GET THOSE TURD TAXIS OFF OUR STREETS! – A STORY OF SLUDGE PIPELINE REPAIR IN WELLINGTON

Elliot Altham

ABSTRACT (500 WORDS MAXIMUM)

In January 2020, it was discovered that the two pipelines that transfer sludge from Moa Point WWTP 8.8km to Carey's Gully sludge dewatering plant had burst. To avoid a significant environmental pollution event involving discharging into the Cook Strait, over a million litres of sludge had to be transferred everyday using road tankers operating 24 hours a day 7 days a week, at significant cost and disruption to local communities.

The two burst locations were located beneath Mt Albert in a wastewater tunnel. The tunnel is 1.7km long, 1.7m wide and 1.95m tall and the two sludge lines had been cast into the concrete benching. The bursts occurred at 170m and 230m from the nearest entry point making investigation and solution delivery difficult due to the wastewater working conditions and confined space entry.

The solution developed involved a 1.7km non-structural PN35 liner being winched through the existing pipelines, the first time this liner had been used in NZ, and the longest pull of this liner ever in the world. This technology, and the specialists to install it, were imported from Germany. There was significant press coverage of the bursts, and pressure to get the sludge tankers (euphemistically named "turd taxis") off the roads as soon as possible. This was all complicated by NZ going in to the Covid-19 country-wide lockdown six weeks into the project, making it difficult to get materials and specialist contractors into the country, and requiring special Health & Safety practices to be put in place to continue to have the worksite operating during the lockdown.

The pipelines were re-commissioned, and transfer of sludge through the pipelines resumed, 3.5 months after the bursts, removing all tankers from the road to the relief of the client and community. Several more months of work were required to install the second liner and repair the damage inside the tunnel while maintaining live sewage flows.

This paper covers what we know about the background to the bursts, the process of client, consultant and contractor working collaboratively to deliver a solution that would remove the ongoing burst risk of the existing asset, the technical solution developed and how the works were completed to enable conveyance of sludge to resume through the pipelines, removing the requirement for the temporary road tankers as soon as possible and reinstating the tunnel.

KEYWORDS

sludge, emergency, pipeline

PRESENTER PROFILE

Elliot is a Senior Water & Wastewater engineer with 9 years' experience in the industry. Originally from the UK, Elliot has worked as a consultant, principal and regulator and has been working with Stantec in Wellington for the last two years for the CAPEX delivery team.

INTRODUCTION

In January of 2020 the two pipelines that convey sludge from the Moa Point Wastewater Treatment Plant (WWTP) to the Carey's Gully Sludge Dewatering Plant burst, resulting in sludge having to be transferred by using road tankers 24 hours a day.

This paper depicts the events of how Stantec reacted to and led a collaborative team to successfully repair the sludge conveyance failure in Wellington in 2020, and ultimately get these tankers off the road.

The solution comprised localised internal patching of the pipes and pulling through 1.7km of non-structural PN35 liner. This was the first time this liner had been used in New Zealand and the longest pull of this liner ever in the world. To the satisfaction of the client and community, materials and specialist personnel were rapidly mobilised from Germany despite Covid-19 lockdown, and sludge operation resumed less than four months after the bursts were first identified, taking the tankers off the road.

1 MT ALBERT SLUDGE LINE REMEDIATION

1.1 THE PROBLEM

In January 2020, the WWTP operators (Veolia) discovered that the two pressure pipes that convey sludge from the WWTP to the Carey's Gully sludge dewatering plant would not pressurise. It was quickly discovered that both pipes had failed and any pumped sludge would be escaping along the 8.8km alignment.

Within days of the failures Wellington Water Ltd (Wellington Water) and Veolia engaged and mobilised a fleet of 24-hour road tankers to transport the WWTP's outgoing sludge flows from the WWTP to the Carey's Gully sludge dewatering plant. The cost to Wellington City Council (WCC) of transporting sludge in this way was in the order of $100,000 per day. The local community named these the 'turd taxis', and not in an affectionate way, and there was significant pressure politically and in the media for a repair to be made as soon as possible. With 120 round trips a day being made by the trucks, a truck could be expected to pass every six minutes. Residents along the south coast complained of the noise, smell and traffic volumes.

Figure 1: Turd Taxi

The initial investigations carried out identified the failures had occurred within the 1.7km wastewater tunnel that runs beneath Mount Albert, between Kilbirnie and Island Bay. The tunnel has access points at each end only; these being Adelaide Road, Island Bay and Queens Drive, Kilbirnie. The tunnel transfers wastewater gravity flow from west to east towards the WWTP, with the sludge pressure pipelines cast in the tunnel benching, pumping sludge from east to west towards Carey's Gully (refer Figure 2).

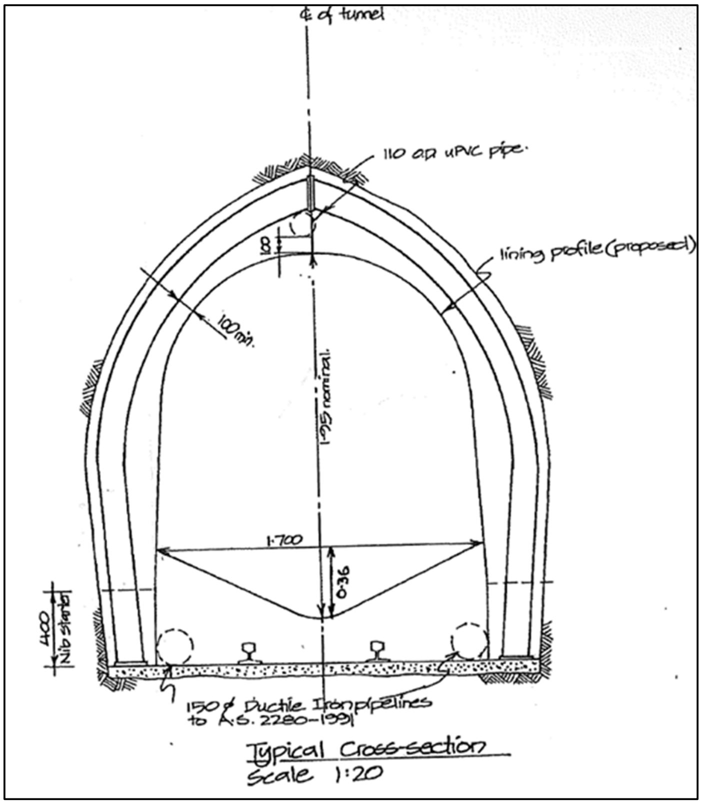

Figure 2: Tunnel Cross Section

The sludge pipelines had been installed into the tunnel in the mid-1990's, and a previous burst had occurred on one pipeline in 2013 which was locally repaired from inside the tunnel.

Veolia manage the plants associated with wastewater treatment for Wellington Water. They do not manage or maintain the tunnel or the sludge conveying pressure pipes in this section of the network; this is the responsibility of Wellington Water.

Stantec were approached due to their experience and reliability in the delivery of critical asset projects to deliver fast tracked investigations, optioneering, procurement and project delivery of a 10-year conveyance solution at similar flows and pressures to the existing conveyance operation.

