



WAYS FORWARD FOR PITA KAIK

How viable are the options for post-earthquake recovery in Peterborough Village?

Geog402

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EXECUTIVE SUMMARY

Peterborough Village (Pita Kaik) has been identified as a neighbourhood centre within the Central City of Christchurch following the devastating earthquakes of 2010 and 2011. The high levels of damage within the Peterborough Village community have meant that there is a need to significantly redevelop the area. Due to zoning, in which the community has been almost entirely zoned as TC3, coupled with the complex geomorphological structures of the area, Peterborough Village has been faced with a range of questions about how to move forward with building and community development.

This research seeks to create an understanding of some of the complex issues present within the Peterborough Village Community in terms of options for future redevelopment. Particular attention has been paid to opportunities for daylighting historical streams in the area, the relationship between the land in the area and the building foundations needed to create more resilient homes and the concept of landsharing in the community's future.

Substantial background research has been undertaken in order to gain an understanding of these issues within Peterborough Village. A focus group was additionally used as a means by which to discuss resident and community members' opinions about such issues.

It was found that a number of options have the opportunity to enhance and define the Peterborough Village community space. Residents have mixed opinions about what should occur within Peterborough Village, who is responsible for future areas of development and how collaboration can occur within the area.

In relation to exposing streams, there is an overwhelming agreement that streams would be favoured in the area. To facilitate this, it is generally agreed that the Christchurch City Council should purchase the land to be daylighted, though there are complexities involved with this, particularly cost.

Foundation options have been essentially reduced, by the Department of Building and Housing, to three choices in the area; Deep Piles, Lightweight Structures on Shallow Foundations and Ground Remediation. Residents are enthusiastic about having the most suitable foundation for their homes, but are unsure about their level of choice in the matter and would benefit from increased involvement in the process.

Discussions on land sharing illustrated the existence of such structures in the community already. Cross-lease scenarios proved to be popular post-earthquake as they provide an appropriate synthesis of independent sovereignty and collective mobilisation. Further investigation is needed into the local political ecology to discover the feasibility of the vast array of communal land share agreements.

It can be seen from this research that there is a need for ongoing discussion within the community about the extensive options available for redevelopment of the area. There is a level of consensus across the group about options, and further discussion with appropriate entities, such as Christchurch City Council may help this consensus to develop further, and promote community empowerment during the rebuild.

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1. INTRODUCTION

The City of Christchurch experienced a series of earthquakes from September 2010, well into mid 2011. Of these, the 6.3 magnitude earthquake of February 22, 2011 was the most devastating, resulting in widespread damage and loss of life (Canterbury Earthquake Recovery Authority, 2011). For a number of months following the February earthquake the Central City was cordoned off, including that of the Peterborough Village community. Peterborough Village lies between Colombo Street and Barbadoes Street, and from Salisbury Street to the Avon River/Otakaro (Figure 1).

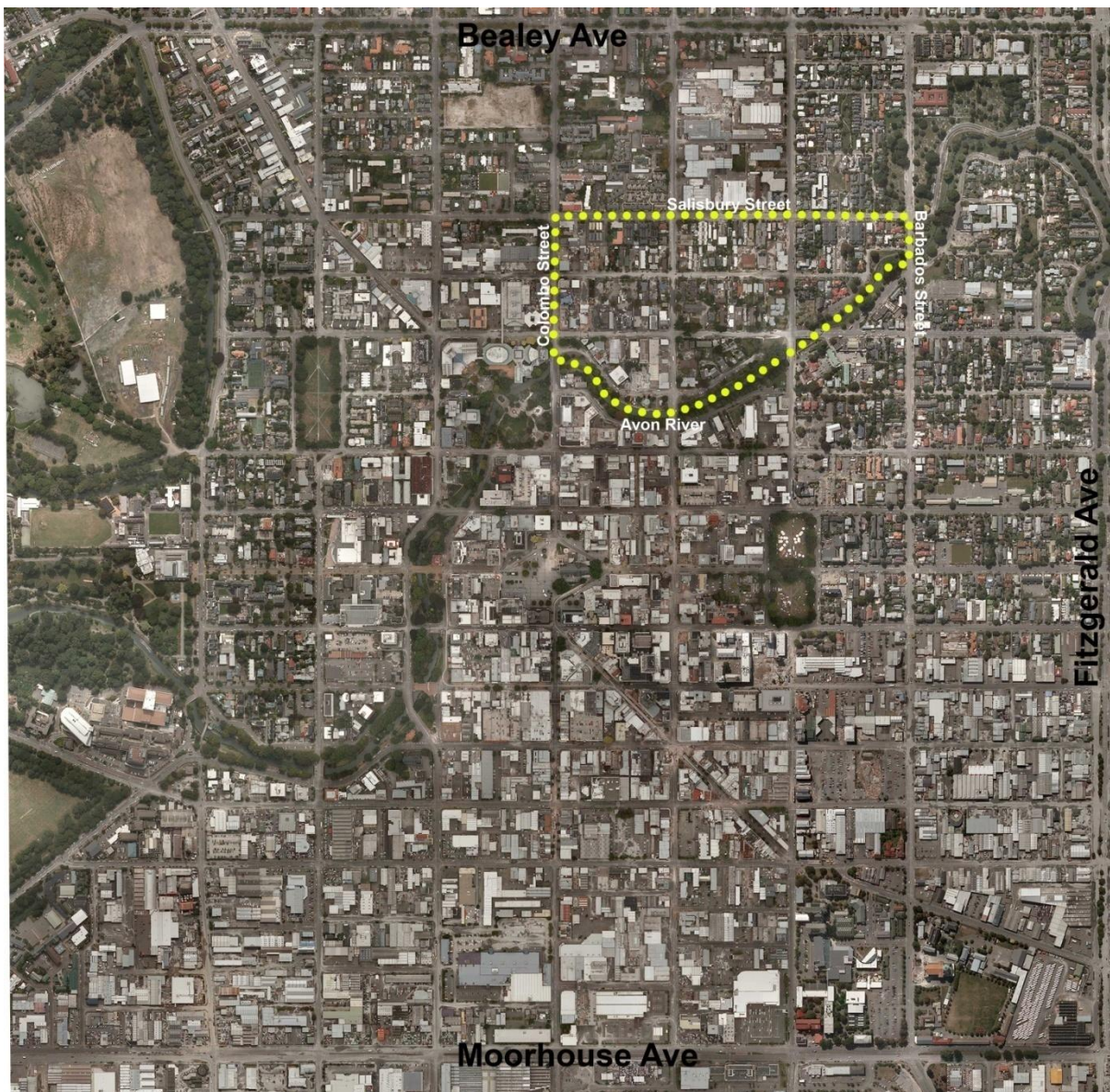


Figure 1: Outline of Peterborough Village (Courtesy of Di Lucas).

The community suffered severe damage from the earthquake with the land considerably prone to liquefaction thus resulting in widespread destruction to houses and buildings.

1.1 Draft Central City Plan

The Draft Central City Plan is a unique approach in terms of urban renewal strategies as it was developed by the wider Christchurch community with respect to how they believed the city should be rebuilt following the earthquake. Within this plan, Peterborough Village was identified as one of five 'neighbourhood centres' which aimed to define neighbourhoods and create a sense of community by providing gathering spaces such as community gardens, meeting venues and drop-in centres. Although the council was to work with each identified neighbourhood, there has been uncertainty about the level of influence that the community will be able to have. As a result, Peterborough Village is seen to have been proactive in developing a relationship with the Council and entering into discussions about the future of the community. Despite this, there is still uncertainty about how much say communities will have in the redevelopment phase due to the considerable influence Christchurch Earthquake Recovery Authority (CERA) has in the future of Christchurch.

A number of ideas have been considered and proposed by Peterborough Village in relation to the rebuild of their area. Included in these ideas is the possibility of daylighting historic streams in the area, building stronger foundations and opportunities for land sharing.

2. CONTEXT

2.1 Demographic data

Peterborough Village, prior to the earthquake, was a vibrant mixed-use community of residential and business. 2006 census data reveals that the area was similar to the rest of the Central City (Table 1).

Table 1: 2006 census data for Peterborough Village and Christchurch Central City (Statistics New Zealand, 2006).

		% under 20	% 20-64	% 64+	Mean of median* Age	Mean of median* household income	% household with no car	% Owner occupier	Total population
Peterborough Village		12.4	85.2	4.0	28	59,700	12.4	10.4	606
Central City	Avon Loop	12.2	77.4	8.8	29	49,000	19.4	19.0	4656
	Cathedral Square	18.2	77.1	4.7	28	50,900	15.8	3.6	1089
	Hagley Park	16.5	67.3	16.0	35	68,900	17.5	9.9	1908
Total centre city		14.1	74.8	10.0	30.4	54,231	18.4	14.5	7653

**Meshblocks provided median values, from which the mean was then calculated.*

In 2006 the majority of the 606 residents in Peterborough Village were between the ages 20-64, with the mean of median household income being \$59,700, slightly more than that of the Central City at \$54,231. 10.4% of the houses were owner-occupied.

A year on from the earthquake, and with ongoing shakes, Peterborough Village has changed in many shapes and forms. A significant proportion of homes and businesses have been demolished, with many residents having to move away from the area.

2.2 St Mary's Stream

One explanation for the extensive damage inflicted upon Peterborough Village is the presence of historic streams in the area, notably St Mary's Stream.

St Mary's Stream historically rose from a spring that was located in the grounds of the old Saint Mary's Church presbytery, hence its name. From here it meandered south towards the Avon River/Otakaro, before tracking north-east along beside the river and eventually emptying into it at the Salisbury-Barbadoes corner (Figure2).

