A NEW APPROACH TO STREAM RESTORATION TRIALED IN NORTH SHORE

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ABSTRACT

This paper case studies a new approach to designing and implementing an urban stream restoration and enhancement project that is currently underway in North Shore City.

Stage 1 of the Lucas Creek stream restoration project is an innovative project that covers 1km of natural stream running through council reserve in the centre of Albany. The project is required to provide multiple benefits to the community such as: enhanced riparian ecology, water quality and increased amenity. It involves stream bank erosion mitigation, planting of 30,000 native riparian plants, building a walking track and viewing platforms.

This project was identified as a result of developing the Storm Water Catchment Management Plan. Numerous concept designs and hard engineering solutions were proposed however none of these were considered appropriate.

The new approach is based on a "design as we go" concept. The exact solution used at a particular location is decided as the project progresses and the banks and erosion are exposed. We are using new soft engineering solutions throughout the project, many of which have not been used in NZ before.

This is an integrated project between North Shore City Council (Water Services, Parks,) and the Auckland Regional Council. We are also using a specialist from the USA who has been successfully using these methods for the last 10 years to assist us in this project.

KEYWORDS

Stream restoration, soft engineering, erosion control, riparian management.

1 INTRODUCTION

This paper case studies a new approach to urban stream restoration which is currently underway in the Lucas Creek catchment on the North Shore. The project trials a number of uncommon approaches to design, construction and project management including:

- Using a more flexible "design as we go" approach to the detailed design by choosing solutions which best suite the situation on site from a toolbox of innovative soft engineering techniques;
- Employing an experienced international consultant for a short period at the beginning of the project to train the contractor on site in the construction of the different soft engineering techniques;
- Managing the contract on a "Time & Cost" basis so that the client accepts more of the risk associated with the "design as we go" approach and the use of unfamiliar techniques;
- Trialling different methods of sediment control when working in or close to a watercourse. This required a close working relationship with the ARC;
- Involving landscape architects and ecologists to design the planting on site once the initial earthworks and bank stabilisation had been completed; and
- Using an environmentally trained project manager to manage the contract.

2 BACKGROUND

The Lucas Creek stream restoration project is located on a 2km reach of the main stem of the Lucas Creek (Waikahikatea Stream) where it passes through the Hooton Reserve adjacent to the new central business area in Albany on the North Shore. This project forms part of a long term vision for a walkway/green link stretching the whole length of the Lucas Creek catchment and then over into the adjacent Long Bay catchment, ultimately linking Albany village with Long Bay.

The Lucas Creek catchment in Albany (refer Figure 1) is the fastest growing area in North Shore City. The size of the catchment is 626ha with 16.3km of stream. Lucas Creek (Waikahikatea Stream) runs from East to West and discharges into a low energy upper harbour estuarine environment which is currently filling up with sediment. The catchment also contains some of the few remaining Greenfield areas in the city with approximately 50% of the catchment area yet to be developed.

Significant development has occurred since 1997, including large business areas and high density residential development. The remaining land and open space in this catchment is under considerable pressure to intensify.

Increased stormwater runoff as a result of recent urban development has caused the channel to erode and widen to adjust to the changing flow regime. Currently during a 2 year storm flows in the order of 22m^3/s can be expected at the site, increasing to around 50m^3/s in a 10 year event. Figure 2 shows the severe bank erosion in the main channel running through Hooton Reserve. Figure 3 shows the how bank erosion gets covered up with invasive weeds

