SCIRT Rebuilding Infrastructure LEARNING LEGACY

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.

Keeping the City Moving – From a Transport Perspective

Story: Keeping the City Moving – From a Transport Perspective

Theme: Construction

A research project on the traffic and transport planning undertaken to support the rebuild of Christchurch's horizontal infrastructure by keeping traffic disruption to an acceptable level while maintaining accessibility to key amenities and limiting congestion.

Programme funded by

Christchurch City Council New Zealand Government

city care Our people. Making it work. Downer Relationships creating success Fulton Hogan McCONNELL DOWELL CREATIVE CONSTRUCTION Fletcher

Programme funded by

"Keeping the City Moving – from a Transport Perspective"

The Transport Planning, Traffic Management & Communications during the Christchurch Rebuild

A research project to partially fulfil the requirements for the Degree of Masters of Engineering in Transportation

Civil and Natural Resources Engineering

College of Engineering

University of Canterbury

ENTR680-13A RESEARCH PROJECT

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2015

Cover page image – Traffic Management Plan for works in the Aranui area in Christchurch, New Zealand 2015

Abstract

The aim of this research project is to document the processes, procedures and tools used to keep traffic moving during Christchurch City's post-earthquake rebuild activities from 2011 to 2016. This report catalogues the challenges faced and solutions implemented during this time of increased construction activity. The processes and procedures used are applicable to the wider Christchurch area. However, the challenges of the horizontal infrastructure repairs causing multiple work sites in relatively high density is amplified within the 'Four Avenues' of Deans Avenue/Harper Avenue, Moorhouse Avenue, Bealey Avenue and Fitzgerald Avenue which form the boundaries of the Christchurch Central Business District (CBD) and the eastern suburbs. The CBD and eastern suburbs were badly damaged during the series of earthquakes, in terms of both land damage and infrastructure damage.

The report presents the traffic and transport planning that has been undertaken, to achieve the overarching goal of rebuilding the city, whilst keeping the impacts to an acceptable level, by maintaining accessibility to key amenities and limiting traffic congestion.

Acknowledgement

I wish to say thank you to a number of people for their help and contribution in this report. Without their support this research would have not been possible.

Firstly, I would like to thank Alan Nicholson for his guidance and support during this research journey with multiple interesting and beneficial discussions. I truly enjoyed working with Alan Nicholson. He has extensive knowledge in the transport sector as well as being a very experienced supervisor being able to guide me and stimulate my thinking.

Secondly, I would also like to thank the New Zealand experts from CERA, CTOC, CCC and NZTA in partaking in the stakeholder survey and giving me an insight into the industry thinking. I am also grateful for the multiple conversations I have had with Linda McGregor, Rod Cameron, Colin Hey and Angus Bargh, who all helped me in preparing the surveys and to get an understanding of the "SCIRT journey" from its beginnings until today.

Lastly, a big thank you and sincere appreciation for my brilliant family, friends, and colleagues who have given me their support, time, patience, and were in general very tolerant of me talking about my research topic a lot.

List of Abbreviations

AAC	An Accessible City
AADT	Average Annual Daily Traffic
AM peak	Morning peak
CAST Model	Christchurch Assignment and Simulation Transport Model
CBD	Christchurch Central Business District
CCC	Christchurch City Council
CCDU	Central City Development Unit
CERA	Canterbury Earthquake Recovery Authority
CITTM	Christchurch Improvements to Temporary Traffic Management
CTOC	Christchurch Transport Operations Centre
DM	Do Minimum
DN	Do Nothing
DS	Do Something
EB	Eastbound
ECan	Environment Canterbury
ECI	Early Contractor Involvement
EEM	Economic Evaluation Manual
FME	Feature Manipulation Engine
FWP	Forward Works Programme
FWV	Forward Works Viewer
GIS	Geographic Information Systems
GPS	Global Positioning System
HCV	Heavy Commercial Vehicles
IRMO	Infrastructure Rebuild Management Office
IST	Integrated Services Team
LINZ	Land Information New Zealand
LINZ_ID	Land Information New Zealand Identification (Road Centreline Identification)
LOP	Local Operating Procedure
LOS	Level Of Service

MCAT	Multi Criteria Analysis Tool
MESHT	Medical, Emergency, Schools, Hospitals, Transport
NB	Northbound
NOP	Non-Owner Participant
NZ	New Zealand
NZD	New Zealand Dollar
NZTA	New Zealand Transport Agency
OD	Origin Destination
OSM	Open Street Maps
PLD	Project Level Discussion
PM peak	Afternoon peak
RCA	Road Controlling Authorities
RD	Roading
RTO	Real Time Operations
SATURN	Simulation and Assignment of Traffic to Urban Road Networks
SB	Southbound
SCIRT	Stronger Christchurch Infrastructure Rebuild Team
SDI	Spatial Data Infrastructure
SIDRA	Signalised & unsignalised Intersection Design and Research Aid
SQL	Structured Query Language
STMS	Site Traffic Management Supervisor
SW	Stormwater
SWIF	Significant Works Identification Flowchart
TIM group	Traffic Impact Minimisation group
TI model	Traffic Interruption Model
TL	Total Length
TM	Traffic Management
TMC	Traffic Management Coordinator
TMP	Traffic Management Plan
TOC	Target Outturn Cost
TOMP	Transport Optimisation Management Plan
TTM	Temporary Traffic Management

UK	United Kingdom
VMS	Variable Message Sign
WB	Westbound
WS	Water Supply
WW	Wastewater

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1. Introduction

1.1. Motivation

New Zealand is in general highly exposed to natural hazards. This is due to the island nation's position in the Pacific 'ring of fire', its geographical isolation, as well as its varied landscape. As such, the people of New Zealand are and always will be particularly exposed to natural hazards.

One of these natural hazards is earthquakes, and the associated hazards of tsunamis, landslides, rockfall, land movement, liquefaction and flooding. An earthquake sequence totalling 1000's of recorded events was experienced during 2010 and 2011 in Canterbury. These earthquakes killed 185 people, injured several thousand, and had a devastating impact on the lives of Christchurch residents. It also badly damaged the city's horizontal infrastructure. Following the September 2010 earthquake the damage to the horizontal infrastructure was significant but limited to approximately 10% of the city by area. The fairly contained damage seen in September 2010 was amplified to affect almost all of Christchurch in the deadly February 2011 earthquake and subsequent aftershocks. This event severely damaged a great proportion of the Christchurch Central Business District (CBD) buildings, damaged significant areas of land, and damaged core infrastructure. After these events a cordon was introduced around the Four Avenues (as shown in **Figure 1**) and access to the CBD was slowly regained over time. On the 30th of June 2013, the Canterbury Earthquake Recovery Authority (CERA) handed back the control of the CBD to the Christchurch City Council (CCC) after the last cordon barriers were removed (Canterbury Earthquake Recovery Authority [CERA], 2015).

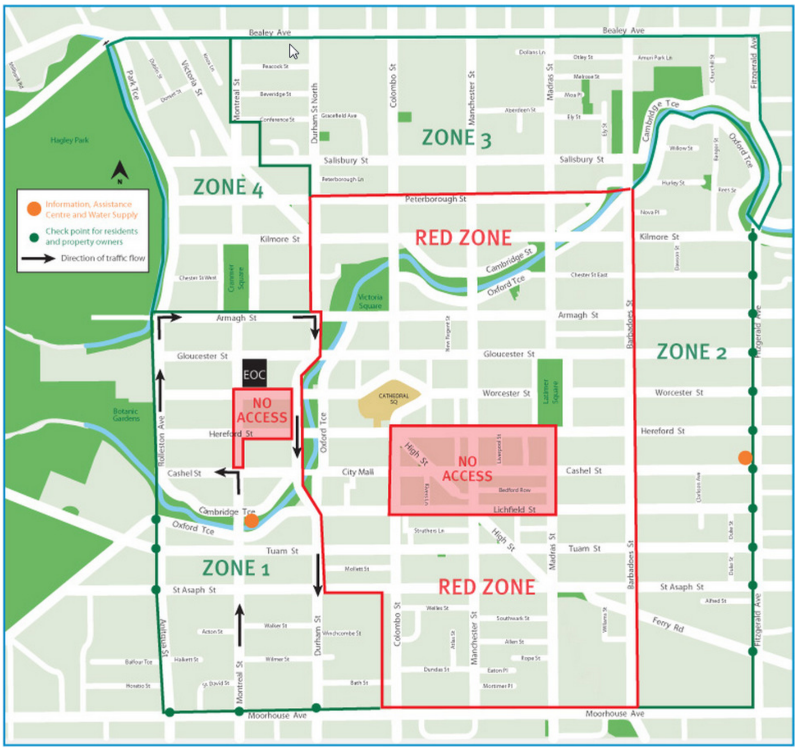


Figure 1: CBD Cordon Map (Rebuild Christchurch, 2015)

The Stronger Christchurch Infrastructure Rebuild Team (SCIRT) is an alliance that was formed to rebuild the city's public civil infrastructure since May 2011. Since SCIRT was formed, thousands of road work sites were planned and established around Christchurch as a programme of projects. Early on it became apparent that these road works needed coordination to avoid grid-locking the transport network and to avoid accessibility issues.

1.2. Objective

This report aims to provide a comprehensive illustration of the work undertaken by SCIRT in the transport planning sector. The road works are one of the most visible reminders of the earthquakes and still cause disruptions to the day-to-day lives of the Christchurch's residents and businesses.

It is important that the work undertaken in this area is accurately recorded, to help identify future opportunities and provide lessons learnt, that can be applied for future large scale natural hazard events nationally or internationally.

Furthermore, some of the tools and methods developed have the potential to become invaluable learnings going forward, as well as recording the development process.

1.3. Structure

This report will discuss the work SCIRT is undertaking in the transport sector. It starts off with providing the background as to why SCIRT was established and what it aims to achieve. This is followed by a detailed description of the transport planning and traffic management systems and SCIRT's communication with the general public (residents and businesses). Each of these chapters outline the work undertaken on a daily basis. Four case studies are presented in detail to illustrate how the different transport planning, traffic management and communications teams work together.

Surveys have been developed to get public feedback and transport industry experts' views regarding perceptions of SCIRT's management of work sites. The conclusion will outline the report findings and provide an update on the progress of SCIRT's programme.

2. Background

According to the latest census data (2013) Christchurch City's population is approximately 341,000 and is spread over approximately 1,415 km^2 (Christchurch City Council [CCC], 2015a). The people of Christchurch have experienced over 16,000 aftershocks since the initial September 2010 earthquake (Canterbury Quake Live, 2015).

The following **Figure 2** shows the earthquake and aftershock locations for the various seismic events around the wider Christchurch area, which collectively caused major destruction of the city's horizontal infrastructure (wastewater, stormwater, water supply, utilities, bridges, retaining walls, reservoirs, pump stations and so on) and vertical infrastructure (buildings).

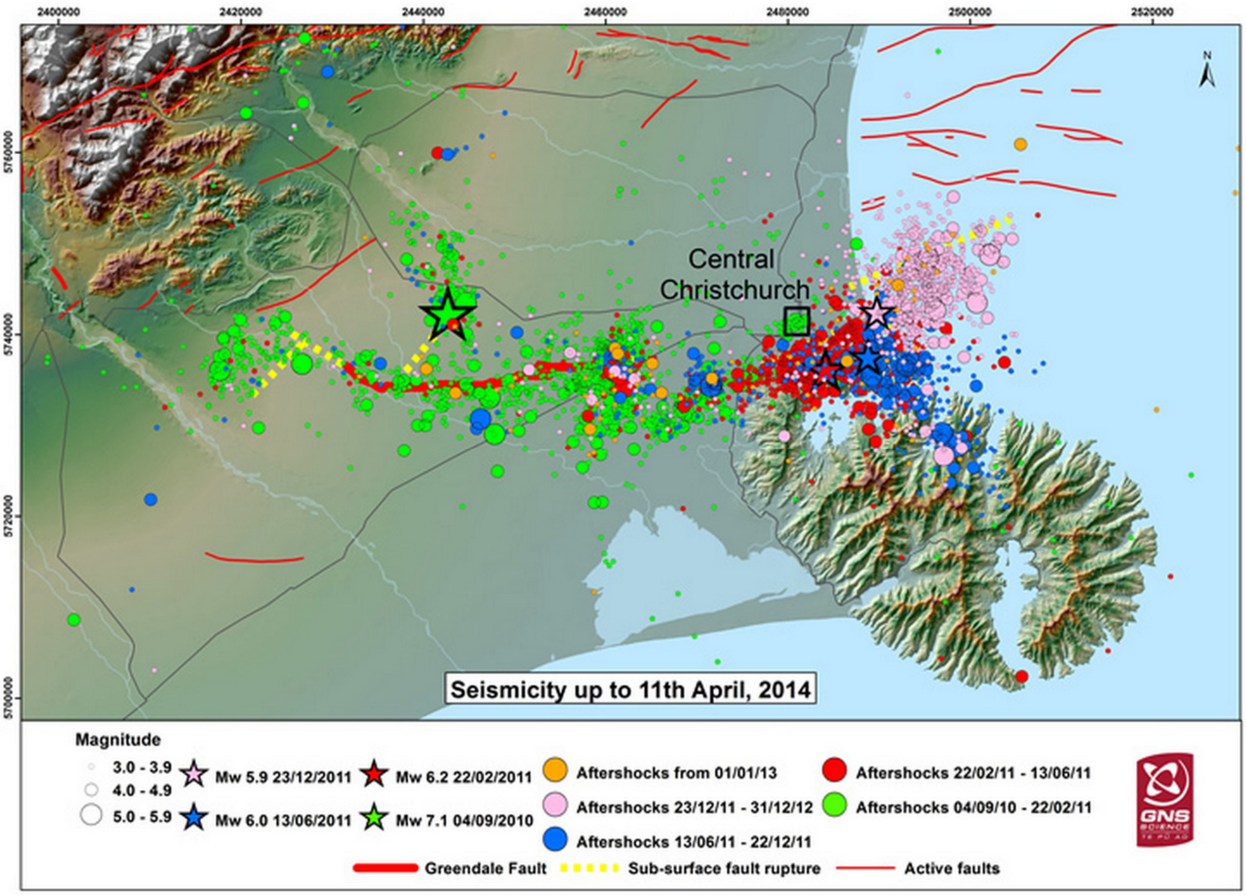


Figure 2: Earthquake map (GNS Science, 2014)

The extent of the damage caused by the most destructive February 2011 earthquake was widespread, with significant liquefaction experienced predominantly in the CBD and the eastern suburbs. This liquefaction far exceeded the liquefaction experienced in the initial September 2010 earthquake. The liquefaction extents for both the September 2010 and February 2011 events are shown in **Figure 3** and **Figure 4**.

