“Bringing Light to the Water- Stream Daylighting in the Auckland Region and Beyond”

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ABSTRACT

The historical practice of reticulating or constructing hard engineered infrastructure was best practice in the management of stormwater. This has resulted in many waterways being piped and the historical landscape being altered.

However, designers and managers now recognise the inherent value of open watercourses in providing for community well-being, including aesthetics, recreation, habitat, stormwater treatment (polishing), and flood management. The restoration of closed or channelised historical stream systems is referred to as “daylighting’ and is considered the practice of bringing buried streams to the surface in an effort to restore their natural systems and processes.

This paper discusses the recent trends in stream daylighting both in the Auckland Region and at an international level. It investigates the key drivers, technical requirements and stakeholder expectations that need to be considered when projects of this type are conducted. An example of this is the 100 Projects in 100 Days Stream Daylighting Opportunities investigation conducted for the Auckland Mayoral Office.

KEYWORDS

Daylighting, habitat, stakeholder, treatment, well-being, multi criteria, social

PRESENTER PROFILE

Damian is an environmental engineer and a founding director of the Auckland based engineering and environmental consultancy Morphum Environmental Ltd. In his role as Environmental Director he leads his team and assist his clients in the development of assessments, plans and designs which are aimed to promote sustainability, meet community expectations and incorporate environmental objectives at their forefront.

1 INTRODUCTION

The modern era has not been kind to streams humankind has enlarged agricultural areas, built roads, and clustered into cities large and small, we have polluted streams, diverted them, straightened then, confined then in concrete channels, out them into pipes, filled there associated wetlands, and otherwise used and abused them, beyond recognition (Pinkham,. 2000).

The development of high density human settlements has required the control of the waters that have surrounded us because of flooding, foul water and human health issues. This type of influence on our environments can be dated back some 4,000 years. “Sites excavated in the Indus Valley and in Punjab show that bathrooms and drains were

common in Indian cities 4 millennia ago…Even in two millennia B.C., the Greeks and Egyptians had adequate supplies of drinking water for their cities, drained streets, had bathrooms in their houses and, in Crete, water flushing arrangements for toilets" (James, 1998). "The much greater quantities of water needed…as well as the increased stormwater from the larger urban area generated the need for new technology, new management processes and new urban form. The industrial city had many new sources of waste that it could not manage" (Newman, 2000).

"Once the streams were buried underground, the towns also found it easier to grow. They built streets, housing, and industrial plants over the buried streams. And the public health problems also disappeared at least for awhile" (National Park Service). "Building sewers in advance of development…gave engineers freedom in their designs….especially in areas of the city where the rectangular grid system of streets prevailed" (Levine, 2005).

However, now planners, engineers and the community recognise the inherent value of open watercourses in providing for community well-being, including aesthetics, recreation, habitat, stormwater treatment (polishing), and flood management. The restoration of closed or channelised historical stream systems is referred to as "daylighting'.

1.1 PURPOSE OF THIS PAPER

The purpose of this paper is to discuss recent trends in stream daylighting both in the Auckland Region and at an international level. An important and illustrative part of this paper being an investigation into the key drivers, technical requirements and stakeholder expectations that need to be considered when projects of this type are conducted using the 100 Projects: Potential Stormwater Stream Daylighting Project as an example.

1.2 WHAT IS STREAM DAYLIGHTING

Stream daylighting is the practice of 'bringing buried streams to the surface in an effort to restore their natural systems and processes' (Lewis, 2008).

Open watercourses, as opposed to pipes or culverts, offer multiple functions and benefits, including providing for community well-being through amenity value, ecological habitat, stormwater treatment (polishing), and flood management. (Lewis, 2008).

"Daylighting is the act of removing streams from underground pipes and culverts, restoring some of the form and function of historic streams" (Pinkham 2000). Daylighting can restore full or partial flows to a waterway, and can naturalize the restored waterway to varying degrees, using either natural soil, rocks, or concrete to line a creek channel (Kennedy and Jencks 2006). In the context of urban stormwater management, stream daylighting can be a valuable way to reduce peak flows and improve water quality in urban areas, as well as provide multiple benefits to surrounding human and ecological communities.

Stream daylighting is an example of low impact development (LID), also called best management practices (BMPs), soft water path development, green stormwater management, or green infrastructure (Figure 1) (Webster 2007).

Alternatively daylighting can involve retaining the closed piped system as a secondary flood conveyance. This may involve constructing appropriately configured weirs and piping to convey baseflows into a constructed surface channel. This technique allows for

the improvement of stream function while providing for flood conveyance within the retained deeper pipe system. This method may require provision of an impermeable layer to prevent loss of base flow to groundwater or the piped network. It is noted that stream daylighting requires careful detailed design to include ecological and hydrological systems in order to increase the likelihood of success.

