Soft Engineering Solutions for Hard Engineering Problems

Developing designs that protect public and private assets while improving damaged ecosystems and promoting stewardship of streams and wetlands and oceans.

A river is the report card for its watershed. —
Alan Levere –Hydrologist

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THE UNTENABLE RELATIONSHIP

Auckland is a city intertwined with natural waters & undergoing enormous growth

- Creeks – serve as part of the drainage network and often public infrastructure is installed along the same gullies
- Freshwater wetlands – mostly gone as land is too valuable to retain this disappearing habitat.
- Saltwater wetlands – cutoff by roads, filled in as landfill areas, globally under attack since the 1930’s.

TYPICAL AUCKLAND URBAN STREAM

Kauri Lands Area

Auckland urban creeks are short with many having a total length of less than 3 km.

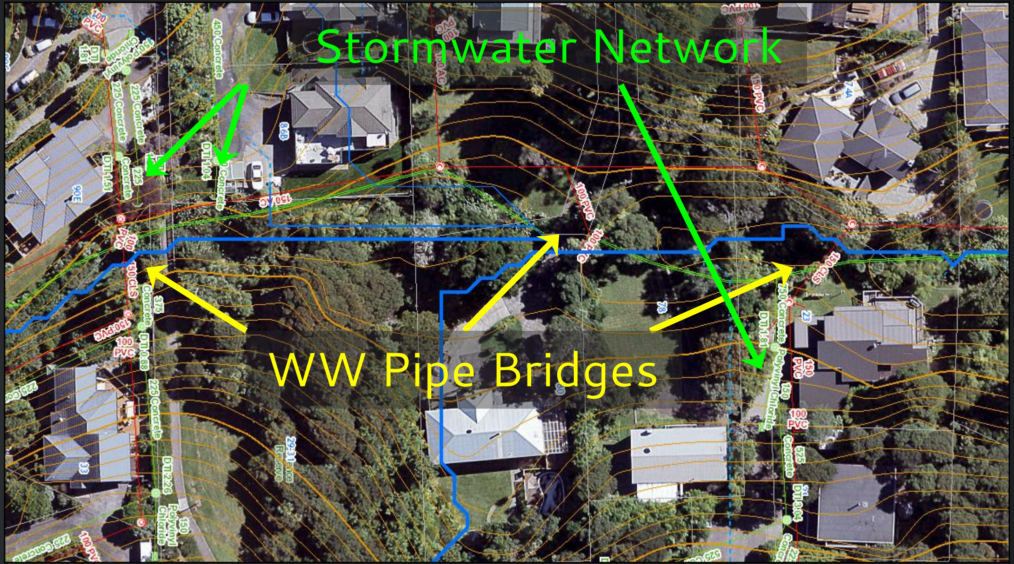
The upper catchments are steep.

Many creeks border private property with little or no riparian margins

Infill development in the contributing catchment has increased peak flows resulting in bank erosion.

Pipe bridges collapse resulting untreated wastewater entering the waterways.

The financial and environmental costs are significant.



TYPICAL AUCKLAND URBAN STREAM

Intense weather systems during 2017 resulted in an unprecedented number of public infrastructure failures.

Untreated sewage wound up on beaches from Milford to Howick due to pipes failing along the urban creeks.

In some cases sewage flowed for days while temporary repairs were made.

URBANISED STREAMS

DECREASE IN STREAM BIODIVERSITY

INCREASED FREQUENCY & MAGNITUDE OF FLOODING

GREATER THAN 10% IMPERMEABLE

EXCESSIVE BANK EROSION

LOSS OF RIPARIAN VEGETATION

GREATER THERMAL LOADING

GREATER CONTAMINATE LOADING

WETLANDS OVER TIME

Death by 1000 cuts

1940

1954

2015

WHY REHABILITATE COASTAL WETLANDS

- The estuarine environment provides significant flood storage & wave buffering during storm events.
- New Zealand's threated fish species rely on the connectivity of estuaries to upland waters for migration as most of our native species spend some of their life cycle at sea.
- Compromised tidal exchange allows an opportunity for pest species to replace native species having a direct and detrimental effect on the fish and bird populations.
- Where rehabilitation of estuaries has successfully mimicked the natural systems and tidal exchange has been restored a healthy marsh environment developed in just over a decade.

