ADAPTIVE CONSENTING AND IT'S APPLICATION TO STREAM WORKS

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ABSTRACT

Urban streams form part of an important dynamic environment that needs to be protected. They are constantly required to adapt and change to meet the constant pressures placed on them by the surrounding environment these changes can occur slowly or sometimes rapidly. When implementing stream enhancement projects sometimes streams have changed so much that what was designed one to two years ago is no longer the best outcome when the contractor establishes onsite; or sometimes streams are covered by such dense bush that the full extent of the issues cannot be evaluated without clearing the vegetation. To minimise these issues an adaptive management approach was adopted whereby a "toolbox" of best practice soft and hard engineering solutions was designed. The consenting authority was engaged to develop the approach that allowed the different "toolboxes" to be utilised on different sections of the stream. Once the contractor established onsite and cleared the unwanted vegetation, the consenting officers, designer, ecologists, Iwi, the contractor and the Engineer met and agreed what "toolbox" options should be utilised to resolve the different issues along the length of stream to be remediated. This flexibility was allowed for in the consent. The outcome; consenting officers, ecologists and Iwi were involved in the process, the designer was more confident that the best "toolbox" was utilised to address the different issues, the engineer was more assured that any variations due to changes were minimised because these were allowed for in the contract documents and the client had more certainty that the best value for money was being achieved.

In this paper and presentation, two case studies will be presented that will explain the process through the consenting phase and the implementation of the physical works onsite.

KEYWORDS

Urban Streams, Resource Consenting, Streamworks Stormwater, Toolbox approach, Adaptive Management

PRESENTER PROFILES

Adrian Percival is an Environmental Engineer and Therese Malcon is an Environmental Scientist working in the interface of planning and engineering for the Water Industry. By acting as interpreters and mediators between the two professions, they achieve easier consenting through improved engagement and reduced environmental impacts. Both are currently working for Auckland Council's Healthy Waters Department but have previously worked within other local government and private entities.

1 INTRODUCTION

In the past the consenting process for stream works consents, to enhance streams to provide for erosion mitigation, naturalisation or provide flood protection works, has usually resulted in single minded, robust and hard engineering options with no flexibility in terms of construction and a drawn-out consenting process. Over time it was established that there was a need to be more innovative in our approach to consenting, especially in streams where work is undertaken in a rapidly changing and dynamic environment. Because it wasn't always the best outcome to predetermine all of the enhancement approaches with a single minded approach to streamworks, the idea of using a "toolbox" approach came about. A more open, consultative, adaptive consenting approach was needed. The "toolbox" incorporates a number of hard and soft remediation options that can be used to stabilise the stream banks and provide increased habitat into the stream bed. Soft engineering options are preferred, but hard engineering options also need to be available where there is no room for retreat, i.e. the stream can't retreat (erode) outwards due to adjacent development, so hard structures need to be installed to prevent the streams from encroaching into the surrounding land and putting structures at risk such as house foundations.

Urban development has significantly changed the nature of stormwater runoff. The introduction of impervious surfaces in place of vegetation and pasture, and the associated compaction of soil reduces the infiltration of water to the ground and therefore increases the volume that runs off ground and into the receiving environment; including streams. The rate at which water runs off hard surfaces is also much faster than the rate of runoff for vegetated surfaces, because hard surfaces are smoother and offer little opportunity for water to slow down, infiltrate to the ground and evaporate. Consequently, stream channels receive greater volumes and flows, causing erosion. High peak flows dring storm events and regular flows during smaller rain events both contribute to stream channel erosion, the latter being the more significant contributor. Loss of stream base flows due to reduced ground water infiltration mean that streams experience lower flows in drier months than in an undeveloped catchment. Therefore past development has not only resulted in both the physical loss (infilling/piping) of streams but also significant modification of streams in the urban area such as straightening, channelising and the introduction of structures; coupled with the loss of riparian vegetation. These issues significantly reduce the ability of a stream to support healthy, diverse aquatic ecosystems. In these circumstances, stream management is often focused on minimising erosion and enhancing community and amenity values of watercourses. Note that new development is now designed to manage streams to support multiple values, including healthy in-stream ecosystems and community and Mana Whenua values. This will primarily be achieved by managing land use to avoid development within flood plains and stream corridors; and management of stormwater runoff to reduce hydrological effects. The provision of riparian margins (typically 10m either side) allows natural migration of the stream bed without endangering surrounding development. Management of impervious areas is also required to ensure the efficient functioning of the reticulated stormwater network, to minimise flood risks, and in some older parts of Auckland, to avoid increasing combined sewer overflows (Auckland Council, 2013). Two case studies are outlined below, Charles Street Reserve and Kahika Stream which explain how having a toolbox approach to consenting has resulted in better environmental outcomes.

