STREAM DAYLIGHTING PROJECT LA ROSA GARDENS – FROM VISION TO REALITY

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ABSTRACT

La Rosa Reserve Stream Daylighting project involved the design, consenting, and construction of 200 meters of watercourse that had previously flowed underground in 1100-1350mm diameter pipes. The project was the first dedicated stream daylighting project in Auckland, and one of the mayor's 100 projects set up to make Auckland "the most liveable city in the world". The design and delivery of the project was undertaken in one year with the help of multiple stakeholders.

Calculated peak flows of 14m³/s were expected within an average stream channel slope of more than 2 percent through highly erodible clay. This demanded fail-safe measures to control erosion, while still delivering on the broader project objectives for landscape amenity, natural character, and enhanced ecology. Construction was also carried out through winter which created many potential issues during construction.

This paper documents the issues and challenges that were overcome in order to complete this project from concept design to physical works.

KEYWORDS

Stream daylighting, stream restoration, community engagement, flood mitigation, greenway linkages, open channel hydraulics.

PRESENTER PROFILE

Tom Mansell is senior Stormwater Project Engineer working for Auckland Council who specializes in stream restoration and soft engineering design and build.

Mark Lewis is a Principal Landscape Architect with Boffa Miskell in Auckland. He has been employed in the fields of water sensitive design, stream and wetland restoration ecology, catchment planning, and detailed design of stormwater management devices in New Zealand, China, and the United States.

1 INTRODUCTION

1.1 STREAM DAYLIGHTING

Stream daylighting is the practice of bringing buried streams to the surface in an effort to restore their natural systems and processes. Open watercourses offer multiple functions and benefits not provided by pipes, including providing for amenity values, community interaction and well-being, ecological habitat, stormwater treatment, and flood management.

As part of Mayor Len Brown's initiative to develop Auckland into "the most livable city in the World", 100 projects were proposed in 100 days. This included a specific project to

daylight a stream in Auckland. Consequently Auckland Council commissioned an investigation and assessment of 'Stream Daylighting' opportunities in the Auckland Region (Heijs and Young 2012; Young and Buchannan 2012).

A site in Greenbay at La Rosa Reserve was selected as the primary candidate as it occurred within an Auckland Council owned reserve that was seasonally boggy and required drainage works. The site was subject to occasional flooding, requiring the reconciliation of the network capacity (Heijs and Young 2012). The stream was also largely un-piped between this site and the confluence between the Avondale Stream and the Whau River, and then through to the Waitemata Harbour.

Because this was a priority project for the Mayor, the whole project, concept through detailed design and delivery, was undertaken within a single financial year (2012-2013). This work was carried out by Boffa Miskell Ltd (Project Landscape Architect), EDC Ltd (Project Engineer), and HEB Construction (Contractor), working with Richard Challis and Tom Mansell (Project Manager) of the Auckland Council Stormwater Unit. They worked closely with the Auckland Council's Parks Department, Arts & Culture, and the Sustainable Catchment Programme.

The project faced a number of challenges because it was Auckland Council's first dedicated stream daylighting project. In addition, the project team had an accelerated programme, requiring them to undertake streamwork construction during the winter works period. The lessons learnt from this project will prove useful for the ongoing delivery of other stream daylighting projects in Auckland, something that is likely, following the positive response to the La Rosa project since completion and opening to the public.

2 THE SITE

2.1 CONTEXT

The Avondale Stream is largely un-piped for the majority of its length from the Waitemata Harbour. The stream divides into the upper Avondale and Parahiku tributaries at La Rosa Reserve in Green Bay. La Rosa Reserve lies close to the headwaters of the Avondale Stream, and at the foot of the Waitakere Ranges. It has dedicated public access from La Rosa Street, off Godley Road and there is future potential pedestrian connections through Auckland Council land to the Green Bay shops. The project is also a short distance from the Portage Road cycle-way and the centre of New Lynn.

The open nature of the stream outside the site, and the existing riparian vegetation along its course, provides enhanced value as a stepping stone within an ecological corridor between the Waitemata, upper Manukau and Waitakere Ranges and in terms of the continuous existing aquatic habitat from the Whau Estuary to the forested headwaters of the Avondale Stream.