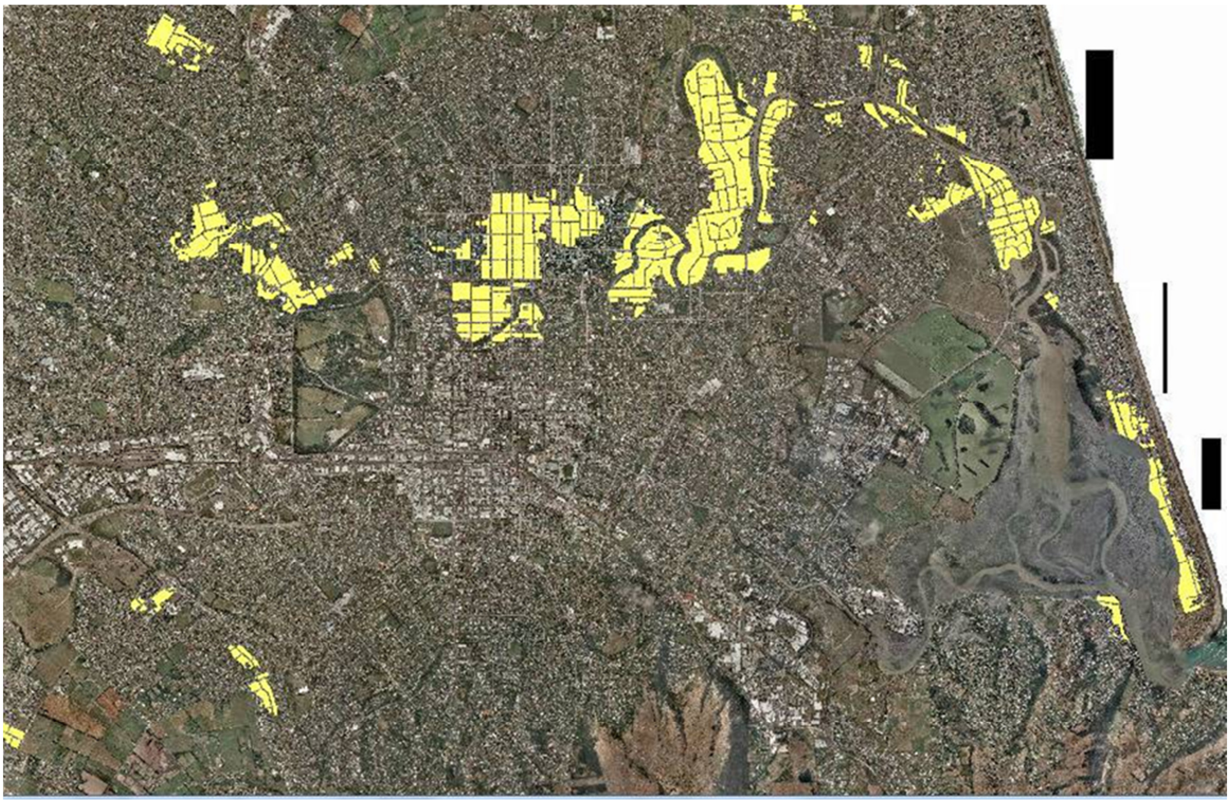


Figure 3: Liquefaction September 2010 (Stronger Christchurch Infrastructure Rebuild Team [SCIRT] viewer, 2014)

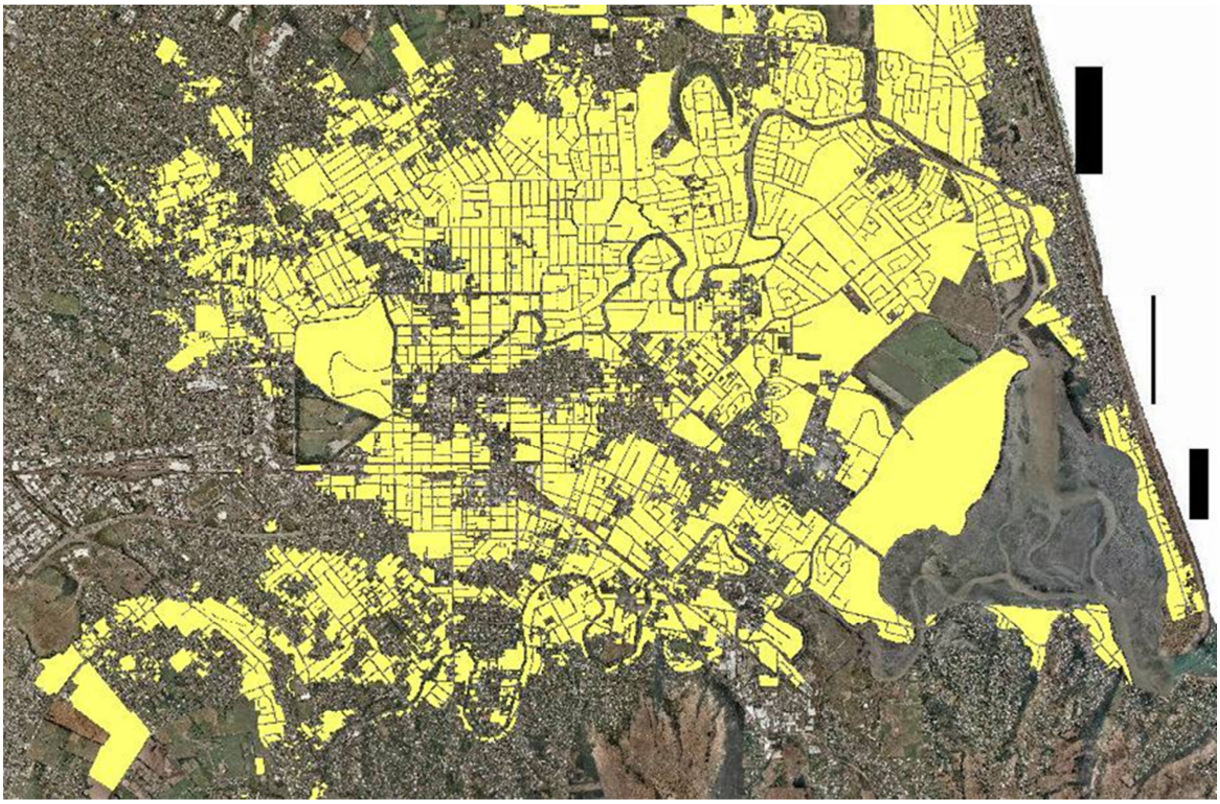


Figure 4: Liquefaction February 2011 (SCIRT viewer, 2014)

After the September 2010 earthquake, the CCC Infrastructure Rebuild Management Office (IRMO) was formed and tasked with the design, construction management, programming and administration of the earthquake repairs. As the extent of damage to the city was considerably increased after the February 2011 earthquake, a decision was made that a different delivery vehicle was needed. IRMO subsequently ceased within six months at the end of August 2011. SCIRT was established as an alliance between the three owner participants and five contractors.

The SCIRT owner participants, asset owners and funders are:

- Christchurch City Council (CCC)
- Canterbury Earthquake Recovery Authority (CERA)
- New Zealand Transport Agency (NZTA).

The SCIRT non-owner participants and contractors are:

- City Care
- Downer
- Fletcher Construction
- Fulton Hogan
- McConnell Dowell.

With the formation of SCIRT, the workforce available for the rebuild was increased. At the height of the SCIRT construction period, there were approximately 300 people within the SCIRT Integrated Services Team (IST) office. The IST included staff from each of the delivery teams, CCC, NZTA, as well as over 150 designers from various consultancy companies. It is intended that SCIRT will finish construction for this large scale infrastructure programme by the end of 2016. The transport planning and traffic management team sits within the SCIRT IST, as illustrated in **Figure 5**.

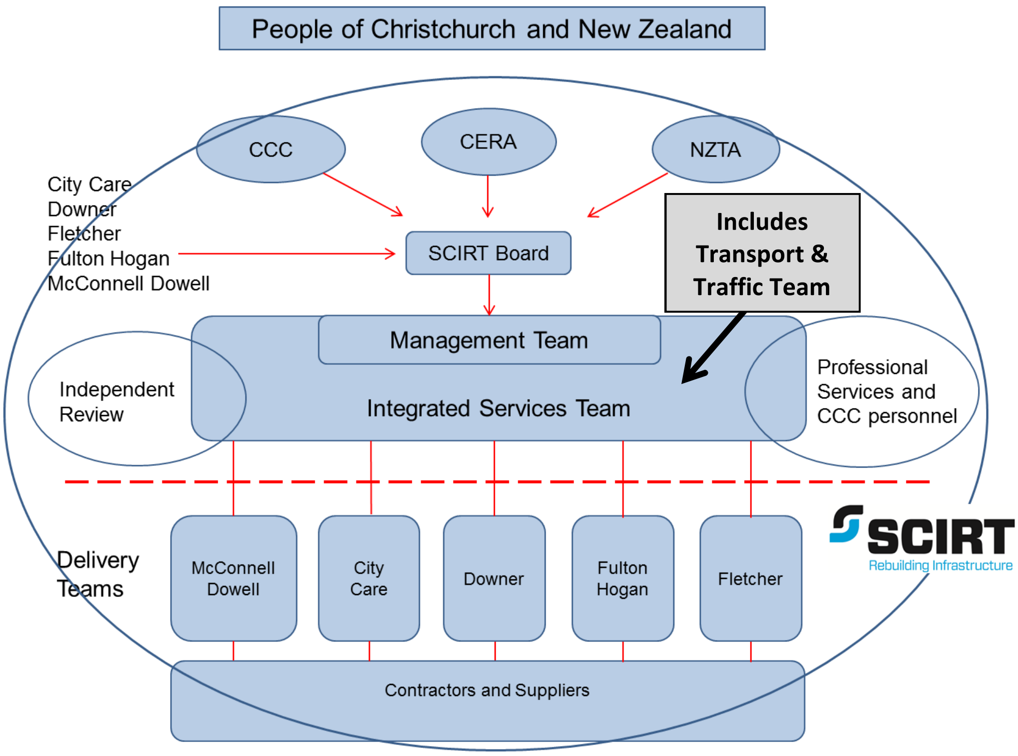


Figure 5: SCIRT team structure (SCIRT resources, 2014)

SCIRT's overarching goal is to "[create] resilient infrastructure that gives people security and confidence in the future of Christchurch" (SCIRT, 2015a). The following **Figure 6** provides an illustration of the horizontal infrastructure assets under repair by SCIRT.

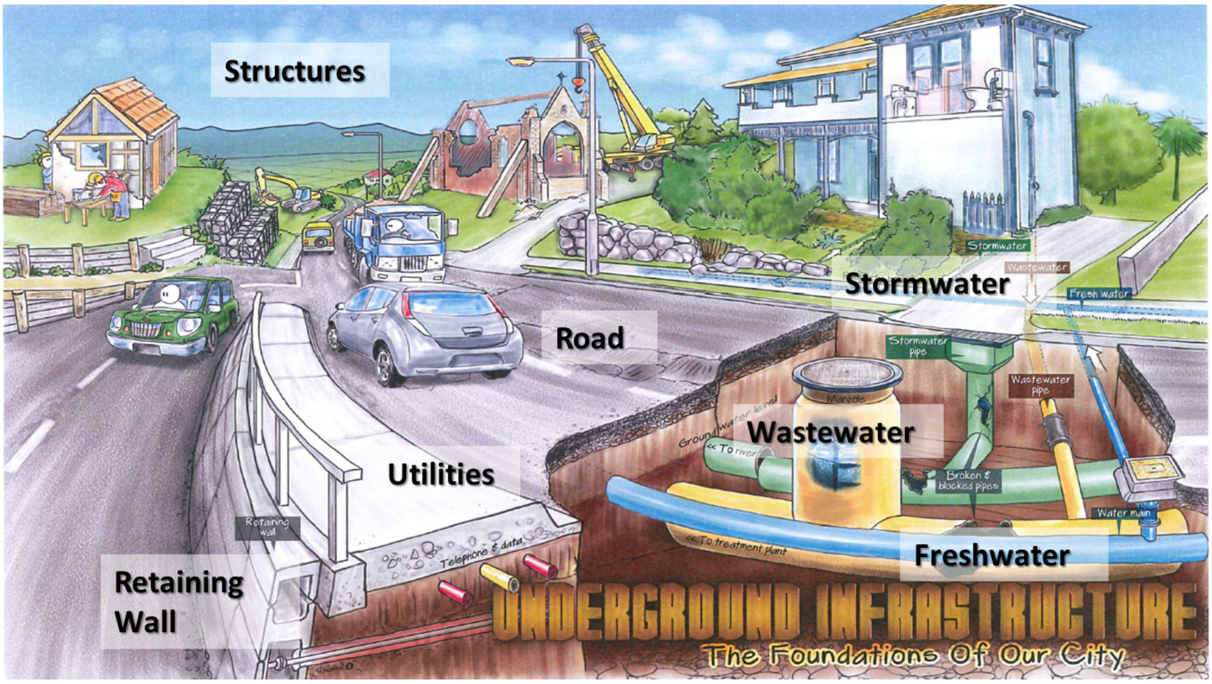


Figure 6: Horizontal Infrastructure Overview (SCIRT, 2012)

These assets comprise of the following elements:

- Water supply reticulation
- Wastewater reticulation
- Stormwater reticulation
- Pump stations (wastewater and stormwater)
- Reservoirs
- Underground utilities
- Retaining walls
- Bridges
- Road pavements and surfaces.