2 DISCUSSION

2.1 WHY ADAPTIVE CONSENTING

There are a range of issues that have arisen from consenting streamworks that have led to the development of the adaptive consenting approach. Firstly, a typical streamworks consent requires a range of specialists to be involved and a range of reports. For example, a detailed erosion and sediment control plan, details of the stream by-pass to divert flows when working in a stream, stream ecological valuation report, an ecological assessment for the riparian habitat and an arborist report. This is due to regulatory requiring a lot of information upfront as they were often worried that the applicant would annihilate the stream. This meant that the consents became overly difficult to obtain than the works proposed, typically for outfall projects and resulted in more money spent on an outfall project than a pipe renewal project. This often led us to spending twenty five thousand dollars to obtain consent for fifty thousand dollars' worth of physical works.

Secondly, there was often a lot of discussion with regulatory regarding various interpretation issues regarding un-quantifiable matters that resulted delays. For example, the status of the stream (an artificial channel vs permanent stream), the merits of fitting a 1 in 20 year stream bypass as a precaution for small-scale stream works, ecological values, the use of hard engineering options as opposed to soft engineering options. Disagreements between different teams in regulatory can also arise making the process more difficult. For example, there were often disagreements between the district plan ecologist and the regional plan ecologist within the regulatory team. The district plan ecologist was focused on the vegetation removal component and the regional plan ecologist was focused on the streamworks component. As an applicant this results in a very difficult and long winded process to obtain consent, especially when the project is intended to create a better environmental outcome and enhance the stream.

Thirdly, although a 'do nothing' approach results in a worse environmental outcome the consent process resulted in delays and uncertainty. To get the required outcome that all stakeholders want traditional consenting involved an extended regulatory process. The resultant consent was inflexible and, once the resource consent was granted and the construction phase started, necessary changes to the works methodology and construction design could not be accommodated without a variation. For example, a timber retaining wall needed to be installed instead of gabion baskets because the stream bank had heavily eroded in the time that had elapsed between the granting of the resource consent and construction commencing. Flexibility is required when working in a dynamic environment and that is where the development of the adaptive consenting approach becomes a very useful innovative tool.

2.2 CONSENTING THE TOOLBOX APPROACH

Before resource consent was sought a consultative process was undertaken with regulatory to ensure that the idea of a consenting envelope via a toolbox approach had buy in. It was successful and meant that the consenting process became straight forward. The backing of all parties, not just regulatory was needed before the consenting phase. This included site visits and meetings, where the idea of a consenting envelope via a toolbox approach was explored and all parties were included in discussions regarding its scope and processes. The draft toolbox options were discussed and a framework was developed to determine under which circumstances the options should be used along the stretch of the stream to be enhanced. An assessment between soft and hard engineering approaches was also explored and in certain instances all soft toolbox approaches were recommended. The resource consent phase didn't start until all stakeholders involved had agreed on all of the toolbox approaches for each site. Agreement from the regulatory team was particularly important. Flexibility throughout the whole process by using the adaptive management approach allowed regulatory to be involved and consulted along the whole process. This allowed for less detail up front at the application phase, thus allowing for consent conditions within an envelope . However, regulatory have to consider the worst possible scenario to capture the works within the consented envelope.