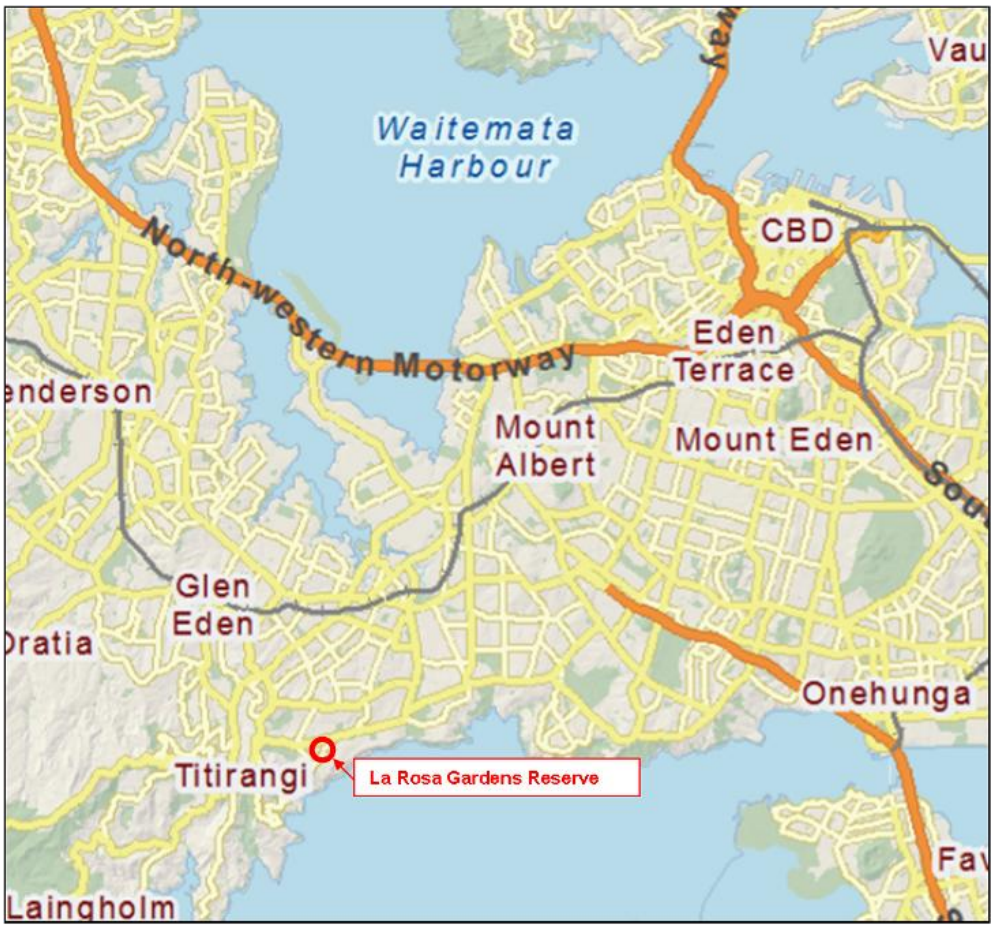

Figure 1: The location of La Rosa Reserve in Auckland

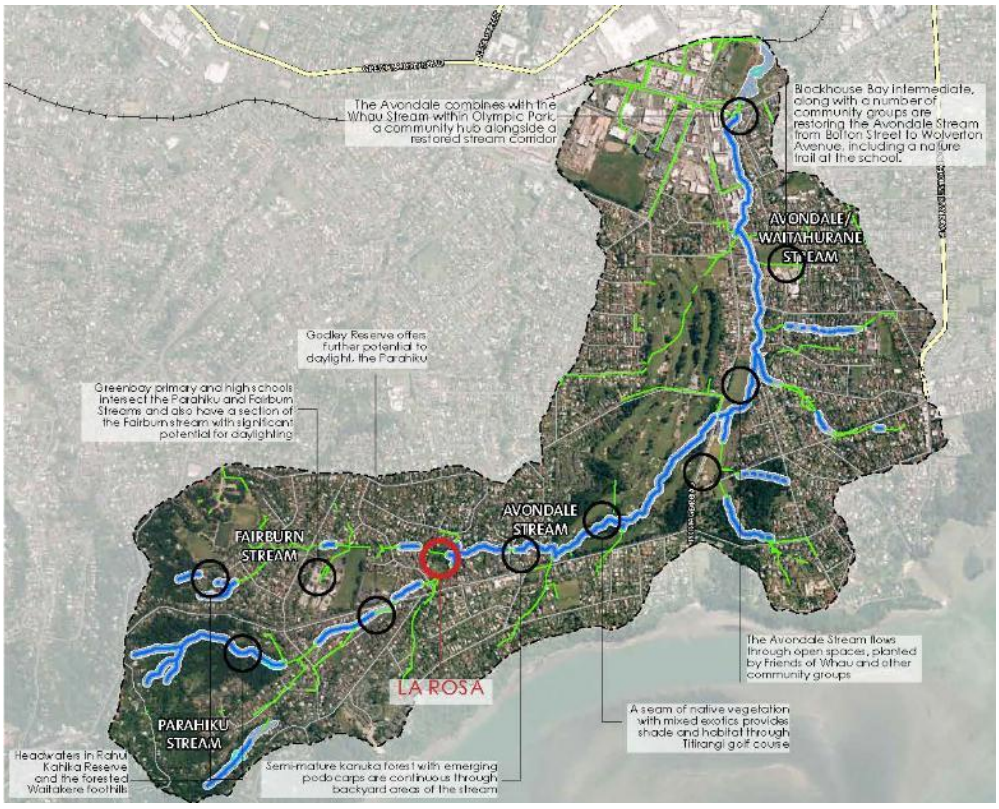

Figure 2: The location of La Rosa Reserve in the Avondale catchment

3 DESIGN OBJECTIVES

The opening of the streams through La Rosa Reserve was expected to improve drainage capacity and reduce flooding extents on properties adjacent to the stream, and was seen as a less expensive alternative to duplicating existing infrastructure (Opus 2001). In addition, the daylighting of watercourses in the reserve was desirable as a means of providing the following benefits:

- Enhancing the habitat and ecological connections for fish and macroinvertebrates from the Waitemata Harbour to the foothills of the Waitakere Ranges;
- Providing for enhanced ecological diversity, including the assistance of fish and invertebrate passage within the catchment;
- Enhancing natural character values and passive recreation opportunities within La Rosa Reserve;
- Providing ready and universal access for the public to the newly restored stream environments, and linking neighborhoods through the park to the Green Bay shops and beyond;
- Providing opportunities for natural resource harvesting and outdoor classroom activities for local schools; and
- Engaging with the local community and involving them in the restoration activities and ongoing functions of the reserve.

The La Rosa project had particular opportunities for engaging with children through the Kindergarten adjacent to the site, and Green Bay Primary and High Schools upstream of the site. Further interpretation was made possible through planting of cultivars for natural resource harvesting, to allow Iwi to directly engage with students and the community in a meaningful way.

Figure 3: Preliminary concepts for the Parakhiu and Avondale Streams in La Rosa Reserve

4 PRELIMINARY DESIGN

A preliminary daylighting concept design included a longitudinal section, cross sections, and earthwork models to determine that a self-sustaining stream was feasible in La Rosa Reserve. Further geotechnical and hydrological analysis investigated adjacent land stability to determine appropriate stream profiles, and to review potential stream bank stabilization techniques. This included the means to identify a planting substrate that would establish riparian vegetation in equilibrium with the new stream, and the developing catchment.

The concept for daylighting streams within La Rosa Reserve included the following approaches:

- Stream profiles based on the relative dimensions of up and downstream reaches and modelled flows;
- Allowing for lower-bank stabilization to the expected and observed levels of erosion and deposition in the channel;
- Flood terracing where practical to spread and slow flows during large storm events;
- A cautious approach based on an existing stream profiles that were actively eroding and likely to be affected in due course by a developing catchment;
- Stream profiles, meander, and stream features based on regular and channel-full events;
- Stream bank profiles based parent geologies;
- A more entrenched stream channel for the Avondale tributary to carry through the character of the downstream section and reinforce the enclosed nature of the steep valley slopes on either side of the channel;
- A wider stream channel in the Parahiku tributary to create a varied riparian character within the park, and to take advantage of shallow side slopes and the large open area in this location. This allowed us to bring paths closer to the stream and wider floodplain environments;
- A relatively shallow longitudinal gradient for the streams (0.3-1.0%), controlled by a series of small weirs or riffle sequences to keep the proposed stream channel close to the existing surface (to reduce the extent of excavation) and to control stream velocities;
- Bioengineering approaches for stream channel and bank stabilization based on stream velocities, and the relative elevation of flow events that would provide a combination of permanent and temporary stabilization (until plant roots establish);
- A path network as close to the stream as practical, with multiple crossings, and connected into a wider enhanced park network;
- In addition to plants suitable for restoration, working with Iwi to include rare plants as appropriate, and cultivars of native plants for weaving and other uses; and
- Balancing requirements for streambank stabilization by plants, with shading of the watercourse, and CPTED issues related to the use of the park.