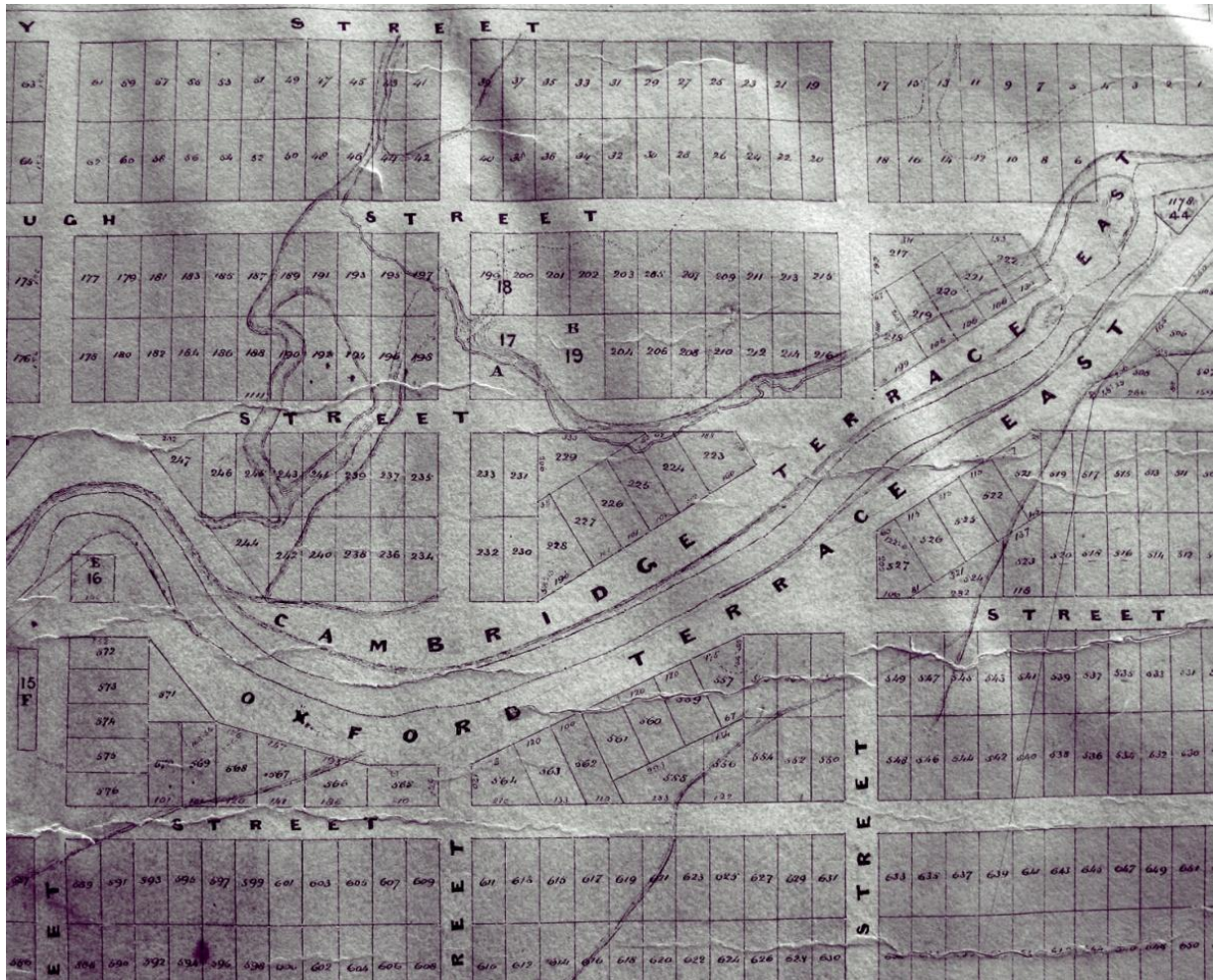


Figure 2: The 'black map' of the underground streams in the Peterborough area. St Mary's Creek is seen to flow to the west of Manchester Street before crossing to the east just below Peterborough Street. From here it flows alongside the Avon River/Otakaro before emptying into the river at the Salisbury-Barbadoes corner. The waters at this junction were used ceremonially by tangata whenua, e.g. for weddings (Courtesy of Di Lucas).

Following European arrival, the stream was diverted to flow into the Avon River/Otakaro at Madras Street (Figures 3 & 4).

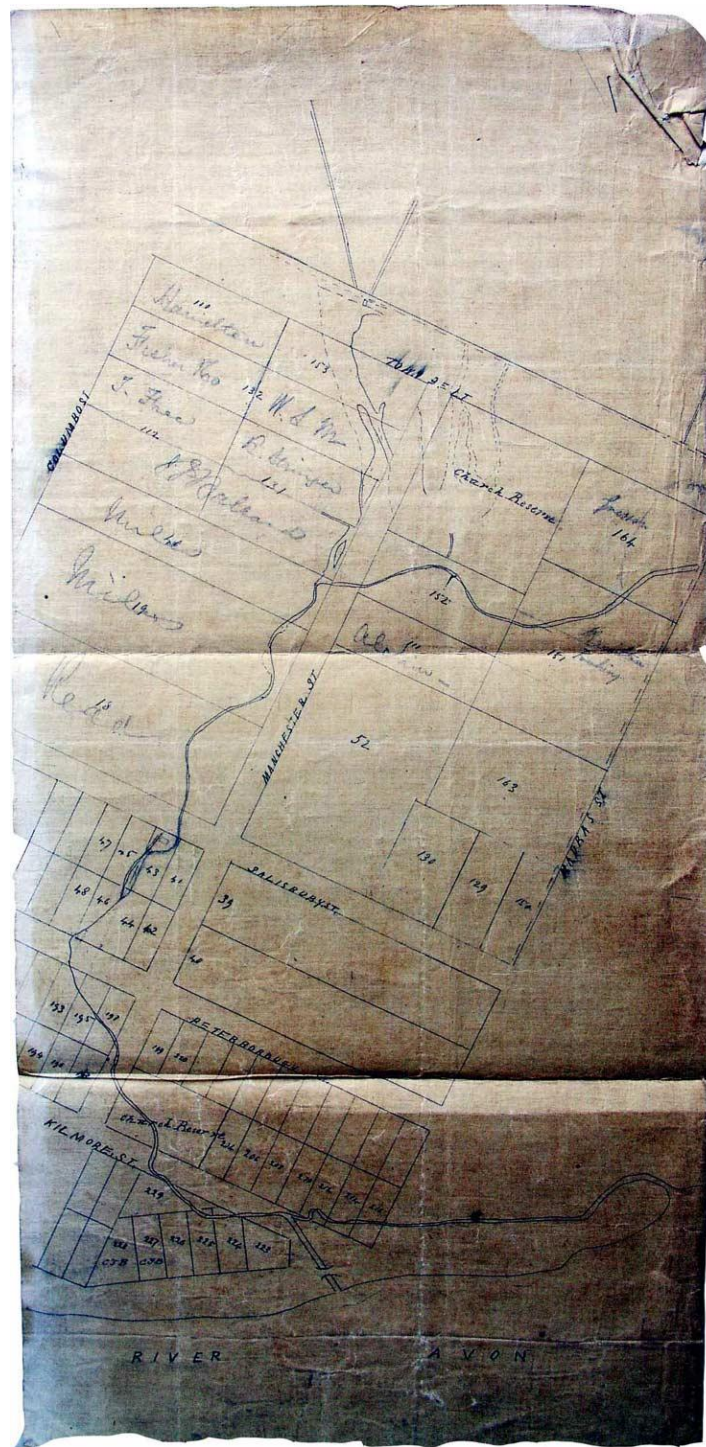


Figure 3: Sketch showing the course of St Mary's stream in 1859. The lower reach has been diverted to flow into the Avon River/Otakaro at Madras Street (Source: Christchurch Online, n.d.).

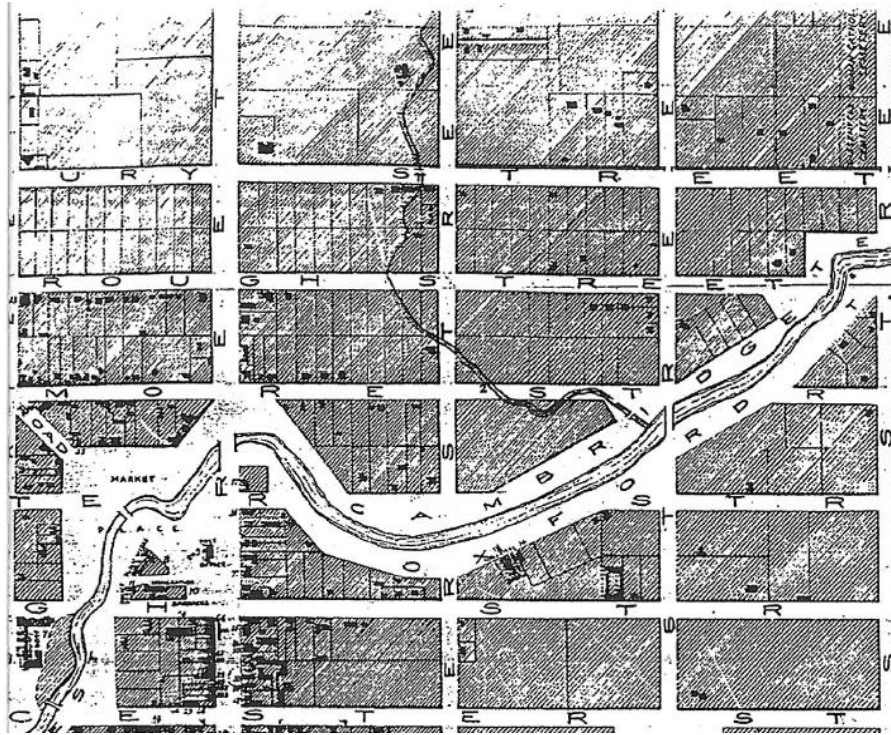


Figure 4: Map of St Mary's creek during the 1870s (Source: Di Lucas).

The stream remained exposed along this course for many years, with development occurring around it (Figure 5).



Figure 5: The first church in Peterborough Village with St Mary's Stream flowing beside it. This was photographed from the vicinity of the Manchester-Kilmore corner in 1905, only 3 years before it was demolished to make way for the 1909 Halswell Stone building (Courtesy of David Moore).

With increased development of the city, the stream was eventually seen as a hindrance and was consequently concealed and re-directed under Salisbury Street, causing long-standing grievances to local Maori. The stream was later diverted even more, into a 1600mm concrete pipe under Manchester Street (Figure 6), and discharge into the river next to the Manchester Street Bridge.

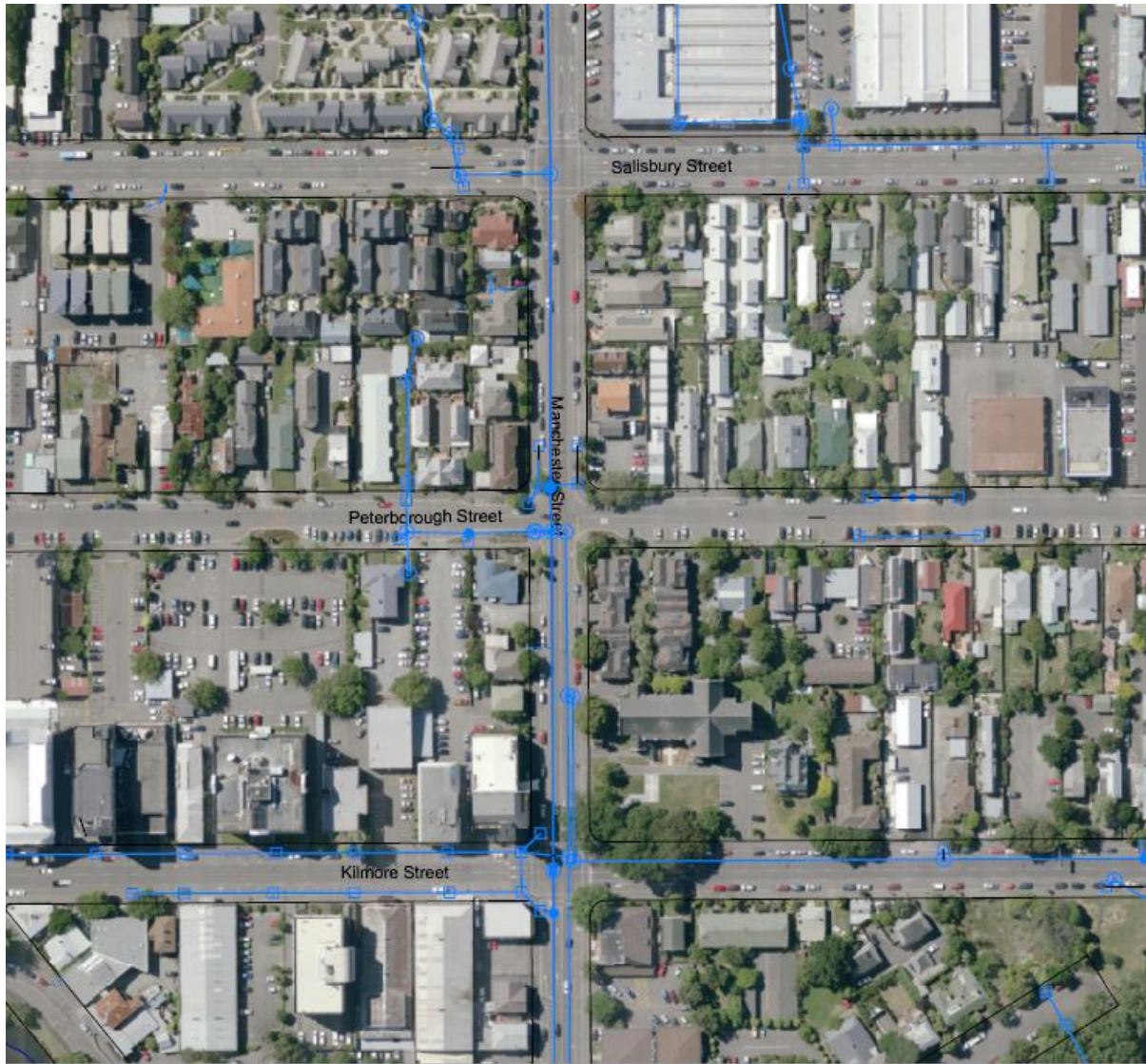


Figure 6: The Christchurch City Council underground stormwater network. St Mary's Creek is seen to be piped down Manchester Street, into the Avon (Courtesy of Graham Harrington, CCC).