Giant kokopu (NIWA)

VANISHED WETLANDS

REDUCED FLOOD STORAGE

INCREASED CONTAMINATES ENTERING THE MARINE ENVIRONMENT

INCREASED PEST SPECIES

LOSS OF NATIVE BIRD & FISH POPULATIONS

LOSS OF CONNECTIVITY BETWEEN THE UPLAND WATERSHED AND THE MARINE ENVIRONMENT

GREATER FREQUENCY & MAGNITUDE OF FLOODING

DESIGN METHODOLOGY

ANALYSIS

Opportunities

- Create Habitat
- Improve Stormwater Quality
- Re-establish Wetland Ecology
- Improve Public Stewardship

Driving Factors

- Floods
- Erosion
- Landslips
- Loss of Infrastructure Services
  - Wastewater
  - Water Supply
  - Roads
- Environmental Degradation

Controlling Factors

- Site Access
- Land Availability
- Channel Morphology

Obstacles

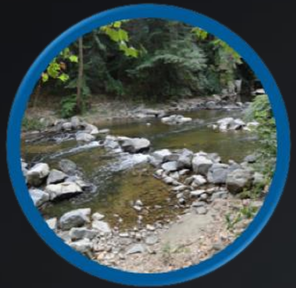
- Costs
- Public Perception

Desired Outcomes

- Protect Infrastructure
- Control Flooding
- Stop Erosion
- Protect Private Property

SOFT SOLUTIONS

Bank stabilisation and waterway enhancement

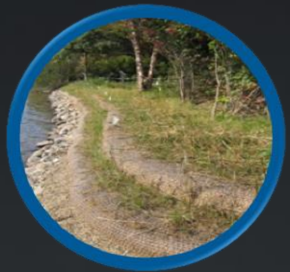


Cross Vanes & 'J' Vanes

- Directs flows away from the banks
- Provides small stilling basins

Root Wads Composites

- Directs flows away from the banks
- Increases hydraulic roughness
- Well suited to clay soils



Stone Toe & Bank Planting

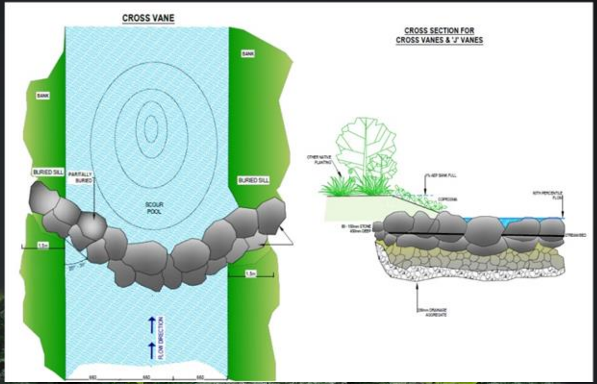
- Prevents bank undercutting
- Prevents channel migration
- Restores riparian vegetation

Rock Spalls

- Slows flows in streams
- Reduces down cutting
- Provides fish passage in engineered channels

CROSS VANES

- Embedded into the bank at least 1.5 m
- Embedded into the stream bed using aggregate or gravel
- Points upstream and forms a weir with daily average flows overtopping a small section in the center of the vane
- Inhibits erosion & undercutting in high flow events
- In series cross vanes can alleviate down cutting
- The areas near the bank upstream of the cross vane and the scour pool provide habitat



‘J’ VANES

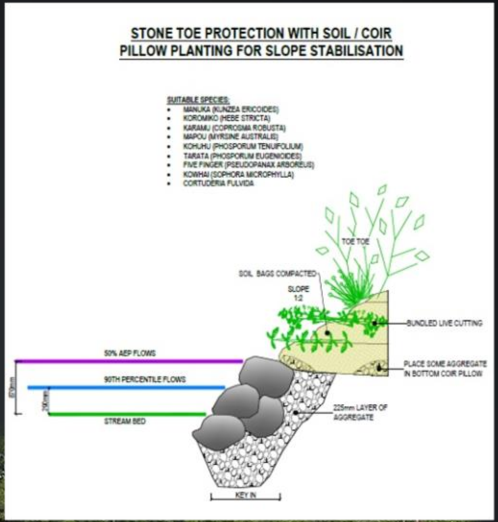
- Constructed in an area of active erosion (i.e. at the point of maximum curvature of a meander in the stream).
- Points upstream at an angle of between 26° to 30° in relation to the bank.
- Deepened pool is created downstream creating a stilling basin and habitat.
- Promotes sedimentation in the upstream area which can provide a substrate for riparian vegetation.