1.2.1 DRIVERS FOR STREAM DAYLIGHTING

The drivers for stream daylighting are varied and diverse. Some drivers are purely technical with operational or flood conveyance being primary. However, these civil infrastructure projects, although entirely relevant, are often secondary to ecological and community interest drivers. Ultimately the most important factor influencing daylighting projects and there relative motivations is that they are all multi-driver multi-outcome initiatives. Some of the drivers include but not limited to the following:

- Flood management and mitigation
- Wastewater separation
- Cultural drivers both spiritual and aesthetic
- Habitat restoration
- As an alternative option during renewal works
- Too improve public access along a riparian corridor
- Urban reinvigoration and beautification

As compared to a conventional reticulated urban stormwater network, the environmental benefits of open streams are wide ranging. They provide bird and wildlife corridors, habitat and a nursery for sensitive fish species and stream environs provide filtering and treatment of stormwater runoff and temporary storage of storm flows. However, these environmental outcomes may be more limited from daylighting a small section of a stream in a highly modified catchment.

Stream environments also play an important role in community well being from an aesthetic and amenity perspective. Daylighting urban streams may also encourage protection for natural waterways, which are continually under threat through piping and inappropriate development.

2 STREAM DAYLIGHTING INTERNATIONALLY

The practice of stream daylighting is being carried out in many parts of the development world including Europe, America and Australasia (Most notably the Cheonggyecheon River, Seoul South Korea). However, this is not the case in general in the less developing nations which are by and large struggling with the fundamental issues of flooding, human health and erosion within their City and urban waterways. It should not then come as a surprise that the costs of stream daylighting can be significant as only the stable maturing civil infrastructures at this stage seem to be able to implement daylighting.

Overall it can be said that stream daylighting is in a very inceptive stage with projects widespread across the world and focused on areas where social and culture focus and will serves to encourage this significant shift in the management of piped infrastructure and open space environments.

2.1 STRAWBERRY CREEK PARK A FIRST EXAMPLE IN AMERICA

Although daylighting streams is relatively new, some of the first international examples can be found in North America. One of the most famous of which being, The Strawberry Creek Park, project conducted in the city of Berkeley, California in 1984. This initiative is widely considered a model for modern daylighting. The creek faced a slow demise as a result of intensifying local landuse associated with the University, upstream development and flooding and associated erosion issues and development for railways. Over period of some 100 years the creek went from being an iconic watercourse supplying drinking water to the growing University Campus, to a dangerous, feted liability that eventually was modified to control these growing issues within the campus and culverted downstream by 1966.

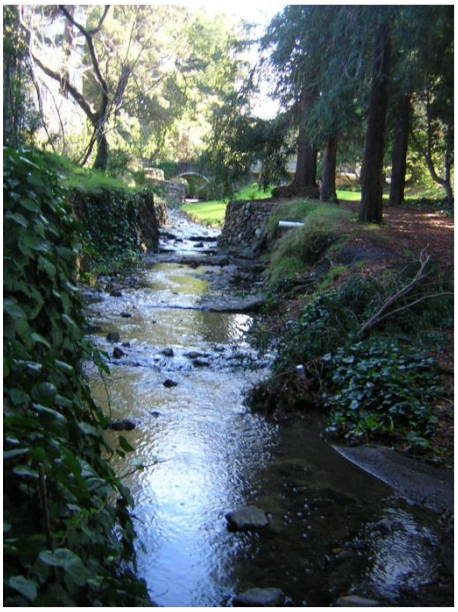

Figure 1 Image of Strawberry Creek through the University of Berkeley Campus Figure 2: Image of Daylighted Strawberry Creek through the Strawberry Parks immeduialty after construction (source Wolfe Mason Associates)

However, this was turned around through the acquisition of a culverted section of Creek situated under an abandoned rail yard located below the Campus grounds. Through the vision of City officials a park project was proposed that included removing the culverted section. Although the project was met with some skepticism it was through the engagement and enthusiasm of the local community the project gained impetus. The existing upstream channels (refer figure 1) although semi modified were used to guide the design team in the design and eventual outcome (refer figure 2) was a success and a open public space that draws hundreds of people every day and set a bench mark for others to follow.

It seems that notwithstanding the ongoing piping and degradation of waterways across America, which is still the dominated trend around the world, daylighting is becoming a more common stormwater trend throughout the United States. By 2000 approximately 13 projects had been completed ranging from catchments of only 40 hectares to several thousand hectares (Pinkham 2000).

2.2 BRINGING LIGHT TO THE STREAMS IN ZURICH, SWITZERLAND (EUROPE)

In Europe there is what is considered the standard for stream daylighting. This work has been conducted in the city of Zurich: More than 21km of urban streams have already

been daylighted (50 projects in 20 years) and the program is still ongoing. The Zurich motto: "with increased density of settlement a stream as a component of area organization becomes more important". The success meanwhile has been so convincing that quarters are struggling to be the next for this program. Citizens have discovered the advantages and want to see them realized for them (web ref 1). Central to this initiative was a clean-water concept for separating uncontaminated water from sewage channels was extended into a stream restoration concept. The goal was to "daylight" as many streams as possible, realigning them on the surface, to increase ecological and recreational values within the urban area of the city Zurich (Antenner 1999).