2.2.1 Daylighting

In response to the Draft Central City Plan, Landcare Research has suggested that central to the 'eco-streets' proposition, is the identification of the cost-benefit opportunities for replacing existing undamaged infrastructure with natural infrastructure, e.g. daylighting or naturalising streams, as has been done previously done throughout the city (Figure 7) (Landcare Research, 2012).

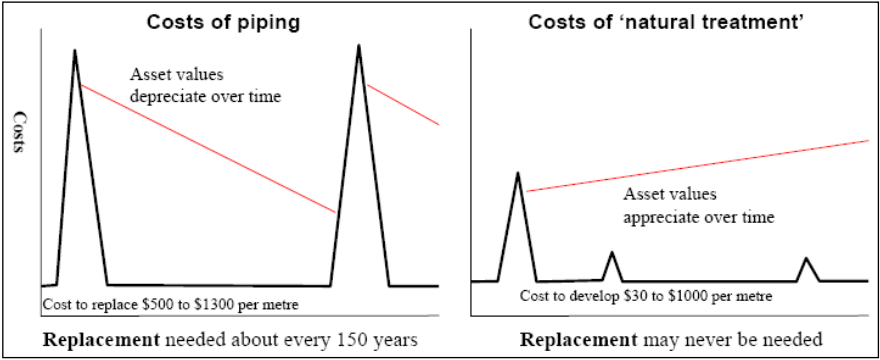


Figure 7: Corsers Stream in Christchurch functions as a true environmental asset and an effective drainage system (Source: Watts & Greenaway, n.d.).

Daylighting describes the deliberate exposure of some or all of a previously covered river, creek or stormwater drainage (Pinkharm, 2000). Daylighting projects can restore perennial or occasionally ephemeral waterways as well stormwater culverts that run with water only during wet weather. Such projects have been undertaken throughout the world, notably the Cheonggyecheon River in Seoul and various streams in Zurich, Switzerland. There are many different reasons to daylight a culverted stream or storm drain, which generally leads to a number of interrelated environmental, economic and social benefits (Table 2) (Gerson et al, 2005).

Table 2: Daylighting streams: the environmental, economic and social benefits.

Issue/subject	Benefits
ENVIRONMENTAL	<ul style="list-style-type: none"> • Improved stormwater quality through use of natural systems and riparian filtering of contaminants and sediments (Schwarz, n.d.). • Reduced stormwater run-off velocity, thus preventing downstream erosion • Improved temperature control through stream shading • Provides natural flood control, absorbing significant amounts of rain water and runoff before saturation and consequent flooding occurs (Jencks & Leonardson, 2004; Taranaki Regional Council, 2010). • Create and maintain the number and diversity of wildlife including small mammals, birds, reptiles and amphibians (Love, 2010).
ECONOMIC	<ul style="list-style-type: none"> • Bicknell and Gan (1997) found that properties located adjacent to Corser’s Stream, Christchurch sold for \$7,000 more than sections across the street. There was also a \$3,472 premium for sections situated on the same block as the stream. • Although daylighting projects can be an expensive activity, many have been completed at a relatively low cost (Pinkharm, 2000). In some cases, daylighting projects also save money. The improved drainage and stormwater quality that results from daylighting reduces the need for related capital works. Additionally, if a culvert collapses, it is often less

	<p>expensive to replace it with an open waterway than to re-install a new culvert (Figure 8) (Pinkharm, 2000; Watts & Greenaway, n.d.).</p>  <p>Figure 8: The costs and percentage of waterways values realised by piping and natural treatment (Source: Watts, 2011).</p>
SOCIAL	<ul style="list-style-type: none"> • Enhanced community character and sense of place. • Improved urban amenity and attract residents and investment into the area (Schwarz, n.d.). • Provision of recreational space, cycling corridors, walking and traffic free routes. • Serves as an 'outdoor classroom' for schools. • Buffer of green space against urban noise, duet and pollution.

Daylighting projects are not without potential problems however and Pinkharm (2001) outlines a number of social, institutional and technical challenges that must be met if daylighting is to be successful (Table 3).

Table 3: Social, institutional and technical challenges of daylighting that need to be addressed for a successful project.

Subject	Challenges
SOCIAL	<ul style="list-style-type: none"> • Daylighting projects that restore flowing water to the surface can raise concerns about safety and water quality and health. • Expectations in the community about the project purposes and results may differ. • Users and viewers of the new creek may expect instant, fully established landscaping. This may not be possible during early years.
INSTITUTIONAL	<ul style="list-style-type: none"> • Who will own the new property? For example, should public or private

	<p>funds be used for daylighting activities (Bicknell & Gan, 1997)?</p> <ul style="list-style-type: none"> • Who will maintain the project? • Daylighting may raise liability and regulation issues for site owners and those adjacent to it, as outlined in Pinkharm (2001, 8).
TECHNICAL	<ul style="list-style-type: none"> • Daylighting projects can raise questions about the site and situation, the inputs from the watershed, the channel design, the stream-bank and floodplain, and the project logistics.

As seen, daylighting can provide a multitude of benefits, however most projects also face a variety of challenges.

Daylighting has been proposed as part of the Peterborough Village rebuild to recognise St Mary's Stream and enhance green spaces. Perhaps the most obvious option is daylighting the 1859 path of St Mary's Stream, although the fact that this flows through private land has been raised as an issue.

Another option that has been considered is the daylighting of a stream along another route, for example along the length of the stormwater culvert that runs down Manchester Street, into which St Mary's Stream was originally piped (personal communication, Di Lucas, Landscape Architect at Lucas Associates, 26 April, 2012). In the Draft Central City Plan, Manchester Street has been proposed as a public transport route; a road-side stream with provision for cyclists and pedestrians is considered to improve the amenity of this proposition (Figure 9 & 10) (Christchurch City Council, 2011).

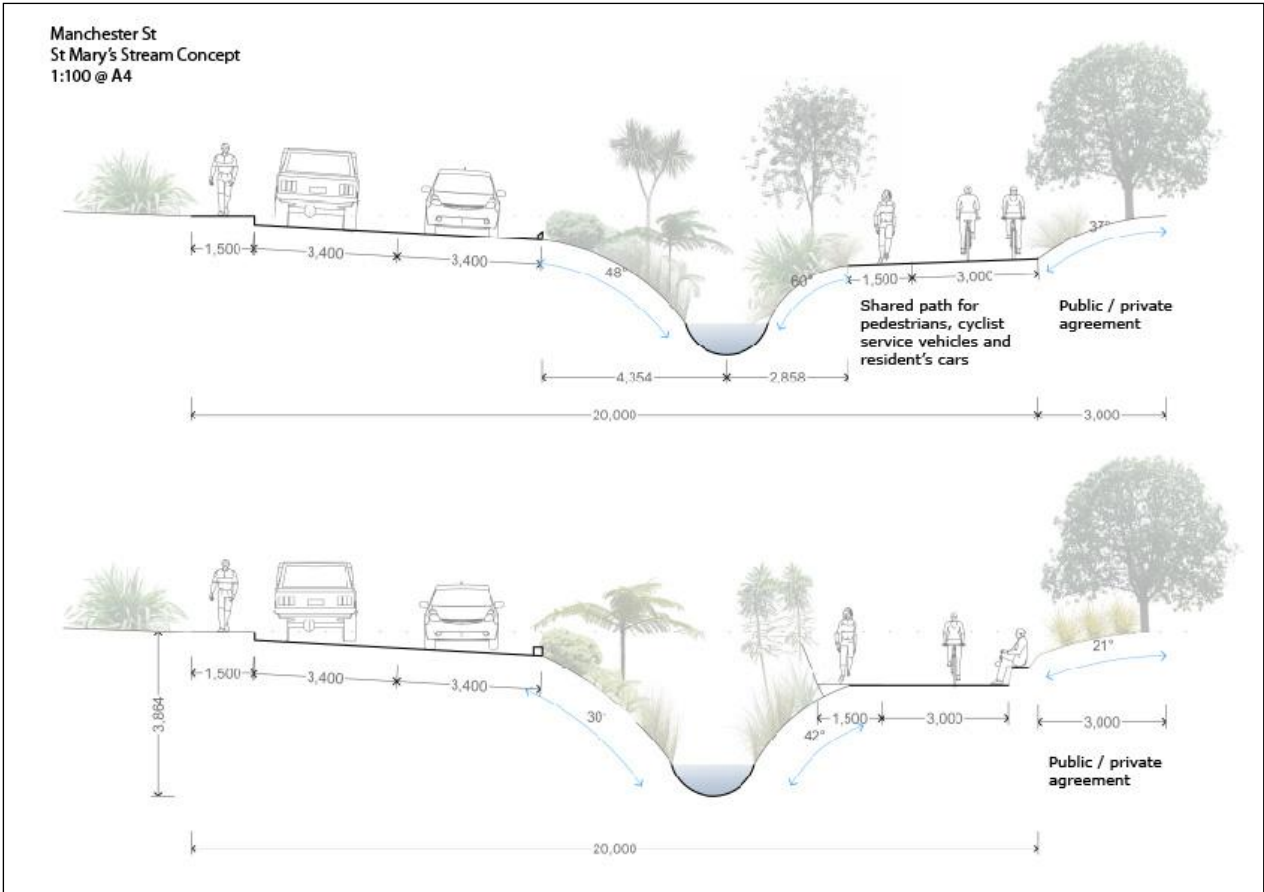


Figure 9: A draft design for the daylighting of a stream down Manchester Street, including a shared path on the eastern side of the street (Courtesy of Di Lucas).