1.2 INVESTIGATION

To determine the location of failure, inspection work was completed inside the tunnel by boat mounted CCTV which was also equipped with laser / sonar scanning equipment. The camera was floated through the tunnel attached to a winch cable while both sludge lines were turned on one at a time. Dye was added to the pipeline flow to assist in spotting any leakage emerging from the benching or tunnel lining.

These investigations successfully identified that the failure was within the tunnel, but further investigations were required to determine the exact location/locations of failures to allow these to be repaired.

A purpose-built camera was commissioned to capture 2km lengths of unimpeded footage enabling the internal inspection of both pipelines within the tunnel. Access for the camera and associated winch cable were established by removing the air valve tees which are located a short distance downstream of the tunnel access chamber.

The camera found the following defects:

- Northern line – burst in the pipe wall approximately 235m from Adelaide Road
- Southern line – burst in the pipe wall approximately 170m from Adelaide Road.

The footage identified significant water ingress to the pipe and post processing of the footage was used to determine the burst widths to be approximately 65-70mm.

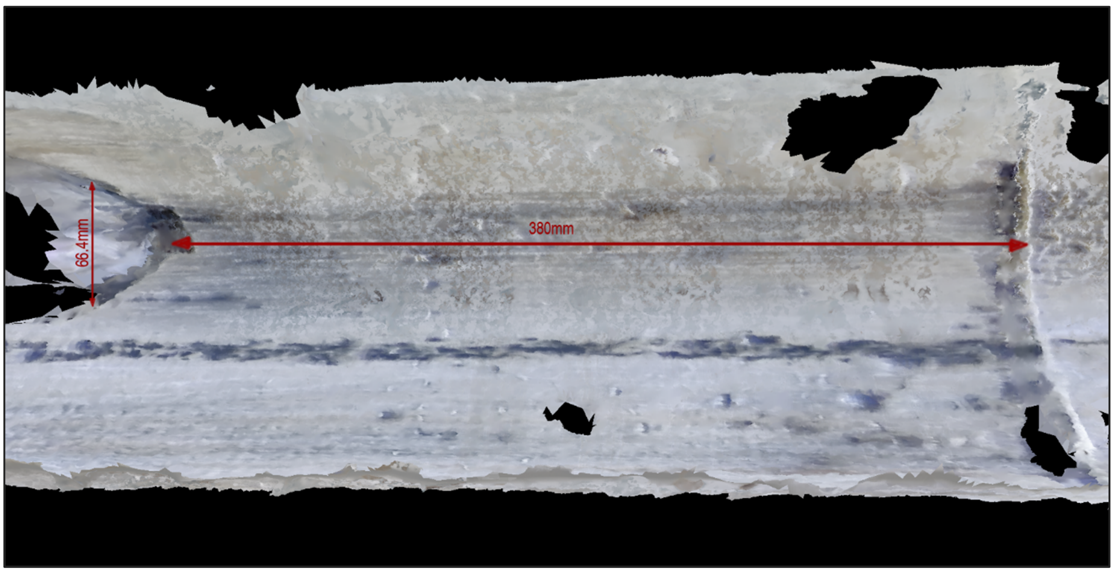

Figure 3: Post processing of CCTV footage to identify burst size and pipe features.

1.3 APPLICATION OF NEW OR INNOVATIVE PROCESSES, TECHNOLOGY OR METHODOLOGIES

Once the location and extent of the damage was identified, possible solutions needed to be assessed. Stantec led workshops on possible repair and rehabilitation options. Due to the unique nature of the incident, it was agreed with Wellington Water that all potential options, including non-approved materials were on the table, and a team of consulting engineers, contractors and clients subsequently refined the options as more information became available from the site investigations.

It was clear the repair works would potentially involve work in a tunnel environment with high chance of gases, and an experienced contractor would be required to manage this process. Wellington Water appointed BPC from their contractor panel to provide early contractor involvement in the options assessment and ultimately to act as lead contractor for completion of the repairs.

As the pipeline failures identified by the CCTV footage had occurred in the same general vicinity of the 2013 burst, and there were no operational or seismic events identified as possible contributing factors, the option assessment progressed on the assumption that the failure mechanism was continued external corrosion, and a solution needed to be found that would minimise the chance of this in the future.

An important element in the option assessment was the need for work inside the tunnel, or to not work inside the tunnel. As there is no alternative discharge route for the gravity flows in the tunnel, isolating the tunnel for any extended period was not possible without setting up over pumping lines within the tunnel itself. The set up and operation of over pumping would add complexity, time and risk to an option, while also restricting the available working space.

Stantec compiled an options long list and recommendations as to whether the option should be shortlisted for further assessment. The assessment criteria included;

- Safety
- Programme
- Cost
- Constructability
- Consent & Approvals
- Meets Design Criteria
- Operational Redundancy
- Resilience & Repair

The long list (Appendix A) was quickly reduced to a short list of just one solution, and the choice of two products, neither of which were in common usage in New Zealand. Both available solutions were unapproved materials; a non-structural polyethylene liner reinforced by a fibrous weave. We were also looking at the works being one of the biggest pull of such liners in the world at the time.

1.4 ORIGINALITY IN APPROACH AND ANALYSIS

It quickly became clear that the repair options to be considered were not standard products that are commonly used in New Zealand. Early on in the process we obtained client agreement to go outside their approved list of materials to be able to consider the non-structural liners.

Stantec undertook a detailed assessment of the products available. The criteria can be summarised to:

- Company history
- Manufacturing location
- NZ approved supplier / installer
- Product details
- Product construction materials
- Manufacturing standard
- Parameters required to achieve operating pressure
- Maximum bend angles
- Design Life
- Operational requirements
- Connectors
- Suitable for single “long pull” installation (1,800m).
- “Approved Product” status with Global Water Authorities
- Projects completed / track record
- Uses in New Zealand

- Cost

It should also be noted that as the options assessment was underway in February 2020, the impact of the rapidly developing COVID-19 situation was not known or allowed for in the assessment.

The assessment of the information on the systems showed that both liner systems met the project requirements for pressure class, design life, ability to accommodate bends and installation loads. Globally both liner systems had been used in similar applications and were accredited for use by multiple water authorities.

Stantec undertook further due diligence on behalf of Wellington Water to be able to provide a recommendation. Among many aspects, this required a detailed understanding of how the product would interact with the host pipe, how damage to the product was mitigated during installation, and how the project can be supported locally both at present and in the future.

Of particular interest was how the liner interacted with the host pipe. The PrimusLine system requires an annular gap between the host pipe and liner; that is, the liner cannot be in complete contact with the host pipe in operation. When the liner options were being assessed, Stantec did not have site verified data to confirm the pipe internal diameter due to difficulties establishing access to the pipe. Reducing the liner diameter to the next available size would have resulted in a much smaller bore and the existing pumping operation would have to be modified with no known consequences on the rest of the network. SaniTube is a close fit system whereby the liner expands under pressure to form a close fit with the host pipe negating any risk around the requirement for an annular gap.