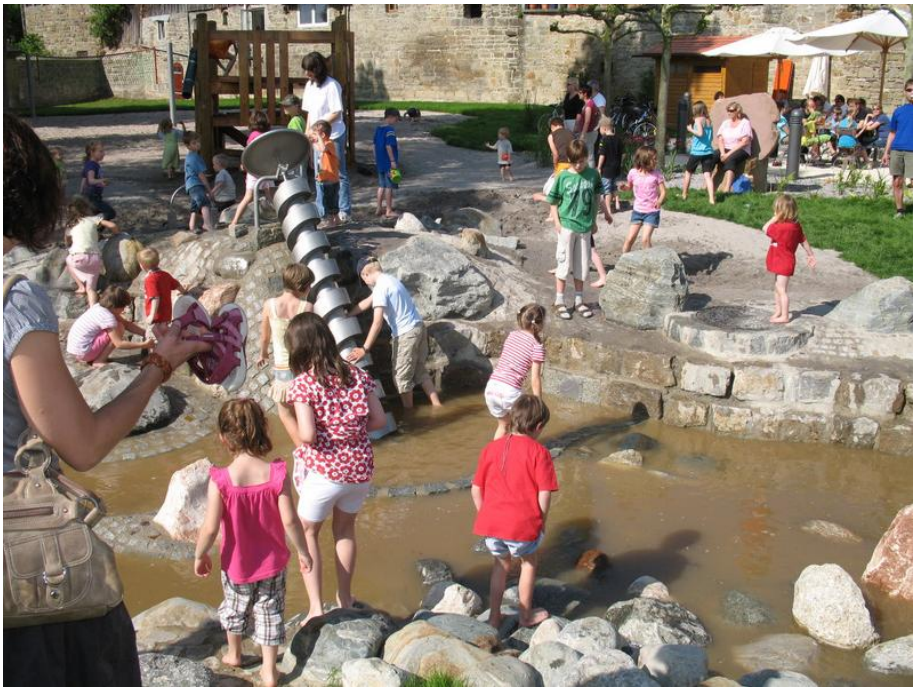

Figure 3: Showing Children in Zurich accessing an open watercourse

3 STREAM DAYLIGHTING INITIATIVES IN AUCKLAND REGION

In 2003 the Auckland Regional Council commissioned a study to prepare a technical publication to provide a summary of some of the best practice examples of stream daylighting internationally, local CBD sites that have the potential for daylighting and guidance for practitioners investigating daylighting sites. This is referred to as Technical Report TR2008/027 (Stream Daylighting- Identifying Opportunities for Central Auckland: Concept Design). This report identified that …" opportunities identified require detailed analysis and broad consultation to determine their feasibility and cost / benefit to the community" (Lewis M, TR2008/027). Although there are 1 or 2 examples of daylighting within the Auckland Region (Lucas Creek 2009) most at this point are limited to the drawing board and have yet to be implemented. However, on the basis of the wide interest demonstrated within Council and community and interest at a political level this is soon to change and following discussion demonstrates how this might occur.

In 2010 Mayoral office of the Len Brown announced an initiative to make Auckland the "most livable City in the World". Part of this initiative was to undertake a raft of projects including stream daylighting.

Consequently Auckland Council commissioned Morphum Environmental in 2011 to undertake an investigation and assessment of 'Stream Daylighting' opportunities in the Auckland Region. The project involved identifying piped or concrete lined and channelised watercourses that have the real potential to be restored as functioning open stream systems. A 'functioning' open stream was considered to include the full complement of riparian and ecological habitat function, stormwater functions, and a range of the visual, landscape, educational and recreational benefits that the community enjoys.

This next section provides a background in the Potential Stormwater Stream Daylighting Projects (Young and Buchannan 2012) study including the technical details and methodology used.

3.1 URBAN AUCKLAND STREAM ENVIRONMENTS

The Auckland region has an estimated 16,500 km of permanently flowing rivers, which increases to 28,240 km when intermittent and ephemeral rivers are included. Most drainage catchment are small with corresponding small streams and waterways that either drain to high energy coastal beaches and or low energy sensitive tidal inlets and estuaries.

Stream environments play an important role in community well being from an aesthetic and amenity perspective. However, in the urban catchments there are a total of 6500km of Council owned pipes with an associated 137,240 manholes and 27,486 stormwater catchpits. Consequently many hundreds of kilometers of streams have been piped.

The environmental outcomes associated with the daylighting of piped urban streams need to be considered in terms of intensification of the contributing catchments. Often the potential for ecological benefits from daylighting a small section of a stream in a highly modified catchment are limited. This is why its important to balance the ecological objectives against others of e.g. of community or flooding. However, within watercourses that retains ecological value the removal of culverts can increase the quality and amount of available habitats and often remove significant barriers to fish passage.