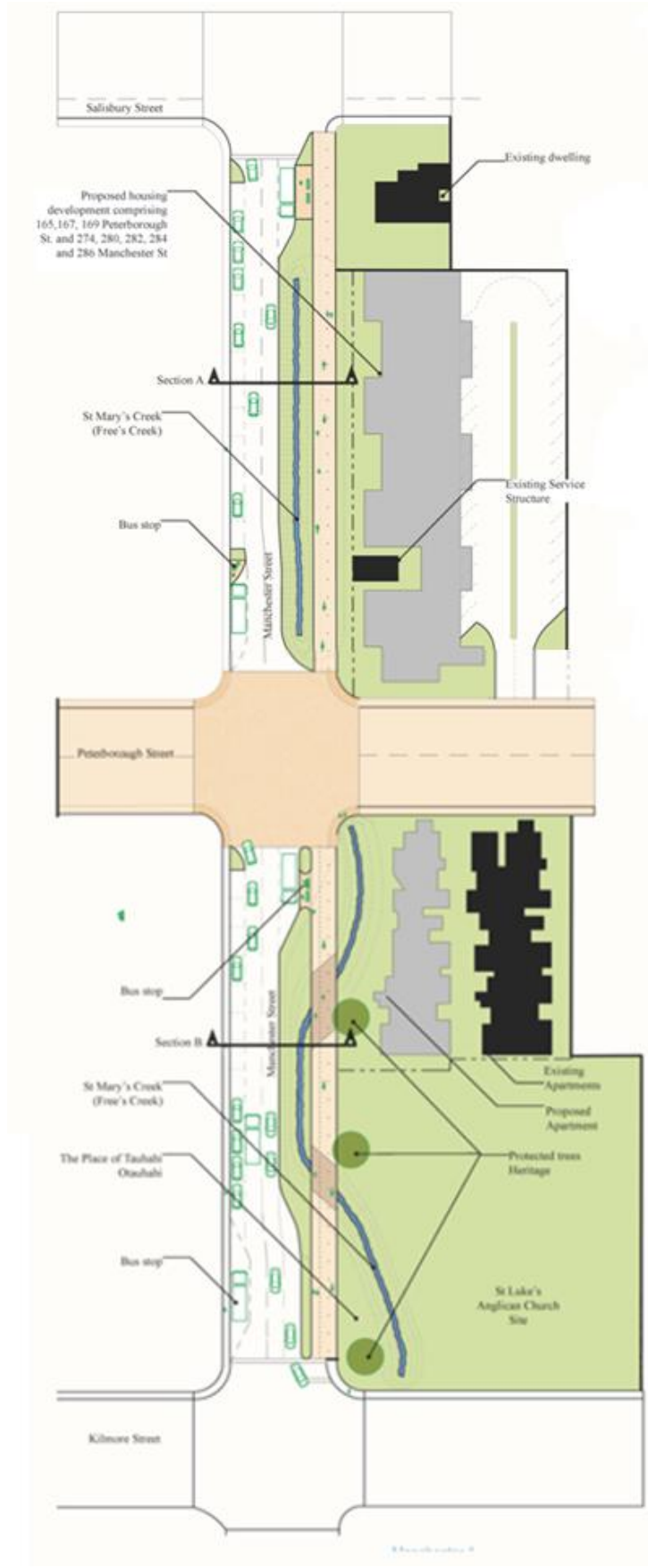


Figure 10: Conceptual design of the stream down Manchester Street. (Courtesy of Di Lucas)

Despite these options, there is uncertainty as to whether a base flow will or can be easily created (personal communication, Robert Watts, Waterways Engineer, 24 April, 2012). Where this is not possible, the stream has been proposed to act instead as a vegetated swale that flows only during high periods of rainfall. In both cases of stream exposure however, concerns have been raised about the consequences of this for land and property ownership and whether private or public funds should be used (personal communication, Michael Fisher, Christchurch City Councillor, 2 May, 2012).

If the full exposure of a stream in Peterborough Village was not seen to be a viable option, the community could choose to pay tribute to the area's history through the construction of a 'ceramic footpath' similar to that found on Peverel Street, Riccarton (Figure 11).



Figure 11: 'Ceramic footpath' on Peverel Street, Riccarton Christchurch (Courtesy of Kelli Campbell, 2012).

This option would result in minimal to no disturbance to private property. In assessing the viability of recognising St Mary's Stream in Peterborough Village all advantages and limitations need to be taken into account in order for the community to make an accurate, informed decision.

2.3 Foundations and Soil Dynamics

Accompanying the extensive history of streams within Christchurch is the complex soil dynamics of the area which, in many respects, defines the region. The Canterbury Plains lie on the floodplain of

the Waimakariri River, consequently creating unique soil structures which vary across the city (Figure 12) (Cubrinovski et al. 2011)

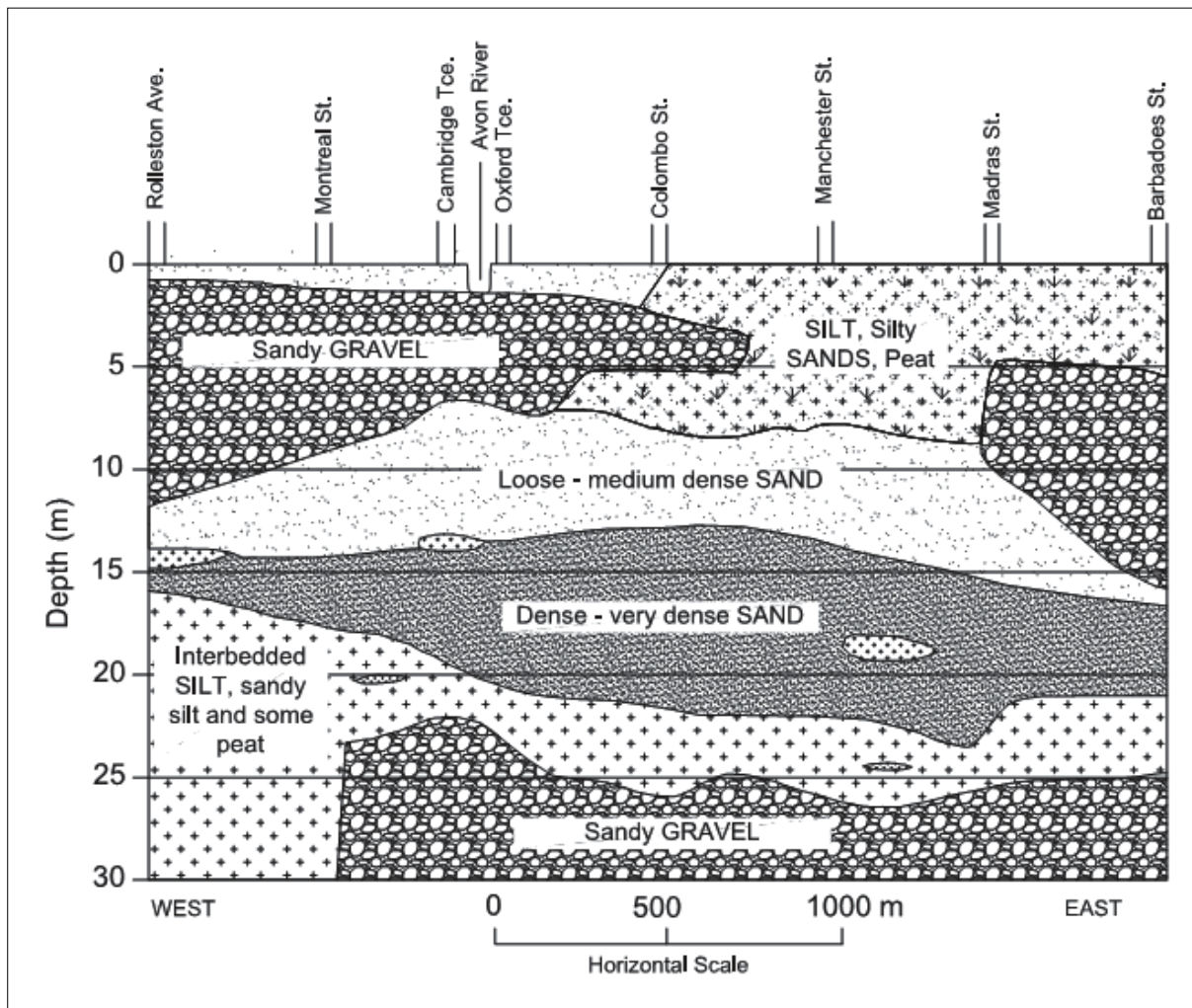


Figure 12 - Soil structure varies across Christchurch, at times even from one side of a property boundary to another. Note the outer boundary of Peterborough Village (Barbadoes St.) represented on the far right (Cubrinovski et al. 2011).

This varying soil composition was found to play a significant role in the damage of homes and properties following the Christchurch earthquakes, with issues of liquefaction and lateral spreading majorly impacting the city, in particular Peterborough Village (Figure 13) (Cubrinovski et al. 2011; Department of Building and Housing, 2012; Wotherspoon et al. 2012).

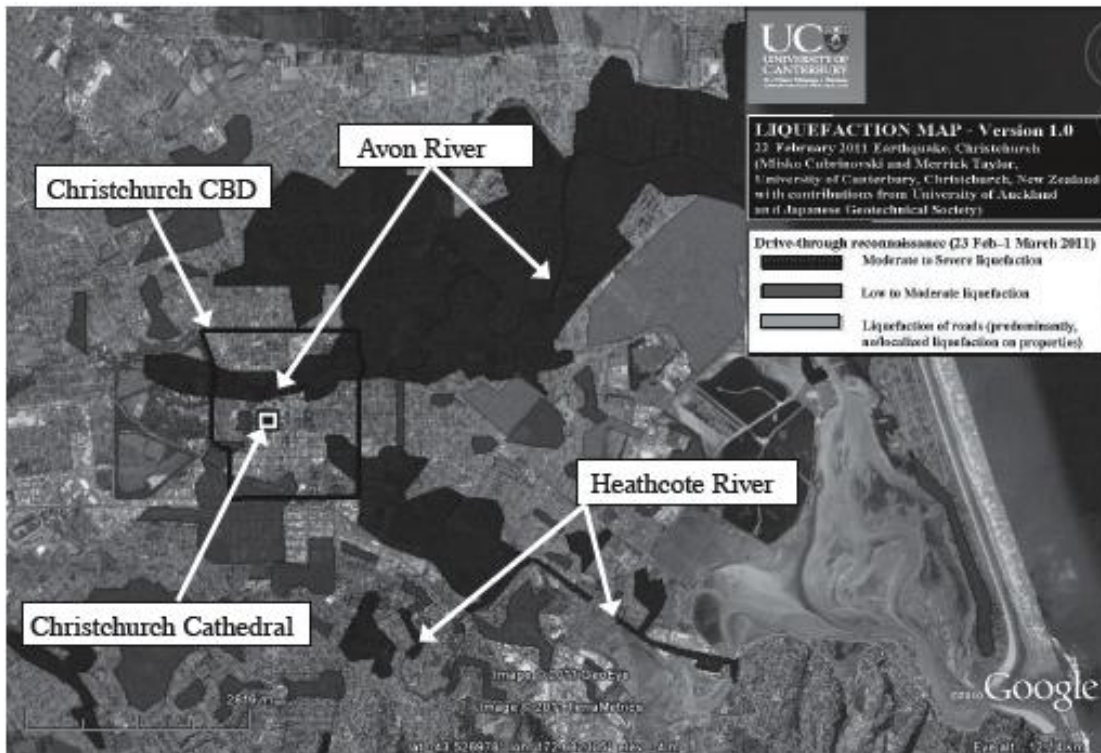


Figure 13 Liquefaction observed across Christchurch following the Feb. 2011 Earthquake. (Cubrinovski et al. 2011).