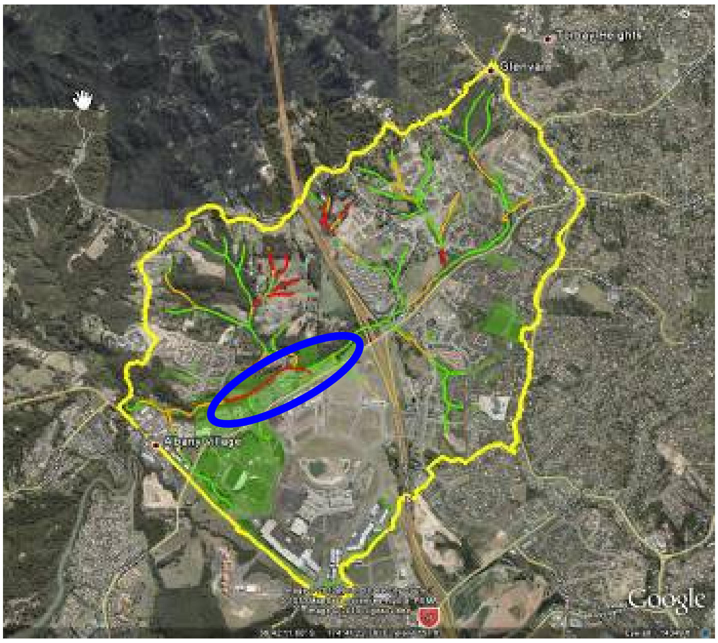

Figure 1: Location of the project within the Lucas Creek catchment

Figure 2: Stream bank erosion

Figure 3: Invasive weed infestation

The Catchment Management Plan (CMP) identified the need to stabilise the true left bank (southern bank) of the Lucas Creek which was slumping from severe bank erosion. The erosion is a result of increased flows caused by urbanization within the catchment. It also identified an opportunity to restore and enhance this section of stream and integrate this work with enhanced amenity and public access.

The project location presents a fairly unique opportunity because the stream runs from East to West across the site which is protected by esplanade and council reserves. The Northern bank is relatively steep, undeveloped and inaccessible, covered with remnant native riparian vegetation and has very few erosion issues. The southern bank which is highly eroded is entirely on council reserve which is relatively flat and easily accessible. The vegetation on the Southern bank is predominately made up of weed species with occasional stands of native trees.

The restoration design allows people on the stream bank to walk, see and connect with the stream while not screening magnificent views of the mature native bush escarpment on the true right hand side of the stream bank. By providing access and improving amenity values along the stream we creating an environment that people will value, and relying on the concept that if people value something they will look after it.

3 THE PROJECT

The Lucas Creek stream restoration project finally started in January 2010 after years of planning and a number of different design approaches. The designs which started as conventional hard engineering solutions to be constructed using conventional construction practices had been transformed into a more flexible design approach using toolbox of innovative soft engineering techniques and a project run on a time and cost basis.

The project was divided up into a number of stages to reduce the risk and also fit in with the different seasons.

- Stage 1: Stream bank protection works involving reshaping and the restoration of 1200m of stream bank running through Hooton Reserve and had to be carried out during the earthworks season (completed);
- Stage 2: The building of a cycle/walkway boardwalks through the entire reserve as well as a pedestrian riparian walkway (currently underway).

- Stage 3: Planting of over 30,000 eco sourced native riparian plants scheduled to be carried out during the planting season between June and August 2010;
- Stage 4: Stream bank protection and reshaping of a further 800m of stream bank immediately downstream of stage 1 planned to commence next earthworks season
- Stage 5: Planting of the lower section of the project planned for the following planting season.

4 THE APPROACH

A number of components of this project were new to North Shore City Council staff and many had not been extensively used in New Zealand before. As a result there was a large degree of uncertainty associated with this project. If this risk were to be passed on to a contractor or carried by consultants, it would have increased the project cost considerably. NSCC therefore decided to trial a new approach for running this project in which much of the risk was carried by the council. The following fairly unique approach was adopted:

1. Flexible construction plans (design as we go approach)
2. Training of the contractor
3. Tool box of 'Soft Engineering techniques'
4. Trialling a different methodology for working in and around the watercourse
5. Contract management using a "Time and Cost" contract. (partnership with council & contractor)
6. On-site design of planting area

4.1 FLEXIBLE CONSTRUCTION PLANS

Originally the project was designed by consulting engineers using more traditional harder engineers solutions predominantly gabion baskets. It had costly detailed design plans for every metre of the works. This approach did not meet our objective of using environmentally friendly soft engineering solutions to the stream bank stability problems faced in the Lucas Creek. We therefore selected a more flexible "design as we go" approach to the detailed design by choosing solutions which best suited each unique situation on site from a toolbox of soft engineering techniques. Each of these techniques had a typical design (in the tool box) and was adapted to fit the location on site. We also had a basic plan of where they would be implemented throughout the stream. This formed the rough plan that we worked to. It was only when the digger had opened up a section of bank that we new exactly what the earth conditions were like and which technique we would use.

