OPTIMISING STREAM RESTORATION OUTCOMES WHEN FACED WITH COMPETING DESIGN INTENTS

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ABSTRACT

Stream restoration is a growing field with communities acknowledging the benefits of restoring streams using natural means to improve hydrology, water quality, ecology, and amenity values. Potential stream restoration projects are typically influenced by multiple stakeholder groups, for example: city councils, regional councils, iwi, private landowners, resident associations, and special interest groups such as conservation and ecological groups. These stakeholder groups may represent a range of competing values, such as: improved ecological value, flood management, erosion management, protection of infrastructure, public amenity, water quality improvement, urban design, safety and community engagement and educational opportunities. The challenge for designers is to achieve the best possible restoration outcome, given the competing objectives and constraints. Transparency in the design process is paramount; designers must communicate to relevant stakeholders the reasons behind decisions made and how these decisions impact the final outcome to appropriately manage expectations. While compromise is often inevitable with competing drivers, meaningful outcomes can be achieved. This paper explores the use of tools such as the Mauri Model, which integrates qualitative and iwi values into the decision making process, and the Stream Ecological Valuation methodology, to identify and communicate stream enhancement opportunities, and to guide the decision making process. Examples and solutions from a variety of design projects are presented where competing constraints have led to compromise in the design, but ultimately achieved outcomes satisfying both stakeholders and the major project objectives.

KEYWORDS

Stream Enhancement, Stream Naturalisation, Optimisation, Mauri Model, Stream Ecological Valuation Methodology, Stakeholder Engagement

PRESENTER PROFILE

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1 INTRODUCTION

Stream restoration is a growing field with communities acknowledging the benefits of restoring streams using natural means to improve hydrology, water quality, ecology, and amenity and cultural values. The principles of water sensitive design have guided a number of design projects to towards achieving multi-functional systems benefiting multiple stakeholders.

The Auckland Council Guideline Document for Water Sensitive Design for Stormwater (GD04; Lewis et al., 2015) defines water sensitive design (WSD) as:

> *An approach to freshwater management, it is applied to land use planning and development at complementary scales including region, catchment, development and site. Water sensitive design seeks to protect and enhance natural freshwater systems, sustainably manage water resources, and mimic natural processes to achieve enhanced outcomes for ecosystems and our communities.*

The United States Environmental Protection Agency (USEPA) describes green infrastructure as "a cost-effective, resilient approach to managing wet weather impacts that provides many community benefits". This approach contrasts traditional piped networks with the intention to "reduce and treat stormwater at its source while delivering environmental, social, and economic benefits" (USEPA, 2015). Green infrastructure is described as using vegetation, soils, and other elements and practices to restore some of the natural processes required to manage water and create healthier urban environments (USEPA, 2015).

While internationally terminology varies, a key characteristic common across these methods is to take an inter-disciplinary design approach. Design considers stormwater management in parallel with the ecology of a site, best practice urban design, and community and cultural values. Both aspire to ensure multiple public benefits from stormwater management and to develop a unique 'sense of place' for our communities. They also seek to deliver low risk and better return on investment for land developers.

Potential stream restoration projects are typically influenced by multiple stakeholder groups, for example: city councils, regional councils, iwi, private landowners, resident associations, and special interest groups such as conservation and ecological groups. While water sensitive systems can provide multiple benefits at a range of scales, the challenge in targeting multi-functional outcomes is that often a project or funding organisation will have a single driving objective, which is not enhanced by the full suite of benefits offered by a system approach. Any client requires clear evidence regarding costs and benefits associated with proposed systems and infrastructure before they are willing to invest and it may be hard to quantify the suite of benefits provided in relation to a single driving objective.

Furthermore, multiple stakeholder groups may represent a range of competing values, such as: improved ecological value, flood management, erosion management, protection of infrastructure, public amenity, water quality improvement, urban design, safety and community engagement and educational opportunities.

The challenge for designers working within complex projects is to achieve the best possible restoration outcome, given the competing objectives and constraints.

2 CASE STUDIES

Stream management responses are as unique and varied as the nature of the streams in question. The interacting systems of land use, geology, surface and groundwater hydrology, geomorphology, vegetation, prior modification etc. all contribute to a unique resource whenever a stream is being considered for restoration or other modification.

Like any complex engineering problem, a holistic response to stream management requires integrated consideration of the interacting systems. Then the problem can be adequately characterised, appropriate options conceptualised and assessed, and the all-important details designed.

While it is good in theory to recommend a holistic response to stream management, it is important for a project engineer to have a framework to manage this complexity and to drive the process of finding the best solutions. An appropriate decision support framework can help to communicate the various objectives that represent this complex set of systems, and make any trade-offs more transparent. This is particularly important when one stakeholder or outcome gets "trumped" by another design intention, and that stakeholder needs to buy into the common good of the whole project as well as see where their priorities have been considered alongside other objectives. The following section outlines a series of case studies from the experience of the authors that aim to show some successes and challenges organised under the following approach frameworks:

- Stream Ecological Valuation (SEV)
- Mauri Model
- Watercourse Management Planning Restoration Opportunities
- Network Remediation Opportunities

2.1 STREAM ECOLOGICAL VALUATION AS A DECISION TOOL

Stream Ecological Valuation (SEV) is a method for assessing the ecological functions of Auckland streams as provided in Auckland Council Technical Report 2011/009 (Storey et al., 2011). The SEV method approaches the complexity of defining a stream's value by assessing the observed or predicted state of a stream against a set of desired ecological functions in four groupings as follows:

- Hydraulic Functions
  - Natural flow regime
  - Floodplain effectiveness
  - Connectivity for natural species migrations
  - Natural connectivity to groundwater
- Biogeochemical Functions
  - Water temperature control
  - Dissolved oxygen levels
  - Organic matter input
  - Instream particle retention
  - Decontamination of pollutants
- Habitat Provision Functions
  - Fish spawning habitat
  - Habitat for aquatic fauna
- Biodiversity Provision Functions

- Fish fauna intact
- Invertebrate fauna intact
- Riparian vegetation intact

The SEV is calculated with a complex calculation spreadsheet, with each function using one or more variables and algorithms. The resultant scores can be between 0-0.1 for a pipe to 0.9-1 for a natural reference stream. While this method was designed to evaluate, it can be used as a decision making tool in design. In essence a stream restoration effort is targeting an improvement in SEV score, and therefore actions that can be taken to improve each function can be targeted as physical modifications made to the stream.

For instance, increasing meanders can improve connectivity to groundwater, increase instream particle retention and even increase the overall length and area of the stream. Stream bank flattening can improve floodplain effectiveness and fish spawning habitat. Creation of in stream naturalisation structures can improve the natural flow regime and increasing riparian vegetation will influence a great many of the functions.

Many of the SEV functions are interconnected. By changing one variable, there can be a multitude of changes across the different functions including increases and decreases to different variables within and across stream functions. Improving the overall SEV score requires an in-depth understanding of the trade-offs within the SEV methodology and calculator in order to achieve the optimum balance and maximum improvement to the overall SEV score.