The assessment ultimately concluded the SaniTube product as the preferred option on the following basis:

- It met the technical requirements of the project and was an established product in use with European water authorities,
- It had been used on similar scale projects,
- De-risked the need to achieve an annular gap,
- Could be installed with additional protection to lower the risk of damage during installation,
- Liner installation would be supervised by experienced staff provided by the European manufacturer / installer,
- It is supported by an experienced New Zealand trenchless contractor with good track record of delivering complex projects and who already had first-hand knowledge of the project, key risks, issues etc.

The recommendation to procure the SaniTube system with Hadlee & Brunton acting as a subcontractor to BPC was accepted by Wellington Water. The appointment was conditional on Amex Sanivar providing suitably experienced staff to supervise the liner installation, testing and commissioning, a recommendation that was made prior to the COVID-19 lockdown.

1.5 DESIGN

1.5.1 SYSTEM HYDRAULICS

The SaniTube system resulted in the internal bore of the sludge pipeline reducing from 152mm to 144mm.

To deliver the required 20 l/s design flow an approximate 1 bar increase in system pressure upstream of the tunnel is required. Post-lining HGL’s are shown in Figure 4.

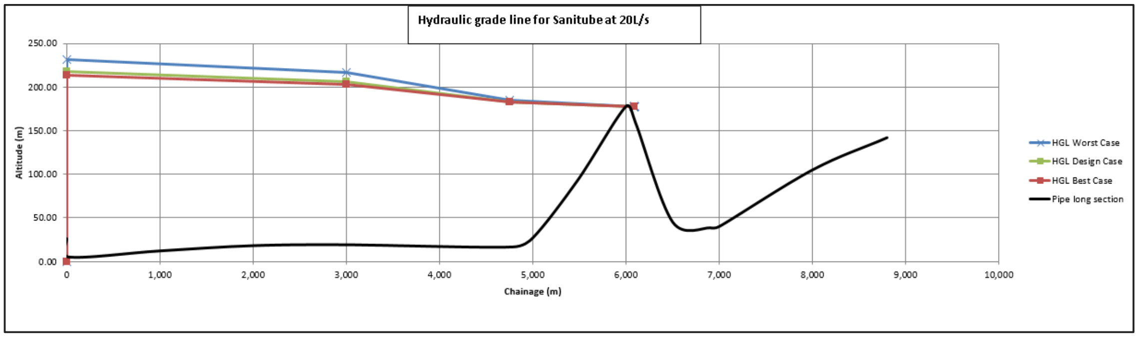

Figure 4: Hydraulic Grade Post lining

Review of the pump curves supplied by Veolia for the positive displacement sludge pumps found this increase was well within their rated capacity. The pipeline between the sludge pump station and the Onepu Road pigging station is constructed from CLS, with DI used between the pigging station and the Kilbirnie tunnel portal. The 1 bar head increase is well with the allowable operating pressure for these pipelines (40 bar and 46 bar respectively), which should be in acceptable condition as they are only ~25 years old. They are also accessible for repair should the minor increase in pressure result in a failure, for instance at a poorly welded joint, although this is considered a low risk.

Flow and pressure data for each pipeline post lining was obtained from Veolia to verify the expected performance. The northern line data sets showed a ~1 bar pressure rise with no loss in flowrate in line with the calculated values.

A Joukowsky head calculation was completed to estimate the transient pressure envelope for the lined tunnel section of the pipeline assuming a pump trip scenario. The calculation provides a conservative estimate of transient pressure and is typically used as a starting point to determine level of risk and whether a more in-depth analysis is required using computer simulation. It also ignores the fly wheels provided at the pump station for transient protection. The maximum pressure rise was found to be 35 bar at the upstream end of the tunnel and this figure was used to set the minimum allowable pressure rating for the liner supply. Please see Figure 5.

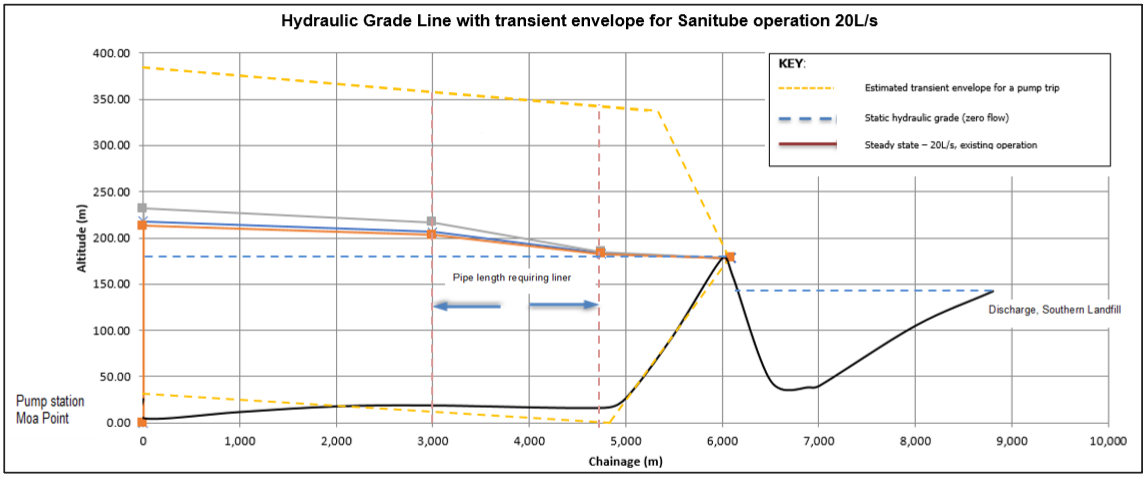

Figure 5 - Transient Envelope with Sanitube Liner

It is noted that this is conservative in comparison to transient analysis completed for the original pipeline design.

1.5.2 CONNECTION DESIGN

For the liner installation it was necessary to expose and remove a section of the sludge pipe at each end of the tunnel. To minimise frictional forces during the liner installation it was necessary to provide access at a point where a straight pull could be achieved.

Difficult access to the sludge pipelines, and the presence of vertical and horizontal bends, meant the most suitable location to expose the pipelines was within the tunnel itself at each end. This construction requirement largely dictated Stantec's design of the transition between the liner and existing pipeline.

KILBIRNIE CONNECTION

The existing access to the tunnel, at approximately 30m from the end of the tunnel, at Kilbirnie was a 7m deep shaft located within Regal Gardens, containing the outlet flow control penstock. The presence of the penstock, depth of the chamber, sloped and constrained worksite in Regal Gardens and poor alignment for pulling the liner meant this chamber was not suitable for construction.

The very end of the tunnel, located beneath the Wellington City Council owned community garden situated between Queens Drive and Leonie Gill pathway, was assessed as a better location to expose the pipelines. At this point the tunnel transitions to a trapezoidal section via a tumbling bay.