4 POTENTIAL STORMWATER STREAM DAYLIGHTING PROJECTS 2011/12

The overall objective of this project, conducted in 2011/12, was to identify the best known locations for urban stream daylighting/restoration in the Region. Specific objectives were as follows:

I. Identify potential stream daylighting projects throughout the Auckland Region;

II. Use a weighted multi-criteria analysis to rank the projects from most feasible and beneficial to least;

III. Determine the overall site specific technical feasibility and benefits of 'daylighting' the identified potential stream daylighting projects;

IV. Further evaluate the highest ranking potential projects to confirm feasibility and benefits.

The ultimate objective of the project was to identify one daylighting opportunity that could be added to the Mayor's project list. Subsequent to this and in tandem, the

investigation and underlying process will result in details to support the implementation of stream daylighting throughout the Auckland Region in the future.

4.1 PROJECT SCOPE

Morphum Environmental Ltd was commissioned in late 2010 to help support Council officers in meeting a Mayoral office request to identify a stream daylighting project as part of the '100 Projects in 100 days'.

The project has evolved into a two stage process. Initially 25 potential sites were identified and evaluated using a detailed multi criteria analysis protocol. The most promising potential projects were further evaluated and a 'short list' was developed. The Stage 1 report developed by Morphum and council's stormwater team (March 2011) was circulated through other areas of council. Through this process and follow-on workshops with a focus group in November and December 2011, 8 more sites were identified, objectives were clarified and a simpler red-yellow-green traffic light analysis was applied. This included a strong community focus and served to further clarify the potential sites.

This project served to identifying piped or channelised watercourses that have the potential to be restored to become functional naturalised open stream systems. Many of these sites had been the subject of previous concept plans or were identified through local catchment management planning studies. No detailed hydrology, hydraulics or geotechnical investigations where undertaken but these factors considered.

4.2 ASSESSMENT METHODOLOGY AND ANALYSIS

The assessment methodology included a two stage process using weighted multi criteria analysis (Stage 1) coupled with a (red)-stop (yellow)-neutral (green)-go traffic light scoring process and with (blue)-neutral being used for some factors where the factor would have a neutral ranking (Stage 2). Both processes included consultation and collaboration with numerous stakeholders, desktop studies, analysis and site field visits.

4.2.1 ECOLOGICAL VALUES

Daylighting sites have not been selected on the basis of the known ecological values or the rarity or the significance of the associated stream system. Sites have been selected on the basis that they are known locations within the urban limits that have the potential to have piped sections removed.

Urban streams can provide habitat for nationally threatened species such Giant kokopu, Koura, Longfin eel or Shortjawed kokopu. The open sections of waterway associated with proposed daylighting sites should be considered in terms of known species richness and diversity. This information should inform the design process and if available be included as a scoring parameter in future iterations of the evaluation and selection process, undertaken in this study.

As compared to a conventional reticulated urban stormwater network, the environmental benefits of open streams are wide ranging. They provide bird and wildlife corridors, habitat and a nursery for sensitive fish species and stream environs provide filtering and treatment of stormwater runoff and temporary storage of storm flows. However, these environmental outcomes may be more limited from daylighting a small section of a stream in a highly modified catchment (Young and Buchannan 2011).

4.3 STAGE 1 MULTI CRITERIA ANALYSIS SCORING PROTOCOL

The first project stage involved developing a list of factors and a corresponding scoring and weighting system (multi criteria analysis protocol) to allow analysis of the identified

sites. The protocol encompassed potential environmental, social, cultural and economic benefits, as well as technical and institutional feasibility and risk. A number of specific factors were included in each category so that there were 24 factors assessed as shown in Table 1. These are intended to reflect the complex and diverse sets if drivers and factors which need to be considered for a daylighting site.

Table 1: Stage 1 Categories and Factors

Category	Assessment Factor	Form of Answer
Social Issues	Is the stream on public (council) or private (non-council owned) land?	Public /Private /Both
	Consider Health and Safety, during and post-daylighting. (e.g. Is it near schools, is public access an issue - fencing required?). Can these be addressed by simple design.	Y/N
	Are there opportunities for community involvement? (this may include existing or potential future groups, who may get involved in restoration works.	Y/N
	Consider the local iwi. Are they likely for or against the daylighting, would they be interested in ongoing community involvement	positive/ negative
	Is access to the stream easy to implement?	Y/N
	Will the daylighting provide improved amenity outcomes. Provide comments as to what these may be e.g. picnic tables, walkways etc.)	H/M/L
Ecological Issues	Will the daylighting significantly improve or degrade existing instream habitat (incl. inanga)	Improve/Degrade
	Will the daylighting significantly improve or degrade existing riparian habitat	Improve/ Improve in time/ Degrade
	Will the daylighting improve fish passage (consider the location of the site within the catchment)	Y/N
	Will the daylighting improve connectivity with/contiguous to other habitat (both instream and riparian)	Y/N
	What potential is there to improve substrate heterogeneity as a function of the daylighting?	H/M/L
Engineering / Stormwater Considerations	Is there adequate space alongside the stream to carry out required works (to make low batters, etc.)?	Y/N
	Are there extended periods of no flow (ephemeral)	Y/N
	What is the erosion potential of the stream following daylighting? (consider catchment location, steepness, geology etc)?	H/M/L
	Are there geotechnical issues that need to be considered/and/or addressed?	H/M/L