One of the most obvious means of improving the SEV score is to increase the length of a stream. Therefore opportunities for daylighting or removing culverted sections of a stream and restoring a natural channel in its place with a high function of >0.6 are certainly a low hanging fruit when using this method to evaluate potential outcomes.

An important driver for the use of the SEV method as a fundamental tool for restoration is the suitability of a SEV modelled restoration for investment from development projects looking for offset mitigation. When a development requires the loss of some stream value, the priority is to find appropriate stream reaches on site that can be restored to obtain an equivalent area / SEV score improvement to off-set the loss of stream from piping or other modifications. If a stream restoration is developed using the SEV methodology it is in effect ready for investment from development contributions.

2.1.1 RAWIRI STREAM PROJECT

The Rawiri Stream Project in the Hobsonville area of West Auckland is a stream restoration project being developed in conjunction with a cycleway development in a future growth area.

This stream passes through a series of lifestyle blocks and rural industrial properties. Existing SEV values are limited by patchy and weed infested riparian vegetation, a series of culverts including fish barriers which have been installed for access to the properties bisected by the stream, and some reaches undergoing down-cutting and bank slumping erosional processes, including sections of unstable bed materials and macrophyte weed infestations.

The concept design included the proposal for active remediation of several key reaches of the stream. Physical works in the stream were limited to those locations where access from the banks was feasible without impacting higher quality riparian vegetation and maximum benefits to the stream value could be obtained without reducing, temporarily or permanently, the instream values. Table 1 below includes the key techniques used in the restoration and their influence on the SEV values

Table 1: SEV improvements resulting from enhancement opportunities

SEV function	Daylighting	Riffles	Bank regrade	Planting
Natural flow regime	✓	✓		✓
Floodplain effectiveness	✓		✓	✓
Connectivity for natural species migrations	✓			
Natural connectivity to groundwater	✓	✓		
Water temperature control				✓
Dissolved oxygen levels maintained		✓		✓
Organic matter input				✓
In-stream particle retention	✓	✓		✓
Decontamination of pollutants		✓		✓
Fish spawning habitat	✓	✓	✓	✓
Habitat for aquatic fauna	✓	✓	✓	✓
Fish fauna intact *				
Invertebrate fauna intact *				
Riparian vegetation intact	✓		✓	✓
Total number of functions	**8**	**7**	**4**	**10**

**Potential fish and macroinvertebrate populations are reliant on a number of factors and are excluded from the ECR calculations*

Table 2 provides the SEV Metrics as observed and modelled as potential achieved for the design. This indicates that there are potential opportunities to improve the overall ecological value of the reaches.

Table 2: Summary of SEV Current and Potential scores

Site	Length of SEV (m)	Average Stream Width (m)	SEV current score	SEV potential score	Change in SEV score
R1	390	0.75	0.58	0.70	0.12
R2	260	0.9	0.52	0.77	0.25
R3	180	1.00	0.45	0.70	0.25
Total	**830**				

This project has proceeded to detailed design based on the concept. The approach of detailing the restoration outcomes in terms of SEV scores has helped with communication of the potential benefit of the project and has also opened potential funding sources from adjacent development sites which impact on stream values and require an offset mitigation recipient site.

2.2 MAURI MODEL AS A DECISION TOOL

This section explores the use of the Mauri Model, which integrates qualitative and iwi values into the decision making process, to identify and communicate stream enhancement opportunities, and to guide the design process.

The mauri model is a best practice framework for the definition of objectives and outcomes for the enhancement of 'mauri' (Morgan 2008). 'Mauri' is a central concept to the worldview of the Māori and how they regard the environment. It is a measure of the life force of a particular living thing, and so how the mauri is affected is an indication of the long-term viability and hence sustainability (Morgan 2006). All things have mauri, a place, a river, a rock, a tree, a person etc., and the mauri of a place can easily be degraded.

The Mauri Model assesses sustainability using 'mauri' as the measure for sustainability (Morgan 2006). It is represented whereby the mauri of the family/whanau (economic), the community (social) and the clan/hapu (cultural) are nested within the ecosystem/taiao (environment) (Morgan 2006).

Berkett et al. (2013) comment that while the Mauri Model was ostensibly developed for indigenous communities, it is equally applicable to non-indigenous groups and communities.

2.2.1 ŌKAHU BAY

The Ōkahu Bay project started with an assessment to identify options to remediate flooding in the Ōkahu Bay urupā (cemetery) (Clarke et al., 2014). One option within the initial investigation proposed daylighting the stream currently piped through the reserve. Ngāti Whātua o Ōrākei (NWŌ) chose to further explore this requesting Morphum analyse needs, identify options and propose a design to reinstate a tidal creek and/or freshwater wetland to the east of the Ōkahu Bay urupā. The primary objectives were to alleviate flooding in the urupā, to enhance local habitat and ecology and to provide cultural resources (e.g. aquatic/riparian native plants). A secondary objective was to improve water quality entering Ōkahu Bay.

Restoration of the mauri of Ōkahu Bay was an integral consideration during concept development. A decision framework using the Mauri Model (Morgan 2008) contributed to the concept designs as a tool to incorporate maximum opportunities in restoration options.

Ōkahu Bay is a culturally significant site for the Ngāti Whātua o Ōrākei. Effective restoration of the Ōrākei Domain tidal creek needed to be based on both an understanding of the natural patterns before human modification, and the effect of human modification on the current flow regimes. As Auckland has grown, urban development has greatly impacted Ōkahu Bay, and the adjacent Ōrākei Domain. The main sewage discharge for the Auckland area was located at the head of Ōkahu Bay from 1914 until 1960 when sewage was diverted to the Mangere Wastewater treatment plant. The construction of the sewer line, as well as the subsequent construction of Tamaki Drive that now lies over the sewer pipeline, created a substantial disconnect between the land and the sea. In addition, the discharge of wastewater to the bay greatly impacted the health and wellbeing of both the bay and its residents.

Ngāti Whātua o Ōrākei and Morphum facilitated a hui with hapu representatives and whanau to determine objectives and priorities for restoration of Ōkahu Bay. This phase occurred prior to development of concept designs to ensure all designs encompassed the true objectives of NWŌ. Open consultation with Ngāti Whātua, throughout the process, ensured concept designs fit within the greater Ōkahu Catchment Ecological Restoration Plan (ŌCERP) vision.

Based on the outcomes of the workshop, the following weightings were attributed to each factor:

- Mauri of the Environment, 31%
- Mauri of the Hapu, 25%
- Mauri of Community, 22%
- Mauri of Whanau, 22%

Table 3 presents the indicators identified in consultation with hapu representatives and whanau for options analysis. Indicators selected based on the responses of NWŌ representatives and whanau reflect the goals of the Ngāti Whātua o Ōrākei Reserves Board (2003) Whenua Rangatira Reserve Management Plan to promote beneficial effects on the water of Ōkahu Bay, conserve open space qualities, maintain public safety, respect the mana and privacy of the urupā and church, and retain the strong cultural connection between the land and the sea.