4.2 TRAINING OF THE CONTRACTOR

Many of the soft engineering techniques had not been extensively used in New Zealand and most contractors were unfamiliar with them. We therefore employed an experienced international consultant for a short period at the beginning of the project to train the contractor on site in the construction of the different techniques. The consultant who had extensive experience in constructing these soft engineering techniques was on site full time for two weeks and helped build, design and train the contractor, consultant and council staff.

4.3 SOFT ENGINEERING TECHNIQUES TOOL BOX

The range of soft engineering techniques used were:

- Stream Widening and Upper Bank Reshaping
- Newbury rock riffles
- Rock Vanes
- Lunkers
- Living Walls and Root Wads

4.3.1 STREAM WIDENING AND UPPER BANK RESHAPING

Throughout the entire reach we effectively double the wetted stream width. Development has increased impervious areas within the catchment resulting from increased peak flows. The channel in response has been undercutting causing severe erosion on the true left bank.

By flattening or reshaping the bank stabilizes the eroding stream bank by reducing the slope angle or gradient. The water velocity reduces by spreading the flow over a greater area. Once the channel has been widened pre-washed gap 20 gravel is spread over the exposed area as a form of sediment control. Over time some of this will eventually get washed away as the stream widens. The figures 4 to 7 show what the bank looked like before and after the reshaping. Figure 8 shows the constructed increase in stream width and profile of original bank. In July 2010 the area will be planted with appropriate native riparian vegetation.