These geomorphological impacts, in combination with building foundation type or structure, were attributed as the main causes of building damage with damage including cracked or displaced foundations, sinking of houses and severe tilting, to name a few (Department of Building and Housing, 2012; Wotherspoon et al, 2012, Lai & Ichii, 2010). Due to complex water issues which define the soil dynamics of Christchurch, and to which the historic streams of Peterborough Village can be attributed, there is a need to build structures with foundations that are suited to these unique sub-surface dynamics. A number of buildings within Christchurch were not originally designed with the anticipation of such severe sediment related damage and although New Zealand's seismic loading requirements have increased over the years, this did not necessarily correlate with the strengthening of existing buildings (IPENZ, 2011). In many countries known to be exposed to high magnitude seismic events, such as the US and Japan, urban hubs have undertaken precautions, where applicable, to ensure the security and stability of the built environment (Leith, 2004). Such preparedness is put in place as a means by which to avoid some of the problems experienced in Christchurch in recent times.

Despite this, Christchurch sits on a soil bed that is unique in comparison to other urban hubs, therefore considerable research has been undertaken in order to understand the options that exist for rebuilding in Christchurch and comparable areas (Cubrinovski et al. 2011; Department of Building and Housing, 2012; Shirato et al. 2008). In early 2012 the Department of Building and Housing released a report outlining the foundation options for rebuilding in TC3 Zones, applicable to the majority of Peterborough Village (Table 4) (Department of Building and Housing, 2012).

Table 4: Criteria for floor or foundation repair or rebuilding. This provides an indication of the typical types of foundation damage associated with particular building structures (Department of Building and Housing, 2012).

Column 1 Floor Type	Column 2 NO foundation re-level considered necessary	Column 3 Foundation re-level indicated	Column 4 Foundation rebuild indicated	Column 5 House rebuild may be indicated
Type A Timber framed suspended timber floor structures supported only on piles	The slope of the floor between any two points >2 m apart is <0.5% (1 in 200) [Note (a)], AND The variation in level over the floor plan is <50 mm	The variation in floor level is >50 mm and <100 mm Note that the floor re-level is expected to be achieved by packing the piles.	The variation in floor level is >100 mm [Note (c)] over the floor plan, OR The floor has stretched >50 mm [Note (d)] Note that full or partial re-piling is expected to be undertaken to achieve a level floor.	The house has fully or partially collapsed off the piles and repair may be uneconomic. This will relate to the degree of superstructure damage [Note (f)]
Type B Timber framed suspended timber floor structures with perimeter concrete foundation	The slope of the floor between any two points >2 m apart is <0.5% (1 in 200) [Note (a)], AND The variation in level over the floor plan is <50 mm	The variation in floor level is >50 mm and <100 mm, AND Individual cracks in the perimeter foundation are <5 mm [Note (b)]	The variation in floor level is >100 mm [Note (c)] over the floor plan, OR Individual cracks in the perimeter foundation are >5 mm, OR The floor has stretched >20 mm [Note (e)]	The house has fully or partially collapsed off the piles and repair may be uneconomic. This will relate to the degree of superstructure damage [Note (f)]
Type C Timber framed dwelling on concrete floor	The slope of the floor between any two points >2 m apart is <0.5% (1 in 200) [Note (a)], AND The variation in level over the floor plan is <50 mm, AND There are no cracks in ceramic floor tiles, AND There is no distress in vinyl floor coverings or carpet	The variation in floor level is >50 mm and <150 mm, AND Cracks in the floor slab are <3 mm and the accumulation of cracks over the major orthogonal dimensions are <20 mm, AND Services are functioning	The variation in level over the floor plan is >150 mm, OR There is irreparable damage to burned services within the house footprint	This will relate to the degree of superstructure damage [Note (f)]

This suggests that through appropriate site specific testing the most suitable foundation options for rebuilds in the area can be determined. These consist of deep pile foundations, lightweight structures with shallow foundations and ground remediation techniques (Table 5 & Appendix 1) (Department of Building and Housing, 2012)

Table 5: Possible Foundation Types for TC3 Land, such as Peterborough village, and the constraints associated with each option (Department of Building and Housing, 2012).

Type	Objectives	Dwelling Constraints	Land Constraints
Deep piles	Negligible settlement in both small and larger earthquakes	No height and/or material constraints likely	Not suitable where either <i>major</i> or <i>severe</i> global lateral movement likely or dense non-liquefiable bearing layer not present
Site Ground Improvement	Improving the ground to receive a TC2 foundation	Limits on some two storey/ heavy wall types and plan configurations	Some ground improvements can be specified to accommodate <i>major</i> lateral stretch
Surface structures/ shallow foundations	Repairable damage in future moderate events	Only suitable for light construction, regular in plan	Type 1 & 2a options only suitable for minor to moderate vertical settlement and varying lateral stretch, Type 2b can accommodate up to 200 mm SLS settlement Type 3 (specific design) concepts can be designed for <i>major</i> lateral stretch and some for <i>potentially significant</i> vertical settlement

Within the three foundation typologies suggested for TC3 zoning, there are a number of variations (e.g. different designs of pile or shallow foundations). This means that there is a certain level of flexibility with different foundation choices, but economic and structural feasibility must also be considered. Suggestions for flexible construction of foundations have included ideas such as the sharing of foundations for two or more houses as a stability and cost-saving measure (personal communication, Di Lucas, Landscape Architect at Lucas Associates, March 7, 2012). While potentially an effective means of creating group collaboration and combining resources within the community, the structural feasibility of such ideas also needs to be considered. As an example; the creation of foundation-sharing would require the installation of heavy fire-walls between two or more homes, creating difficulties for the use of potentially more affordable, lightweight foundations (personal communication, Dave Brunson, Engineering Consultant at Kestrel Group, May 6, 2012).

Discussion of rehabilitation of homes is a theme commonly experienced within the recovering city, and unique strategies are commonly associated with ensuring that urban living can continue following events of severe disruption. Hurricane Katrina and subsequent housing rehabilitations projects may be seen as an example of such redevelopment tailored to suit the needs of a disaster-prone urban hub (Goedert, 2009).

2.4 Land Share Agreements

As a result of exposing streams, or employing ground remediation foundation techniques, there is a need to explore options for land-sharing agreements. A land-share agreement, or land re-adjustment, describes a situation in which two or more parties enter into a legal agreement to merge their land titles in order to facilitate the building of structures, or better utilisation of land across all titles. The joint title can then be managed by the individuals themselves, a supervisory trust or a body corporate. Although collective participation into a land-share agreement can lead to increased economic management of the assets, this can lead to a reduction in sovereignty.

Land share agreements originated in post-World War II Germany, with subsequent spread to Japan and Asia (Home, 2007). They have been employed in Japan, Kobe, following the devastating earthquake of 1994 where crowded urban environments required restructuring to create a broader municipality zone (Edgington, 2010). In New Zealand there are three main types of land-share agreements in New Zealand; land trusts, cross-lease and unit title (Table 6).

Table 6: Types of land-share agreements in New Zealand

Land share agreement type	Description
Land Trust	The most applicable type of land trust is that employed by the Maori Land Court under Te Ture Whenua Maori Act of 1993, where “a trust is a group of people nominated by landowners/ shareholders to manage their land block or shares” (Maori Land Court, 2012). The most effective forms in relation to Peterborough Village would be the Ahu Whenua or a Putea style trust association.
Cross-lease	All interests share the land title, known as a Certificate of Title. The land is then divided into lease agreements for the individual existence of dwellings, known as a Composite Title (Valuation Consultants New Zealand, n.d. a).
Unit Title	Ownership of a dwelling is building-based rather than land based; an individual purchases a dwelling within a complex rather than a percentage of the land title (Valuation Consultants New Zealand, n.d. b). The complex is then generally managed by a body corporate to administer maintenance of the property.

Land share agreements can facilitate the land remediation process following an earthquake. In the case of Peterborough Village, land share agreements could enable the incorporation of an urban stream and green spaces, or the ability for ground remediation foundation techniques.

3. RESEARCH QUESTIONS

The purpose of this research is to investigate how viable the options are for post-earthquake recovery in Peterborough Village?

1. What opportunities exist for stream restoration and how might this be facilitated?
2. What are the options for foundation rebuilding in relation to land within Peterborough Village?
3. What different types of land-share agreements exist and what are the resident's perspectives associated with these?

4. METHODS

4.1 Background Research

In order to gain an understanding of the issues within Peterborough Village, and the possibilities for the future, extensive background research was undertaken in relation to streams, land sharing and foundations. This involved a combination of background reading, consultation with the Peterborough Village (Pita Kaik) Community committee, retrieving information from community locals, and a number of interviews with professionals in the required fields.

4.2 Focus Group

A focus group was held to facilitate community discussion and retrieve opinions about the range of options explored through background research. This was advertised twice through the Peterborough Village community group email list, and at a seminar about community co-housing held in the Village. The focus group took place in the Christchurch Central Library on Peterborough Street, at 5:30pm, Sunday May 13th, 2012. Eleven people were present. Each participant was first required to fill out a survey of questions relating to individual information (Appendix 2). Participants were then split into two groups of 5 and 6. Kelli and Megan, focusing on streams, took one group while Ashton and Fiona, focusing on land sharing and foundations, took the other. Before the discussion began, each group was briefed with background information associated with the topic. Following an hour of idea sharing about the subjects at hand, each group switched to the remaining topic for a further hour of discussion (Appendix 3). All conversations were voice recorded.

Survey and focus group questions were also emailed to three members of the community group who had expressed interest in participating in the process, but could not make it to the focus group. Replies were received from 2 of these members.

4.3 GIS Analysis

Using ArcGIS, a range of maps were created to help visualise aspects of the Peterborough Village community and aid the community in terms of decisions centred around spatial relationships. The maps depict rivers, levees, vegetation, zoning, flood management and elevation aspects of Peterborough Village both historically and post-earthquake (Appendix 4).

5. RESULTS AND DISCUSSION

5.1 General Survey

A basic context of focus group participants could be established from the initial survey. Almost all of the participants had insurance covering earthquake damage, but were unsure about whether this would cover the losses they had experienced. Home-ownership was seen as a significant tie to the Peterborough area, along with family. Just over half of participants had a mortgage on a Peterborough Village property. Almost all participants felt well informed by and able to participate in the Peterborough Village community group submission to the Central City Plan, however they were divided on how well informed they were about the Draft Central City Plan. Most participants did not wish their land had been red-zoned, although some had not considered this question previously, some felt that it would be a way to “*move on*”.

5.2 Streams

All participants were in favour of daylighting a stream in the area. Despite this, for participants who did not want to leave their home, there was concern that daylighting would force them to do so. In this case, they would prefer that the council ‘red zone’ their land, so that they could move on with one respondent stating, “*Don’t daylight it if I can live there but daylight it if I can’t.*” Concerns were also raised that the purpose of daylighting would only be for cosmetic purposes and others felt that there were more important things to highlight in the area such as “*the historical Ngai Tahu trails.*”

5.2.1 Historical route of St Mary’s Stream

As mentioned above, concern was expressed about the fact that daylighting might force property owners to leave the area against their wishes. Rather than following the historical route of St Mary’s Stream, participants felt that once the geo-tech reports were complete, and if areas of Peterborough Village were deemed un-buildable, an area could be mapped out for a stream to be created. There was mention that in areas where the original levees had once been a walkway could be created.