Six possible concept scenarios were identified and assessed following the mauri model:

1. Retain status quo
2. Tidal creek day lighting
3. Wetland treatment system
4. Partial wetland treatment system
5. Partial wetland treatment system and tidal creek day lighting
6. Tidal creek daylighting and tributary daylighting.

Table 3: Indicators for Mauri Model Assessment of Ōkahu Bay Tidal Creek Restoration Options

Factor	Indicator Name	Indicator Description
Environmental	Stream Habitat	Stream habitat supporting visible diversity from eels to kahawai
	Authentic Ecosystem	Diverse authentic ecosystem falling into place
	Connected Waterways	Connected healthy waterways that function naturally
	Clean Water	Water that is drinkable at the headwaters and clean in the bay, protected from wastewater and other contaminants
Hapu/ Cultural	Ahi ka & Manawhenua	Sharing the past to bring about a healing connection with the bay
	Whakawhanaungatanga	Physical presence into the future to grow the relationship between people and place
	Living Classroom	Providing a living classroom to enable kaitiakitanga

Factor	Indicator Name	Indicator Description
	Harvesting Kai	A harvest of kai from fish, bush and gardens
Community/ Social	Safe Interaction	Safe interaction for our kids from headwaters to bay
	Recreational Use	Allow for recreational needs of Ngāti Whātua and the wider Auckland community
	Flooding Prevention	Protect the urupā from flooding and reduce the flooding of recreational areas
Whanau/ Economic	Commensurate Benefit	Costs reflective of the outcome without being wasteful - "can't have half a mauri!"
	Resilience	Resilience to future operational costs
	Social Enterprise	Design offers whanau social enterprise opportunities for work, training, and capacity building of people

The preferred option to daylight the tidal creek and adjacent tributaries (Option 6) received a score of +1.2, indicating the option will enhance mauri in Ōrākei Domain and Ōkahu Bay more than the others. The option comprises four main components:

1. Daylight the tidal creek, generally following the alignment of the original tidal creek;

2. Daylight three adjoining freshwater tributaries, to provide connection between freshwater and saline environments;

3. Construct a gravity drained pipe diversion from the urupā discharging to a swale system to provide flood mitigation and water quality enhancement; and

4. Use excavated material to infill the urupā and undulating sections of the Ōrākei Domain to alleviate flooding and enhance the recreational space.

These components minimise the excavation footprint, in order to preserve the footprint of the historic papakāinga while mitigating existing flooding issues.

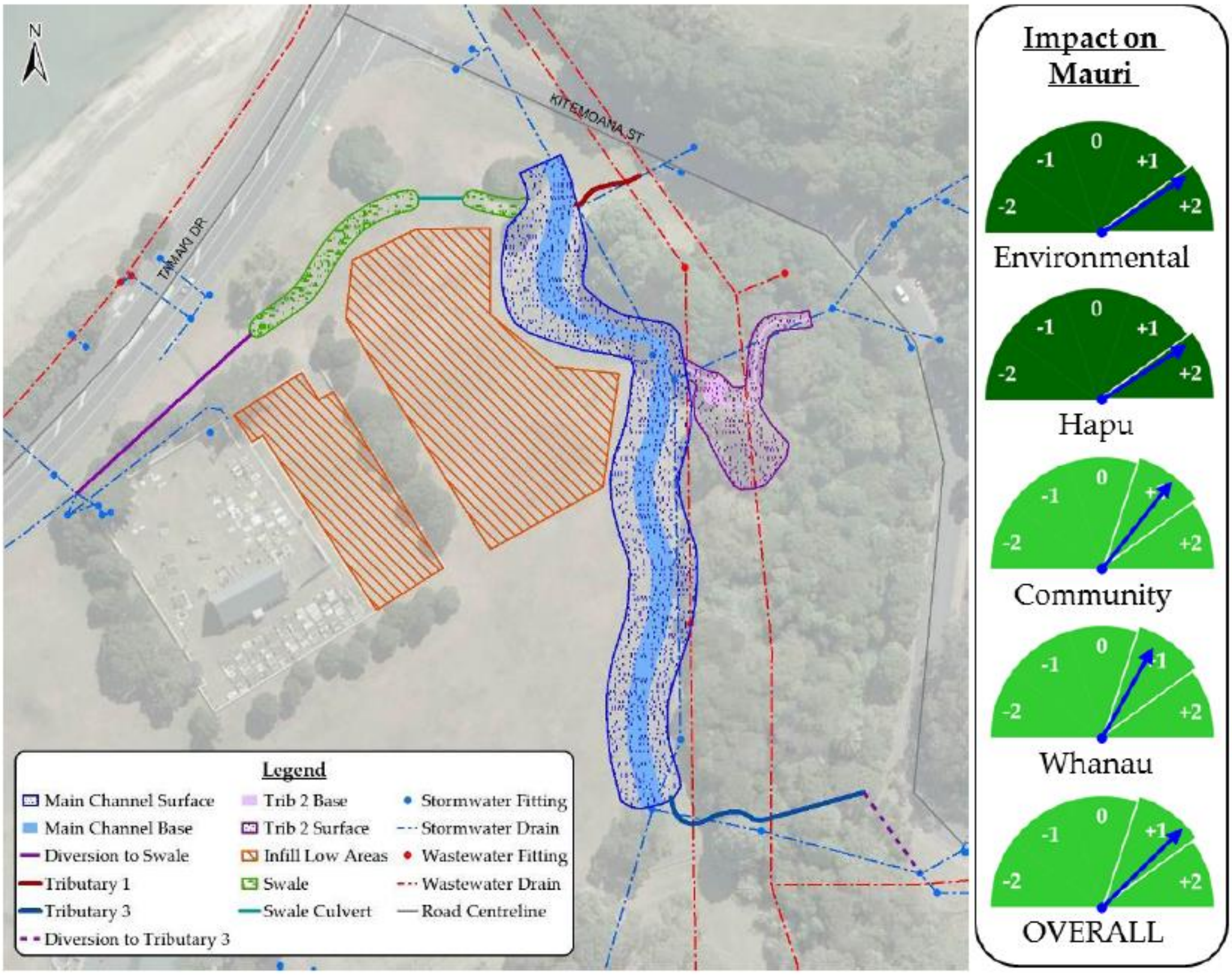

Figure 1: Concept Option 6, Tidal Creek and Tributary Daylighting

Use of the mauri model and frequent and transparent communication ensured the most suitable concept option was presented as the preferred approach. In this case study, the most suitable option did not mean the most economic, but rather the option that met the primary driver to restore the mauri of Ōkahu Bay and Ōrākei Reserve through restoration of the tidal channel, daylighting of freshwater tributaries, respect for and protection of the urupā and site of the historic papakāinga and, improvement to the remaining recreational area to enhance the enjoyment of users.