	Are other utilities present which may make works difficult?	Y/N
	Status of project	pre, concept, design
	Is the stream likely to be negatively impacted by other works proposed in the area.	Y/N
	Is there an integration opportunity ?	H/M/L
Cost/ Benefit	What is the cost per length of stream to be daylighted?	<$1,000/m, $1,000-$3,000/m, $3,000-$6,000/m, >$6,000/m
	Likely Confidence in Cost Estimate	H/M/L
Implementation, Operations and Consents	What is the difficulty in gaining consents?	H/M/L
	Consider the ease of implementation.	H/M/L
	Does daylighting this section of stream have the potential to increase or reduce flooding. Consider both upstream and downstream of the site	increase/ reduce
	Long term operations issues	Y/N

Overall, the weighting system and factor categories are as follows in table 2:

Table 2: Stage 1 Factor Category Weightings

A	Social factors and considerations	20%
B	Ecological factors and considerations	20%
C	Engineering feasibility and stormwater benefits or considerations	20%
D	Project cost factors	20%
E	Implementation and operational factors	20%

A desktop exercise was completed using the multi criteria ranking system to initially rank the projects. Those projects considered to have fatal flaws or to be unfeasible were not considered further at this stage.

Site visits were then undertaken of the most feasible proposed project sites to verify that the ranking was correct. Previously unidentified constraints (or benefits) were noted, photographs taken and other pertinent site information recorded. This included an assessment of the levels and piped network available through Council records. Key factors being the depth of the pipe below the ground surface and the steepness of the surrounding topography which influence the geotechnical and feasibility factors.

2.1 STAGE 2 FLAG AND MULTI CRITERIA ANALYSIS

The kick-off of the Stage 2 phase began with workshops with the Mayoral office focus group, Local Board advisors, and parks and stormwater council officers in November and

December 2011. Eight new sites were added to the initial list of 25, giving 33 sites for review. As a result of the Local Board and community focus a simpler traffic light protocol was adopted at the recommendation of Council for this stage of the evaluation. Factors were developed around the following categories and assessment factors as presented in Table 3 below:

- Social Issues
- Cultural Values
- Ecological Issues
- Economic Objectives
- Corporate Objectives

Table 3: Factor Category Weightings

Category	Assessment Factor	Form of Answer
Social Issues	Easy public access	Y/N
	Increased local amenity e.g. becomes local water feature, "treasured" place	H/M/L
	Enhanced connectivity for walking and/or cycling	Y/N
	High potential visibility for education, demonstration purposes	H/M/L
Cultural Values	Association with history: important site for maori, pakeha or other significance	Y/N
	Does local Community have an interest in site or area?	Y/N
	Existing community group in place having relationship/commitment with site (e.g. Sport Club)	Y/neutral/ negative
	Support from Local board	Y/neutral/ N
Ecological Issues	Immediate evidence of restorative actions	Y/N
	Potential to be part of staged or integrated programme (in conjunction with parks, urban development, transport, SW, etc.)	Y/neutral/ N
	Current environmental information readily available?	Y/N
Economic Objectives	Demonstrates best value for money	H/M/L
	Potential funding from external partners or sponsors	Y/N
	Funding is in Council budgets (SW, transport, parks, urban dev.)	Y/N
	Consentable/Doable in 2012/2013	H/M/L

Corporate Objectives	Future 10 year programme of work is included in planning and funding plans for multiple departments	Y/N
	Go Now project has cross council planning and implementation team in place	Y/N
	10 Year programme of work resourced from multiple council department (including transport and Watercare)	Y/N
	Engineering or other identified constraints (New criteria that wasn't included in workshop)	L/M/H

For each site each factor was assigned a traffic light of red, yellow or green with blue being used for some factors where the factor would have a neutral ranking. The definition of the traffic lights is provided in the following table 4.

Table 4: Stage 2 Traffic Light Definition

Key to Lights		Definition
	Low/ Negative/ Many	If red light would not support project on this criteria
	Yes/ High/ Improve	If green light would support project on this criteria
	Neutral/ Else	If blue light would not support nor hinder project
	Some/ Medium	If yellow light would not support nor hinder project but is a caution

The projects that scored highest had a number of green traffic lights and no red traffic lights. The factors that were given a red traffic light are as follows:

- Poor public access
- Existing amenity reduced
- Low visibility for education/ demonstration purposes
- Negative community group reaction
- No Local Board support
- No potential for integration with other council projects or activities
- Perceived low value for money
- Not consentable or implementable (in the short term)
- Engineering constraints that would be difficult to overcome

During Stage 2 the 8 new sites were evaluated through the original Stage 1 multi-criteria analysis and all 33 sites were evaluated using the traffic light protocol.

