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CITYWIDE WALKING NETWORK

Network Development Report

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transportation engineers

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Network Development Report

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1 INTRODUCTION

Background

1.1 Christchurch City Council (CCC) commissioned *Abley Transportation Engineers Limited* (ATEL) to build a citywide walking geographic information system (GIS) network layer. This GIS layer will further the work that is being undertaken by CCC regarding Public Transport Accessibility Levels (PTAL). It is intended that the walking network is being developed principally for the PTAL project, although it will be possible to expand, add further detail to and sub section the walking network for use with other projects as needed. As far as ATEL is aware, this project is the first walking network in New Zealand to be built to such a high level of detail and extent. It was agreed that the network should include traffic signals, zebra crossings and pedestrian refuges on bus routes.

1.2 This project was undertaken concurrently with the development of a high detail, central city walking network GIS layer for Christchurch City Council.

1.3 Tools, data and information have been procured from a number of sources and have been used for the evaluation, testing or interrogation of data to assess its suitability for use within the tool.

1.4 When undertaking this work ATEL has, where appropriate, verified information via reference to other data sources and observation.

Report Structure

1.5 This report is divided into sections to aid understanding:

Objectives

- Outlays the objectives of the citywide walking network.

Methodology

- A non-technical section which outlines the steps taken to create the walking network; it covers the data sources used and the methods used to produce the final walking network. It is divided into two sections; data sources and data manipulation.

Technical Details

- A brief, technical overview of the software, tools and data formats used in the creation of the citywide walking network. It then provides technical information on the steps taken to manipulate the data used in the citywide walking network. It is divided into three sections; software, data and processes.

Discussion & Recommendations

- Provides a summary and a list of recommendations.

1.6 A number of quotations are taken from other references. Typically these are noted in the text and all quotations are *"italicised"*. Important or especially relevant sections of quotations are **bold**.

2 OBJECTIVES

Public Transport Accessibility Level Assessments

2.1 Currently CCC is undertaking PTAL research in Christchurch. The calculations for PTAL are currently done manually using estimated walking distances based on 'straight line' distances. The use of GIS allows for the automation of these calculations, and the creation of a walking model adds detail to the variable inputs involved with calculating PTAL. The use of Network Analysis and GIS geoprocessing models will allow for comprehensive levels of analysis to be undertaken quickly and iteratively in the future.

2.2 A walking network differs from a road network as it allows for analysis to include real world scenarios where pedestrians are likely to use links that are not alongside roads. This includes walking paths through conservation areas, parks, schools and other off road short cuts frequently taken by pedestrians. Walking networks allow for PTAL to be calculated and compared between users of different levels of mobility based on user accessibility.

2.3 The creation of the citywide walking network is an ambitious project with the inclusion of large amounts of detail over a wide area. The walking network combined with the public transport network will enable a PTAL model of the city to be created. This will later allow for the citywide mapping of PTAL. It will enable the testing for effects of manipulating bus route, bus frequency and walking connectivity. It will also allow for the analysis of service areas of both the current, and any proposed public transport service performance level.

3 METHODOLOGY

Introduction

3.1 The creation of the citywide walking network was achieved by using a wide variety of data from different sources and combining this data to form a single GIS layer.

Data Sources

3.2 The data collected and used for this project is shown in **Table 3.1**

Table 3.1 Data Sources Used to Create the Citywide Walking Network

Data	Details	Source
Road Centreline	Contains road hierarchy and other detailed information related to each road	Christchurch City Council
Aerial Photographs of Christchurch city	Most recent aerial photographs, taken in January 2007. Pixel size is 0.125m	Christchurch City Council
Bus Route	2006 Metro bus routes	Environment Canterbury, Christchurch City Council
Bus Stop	2006 Metro bus stops	Environment Canterbury, Christchurch City Council
Open Space Zones	Most of the parks and reserves in Christchurch set aside primarily for recreation. Defined in the City Plan; Volume 3, Part 6.	Christchurch City Council City planning zones GIS layer
Conservation Zones	Areas within the city of scenic, ecological, or heritage significance. Defined in the City Plan; Volume 3, Part 5	Christchurch City Council City planning zones GIS layer
Cultural Zones	A range of sites predominantly associated with a range of metropolitan and local facilities of a cultural, recreation, educational, research, artistic or heritage character. Defined in the City Plan; Volume 3, Part 7	Christchurch City Council City planning zones GIS layer
Traffic Signals	Plans for each set of traffic signals operative in Christchurch including phasing and pedestrian links	Christchurch City Council
Zebra Pedestrian Crossings	Locations of Zebra Pedestrian Crossings	Abley Transportation Engineers Limited
District Centres and Business Retail Parks	Based on B2 and BRP zones as defined in the City Plan; Volume 3, part 3	Christchurch City Council Transport Commercial Strategy via ATEL.