5.2.2 Manchester Street

With regard to the proposed stream down Manchester Street, participants expressed differing opinions about the idea of a swale or an intermittently flowing stream. Many believed that a swale was a separate concept to a stream as the purpose of a swale was to treat stormwater, while the purpose of daylighting was to pay tribute to what was once there by restoring permanent flow: “*I am for a stream anywhere so long as it has water in it all year round.*” This is consistent with Pinkharm (2001) who states that expectations in the community about the project purposes and results may differ, thus this would need to be addressed if a stream, or swale, was to be exposed along Manchester Street. A swale was generally considered to be a good idea if the daylighted stream was not able to have constant flow: “*I think ideally they would like to hook it up to a spring, but if you can’t it could be a storm water drain.*” Participants were supportive as they saw that it would improve the quality of stormwater before it entered the Avon River/Otakaro. However, it was also recognised that as this would not treat enough water to make a significant difference and more roads should have swales on them.

5.2.3 Ceramic footpath

The option of a ceramic footpath was debated among participants. While some thought that it was a *“lovely idea”* and would be a good back-up if daylighting did not go ahead, others believed that it would depreciate property values as potential buyers might not wish to buy a house that obviously had a historic underground stream next to it, especially as considerable earthquake damage was seen to occur near historic streams. Other focus group members felt that a less permanent representation of the old streams would be more suitable than a ceramic path as it could be created by the community and bring people together.

5.2.4 Council purchases land

Most focus group members were favourable toward the Council purchasing land for stream-daylighting purposes, particularly if such land was deemed un-buildable. There was a general belief that the Council should be responsible for stream maintenance, as collectives may not keep them maintained. Some stated that they believed the Council would purchase such land to add financial value to the area, and, consequently, charge more rates. Despite this, all said they would love a stream running through or near their house and if this meant having to pay more rates they did not mind.

Consistent with Bicknell & Gan (2007), all participants believed a stream restored within the vicinity of their property would positively affect the value of their property, but as long as it was *“done properly, looks nice and is not dangerous”*. It was considered that streams would attract people to Peterborough Village, increasing business. Streams were also believed to improve the *“beauty”* of the area and provide *“pleasant...green spaces”* for workers and residents, as well as encourage people to be more active.

Approximate costs of purchasing land along Manchester Street, between Salisbury and Kilmore streets, where stream daylighting has been proposed, was calculated (Figure 14).



Figure 14: Properties required to be purchased by the Council to allow for the daylighting of a stream along the eastern length of Manchester Street.

Land values, not including property values, totalled a cost of \$3,088,000. Although it is likely that land not employed for stream purposes could be sold-on, this still represents a considerable cost to the Council.

5.2.5 Council does not purchase land

The majority of participants believed that if the council did not purchase the land, daylighting would be too difficult to achieve. This was due to the uncertainty and issues around working with other landowners and reconfiguring properties as discussed by Pinkharm (2001). One respondent stated, *“The whole question is just too big for me to understand. I don’t know what the ramifications are, the property title, and the legal ownership it’s a bit of a minefield.”*

Additionally, all members stated they were not able to contribute some of the costs of daylighting a stream, particularly if this stream did not run through or near their property. They stated that they had *“bigger priorities”* and could not *“be bothered with a fight”* and many did not believe that their

insurance pay-out would allow them to do so anyway. Some indicated they would be more likely to contribute to stream daylighting if evidence indicated that this would reduce liquefaction and earthquake-related damage. Still, most believed it was the Council's responsibility to create and maintain the urban stream.

5.2.6 Daylighting in Pita Kaik

In this sense it appears that the only possibility for daylighting in Peterborough Village will result from the Council purchasing such land. Despite this, the cost of doing so is substantial. However, such an option may be considered by the council if the community makes a collaborative decision to create streams in their area, and are seen to be proactively working together on this. There is potential that the possibility of this may be enhanced by the presence of a stormwater culvert that is in need of replacement, and thus it could be argued that daylighting this would be cheaper and more beneficial in the long-term than replacing the pipe (Watts & Greenaway, n.d.). However, this would still require a significant land purchase by the Council.

In any case, while the earthquake has presented opportunities for exposing streams in Peterborough Village, it has also placed considerable pressure on public and private funds, consequently reducing the feasibility for such opportunities to go ahead. Nevertheless, there appears to be considerable backing from the community for exposure of a stream within Peterborough Village, and further discussion between the council and community should be facilitated.

5.3 Foundations

5.3.1 Advice

Participants of the focus group had been given a range of advice relating to foundation damage and had a range of knowledge about building foundations. Generally, participants had an understanding of the types of foundations that their homes were built on and what problems or damage had occurred to these. Terms like *"tilt slab"*, *"cheap joining"*, *"concrete slab"* and *"piles"* were discussed in relation to homes or properties. Participants made strong associations with foundation type and damage levels, having experienced the impacts of what they deemed to be the *"wrong"* types of foundations in the past.

5.3.2 Deep pile and lightweight foundation types

When asked what type of foundations they would feel most comfortable with, only some participants felt that their knowledge was comprehensive enough to decide. Those with an opinion mostly felt that lightweight structures on shallow foundations would be the most positive choice. This opinion was justified by the reading that people had done and the fact that they felt that this choice of foundation had been researched well within a Christchurch-specific context. *"... and the new lightweight structures where they use ultra-thick plywood, timber tilt slab, that sort of stuff that is really wonderful ... the days of tile roofs are gone there are no brace from tile roofs in an earthquake whereas steel roofs bring huge bracing."*

Preferences about various foundation options were often discussed in relation to opinions of others and the prevalence of certain options in the media. Some statements demonstrated a level of

confusion about the differences between what foundations houses would be built upon, especially when discussing concepts of 'lightweight' and 'heavy'. One participant stated, *"I would even be happier with a raft; I just want it to be a little bit thicker than it probably was the first time."*

5.3.3 DBH Report

When presented with the DBH's three foundation types for TC3 zones (Department of Building and Housing, 2012), the majority of the group felt that lightweight foundations were both a suitable and an appealing option. Some participants expressed concern at the lack of choice the report gave property owners. *"They have now gone and said that TC3 land has... 3 types of foundations that will (be applicable) and depending on what they find under there (the land) you will be one of those three. You won't get a choice."*

Participants felt that the report was of little help to them until their land was assessed. In turn, participants either felt exasperated by this, or had not taken the time to further investigate the options as they felt that there was no point in doing so until their land was formally assessed.

5.3.4 Collective Ground Restoration

The focus group was divided on the concept of collective ground restoration. One participant felt that the process was intrusive, especially when considering emotional ties to land, *"I feel like that ground (re)mediation thing is really tied into justifying that your land is okay to be built on in terms of re-sale value... why would you bother to do it? Because you want to sell your house and the people that are buying it want to be assured that everything has been done to make this land constant. But for me personally it's a huge invasion to do that."*

This viewpoint highlighted a strong connection of some to their land in its current state. Other members, without such ties, had no strong objections to the idea. Half of the focus group saw collective ground restoration as a positive way to move forward and were in favour of it.

5.3.5 Foundations in Pita Kaik

Feelings and opinions about the rebuilding or repairing of homes in Peterborough Village tie in with similar experiences seen in other recovering cities. Concepts of “home rehabilitation” were considered to be the most effective and affordable within New Orleans following Hurricane Katrina, and the views expressed by Peterborough Village residents express a desire for a similar solution (Goedert, 2009). Connections with home are strong in the area, emphasising a need for affordable foundation and building structures that, to a degree, fit in with what was previously within Peterborough Village, while tying in with complex code and land issues. Broadly, this means that Peterborough Village residents and building owners need to have a better understanding of their options in terms of rebuilding, especially in regard to foundations, and a level of knowledge of how flexible these options are. Peterborough Village residents are enthusiastic about moving forward with building and ground remediation collectively, but, as a result of the complexities of Christchurch’s geomorphology, this enthusiasm needs to be developed with the advice and protocols of appropriate governing bodies in mind.

5.4 Land-share agreements

5.4.1 Unit title

Unit title land sharing and community housing through a body corporate structure produced mixed response, generally around the size, structure and type of amenities. It was felt that to be involved in such a structure, the collective vision needed to be accepted. Many residents were operating under unit title before the earthquake; and had different opinions of the situation (Table 7).

Table 7: Focus group points raised about Unit Title Land Sharing

<i>“...co-housing... seems like a great model comprising a standard body corporate structure with unit titles, that way you would still own your flat outright and then have a portion in the commons.”</i>
<i>“Our unit title works really well, we all own our little gardens and land around our own townhouse. The driveway is common that is the only common land and that is fine.”</i>
<i>“People are often scared of and concerned with the idea of shared property, and having walkways near their homes that is accessible by the public.”</i>
<i>“While many body corporates are well funded and managed, this is not always the case. In such situations, the availability of a cross lease allows individuals to be responsible for their own house...”</i>
<i>“With land sharing what happens if I want to move? Do I have to find a likeminded person that is going to move in? Well of course you do, because you know they are going to say well where is my land? We’ll say; well it actually floats into this, and we all sort of own all of this common land and they will think, but what do I own? Where are my boundaries? Because you know when things get bad people want to be able to mark out their boundary and protect it. So you have to have</i>

likeminded people otherwise it could turn sour.”

5.4.2 Cross-lease

Cross lease agreements proved to be a far more popular and a robust land share agreement in times of crisis, but still not without its flaws (Table 8).

Table 8: Discussion points around Cross Lease Agreements among focus group participants

I think the cross lease “is a great idea... it is a suit of armour, you have more clout than you would have if you were on separate sections.”

“What I am concerned about now that I am in a cross lease is that we are all individual owners and we actually all want different things, two of the properties are rentals and one of them is untenanted so he is going to want stuff sorted out a whole lot faster than the rest of us.”

“... they reckon that the earthquake has shown that cross leases are better than a body corporate structure. Many body corporates have gone bust through insurance excesses, if I owned a plain section and wasn’t on a cross lease, I would feel that I would like support from a group in remediation negotiation.”

5.4.3 Land trusts

Debate over land trusts produced interesting perspectives on responsibility and political ecology. People tended to waive responsibility due to the collective nature of trusts, relating to the tragedy of the commons. The second debate questioned the effectiveness of resource allocation under the current neo-liberalist system in providing for the population (Table 9).

Table 9: Discussion points relating to Land Trusts and resource allocation

“I think that with common land, people love the fact that they share it but they don’t understand that you actually have to contribute to its upkeep.”

“The idea of common title is a really lovely old socialist dream; all land should be in common title although you need a change in the political ecology for this to work in New Zealand.”

Residents found that the landlords in the district they had spoken to would be driven by the economics of any change in title and did see the merits of collective rights and power within land sharing structures so long as profitability is maintained.

5.3.4 Land sharing in Pita Kaik

Land readjustment according to Home (2007) and Edgington (2010) consists of state intervention for the betterment of society; land sharing on the other hand involves individuals or collectives cooperating privately through legal structures to enhance their community. In the case of Pita Kaik, a bottom up approach to land readjustment to expose streams, facilitate land remediation or simply for collective economic benefit through land sharing is a way to form a more resilient, attractive community with limited public funds.

The three main forms of land share agreements in New Zealand queried in this research saw the concept of cross-leases being the most favourable. This is because people maintain a high level of privacy, sovereignty and economic independence, and can act collectively to maintain their democracy when faced with disaster. A change in the Christchurch political ecology is required for there to be a wide spread implementation of the different forms of land share agreements, one where the merits of a collective good outweigh a marginal loss in sovereignty.