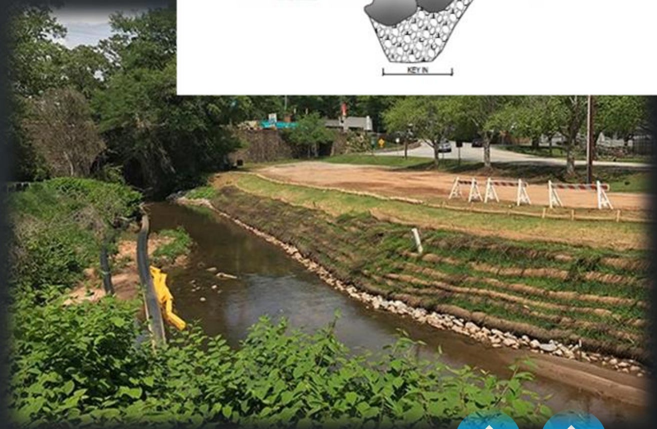
ROOT WAD COMPOSITES

- Have numerous ecological benefits, creating a variety of habitats.
- Promotes localised sediment deposition around the structure allowing riparian vegetation to take hold.
- Accumulate other woody debris inhibiting future channel migration through back water effects.
- At the end of the design life the bank remains stable as it has allowed riparian vegetation to mature.

STONE TOE PROTECTION & BANK PLANTING

- Easiest soft solution to install.
- Rocks are placed along the banks up to the 2 year flood level.
- Rocks are keyed into the river bed and underlain by gravel to prevent scour.
- Prevents stream migration.
- Combine with native planting above the 2 year flood level for ecological benefits.
- Revegetation of slopes can occur at a steep gradient using layers of seeded soil wrapped in biodegradable fabrics.
- Water tolerant shrubs and grasses are laid between each soil pillow.





ROCK SPALLS & RILLS

- Installed in creek beds to provide turbulence and slow flows.
- Inhibits downs cutting & tidal scour.
- Provides for fish passage in engineered channels reconnecting upland streams to estuaries.
- Provides habitat for a myriad of organisms in both freshwater & saltwater environments.
- Inexpensive and easy to install.

PROJECTS – BANK STABILISATION

Luplau Crescent, Howick – Driving Factors

The catchment is at or near maximum impermeability with stormwater outlets discharging into the stream.

A wastewater asset is located adjacent to the natural stream.

Stream erosion is causing both sides of the stream to become unstable.

A large slip at on 3rd March, 2017 resulted in the failure of a wastewater pipe (Barnes, 2017).

Other pipes within the reach are similarly at risk and as such stabilisation of the stream banks was required.

CONTROLLING FACTORS

- Access is limited.
- No riparian margin.
- Wastewater pipe is shallow.
- Gully is steep sided & highly erodible.

DESIRED OUTCOMES & OBSTACLES

- Develop long term protection of at risk infrastructure
- Protect private property
- Reverse the erosion caused by recent storms
- Preserve or enhance the ecosystem

- Limited access for construction (only one restricted access way through private property exists)
- Lack of understanding around soft engineering
- Lack of supporting data for soft engineering solutions

OPPORTUNITIES

- Restore or enhance the riparian margin.
- Create instream habitat for fish passage and eel migration.
- Remove pest species.
- Change public perception from viewing the creek as a liability to viewing it as an asset.

PROJECTS – FLOOD ALLEVIATION

Tawaipareira Creek & Wetland – Driving Factors

- The lower Tawaipareira Creek, was a tidally influenced estuary prior to the construction of the Ostend Road causeway in 1917.
- Approximately 2.2 ha of the upper estuary has been used as a landfill since 1917.
- Ongoing filling has raised the ground level 2–3 m and created a dam.
- Stormwater flows are obstructed with the estuary cut off from the nearshore marine environment.
- The dam results in frequent and severe flooding of the industrial properties surrounding the wetland.
- The ecological costs are significant.