Data Manipulation

3.3 The first step in creating the citywide walking network was to create a base walking network. The base walking network was created using CCC road centreline data. All road centrelines that run through rural land, mostly on the outskirts of the city, were not included in the process as it is unlikely for pedestrians to use a rural road for commuting or for access to public transport. In addition to this, rural roads do not provide pedestrian facilities. In order to best represent the location of footpaths at a citywide scale, a buffer was created around each road link using road hierarchy values to estimate the road width. Lines generated from the buffers formed the footpath links for the walking network. The process was repeated several times, each time with different road width values to improve on previous results. **Figure 3.1** displays the base walking network layer on top of an aerial photograph for comparison.

Figure 3.1 Base Citywide Walking Network - Riccarton

3.4 Two major attribute fields were created for the walking network spatial data. One attribute defines the link type, and another defines road crossing or intersection type for links that cross roads. Each walking link in the base network was identified with a type attribute of "FOOTPATH". Link type and intersection attribute names and possible values included in the walking network are detailed in **Appendix A**.

3.5 The walking network in district centres and business retail parks as defined by the Transport Commercial Strategy is highly detailed, and was edited manually using aerial photographs in order to achieve an increased level of accuracy. The base walking network within the district centres or business retail parks were deleted and manually re-created. The district centres and business retail parks identified are located in the areas shown in **Appendix B**. Each walking link within a district centre or business retail park was identified with a type attribute of one of 'CARPARK', 'CARPARK_PUBLIC' or 'OPEN AIR MALL' in accordance with the link type. Only outdoor walking links have been recorded in the walking network. Road crossing links within district centres or business retail parks were also re-created manually using aerial photos, these links were given the value 'ROAD' for the intersection attribute. Road crossings were recorded at road intersections. The attribute for the street name of a road crossing is the street name of the road that is being crossed, not the street which runs parallel to the road crossing.

3.6 Edits made to the base walking network include accessibility details for mobility impaired users. A 'WHEELCHAIR' attribute is also included in the walking network data. Values of 'N' indicate the link is not suitable for wheelchairs, all other links are assumed to be suitable for wheelchairs.

3.7 The location of zebra pedestrian crossing links were added to the GIS city wide walking network GIS layer and confirmed using aerial photographs. Each zebra crossing link was given the intersection attribute 'ZEBRA'.

3.8 Intersections that included traffic signals were recorded on the walking network. These intersections were deleted from the base network and re-created using aerial photos; this was important where intersections used a combination of traffic lights, traffic islands and pedestrian crossings. Information on the frequency of traffic light phases that allowed for pedestrians to cross was also recorded. Traffic signal intersection links were assigned with an intersection attribute of 'LIGHTS'.

3.9 Walking links that are not along the sides of public roads, and therefore not included on the base network, were coded using a combination of aerial photographs and land zoning data that fall under three categories:

Open Space Zones

- Open space 1 zone: small areas of public open space which are of value to local neighbourhoods and communities
- Open space 2 zone: large areas of public open space for active recreation which serve a suburban or district-wide function
- Open space 3 zone: large public recreation areas, may be associated with areas of open parkland

Conservation Zones

- Conservation 2 zone: public parks of city-wide significance which help provide the city with its unique scenery and character
- Conservation 4 zone: most of the cemeteries which are currently operating. Other cemeteries that have significant heritage value are zoned in conservation 2 to provide greater recognition of their historic values

Cultural Zones

- Cultural 4 zone: campuses of tertiary education facilities

3.10 For each walking link running through one of the six zones mentioned above, the code was assigned as the type attribute. For example, a walking link running through Hagley Park was assigned 'O2', as Hagley Park has a land zoning of 'Open Space 2'.

3.11 The location of bus routes in the city was used in conjunction with aerial photographs to identify pedestrian refuges. Each bus route was inspected to ensure that all pedestrian refuges were located. The crossing links running through the pedestrian refuges were then manually coded and added to the citywide walking network layer. All crossing links associated with a pedestrian refuge were given the intersection attribute of 'REFUGE'.