All of these asset repairs or rebuilds could potentially cause disruptions to the transport network. This could either be through:

- Additional heavy vehicle movements to deliver materials and machinery to site (manoeuvring into the site can by itself bring traffic to a standstill for a few minutes)
- Accessing the underground services
- Work space requirements to store machinery to undertake the works
- Work space to undertake works safely.

The following **Table 1** and **Table 2** provide an overview of the works that need to be undertaken in the CBD and in the greater Christchurch area overall. These tables illustrate the extensive damage to the infrastructure as a percentage.

The CBD has been proven to be particularly challenging context given the density of road works required to repair the assets. The damage to the wastewater system alone is approximately 75-90% of the total length (TL) of the overall CBD network.

Table 1: Network damage proportions by asset type in the CBD (SCIRT internal, 2014)

Asset Type	Length / No (approx.)	Damage (approx.)
Wastewater (WW)	65km	75-90% of TL
Stormwater (SW)	55km	30-50% of TL
Water supply (WS)	75km mains 50km sub mains	10% of TL
Roading (RD)	65km	35% severe/major 45% moderate 20% minor/none

Table 2: Network damage proportions by asset type overall (SCIRT internal, 2014)

Asset Type	Length / No (approx.)	Damage (approx.)
WW reticulation	1,600km	40%
WW pump stations -repair	165	35%
pump stations – new / decommissioned	30 / 10	-
WW lift stations - new	65	-
WS reticulation	2,850km	2%
WS pump stations and reservoirs	220	35%
SW reticulation	330km	10%
SW pump stations - repair	38	20%
pump stations - new	3	-
RD carriageway	11,672,000m^2	10%
RD bridges/culverts	225	65%
RD retaining walls	490	45%

To further visualise the damage and the rebuild works required, the magnitude of damage is shown in maps in **Appendix A**.

The estimated cost of the rebuild work has shifted over time with changes to the definition of scope to match funding. It is currently estimated at approximately $2.2 billion. To put this cost into perspective by comparison to another large infrastructure project underway in New Zealand, the Waterview Connection, which is labelled "one of the most important infrastructure developments ever to take place in New Zealand" (NZTA), has an estimated project cost of $1.4 billion. This is approximately two thirds of the cost of the Christchurch rebuild, demonstrating the scale of the rebuild.

This makes the Christchurch rebuild the largest and most complex project ever undertaken in New Zealand. The rebuild is essentially a non-stop operation, with some sites operational 24 hours per day, until programmed completion in December 2016. The construction value spent since January 2012 is shown in **Figure 7.** This shows that since construction ramped up at the end of 2012, the average monthly construction value spent has been between $20-30 million NZD.

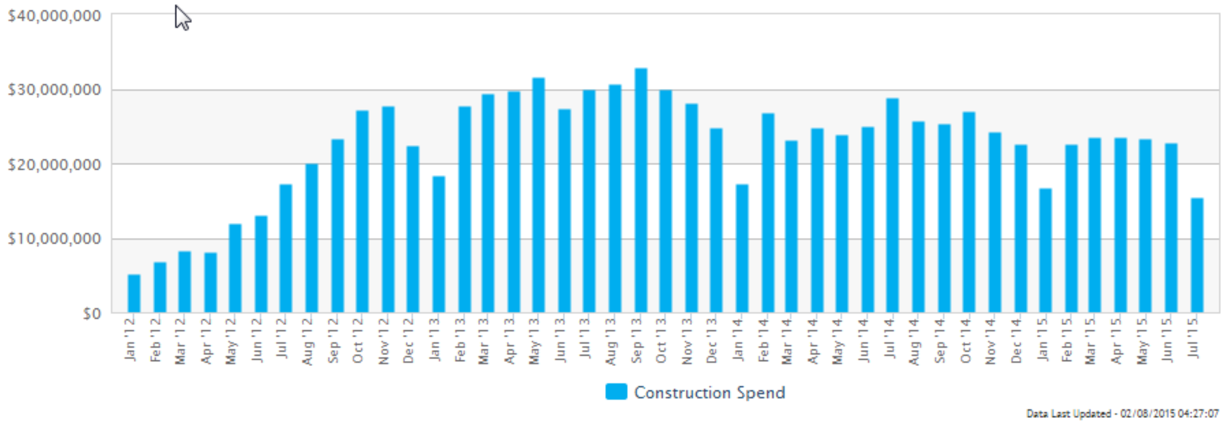


Figure 7: Monthly Construction Spend Summary (SCIRT internal, 2015)

Appendix B shows the monthly progress by project stage. This illustrates also the amount of work that has been completed to date and what is still is to be undertaken, stated as project construction values.

Associated with the repair works is the impacts on road users. The CBD is facilitating a large number of traffic movements on any one day (see Figure 8), meaning road works cause interruptions to a large number of road users. Barbadoes Street and Madras Street are classified as major arterials and Durham Street, Cambridge Terrace and Montreal Street as minor arterials, as per the operative Christchurch City Plan (Volume 3, Appendix 3). These roads are one-way only and provide two through lanes for the whole length between Moorhouse Avenue and Bealey Avenue and vice versa.

Figure 8 shows the average annual daily traffic (AADT) bands for these arterials, from the Christchurch Assignment and Simulation Transport (CAST) Model. This figure shows that the Four Avenues and the four northbound and southbound arterials are highly utilised. The eastbound and westbound one way roads (St Asaph Street, Lichfield Street, Kilmore Street and Salisbury Street) carry less traffic. However especially the Lichfield Street and St Asaph Street located at the southern end of the CBD are also highly utilised. All four of these eastbound and westbound routes are classified as minor arterials in the operative Christchurch City Plan (Volume 3, Appendix 3).

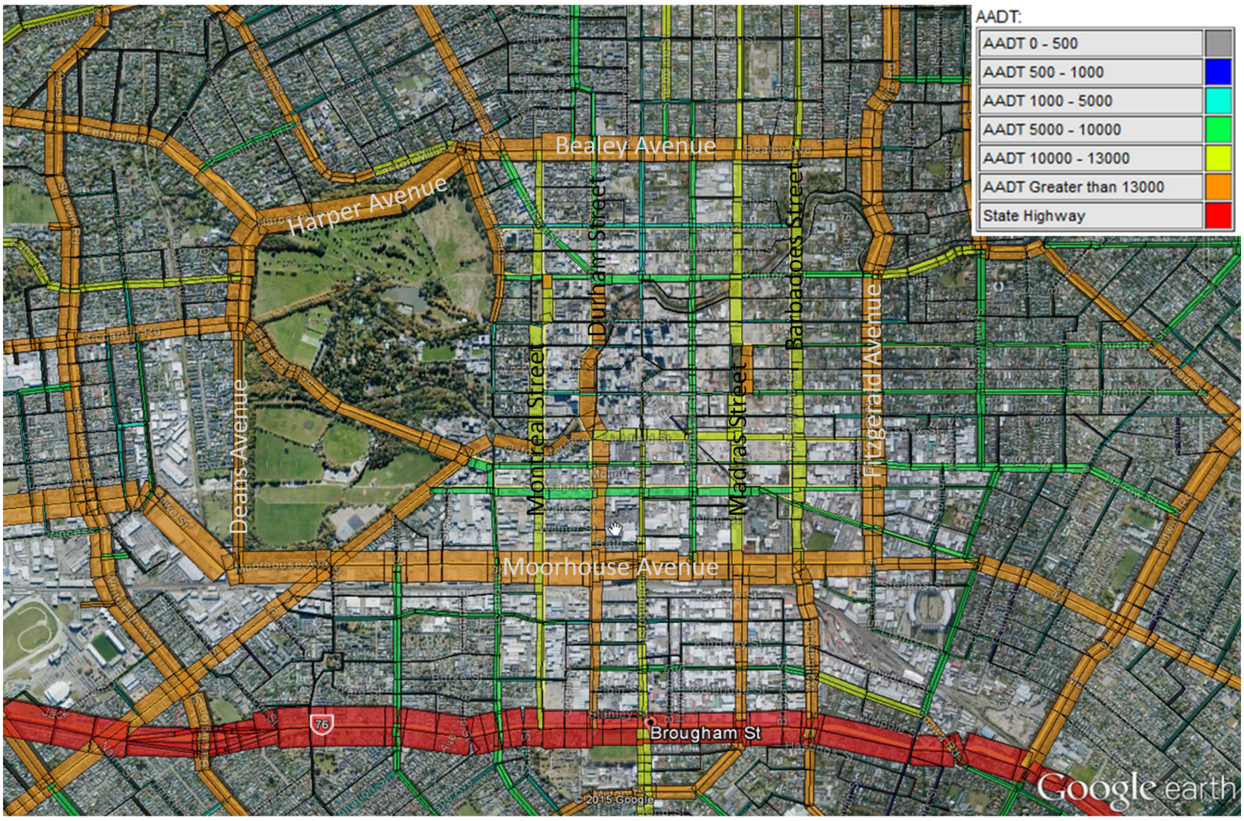


Figure 8: Google map with AADT bands (based on CAST SATURN model)

Work sites on arterial roads need special consideration and careful communication to the public. These considerations address means to accommodate traffic movements through the site and/or achieve diversion away from the impacted roading network, and to maintain sufficient capacity on the remaining roading network. How the latter is evaluated and achieved is set out in the subsequent chapters.

Furthermore, the Central City Development Unit (CCDU) of CERA (also established post-earthquake to facilitate the rebuild of the central city), proposes major anchor projects which require road space during their construction. CCDU is also using the opportunities presented by the vertical rebuild to reshape the CBD roading hierarchy as well as the layout of the transport network. Their 'anchor projects' make it particularly important for SCIRT to progress the horizontal infrastructure repair works in the CBD as soon as possible, to avoid conflicting demands for road space. **Figure 9** shows the changes to the roading network that are currently being implemented to support the anchor projects (indicated by the numbers 1-9, see legend for specifics; the new bus interchange is shown in purple).

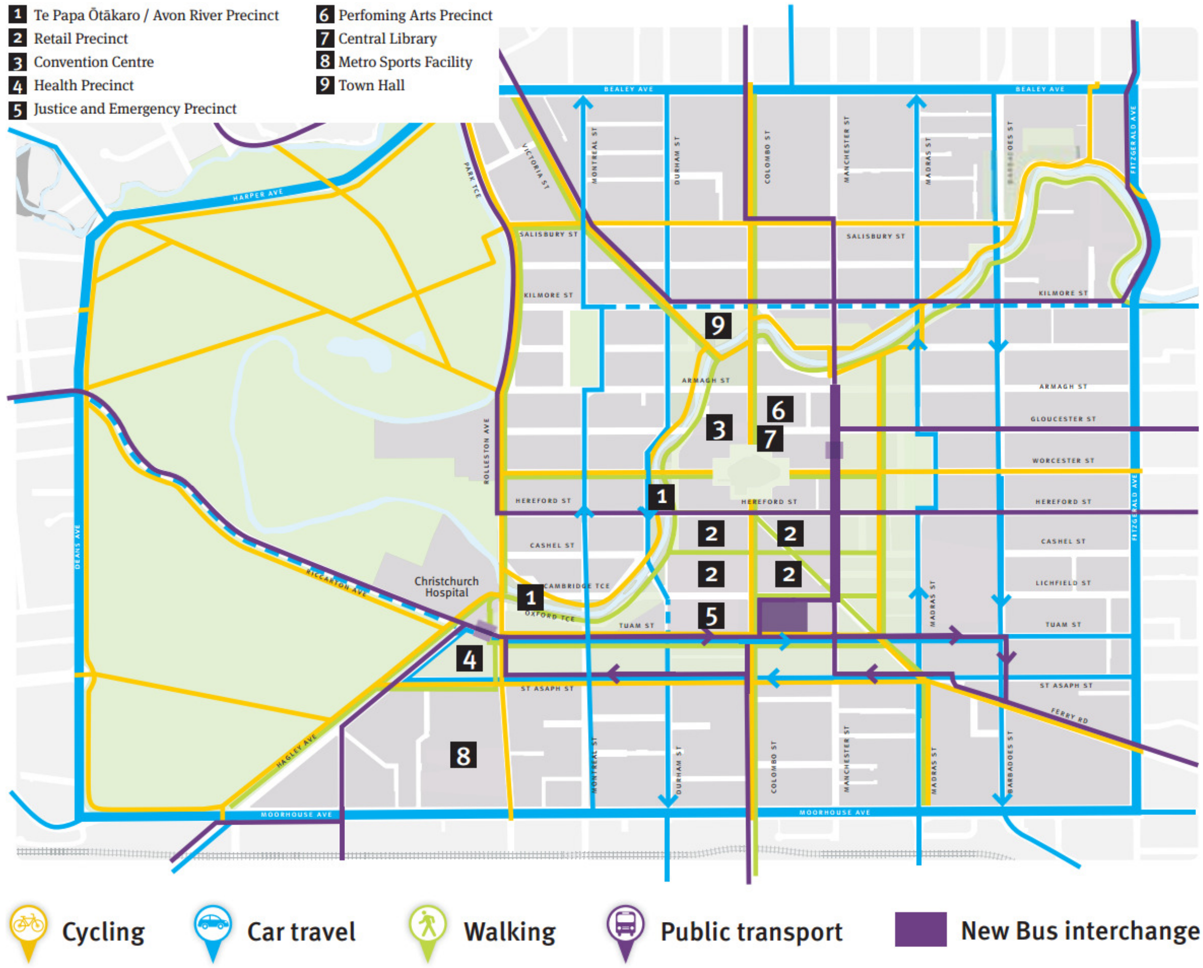


Figure 9: Central City road priority by mode [amended] (Central City Development Unit [CCDU], (2014), p. 7)

Figure 10 presents the new car travel road hierarchy and presents the changes proposed by the CCDU to the roading network. The four northbound and southbound one-way streets will be kept with the intended function of facilitating traffic through the city. However, the current eastbound and westbound one-way streets located in the CBD's north (namely Salisbury Street and Kilmore Street [west of Madras Street]) will be reshaped to facilitate two-way traffic.