Figure 4: Before work

Figure 5: After

Figure 6: Before

Figure 7:After

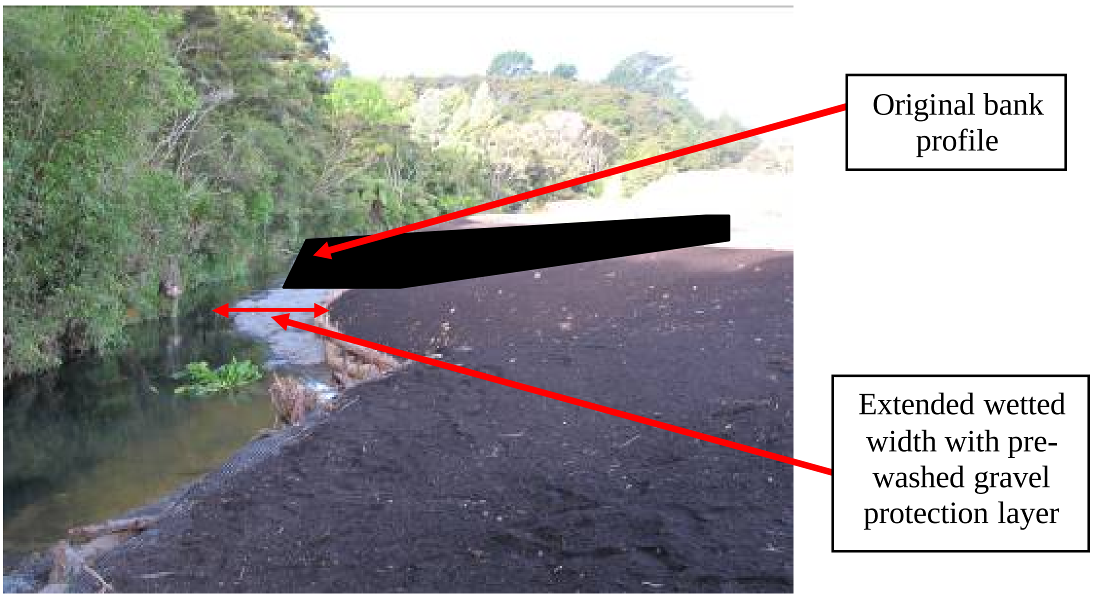

Figure 8: Widened stream section

4.3.2 NEWBURY ROCK RIFFLES

Newbury rock riffles are ramps with long aprons made from small rocks that are constructed at intervals along the channel approaching natural riffle spacing (5 to 7 channel widths). The riffles ranged from 10 to 15m in length. The structures are built by placing washed clean rock within the existing channel. Rock riffles are an environmentally-sensitive grade control structure that is used to ensure that future incision of Lucas Creek will be arrested. These structures also provide pool and riffle habitat, and are visual diversity in otherwise soft clay bottom sub-straight. These structures were placed in the long more uniform sections of the stream to reduce the undercutting. Larger boulders were placed on the down stream end to anchor the structure in place. Figure 9 shows a completed riffle.

Figure 9: Newbury rock riffle

4.3.3 ROCK VANES

Rock vanes are flow redirecting structures angled upstream at 20 to 30 degrees. The purpose of the structure is to redirect flows from the bank to the centre of the channel reducing bank erosion. Rock vanes can reduce the need for harder engineering options. Only one of these structures was constructed in this project situated just upstream of a vehicle bridge to protect its foundations. Figures 10 to 13 illustrate how the rock vane was constructed.

Figure 10: Rock vane under construction

Looking downstream at the outer bend in Lucas Creek just before it flows under a bridge (on right). The contractor is preparing the keyway for a flow redirecting Rock Vane. Rock Vanes point upstream at a 30-degree angle and dip from a high water elevation down to the stream bed.

Figure 11: Rock vane under construction

Rock Vanes are best built of self-launching stone (poorly sorted, well graded) but placement of some big anchor stones is also recommended.

Figure 12: Placing rock

Figure 13: Rock vane completed

Next we placed the self-adjusting, self-launching stone. The average highwater here is expected to be as high as the excavator bucket. The area was then composted for stabilisation which will then be planted.

4.3.4 LUNKERS

Lunkers are woody structures constructed from interlocking tree material. These structures are intended to mitigate erosive flows and are used on the outer bank of a meander bend. The lunkers were constructed from mature Tee Tree which was removed from the stream bank reshaping. They also provide habitat within the stream bank. Two of the lunkers that were constructed as part of this project are shown in Figures 14 and 15.

Figure 14: Lunker

Figure 15: Lunker

4.3.5 LIVING WALLS & ROOT WADS

Filtrex Living walls are basically socks filled with compost running along the bank which is planted into for long term stability. Planting is expected to succeed these materials over time as the principle method of soil stability and cohesion. Living walls were used in the steeper sections of the bank, either where the rock substrate was too hard to widen the upper banks or where there was limited space. They were also used to protect protected trees in the riparian margin. Figures 16 to 18.

Figure 16: Rock toe under construction

Figure 16 shows the toe of the socks are constructed from poorly graded rock dug down 600mm by 600mm to protect the socks from being undercut from stream erosion.

Figure 17: Rock toe with root wads

Figure 17 shows the same bend with rock toe and wood incorporated. From this secure base construction of a "living wall" built from compost berms and geo-grid for a reinforced soil wall.