CONTROLLING FACTORS

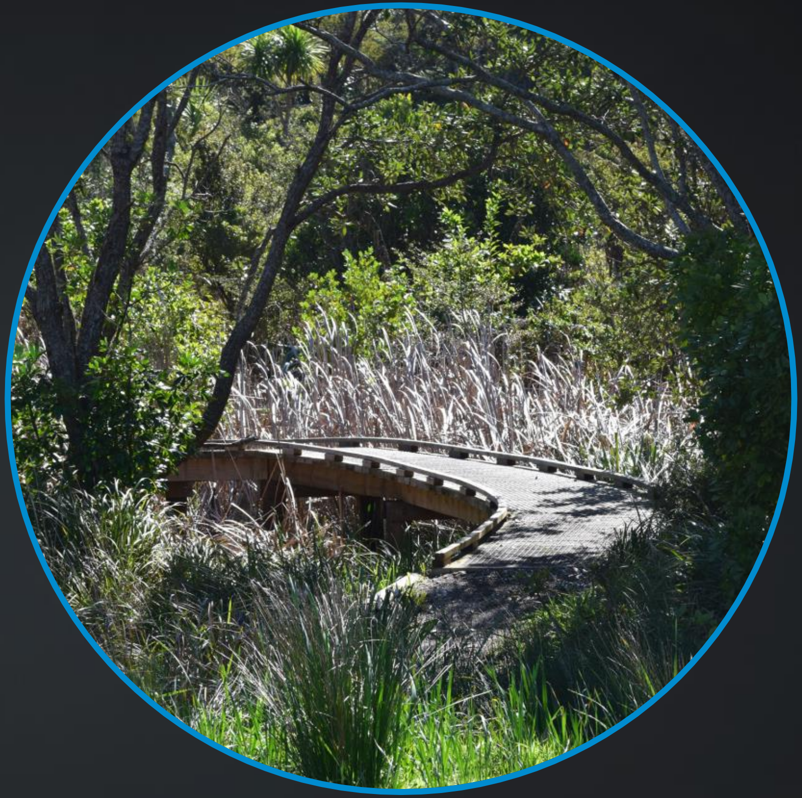
- Road levels.
- Requires excavation of a closed landfill site.
- Leachate under pressure (possibly).
- Requires renewal of tidal channel in the near shore SEA.
- Costs

DESIRED OUTCOMES & OBSTACLES

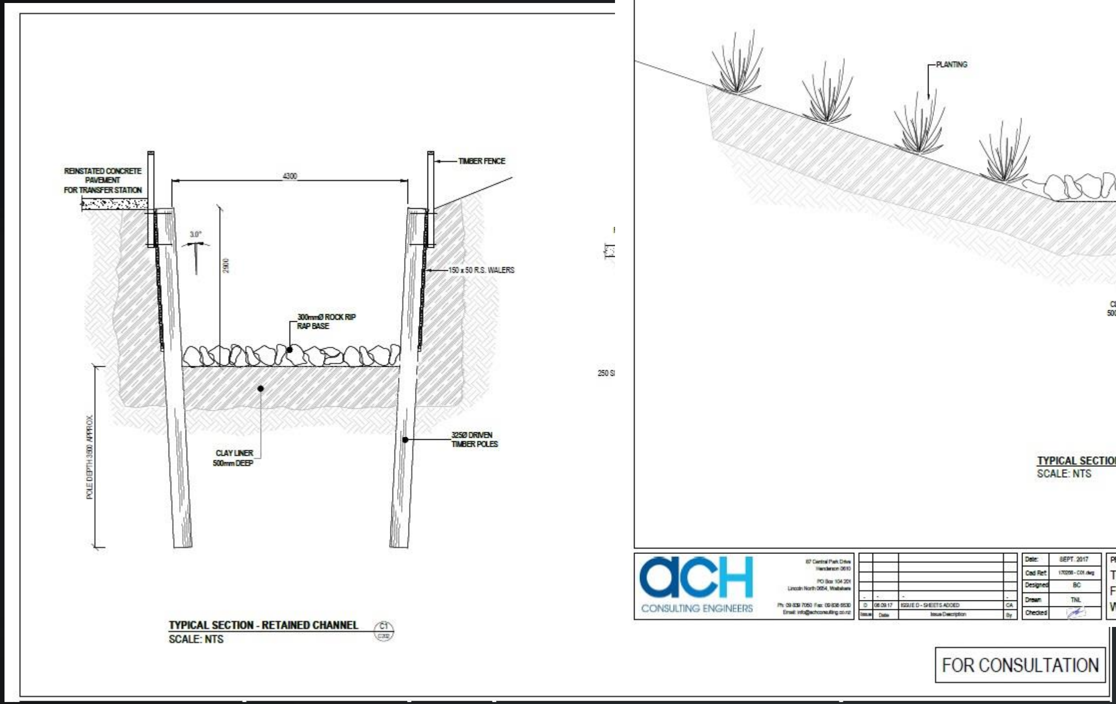
- Alleviate flooding in the lower catchment
- Requires digging a channel through the transfer station
- Disposal of contaminated fill
- Myriad of consents required