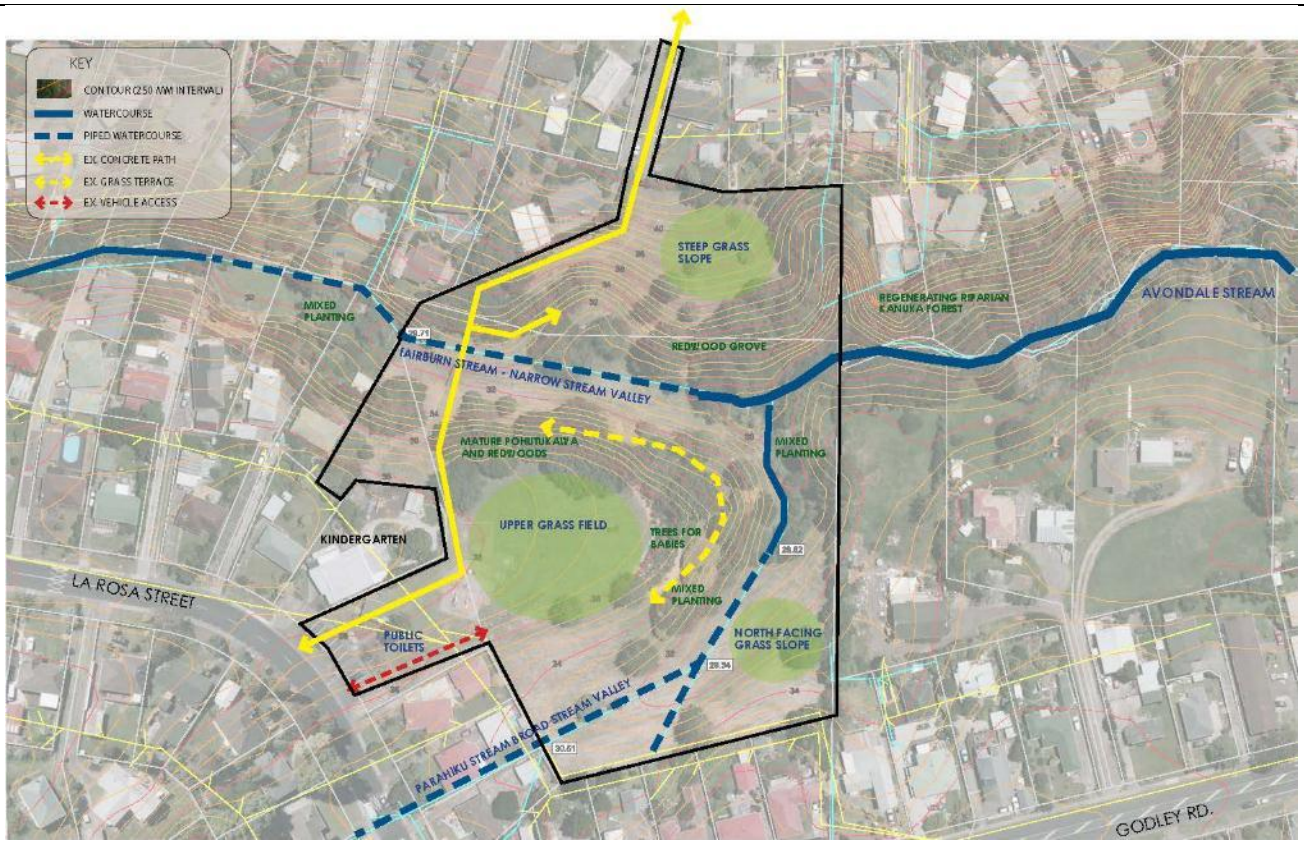

Figure 4: Site analysis

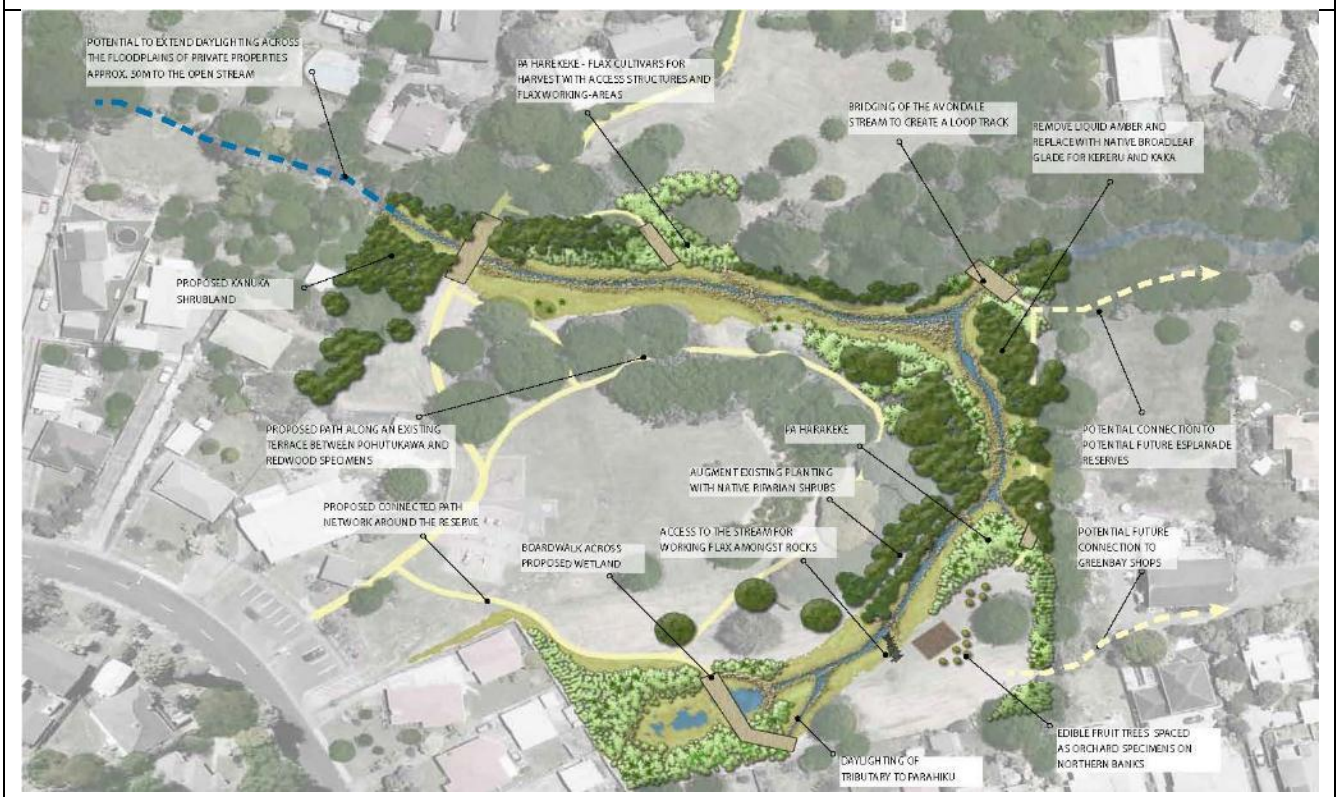

Figure 5: Early concept work

4.1 DESIGN DEVELOPMENT & DELIVERY

Detailed design and consenting was undertaken in a fast tracked programme. This was augmented by adaptive design decision-making by the designers and Stormwater Team on-site and during construction. This allowed decisions to be made allowing the constructors to avoid poor soils and take advantage of good geological material. The team could also re-align the stream, place stabilization materials, and configure in-stream features in a manner that met the objectives for landscape and ecology outcomes for the project. Some of the adaptive-management approaches are discussed further below.

4.1.1 HYDROLOGY

Modelling for the project was necessarily crude, based on the limited existing information of the catchment and its probable development. One of the few advantages of undertaking work during the winter period was the potential to witness significant peak stormwater events, during saturated ground conditions, interacting directly with newly constructed design profiles. This allowed some adjustment of channel stabilization extents, bridging cross sections, and limits of work.

As construction progressed into the winter work period, the methodology changed from opening up large sections in bulk earthworks and then trimming to form the stream profile, to waiting for 3-5 day fair-weather periods where sections of the pipe could be removed, the channel formed and finished prior to the stream being brought on line. This allowed the existing infrastructure to channel large storm flows, and prevented large areas of the site being open to overland flow and the potential for saturation and destabilization prior to being finished. This also limited the tracking by machinery during saturated ground conditions. In addition to changing the timing of works, the use of the existing pipes as a flow path, meant that designs were adapted as pipes were uncovered, to optimize the potential for off-line works.

The groundwater table encountered during preliminary geotechnical investigations, generally occurred at the base of fill. As expected there was elevated water in the side slopes, which seeped into the base of excavations. This required many subsoil counterfort drains to stabilize saturated slopes. The project team encountered many perennial springs on the Parahiku tributary that required specific subsoil treatments. An existing and unmapped drain was also uncovered, and this system delivered considerable flows during rainfall events. Since this pipe did not have a significant length of open watercourse above it, the team used this flow as an opportunity to provide a dramatic water feature over a cascade, creating an amenity for the park.

Although the stream has only recently been reinstated at La Rosa Reserve, anecdotal evidence from local residents suggests that rainfall events that would previously have led to the surcharge of the stormwater system and flooding from manhole covers have not had this affect.

