

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.

## Beca Heritage Week brochure – Central City

**Story:** Heritage Bridges

**Theme:** Construction

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A brochure created for Beca Heritage Week 2014, outlining SCIRT's repair work on heritage structures in the Central City. It was handed out to members of the public at SCIRT's walk and talk tours.

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](http://www.scirtlearninglegacy.org.nz)



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## UNCOVERING OUR PAST WHILE BUILDING FOR OUR FUTURE

A walk and talk tour of the Central City



## SCIRT

SCIRT (Stronger Christchurch Infrastructure Rebuild Team) is repairing and rebuilding Christchurch's earthquake-damaged horizontal infrastructure; the publicly-owned water supply, wastewater, storm water and road networks, as well as supporting structures like retaining walls, bridges and culverts. The SCIRT programme of more than 500 projects is valued at around \$2 billion and is the biggest civil engineering project in New Zealand's history. Work has been underway since September 2011 and is expected to take around five years to complete.

Pipes, roads and bridges are as essential to a city's functioning as veins and arteries are to our bodies. Some of Christchurch's most important infrastructure is historical, dating from the late 1800s. SCIRT has the privilege of repairing and rebuilding many historical pipes and structures so they can continue to be used for many more years to come.

## UNDERGROUND OVERGROUND ARCHAEOLOGY



Underground Overground Archaeology has been working in Christchurch for over 10 years. The team now consists of 14 people, providing archaeological services all over the city and further afield.

### Front cover images:

**Top:** Colombo bridge - The warp of the girders is visible in this shot. The curve has been retained in the repaired and strengthened bridge as a memory of the effects of the earthquake.

**Bottom:** Armagh Street bridge - Dams were installed in the river around the Armagh Street bridge so the lower sections of a crack could be accessed and repaired.

## WORKING ON ARCHAEOLOGICAL SITES

### Non-earthquake related repairs

When repairing pre-1900 infrastructure or working near an archaeological site, the organisation carrying out the work needs to contact Heritage New Zealand to find out whether or not they need an authority to destroy or damage an archaeological site.

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### Earthquake related repairs

After the 2010 and 2011 earthquakes, there was an urgent need to get infrastructure repair work underway. SCIRT, together with the Christchurch City Council (CCC), Environment Canterbury (ECan) and Heritage New Zealand, established a suite of global consents to enable SCIRT to carry out infrastructure repair and rebuild work quickly and efficiently. Four of these consents are archaeological 'authorities' which outline the conditions under which an archaeological site can be destroyed, damaged or modified.

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### Archaeological risk maps tell SCIRT if an area is of low, medium or high archaeological risk:

- Low archaeological risk means there is no known history of pre-1900 activity in the area.
  - High risk means there is known history of pre-1900 activity and there is a reasonable likelihood of encountering an archaeological site in the area.
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### Each level of archaeological risk has detailed requirements for archaeological involvement:

- When working on low risk sites, SCIRT workers follow an 'accidental discovery protocol' (stop work within a 20 metre radius and contact an archaeologist).
- When working on high risk sites, SCIRT might have an archaeologist and an iwi monitor on site at all times.

## BRICK BARRELS AND EARTHENWARE PIPES



*Examples of circular brick drains known as 'brick barrels'. These structures were built between 1885 and 1905 and are still in use today.*

A significant proportion of the central city's wastewater (5.2 km) and storm water (6.9km) network is made up of 'brick barrels'. These beautifully crafted pipes, many located at depths more than 2.5 metres below ground level, were built in the 1870s and are still in use today. The wastewater barrels are typically oval or egg shaped, and the storm water barrels are circular, ranging in size from 600mm to 1300mm in diameter. The arched form of some of these brick barrels was achieved by using special tapered bricks, though brick shortages in the 1870s meant many of these special wedge shaped bricks were manufactured on site by simply cutting regular building bricks down to size.

The earthquakes of 2010 and 2011 broke or loosened the mortar joints between the bricks, allowing sand and silt to enter.

SCIRT's investigation work (using CCTV cameras) found that only 20 percent of the brick barrels in the Central City had enough structural and watertight integrity to last beyond another 10 years.

Glazed earthenware pipes up to 460mm in diameter were used to construct the smaller size branch sewers that connect up with the brick barrels. Investigations of some of these damaged 19th century pipe sewers by Underground Overground Archaeologists during the course of their replacement has revealed that these pipes were not locally made but imported. Impressed manufacturers marks on the pipes show that they were made at James Binnie's 'Gartcosh Fireclay Works' located just outside of Glasgow, in Scotland.





*Part of a 100mm diameter earthenware pipe drain private sewer connection installed c. 1885, St Asaph Street. Individual pipes were joined together with a coal tar type material rather than a rigid cement mortar.*

The brick barrels were cleaned out using high-pressure water jets and repaired using trenchless technologies to restore their structural integrity.