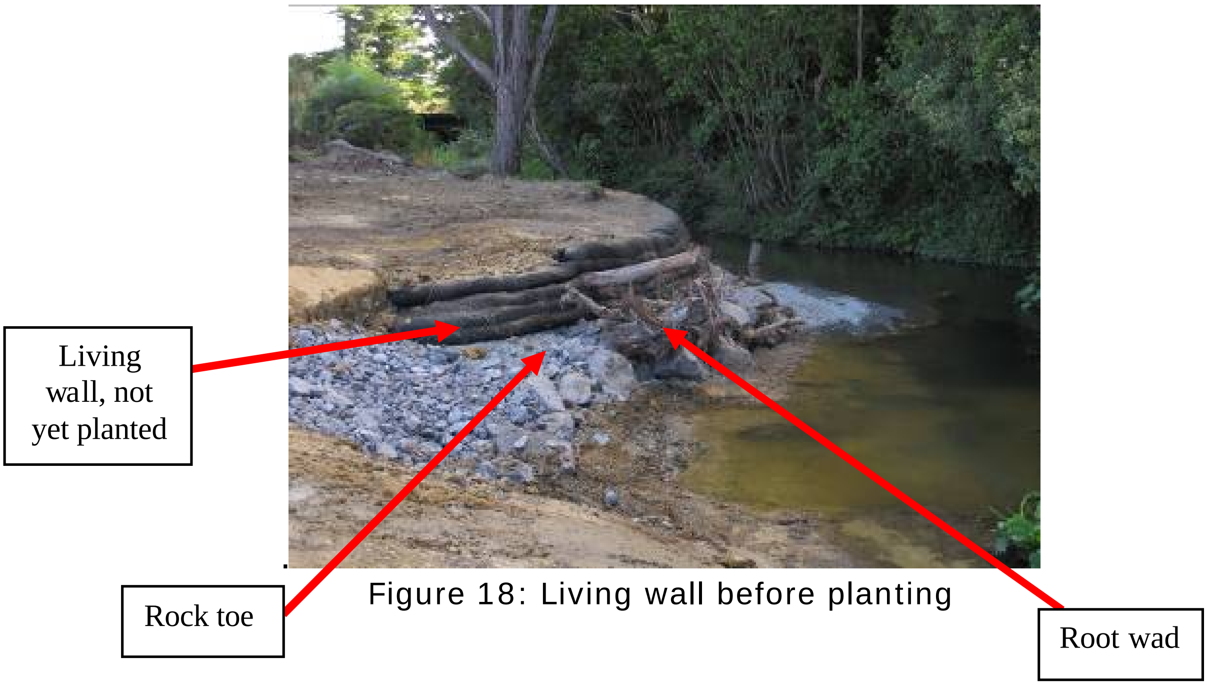

Figure 18: Living wall before planting

Figure 18 shows Root Wads which are tree roots with 3m to 5m section of trunk still attached that are pushed trunk first into the bank. They were used at the toe of the living walls to reduce the water velocity and provide in-stream habitat.

4.4 METHODOLOGY: FOR WORKING IN AND AROUND THE WATER COURSE

The traditional method of working in or around a water cause would be to temporarily dam the stream upstream and downstream of the work area and divert water around the work area. Any water between the two temporary dams would then be pumped out providing a relatively dry area in which to work. This would also require the trapping and translocation of eels, fish and other aquatic creatures. We initially tried this method on the first day of construction but found it to be unsatisfactory. (refer Figure 19). While it sounds reasonable, the overall effect was much more turbidity than wanted, for a longer period of time, and a badly degraded bottom (from walking on the soft clay substrate). Also the dam leaked causing more turbidity. It took the contractors a day to seal the dam as best they could. Secondly, laying the diversion pipes in an "incised stream" was also turbidity producing. Thirdly, when you pump water around site it ended up causing erosion or extremely turbid water downstream - an option would be to require a huge sediment pond. Finally, walking thru the stream to rescue eels and fish causes more damage to bottom and even more turbidity. On this occasion we removed 16 banded Kokopu, 55 kouri, 12 eels and 20 further unidentified identified fish from a single pool of 5m by 5m in area.

Figure 19: Damming and diverting

The new protocol and methodology was to "stay out of active stream, period". When we built structures on stream banks or stream bed, we used "clean" rock and wood. We minimized touching the active bottom with equipment. We constantly monitored the water quality and if a problem occurred we would stop, find out what happened, and re-evaluate.

Officers from the ARC assessed the new methodology onsite and were satisfied with this new approach, but monitored it very closely. This new approach to working in a water course allowed us to open up more than one 50m section at a time. This, along with not having to dam and divert the water course almost halved the construction time.