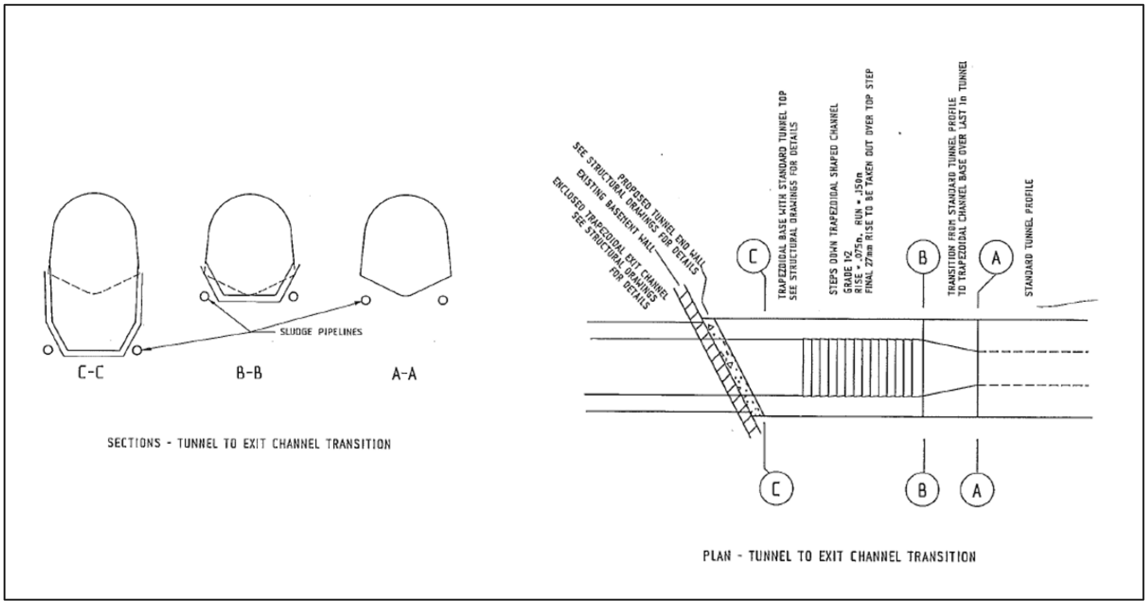

Figure 6: Kilbirnie Tunnel Transition

The sludge pipelines were exposed by breaking out the tunnel benching and a stainless-steel sleeve used to transition the liner through the headwall of the tunnel. The headwall, which includes a steel plated access opening, is normally buried. The Wellington Water Customer Operations Group (COG) requested that a chamber was provided around the headwall opening for future tunnel access and to locate the SaniGrips within, this was added to the design.

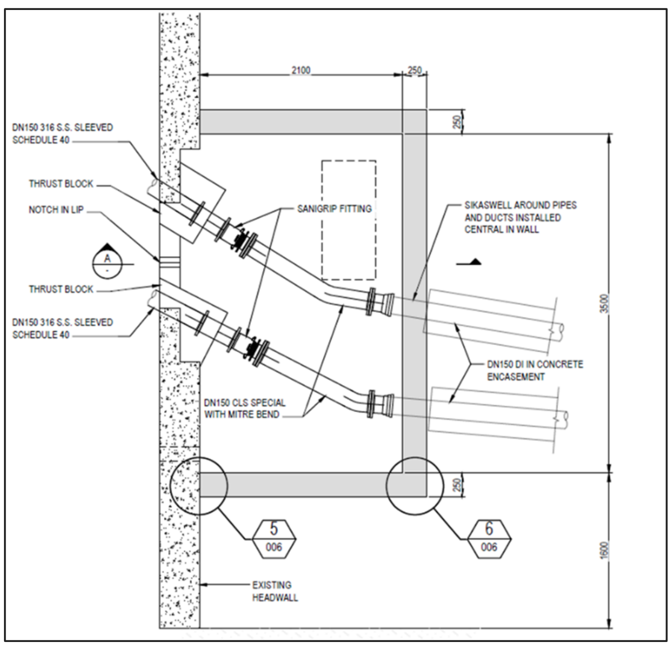

Figure 7: Kilbirnie Tunnel Access Chamber

The existing sludge pipelines follow the incline of the tumbling bay to the invert level of the trapezoidal channel. To avoid excavating adjacent to the channel to connect back into the existing pipelines a short length of new DN150 PN35 DI pipe was provided between the headwall SaniGrip chamber and the existing scour chamber in Leonie Gill pathway. The old section of sludge pipe was plugged and abandoned.

ISLAND BAY CONNECTION

The limited as-built drawing information for this site indicated that the sludge pipelines passed from the tunnel into the base slab of the 2x2m access chamber where they turned horizontally to clear the chamber footprint before turning vertically to transition to a shallower depth. Air valves and the Adelaide Road pigging station are located immediately downstream of the vertical transition.

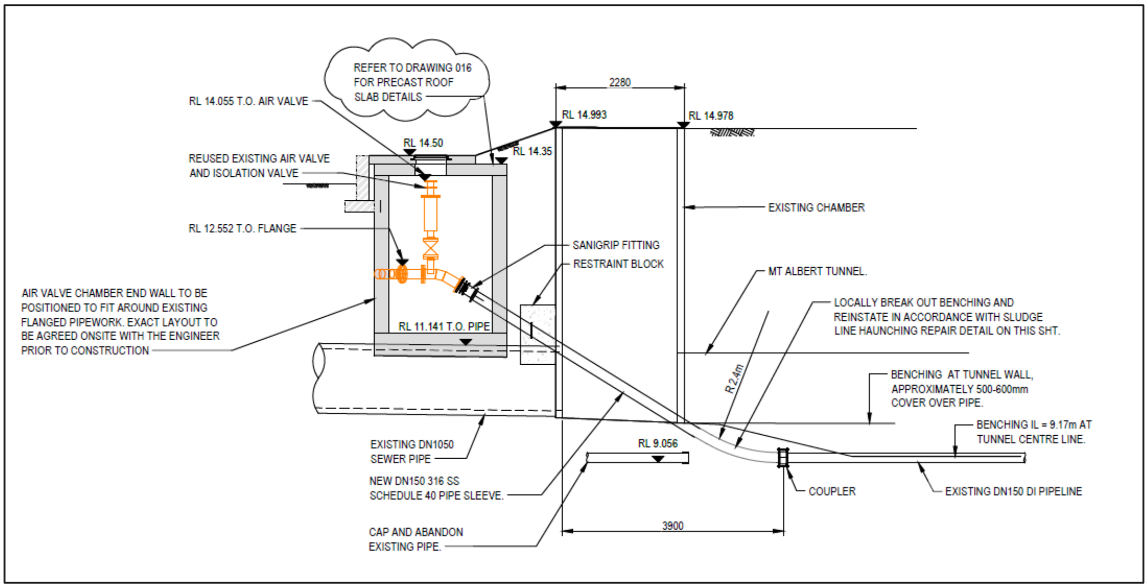

Figure 8: Island Bay Tunnel Access Chamber

The benching concrete was broken out at the mouth of the tunnel to expose both pipelines and stainless-steel sleeve pipes used to transition the liner out through the wall of chamber either side of the incoming DN1050 sewer.

The air valves that had previously been removed to create access for the CCTV inspection were relocated into a new RC chamber that also housed the SaniGrip fittings. The chamber drains and vents back into the original access shaft. DN150 CLS pipework was used to tie back into the original pipelines at the point where the air valves were originally located.