OPPORTUNITIES

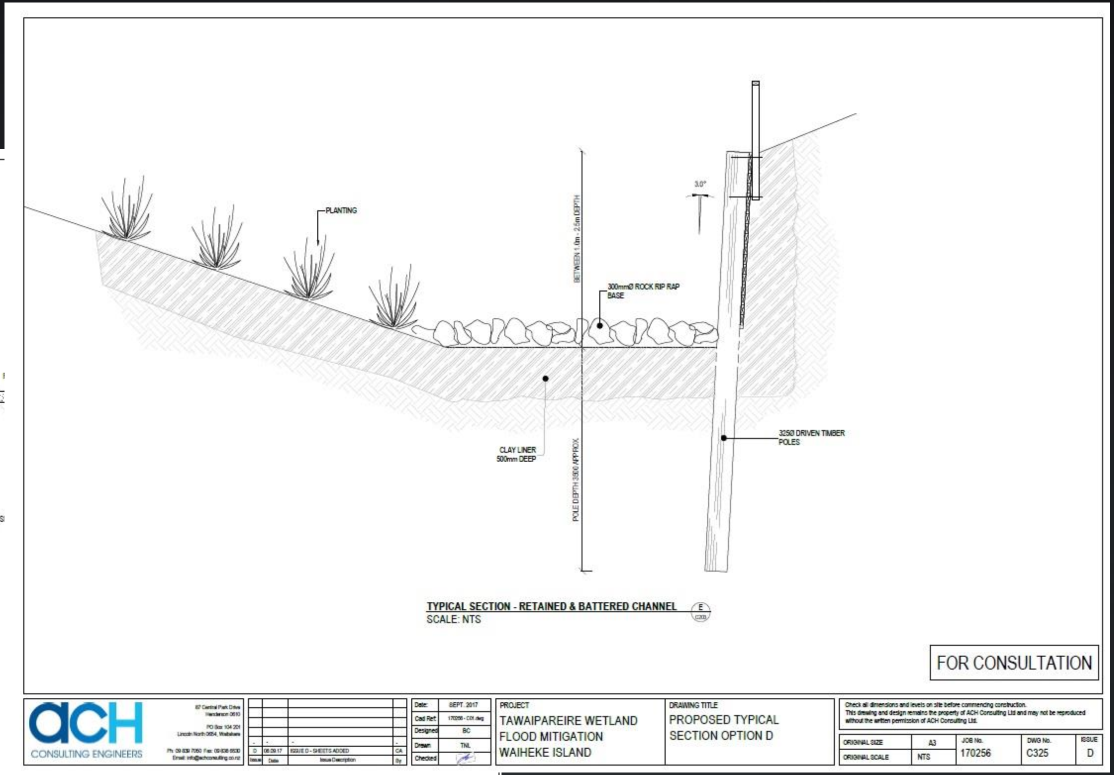
- Reduce the amount of sediment reaching the reserve.
- Include wetland rehabilitation to create better ecological outcomes.
- Promote native vegetation and remove pest species in the reserve.
- Achieve social benefits by creating a water sensitive green space.