2.2.2 ATKIN AVE

Concurrent to the development of concept options for Ōkahu Bay, Morphum worked with NWŌ to develop concept options for daylighting opportunities on the Eastern Boundary of the Whenua Rangatira alongside Atkin Avenue in Mission Bay.

An eroded section of stream bank within the bounds of the Whenua Rangatira, and adjacent to a residential property (7E Atkin Avenue, Mission Bay), was brought to the attention of the Ngāti Whātua o Ōrākei Reserves Board. An engineering report commissioned by Auckland Council Parks recommended construction of a 1.2 m high timber pole retaining wall to remediate the 12 m length of eroding stream bank impacted by stormwater discharge.

The Ngāti Whātua o Ōrākei Reserves Board requested further options be explored placing particular emphasis on naturalising sections of the urban stream and encouraging habitat creation and improvements to water quality, while allowing for bank protection of the 12 m length of eroding stream bank originally identified.

Four zones suitable for remediation were identified and a recommended solution presented for each. The concept options identified as best achieving NWŌ objectives to naturalise piped sections of the stormwater network, to create habitat, and to improve water quality were (Figure 2):

- Zone A, Option 3: Naturalise the true left bank and reinforce the upstream section of true right bank adjacent to 7E Atkin Avenue using natural materials
- Zone B, Option 3: Daylight sections of culvert within both the Whenua Rangatira and the Council Reserve (this work would require additional approval from, and collaboration with, Auckland Council to proceed)
- Zone C, Option 4: Install a level spreader bar to allow vegetative filtration of the stormwater discharge pipe crossing the Whenua Rangatira and formalise the existing tributary watercourse
- Zone D, Option 2: Divert base flows from the stormwater line to a restored open stream channel

The works for Zone A, Options 3 and Zone D, Option 2 have now progressed to detailed design. The original concept allowed for removal of a block wall along the true left bank with re-grading and riprap erosion protection. The extent of works on the true right bank was limited to an existing 12 m length of exposed stream bank actively eroding. Two sections of existing retaining wall were to remain in-situ.

NWŌ and the Reserves Board undertook consultation with adjoining property owners to the stream regarding the proposed works. The adjoining property owners advocated for an extension of the works on the true right bank to include their boundary, including upgrade to the existing retaining walls.

Concept design for stream bank naturalisation in the Atkin Avenue stream was developed with NWŌ with a focus on the restoration of Mauri. Concept solutions were kept in line with the wider objectives of the Ōkahu Catchment Ecological Restoration Plan (ŌCERP) with a wish to have waters fit to swim in, with thriving ecosystems that provide sustainable kaimoana to the local community, and to improve the mauri of the area. Restoration objectives were identified to guide concept design development based upon the input of NWŌ, review of the Ngāti Whātua o Ōrākei Reserves Board (2003) Whenua Rangatira Reserve Management Plan, and best practice stormwater management methods. Particular emphasis was placed on naturalising sections of the urban stream. Key objectives of the concept relating to the subject Zone 1 were:

- Improving habitat and ecosystem function in the existing open channel by allowing for interaction between fauna and the stream banks
- Reducing the proportion of lined channel, and improving riparian vegetation diversity and quality in accordance with NWŌ planting objectives
- Allowing for bank protection for the properties neighbouring the Whenua Rangatira on the true right bank of the stream.

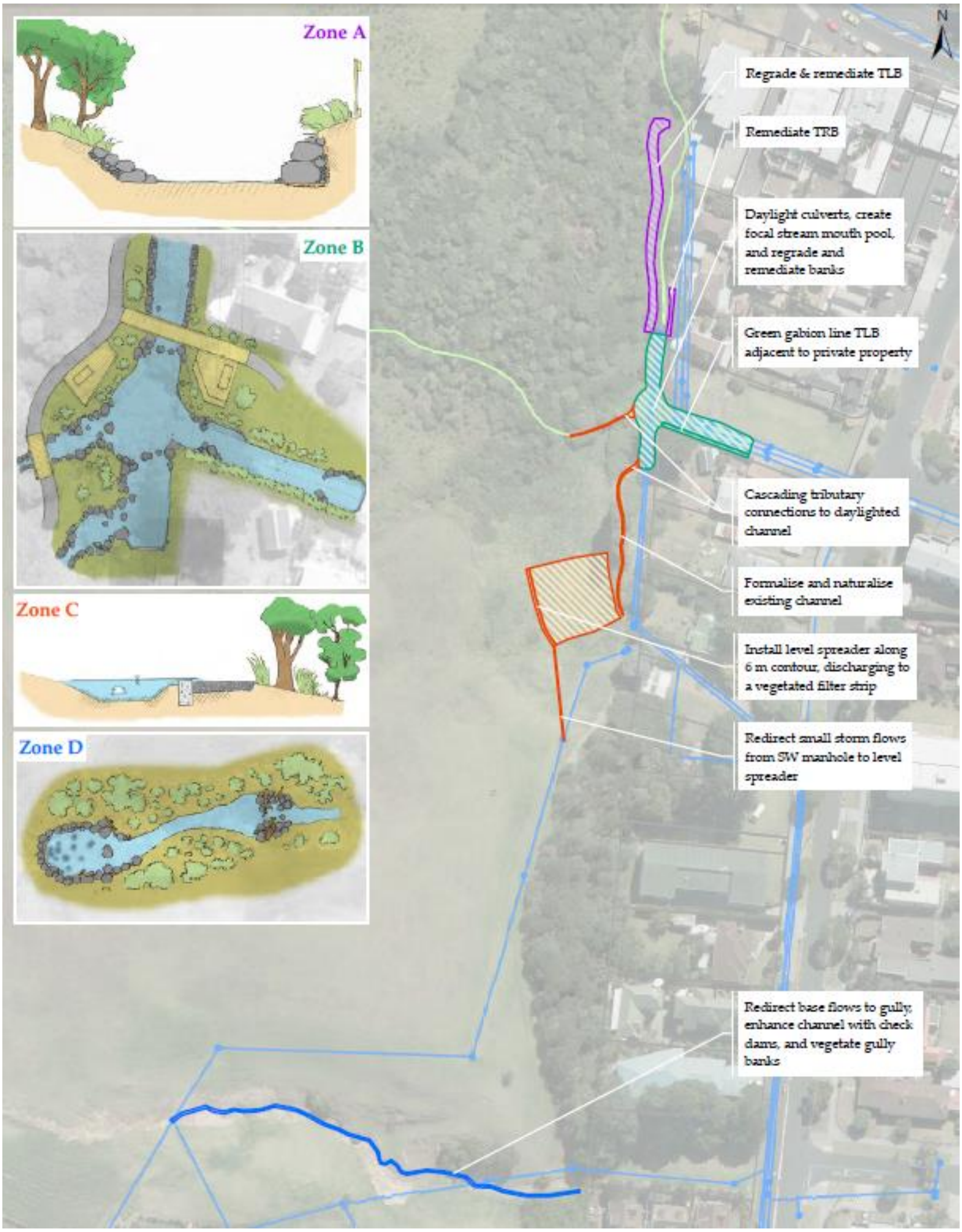

Figure 2: Atkin Avenue Recommended Enhancement Options

The addition of adjacent land owners to the stakeholder group meant it was essential to communicate the intent of the works and the driving objectives. The design philosophy was carried through to detailed design with the restoration and enhancement of ecology and mauri at the centre of the decision making framework. A comprehensive Mauri Model assessment was not replicated for the Atkin Stream Zone 1 restoration due to the small scale of the project. However the Ōkahu Stream Mauri Indicators were used as a lens to guide and provide specific practical elements included in the Atkin Stream Zone 1 restoration detailed design. Table 4 lists the key objectives from the Ōkahu Stream Mauri assessment included in the design of the Atkin Stream Zone 1 restoration.