Changes have already been implemented at the 'Hospital Corner' intersection (Hagley Avenue, Riccarton Avenue, Oxford Terrace and Tuam Street). Removing Oxford Terrace as a vital link into the CBD means the use of Lichfield Street will be reduced. The main eastbound route through the city will switch to Tuam Street, which will be converted to one-way between the Four Avenues.

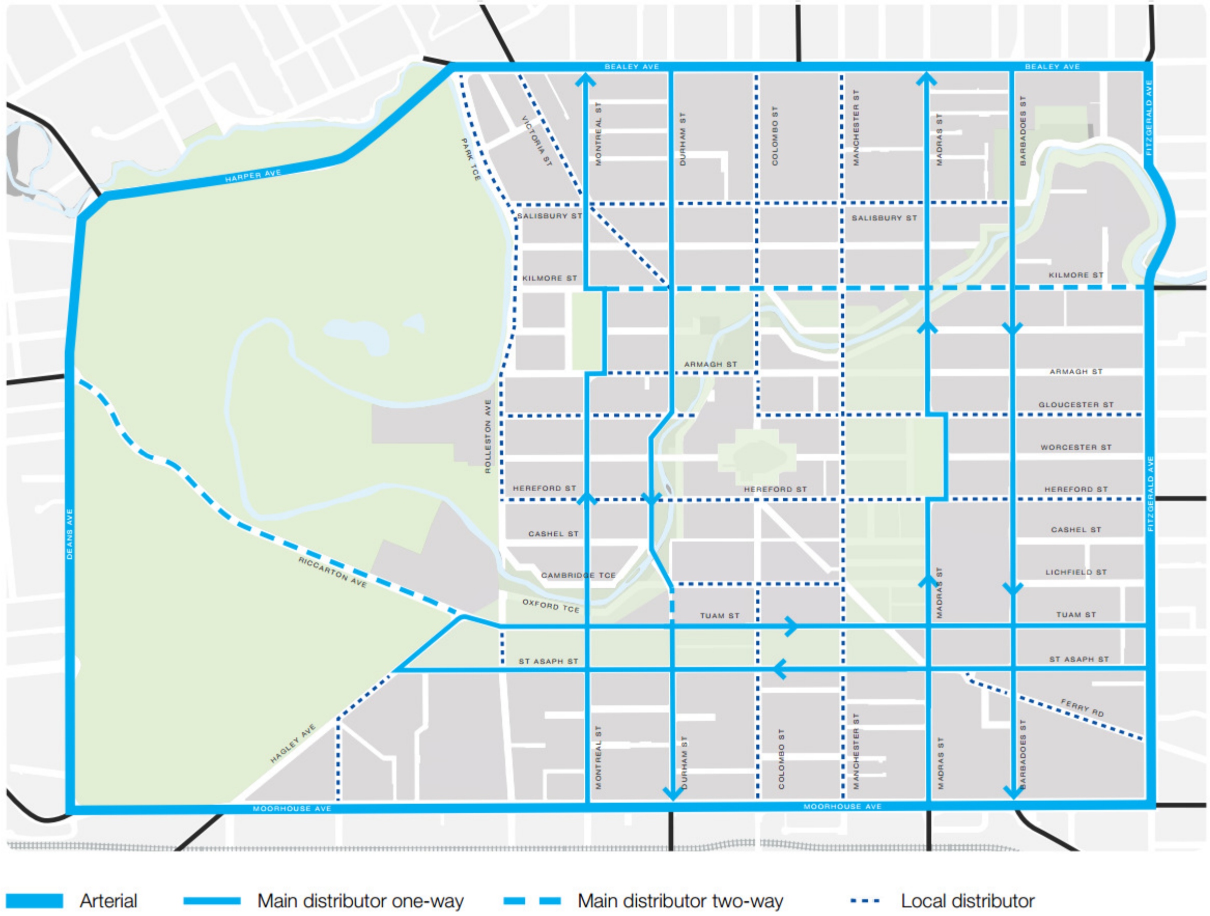


Figure 10: Central City car travel hierarchy (CCDU (2013), p. 17)

To a lesser extent, CCC is still implementing its scheduled maintenance programme. This programme also needs consideration and coordination with the other programmes.

To accommodate all these different programmes and sometimes conflicting road space requirements, it was crucial to have all the pertinent information in a common format. This data allows coordination and planning of forward works, to avoid costly conflicts.

3. Transport Planning

3.1. Relationships

Transport planning sits within the Delivery Management team of the IST. The transport planning team works closely with the traffic managers, delivery teams, communication teams and (to a lesser extent) the designers, schedulers and the central city project manager, to collect all available data and discuss projects as required. Furthermore, SCIRT traffic managers and transport planners are part of the Traffic Impact Minimisation (TIM) group, which is tasked with minimising the traffic impacts in the wider Christchurch area. As part of this, SCIRT is responsible for developing the necessary tools and outputs to help with the decision making process.

For the eventuality that the TIM group is not able to come to a consensus whether works can be facilitated or not, a process is in place to escalate the decision. This escalation process is described in the Transport Optimisation Management Plan (TOMP) and sets out the responsible parties and information needed for the nominated personnel to make a decision. To date the TOMP process has been initiated but agreement has been reached before the formal processes outlined needed to be progressed.

The tools and procedures developed to undertake the transport planning required to keep the city's traffic flowing will be explained in detail in subsequent chapters and case studies of the tools in use are provided in **Chapter 6**.

Figure 11 shows where the transport planning team sits within the Delivery Management team and the main working relationships.

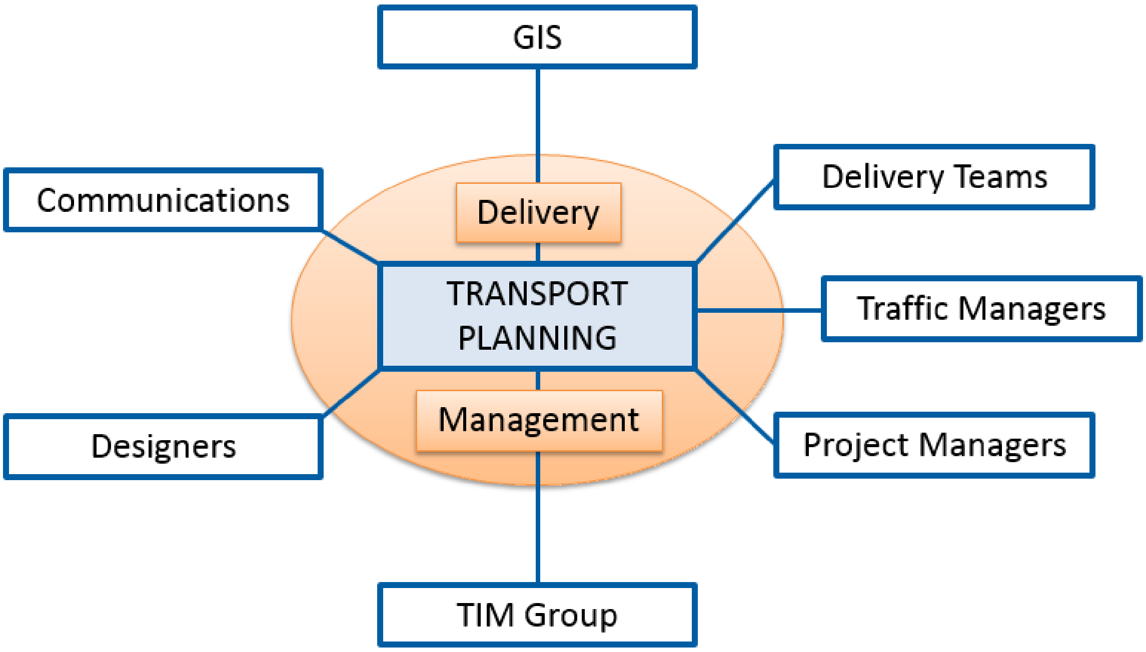


Figure 11: Transport planning within SCIRT

The transport planning team within the IST primarily undertakes the following tasks:

1. Scheduling
2. Impact assessment
3. Economic assessment
4. Communication strategies
5. Traffic management strategies.

Traffic management and transport planning are interdependent and the responsibility boundaries are somewhat fluent.

3.2. The Beginnings, Priorities and Challenges

Following the earthquakes, emergency repairs were carried out to address the immediate concern of getting damaged infrastructure functioning again. It is the nature of emergency repairs that these cannot be foreseen and planned for, and therefore the chief concerns at the emergency response phase was the safety of the workers and the public, and reinstating a functioning network.

After this initial response, the overall master programme was established using a Multi Criteria Analysis Tool (MCAT). The MCAT is run on a three-monthly interval, using updated data to re-evaluate if the right action is still being undertaken at the right time. This iteration is part of the objectives as set out in the Project Prioritisation Management Plan (SCIRT, 2013b), and this project prioritisation process was developed within a few months of SCIRT's establishment. The four-step MCAT that was developed is set out in **Figure 12**.

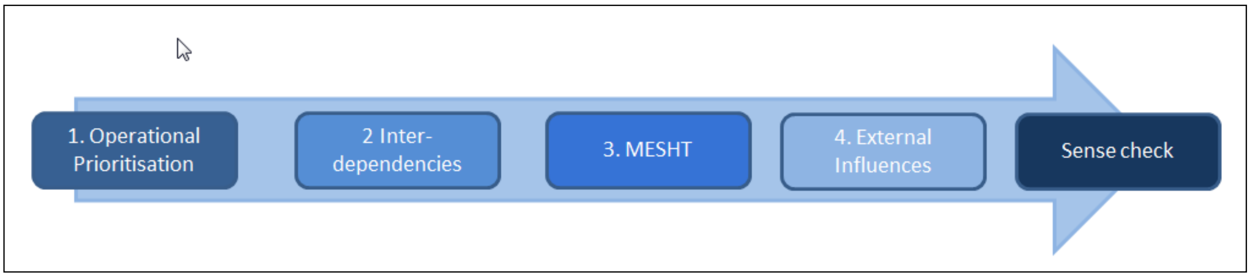


Figure 12: Prioritisation Process (SCIRT (2013b), p. 5)

The four steps of the MCAT are described in detail below (SCIRT, 2013b):

1. Operational Prioritisation

   Within this step, the asset condition, criticality, post-earthquake level of service and maintenance costs are assessed and scored to calculate the overall operational score per individual asset. An exception is the roading network. Maintenance work is rolled out in areas where limited rebuild activities need to be carried out, and potholing and drainage repairs are undertaken elsewhere to keep the network functioning until the underground infrastructure and roading repairs have been concluded.

2. Interdependencies

   In this step two main types of interdependencies are considered: catchment and proximity dependencies.

   The catchment dependency considers the need for wastewater and stormwater pipe repairs being carried out for hydraulic catchment areas. The earthquakes caused widespread ground settlement and individual pipe segments cannot simply be replaced in isolation, as gradients have changed. To meet hydraulic velocity and capacity requirements these assets need to be designed within a dedicated catchment, which usually encompasses a pump station or other prominent collection or discharge facility. Given this requirement, a cumulative prioritisation score per individual asset per catchment was created and applied as a per hectare measure.

   The proximity dependencies mean that works within a catchment is geographically broken down into a series of projects to progress through the design and delivery phases. This grouping occurs after concept design is completed; assets are grouped based on their geographical proximity, to achieve project sizes of approximately $10M or to facilitate a 'one pass' approach. Independent structures such as retaining walls, bridges or reservoirs are grouped together if possible, or else individual projects are created.

   Secondary scores created at a project level can be used to determine the project order within a catchment level.

   This also creates opportunities for transport planning to be involved in the ordering of individual projects within a catchment. Analysis can be undertaken to demonstrate the impacts, and re-sequencing of projects /sub-projects within a catchment can be requested. Re-sequencing may be necessary when the expected impact caused by the proposed works is very large and mobility through the catchment cannot be guaranteed. This potentially increases travel times experienced and has the potential to grid-lock a catchment.

3. MESHT (Medical, Emergency, Schools, Hospitals, Transport)

   This step is generally applied to the project level and ensures that services to medical and emergency facilities, schools and hospitals, and important strategic transport routes or public transport links are maintained.

   To support wider recovery plans, a catchment re-prioritisation can be stipulated for the overall greater good by the stakeholders. The specific MESHT priorities would need to be provided to SCIRT.

   During this stage, transport planning can flag issues and assist re-programming of projects to address accessibility issues.

4. External Influences

   This step includes all other geospatial and temporal targets that need consideration and which may impact on the prioritisation of the projects. This step recognises stakeholder-specific goals or priorities, such as the Central City Blueprint and anchor project consideration.

   These external factors may cause re-prioritisation at a project or a catchment level. A thorough and transparent process is followed when external factors start influencing the programme.

5. ‘Sense check’

   Sensitivity tests and a human ‘sense check’ may be applied to understand the impacts of the MESHT and external factors re-prioritising the overall programme. After this step, the second and final priorities are captured and provided to the scheduling process.

Figure 13 shows a programme of works created by SCIRT based on the prioritisation process described above. This programme takes into consideration external and MESHT factors through collaboration with the Government, CERA, and CCC, by receiving stakeholder programmes and priorities for inclusion into the MCAT analysis.

This process is used to reinstate services where they are most needed and to improve the overall level of service of the Greater Christchurch area. This process is transparent and the resulting schedule is made publicly available to inform interested parties.