1.5.3 SAFETY IN DESIGN

Safety was paramount on this project, both during the construction works and for ongoing maintenance due to the location of the bursts. A Safety in Design register was maintained as a live document throughout the project and is now owned by Wellington Water. Repair options were workshopped with the Wellington Water COG team and panel contractor to ensure the construction and operational risks were fully assessed and mitigated.

Key project risks and mitigations are noted below:

- Confined space entry to the tunnel to implement repairs. The selection of a pull through liner minimised the need to operate within the tunnel.
- The sludge tanker operation presented risks around driver fatigue, high traffic volumes in residential areas and the handling of infectious material. The selection of a pull through liner had a relatively short implementation period allowing the sludge tankers to be demobilised.

- PS38 gravity network was used store flow while the pumps were switched off for access to the tunnel, this presents a risk of overflow and a pollution event occurring on the south coast. The selection of a liner reduced the need to implement flow control measures reducing the likelihood of an overflow.

1.6 CONSTRUCTION

The construction work was completed in three key phases through March to December 2020:

- Enabling works (March / April)
- Liner installation and pipeline connections (May / June)
- Chamber construction, tunnel benching repairs and site reinstatement (July to December)

It is noted that due to Covid-19 delays with the supply of the pressure patches the insertion of the patch only occurred immediately prior to lining. The original plan to insert the patch ASAP and return the pipeline to service until the liner was ready did not eventuate.

The project team did however source temporary high head pumps and obtain approval from WCC to place them within Berhampore Golf Course. Re-pumping significantly de-risks the chance of a new burst or patch failure by lowering pipeline pressure within the tunnel. While the pumping equipment was ultimately not required due to the delay in the patch supply, the re-pumping measures did provide a Plan B if the liner installation encountered issues, following patch installation.

1.6.1 LINER INSTALLATION AND PIPELINE CONNECTIONS

The liner installation was completed by Hadlee and Brunton Ltd with support from the manufacturer Amex Sanivar. The installation was preceded by patching of the burst within each pipeline, after BPC had broken out and exposed the pipe at each end of the tunnel.

The patching was essential to halt the flow of sewage and groundwater into the pipeline allowing each line to be thoroughly flushed, pigged, and inspected by CCTV prior to installation of the protective sleeve and subsequently the liner. The patch also protected the liner from the shape edges of the failed section of the pipeline.

The patching was completed with the Quick-Lock system uses a stainless-steel sleeve with EDPM compression seal wrapped around it. The repair and seal of the damaged area is achieved by means of a permanent pressure contact between the EDPM seal and pipe wall, held in place by the steel sleeve which is expanded and locked off once pressure contact with the wall is achieved. The patching successfully achieved a full seal from external water entry in both pipelines

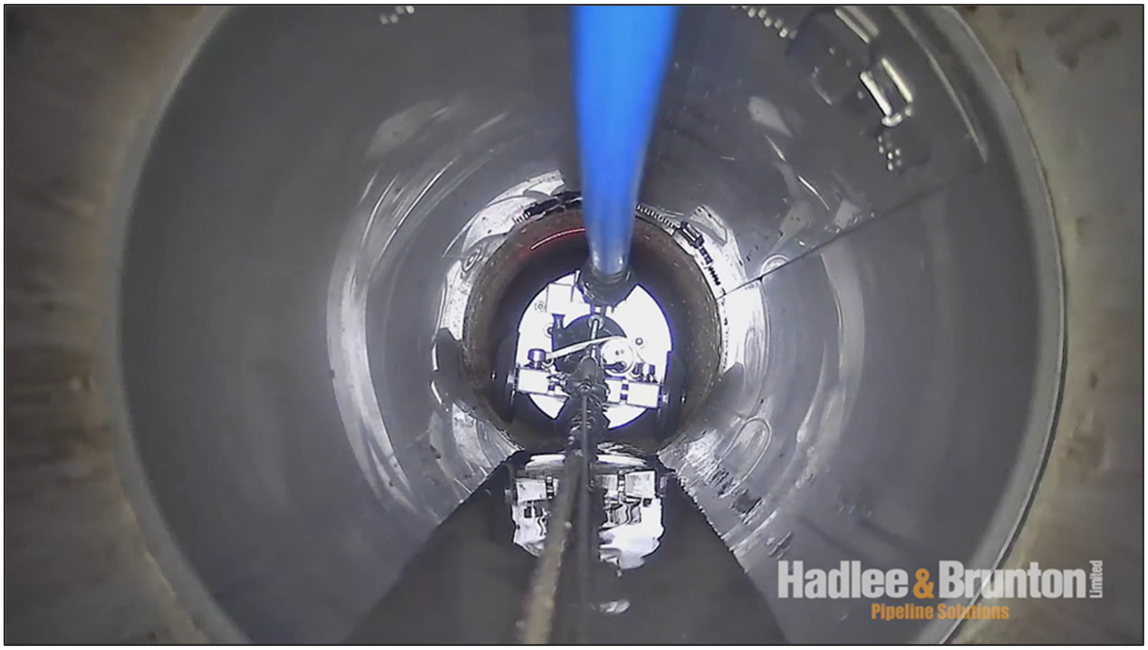

Figure 9: Quicklock Patch

Final pre-lining CCTV showed a clean bore free of debris and no unexpected features, such as sharp edges, at the bends. It was also noted that the level of scouring /scratching to the soft foam surface of the pigs after pull through was minor indicating a suitable bore for lining.

The protective sock and liner were winched from the Adelaide Road end to Kilbirnie to lower frictional forces as the tunnel bends were closer to the Kilbirnie side. The liner and sock were installed using winching equipment supplied and operated by Broadspectrum. The equipment allowed monitoring of winch loads, which as expected were highest at the very end of the pull but still significantly below allowable maximum load. The installation of both liners was completed in one continuous shift with no notable issues encountered for either pull

Figure 10: Commencing lining

The CLS and DI pipeline connections at Adelaide Road and Kilbirnie were completed by Wellington Water's Pipelines Group and GP Friel Limited after the liner installation. Both sections successfully passed pressure testing completed in accordance with the Regional Specification for Water Services (2019).

Pressure testing of the northern pipeline liner was completed in accordance with the manufacturer's guidelines. Issues were encountered with the continued displacement of lubricant from at each end of the tunnel as the liner was pressurised and the annular space between the liner and host pipe reduced (approximately 1m3 of lubricant was used during installation). This continued displacement meant the pressure drop recorded during the test was marginally outside the allowable to achieve a pass. The risk the pressure drop was due to leakage was deemed to be low and given the urgency of the project the pipeline was put into service after agreement with Wellington Water. No observable leakage has been noted from the sleeve pipe ends (following an initial period to push out any remaining lubricant) and static pressure during pump cycles remains stable indicating the pipeline is preforming as expected.

The southern pipeline was tested in accordance with NZS 2566 Appendix M5 which it passed. This test has a longer initial pressurisation (12 hours) which allowed for the annular fluid discharge to stabilise prior to the test being completed. A lesser volume of lubricate was also used during installation.

A destructive test was also completed on a sample piece of the liner by EHL Group in New Plymouth. The sample piece burst at 78.5 bar, which exceeded the rated 70 bar burst pressure.