Table 4: Indicators for Mauri Model Assessment of Ōkahu Bay Tidal Creek Restoration Options

Factor	Indicator Name	Indicator Description	Design Element
Environmental	Stream Habitat	Stream habitat supporting visible diversity from eels to kahawai	Include habitat complexity with rock lining and install fish hide structures
	Authentic Ecosystem	Diverse authentic ecosystem falling into place	No use of geotextiles, tanalised timber or structures. Include riparian restoration for weed control
	Connected Waterways	Connected healthy waterways that function naturally	Increase width and roughness to slow flows without impacting water levels
Hapu / Cultural	Whakawhanaunga-tanga	Physical presence into the future to grow the relationship between people and place	Normalise natural stream systems with natural materials and aesthetic elements
	Harvesting Kai	A harvest of kai from fish, bush and gardens	Increase riparian species diversity and aquatic habitat supporting fish and benthic diversity
Community / Social	Safe Interaction	Safe interaction for our kids from headwaters to bay	Maintain safe batter slopes and minimise fall hazards over 1.5 m
	Flooding Prevention	Protect the urupā from flooding and reduce the flooding of recreational areas	Increase cross section area to ensure upstream flooding is not worsened
Whanau / Economic	Commensurate Benefit	Costs reflective of the outcome without being wasteful - “can’t have half a mauri!”	Limit scale of true left bank intervention to steeper eroding section with vegetation management in lower risk areas
	Resilience	Resilience to future operational costs	Natural assets that have flexibility. Consider sea level rise in saline interface planting

With Auckland Council Parks, under the Council’s co-management role on the NWŌ Reserves Board, NWŌ, and private landowners as stakeholders involved in the development of the Atkin Avenue stream restoration detailed design it was essential to provide transparent communication. It was particularly important to discuss the reasons behind design decisions and proposed construction methods. Previously durability had been the overriding objective with concrete and timber retaining walls considered. However, the consideration of mauri gave the impetus to prioritise ecological and aesthetic benefit from using recognisable natural materials with increased surface material and ecological niches.

2.3 WATERCOURSE MANAGEMENT PLANNING OPPORTUNITIES

Watercourse Assessment Reports (WAR’s) (previously called Watercourse Management Plans, WMP’s) provide baseline information on the existing condition of waterways in both urban and rural settings. A Watercourse Assessment Report is a core resource in managing waterways to multiple objectives within realistic environmental, economic and social constraints. Watercourse Assessment Reports aim to provide information which can be used to maintain high value streams and enhance degraded streams while recognising the future growth pressures facing the Auckland Region and the essential function of urban streams in conveying stormwater.

The purpose of a Watercourse Assessment is to collect and report on meaningful data (engineering assets, biological and geomorphological stream state) in order to inform effective management of stream ecological health; stormwater infrastructure; and stormwater conveyance. A WAR provides a framework for prioritised management of the streams in the named catchment, and typically include a Watercourse Management Plan for the catchment which should include a summary of maintenance required for the stormwater assets assessed during the survey and identification of opportunities for restoration at selected locations in the streams.

WAR's are used by Auckland Council as a valuable tool for identifying restoration opportunities, and often highlight the varied stakeholders to a project. Key stakeholders in a catchment wide assessment include:

- Auckland Council Stormwater Unit
- Auckland Council Parks
- Auckland Council Research, Investigations and Monitoring Unit (RIMU)
- Auckland Council Environmental Services Unit
- Local Boards
- Auckland Transport
- Watercare Services Ltd.
- Iwi
- Pollution Prevention
- Community Groups

2.3.1 OTARA CATCHMENT ENHANCEMENT OPPORTUNITIES

Twenty-four Enhancement Opportunities (EOs) were identified within the Ōtara Catchment Watercourse Assessment Report (2014). A selection of these opportunities were presented as case studies to the Ōtara lakes and waterways steering group, grouped into the following themes:

- Daylighting the Green Corridor
- Water Sensitive Communities
- Stabilising for Change (erosion remediation)

Morphum have identified opportunities to provide seven concept designs to provide enhancement from the 'headwater to sea' for one tributary within the Otara Catchment, and proposal of a methodology to assess both physical and social change as a result of the physical works. The intention is that this can provide remediation at a full tributary scale rather than isolated improvements scattered across the catchment. Proposed improvements include:

- Removal of channel lining, 0.3 km
- Riparian enhancement of an unlined channel, 0.12 km
- Improve fish passage through two structures
- Channel daylighting in Otara Creek Reserve, 0.4 km
- Channel daylighting in Sandbrook Reserve, 0.4 km
- Weed/debris removal & riparian restoration of the headwaters, 0.85 km
- Removal of channel lining, 0.13 km

The intent of the concept development is to provide a document accessible to a wide audience providing a resource the Ōtara-Papatoetoe Local Board can share with the community. The document will develop a single concept for each site as a placeholder for collaboration and enable the forecast of budgets for the different aspects of the project. The use of a Watercourse Assessment Report helped to balance priorities and influence the concept design by clearly assessing a wide spectrum of stream characteristics from engineering assets to biological and geomorphological stream state. The WAR recognises varied stakeholders and future growth pressures to assist in prioritisation of potential enhancement and remediation. The WAR takes into account multiple objectives within environmental, economic, and social constraints to guide development of solutions.

2.3.2 MOA RESERVE DAYLIGHTING

Morphum was commissioned in 2010 to help support Auckland 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 evolved into a two-stage process. Stage 1 of the project involved identifying piped or concrete lined and channelised watercourses that have potential to be restored as functioning open stream systems. Initially, 25 potential sites were identified and evaluated using a detailed multi-criteria analysis protocol. The Stage 1 report developed by Morphum and council's stormwater team (March 2011) was circulated through other areas of council.

The Stage 2 phase began with workshops with the Mayoral office, Local Board advisors, and parks and stormwater council officers in 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 for this stage of the evaluation and served to further focus the potential sites.

Walmer Reserve North was identified as one of the potential daylighting projects in the Meola Creek catchment. This reserve is located between Moa Road and Walmer Road and is included in the area investigated for the Moa Reserve daylighting. The site of interest was also identified as a potential restoration opportunity (RO) within the Meola Creek Watercourse Management Plan.