Both the Stage 1 and the Stage 2 evaluations were extremely useful in prioritising sites for further consideration. The Stage 1 multi-evaluation criteria had a more engineering and science orientated quantitative base, while the Stage 2 traffic light criteria was simpler and slightly more community and outcomes focused. Regardless, neither analysis was considered to 'neglect' important assessment factors and final site selection would require a more detailed site specific assessment.

4.4 STREAM DAYLIGHT SITES

A total of 33 sites have been identified as part of this study (refer table 5). It is anticipated that there are many many more sites (most probably hundreds) and the supporting database to this project has the potential to be expanded and the information shared as required.

Table 5: Stream Daylighting Sites

Site Code	Catchment	Stream Name	Location
1	Parnell	Waipapa Stream	Heritage Newmarket Station
2	Oakley	Wairaka Stream 1	UNITEC Campus
3	Meola	Meola Creek 2	Walmer's North Reserve
4	Hillsborough	Goodall Reserve Stream	Goodall Reserve
5	Freemans Bay	Tunamau Stream	Western Park
6	CBD	Wai-horotiu	Myers Park
7	Meola	Meola Creek	Mt Albert War Memorial Reserve
8	Meola	Meola Creek 1	ESR and Ed sites, adj. Camden & Haverstock Rds
9	Meola	Farm Tributary	Mt Albert Grammar School Farm
10	Wharua	Wharua Creek	Across Shore Rd from Waitaramoa reserve
11	Avondale	South Branch Avondale Stream 1	South Branch in La Rosa Gardens
12	Avondale	South Branch Avondale Stream 2	3 and 6 La Rosa Street
13	Avondale	South Branch Avondale Stream 3	Godley Reserve & 100 Godley Rd
14	Avondale	South Branch Avondale Stream 4	24 - 32 Taupiko Place
15	Avondale	North Branch Avondale Stream	La Rosa Gardens & 14, 16 & 20 La Rosa St
16	Rewarewa	Scroggy Stream	Commercial site at 2 & 14 Titirangi Rd (north of railway reserve)
17	Wairau	Wairau Creek	Fred Thomas Park
18	Wairau	Wairau Creek	Currys Lane
19	Hillcrest	Hillcrest Creek	Northcote Greenway
20	Shoal Bay	Ngataringa Stream	Ngataringa Road
21	Oteha Valley	Oteha Valley Stream	Tawa Drive
22	Manly	Unknown	Edith Hopper
23	Stanmore	Upper Vipond	unnamed? Reserve parallel to Vipond Ave
24	Orewa	Kinloch Reserve Stream	385 Hibiscus Coast Highway
25	Stanmore	Doyly Reserve	Doyly reserve upstream of Diversion
27	Oakley	Wairaka Stream 2	UNITEC Campus, Mason Clinic
29	Grey Lynn	Coxs Creek	Edgars Stream
30	Tamaki	Tributary to Tamaki Estuary	Boundary Reserve, Tamaki Estuary
31	Tamaki	Tributary to Tamaki Estuary	Johnson Reserve, Tamaki Estuary
32	Oakley	Oakley Creek	Underwood, Walmsley parks areas
33	Mangere	Tarata Creek	Moyle Park, Manukau
34	n/a	Puhinui Stream	Rata Vine section, near Botanical garden

4.4.1 TOP RANKED EXAMPLE SITES

It is important to note that many of the sites selected for daylighting show excellent promise and should be considered for the future in association with other relevant

initiatives such as urban renewal projects, catchment management plans or other infrastructure developments such as rail or transport corridors. This could be facilitated by the adoption of a master list of possible daylighting and naturalizing projects, so that all potential projects can be prioritised in a coordinated manner in association with key stakeholder initiatives.

At the end of the second stage of the project five sites where selected for consideration and three of these are presented following.

4.4.2 MEOLA CREEK MT ALBERT WAR – (MEMORIAL RESERVE)

This site has a red flag associated with do-ability and consent-ability within the required timeframe. However, the site was selected as it ranked 5 in Stage 1 and number 14 in Stage 2 and significantly it is a major urban watercourse with high proximate population and because the culverted channel is covered with only 350mm of concrete; from a technical perspective it is feasible to achieve. An artist's impression is shown in figure 5 and 6.

The overall impression from the site visit was that although the site has great promise, the scale of the required works might be prohibitive and therefore, as far as being the chosen project would have to be put aside but remain on the Daylighting database. Another compounding factor is the timing and scale of works associated with the Central Interceptor Project. It should be noted that channel widening to alleviate flooding is a likely scenario and that daylighting would be a consequence of these types of works.