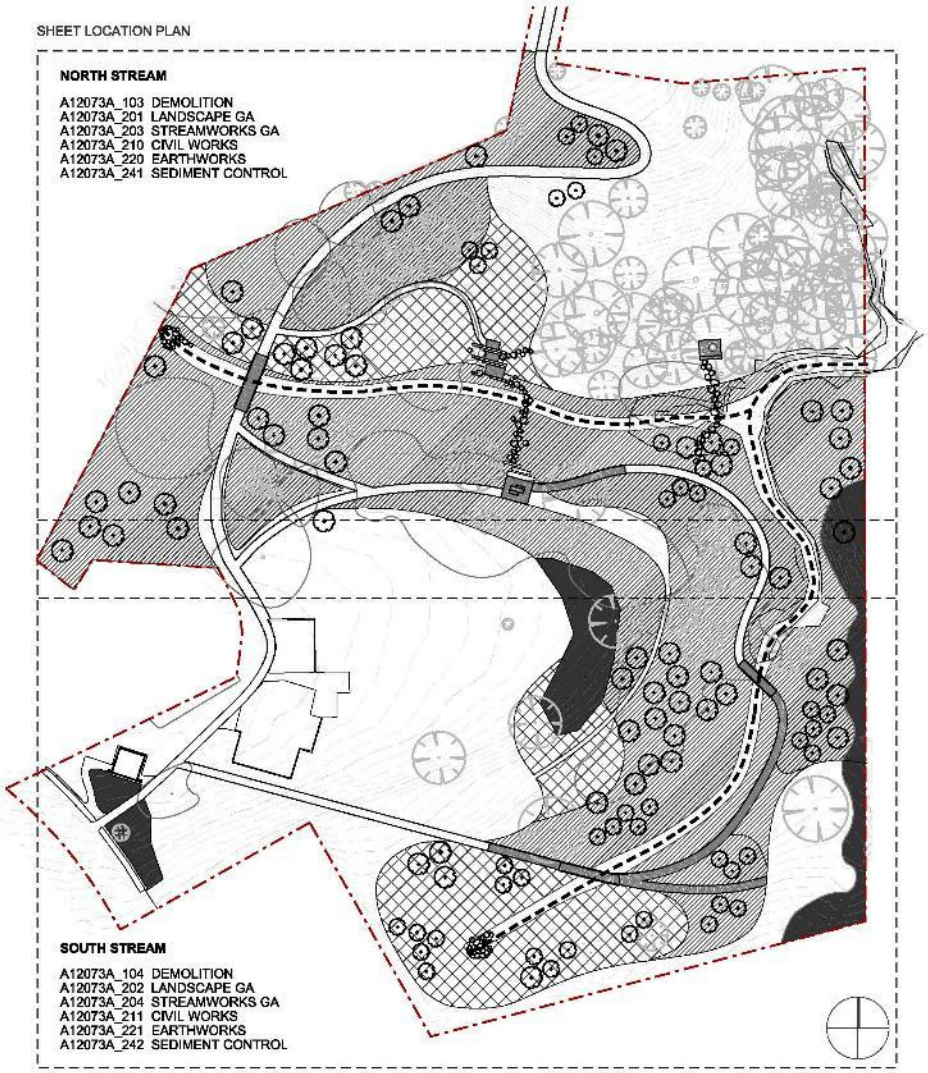

Figure 6: Developed design for construction

4.1.2 GEOLOGY & GEOTECHNICAL DESIGN

The Waitemata Group soils encountered during construction works were prone to shrinking and swelling following changes in natural moisture content while they were worked by machinery. Around the area of the historic stream and existing pipes there was also deposits of soft to very soft, blue/grey to brown/grey, organic clay up to 1.5m thick which are likely to have been formed by alluvial stream and wetland deposits. These areas sometimes required over-excavation to replace with a suitable material, less prone to erosion and channel bed incision.

There was a firm/stiff, grey/blue silt layer below the softer stream bed deposits, consistent with more competent alluvium or weathered Waitemata Group deposits. Where this was encountered, it was favored as the substrate for the daylighted stream, with appropriate, but minimal rock protection. In this way, the stream invert and meander profile differed in some points from the original design in order to provide for a design that suited construction conditions. In all, 5,000 m^3 of clay was removed from the

site and 600 m^3 of basalt rock imported to help form the new channels of the streams. An additional 1,000 m^3 of topsoil was placed to help form the stream embankments for planting.

In addition to work on the immediate stream profile, geotechnical investigation of slopes above the stream were required to determine their vulnerability to slumping from localized earthworks. This led to a need for further subsoil drainage and the adjustment of batter slope and length of the daylighted channel banks.

Throughout construction it was necessary to have the designers manage construction work to ensure optimum functionality whilst maintaining a natural profile. The Project Landscape Architect, Project Engineer, and Council's Project Manager were therefore on site on a regular basis to make these decisions. This applied across the bridges and, pathways and platforms to balance stream and bank profiles with future use.

Figure 7: The design and construction team working through sections of the Avondale Stream

4.1.3 BIOTECHINICAL STABILIZATION MATERIALS

During the course of the project the following innovative bioengineering materials and techniques were used:

- Topsoil lifts were required to vary, with thinner horizons (200mm) for some steep slopes, allowing suitable scarification, dressing of subsoils, and application of compost to individual plant holes. This removed some of the weight from these slopes.
- Mid slope breaks with soil 'socks' and/or logs allowed for deeper soil zones and reduced weight of topsoil on the slopes.

- Soil 'socks' were utilized above the immediate channel to form a stabilized toe for the topsoil bank. These comprised a manufactured soil mix within a photodegradable or biodegradable material. These were specified to have an appropriate weave of 3-5mm to allow root penetration following plant establishment. Soils were also tested for suitable long term nutrient values.
- Photodegradable socks were used for areas prone to erosion. These were sometime staked in place with inverted steel bars where they sat above rock and on steep slopes.
- Biodegradable socks were used elsewhere. These were weaker, with a larger aperture weave and during the winter works were prone to erosion, especially when a 'woolmat' covering them began to degrade. It was determined that either a thicker hessian weave was required above these socks or they should only be installed in the summer
- Socks were blown in a continuous manner. This was more efficient than 3m lengths when larger sections of streamworks could be undertaken at once.
- Woolmat was used for surficial soil protection and plant mulch simultaneously (although it is not as effective for weed suppression). This was 500g/m2 with hessian weave. The winter works did not work as well with this material, since the problems of saturation of soils was exacerbated by this material. This would ordinarily be a benefit to this material during the summer, and for plant establishment. The material also broke down quickly under wet and dry cycles, again an issue during winter works.
- Staking of the woolmat was with biodegradable starch pins. These were of an insufficient length to retain a 'grip', especially since the design of these has recently been modified to exclude a 'barb'. Alternatives will need to be reviewed, including the potential use of staples in the lower stream bank, prone to stream flows.
- The application of grass seed to prevent erosion was discussed, especially with the advent of the winter works, but this was not applied. This may have assisted with stabilization, and dewatering of the slopes. The right species would need to be applied to be easily supplanted by native planting.
- Existing pipe sections were used as bridge piers, inverted on location to quickly stabilize steepened banks and allow the re-use of materials.
- Trees cleared on the site were also used for slope stabilisation as well as in-stream woody debris features for enhanced habitat.
- Some geofabric and cement was used on the project around pipe collars and for the cascade describe previously. Geotextile is necessary on places where the gradient of the steam channel will cause incision, and the depth of back excavation and fill of suitable material has to be limited.
- It is the nature of bioengineering and the construction of natural streams that some self-correction will occur. It is necessary to educate the public and stakeholders that localized erosion will occur and can be corrected, that this is part of the design-build process and is often part of the consolidation and settling period, which unfortunately is longer and more marked during winter works.
- Accoya timber was used for boardwalks and platforms. This is a processed NZ pine without CCA treatment (copper, chromium, arsenic) and is FCC certified. This allows a long-lasting durable wood to be used in our parks without contributing contaminants. Further developments in this product will reduce the need for a separate non-slip tread. The wood is difficult to set alight or graffiti.