6. CONCLUDING REMARKS

This research has investigated three key areas that relate to the multi-faceted recovery of Peterborough Village following the Canterbury earthquakes. These areas include stream exposure, foundation repair and land sharing techniques. Research was conducted through extensive literature review, discussion with related experts and the use of a focus group to gain an understanding of the positionality of residents in relation to the key themes. Key areas of redevelopment identified in the research included the daylighting of historic streams, the rebuilding of homes with earthquake-suited foundations and potential for the sharing of land titles. Options received particularly well by the community included stream daylighting or the development of a swale in the area, the use of lightweight or tilt foundations alongside collective ground remediation and the potential emergence of more cross lease arrangements in the area. Despite this, our research found that due to the nature of Christchurch's recovery, many redevelopment opportunities are tied to government agencies or protocols, and require local-government or expert support to be viable. From these findings, we can conclude that when considering the redevelopment of Peterborough Village, in depth conversations about responsibility and opportunity need to be held between Christchurch City Council, CERA and the Peterborough Village Community. Additionally, residents would benefit from a greater understanding of the process of individual home rebuilding, especially in relation to foundations and soil dynamics. Finally, it was found that there needs to be a change in perception of the concept of land sharing, not only at the individual level but also at the commercial level. This study was limited by the short time frame available and the complex nature of the issues at hand. Of further benefit to the Peterborough Village community would be an extension of this study in collaboration with the wider community, the council and appropriate experts.

It can be seen that there are a number of viable options for the redevelopment of Peterborough Village. This viability, however, depends on the ability and willingness of government organisations to become involved in particular projects, as well as the meeting of complex regulations and codes in relation to particular aspects of the community. As a result of the ongoing nature of the redevelopment of both Christchurch and Peterborough Village, there is a need to recognize that this project is of an open ended nature and has an opportunity to extend into the future of both Peterborough Village and Christchurch as a whole.

Acknowledgements

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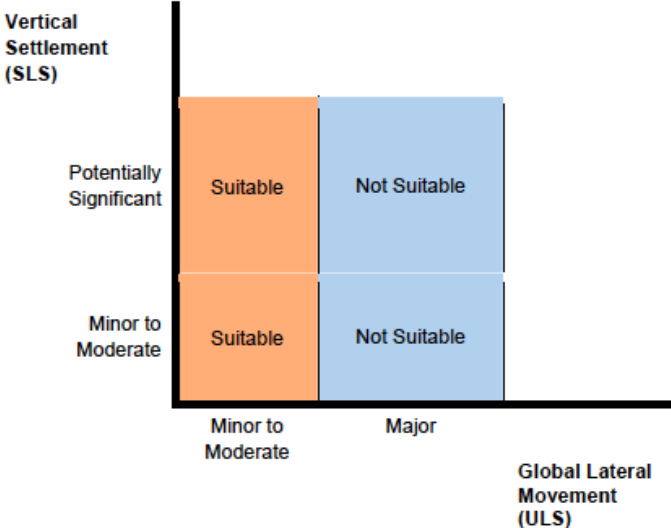
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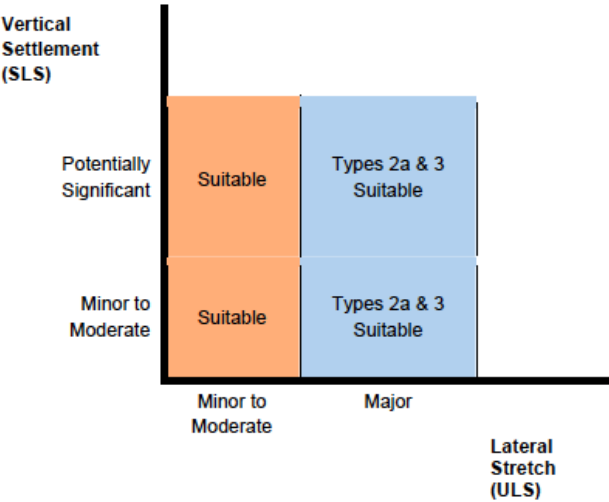
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APPENDIX 1: Descriptions of Deep Piles, Lightweight Structures on Shallow Foundations, and Ground Remediation techniques. (Adapted from Department of Housing and Building, 2012).

	Deep Piles
DBH Objective and Scope	<p>“The objective of using deep piles is to obtain dependable vertical load capacity at both SLS and ULS levels of earthquake. Where deep piles are appropriately selected, designed and constructed, they provide the greatest flexibility for the superstructure configuration and weight.</p> <p>Deep piles are not considered suitable for major or severe global lateral spreading situations, and require careful detailing for ductility to accommodate lesser levels of lateral spreading.” (DBH, 2012, p. 42)</p>
Variations	Screw Piles, Driven Timber Piles, Driven Steel H-Piles, Driven pre-cast concrete piles, Continuous flight augur piles, Bored Piles, Micropiles
Suitability Analysis	
	Lightweight Structures on Shallow Foundations
DBH Objective and Scope	<p>“The following is a list of the more commonly used methods of ground improvement. There are many variants, but they can be generally grouped as follows:</p> <ul style="list-style-type: none"> • densification of either the crust layer and/or the deeper liquefiable soils. This includes methods such as compaction, excavation and replacement/re-compaction, vibroflotation, preloading, dynamic compaction (DC), and rapid impact compaction • crust strengthening/stabilisation by permeation grouting, stabilisation mixing or replacement • deep strengthening using deep soil-cement mix piles, jet grouting, stone columns, close spaced timber or pre-cast piles

	<ul style="list-style-type: none"> • containment by ground reinforcement or curtain walls • drainage using stone columns or earthquake drains “ <p>(DBH, 2012, p.53)</p>
<p>Variations</p>	<p>“Type 1 - Densified raft (ie, re-compacted soil or replacement fill; also dynamic compaction or rapid impact compaction).</p> <p>Type 2 - Stabilised crust (ie, cement mixed soils, either by excavate and replace or in-situ mixing).</p> <p>Type 3 - Deep soil mixing (ie, soil mixed or jet grouted columns).</p> <p>Type 4 - Stone columns.</p> <p>Type 5 - Low mobility grout columns.</p> <p>Some or all of these methods may require a resource consent. In particular, noise and vibration effects should be considered.”</p> <p>(DBH, 2012, p. 53)</p>
<p>Suitability Analysis</p>	 <p style="text-align: center;">Note: Ground Improvement Types 1a, 4 and 5 can be used in areas of major lateral stretch with specific geotechnical engineering design</p>
	<p>Ground Remediation Techniques</p>
<p>DBH Objective and Scope</p>	<p>“This section provides surface foundation options that can be used on most TC3 sites without ground improvement or deep foundation works. These options are able to be re-levelled in the event of future differential settlements caused by earthquakes, and can accommodate varying levels of lateral spreading without causing rupture of the superstructure.</p> <p>It is considered that any damage experienced in SLS level earthquakes would be readily repairable and is not likely to prevent continued occupation of the dwelling.</p> <p>The surface structure types outlined in this section are only applicable for timber or steel framed structures with light roofing materials and light-weight and medium-</p>

	<p>weight wall cladding, and with regular plan layouts.</p> <p>Due to the range and different combinations of future vertical land settlement and lateral spreading (stretch) on TC3 sites, careful consideration needs to be given to the selection of surface structure options.” (DBH, 2012, p. 66)</p>																								
<p>Variations</p>	<p>“Type 1 surface structure - modified NZS 3604 light-weight platform. Capable of withstanding moderate differential vertical settlement from liquefaction at SLS levels (ie, corresponding to <u>minor</u> land settlement of less than the index value of 100 mm), and <u>minor to moderate</u> lateral strain across the building footprint at ULS levels (ie, up to 200 mm).</p> <p>Type 2 surface structures provide platforms that are capable of resisting major lateral strain (ie, between 200 and 500 mm)</p> <p>Type 3 Surface Structures comprise a mix of re-levellable and stiff platforms that are also capable of resisting major lateral strain (ie, between 200 and 500 mm) in a ULS event. It is intended that they be designed to either bridge loss of support or as light-weight flexible platforms that are capable of being simply re-levelled.” (DBH, 2012, p. 67)</p>																								
<p>Suitability Analysis</p>	<table border="1"> <thead> <tr> <th rowspan="2"></th> <th colspan="2">Vertical Land Settlement (SLS)</th> <th colspan="2">Lateral Stretch (ULS)</th> </tr> <tr> <th><100 mm (Moderate)</th> <th>>100 mm (Potentially significant)</th> <th><200 mm (Moderate)</th> <th><500 mm (Major)</th> </tr> </thead> <tbody> <tr> <td> Type 1 – light-weight platform (standard solution) <ul style="list-style-type: none"> Enhanced NZS 3604 sub-floor </td> <td>Yes</td> <td>No</td> <td>Yes</td> <td>No</td> </tr> <tr> <td> Type 2 – underslab platform (standard solution) <ul style="list-style-type: none"> Type 2A – 150 mm underslab on gravel Type 2B – 300 mm underslab on gravel </td> <td>Yes</td> <td>No Up to 200 mm</td> <td>Yes</td> <td>Yes</td> </tr> <tr> <td> Type 3 – concepts for specific design <ul style="list-style-type: none"> Type 3A - Re-levellable platform Type 3B - Stiff platform </td> <td>Yes</td> <td>Subject to design</td> <td>Yes</td> <td>Yes</td> </tr> </tbody> </table>		Vertical Land Settlement (SLS)		Lateral Stretch (ULS)		<100 mm (Moderate)	>100 mm (Potentially significant)	<200 mm (Moderate)	<500 mm (Major)	Type 1 – light-weight platform (standard solution) <ul style="list-style-type: none"> Enhanced NZS 3604 sub-floor 	Yes	No	Yes	No	Type 2 – underslab platform (standard solution) <ul style="list-style-type: none"> Type 2A – 150 mm underslab on gravel Type 2B – 300 mm underslab on gravel 	Yes	No Up to 200 mm	Yes	Yes	Type 3 – concepts for specific design <ul style="list-style-type: none"> Type 3A - Re-levellable platform Type 3B - Stiff platform 	Yes	Subject to design	Yes	Yes
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Type 1 – light-weight platform (standard solution) <ul style="list-style-type: none"> Enhanced NZS 3604 sub-floor 	Yes	No	Yes	No																					
Type 2 – underslab platform (standard solution) <ul style="list-style-type: none"> Type 2A – 150 mm underslab on gravel Type 2B – 300 mm underslab on gravel 	Yes	No Up to 200 mm	Yes	Yes																					
Type 3 – concepts for specific design <ul style="list-style-type: none"> Type 3A - Re-levellable platform Type 3B - Stiff platform 	Yes	Subject to design	Yes	Yes																					

APPENDIX 2: Survey questions given to focus group participants prior to discussion

- *What would you describe as your main ties to Peterborough Village? (E.g. financial, family, home ownership...)*
- *Did you feel well informed by the Peterborough Village community group with regard to the community submission to the City Central Plan, and able to participate in this?*
- *Do you feel well informed in general about the central city plan and rebuild?*
- *Do you have a mortgage?*
- *Do you have insurance that covers earthquake damage?*
- *Will your insurance pay-out be enough for you to rebuild your home/workplace in the way that you wanted or needed to?*
- *Do you wish your land had been red-zoned? Why?*

APPENDIX 3: Focus group questions posed for discussion to participants

Streams:

- *Do you like the idea of a stream through Peterborough Village?*
- *If a stream were to be 'exposed' within the Village would you prefer for it to be located where the historical stream was situated (refer to the blue line on Figure 1 where the stream runs to the west of Manchester Street before crossing to the east after Peterborough Street).*
- *Manchester Street has been proposed in the Draft Central City plan as a public access transport route. It has been suggested that a stream be created along this street separating a pedestrian and cycleway from the busy road. This stream will run the length of the road towards the Avon River, likely without base-flow but acting as a vegetated swale. What are your thoughts about this?*
- *What do you think about recognition of the historic streams, i.e. the placement of ceramic 'path' within public property over the historical stream route and a sign detailing this history?*
- *The Council has suggested that if Peterborough Village makes a collective decision to 'expose' or create streams within the village, and is seen to be working together on this option, they will consider buying the land proposed for stream restoration. Would you be willing to enter into discussion/agreement about this with other community members?*
- *If the Council chooses to not purchase such land, would you still be willing to expose streams on your property, including contributing some of the cost?*
- *If a stream were to be restored within the vicinity of your property do you believe this would have an effect on the value of your property? In what way and why?*

Land – share:

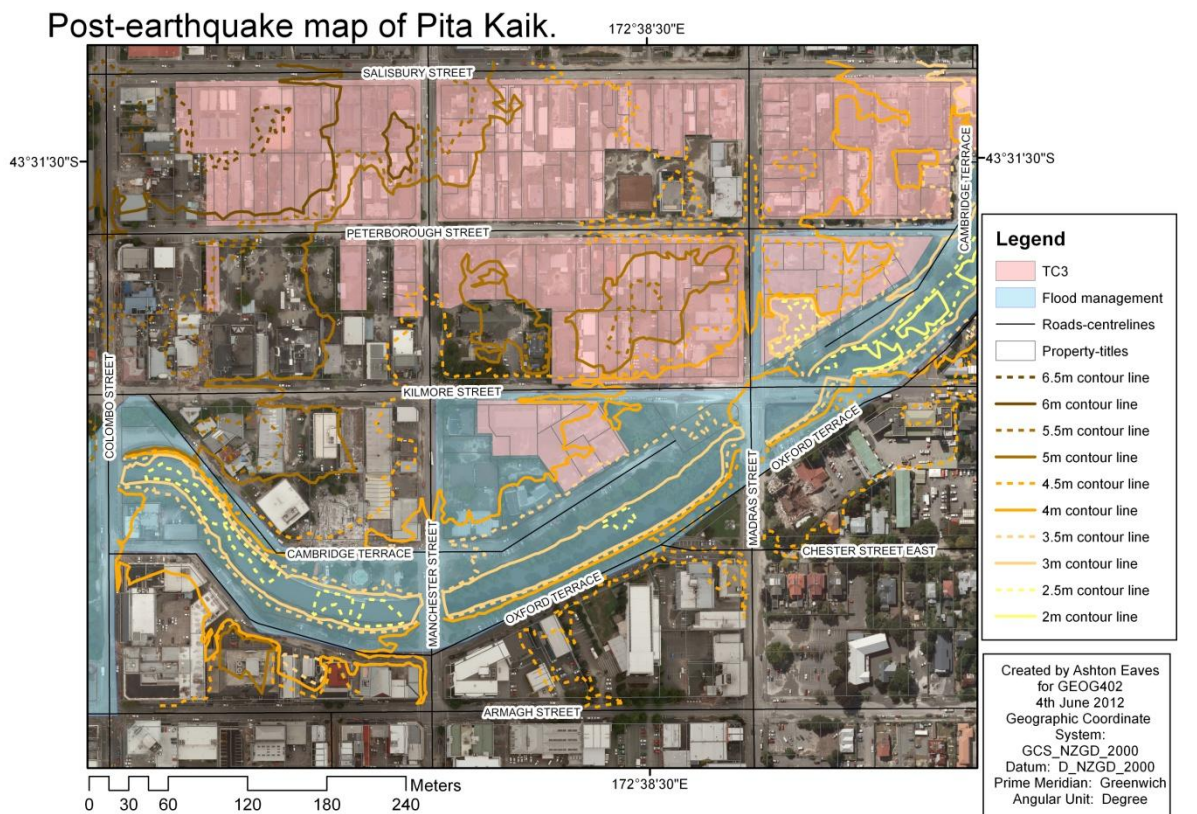
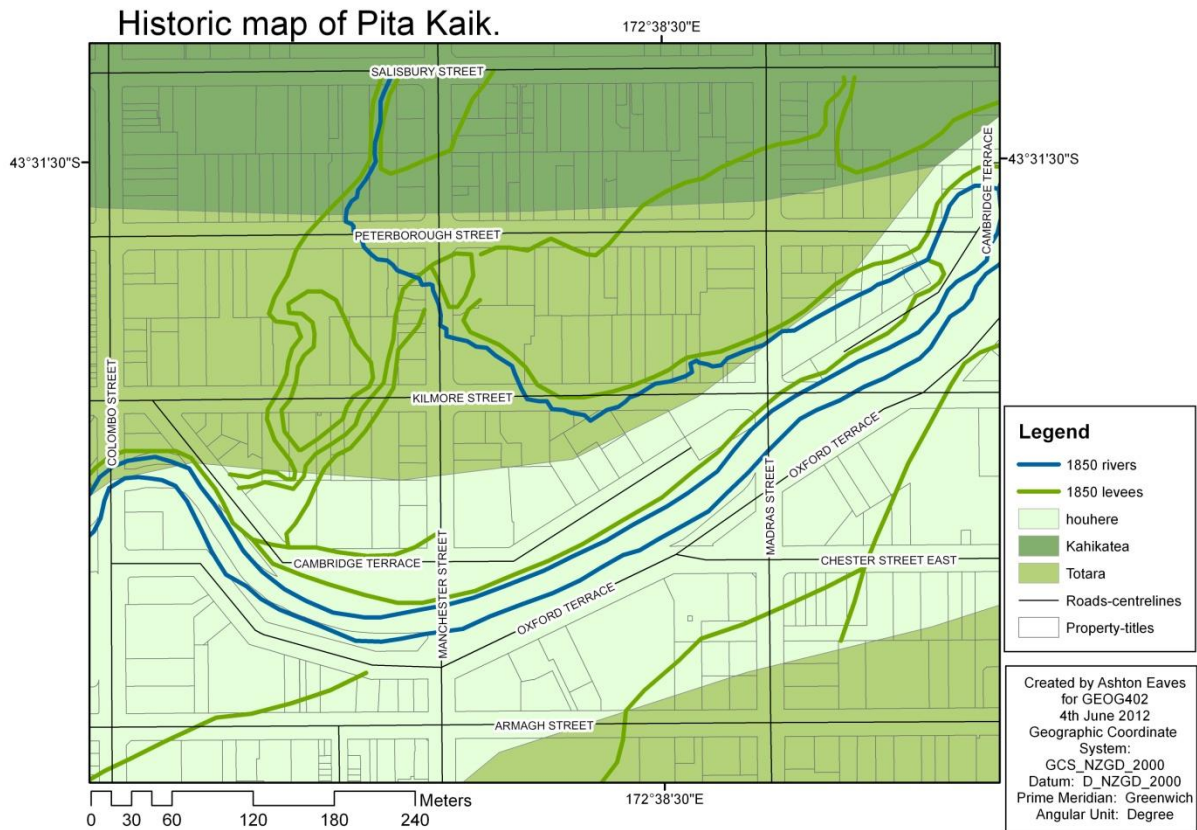
- *Would you be willing or interested in taking part in land-share agreements?*
- *If yes, what type of structure interests you? Trust, Cross-lease or Unit title or other?*
- *Do you have any further thoughts on Trust, Cross-lease or Unit title or other?*
- *If no, what are your reservations about land-sharing?*
- *Do you intend to be the owner/occupier of your property or do you plan for it to be a rental?*
- *Do you feel low-rise apartments with communal garden facilities and vegetable garden allotments are appropriate for some rebuilds of Peterborough Village?*
- *Do you see an economic advantage in land-share agreements?*

Building Foundations:

- *Do you own, or live in, a property that either needs rebuilding or extensive foundation repairs?*
- *If so, what advice have you been given about your options for foundations on your property, if any?*
- *Have you seen the recently produced DBH report on foundation options for properties in TC3 zones? What are your opinions about the report and its suggestions?*

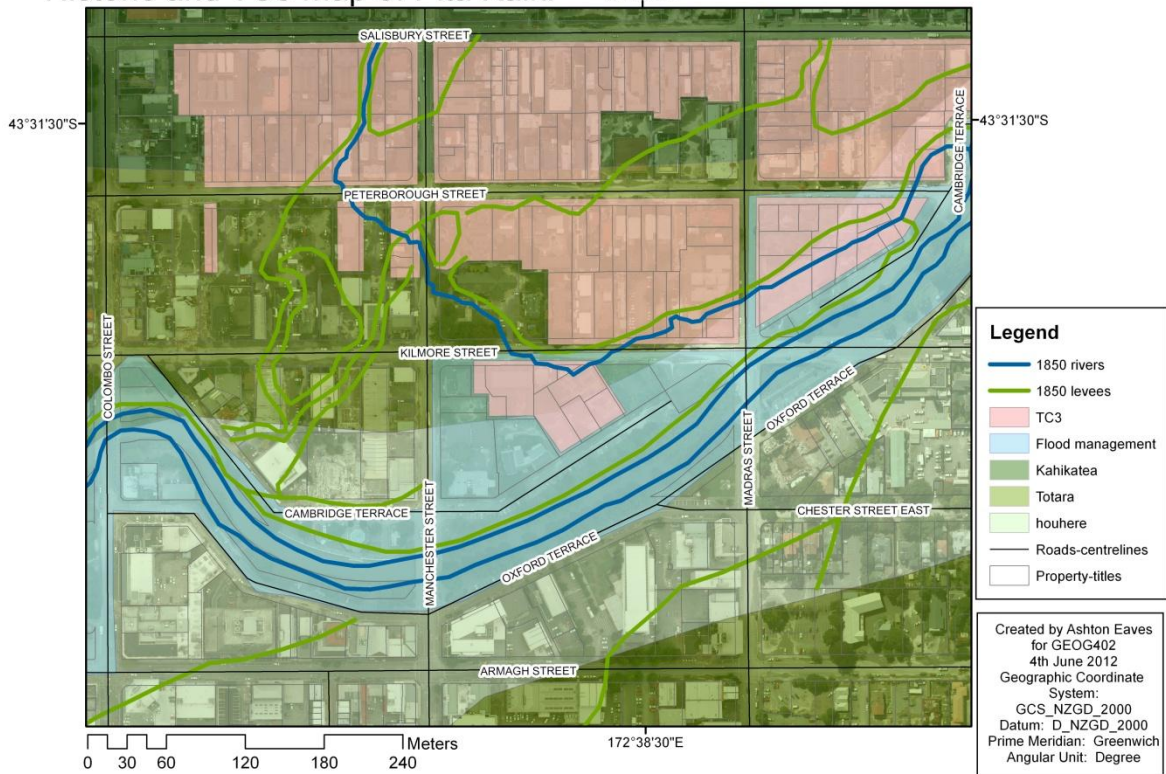
- *The options listed by the DBH for foundations include deep piles, site ground improvements and surface structures with shallow foundations – do you feel well informed about these options?*
- *Are you more interested in lightweight, re-levelable structures and the foundations which support them, or would you prefer strong, fixed structures?*
- *If necessary, would you be interested in undertaking site ground improvements as a collective group or with your neighbours, instead of just on your own property?*
- *Would you be willing to pay over and above the insurance pay out to rebuild your home in the way that you want or need to?*

APPENDIX 4: GIS mapping of Peterborough Village



Historic and TC3 map of Pita Kaik.

172°38'30"E



Historic and LiDAR map of Pita Kaik.

172°38'30"E