NOTES:
1. COORDINATES ARE IN TERMS OF MT EDEN 2000.
2. LEVELS ARE IN TERMS OF LANDS & SURVEY DATUM 1946 (MSL).
3. CONTOURS ARE SHOWN AT INTERVALS OF 500mm
4. CONTOURS / SERVICES SOURCED FROM AUCKLAND COUNCIL GIS / SURVEY
N
OSTEND ROAD
OPTION C1 - SIMILAR RETAINED OPEN CHANNEL
OPTION D PLANTED BATTER SLOPE
OPTION D 2 / 2.0m x 1.5m DEEP BOX CULVERTS UNDER ROAD
OPTION D RETAINED OPEN CHANNEL
#104
#106
#112
#116
#2
#4-6
#8
#10
#14
#16
#18
#20
GYM
FOR CONSULTATION
0 5 10 15 20 25 30 35m
Scale: 1:750



REINSTATED CONCRETE PAVEMENT FOR TRANSFER STATION
4300
TIMBER FENCE
3.0°
2900
150 x 50 R.S. WALERS
300mmØ ROCK RIP RAP BASE
CLAY LINER 500mm DEEP
325Ø DRIVEN TIMBER POLES
POLE DEPTH 3500 APPROX
TYPICAL SECTION - RETAINED CHANNEL
SCALE: NTS
FOR CONSULTATION



PLANTING
3.0°
BETWEEN 1.0m - 2.5m DEPTH
300mmØ ROCK RIP RAP BASE
CLAY LINER 500mm DEEP
POLE DEPTH 3500 APPROX
325Ø DRIVEN TIMBER POLES
TYPICAL SECTION - RETAINED & BATTERED CHANNEL
SCALE: NTS
FOR CONSULTATION
ACH
CONSULTING ENGINEERS
D 08.09.17 ISSUE D - SHEETS ADDED CA
Date: SEPT. 2017
Designed BC
Drawn TNL
PROJECT
TAWAIPAREIRE WETLAND
FLOOD MITIGATION
WAIHEKE ISLAND
DRAWING TITLE
PROPOSED TYPICAL
SECTION OPTION D
Check all dimensions and levels on site before commencing construction.
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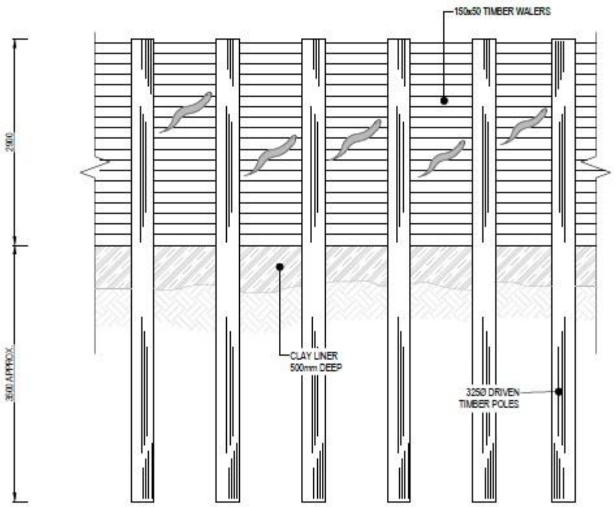
ORIGINAL SIZE A3
ORIGINAL SCALE NTS
JOB No. 170256
DWG No. C325
ISSUE D



PROPOSED RETAINING WALL DESIGN
SCALE: NTS

DRAINAGE CHANNEL BASE

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Issue	Date	Issue Description	By
B	27.07.17	AMEND CHANNEL BASE	TNL
D	08.09.17	ISSUE D - SHEETS ADDED	CA

Date:	SEPT. 2017
Cad Ref:	170256 - C01.dwg
Designed	BC
Drawn	TNL
Checked	

PROJECT
TAWAIPAREIRE WETLAND
FLOOD MITIGATION
WAIHEKE ISLAND

DRAWING TITLE
RETAINING WALL ELEVATION
& DRAINAGE CHANNEL BASE

ORIGINAL SIZE	A3	JOB No.	DWG No.	ISSUE
ORIGINAL SCALE	NTS	170256	C324	D

CONCLUSIONS

The ecological consequence of the degradation of urban waters presents imminent risk to public infrastructure as climate change brings storms with greater frequency and intensity.

Without coastal wetlands there is neither flood storage nor wave dampening.

The ecological costs have also been significant with 31 of our 40 native freshwater fish species on the threatened list.

Soft solutions offer up an opportunity to arrest erosion and stabilise stream banks.

The restoration of tidal exchange and connectivity of the wetland to the foreshore will allow for flood waters to drain efficiently from the catchments during high flow events.

No single engineering solution should be applied in isolation but a combination, similar to the treatment train approach for stormwater.

ACKNOWLEDGEMENTS

Auckland is a city interwoven with natural waters and greater stewardship of our natural waters will provide better outcomes

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