Some short sections of the barrels collapsed completely during the earthquakes. SCIRT has replaced these damaged sections with modern materials. Underground Overground Archaeologists have been involved in recording these damaged sections during the course of replacement works, taking measurements and photographs, making drawings, and sampling materials.

Most of SCIRT's brick barrel repair work used trenchless technology, or 'lining', which is a bit like keyhole surgery. When brick barrel pipes are lined, no archaeological involvement is needed because the original structure is not altered.

**There are two main lining methodologies used:**

- 1 'Spiral lining' - a single, continuous strip of PVC is wound into the pipeline using a winding machine (see photo below).
- 2 'Cured In Place Pipe' lining (CIPP) - felt liners are filled with a thermosetting resin, fed into the brick barrel pipes and cured with hot water or steam so the liners stick to the inside of the barrels (see photo below).



## COLOMBO STREET BRIDGE



*SCIRT's Downer bridge repair team uncovered a couple of solid brick walls or buttresses on the Colombo Street bridge. They are probably the remains of part of the 1875 Avon River bridge on the same spot. How do we know the date? From the bricks, which have the initials "WN" for William Neighbours, the brickmaker, who made these bricks between 1868 and 1883.*

*Underground Overground Archaeology Ltd were on site to examine the findings.*

Old Christchurch City Council records show that the Colombo Street bridge was built in 1902, which means it is not an archaeological site in terms of the Historic Places Act. It is however, listed on the Register of the New Zealand Historic Places Trust as a Category II Historic Place. The 1902 bridge replaced a brick and timber bridge dating from the late 1800s.

The 1902 bridge was widened on both sides in 1930 by the addition of new girders (steel structural beams), one on the eastern side of the bridge and three on the western. This widening also included the addition of the arched riveted steel edge girders which were put in place for aesthetic reasons to create the impression of an arch bridge. The ornamental cast iron balustrades date from the original 1902 bridge and were relocated to the edges of the bridge when it was widened in 1930. The concrete pilasters and wingwalls are detailed with stepped rectangular architraving and a lime-based plaster finish.

In 1963, the timber deck was replaced with a reinforced concrete deck and an additional beam was added to improve the bridge's load capacity.

In the February 2011 earthquake, the aesthetic arched girders, which are not load bearing, warped and twisted. The bridge's abutments twisted about 30 degrees, causing the hand rails to bend and pull out of the pilasters.

SCIRT, at the request of the Christchurch City Council, designed the bridge's repair so it would intentionally keep some of these earthquake damaged elements as a visual reminder of the February 2011 earthquake.



## ARMAGH STREET BRIDGE



*Site engineer Tom Harding-Ilott checks the repaired, resin-filled cracks running across the top of the brick arched bridge.*

The Armagh Street bridge was built in 1883 to replace a bridge which had been built on the site in 1873. The new bridge was designed by City Surveyor Charles Walkden, who was responsible for building or rebuilding many of the bridges in the Central City. The Armagh Street bridge is an archaeological site in terms of the Historic Places Act and is listed on the register of the New Zealand Historic Places Trust as a Category II Historic Place.

The bridge suffered significant damage in the February 2011 earthquake including cracking of the brick underside of the bridge, movement of the brick blockwork, damage to the bridge road and footpath surface and fracturing of the cast iron balustrade.



*Below: Some of the old treasures found under the Armagh Street bridge.*

While repairing the bridge, SCIRT has discovered some interesting items, including numerous old bricks (dating back to pre 1900), pieces of metal, an old bullet casing, a tiny hand-nailed shoe, rusty horse shoes and old wooden piles from the original wooden bridge built in the 1870s. Archaeologists

took one of the old bricks, the bullet casing, the shoe, a piece of timber and a metal pin for assessment. The timber pile from the original bridge was identified as Beech. There is a horse ramp near the bridge where people used to wash their steeds and carts hence the horseshoes.

When working on top of the bridge a 20mm thick layer of compacted leather offcuts was found next to a layer of clay material beneath the asphalt surface. It is believed that these were used as shock absorbers for the tramlines as they were also found near other tramlines in Christchurch.

# WALKING TOUR LOCATIONS



Black Map Christchurch 1850 sourced from Wikimedia Commons  
[http://commons.wikimedia.org/wiki/File:Black\\_Map\\_Christchurch\\_1850.jpg](http://commons.wikimedia.org/wiki/File:Black_Map_Christchurch_1850.jpg)

- 1 Armagh Street bridge
- 2 Colombo Street bridge
- 3 Storm water brick barrel outfall
- 4 Stone-capped Victorian drain