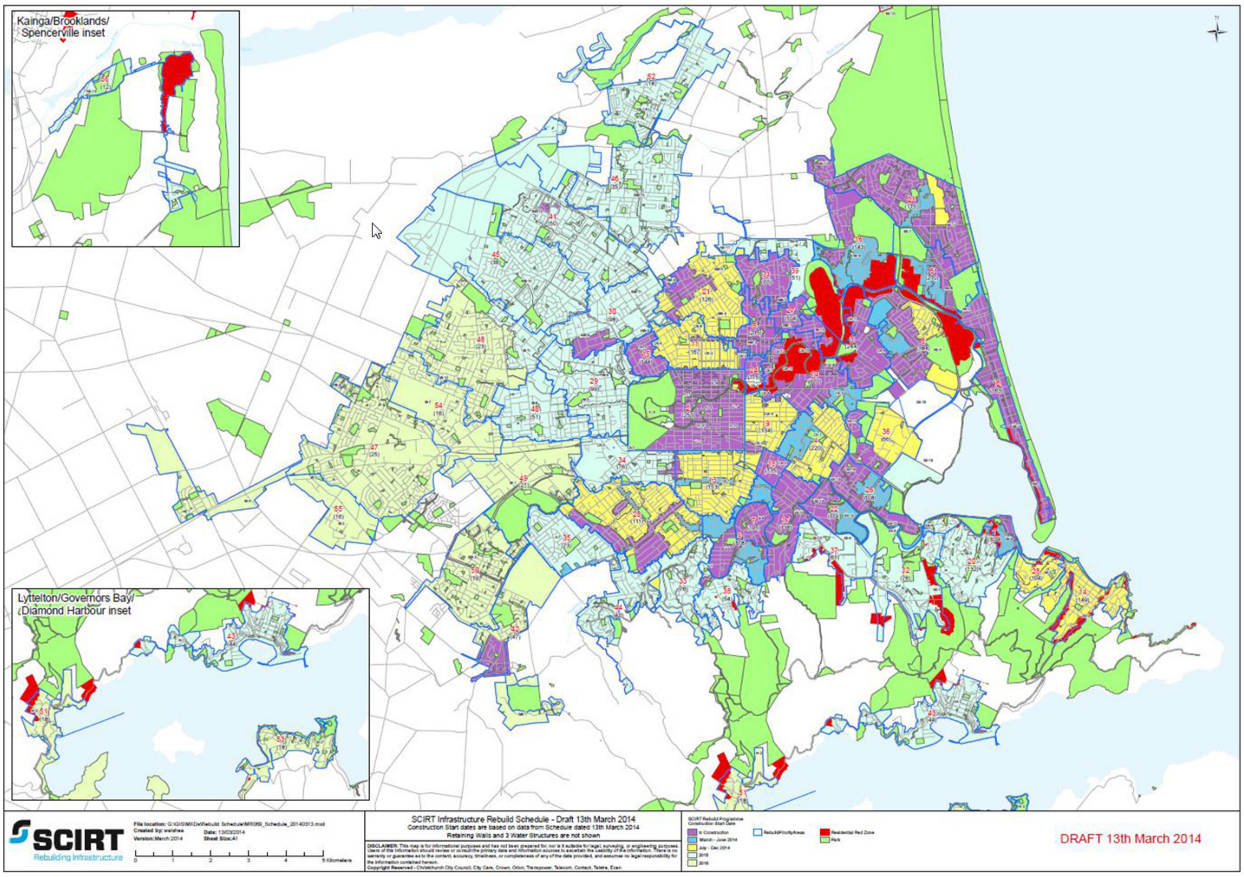


Figure 13: Overview map of project schedule at a catchment level (SCIRT (2014c), p. 16)

SCIRT’s transport planning team gets involved mostly in the sequencing of works within a catchment, as described under step 2 (described on p.13 and 14). The involvement at this level is to prevent long detour routes around particularly intrusive work sites and to make sure the remaining available alternative routes are not ill-equipped to deal with the additional demand. If road capacities within a catchment drops below the expected traffic demand, it results in substantial delays, and in the worst case scenario, it will partially grid-lock Christchurch’s roading network, leading to increased driver frustration and larger transportation dis-benefits

To illustrate what impact catchment works can cause, an example is outlined in **Figure 14**. Road network catchments, as previously discussed, are further subdivided into smaller projects of approximately equal costs. If no re-sequencing of projects would occur, this would result in approximately 10-15 crews working concurrently per catchment.

As shown in **Figure 14**, a high density of work sites has the potential to cause accessibility issues within the catchment and mobility issues in facilitating traffic through the catchment.

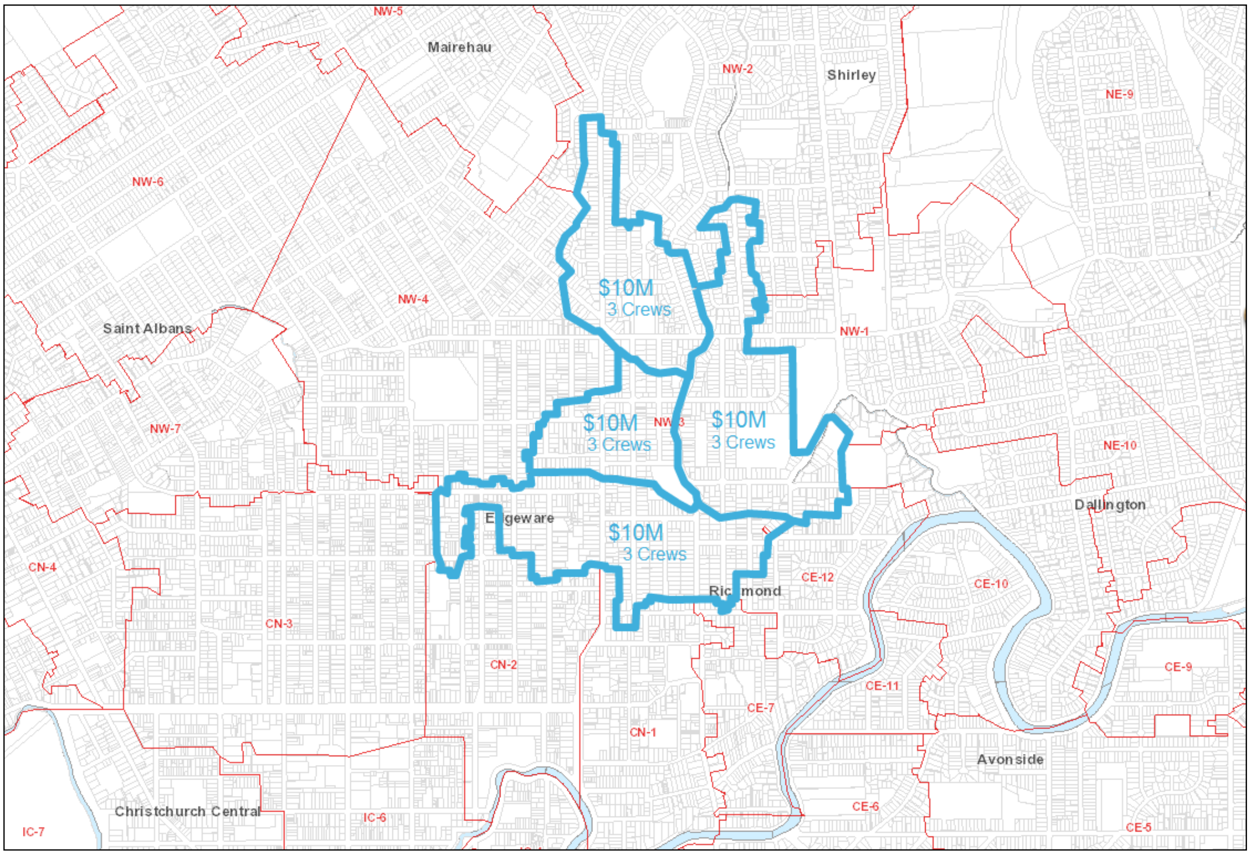


Figure 14: Catchments and project level with crew demands

The SCIRT programme requires up to about 10-12 catchments (equivalent to approximately 40-50 projects) being worked on concurrently to complete SCIRT's horizontal rebuild programme in the given five-year period. As shown in **Figure 15** this heightened activity on the ground creates transport planning challenges. The overall network capacity, and restricted accessibility due to the amount of rebuild work required, makes it necessary to facilitate up to 150 work sites network-wide whilst keeping traffic flowing.

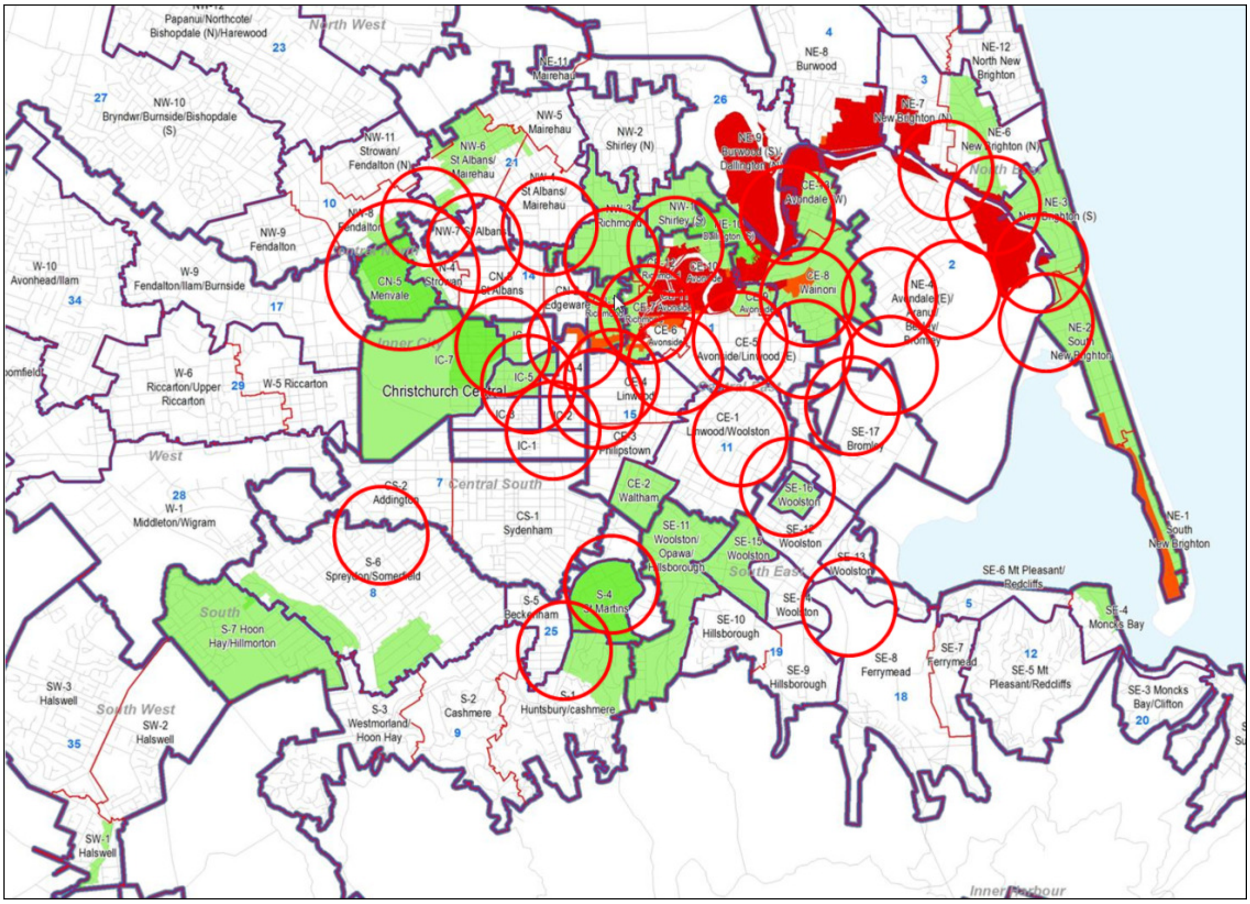


Figure 15: The transport planning challenges

3.3. Transport Modelling & Economic Evaluations

Individual transport modelling is undertaken to evaluate specific Traffic Management Plans (TMPs) when either:

- Works are on strategic roads potentially causing accessibility and/or delay issues
- More than just one worksite occur in close proximity to each other
- An economic analysis is required to evaluate different work methodologies.

To undertake the aforementioned analysis within SCIRT, the following three tools are used if a simple calculation is deemed insufficient:

1. The Christchurch Assignment and Simulation Traffic (CAST) SATURN[1] model
2. SIDRA[2] Intersection analysis

[1] SATURN stands for Simulation and Assignment of Traffic to Urban Road Networks and estimates traffic demands throughout the network by iteratively assessing intersection delays which results in a specific route choice. It was developed in the United Kingdom (UK) and is widely applied when assessing urban networks (Atkins, 2014).

[2] SIDRA stands for Signalised & unsignalised Intersection Design and Research Aid. Intersection 5.1 was used for all analysis undertaken. This is a software package version used to analyse signals, roundabouts or priority intersections. This model estimates capacities and provides performance indicators such as a level of service, delays, queues etc. Outputs are provided for movements as well as the overall intersection performance over all approach. (SIDRA Solution, 2011).

3. A modified CAST economics assessment tool, for assessing temporary traffic management impacts only.

Due to the earthquakes there was a significant shift of population within the city, predominantly from the east to the west, which was relatively less damaged. This bulk shift in residential addresses was derived from information provided by NZ Post (as cited in Blyleven, Roberts, & Ballantyne, 2011) from mail redirection requests, and is shown in **Figure 16**. Green dots indicate the pre-earthquake addresses and red dots indicate the new post-earthquake addresses.

