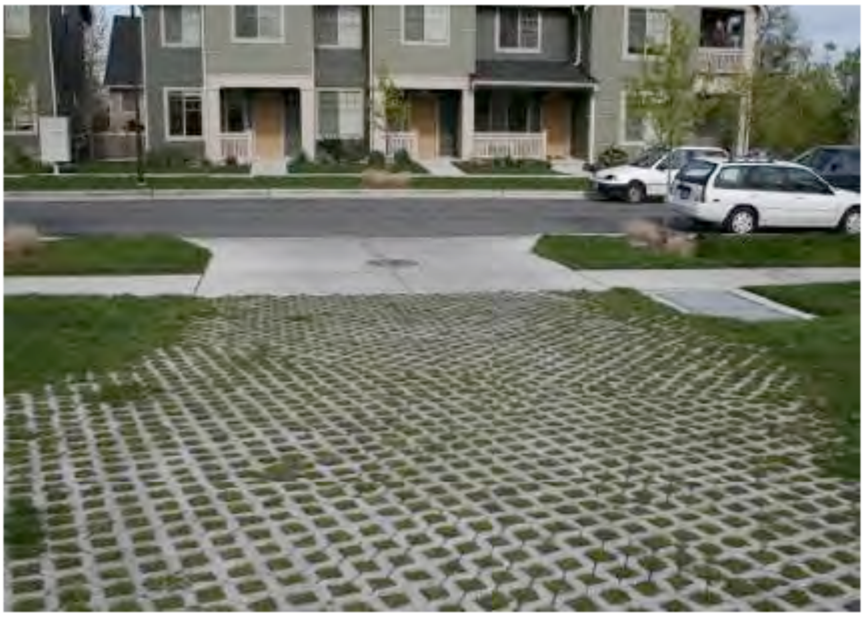

Figure 6: Example of a driveway replaced by permeable pavers. ***Source: Hostetler et al 2008***

Permeable surfaces can also replace conventionally paved driveways. Private driveways occupy much of any residential property's impervious surface, so replacing this with open pavers like those in figure ? is a good way for private residents to promote infiltration of storm water.

4.2.2 Swales and Filter Strips

"A swale or filter strip is an ephemeral watercourse for overland flow of storm water" (Hostetler et al 2008).

Swales have been used only infrequently in New Zealand (Long Bay development for example), but are one of the most effective ways of naturally removing pollutants collected by storm water runoff before they arrive in our urban streams. They are comprised of a stabilised trench filled ideally with native vegetation and often also have pipes for collection of excess water runoff in the largest of storms which are not able to be immediately infiltrated. Swales are often located adjacent to roads in the road reserve so they can intercept more overland water flow.

Swales function by first having the vegetation slow surface runoff simply by the presence of plant stems and stalks as a physical barrier. When water is slowed as such, not only is there additional chance for infiltration rather than surface flow, but the evapotranspiration process of the plants has additional time to naturally remove water and contained pollutants and prevent them from reaching streams. As with permeable pavement, residents should demand that swales are installed at the time of road upgrades or maintenance: the Council will be more receptive when they are already funding activities in this zone. They can also be associated with the installation of traffic calming devices so that they benefit not only the community's environment, but also its safety.

4.2.3 Rain Gardens

"Rain gardens look and function like any other garden except they treat runoff…limited monitoring of rain gardens have shown them to be very effective in removing contaminants" (Shaver 2000)

Rain gardens are deep gardens built into a geotextile-lined excavated pit. Within these pits, which are located in low-lying areas, are several layers of different sediment that are designed to filter water through detention, evaporation and infiltration. Rain gardens are especially effective on private properties and can completely eliminate the need for reticulated storm water conveyance from the property by intercepting water from all paved surfaces. They can also intercept water from roofs if other mechanisms such as grey-water storage from roofs are not used. The main issues associated with raingardens are their relatively high construction costs and time required to maintain them.

4.2.4 Retention and Detention Ponds

"Contaminants in the water bind to soil particles and help clean underground water flow so that if and when it does encounter surface water (e.g. a stream), it is not polluted" (Hostetler 2008).

Retention and detention ponds can be seen as a last line of defence to halt runoff before it enters urbanised streams simply by collecting it and removing polluted sediment by allowing it to settle. These are used heavily in new developments, but in an already heavily urbanised location such as Point Chev. they are less ideal. This is simply because they require space in which to be constructed. For this reason, they are not recommended for the improvement of Meola Creek.