Figure 8: Rootwads and woody debris integrated with rock for slope-toe protection

Figure 9: Rock and woody debris integrated with soil lifts, compost socks, and wool mat

4.1.4 ECOLOGY

Many community groups have previously recognised the importance of the streams as a habitat and tributary to the Whau and as a landscape corridor. These groups are active in restoration and broader sustainability initiatives in the catchment, including Friends of Whau, Ecomatters Trust, the Sustainable Neighbourhood Programme (SNP), Sustaining our Streams, Conservation Volunteers, and schools including Greenbay High, Greenbay Primary, Blockhouse Bay Intermediate, and Avondale College. There are also specific groups of the SNP situated around La Rosa Street, Godley Road, and Lantana Road.

Beginning in the foothills of the Waitakere Ranges, the Avondale Stream and its tributaries provide a natural connection between the ecosystems of the West Coast rain forests, Waitemata Harbour and Hauraki Gulf.

The Avondale Stream, immediately downstream of La Rosa Reserve supports regenerating Kanuka forest with associated shrubs, tree ferns, and young emergent podocarp. This stream is reaching an equilibrium as it changes to a forested state, actively eroding and aggrading sediment in some areas of the stream.

A number of bush birds were encountered on site visits including tui, fantail, and resident kereru. Mallards were also common. A wide range of birds, including Kaka are possible as visitors at the reserve when considering its position within the Waitakere foothills and close to large areas of open space downstream at Craig Avon and the Titirangi golf course.

The surface of the daylighting area was previously pasture grass in line with its function as an overland flow path and had multiple mature exotics (including pest liquid ambers and willow) and a few immature native species. The loss of any vegetation was mitigated by large areas of intensive native planting, including replacement specimen trees. More planting is planned for the upcoming planting season, including specifically to provide shade to the stream.

There is some continued concern with willow weed and tradescantia in the upstream areas, which will require a comprehensive weed management exercise, ideally involving long-term buy-in by the community.

Monitoring data collected to date for in-stream habitat has indicated only some improvements in the stream reaches for EPT richness and abundance. However, the stream is newly daylighted and it will take time for the effects of the disturbance caused by earthworks and streamworks to settle and for invertebrates to colonise the new habitat.

Changes in several samples since daylighting has seen a score above 80 which means the stream can be assessed as ‘fair’ instead of ‘poor’. EPT richness refers to the number of taxa that belong to sensitive groups of stream insects (Mayflies, Stoneflies & Caddisflies). A high or increasing number is seen as a positive indicator of stream health. Prior to daylighting no EPT taxa were found. Since daylighting four taxa (latest sample – October 2013) have been recorded. Short finned eels and whitebait have also been found in the streams following daylighting.

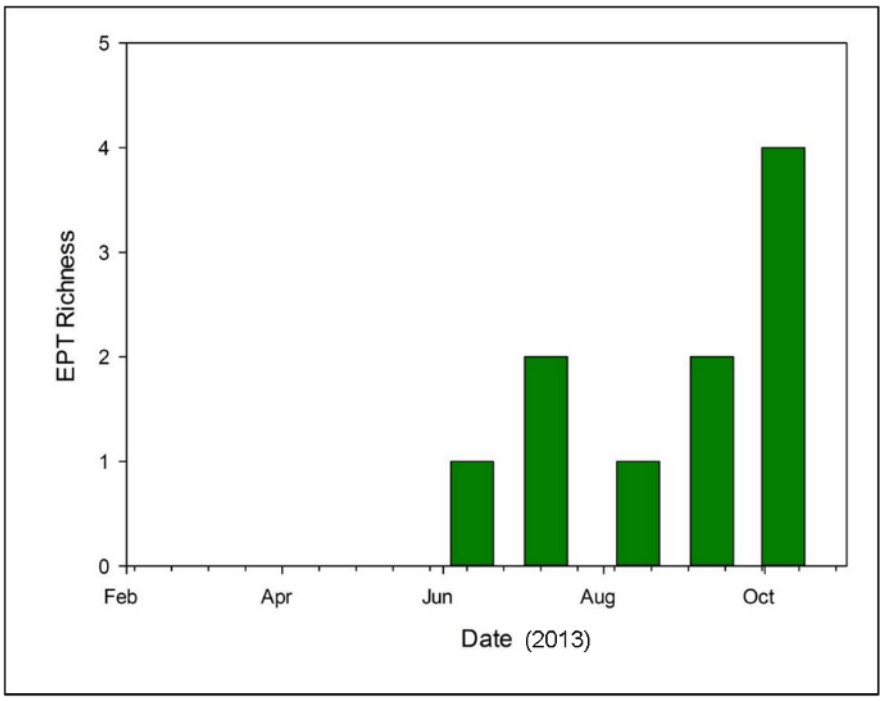

Figure 10: EPT Richness of Avondale Stream before and after daylighting (in May11:

Figure 11: Rimu Unit showing the public invertebrates from the stream at the open day

5 ADDED VALUE

5.1 COMMUNITY ENGAGEMENT

Auckland Council's Sustainable Catchment programme and the Ecomatters Environment Trust helped to inform and involve the local community in the La Rosa daylighting project. Newsletters, meetings, planting days, art projects, education with local schools and kindergartens, and community open days helped to ensure the community was involved with the project.

