

Lessons learned from one of New Zealand's most challenging civil engineering projects: rebuilding the earthquake damaged pipes, roads, bridges and retaining walls in the city of Christchurch 2011 - 2016.

Considerable benefits of pipe lining

Story: Pipe Lining

Theme: Construction

A document which describes SCIRT's experience with the trenchless technology of pipe lining.

This document has been provided as an example of a tool that might be useful for other organisations undertaking complex disaster recovery or infrastructure rebuild programmes.

For more information about this document, visit www.scirtlearninglegacy.org.nz



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Considerable benefits of pipe lining

Christchurch may have been only an occasional user of trenchless pipe lining technologies to repair pipes before the destructive February 22 2011 earthquake, but all that changed after the seismic upheavals.



All wound up: The Spiral Wound pipe lining technique in use in the suburb of Fendalton.

In the few short years of the SCIRT horizontal infrastructure repair programme the city became the pipe lining capital of New Zealand.

Internationally proven

With about one-third of the city's 1800 kilometres of wastewater network main lines damaged to varying degrees, the prospect of digging up street after street and relaying new pipes was financially daunting.

Not only that, traditional excavation and trenching methods would wreak enormous disruption to many neighbourhoods. That could not be avoided in suburbs where underground pipes were damaged beyond repair and that was the case in many parts of the east of the city.

But, in less critically-affected areas utilising other internationally-proven and cost-effective 'no dig' technologies like pipe lining was attractive.

Substantial savings

The benefits of considerable cost savings from pipe lining for the ratepayers and taxpayers funding the SCIRT programme could not be ignored.

Pipe lining, which does not require trenches to be excavated, involves inserting a new pipe into a damaged host. It's a pipe-within-a-pipe repair.

"It was an internationally proven technology, well-established worldwide, and the economics of it were compelling," SCIRT Executive General Manager Ian Campbell said.

Pipe lining offered a saving of approximately 30% over excavated trenching and relaying. Typically, the damaged pipe was accessed through manholes and crews worked from manhole to manhole installing the liners.

"Relining pipes was much faster, less disruptive and cheaper than trenching and replacing pipes. It avoided having to dig deep trenches in the streets, sheet piling the trench for stability and safety and then resealing the road," Campbell said.

"The total savings of pipe lining to the SCIRT programme is estimated to be \$65 million," Campbell said.

Bigger tool box

"One result of the earthquake repairs has been that we have broadened the range of construction and repair technologies available for horizontal infrastructure here in Christchurch," Campbell said.

"The total savings of pipe lining ... is estimated to be \$65 million"

- Ian Campbell, SCIRT executive general manager



Line up: A SCIRT team uses Cured-in-Place-Pipe lining in the central city in Christchurch.

“The Christchurch City Council now has a number of different tools in the tool box for pipe repairs. Pipe lining has become another option for them.”

Raising the bar

Although pipe lining was used in New Zealand before 2011 it was on a limited scale.

Local authorities contracted pipe lining companies to do the designs and installation of liners. They typically did not set out a specification which meant they had less control over the end result.

That meant there was no specification that SCIRT could pick up, so it developed one itself.

“We set up a system where we have written the specification, we have an approval process for design and installation contractors and that has meant greater control over the results,” SCIRT ‘three waters’ discipline lead Tony Gordon said.

External consultants were brought in to help develop the specification.

“We have done a significant amount of successful lining in the city. There have been teething problems because this was a relatively new technology in Christchurch but we’ve had a great deal more success.”

In developing designs and specifications SCIRT raised the performance bar in the industry. The specification

that references international standards can be used widely in New Zealand.

Streamlining approvals

SCIRT’s “Specification for Pipe Lining” document set out the processes and standards pipe lining contractors must meet in undertaking SCIRT projects.

The specification covered the general design methods to be followed with specific details for each of the three accepted pipe lining techniques: Cured-in-Place-Pipe (CIPP), Spiral Wound PVC and Folded PVC.

SCIRT also established an approval process for contractors who applied to be an approved supplier of one of the three pipe lining products and services. The approval process also covered lining designs for gravity pipes 375mm and less in diameter. Contractors lining pipes of more than 375mm in diameter had to submit a specific design to SCIRT.

Over the SCIRT programme nine contractors and their products were pre-approved to undertake SCIRT pipe lining work. They had to demonstrate their relevant experience, track record, methodologies, management processes and skills and the company’s financial capability to be accepted.

Please refer to the attached document “Approval for Pipeline Rehabilitation Contractors and Systems”.

Contractors, drawn from throughout New Zealand, found Christchurch’s swampy ground conditions challenging.

“The marketplace determined what product would be installed to meet the specification from the list of approved products,” Gordon said.