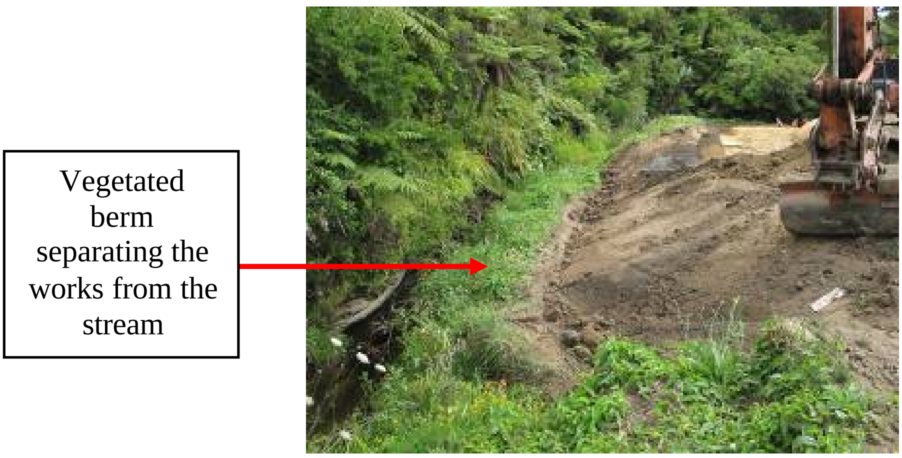

Figure 20: Vegetated berm

Figure 21:Berm removal

Figure 22:Working back from stream

The methodology consisted of the following main steps:

- The first step was to start excavating about a metre back from the bank so that a vegetated berm (called a bund) was left between the working area and the stream (refer Figure 20). This allowed the bulk of the earth works to be carried out without affecting the water course. Any runoff would be captured by this bund, preventing it from carrying sediment into the stream.
- The second step was to remove the bund. During this stage the digger operator carefully scrapped back the bund in stages, always creating a slope back away from the water so any clods or soil would fall away from the water. . Also note that the "back slope" of the bund is steep.
- Finally the banks were shaped right down to just above water level. Even at this stage we did not enter the water course as. (Figures 21 and 22).

This method could only be effective with a skilled digger driver who had a good eye for detail. Without this it could cause significant disturbance to the stream bed.

4.4.1 SEDIMENT CONTROL

Figure 23: Compost blanket

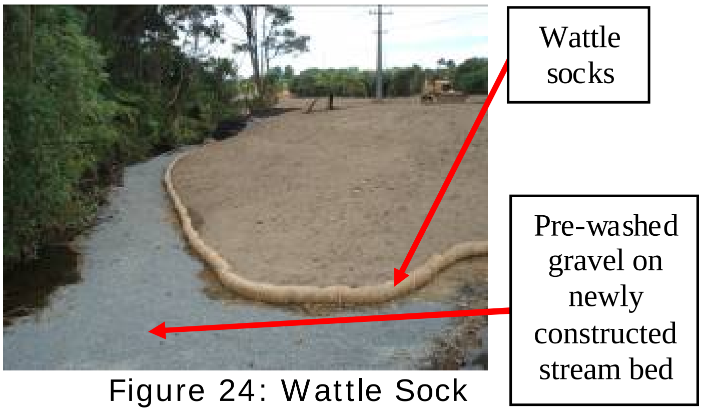

Figure 24: Wattle Sock

Another approach was the use of a compost blanket to secure the earth-worked site until the site is fully vegetated. Figure 23 shows the use of a compost blanket instead of a silt fence to secure this worked area. Overseas research suggests compost blankets catch rocks and clods and certainly sediment from sheet flows. Grasses and vegetation will establish through the blanket. The other advantage is reduced disturbance after project has been stabilised and no silt fence going to landfill/dump. Properly aged compost doesn't discharge N to waterways and is reasonably resistant to floating or being washed away during small to moderate rainfall events. This approach is however quite costly and was only used on one section of the project due to costs.

Wattle socks (Figure 24) were also used at the toe of the banks to capture any sediment from running into the stream. The bare soil was mulched with hay and hydro seeded to secure the banks until planting. The wattle socks were used where we would normally be required to install a silt fence. The advantage of the sock is that we can leave the socks in place and do not have to remove them as they will break down within a couple of years.

Another sediment control method used was the spreading of a layer of pre-washed gap 20 gravel on the newly constructed stream bed. Over time some of this gravel will get washed down stream. The use of prewashed gravel can clearly be seen in Figure 24.