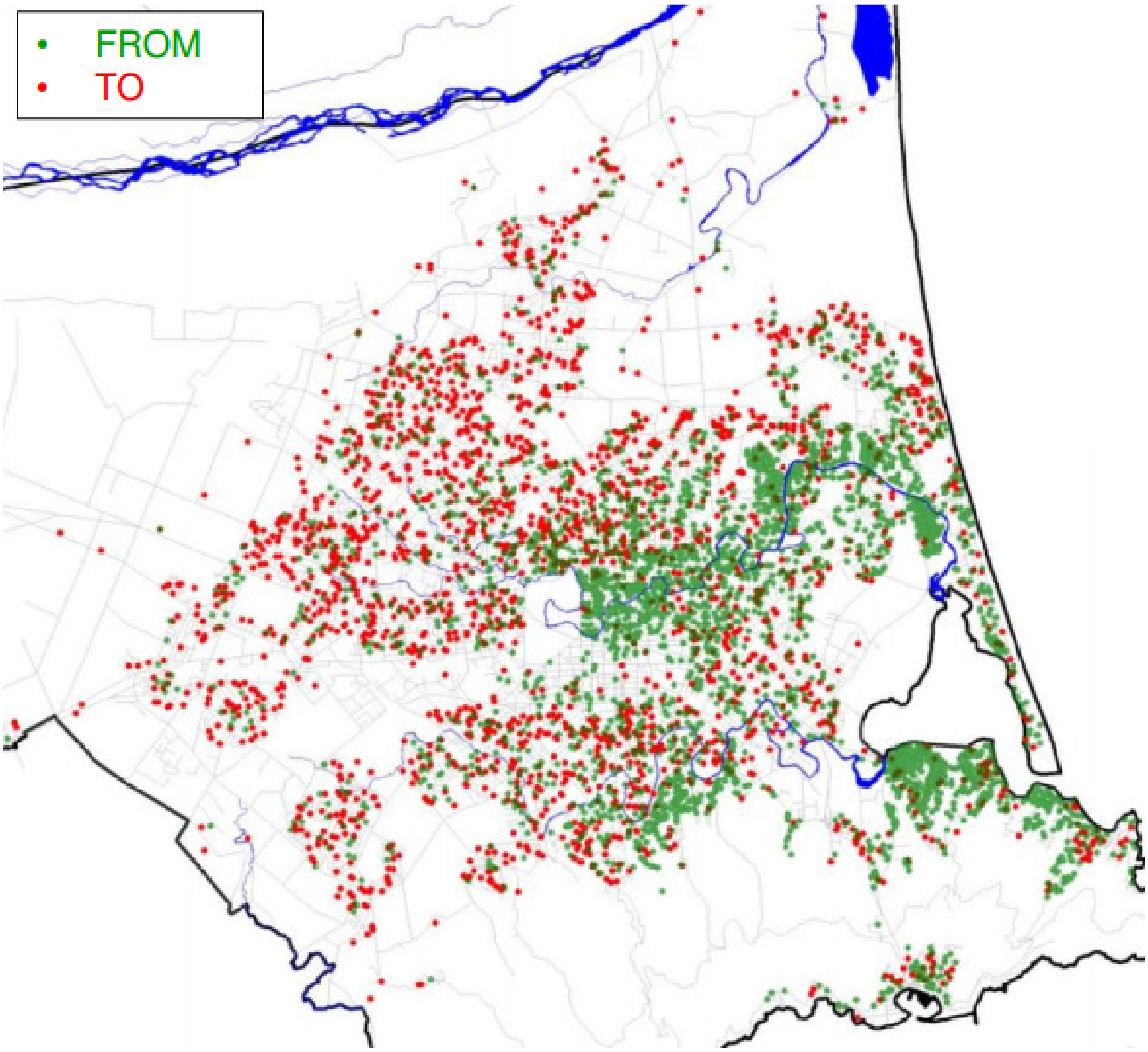


Figure 16: Household Postal Redirections (Blyleven, M., Roberts, P. and Ballantyne, J., 2011)

This bulk shift has also triggered changes in road classifications and created new strategic routes. Some roads are now subject to heavier traffic loading and others less. These changes to the land-use across the city were taken into account by the update of transport models, which continue to be updated to reflect ongoing changes in demands and transport network. These updates ensure that the best information available at the time is used in the transport planning analysis.

Traffic impact analysis is also carried out to fulfil the Christchurch Transport Operations Centre (CTOC) requirements. **Figure 17** illustrates the 'balance diamond' as provided by CTOC. CTOC's aim is it to engrain this 'balance diamond' into the thinking of the delivery teams and other parties applying for TMPs. The TMP applicants should consider the potential consequences of different work methodology choices and their proposed solution(s) should be balanced as indicated below. This balance diamond is used by the traffic management coordinators (TMCs) to assess whether the proposed works cause as little disruption as possible, but are still able to progress the rebuild programme, without compromising safety but aiding business vitality. This diamond is applicable for all works, strategic or otherwise.

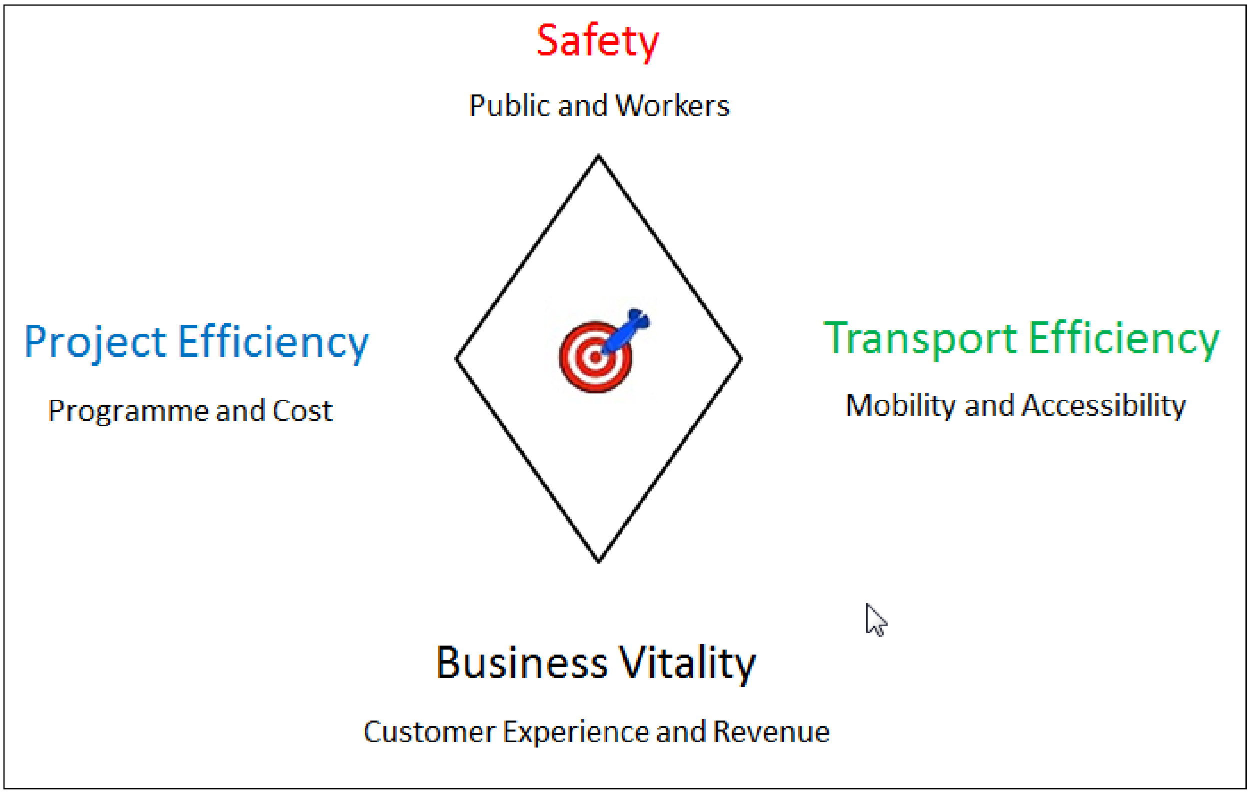


Figure 17: Balance Diamond [amended] (Christchurch Transport Operations Centre [CTOC], 2014c)

Key aspects of the diamond are:

- Project efficiency regards the programme duration and cost. Often road works can be conducted based on different methodologies. In general the time requirement is dependent on the road space available and vice versa. To decrease traffic impacts it may well be necessary to increase the length of the work, making the project more costly, in order to keep disruptions to a minimum.
- Transport efficiency comprises accessibility (e.g. all residents and businesses should be able to get to and from home and work, and transport goods and services) and mobility (meaning traffic can flow without causing too much disruption and keep the inconvenience to road users as limited as possible).
- Business vitality acknowledges that businesses potentially suffer loss of income as work sites may close off certain accesses, roads and car parking, and may potentially result in less customers. Stopping near businesses quickly or easily may also not be possible anymore, which can impact on business revenue considerably.
- Safety sits on the top of the figure to reiterate the importance of safety. A safe working environment for the workers and safe sites for the road users (including vehicular traffic, pedestrians and cyclists) are crucial to create a zero harm culture which is the highest priority for CTOC as well as SCIRT.

In general, CTOC expects the deliver teams to cause as little disruption, delay or inconvenience to road users without compromising on safety.

CTOC's flow chart showing the significant works identification process, as shown in **Figure 18** is another requirement that makes traffic impact analysis compulsory. If works are located on a strategic or lifeline route, where accessibility would be seriously impaired due to a lack of alternative routes or access, or where road space requirements are intrusive (for example turning restrictions at intersections, lane drops, one-way closures or full closures), then works are deemed 'significant works'. Significant works need to be evaluated on a case by case basis to quantify the impacts on the road users.

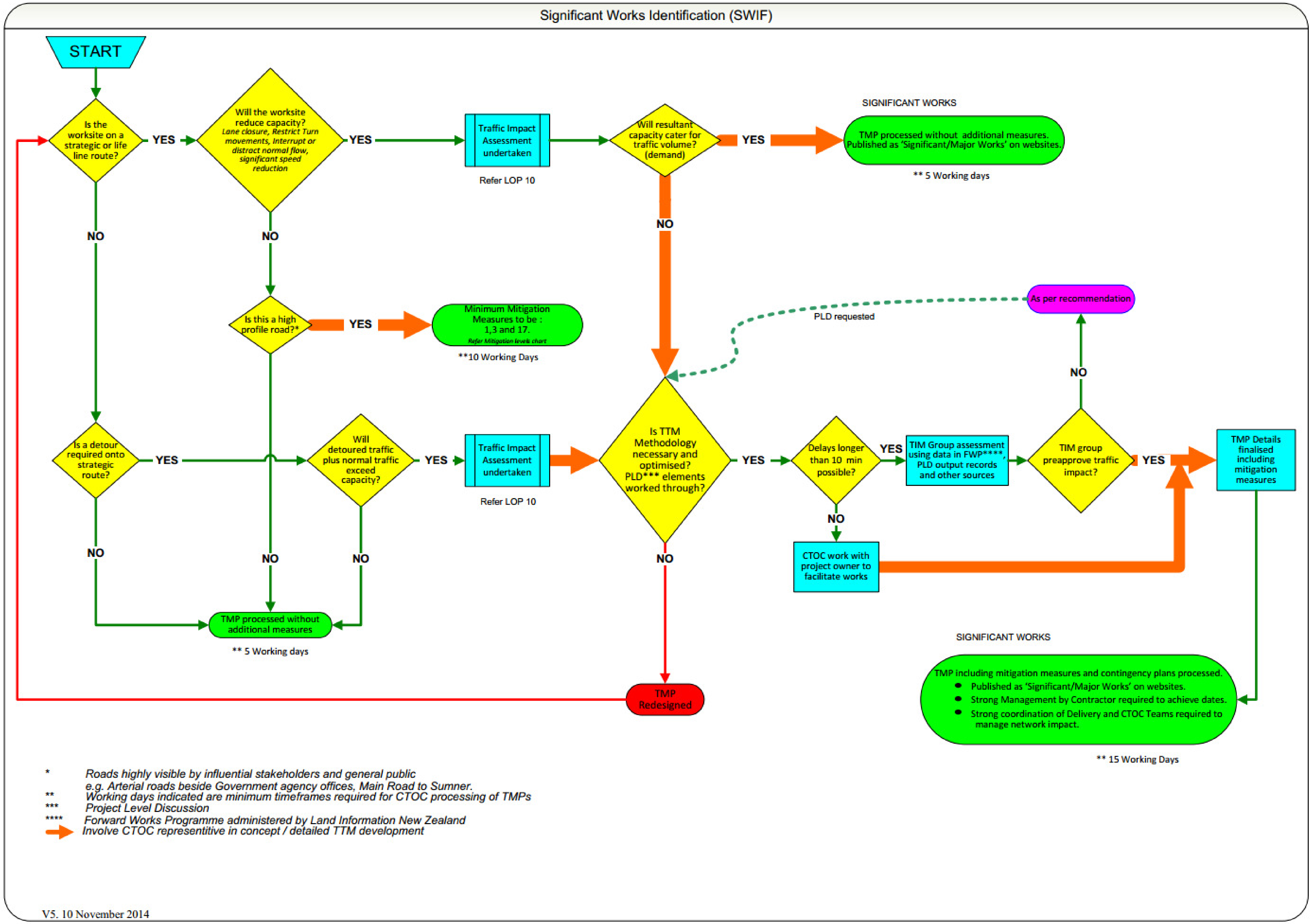


Figure 18: Significant Works Identification (CTOC, 2014e)

The CAST model is used to evaluate the impact of individual TMPs (an approved TMP is required to allow work crews access to the roads) on the roading network. If required, an even more detailed intersection performance analysis is undertaken using SIDRA software.

The CAST model was used to undertake area-wide modelling, also taking account of works that are already ’on-the-ground‘. To source the information for already approved works, ‘TMP for Christchurch’ was used. TMP for Christchurch’ is a website that “has been set up by Christchurch City Council & New Zealand Transport Authority to streamline the submission process of Traffic Management Plans within the Christchurch Area” (http://tmpforchch.co.nz/). The use of this system is mandatory for all works in the Christchurch area and is useful as a database about work sites and detour routes for coordination of works.

The following example is just one of a number of individual assessments undertaken by SCIRT to fulfil the Significant Works Identification Flowchart (SWIF) requirements of assessing traffic impacts and to gain TIM group approval if required.

The example analyses parts of a proposed Avonside Drive road closure with already approved works considered in the area. The modelling evaluates what the additional impact on the roading network is, meaning additional to all other work already approved in the system or deployed, considered as a specific base case. Subsequently, the proposed work is compared against the base case to get an understanding of the additional expected delays, most likely detour routes and to help select locations for Variable Message Signs (VMSs) deployment.

The actual analysis is undertaken for all three CAST network peaks (namely AM, IP and PM peak) but **Figure 19** displays only the changes in forecast traffic flows for the PM peak, as this is typically the worst case peak. Blue indicates expected decreases in traffic flow and red indicates expected increases in traffic. The width of the line indicates the magnitude of change.