1.6.2 BENCHING REPAIRS

The initial CCTV survey of the tunnel, completed via boat mounted camera in February 2020, had identified areas of damaged benching up to approximately 222m into the tunnel from the Adelaide Road access shaft. Due to the urgency to complete the liner installation further inspection of this damage was not completed until after the liner was installed and sludge pumping recommenced.

A confined space entry was completed in July 2020 with the flow from PS38 being held back to allow assessment of the damage with minimal flow in the tunnel. This identified areas where benching had been fully lifted, tilted and / or cracked. The damage was generally concentrated in the vicinity of the two burst locations and as such is thought to be related to the pipe failures, as opposed to other mechanisms such as seismic movement, or groundwater pressure. The boat survey showed no other notable damage in the remainder of the tunnel beyond the 222m mark.

To enable the repairs an pumping system used whereby sewage was pumped through temporary rising mains installed into the tunnel. A new access chamber was installed onto the DN1050mm incoming pipe to the tunnel to act as a wet well to reduce the number of pipelines required within the access shaft to the tunnel.

Figure 11: Over pumping set up

No pre-existing benching damage was observed at the Kilbirnie end of the tunnel, however, the inside face of the headwall, which is located immediately above the tumbling bay, had experienced significant hydrogen sulphide attack. As the headwall had been modified to allow the two sleeve pipes to transition out of the tunnel the corrosion was repaired at the same time as the making good of the penetrations created for the sleeves.

2 CONCLUSIONS

2.1 ENHANCED RESILIENCE AND REDUCED RISK

Both sludge pipelines had burst in close proximity to the Adelaide Road. The client has accepted that the likely failure mechanism is due to external corrosion of pipe. The solution implemented by the project team involved lining of the whole pipeline, and not just a repair at the location of the break, which is what occurred in 2013. This ensures a greater resilience of the whole pipeline in the future if there are other are sections susceptible to external corrosion. So, as well as removing the existing failure, the solution implemented reduced risk of further failure.

2.2 SUSTAINABILITY

Whilst the liner has a design life of 50 years, the idea of pumping and disposing of sludge at the landfill is not expected to have a life of 50 years, and the operation is reaching the end of its consent period. This means at some point there is potential the sludge pipelines, and liners installed within them, will become redundant.

Wellington Water was looking for a solution that would give them at least ten years of pipeline life, and this solution meets this requirement.

2.3 CONTRIBUTED TO BETTER ENVIRONMENTAL OUTCOMES

The result of the pipeline burst was that sludge could not be piped to Carey's Gully, and the only option available bar pumping it out to sea was to truck the sludge for a 24-hour operation in road tankers.

These road tankers were noisy, smelly, and as they were going past at six-minute intervals, fairly disruptive to the local community. Fast tracking delivery of a solution removed the risk of an environmental incident, and also meant Wellington Water could get these trucks off the road when they said they would.

The disposal of biosolids (sludge) to landfill is a problem that exists across New Zealand and is not the long-term solution for sludge disposal. Sludge drying and stabilisation is carried out in New Zealand, but not at every plant. Wellington Water is currently underway looking at alternative options for biosolid treatment and disposal as the consent for disposing at the landfill nears its end. The solution agreed upon and implemented has been designed to extend the life of the pipelines for at least ten years, while a longer term, more sustainably solution, for the sludge is found.

During construction considerable care and planning had to be undertaken with the assistance of Wellington Water in order to reduce flows from local wastewater pump stations to enable works inside the tunnel to occur safely, but not result in a spill to the environment. This became a well-planned communications exercise with trigger points to enable resource to exit the tunnel and the pumps to be turned back on safely with no spills to the environment.

2.4 OTHER ENVIRONMENTAL FACTOR

On 25 March 2020 New Zealand entered a country-wide COVID-19 Level 4 lockdown, meaning all but essential workers had to remain at home and in their bubbles. Whilst there had been some preparation for this in the weeks prior, the change from Level 2 to Level 4 was rapid. This was quickly deemed a critical site and the staff on it essential workers, but Stantec needed to work with Wellington Water and the contractors to determine how the work could be carried out safely under these circumstances.

Josh Wright, Stantec Project Manager on this project as well as the Moa Point Interceptor Lining project, was deemed a critical resource, and it was decided he could not visit either of the sites with the team, as the consequence of him getting unwell was high. There previously was some cross over in the teams, but Stantec rearranged resourcing to ensure two separate teams were involved in the site monitoring of these projects, removing the risk of cross contamination if there was illness in one of the teams.

Protocols were put in place with the contractor around distancing on site, materials that could be touched, and site PPE. Emergency service cards were issued by Wellington Water to ensure the access of anyone travelling to or from site was not impeded.

The German workers who were flown to New Zealand to carry out the installation completed the same two-week quarantine period as all others coming into New Zealand. This time period had to be built into the planning of the works.

2.5 THE COMMUNITY

The planning efforts of Stantec identified risks such as property excavation, environment spills, and odour. Stantec were able to identify affected areas of the community and communicate directly with them.

Excavation of the community garden began in February 2020, not long before the gardeners could harvest their crops. Site meetings were held by Stantec to inform gardeners of the issues and the proposed solutions. The gardeners then understood and agreed with the objectives of the project and promises of improved reinstatement of the garden were offered and delivered. Additional plots were created to enable new members to join.

Significant effort was put into stopping wastewater entering the environment, both in this project and the sludge trucking operation. Stantec was conscious of recent media attention regarding the water quality at beaches along the south coast. Planning was carried out in conjunction with Wellington Water and BPC to successfully convey all waste to the Moa Point Treatment Plant.

Residents who had odour issues were able to contact the project team directly. Stantec would work with BPC on an appropriate measure to successfully suppress odour. It was also communicated that odour issues usually occurred during a change in phase or activity which enabled residents to understand that progress was being made.

Further to this, BPC utilised the local scout hall as their site office. This provided the Scout troop with a revenue stream through the Covid-19 lockdown and beyond.

2.6 CLIENT SATISFACTION

Testimonials on the success of this project from Stephen Wright (HEB, formerly Wellington Water Head of Major Projects) and Steve Hutchison (Wellington Water Chief Advisor Wastewater) are included in Appendix B.

Wellington Water's CEO, Colin Crampton, described this project as "A defining project in Wellington Water's history". There was no possibility of failure on this project, of not finding a suitable solution in the timeframe, and not implementing that solution.

Mayor Andy Foster and councillor Sean Rush visit the site with Josh Wright and Elliot Altham, right, from consulting engineers Stantec. Photo: Supplied / Wellington Water

Figure 12: Stantec team onsite with WCC Mayor (Radio New Zealand website)

In this regard cost became a secondary element to time and quality. Stantec focused on reallocating the best resources to this project team, and the core team focused on finding a technical solution to take to Wellington Water for approval, and then designing and procuring that technical solution in a short timeframe. As this solution had never been used before in New Zealand, we needed to provide sufficient analysis and confidence to Wellington Water that it would have a high chance of success and be delivered in a timely and safe manner

ACKNOWLEDGEMENTS

Project name	Mount Albert Sludge Pipeline Repair
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REFERENCES

APPENDIX A

Sludge pipeline rehabilitation/repair options

Stantec were tasked to undertake a long list multi-factor analysis for the repair and rehabilitation of the recently failed sludge pipelines within the Mt Albert Tunnel. The purpose of the analysis is to undertake a high-level review of options and discard options that are not feasible, resulting in a short list. The short list option will be reviewed in more detail and a preferred option will be determined.