4.2.5 Riparian Planting

"*Riparian planting of tall woody shading species of vegetation is potentially one of the most effective means to enhance habitat*" (Sinclair Knight Merz, 2002).

Riparian buffers, which are the vegetated areas surrounding a stream or river channel, can result in more naturalised channel morphology and hydrological processes. In particular riparian vegetation can increase friction and reduce velocities. This increases water levels for the same flow capacity. The lower stretches of Meola Creek in Point Chevalier currently retain much of their natural characteristics including riparian planting, but there are still opportunities on private properties to increase this with the planting of native species. This would ensure that any storm water contaminants not already captured and filtered by other treatment train components is slowed in order to cause the least adverse impacts to the creek.

4.2.6 Green Roofs

"A green roof is a roof partially or fully covered by plants. Modern green roofs can be categorized as extensive… or intensive" (Hostetler et al 2008).

The main difference between the two types of green roof is the stature of the plants growing on them. Intensive green roofs are those with thick soil layers to support large, woody vegetation. Though they can be valuable in some cases such as to inject nature into the otherwise steel and concrete centre city environment, the needs for constant irrigation and maintenance makes them unsuited to residential applications.

Extensive green roofs are planted with a thin layer of drought resistant native plant species. They offer both evapotranspiration processes (cooling) as well as runoff control. Similar to swales, runoff of stromwater is slowed by the presence of the plants to allow for more take-up by the plant's roots and evaporation. With current technologies, such extensive roofs need not be on flat roofs and can thus be installed, relatively easily in some cases, as a retrofit on existing homes' sloped roofs. Green roofs on slopes will still have runoff produced from them, which mens they must be part of a storm water treatment train. Green roofs can be quite costly to install on existing homes, but new construction will find it much cheaper. To promote them in new construction, local examples in both residential and institutional buildings (such as a school) could show that green roofs are desirable in the community.

5.0 Conclusion

From our research on urban streams we see that urbanisation and urban process such as building roads, infrastructure and urbanisation syndrome can degrade streams. This is mostly due to increased total impervious surfaces within a catchment. We recognise that urbanisation processes change stream flow, and hydraulic mechanics as well as sedimentation and runoff which carries many pollutants and contaminants into streams. This is the case for Meola Creek, with most of it's catchment being urbanised. The upper reaches of the stream have been degraded predominantly through increased storm water runoff and the combine sewerage overflow which have affected the water quality further down stream around Point Chev.

This report notes that although streams cannot be fully rehabilitated or restored to their natural state, there are ways to improve its water quality and stream health. Through "new approaches" such as composting toilets, community-led rehabilitation projects, and riparian planting can improve the water quality of stream.

Further, we recognise the importance of community and individual responsibility (including action) in maintaining stream health through landscape choices. An environmentally aware community could help improve the streams rehabilitation and it's water quality through increased manpower and increased funding.

Finally this report outlined recommendations that we have researched that may be of help to the Point Chev. Community in their pursuit of improving overall water quality of Meola Creek. These recommendations can be applied within the community to reduce wastewater, storm water runoff, sedimentation and pollutants being carried into stream. Further these recommendations would help foster community engagement in stream rehabilitation projects in the future. The report also listed a number of other community action groups that are also involved with rehabilitation projects on Meola Creek.

Importantly, future efforts to restore Meola Creek need to be organised and participatory. Point Chev. Transition Town group can move forward working with all levels of action groups.

The responsibility lies with you and your actions.

6.0 Appendix

6.1 Terms of Reference

Appendix 1

Terms of Reference

Project Name

Draft report of Meola Creek Community rehabilitation/revitalisation poject for Point Chevalier Transition Town (PCTT), in association with the University of Auckland.

Overview of Request

Point Chevalier Transition Town has requested the help of our student group to report on the past, present and future state of Meola Creek. Further, they have requested to seek out what measures are taking place to clean up the stream. And in addition, they also requested us to explore different apporaches that would allow for more community engagment in cleaning up the stream.

Context/background provided

According to Transistions Town New Zealand's website, the Point Chevealier chapter of Transistion Towns New Zealand was established in 2008. Since their establishment they have had monthly meetings to discuss on issues relating to their physical environments, they have particular intrests in community gardening and furit tree planting.