The consent conditions were heavily discussed between the Healthy Waters Planning Team and the regulatory team to make sure that the conditions imposed on the project allowed the flexibility that was required to deliver the toolbox approach. An example of how flexibility was incorporated into the conditions is shown through condition 14:

- *Following vegetation clearance and prior to commencement of stream works at the subject site, a meeting shall be held onsite to discuss:*
  - *a) the use, location and extent of the different stream restoration toolbox methodology's outline in the documents referenced in condition 1;*
  - *b) any specific erosion and sediment control measures required to implement the stream restoration toolbox methods; and*
  - *c) if a native fish survey and fish relocation is required.*

The following shall be present at the meeting:

- *d) an officer from the Northern Monitoring Team; and*
- *e) Resource Consents Ecologist.*

The specific wording in this condition was discussed and ultimately allowed the toolbox approach to be implemented in the most practicable way on site.

Soft toolbox options include:

- cutting back banks and reinforcing the toe of the bank with rock or geo-grids which are used for most soil reinforcement applications such as reinforced soil slopes and when soil consolidation and support is required,
- Small rock structures/root wads in the stream to create run, riffles and pools, root wads in the bank to create habitat and divert water away from areas that are easily eroded,
- Using rip-rap and stone over wing walls around outlets and outfalls,
- Filtrex living wall,
- Cross-vane structures in the stream to direct flow and
- timber reventment which is a retaining wall made of root wads and tree stumps.

Hard toolbox options include:

- gabion baskets,
- timber retaining walls,
- concreted outfalls and wing walls and
- rock lining along the bed of the stream.

Sox (mesh tubes filled with compost) are usually incorporated into soft toolbox options but can also be used to soften hard engineering structures. They are installed across a slope or channel to prevent erosion and filter sediments out of runoff. They can also be planted.

Two examples below show how using the toolbox approach for consenting stream works can provide the best practicable project outcome from an environmental, construction and economic perspective. The first example below shows how hard engineering solutions is not always required, in this instance the design only included soft engineering options. The second example shows how a stream can benefit from soft and hard engineering options and at different lengths of the stream more than one option was suggested allowing flexibility to implement the most appropriate design.

2.2.1 CASE STUDY – CHARLES STREET RESERVE

In the Charles Street Reserve project, due to the limited access to the stream running through the reserve, the stream characteristics were unknown before construction on site started. Flexibility was required as the stream was heavily vegetated which meant the designers couldn't see the state of the channel or how strong the banks were until all of the vegetation was removed. The vegetation removal required a resource consent therefore the options for stream enhancement could not be predetermined. Staging the consent by first stripping the vegetation and then designing the bank remediation would have left the banks exposed for far too long and generated significant erosion. . The proposed stream restoration toolbox approach comprised of eight potential design and construction methods that are all soft engineering options, there were no hard engineering options proposed. The options that were proposed for the stream enhancements works at the consenting phase are outlined in Table 1 below.

After the clearance of vegetation along the stream was undertaken to enable unhindered access, a geotechnical investigation was undertaken to determine the soil strength along the entirety of the stream. A consultative approach was undertaken between council officers, compliance officers, iwi, ecologists and the project manager on site to determine what "toolbox" approach from Table 1 below should be utilised along the stream reach.

The most extensive bank protection is required immediately around and downstream of the stormwater outfall to protect the banks against the higher velocity of the water which discharges to the stream from the stormwater pipe. As the high velocity around the outfall is creating erosion and this needs to be minimised through bank protection. Within the first 10m as much energy will need to be dissipated as possible through the creation of eddies along the stream banks. Once the velocity of the flow reduces and reaches the main channel, a lesser level of bank protection will be required.