4 TECHNICAL DETAILS

Software

4.1 There is a wide variety of GIS software available for use in spatial analysis. The creation of the CCC citywide walking network has used ESRI ArcGIS and MapInfo Professional for the primary data input and editing tools.

4.2 ESRI Network Analyst is an extension to ESRI's ArcGIS software product. Network Analyst enables network queries to be solved such as shortest path or service area analysis. Spatial data must be prepared correctly for Network Analyst to build a network for later analysis.

Data

4.3 ESRI ArcGIS works with in a number of different formats, most of which have been created by ESRI for primary use with ESRI products. A shapefile is a set of related files that stores vector spatial data in a specified format, such as point, lines or polygons, and at a specified projection. The data stored for each feature in a shapefile is stored in a DBF file. All outputs from the development of the Christchurch City walking network are in ESRI shapefile format.

4.4 Mapinfo data is stored in native TAB file format. A TAB file is similar to an ESRI shapefile in that it is made up of several files with each file playing a specific role. TAB files were used in the process of creating the walking network but are not featured in the final set of walking network data.

4.5 Data supplied for the walking network project came in a number of formats including predominantly Shapefiles and TAB files, files were converted and / or used as appropriate to project requirements.

Processes

4.6 The initial base layer was created by creating a buffer around the existing road centre line data. The buffer was based on the assumed road width of the various road hierarchies, as taken from the attribute table of the road centreline data. Road width and hierarchy information was taken from the Road Hierarchy Standards, Volume 3: part 8, Appendix 2 of the Christchurch City Plan. The buffer polygons were then converted into polylines and then planarized in ArcGIS to ensure connectivity. The planarize tool is a tool available in ArcGIS that splits and connects all line features together by creating intersections at all points where paths originally crossed but did not intersect (also known as spaghetti data). Planarizing has the effect of reducing complex 3D networks or unstructured linear data into simple, fully connected 2D networks. This enabled the creation of generic footpath and intersection links which formed the base walking network.

4.7 An essential practice to undertake when manually entering or editing spatial data for a connected network is to use the 'snapping' tool. The snapping tool snaps feature end point to other feature end points when the mouse cursor enters the 'snapping range' of the specified destination point. Snapping ensures topological connectivity of the network. All spatial data was entered or edited using the snapping tool.

4.8 An extra precaution taken when entering and editing the walking network was to not only snap all features, but also to slightly overlap crossing links to the base road network, then planarize the edits. This method ensures that if an intersection or road crossing link was not correctly snapped to the base network, then the link overlapping the base network would always connect through creating an intersection at the point of overlap.

4.9 The data from the CCC gave information regarding the traffic signals location, identification number, and phasing i.e. the order that vehicular and pedestrian traffic is allowed to move. It also indicated which road crossings at the intersection allowed for dedicated pedestrian movement. Once the intersection was identified, the aerial photograph covering the area was used to ensure accuracy of data editing and input of the related links. Each crossing link was given a percentage value based on the frequency that the crossing line is available for pedestrians to cross. This percentage information is recorded in the 'PERCENTAGE' attribute field of the walking network.

5 DISCUSSION & RECCOMMENDATIONS

Discussion

5.1 The production of the Christchurch City Wide Walking Network has resulted in an extensive detailed dataset that will be used for the analysis of PTAL in Christchurch City. The use of the walking network for other transit applications is expected to follow. The walking network provides a high level of detail and is ready for automated analysis. A higher level of detail could be achieved through breaking walking links not only at intersections, but every time the type of pedestrian facility changes. Examples of this would include the addition of driveway crossings, commercial driveways crossings, street crossings other than main intersections and areas along roads where there are no footpaths as it is accepted that pedestrians walk along these areas at different speeds than what they would a formed footpath.

5.2 District centres and business retail parks have been identified as significant areas of interest within suburbs. The higher level of detail within these areas allows for accurate analysis of PTAL within district centres and business retail parks initially, with the intention of further PTAL analysis. District centres and business retail parks have higher pedestrian traffic volume flows than other suburban footpaths and provide important amenity for the community such as shopping, healthcare and community services. Pedestrians in these areas also often use buildings, especially indoor shopping malls as thoroughfares, and the addition of these to the walking network would again increase the detail of the walking network, and allow for the analysis of service areas of public transport within suburbs to be achieved to a higher level.