Last year PCTT worked with MurbPlan students of University of Auckland to plant furit trees in their local reserve, Priemer Resereve. The project benefited their community group with organic furit and it encouraged community gardening within their community.

This year PCTT has requested our student group to take on a project which would find out water quality and the state of a local stream within their community, Meola Creek. Adriane the Chairperson of PCTT said that the water quality and the state of the stream has been imporving but she asked if there is more that could be done to further imporve the water quality and the state of the stream?

To do this, the student group is asked to "find out what the Auckland Council, Western Springs College and other groups are doing in relation to Meola Creek, and what it would take for the water to become swimmable." The student group is also asked to find out different community approaches to rehabilitate/revitalise Meola Creek. "The students could look at other models for creek clean-ups, like the Oakley Creek and Project Twin Streams." Notes of the 12th of March 2013 meeting from Dr. Niki Harre. Overarching aims of the group

<u>Aim of this Project:</u>

- To report on the past and current planning/projects/initiatives
- Find out Existing/potential community engagement projects
- Find out potential benefits for the community
- Encourage more community engagement on rehabilitation of stream

<u>Objectives (completion of this project will result in):</u>

- Present Pt Chev Transition Town group with a report that provides a basis for their future action.
- Provide PCTT with a report on the different community approaches which the community could take

<u>Supplementary Information:</u>

Students will work and communicate with the Auckland Council and other organisations such as the Auckland Zoo, Water Care Ltd and St Lukes Environmental Protection Society (STEPS) to find out information on the past, present and future state of Meola Creek. Further, students will find out information on what initiatives there are to clean up Meola Creek.

Along with contacting relevant organisations and groups, students will also conduct academic research to find relevant information on community stream rehabilitation/revitalisation.

<u>Project deliverables</u>

- **Provide and present a report which would outline and identify the state of the stream, how it has improved and how it can be improved further. Also present on the approaches that would encourage more community engagement in stream rehabilitation.**

<u>Timeframe</u>

<u>Completion Date</u>	**<u>Task</u>**
12/03/13	**Initial Pt. Chev TT meeting**
21/03/13	**Student group meeting to discuss methodologies**
21/03/13	**Student Research commences**
09/03/13	**Second Meeting with Pt. Chev TT**
23/05/13	**Final report**

<u>Parties</u>

- Pt Chevalier Transition Town community group: Chair Adrienne Wood and Dr. Nikki Harre

- University of Auckland Group students: Jessica Rainford, Kurtis Dafoe, Toby Shephard, Jun Lan and Anissa Suryaningtyas
- University of Auckland staff suporviser: Prof. Dory Reeves

6.2 Useful Information and Points of Contact

Appendix 2

Existing Groups and Organizations

STEPS: http://www.meolacreek.org.nz/

Wai Care: https://www.waicare.org.nz/Resources/relatedlinks/links.aspx

- Stream ecology
- Water management
- Environmental education
- Streamside restoration- into action!
- Other groups involved in stream protection
- Funding Opportunities
- International Links

Projects and Reports

Meola Creek Watercourse Management Plan:

- Executive Summary: http://www.morphum.com/index.asp?pageID=2145886804
- Map: "Lower Meola Creek Restoration Plan: Management Zones and Group Responsibilities" https://www.waicare.org.nz/Files/LMCRP_ROs_AP%2029%2003%2012_resized.pdf

Morphum Environmental Ltd
http://www.morphum.com/index.asp?pageID=2145877327

- "Meola Creek Improvement Concepts From the Central Auckland Storm water Initiative"
- "Urban Stream Restoration and Community Engagement: Examples from New Zealand"

Meola Creek Restoration
http://riversymposium.com/wp-content/uploads/A4E_Caleb-Clarke.pdf
"Urban Stream Characterisation and Improvement Opportunities in Central Auckland (Meola Creek)"

The Roy Clements Treeway
http://www.thesustainabilitysociety.org.nz/conference/2008/papers/Clarke.pdf
"Roy Clements Treeway Boardwalk- Urban Stream Management"

Funding

Environmental Initiatives Fund 2011 Grant Recipients:
http://www.aucklandcouncil.govt.nz/EN/newseventsculture/communityfundingsupport/grantsfunding/environmentheritage/Documents/eifgrantrecipients2011.pdf

- Western Springs College (Lower Meola Creek Project $2,500)
- C Severne (Meola Creek Restoration $2,430)

6.3 Catchment Map

Not attached

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