Table 1: Toolbox options for Charles Street Reserve stream enhancement project

Option	**What works were proposed?**	**When is option likely to be used?**	**Is the option likely to be used at Charles Street?**
1. Filtrex living wall with reinforced earth slope/bank	Reshape the bank and install a 300mm sox filled with compost (or alternative organic	When the bank face is steep and requires stabilization. To install this option	Yes, this option is likely to be used within 40m downstream of the stormwater outfall

stabilisation	matter) and a geo-grid. The geo-grid must be tied in for a minimum distance of 1.7m beyond the extent of the sox.	the area must have all vegetation and obstacles removed to provide a clear area, in order to "tie back" the geo grid. Once installed vegetation will be allowed to grow.	where there is a sufficient clear area to install the geo-grid and the banks are steeply sloping. This option provides a high level of bank protection where flows have a higher velocity.
2. Cross Section Incised Channel – Rock rip-rap on stream bed and banks	Install rock rip-rap 400mm thick, contoured to fit the existing surface, using 150mm-300mm hard angular rock.	This will help protect the stream bed and is likely to be only used around an outlet.	Yes, this option is likely to be used within the first third of the stream downstream of the stormwater outfall. This option provides a high level of bank protection where flows have a higher velocity.
3. Soil and grasses/plants covered rip-rap	Form a rip-rap layer, 400mm thick, cut into and contoured to fit the existing bank surface, using 150mm-300mm hard angular rock. This option minimizes the excavation/ disturbance of the stream bank. The rip-rap will be covered with 150mm topsoil.	This may be used as an alternative to Option 1: filtrex living wall where insufficient area behind the living wall is available (mainly due to the presence of trees).	Yes, this option is likely to be used within 40m downstream of the stormwater outfall. This option provides a high level of bank protection where flows have a higher velocity.
4. Root wads/natural occurring materials at base of stream bank	A root wad item consists of at least, 1 root wad and some large wood debris. One root wad (key piece) which is placed more or less parallel to the stream flow with the roots facing	This option will be utilized where the existing bank slope requires little or no further works. Its primary usage is to provide additional bank protection and to create new	Some trees will need to be removed within the Charles Street reserve to enable construction therefore there will be a surplus of root wads. The possibility of utilizing this

	upstream. Stacked large wood debris are placed on top of the key piece, and racked smaller wood is placed against the upstream face of the key piece perpendicular to the direction of flow.	ecological habitat.	technique for habitat improvement is therefore likely. A smaller modified version of this option may also be utilized. The use of this option will be dependent on the existing stream bank characteristics which are currently unknown.
5. Live brush mattress	A layer of top-soil is laid (200mm thick), covered in coconut matt (or similar) and is planted with selected bank stabilising vegetation.	This option will be utilised where the existing bank slope requires little or no further works. Its primary usage is to provide additional bank protection and to provide new ecological habitat.	Yes, extensive planting of the site will occur and so this option is likely. The use of this option will be dependent on the existing stream bank characteristics which are currently unknown.
6. Vegetated rip-rap	A rip-rap layer 400mm thick is formed, suitably placed and contoured to fit the existing bank surface, using 150mm-300mm hard angular rock. The riprap is covered with topsoil and bank stabilising (100mm thick) and plat vegetation.	This is a minor/lesser version of Option 2 (without the channel rip-rap). This may be used as an alternative to Option 1: filtrex living wall where insufficient area behind the living wall is available (mainly due to the presence of trees).	Yes, this option is likely to be used within 40m downstream of the outfall. The use of this option will be dependent on the existing stream bank characteristics which are currently unknown.
7. Slope flattening	The stream bank is reshaped/flattened. The anticipated maximum depth of	To provide greater cross-sectional area of the stream bank to reduce the	Yes, this option is very likely to occur along most of the stream