The section of piped network was inspected in 2014 as part of the CCTV critical asset inspection programme, which revealed several defects in the pipe. It was proposed that

AC Stormwater renew approximately 350 m of 1350 mm diameter stormwater pipes, running through Moa Reserve. AC Stormwater engaged Morphum to also present a concept option for daylighting for consideration in the asset upgrade business case.

The three reserves, Walmer Reserve South, Walmer Reserve North, and Moa Reserve are currently designated as "Passive Outdoor" e.g. Parks. Moa Reserve and Walmer Reserve South currently serve as open green spaces to provide recreational opportunities for local residents. Moa Reserve appears to be well used, especially as an off leash dog exercise area and including a fenced playground.

The Albert-Eden Local Board has partnered with a collective of local weavers, the Kāhui Kairāranga o Tāmaki Pa Harakeke, to set up a pa harakeke in the reserve. This involves planting different varieties of flax which are selected for fibre and weaving qualities. There is opportunity to collaborate and build capacity on their project by including harakeke varieties that are suitable for weaving along the riparian margin of the daylighted stream.

The concept design intends to minimise the amount of space used in these valuable urban reserves. The design has been constrained to the North-western boundary through Moa Reserve to preserve flat grassed recreational areas. The concept attempts to balance the need for open space, ecological outcomes and increasing the connection between people and freshwater systems. For a short section of the design, this means concentrating the stream into a "gorge" type section to drop down a steeper transition, which would otherwise have prohibited the daylighting approach. Figure 3 and Figure 4 provide concept sketches for the proposed daylighting, ensuring a 100-yr ARI event level of service.