For example, the Folded PVC method could be difficult to install in pipes where ground water was entering the pipes through cracks or defective joints. That could cool the setting pipe too fast, whereas the Spiral Wound method, which doesn’t require product curing, was well suited to these conditions.

Where a large majority of a pipe was in good order, it was patched lined rather than the whole pipe being lined.

Teething problems

While pipe lining is a technology that has been used for several decades worldwide, a number of problems were experienced in Christchurch. Despite the development of the specification, there were problems with liner damage during installation, wrinkles, bulges due to debris still in the pipes, buckling and shrinkage.

The technology required attention to detail and good supervision. Well-trained and experienced crews produced a good finished product.

Widespread application

Of the total 560 kilometres of sewer and storm water main lines which were repaired or replaced during the SCIRT programme, about 150 kilometres were relined and more than 2000 CIPP patch liners installed.

Pipes ranging from more than 100 year-old brick barrel sewer pipes to earthenware pipes that were installed up to the early 1970s in Christchurch were repaired this way.

This “no dig” technology was used in most suburbs in Christchurch during the SCIRT programme.

Service life

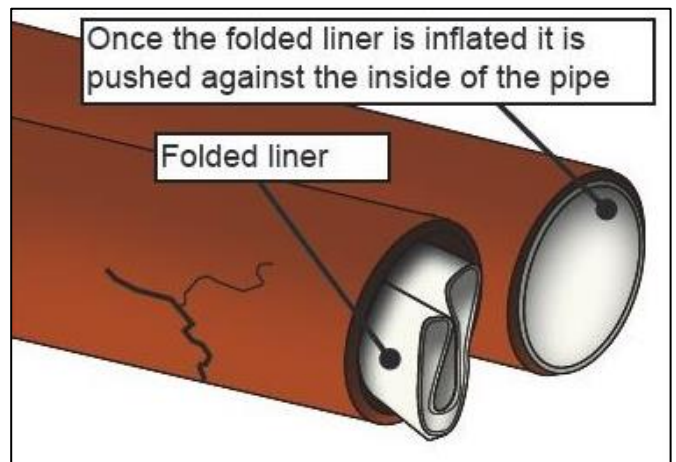
While the pipe lining specification requires consideration of a design life of 50 years, liners may well last significantly longer depending on the onsite conditions and the quality of the installation.

Gordon said the product life included assumptions of how the pipes and materials would behave under 50 years of stress but very few pipes undergo maximum stress continually for that long.

“Basically pipe lining is a plastic pipe within a pipe and should perform as well as any other plastic pipe system if it is installed well,” Gordon said.

Cured-in-Place-Pipe

This method involves a polyester or fibreglass tube or sleeve being saturated with resin and pulled into a damaged host pipe. Then the tube or sleeve is inflated using hot water or steam to harden the resin, making it adhere to the damaged host pipe. The result is a new



Flexible form: An illustration of Fold and Form PVC lining.

pipe within a pipe which restores structural integrity to cracked underground pipes.

Fold and Form PVC Liner

For the Fold and Form method a PVC liner is preheated to make it more flexible so it can be folded and pulled into the damaged pipe. The liner is then inflated and pushed against the inside of the host pipe with steam where the pipe sets in place. This method is simple to install.

Once the pipe is lined, a robotic cutter operated by remote control from outside the pipe is sent down the pipe to cut holes where lateral pipes join the main line.

The advantage of this method is that it can be used on circular, oval and egg-shaped pipes. A skilled crew is critical for this method which also requires a large set up area for equipment.

Spiral Wound Pipe

For the Spiral Wound method a continuous strip of interlocking PVC on a large spool is wound around the inside of the damaged main pipe. The rotational action of the spool pushes the PVC strip through the host pipe with the strips interlocking to form the lining. The lining is then expanded to push against the host pipe to form a secure seal.

This method only suits a circular pipe and cannot negotiate bends but is quick to install.

Similar to other pipe line methods, robotic cutters travel

along the lined pipes and cut holes for openings to the lateral pipes.

Lessons learnt:

- **Good training:** Underestimating the level of training required to carry out pipelining can result in poor installation and problems later. Competent installation crews are essential.
- **Attention to detail:** A specification setting out clear and detailed quality assurance processes to be followed will help contractors produce an acceptable result.
- **Supervision required:** Supervision to ensure contractors carry out pipe lining by following proper designs and specifications produces a better quality installation.
- **Potential savings are considerable:** Pipe lining is estimated to have saved the SCIRT programme tens of millions of dollars over trenching and relaying new pipes. However, as with all developing technologies, there is an increased risk of rework being required and this should be allowed for in cost and time estimates.



Cool approach: Large diameter CIPP lining took place in the cool of night to prevent the resin from curing in Kilmore Street, central Christchurch.