	excavation shall be approximately 1m.	risk of bank failure.	bank beyond 10m downstream of the existing outlet and especially on the southern side of the bank where adequate space is available.
8. Cross vane and outlet protection	Rocks for cross vane structures are un-weathered sedimentary rock of the greywacke group or basalt. Rocks are sized 600mm to 800mm on the longest dimension, with an equivalent diameter of 500mm to 650mm, and shaped closer to cuboid than round. The vane arm portion is 20 to 30 degrees to the bank. The slope of the vane, defined by the ratio of bank height/vane length, extending from the bank full level to the stream invert shall be between 2 to 7%. Vane length shall be the distance measured from the bank full level to the invert at 1/3 of the bank full channel.	This is normally used around a stormwater outfall/outlet to help protect the stream bed and as an energy dissipation device. It may also be used if the stream bed needs to be flattened to avoid future incising off the stream bed, which will lead to future bank de-stabilisation.	Yes, this option will be used immediately around the stormwater outfall.

To summarise, the following options were proposed within the Charles Street Reserve:

- Immediately around the stormwater outfall (within 10m downstream) – option 8 will definitely be implemented immediately around the stormwater outfall to provide for required outlet protection. A combination of options 1,2,3 and 6 will be used, the exact location and extent of which will depend on the existing stream bank characteristics which are currently unknown.

- Within 10-40m downstream of the stormwater outfall – mainly options 1,2 and 3 will be used to provide the greatest level of bank protection. However, depending on the existing stream bank characteristics, the preferred option would be to use a combination of options 4,5,6 and 7; and

- Remainder of stream – preferred option is to implement option 7 along the whole stretch. However this will be dependent on the width of the existing stream banks and may not be possible along the eastern bank of the stream. Options 4, 5 and 6 will be used intermittently as required or where the bank is not wide enough to implement Option 7.

All of the toolbox options except option 5 were utilised at Charles Street Reserve. Determining what toolbox option was going to be utilised at different stages throughout the stream was the result of collaboratively talking on site with all stakeholders. Firstly, all the issues were discussed on site, then all the toolbox options were looked at and then decided together what the best outcome was. When there was a disagreement a discussion was held as to what the best solution would be and only once everyone agreed was a decision made.

The end result was that less physical work was required to restore the stream in the case of Charles Street Reserve, this was mainly due to once the vegetation was cleared and the banks were tested they were a lot stronger than what was assumed during the consenting phase. This allowed for the use of soft engineering whereas a traditional consent would have facilitated the use of hard engineering. Having the flexibility in the consent through the "toolbox" options allowed the range of people involved in the project to deliver the best project outcome with an innovative fit for purpose approach.

2.2.2 CASE STUDY – KAHIKA STREAM

This project was the rehabilitation of a 170m stretch of the Kahika Stream by stabilising stream banks, widening the stream channel and improving the terrestrial and aquatic habitat in and around the stream.

Kahika stream was prone to erosion due to an increase in stormwater flows because of development in the catchment resulting in a constantly changing stream environment. This meant that prior to consent to construction phase the stream environment was rapidly changing so there was a need to use the toolbox approach within the resource consent for the stream works. Having a toolbox approach to consenting allowed the best option to be pursued because the stream had altered between consenting phase and the construction phase and the best design options could not be determined until the works commenced on site.

In this example the proposed works to the Kahika Stream, two options have been proposed at each stage, one offering a hard engineering approach (Option A) and the other providing a soft engineering option (Option B). These options can remedy bank instability across the scale from severely unstable to moderately unstable, both of which were foreseeable in this stream. Where practical and appropriate, Option B is preferred. The most appropriate option would be confirmed at the time of construction and consent was sought for both options as there was a need for flexibility in this project. The consenting process for this case study needed to be more structured and designed before works commenced on site due to the nature of the stream.

The proposed works are described in sections below and are divided into nine cross-sections provided below. Some sections of stream had eroded to the point where there were no soft engineering options, so not all cross-sections provide for both options.