Recommendations

5.3 Abley Transportation Engineers Limited recommend that the council considers:

- Development of a GIS based automated PTAL model that includes the ability to undertake iterative and 'what if' analysis to test for the effects of altering bus routes, bus stop locations and bus timetabling.
- Expansion of the Christchurch City Wide Walking Network to include a higher level of detail.
- The addition of other land use areas to the Christchurch City Wide Walking Network.
- Linking the Christchurch City Wide Walking Network with LTNZ neighbourhood accessibility assessment tool development.

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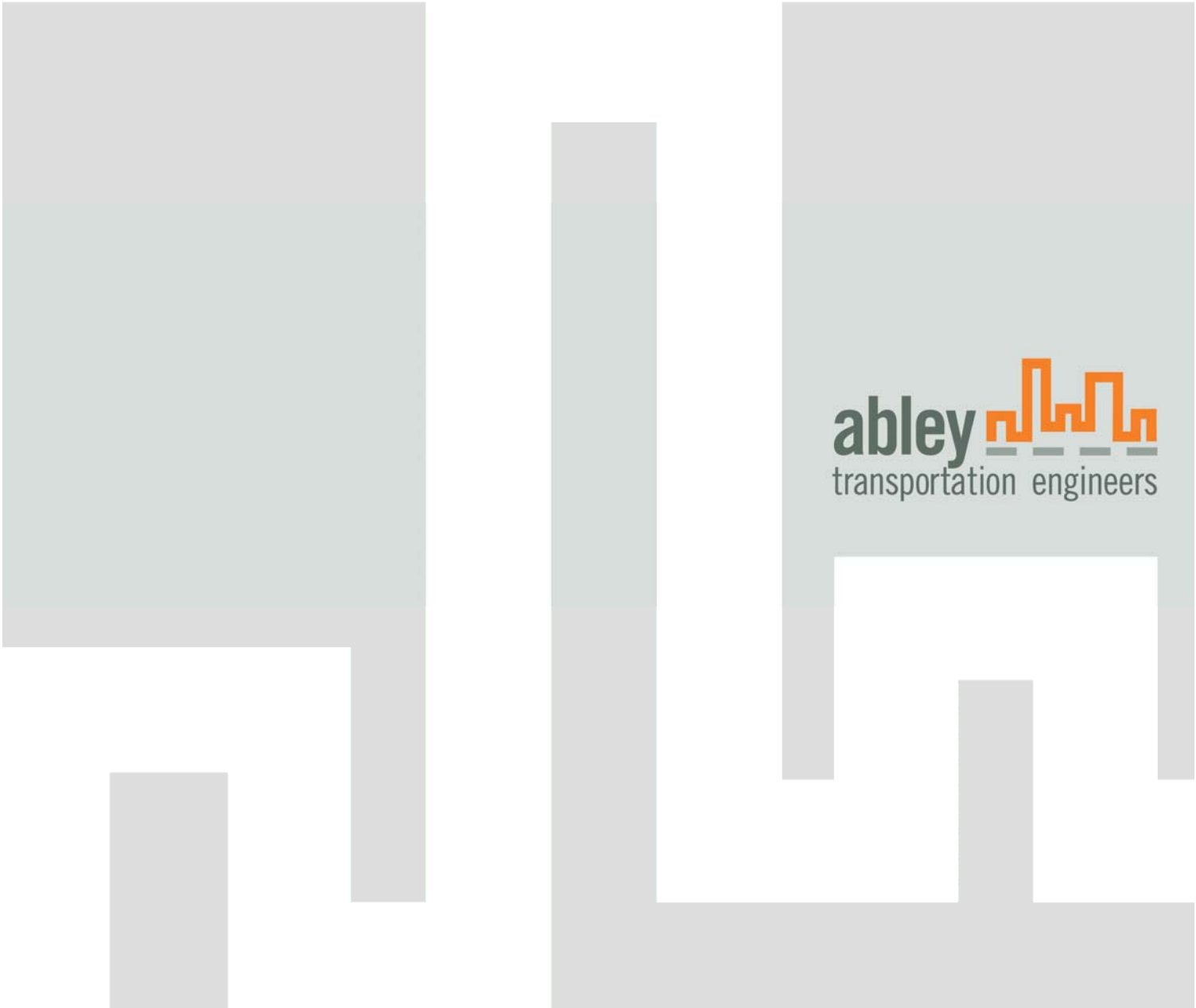
Appendix A