Community planting days were held, with residents helping to plant the stream and establish a community orchard. Local children were also involved on two of the planting days. Pa harakeke (flax garden for cultural harvesting) plantings were coordinated with Ngati Whatua.

Local schools and kindergartens were engaged to help create both temporary and permanent artwork for the La Rosa Gardens Reserve. Information panels are located around the reserve informing visitors about the work that has been carried out and also the natural habitat that now exists.

Students from surrounding schools visited La Rosa Gardens Reserve before earthworks started. They had a guided walk and were taught about the benefits of stream daylighting. They continue to be involved with the project, creating artwork, attending planting days and the final open day, and having ongoing classroom visits to the stream.

Figure 12: Community members working on public artwork at La Rosa

5.2 HERITAGE

Over the centuries, a number of related hapu have lived in the area. Local tribal entities of Te Kawerau a Maki and Ngati Whatua recognise heritage sites along the Avondale Stream. Daylighting of the streams in La Rosa Reserve is seen as making a contribution towards improving water quality of a tributary to the culturally significant portage to the Manukau, and for maintaining the aquatic and avian native biodiversity present, including kereru, tui, and piwakawaka (Papa 2012).

The Iwi has expressed a wish for waterways to be managed to ensure their use as a food source, and they support active restoration programmes, including stream edge planting. Above all, the Iwi requires that spiritual and cultural concepts should be recognised as key issues in water management. Te Kawerau a Maki also has concern in relation to native plants and wildlife in terms of access to flora and fauna for cultural harvest and craft.

La Rosa Reserve provides a significant opportunity to improve the provision of natural resources valued ceremonially (the trees for babies site), medicinally, and for the arts. Pa harakeke (and other weaving resources) has been established for local artisans as well as to provide resources for costumes, workshops, and tutoring of local schools. Specific resources have included Toetoe kakaho (Cortaderia splendens & C.fulvida), Toetoe whatumanu (Cyperus ustulatus var. ustulatus) & kiekie). Food resources have also be improved in the reserve, in particular through planting of orchard trees.

6 LESSONS LEARNT

There was a minor disconnect in the design-build methodology during the planting phase. This was supervised by another unit within Council with a different landscape contractor. Although planting was relatively successful, especially in terms of involving a grateful community, the designer's overview and a combined streamwork and planting contract would have further benefited the project for:

- Coordinated finishing of works with planting to achieve more rapid stabilization and planting earlier in the season;
- Quality assurance for the planting installation to ensure plants provided their multiple objectives (stream stabilization, amenity, shade, CPTED (crime prevention), etc.) and responded to the likely hydrological conditions of the site;
- A manageable project team and construction programme for more seamless and robust delivery; and
- The need for landscape and civil designs to be drawn from the same 3D model. This would allow a minimum of iteration before detail was required, would assist contractors with a GPS constructible profile, and would ensure that proposed and existing formations could be accurately mapped and measured. This allows an accurate representation and expectation of cut and fill, and therefore allows decisions to be made on material quantities and the necessity to change profiles where required to meet budget expectations.

7 CONCLUSIONS

The process of daylighting streams can be less expensive than upgrading the underground pipes to the required size. In addition, daylighting the Avondale and Parahiku Streams has helped to:

- Increase the amenity and community values of the La Rosa Garden Reserve;
- Provide opportunities for community involvement in their park, including outdoor classroom opportunities by the local school;
- Provide a modicum of water quality treatment;
- Reduce flow velocities and associated peak flows;
- Increase flow capacity and thereby reducing flooding potential;
- Increase the abundance and EPT richness of aquatic habitat; and
- Provide enhanced terrestrial habitat and a wildlife corridor.

The rapid design and construction process led to the conclusion that less detail is necessary on the initial detailed design plans and more resources should be directed towards having on-site design management during construction to ensure the stream has a natural profile and optimum functionality. As construction evolves, decisions on final placement around existing geologies and optimum value of pools, riffles and cascades can be made between construction staff and designers. Initial design plans submitted for planning and resource consent approval should be kept general to allow this flexibility.

Importantly, construction should be undertaken in the summer months with planting carried out in autumn.

Auckland Council will continue to monitor the stream's recovery so that the full range of environmental outcomes associated with the daylighting project can be recorded.

Figure 13: La Rosa shortly after completed planting.

8 ACKNOWLEDGEMENTS

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