Table 2: Toolbox options for Charles Street Reserve stream enhancement project

Option	What works were proposed
Cross-section 1	- Installation of a gabion wall on true right bank. The wall will be approximately 8m in length, 1.2m in height and will be stepped back to match the bank profile and keyed into the base of the stream; - The existing pedestrian bridge and supporting retaining wall will be either repaired or replaced with similar structures; - The bed of the stream will be widened to approximately 1-2m. A meandering primary channel will be located within the bed of the stream; - Re-grading of the true right bank to reduce the gradient. The bank will then be planted with native species to provide support to the bank; - Rock protection will be provided at the toe of the stream banks; - A cross-vane structure will be installed in the stream.
Cross-section 2	**Option A:** - Construct a new timber retaining wall. The area behind the wall will be filled and levelled; - Rock protection will be placed at the base of the retaining wall and a vegetated soft block will be installed in the rock protection; - The bed of the stream will be widened to approximately 1-2m and two benches will be created above this to provide for flood flows of varying sizes. A meandering primary channel will be located within the bed of the stream; - Regrading of the true right bank to reduce the gradient and create the benches in the stream. The bank will then be planted with native species to provide support to the bank and rock protection will be installed at the toe of each bench; - A cut-off drain will be installed up-slope of the

	regraded bank **Option B:** - Option B is the same as Option A on the true right bank of the stream, but includes two key variations to the true left bank. - The true left bank will be regraded to reduce the gradient. The bank will be planted with native species and a vegetated soft block will be installed at the base of the bank and planted. Rock protection will also be installed at the base of the bank. - The fence at 10 Woodhams St will be replaced and moved. This will provide the space for re-grading the bank.
Cross-section 3	**Option A:** - Construct a new timber retaining wall. The area behind the wall will be filled and levelled, and disturbed planting will be re-established; - Rock protection will be placed at the base of the retaining wall and a vegetated soft block will be installed in the rock protection; - The bed of the stream will be widened to approximately 1-2m and two benches will be created above this to provide for flood flows of varying sizes. A meandering primary channel will be located within the bed of the stream; - A cross-vane structure will be installed in the stream; - Regrading of the true right bank to reduce the gradient and create the benches in the stream. The bank will then be planted with native species to provide support to the bank and rock protection will be installed at the toe of each bench; - A cut-off drain will be installed up-slope of the regraded bank **Option B:** - Option B is the same as Option A on the true right bank of the stream, but includes one key variation in the true left bank. The true left bank will be regraded to reduce the gradient. The bank will be planted with native

	species and a vegetated soft block will be installed at the base of the bank and planted. Rock protection will also be installed at the base of the bank.
Cross-section 4	- Provision of rock protection on the true left bank at the toe of the bank and at the base of the existing bridge abutment and; - The bed of the stream will be widened to approximately 1m. A meandering primary channel will be located within the bed of the stream
Cross-section 5	- The concrete apron at the base of the outfall will be removed. (The existing stormwater outfall and headwall are located in this area of the true left bank); - The true left bank below the outfall will be regraded and rock toe protection will be installed; - Planting of native species on the true left bank above the outfall - The bed of the stream will be widened to approximately 1-2m and two benches will be created above this to provide for flood flows of varying sizes. A meandering primary channel will be located within the bed of the stream; - Regrading of the true right bank to reduce the gradient and create the benches in the stream. The bank will then be planted with native species to provide support to the bank and rock protection will be installed at the toe of each bench;
Cross-section 6	- Extension of the existing timber retaining wall approximately 10m to the south (upstream), and provision of riprap protection at the base of the retaining wall; - Regrading of the true left bank to reduce the gradient and create a bench in the stream. The bank will then be planted with native species to provide support to the bank and rock protection will be installed at the toe of the bench; - The bed of the stream will be widened to approximately 1-2m and two benches will be created above this to provide for flood flows of varying sizes. A meandering primary channel will be located within the bed of the stream;