4.5 CONTRACT MANAGEMENT

The contract was separated the contract into two components: scheduled rates and a time & cost component. This was done because the construction approach and the majority of the methods being used were unfamiliar to most contractors in New Zealand. Rather than the contractor carrying that risk, which would have been reflected in the tender price, the council decided to carry most of the risk by engaging the contractor on a time and cost basis. The two components were:

1. Scheduled rates for know items. The tenderers were required to price the 'tool box' of soft engineering techniques at the tender stage. These were priced on a metre rate.
2. Time and Cost: Plant, equipment and labour were priced on a hourly rate plus their mark up on costs.

It turned out the majority of the work was bulk earth works which was on a time a cost basis. For this to work there had to be a strong partnership and trust between the contractor Dempsey & Wood and the principle (North Shore Council). The advantage in this type of contract is that it did not require multiple variations to the contract as the work requirements changed from day to day. It also allowed the contractor to experiment with new methods of erosion control and erosion techniques without worrying about profit. With the risk taken away from the contractor it kept the price down. The disadvantages were that it was very time consuming for council. The council's project engineer needed to be onsite every day to make sure the site was running efficiently. There was also a grey area when separating the scheduled work from the time and cost.

4.6 ON-SITE DESIGN OF PLANTING AREA

The final stage of the project once the earth works and pedestrian path have been built is the planting. There are two objectives to the planting: Ecological and Amenity.

The ecological objectives are to provide as much uninterrupted shaded buffer of native riparian habitat as possible, while the amenity objectives are to provide a visually diverse interesting open riparian environment that allows the public to see and access the stream. This requires a balance of the two sometimes opposing objectives. To achieve this balance a landscape architect has been engaged to design the planting plan from an amenity perspective. This planting plan will then be reviewed by a landscape ecologist to make sure it provides the necessary ecological benefit. The riparian area will be planted according to the planting plan using predominantly eco-sourced plants by the community in June 2010.

5 LESSONS LEARNED

This project has been run as a trial project to enable better management of future stream restoration projects. The following are some of the lessons learned during this project to date:

- The contractor was initially very sceptical about the approach to sediment control and the use of sort engineering solutions for stream bank stabilisation. Over the duration of the contract the contractor has bought into the process as they have become more familiar with the concepts and confident in their implementation.

- This type of project requires a strong working partnership between client & contractor. This project has required considerable input from the client as numerous decisions which have had to be made on site and made quickly. Any delay can result in machinery standing with high cost implications for the project.

- The work in close proximity to the stream requires the use of very skilled machine operators as an unskilled operator can cause considerable damage. A skilled operator with a bit of artistic flair is able to shape the banks so that they look natural and while doing so have very little impact on the existing waterway.

- Improved access to the stream is a double edged sword. While it allows the community to appreciate the stream and value it, it also allowed children to catch and kill some of the eels, an unintended consequence.

- Members of the public are already taking ownership of the stream and over the weekends they removed a lot of rubbish which had been in the stream channel for some time.

- Relatively small pools can hold a significant amount of aquatic life as was established when the project first started and an attempt was made to dam and divert stream flows.

6 CONCLUSIONS

Undertaking a new approach to designing and implementing an urban stream restoration and enhancement project was not only achievable but highly beneficial. The project provided multiple benefits to the community such as: increased conveyance capacity and reduced flood levels; enhanced riparian ecology, improved water quality and increased amenity. It involved stream bank erosion mitigation, planting of native riparian plants, building a walking track and viewing platforms.

The new approaches that were covered in this project were:

- Flexible construction plans (using a toolbox of solutions)
- Training of the contractor
- Tool box of 'Soft Engineering techniques'
- Trialling a different methodology for working in and around the watercourse
- Contract management using a "Time and Cost" contract. (partnership with council & contractor)
- On-site design of planting area

There has been a steep learning curve for North Shore City Council, Auckland Regional Council and the contractors but so far the project has exceeded all expectations in costs, timing and most importantly the quality of the finished product. It also demonstrated the benefits of strong partnerships between council (principle) and contractor.

The project is currently still under way with the next stage, the riparian planting, about to start in June 2010 followed by continued earthworks in October 2010.

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Auckland Regional Council

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