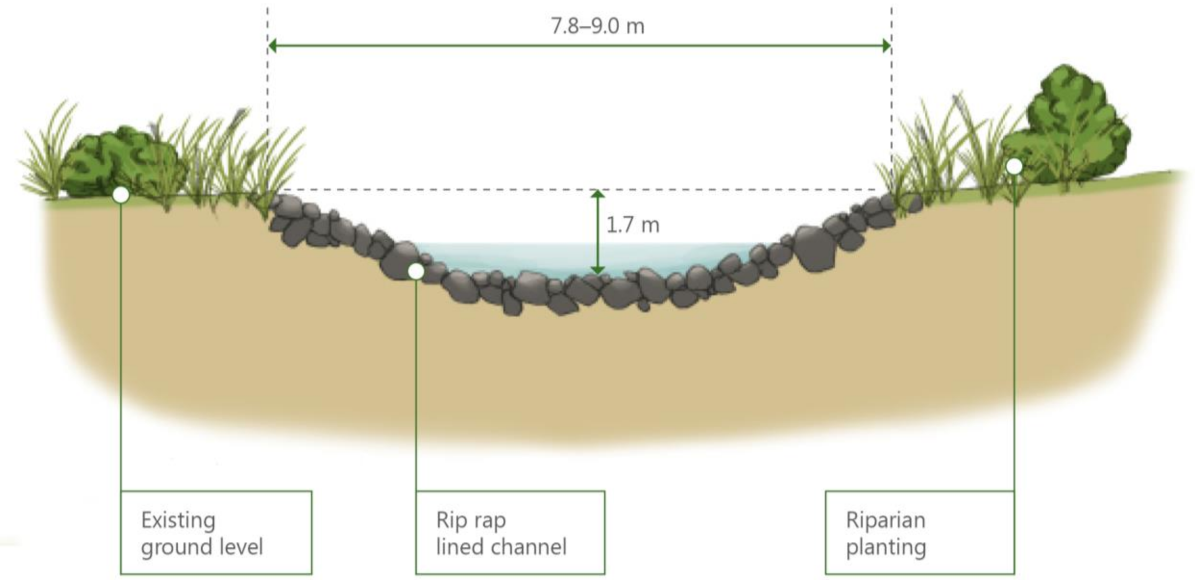

Figure 3: Trapezoidal rock-lined channel option for Moa Reserve

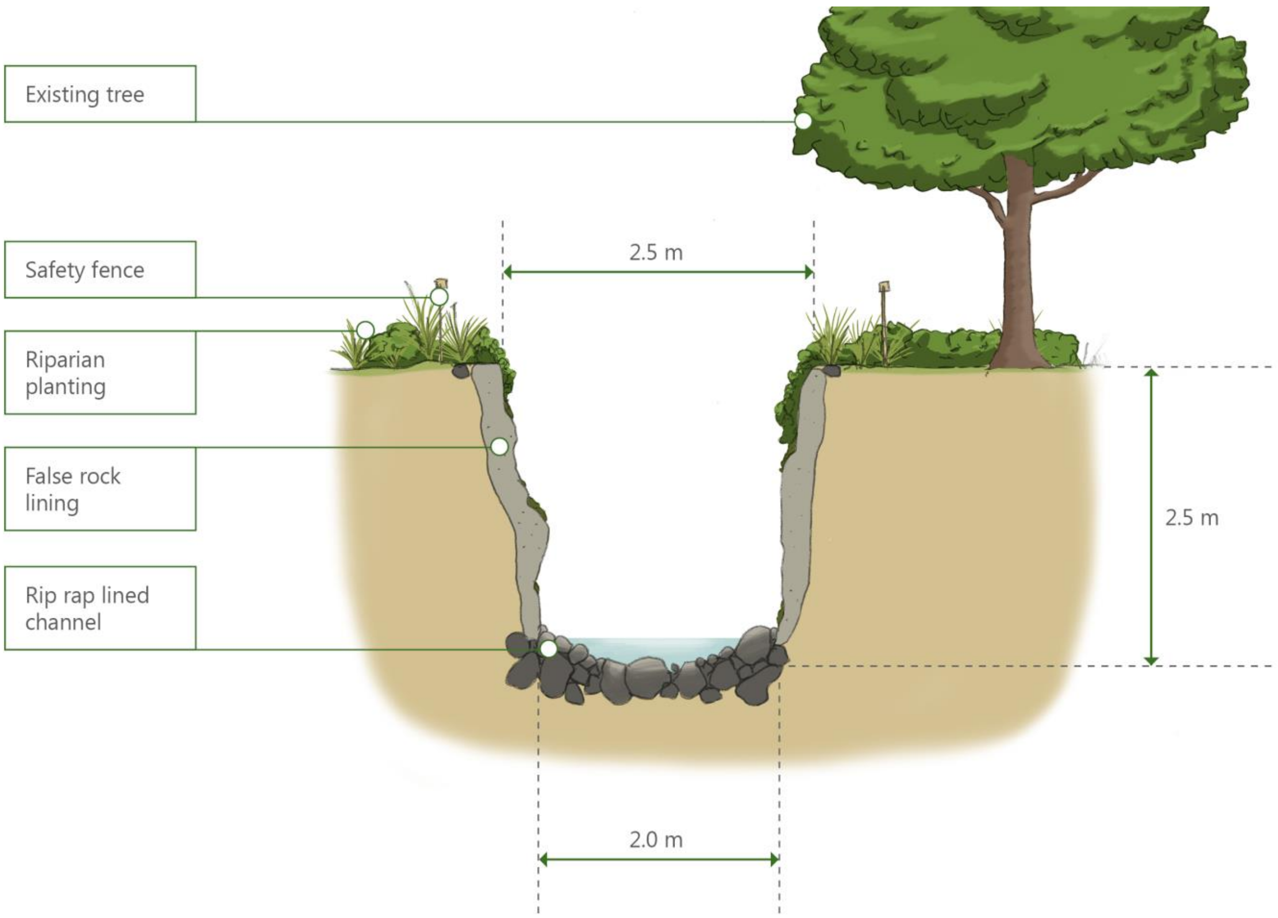

Figure 4: Gorge channel section for Moa Reserve

The daylighted option provides a unique opportunity to enhance the local community's connection with freshwater systems. The Meola Creek has been identified as an Outstanding Natural Feature which has limited public access points along its length. Daylighting in Moa Reserve provides an opportunity to further connect the community with the Meola Creek by activating the unused space at the interface with the creek (at the northern extent of the reserve). The design seeks to install a 15 m wide meandering rock lined spillway section at the interface with the creek. This could include informal access points and crossings providing natural play features and exploration opportunities.

Concept option selection may also be enhanced through using a decision making framework such as the Mauri Model to integrate qualitative and indigenous values into the decision making process.

2.4 NETWORK REMEDIATION OPPORTUNITIES

Network Operation and maintenance activities are a critical aspect in the lifecycle of stormwater network assets. Many repairs and renewals are undertaken by network managers and operators with limited call for planning and upgrading of the asset. The repairs may range from various unblocking and repair of broken pipes and nodes, to minor erosion repairs to streams and outfalls. These everyday activities can reveal opportunities for environmental and ecological outcomes that move beyond the typical like for like replacement of the original asset, which was often designed in a simpler age when the myriad of objectives now expected to be met by a stormwater network were less of a focus.

Green infrastructure or bioengineering options can represent an economic and added value approach to include as options for some routine maintenance activities. The following case study reveals added value realised by including non-standard options in what may have been run of the mill network maintenance activity.

2.4.1 TRIANGLE ROAD

Morphum was engaged by Auckland Council to design remediation for a collapsed 300 mm Ø stormwater pipe on private property at 2 Triangle Road, Massey (Figure 5). The broken pipe and downstream sections of pipe are located under a gravel maintenance track at the rear of eight commercial units. The pipe is significantly undersized and located within 2 m of a large wooden pole retaining wall, making replacement a difficult and expensive task. The maintenance track runs directly adjacent to a natural gulley which forms an ephemeral channel, on the boundary of the commercial property and five residential properties. The existing channel has been neglected and used to dump rubbish, affecting its conveyance, aesthetic, and ecological qualities.

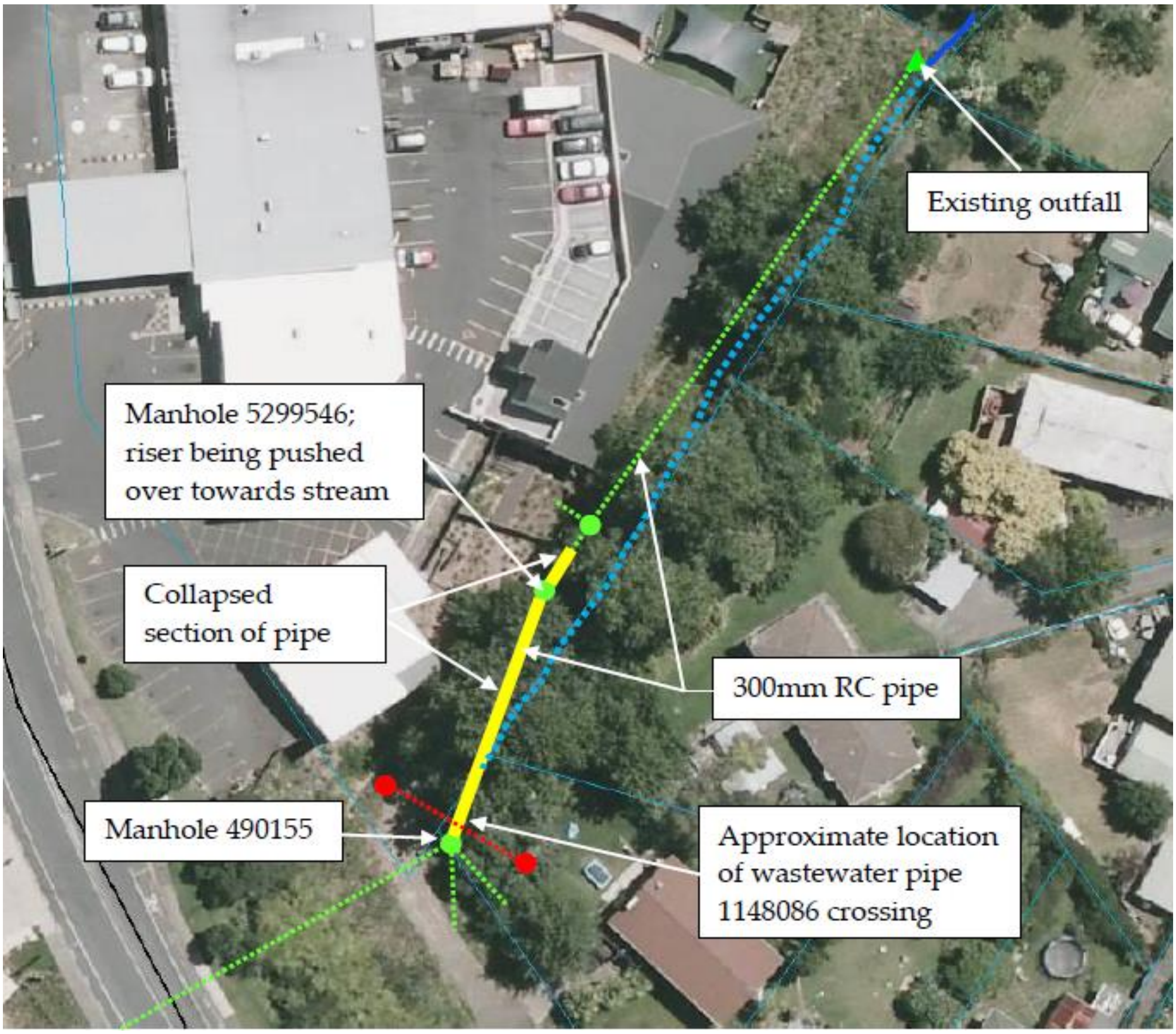

Figure 5: Triangle Rd pipe collapse

Morphum undertook a hydraulic analysis before a concept design and options assessment phase, and subsequently detailed design. Council, private landowners, and Morphum agreed on a concept design which included abandoning the old network, and diverting all flows into the existing channel. The collapsed pipe was causing an upstream manhole lid to surcharge and flow into the existing channel, meaning that nearby residents were aware of both the issue and the location of the overland flow path. The existing channel had the capacity to convey the required flow, meaning that design objectives were simplified. Morphum consulted with all affected landowners in an effort to understand what they thought of the stream, their current interactions with the stream and what their desired upgrade would be. Morphum received a range of responses, including wanting access to the channel, wanting to cross the channel, concern about the safety of introducing rocks and pooling water, and some who did not want to provide input to the project.