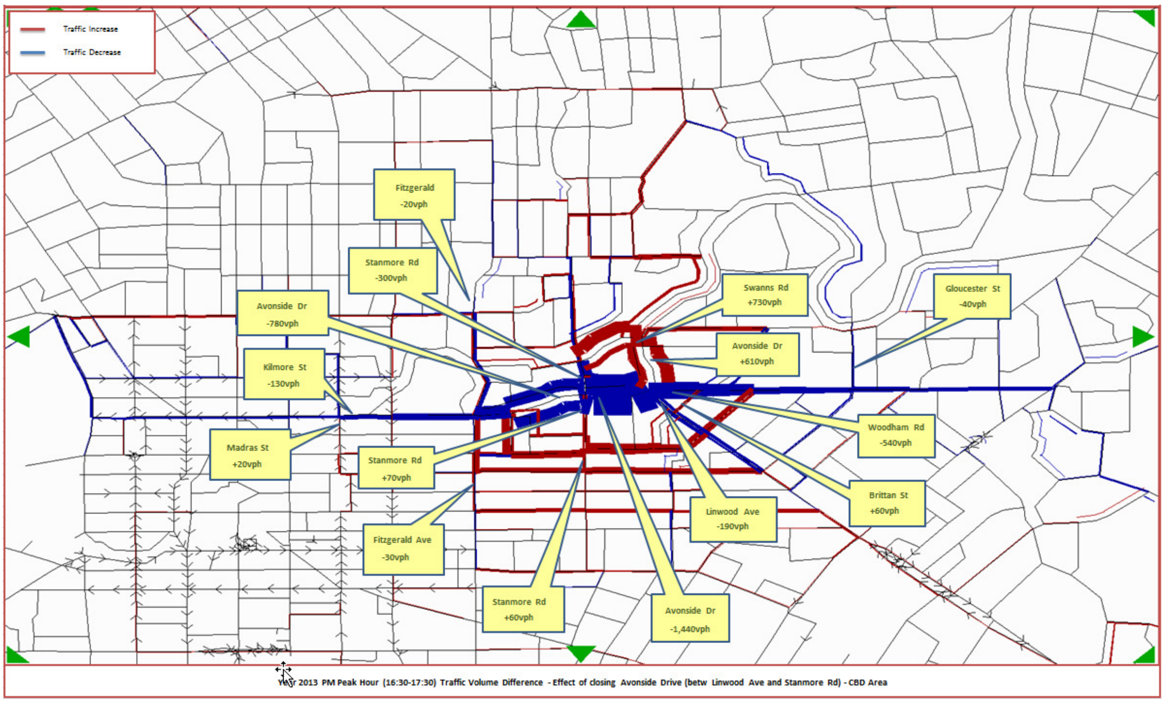


Figure 19: Individual assessment of Avonside Drive closure

Figure 19 presents only one of the outputs created through the modelling. A number of other outputs can also be created, such as differences in level of service or delays. Batch-files and templates are set up and used to extract the two-way flows around the affected roading network, with semi-automatic extraction of other outputs.

The output for differences in two-way flow shows the immediate impact of works and helps to determine the preferred detour routes. This output visualises the traffic impact to all parties involved and forms a good basis for all parties to discuss impacts and potential changes required to the methodology, through a so-called Project Level Discussion (PLD).

The information can be used to test different closure types (full or partial) to determine the lesser impact option. The information is summarised in an email or via an alternative format and sent to representatives of the SCIRT delivery team, SCIRT IST and CTOC. If the modelling indicates that the traffic impact is only minimal or moderate, a PLD is not required and the TIM group approval can be obtained without further discussions.

The modelling outputs can subsequently be used in an economic assessment to understand the associated transport costs of the works. The economic assessment tool is based on the CAST model Economics Evaluation Framework tool. This tool was obtained through CCC, who is the owner of the CAST model and its associated tools. The existing tool is modified to account only for daily figures compared to the standard 40-year evaluation period, as suggested in the Economic Evaluation Manual (EEM) (New Zealand Transport Agency [NZTA], 2013). The tool compares only a single pair of scenarios, as no interpolation between multiple forecast years is required to analyse the impact of temporary traffic management. The NZTA-provided underlying EEM update factors for benefits (NZTA, 2014a) can be modified to account for the latest update factors when comparing costs and benefits.

At the beginning, this type of analysis was very reactive, as it was undertaken only when a TMP was submitted. The time between lodging the TMP and the proposed start of the work could range between a few days and a couple of weeks. At this point the resourcing and materials for the site works were typically already arranged and delays in mobilising meant it was potentially very costly. This triggered the need to plan works earlier to avoid such consequences.

3.4. The Forward Works Planning

As mentioned previously, proposed works need to be scheduled about three months or more in advance to undertake a traffic impact analysis and to optimise the programme. This timeframe allowed planners to take full advantage of opportunities to combine works, avoid conflicts and avoid expensive delays. The forward planning process provides certainty to the delivery teams to undertake their works, assists resourcing, alleviates stress and frustration when lodging TMPs, and gives clarity.

The Early Contractor Involvement (ECI) model that SCIRT adopted helps immensely in undertaking early forward works planning. SCIRT designers engage with the delivery teams early-on during a project. As part of this engagement the Site Traffic Management Supervisor (STMS) also gets involved to ensure that the impact caused as a result of the proposed road work methodology is understood. The ECI principle is shown in **Figure 20**.

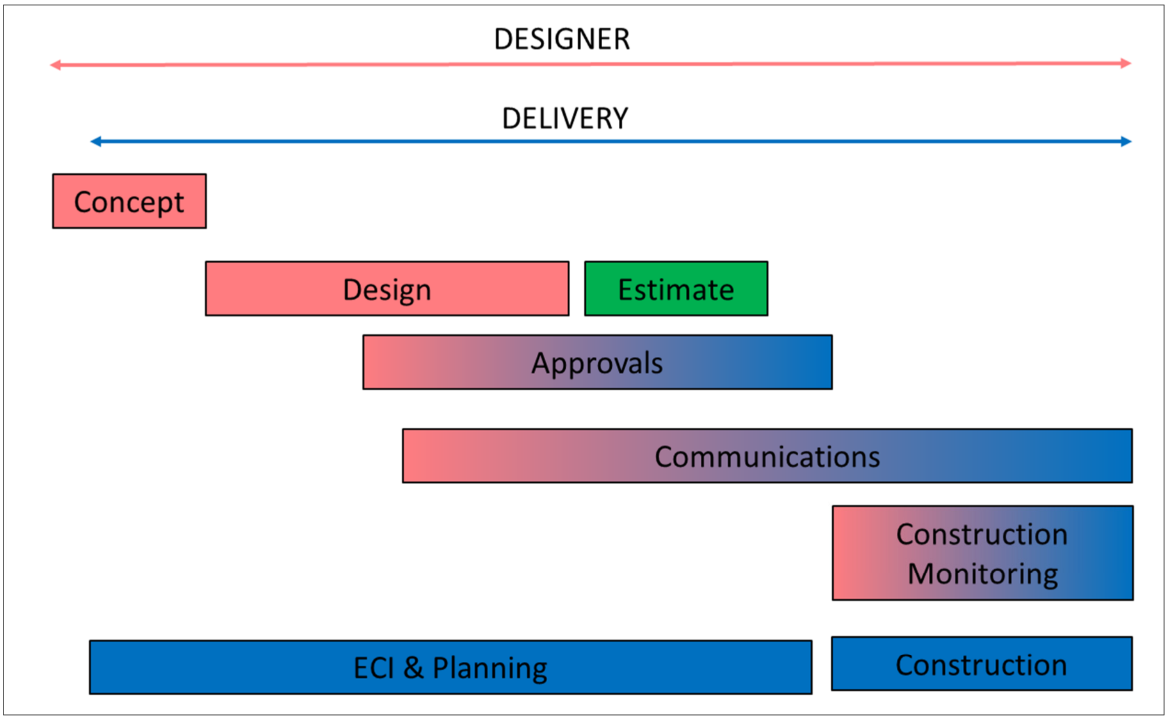


Figure 20: SCIRT's early contractor involvement (SCIRT internal, 2013)

This is in contrast to a traditional project delivery model, where the delivery team engagement occurs at later stages in the process, see **Figure 21**. Using the conventional approach means that projects are put up for tender and competing engineering companies bid for the project. Awarding the contract can take months and increases the risk of construction delays and cost overruns. Also, the traffic impacts are not known until shortly before construction commences.

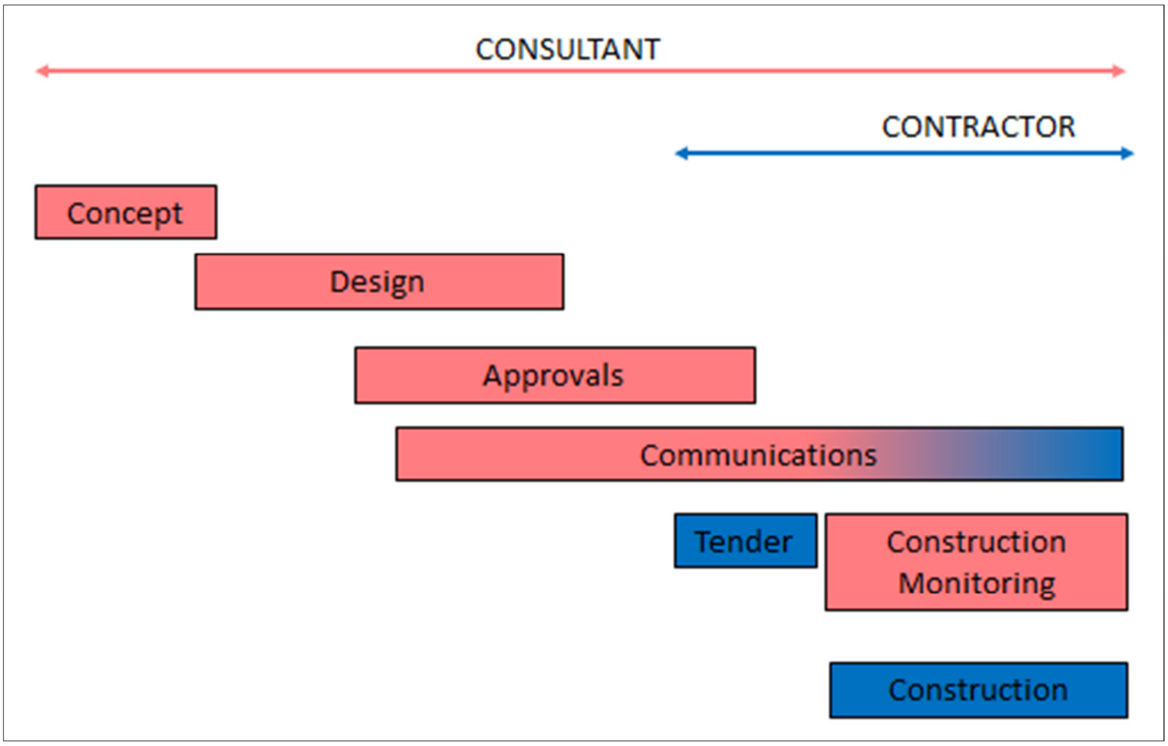


Figure 21: Traditional Project Delivery (SCIRT internal, 2013)

The SCIRT model of incorporating all parties fosters an environment of collaborating with each other whilst competing for work based on identified performance indicators.

The ECI model is beneficial on multiple levels:

- the design and construction methodologies can be aligned and any identified risk addressed early on;
- cost estimates are improved due to more information being available;
- the delivery teams know about upcoming work and the design to be put in place, and therefore have an understanding of the work methodology, the required traffic management methodology and resulting traffic impacts early-on.

The traffic impacts should ideally be known approximately three months ahead of construction; sometimes more time is desirable. It is of note that there is a potential for re-allocation of work between delivery teams between the ECI and Construction phases. This reallocation is based on the SCIRT delivery team performance indicators, which include costs, timeliness and the value of the delivered projects to determine the share of work amongst the delivery teams.

Put simply, delivery teams which perform better will get more work allocated and vice versa. Initially all delivery teams started with an equal share of the work, with new project allocation subject to performance indicators, to create a degree of competitive tension within the alliance model. The amount of re-allocation of work is relatively small, meaning the delivery team undertaking ECI on a project is generally likely to retain the project for construction.

Even when re-allocation occurs, the planned traffic impacts are unlikely to change and therefore ownership can be readily transferred to another delivery team. The receiving delivery team is then responsible for updating the programme and impacts and producing a more refined construction methodology as the construction start date draws closer.

To evaluate the traffic impacts of proposed works, a spatial display in a common format was required to comprehend the project information for concurrent works and sequencing. Initially all these impacts were collected over all delivery teams and combined into a master programme. A screenshot of the programme is shown **Figure 22**.