Appendix A

Building Field Definitions

BRIDGE	Walking links along bridges.
C2	Public parks of city-wide significance which help provide the city with its unique scenery and character.
C4	Most of the cemeteries that are currently operating. Other cemeteries that have significant heritage value are zoned in C2 to provide greater recognition of their historic values.
CARPARK	Private car parks.
CARPARK_PUBLIC	Public car parks.
CU4	Campuses of tertiary education facilities.
FOOTPATH	Footpath walking links.
O1	Small areas of public open space which are of value to local neighbourhoods and communities.
O2	Large areas of public open space for active recreation which serve a suburban or district-wide function.
O3	Large public recreation areas, may be associated with areas of open parkland.
OPEN AIR MALL	Malls such as New Brighton or Bishopdale that are pedestrian access only.
RIVER	Walking links alongside rivers.

Intersection Field Definitions

LIGHTS	Road crossing links at intersections controlled by traffic signals.
REFUGE	Road crossing links that traverse through pedestrian refuges, recorded along public bus routes only.
ROAD	Road crossing links at intersections not controlled by traffic signals and within district centres.
ZEBRA	Road crossing links over zebra pedestrian crossings.

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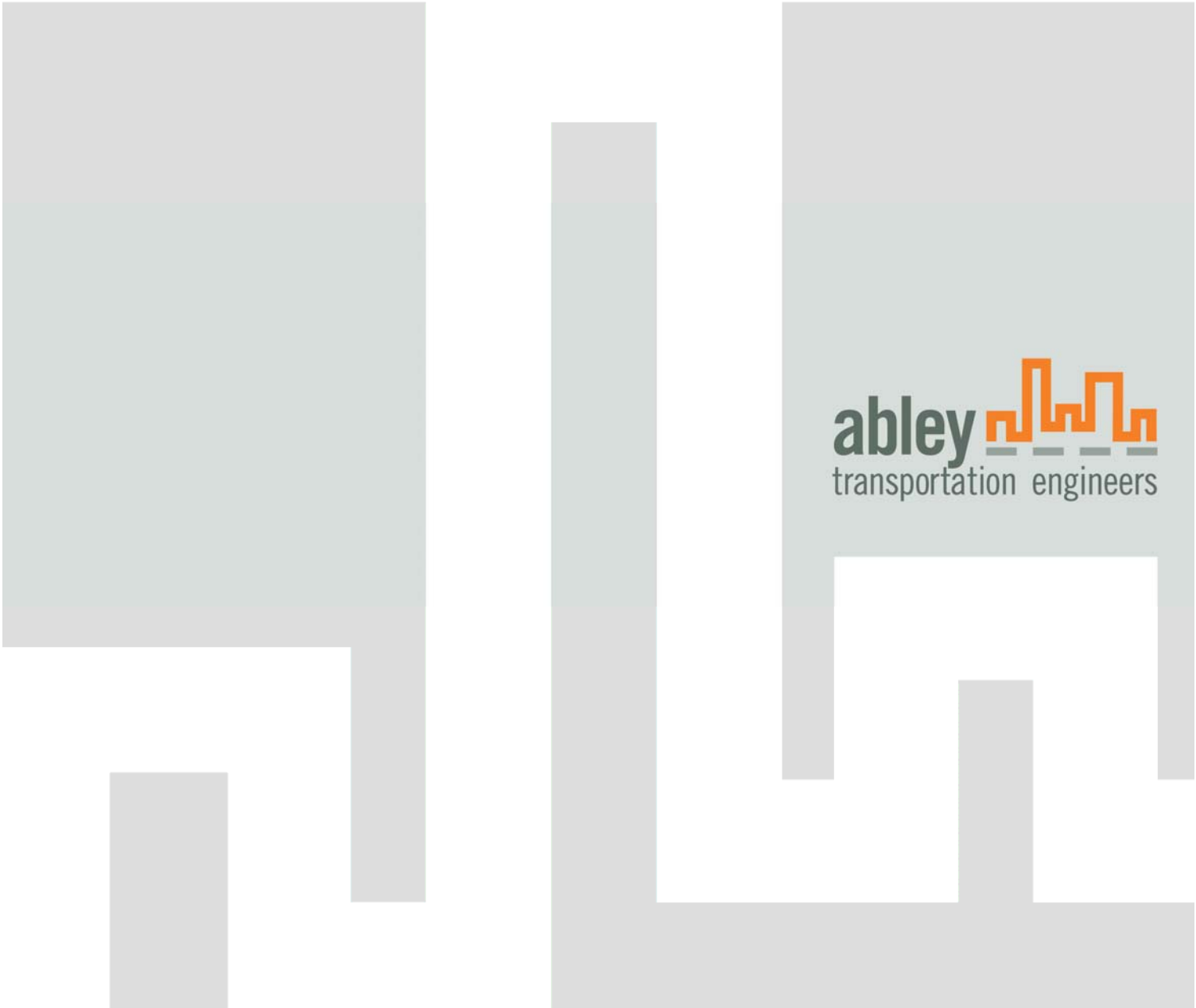
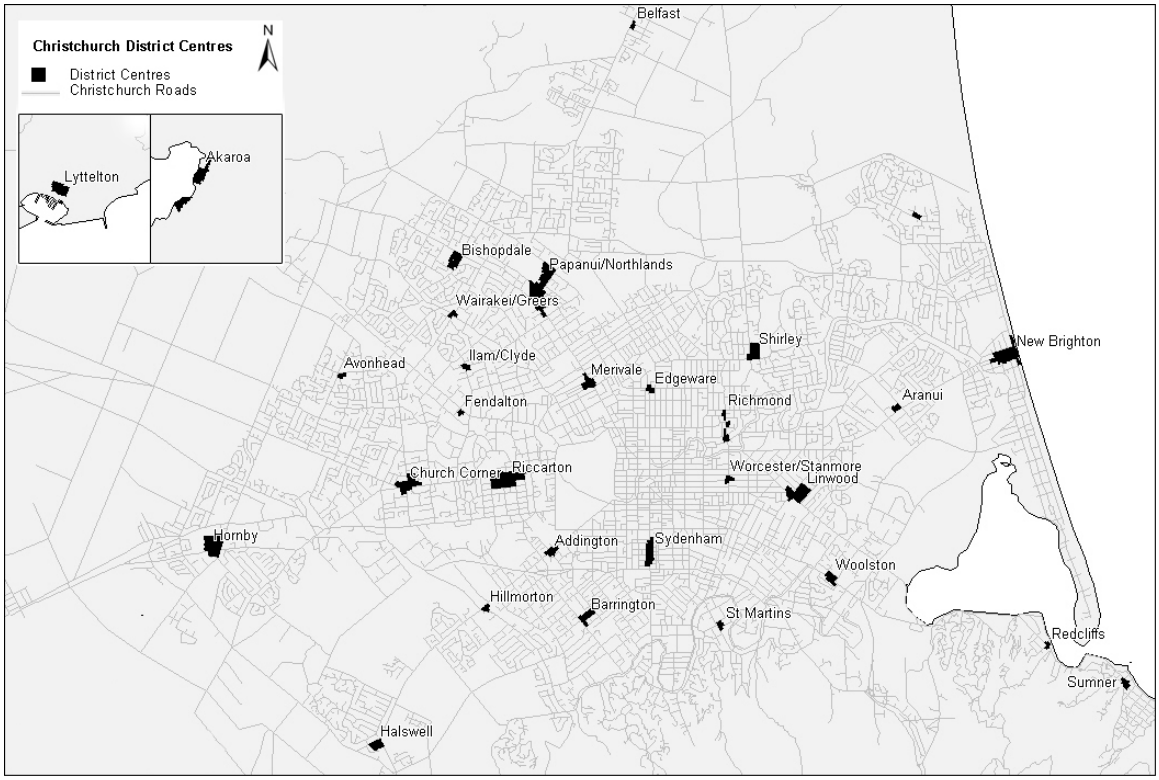
Appendix B



Appendix B


Christchurch District Centres
District Centres
Christchurch Roads
N
Lyttelton
Akaroa
Belfast
Bishopdale
Papanui/Northlands
Wairakei/Greers
Shirley
New Brighton
Avonhead
Ilam/Clyde
Merivale
Edgeware
Fendalton
Richmond
Aranui
Church Corner
Riccarton
Worcester/Stanmore
Linwood
Hornby
Addington
Sydenham
Woolston
Hillmorton
Barrington
St Martins
Redcliffs
Sumner
Halswell


Christchurch District Centres
Business Retail Parks
Christchurch Roads
N
Belfast Supa Centa
Tower Junction
Moorhouse Central
Chappie Place
Ferrymead