Morphum's recommended option to upgrade the existing channel downstream of the existing wastewater line crossing the pipe (Figure 6), by installing three Newbury rock riffles in the 100 m section and stabilising the toe of the banks (Figure 7), was accepted by Auckland Council and progressed to detailed design. Riffles were used to create habitat diversity and provide velocity control to prevent erosion. Pooling areas were limited to a depth a 300 mm for safety and surrounded by dense riparian vegetation to deter children entering the water. Dense vegetation in conjunction with a fence was used to reduce the falling hazard from a steep property adjacent.

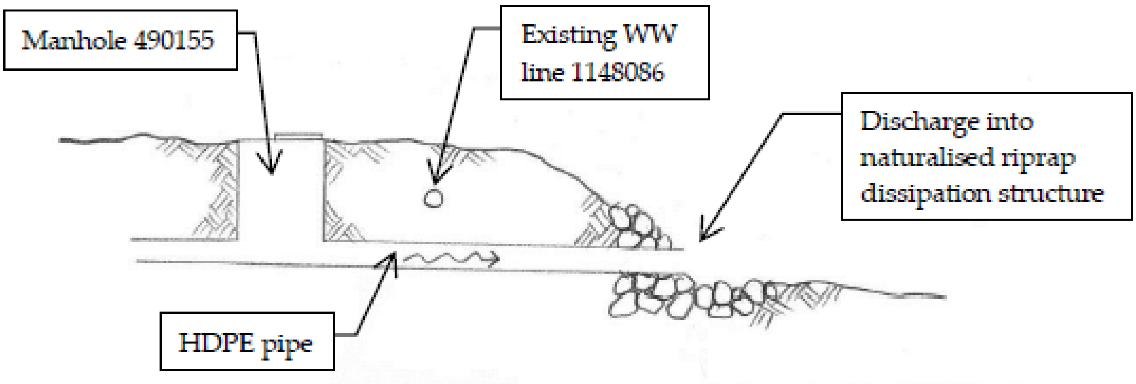

Figure 6: Recommended option to daylight the piped section downstream of the wastewater pipe crossing

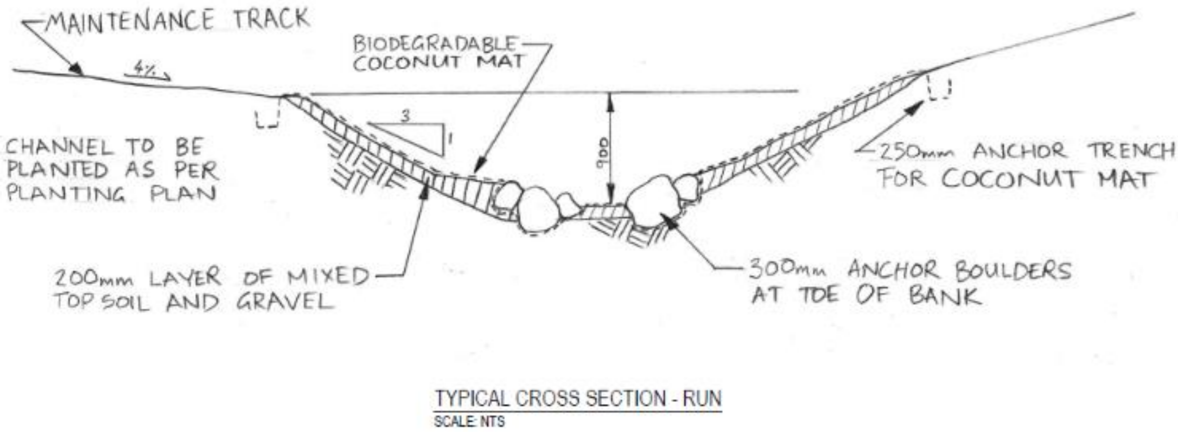

Figure 7: Typical run cross-section

The project has enabled council to abandon a number of undersized assets and upgrade a channel at a lower cost than a dig up repair on the collapsed network. Key design drivers included hydraulic efficiency, low maintenance as private landowners will own the asset, health and safety in design due to channel proximity to residential housing and play centre, reducing risk of erosion, and improved habitat.

3 CONCLUSIONS

Water sensitive design aspires to ensure multiple public benefits from stormwater management and to develop a unique 'sense of place' for our communities. It also seeks to deliver low risk and better return on investment for land developers. However, while it may provide multiple benefits at a range of scales, the challenge in targeting multi-functional outcomes is that often a project or funding organisation will have a single driving objective, which is not enhanced by the full suite of benefits offered by a systems approach. It is important for a project engineer to have a framework to manage project complexity and to drive the process of finding the best solutions. An appropriate decision support framework can help to communicate the various objectives that represent this complex set of systems, and make any trade-offs more transparent.

A range of case studies were presented to provide examples for four approach frameworks: Stream Ecological Valuation (SEV), the Mauri Model, Watercourse Management Planning Restoration Opportunities, and innovation in Network Remediation Opportunities. Detailing restoration outcomes in terms of SEV scores helps communicate and quantify the potential benefit of a project with regard to ecological value. This tool may be most appropriate when the natural environment values are of highest priority and the site is suitable for development contributions in terms of land ownership and intent. The Mauri Model uses 'mauri' as the measure for sustainability and integrates qualitative and iwi values into the decision making process. It is equally applicable to indigenous communities, non-indigenous groups, and communities. The Mauri model comes into its own when strong stakeholder concern is present and a social and cultural engagement is desired for the project. A Watercourse Assessment informs effective management of stream ecological health; stormwater infrastructure; and stormwater conveyance, provides a valuable tool to identify restoration opportunities, and can highlight the varied stakeholders to a project. Network remediation activities can reveal opportunities for environmental, amenity, and ecological outcomes that lead to non-standard solutions to routine maintenance activities for added value.

These various approaches can help manage project complexity and drive a solutions based approach but ultimately transparency in the design process is paramount. Designers must communicate to relevant stakeholders the reasons behind decisions made and how these decisions impact the final outcome to appropriately manage expectations. While compromise is often inevitable with competing drivers, greater integration and meaningful outcomes can be achieved.

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All views presented herein are those of the authors and do not represent the views of Auckland Council, Ngāti Whātua Ōrākei Reserves Board, or Ngāti Whātua Ōrākei Whai Maia Ltd.

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