The following categories were used in the high level multi factor analysis:

Safety	• Does the option minimise or reduce working inside the tunnel which is a critical risk? • What new risks does the option introduce?
Programme	• Lead time for materials / mobilisation • Construction time
Cost	• Physical construction costs • Any ongoing operational cost to consider?
Constructability	• Technically feasible- within current machine / material capability • Contractor experience • Access & temporary works requirements e.g. flow control
Consent & Approvals	• Permissions & consents that are likely to be required
Meets Design Criteria	• 10-year minimum design life • Maintain current flow rate
Operational Redundancy	• Maintain or improve the operational redundancy of the current system (duty / standby pipelines).
Resilience & Repair	• Ease of locating and repairing failed pipe. • Seismic resilience

The analysis was undertaken with based on the below assumptions:

- Failure method is external corrosion
- Existing pipeline is a continuous conduit and no realignment is required
- Benching repairs requiring man entry will be required irrespective of pipeline rehabilitation option.

Option No.	Description	Safety	Programme	Constructability	Consents & Approvals	Meets Design Criteria	Operational Redundancy	Resilience & Repair	Cost	Recommendation
1	Do nothing to pipeline – use trucks to dispose of sludge	• Minimises working time within tunnel (benching repair only). • Residual risk due to increased tanker traffic through urban area	• No construction timeline, but 10-year programme for overland flow management	• N/A	• N/A	• Does not fulfil design requirements	• No operational redundancy	• N/A	• Construction costs are negligible, however operationally the solution will cost far more over the 10year requirement	**Discard** Too costly, poses an ongoing safety risk and does not meet design requirements.
2	Breakout pipeline in tunnel and complete spot repair (at same time as benching repairs)	• Increased duration in tunnel for pipe repair (in addition to benching works). • Work within live sewage environment	• Relatively short duration compared to alternatives.	• Constructible; historic project completed	• No additional approvals over and above those required for benching repairs.	• Unlikely to meet design life requirements – pipe is likely to burst again.	• Will perform as the system does currently – duty / standby pipelines	• Difficult to repair, entry to tunnel likely to be required.	• Expected costs to be minimal when compared to other options	**Shortlist** High risk the option won't meet the design criteria as another burst is likely in next 10 years. *Immediate, very short-term solution*
3	Internal patch repair (CIPP, metal sleeve)	• Minimises tunnel access requirements. • Minimal work in the carriageway	• Relatively short duration compared to alternatives.	• Constructible, past repairs completed on Kilbirnie rising main	• No additional approvals over and above those required for benching repairs.	• Does not meet design life requirements – pipe is likely to burst again. • Relatively new technology, lacks WWL track record.	• Will perform as the system does currently – duty / standby pipelines	• Difficult to repair, entry to tunnel likely to be required.	• Expected costs to be minimal when compared to other options	**Shortlist** Option does not meet design criteria as the pipeline is likely not to last 10 years. *Immediate, very short-term solution*
4	Slipline with HDPE	• Works in tunnel required to breakout and expose bends. • Minimal work in the carriageway.	• Mid placed in terms of duration compared to other options.	• Poor - safe maximum pulling length of HDPE through existing pipe is approximately 300- 900m based on tensile strength of PE pipe.	• Additional approvals likely for access to park space for welding / storage / pipe insertion	• Significant loss in internal diameter • PN25 rated 140mm OD has an ID of 102mm ID, current ID is 152mm.	• Will perform as the system does currently – duty / standby pipelines	• Expected to be more resilient than the current situation due to new pipes. • Difficult to locate burst/leakage and complete repair in unlikely event of failure.	• Cost to implement the solution is expected to be median of the options	**Discard** Option is not constructible.
5	Close fit slip line with HDPE or PVC (swage lining or fold and form)	• Work within tunnel required to breakout and expose bends	• Mid placed in terms of duration	• Knowledge and experience is limited within New Zealand.	• Additional approvals likely for access to park space for	• May require the use of a lower pressure	• Will perform as the system does currently – duty /	• Expected to be more resilient than the current	• Cost to implement the solution is expected to be	**Discard** Option is not constructible

Sludge pipeline rehabilitation/repair options

Option No.	Description	Safety	Programme	Constructability	Consents & Approvals	Meets Design Criteria	Operational Redundancy	Resilience & Repair	Cost	Recommendation
		• Minimal work in the carriageway.	compared to other options.	• Supplier / contractor confirmed that swage lining can be pulled through 400m lengths only. A 1.8km length is not achievable • Safe maximum pulling length of HDPE through an existing pipe is approximately 300- 900m based on tensile strength of PE pipe.	welding / storage / pipe insertion	rated pipe in order to fold.	standby pipelines	situation due to new pipes. • Difficult to locate burst/leakage and repair in unlikely event of failure.	median of the options	
6	CIPP full length	• Minimises work within tunnel • Minimal work in the carriageway.	• Mid placed in terms of duration compared to other options.	• Contractor / supplier has confirmed that lining is completed in 400m maximum lengths	• No additional approvals over and above those required for benching repairs.	• Liner is only PN15 bar so will reply on host pipe strength, need to confirm if this is acceptable • Internal diameter will only be reduced by approx. 8mm.	• Will perform as the system does currently – duty / standby pipelines	• Expected to be more resilient than the current situation due to new pipes.	• Expected costs to be median when compared to other options	**Discard** Option is not constructible.
7	Slipline with non-structural liner. E.g. Primusline or Sanitube	• Minimises work within tunnel • Minimal excavation within carriageway	• Suppliers indicate 2-3 weeks materials lead time • Construction time minimal	• Constructible but contractor knowledge and experience is limited within New Zealand.	• No additional approvals over and above those required for benching repairs.	• Technical specification looks like they meet design criteria. • Relatively new technology, lacks WWL track record • Not manufactured to NZS / AS standards. • Questions on cyclic loading capability	• Will perform as the system does currently– duty / standby pipelines	• Expected to be more resilient than the current situation due to new pipes. • Difficult to locate burst/leakage and repair in unlikely event of failure. • May need to remove and replace entire liner	• Cost to implement the solution is expected to be median of the options	**Shortlist** Option should be explored further in the shortlist.