	- Two cross-vane structures will be installed in the stream; - Vegetated soft blocks will be installed in the existing rock protection on the true right bank.
Cross-section 7	- Regrading of the true left bank to reduce the gradient and create a bench in the stream. The bank will then be planted with native species to provide support to the bank and rock protection will be installed at the toe of the bench; - The bed of the stream will be widened to approximately 1-2m and two benches will be created above this to provide for flood flows of varying sizes. A meandering primary channel will be located within the bed of the stream; - A cross-vane structure will be installed in the stream; - Rock protection will be installed at the base of the true right slope. Vegetated soft blocks will be installed in/on this rock; and - Native species will be planted on the true right bank
Cross-section 8	**Option A:** - Regrading of the true left bank to reduce the gradient and create a bench in the stream. The bank will then be planted with native species to provide support to the bank and rock protection will be installed at the toe of the bench; - The bed of the stream will be widened to approximately 1-2m and two benches will be created above this to provide for flood flows of varying sizes. A meandering primary channel will be located within the bed of the stream; - A cross-vane structure will be installed in the stream; - On the true right of the stream, part of the bank will be cut back and regraded. Timber piles will be installed at the edge of the stream to support the bank over a distance of approximately 27m. tree-trunks will be placed behind the piles, parallel to stream flow, this arrangement is referred to as a timber revetment. The area behind the piles will then be laid with geotextile and coir matting and will

	be backfilled; - Native species will be planted on the true right bank **Option B:** - Option B is the same as Option A on the true left bank of the stream, but includes one key variation to the true right bank. - A timber retaining wall will be constructed to support the true right bank. The retaining wall will be approximately 2.5m in height and will extend over approximately 27m. The land behind the retaining wall will be regraded to reduce the gradient and lined with geotextile and coir matting, before being planted with native species.
Cross-section 9	- Re-grading of the true left bank to reduce the gradient and create a bench in the stream. The bank will then be planted with native species to provide support to the bank and rock protection will be installed at the toe of the bench; - Native species will be planted on the true right bank

The implementation of the physical works on site resulted in use of more hard engineering options than what was initially expected as the banks were rapidly eroding and needed to be stabilised. This meant that many of the soft engineering options in this case were unsuitable. The toolbox approach in this instance was a lot more structured and hard engineered focused compared with the Charles Street reserve project and the works were implemented as designed in the consenting process. However, having the flexibility to use the "toolbox" approach in the consent provided for the best outcome because the use of soft engineering was able to applied to some extent.

2.3 LESSONS LEARNT

The key lesson learnt from both case studies explained above is that all stakeholders involved needed to agree on the appropriate toolbox approach that was undertaken along the reach of the stream. This also showed that a dispute resolution process is needed for when all stakeholders can't agree on what toolbox option to use along the stream reach. This is particularly useful when flexibility is needed on site if the stream is in a different state to when the initial design was undertaken. An escalation protocol or an appointed mediator who is a qualified professional and has worked on a range of projects specifically experienced in earthworks, streamworks and ecology would be beneficial to the implementation of the toolbox approach.

3 CONCLUSIONS/RECOMMENDATIONS

Utilising an adaptive management approach via a toolbox, to consenting stream works has allowed greater flexibility, more innovation and better project outcomes. In the case of Charles Street Reserve this meant that rather than going in with a pre-determined design we were able to use a more environmentally sensitive approach to restoring the stream by taking a soft engineering approach wherever possible and restoring the stream in a more innovative way that is fit for purpose on the subject site. The collaborative, open, flexible approach with the different stakeholders paved the way for the best project outcome. In contrast to that Kahika Stream, which was a rapidly eroding stream, ultimately required more hard engineering options. However, flexibility was retained during the construction phase to enhance the stream with the most suitable option. Overall in both case studies, the greater flexibility allowed by taking a adaptive consenting approach via a toolbox has allowed the best practicable option to be used to allow the works to fit in with the constantly changing stream environment to ensure the best and most environmentally sensitive outcome for the stream and the project.

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