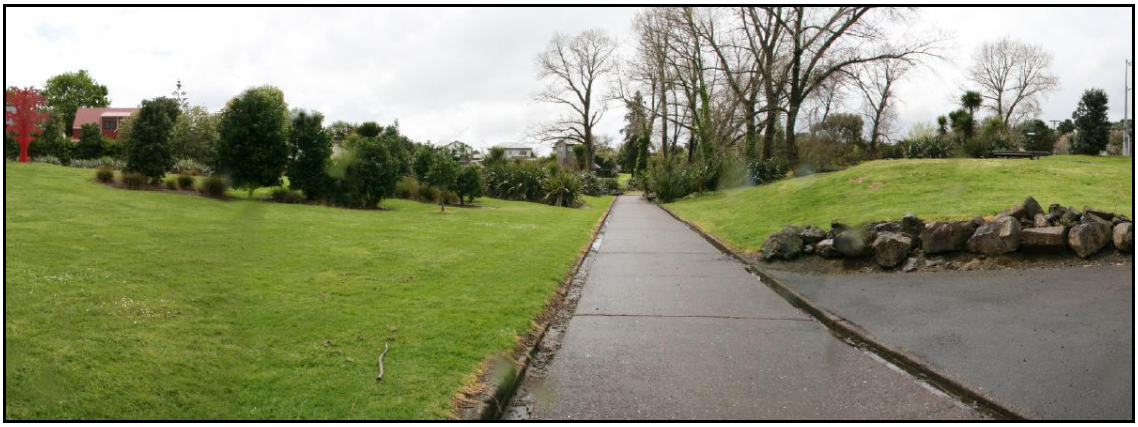

Figure 4: Showing walkway covering top of culverted Meola Creek- Rocket Park

Figure 5: Showing artists impression of daylighted section Meola Creek- Rocket Park

4.4.3 NORTH BRANCH AVONDALE STREAM - LA ROSA GARDENS

This site was selected as it ranked 1 in Stage 1 and number 3 in Stage 2. It also is within a reserve associated with another site for daylighting (South Branch) and community interested through formal and informal community groups. It is a boggy area for mowing in the winter and has an adjacent pathway that could be upgraded to facilitate community access. Shown in figure 7 and 8 is the downstream natural channel that provides excellent design tips for the removal of the shallow pipe shown in figure 8.

The overall impression from the site visit was that the site has great promise and would be feasible to implement. In terms of 'star quality', being in a quiet reserve not highly accessed by the public is a limiting factor. However, the potential to expand the project scope to include an extension of the existing walkway through to the adjacent Green Bay shops via 83b Godley Road mitigates the lack of star quality. Additionally the opportunity to extend the project to include the South Branch was considered very positive for this site, making it a top candidate.

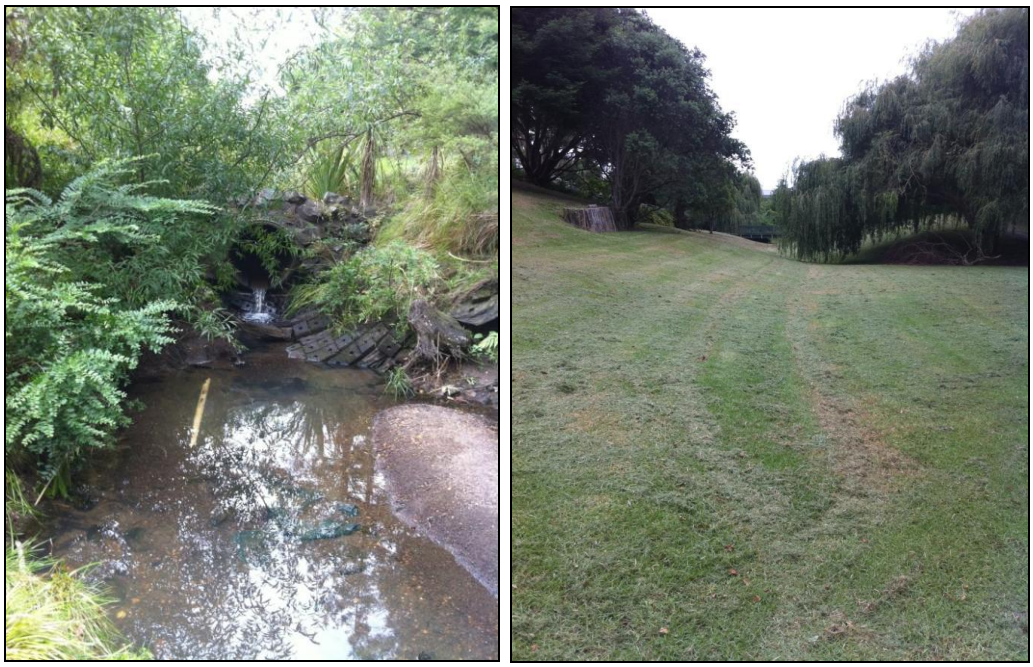

Figure 6 and Figure 7: Showing downstream open channel (which provides an example for design) and upstream piped section to be daylighted North Branch Avondale Stream

4.4.4 MEOLA CREEK 1 - ESR AND ED SITES, ADJ. CAMDEN & HAVERSTOCK RDS

This site was selected as it ranked 10 in Stage 1 and number 2 in Stage 2. It also is adjacent with other downstream restoration projects associated with the open sections of Meola Creek. This includes the Roy Clements Treeway and potential widening works associated with flood mitigation requirements for the catchment. Community interest is high through formal and informal community groups and landowner interest. Also no Red flags for this site recorded.