Sludge pipeline rehabilitation/repair options

Option No.	Description	Safety	Programme	Constructability	Consents & Approvals	Meets Design Criteria	Operational Redundancy	Resilience & Repair	Cost	Recommendation
8	Construct new pipe within existing tunnel.	• Extensive physical works required within the tunnel. • Work within environment with live sewage • Over pumping sewage	• Mid placed in terms of duration compared to other options.	• Option is expected to be constructible, however temporary over pumping may be tricky to manage • Condition of tunnel wall to drill into unknown	• Additional approvals likely for access to park space for welding / storage / pipe insertion	• Will meet design criteria • Considered a long-term solution	• On the assumption that one pipeline is constructed, this will not provide operational resilience.	• Expected to be more resilient than the current situation due to new pipe. • Maintenance (leak detection and repair) will be improved as asset is no longer within concrete benching.	• Cost could potentially be quite high dependant on over pumping methodology and time taken to secure pipe within tunnel.	**Shortlist** Option should be explored further in the shortlist. Main concern going forward is H&S issues around access.
9	Lay new pipe(s) on land route	• Minimises tunnel access requirements • Introduces other risks for pipeline construction	• Long duration to implement	• Constructible; business as usual	• Additional approvals required.	• Will meet design criteria • Considered a long-term solution	• Assume 2 no. pipelines constructed. Will perform as the system does currently	• New pipe will improve resilience • Repairs will be business as usual.	• Expected cost to be high when compared to other options.	**Discard** Option has a long construction period and high costs.
10	Directional Drill	• Minimises tunnel access requirements. • Minimal work in the carriageway.	• Long duration to implement. Extensive investigations, design and permitting required.	• Long drill shot technically challenging, high risk. • Knowledge and experience is limited within New Zealand.	• Additional approvals required.	• Will meet the design criteria • Considered a long-term solution	• On the assumption that one pipeline is constructed, this will not provide operational resilience.	• New pipe improves resilience, but repairs will be difficult.	• Expected costs to be relatively high when compared to other options	**Discard** Option has high construction cost, long duration programme, high risks and there is limited knowledge and experience within New Zealand.
11	New PS at Adelaide Rd + Option2 or 3.	• Entry to tunnel still required to repair existing pipe • PS construction introduces additional risks	• Long duration to implement.	• Constructible	• Additional approvals required.	• High risk design criteria are not achieved as pipe is still in bad condition outside of patch repairs	• Will perform as the system does currently– duty / standby pipelines	• Should a repair be required, the pipeline will be in the current situation now.	• Expected costs to be relatively high when compared to other options, ongoing operation & maintenance of new PS.	**Discard**

APPENDIX B

From:	Steve Hutchison
To:	Bridgman, Anna
Cc:	Wright, Joshua; Tonia Haskell; Gary Cullen
Subject:	Reference for ACE awards - Mt Albert sludge pipeline project
Date:	Friday, 26 March 2021 4:38:48 pm

To whom it may concern,

I can confirm I am happy to act as a referee for this project and can confirm that Wellington Water is happy for you to enter this project.

This was a reactive project brought about by the discovery in late January 2020 that both sludge pipelines that usually convey sludge from Moa Point to Carey's Gully sludge dewatering plant had failed. Wellington Water met with our consultancy panel leads and agreed that Stantec would be best placed to pick up this work, which was unclear scope at that stage.

Stantec were able to bring a highly skilled team together quickly by reallocating some existing commitments from the core team to other resources within their business. The team then ran through an assessment of the technical options and brought that back for approval through our 3 Waters Decision Making Committee and proceeded with design and procurement.

The preferred option was particularly innovative, not having been used in New Zealand and with very few examples of similar length, but the team were able to provide sufficient analysis and reassurance to Wellington Water that it would have a sufficiently high chance of success and could be delivered in a safe manner.

This was a high profile project, with significant pressure from many stakeholders to install a solution as quickly as possible to get the sludge tankers off the road. There were some major complications with the Covid situation disrupting the planned approach but contingency planning was undertaken to have alternative options if the overseas materials and specialists couldn't make it into the country.

I can certainly say I was impressed with both the approach to the project and the solution. This was a standout project for Wellington Water last year due to the high profile of the operation and the way an innovative approach was successfully delivered.

Feel free to contact me if you wish to discuss.

Regards,

Steve

Steve Hutchison **Chief Advisor – Wastewater**

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Wellington Water is owned by the Hutt, Porirua, Upper Hutt and Wellington city councils, South Wairarapa District Council and Greater Wellington Regional Council.
We manage their drinking water, wastewater and stormwater services.

From:	WRIGHT Stephen
To:	Bridgman, Anna
Cc:	Wright, Joshua
Subject:	RE: Mt Albert Sludge Pipeline
Date:	Monday, 29 March 2021 2:22:35 pm

On 17 January 2020 one of Wellington City Councils critical assets, a pipeline transferring 1.0Ml a day of sludge to a landfill 8km across the city, failed. Twin 150mm CI pipelines operating at over 200m head had burst along a length laid in the benching of a 1.8km wastewater tunnel beneath Mt Albert.

The temporary measure put in place to avoid discharging wastewater sludge to the sea, was to transport the sludge across the city by road tankers at a cost of $100k a day with a significant impact to local residents with an average of 200 tanker movements a day and the risks of handling and spilling sludge.

The problems to be resolved were complex, a high pressure pipeline, extent of damage unknown, inaccessible within concrete benching in a 1.8km tunnel conveying up to 630l/s of wastewater with no bypass and temporary solution which was costing $700,000 a week.

Utilising their consultant and contractor panels Wellington Water were able to quickly appoint Stantec and Brian Perry Civil (BPC) to undertake the optioneering, design and construction of a solution. The activity brief sought an innovative solution which would be low risk, have minimal operational impact, provide a resilient long term solution, could be constructed quickly (give the high costs of ongoing tankering) and safely, have minimal impact on the community and be of low cost.

Within a month of completing the site investigations, Stantec presented to Wellington Water's Three Waters Decision Making Committee of chief advisors a preferred option of lining the existing pipeline with two 1.8km 150mm diameter high pressure rated polyester liner from Amex Sanivar - Germany. This had been achieved by Stantec and BPC's collaborative project management and knowledgeable technical teams working closely with Wellington Waters operational team, specialist sub-contractors and suppliers to develop robust solutions and understand the detail and risks of each option, which were assessed through long and short list optioneering.

Despite commencing design and construction work as Covid19 arrived and the difficulties caused by the lockdown, Stantec were able to manage and respond to the complexity of developing and delivering an innovative proposal with unknown underground services and structures, and live flows in the wastewater tunnel by establishing clear communications with all. The extent of these communication was excellent and even though everyone except the construction teams was locked up at home, Wellington Water had confidence in the technical decisions being made and work being delivered. Having identified a number of robust options, Stantec also provided Wellington Water with a number of alternatives to partially develop as backup solutions whilst waiting for the resources to arrive from Germany during the international lockdown and restrictions on travel and transportation.

Stantec's work in progressing the optioneering at speed, seeking an innovative solution and a thorough investigation of options against complex constraints, provided Wellington Water with not only a robust solution, but provided a number of alternatives. The collaborative way in which the Stantec team worked with the contractor, sub-contractor and suppliers allowed the team to resolve the technical and logistical issues that came from working in a confined space, within a Covid19 lockdown and with significant time and reputational constraints caused by the ongoing tankering of sludge across the city.

The outcome was achieved with the tankers being removed from the road after four months and new liners installed to provide Wellington City with a resilient solution for the next 50 years.

Happy to be a referee and tweek wording.

Ngā mihi

HEB construction
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