Meola Creek is piped into the grounds of ESR (Environment, Science and Research). Approximately 460m of tributary and groundwater inputs from Mt Albert could be daylighted through an existing overland flow path, although existing combined sewer overflows will need to remain piped. This opportunity may be enhanced by the construction of the Central Interceptor.

The overall impression from the site visit was that although the site has great promise, the scale of the required works might be prohibitive and therefore, as far as being the chosen project would have to be put aside but remain on the Daylighting database. Figure 8 shows the existing site combined with an artist's impression of the possible works.

Figure 8: Showing existing site and artist's impression of the possible works ESR

5 CONCLUSIONS AND RECOMMENDATIONS

The daylighting of streams requires many skills and professional disciplines. It is a technical, logistical and communication challenge that can have positive benefits for the environment and community.

Internationally the practice of stream daylighting is generally restricted development affluent nations that are in the position to be putting the people and environment first and valuing the inherent values that contact with flowing water can bring. However, within this positive framework of stream daylighting streams, rivers and waterways are still under significant threat from continued piping in both developing and development nations.

Hermann in 1990 wrote of the city of Zurich..."Meadowbrooks, ditches and water courses are relatively small but even in the city form numerous veins of life. They are non-renounceable characteristics of cities and landscapes. They serve for arranging and greening of settled areas, they are ecologically very important veins for network the scattered biotopes. People enjoy their rights of access to the open brook courses, greening through the cities. There they will find the untouched nature, meditative open space, the visible-aesthetic space, facilities for children's play, a space for doctrine and research, reproduction, relaxation and recreation." This concept that waterways are a vital part of our built environment has slowly resonated until today in 2012 we are beginning to believe this is how our cities should be. However, despite the feeling some of us might have the challenges technically, economically and politically are none the less significant.

5.1 RESTORATION AND DAYLIGHTING DATABASES

There is a need both domestically in New Zealand and internationally for information about potential daylighting sites to be available for the community and planning professionals. This could be achieved through the development of "Stream Restoration and Daylighting Central Data Repositories". This has in part been started through the Stormwater Stream Daylighting Project (Young and Buchannan 2012) and has the potential to provide a template for the Auckland Region and wider areas.

The successful application of adaptive management to the science and practice of restoration ecology requires specific knowledge about the outcomes of past restoration efforts. Ideally, project results would be readily available to scientists or other project managers with similar goals or in analogous ecosystems (Jenkinson 2006).

Databases could also demonstrate the value of improving the integrity of stream ecosystems to funders and policymakers. Costs could be assessed and evaluated against reported social and environmental successes. Such evaluations could provide greater information for making annual budgetary recommendations for programs that fund restoration projects (Jenkinson 2006).

It is vital that we monitor the success of daylighting projects from an economic, social and ecological perspective. The most important outcome of a great and successful project is that policymakers, the community and local leaders are able to understand and articulate these successes.

5.2 STORMWATER STREAM DAYLIGHTING PROJECT

The primary objective of this project was to identify one daylighting opportunity that could be added to the Mayors project list. However, it is important to note that many of the 33 sites show excellent promise and should be considered for the future. This would be facilitated by the development of a master list of possible daylighting and naturalising projects, so that all potential projects can be prioritised in a coordinated manner. Additionally, projects on this master list should be reflected back through the catchment management plan process as they provide mitigation to the effects of urban development. Additional recommendations and conclusions from this study are as follows:

- Acknowledge that there are many interested stakeholders with diverse drivers and expectations.
- That all sites identified remain on the "Regional Stream Day-Lighting Database (RSDD)" that can be updated and referred by multiple stakeholders.
- This list be referred too and populated through the CMP development process and be a "Module" of the CMP.
- That the multi criteria analysis be further developed and considered as an information database as well as an evaluation tool.
- Include a more in depth cultural component to the analysis in partnership with iwi.
- Establish a standard methodology for assessing stream day-lighting sites (feasibility, hydraulics, geotec, consenting).
- Undertake a Region-wide spatial analysis exercise to identify sites.
- Develop policy to support stream day-lighting".
- That we get runs on the board by funding and supporting 'Low Hanging Fruit" projects!!!

It is recommended that detailed, engineering, hydraulic and geotechnical investigation are conducted to develop concept plans and cost estimates. This would additionally require stakeholder consultation (especially Parks and other landowners). This is generally a requirement of all such projects and is relevant for all stream daylighting initiatives.

"Bringing Light to the Water" is possible with sufficient planning and sound information to establish the plans upon which the interests of the community can be fulfilled and technical requirements can be met.

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