Project	Project Name	Total Stag	Project St Date	Asset Typ	Stage #	Activity Status	Stage Star Date	Stage End Date	Depender	Date Offs	Duration (weekday)
10916	Bromley & W	4	Aug 22, 2014	WW	A57830	Not Started	Jun 16, 2015	Jul 09, 2015	A57820		
10798	NZTA Port Hil	2	Jul 08, 2015	RD	10798-1020	Not Started	Jul 08, 2015	Jul 29, 2015	10798-1010, 10798-1150		
10881	Northern Rel	4	May 14, 2015	WW	10881-1502	Not Started	Jun 11, 2015	Jun 17, 2015	10881-1501		
10544	PS28 Retrofit	2	May 04, 2015	WW	10544-1010	In Progress	May 04, 2015	Feb 23, 2016	10544-2049, 10544-2570		
10881	Northern Rel	4	May 14, 2015	WW	10881-9100	Not Started	Jun 24, 2015	Jun 30, 2015	10881-9080		
10916	Bromley & W	4	Aug 22, 2014	WW	A57790	Not Started	Jul 09, 2015	Aug 31, 2015	A57830		
11221	Shirley Strea	7	Jun 08, 2015	SW	11221-1060	Not Started	Feb 11, 2016	Feb 29, 2016	11221-1050		
10881	Northern Rel	4	May 14, 2015	WW	10881-1501	In Progress	May 14, 2015	Jun 10, 2015	10881-1500		
11221	Shirley Strea	7	Jun 08, 2015	SW	11221-1000	In Progress	Jun 08, 2015	Jun 23, 2015	A1000		
11221	Shirley Strea	7	Jun 08, 2015	SW	11221-1010	Not Started	Jun 26, 2015	Jul 10, 2015	11221-1000		
11221	Shirley Strea	7	Jun 08, 2015	SW	11221-1020	Not Started	Jul 13, 2015	Oct 16, 2015	11221-1010		
10916	Bromley & W	4	Aug 22, 2014	WW	A53470	In Progress	Aug 22, 2014	Jun 11, 2015	A49840		
11159	Linwood Wo	2	Jun 02, 2015	WW	11159-1060	Not Started	Jun 29, 2015	Oct 16, 2015			
11221	Shirley Strea	7	Jun 08, 2015	SW	11221-1030	Not Started	Oct 19, 2015	Nov 09, 2015	11221-1020		
11221	Shirley Strea	7	Jun 08, 2015	SW	11221-1050	Not Started	Jan 26, 2016	Feb 10, 2016	11221-1040		
10704	Dyers Pass R	1	Feb 23, 2015	RW	A25540	In Progress	Feb 23, 2015	Aug 25, 2015			
11221	Shirley Strea	7	Jun 08, 2015	SW	11221-1040	Not Started	Nov 10, 2015	Jan 25, 2016	11221-1030		
10544	PS28 Retrofit	2	May 04, 2015	WW	10544-2075	Not Started	Jun 22, 2015	Jul 31, 2015			
10881	Northern Rel	4	May 14, 2015	WW	10881-9080	Not Started	Jun 18, 2015	Jun 23, 2015	10881-9070		
11187	St Albans Edg	2	Jul 13, 2015	WW	11187-1010	Not Started	Jul 22, 2015	Aug 12, 2015			
10798	NZTA Port Hil	2	Jul 08, 2015	RD	10798-1030	Not Started	Jul 30, 2015	Jul 30, 2015	10798-1020		
11187	St Albans Edg	2	Jul 13, 2015	WW	11187-1000	Not Started	Jul 13, 2015	Jul 29, 2015			

Project	Stage Descriptio	Crew Reference	Traffic Impact (Primary)	LINZ Road (Primary)	Direction Affected (Primary)	Road Spac available (Primary)	Start Date (Primary)	End Date (Primary)	Time of Effect (Primary)	Detour? (Primary)	Traffic Impact (Secondar	LINZ Road (Secondar	Direction Affected (Secondar	Road Spac available (Secondar	Start Date (Secondar	End Date (Secondar	Time of Effect
10916	Drainage Ope	D and D	Full Closure	8995_13292	Both				24h7d	Yes							
10798		FH	1 Lane Drop	15022_9866	With	1			24h7d	Yes	Full Closure	15063_1725	With				Night
10881	One way clos	Connell Cont	One-way Clos	6232_6234,	With				24h7d	Yes	One-way Clos	6234_10234,	With				24h7
10544	Upgrading of	ARC Projects	Capacity Red	8387_17263,	With	1			24h7d	No	Capacity Red	17092_1726	With	1			24h7
10881	One way clos	Connell Cont	One-way Clos	6232_6234,	With				24h7d	Yes	One-way Clos	6234_10234,	With				24h7
10916	Drainage ope	D and D	Full Closure	8308_8373,	Both				24h7d	Yes							
11221	Contraflow s	FCC Jack Pen	Capacity Red	6551_6605	Both	1			24h7d	No	Full Closure	15480_6605	Both				24h7
10881	One way clos	Connell Cont	One-way Clos	6232_6234,	With				24h7d	Yes	One-way Clos	6234_10234,	With				24h7
11221	Contraflow s	FCC Jack Pen	Capacity Red	6551_6605	Both	1			24h7d	No	Full Closure	15480_6605	Both				24h7
11221	Contraflow s	FCC Jack Pen	Capacity Red	6551_6605	Both	1			24h7d	No	Full Closure	15480_6605	Both				24h7
11221	Contraflow s	FCC Jack Pen	Capacity Red	6551_6605	Both	1			24h7d	No	Full Closure	15480_6605	Both				24h7
10916	Bayswater Cr	Johnsons	Full Closure	8876_8995	Both				24h7d	Yes	Intersection	8876	N/A				24h7
11159	Waste Wate	D&D	Capacity Red	7467_7555,	Both	1			24h7d	No	Full Closure	7555_7590,	Both				24h7
11221	One Way syst	FCC Jack Pen	One-way Clos	6551_6605	With				24h7d	Yes	Full Closure	15480_6605	Both				24h7
11221	Contraflow s	FCC Jack Pen	Capacity Red	6551_6605	Both	1			24h7d	No	Full Closure	15480_6605	Both				24h7
10704	Retaining wa	FCC Conc	Priority Arrov	17025_6075	Both	1			24h7d	No							
11221	Contraflow s	FCC Jack Pen	Capacity Red	6551_6605	Both	1			24h7d	No	Full Closure	15480_6605	Both				24h7
10544	Overpumping	ARC Projects	One-way Clos	9948_8454	Against				24h7d	Yes	Capacity Red	9948_8456,	Against	1			24h7
10881	One way clos	Connell Cont	One-way Clos	6232_6234,	With				24h7d	Yes	One-way Clos	6234_10234,	With				24h7
11187	Waste water	D&D	1 Lane Drop	4624_4765,	With	2			24h7d	No	Full Closure	10403_5410	Both				24h7
10798		Isaac	1 Lane Drop	15022_9866,	With	1			24h7d	No	Full Closure	15022_9866,	Against				Night
11187	Waste Wate	D&D	Capacity Red	10465_1522	Both	1			24h7d	No							

Figure 22: Delivery team's project programme add-on

Historically the traffic impact planning was undertaken by adding columns to the delivery team's project management programme. To fill out this information the SCIRT geospatial viewer needed to be used to obtain the Land Information New Zealand Identification (LINZ_ID) data (road centreline network), number of lanes, and directional information. Educating the delivery team staff was necessary so they could correctly identify traffic impacts. Data validation was important and time consuming. Mistakes in the data entry needed to be manually found and corrected by SCIRT IST staff as SCIRT is the programme master holder.

Often it was found that programmes sent by delivery team staff were not standardised and manual interventions by IST staff were required to provide one overall programme for SCIRT works. Project information changed continuously, requiring weekly updates to the individual programmes and the master programme.

Other parties' programmes (e.g. CERA, Enable fibre-optic cable installation) needed to be discussed with representatives, and a programme needed to be developed and manually inserted into the overall programme. As not all parties had access to the SCIRT viewer (e.g. private developers), not all information was able to be captured.

The master programme was subsequently processed and displayed using the traffic impacts part of the SCIRT viewer. This viewer mapped the location, duration and impact of each work stage, as shown in **Figure 23**.

Figure 23: SCIRT viewer traffic impacts display

As discussed previously, not only the traffic impacts caused by SCIRT works are of interest, but also works managed by other authorities e.g. by CERA, CCC, NZTA, any special events and works by private developers. All involved parties need to be able to enter the projects/programme data into a standardised viewer to achieve a holistic and city-wide view. The need for improving the information-sharing over all parties involved led to the development of the Canterbury Spatial Data Infrastructure (SDI) Programme, and as a sub-project of this, the Forward Works Viewer (FWV) was developed. The SCIRT traffic impacts were provided to LINZ, the SDI project owner.

The information from the master programme was passed on to LINZ and shared with other parties, but entries for traffic impacts were initially only possible through the SCIRT system, feeding into the FWV traffic impact layer. Other parties' entries were not projected onto a particular road but instead the traffic impact was assigned to the drawn project extent (see "the second screen" description on p. 30), which was too coarse to undertake a traffic impact analysis.

This shortcoming of the FWV was addressed by creating a function that is called "the fourth screen". This fourth data entry screen is activated only for traffic impacts and allows the assigned traffic impact to be allocated to a road using the web-based application Open Street Maps (OSM).

The four screens are split up as follows>

- First screen: General project information
  Includes project name, project reference, project start and end dates, contact person including email and phone number, project type (horizontal construction, vertical construction, events…), project status (e.g. construction, tender, negotiations…) and a project summary.

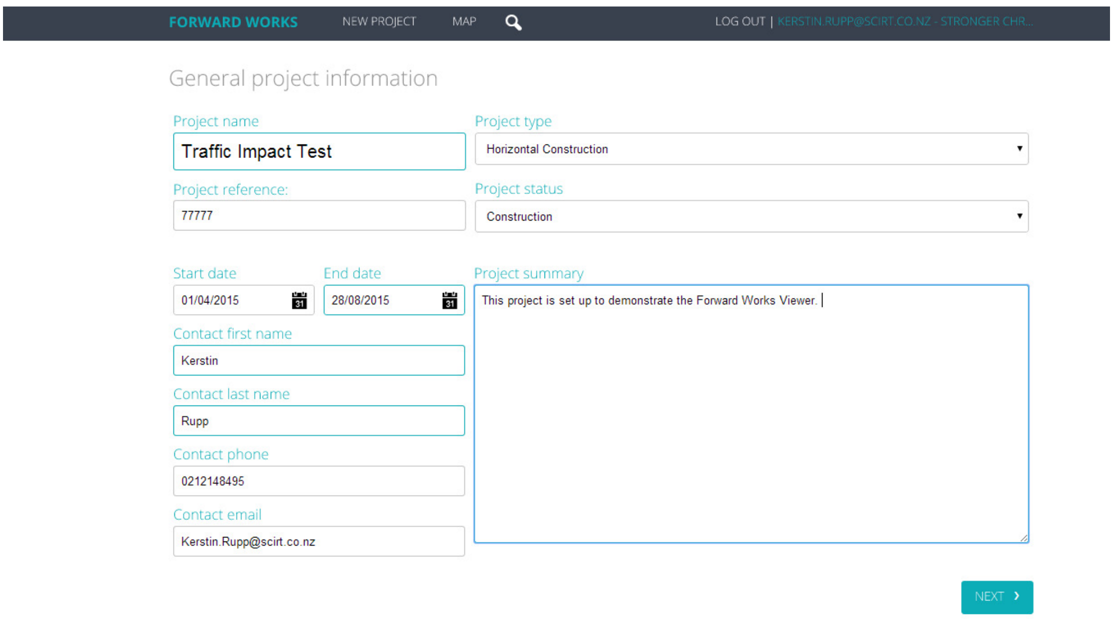


Figure 24: First Screen template

- Second screen: Project extent
  Provides the tools to draw the overall project boundary. This is the full project area, for example, the whole catchment. The extent can range from one TMP worksite to a large $40M catchment that can get split up in smaller projects in subsequent screens.

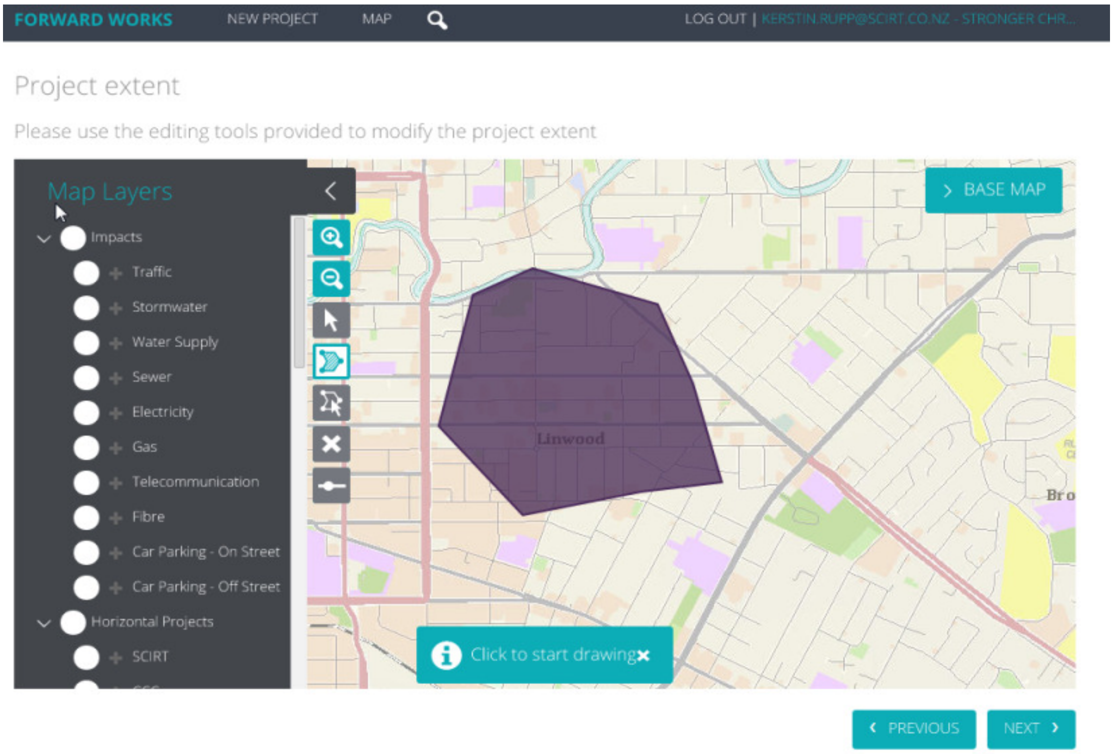


Figure 25: Second screen template

- Third screen: Project stages
  This screen splits up a whole catchment into smaller pieces of work. For each individual stage, the stage number or name needs to be given, and the start and end date and duration of a work stage, as well as the traffic impact, can be chosen from a drop down list. For the traffic impacts the following choices are available:

  - Full Closure
  - 1 Lane Drop
  - 2 Lane Drop
  - Capacity Reduction
  - Intersection
  - Shoulder
  - Stop Go
  - One-Way Closure
  - Priority Arrow

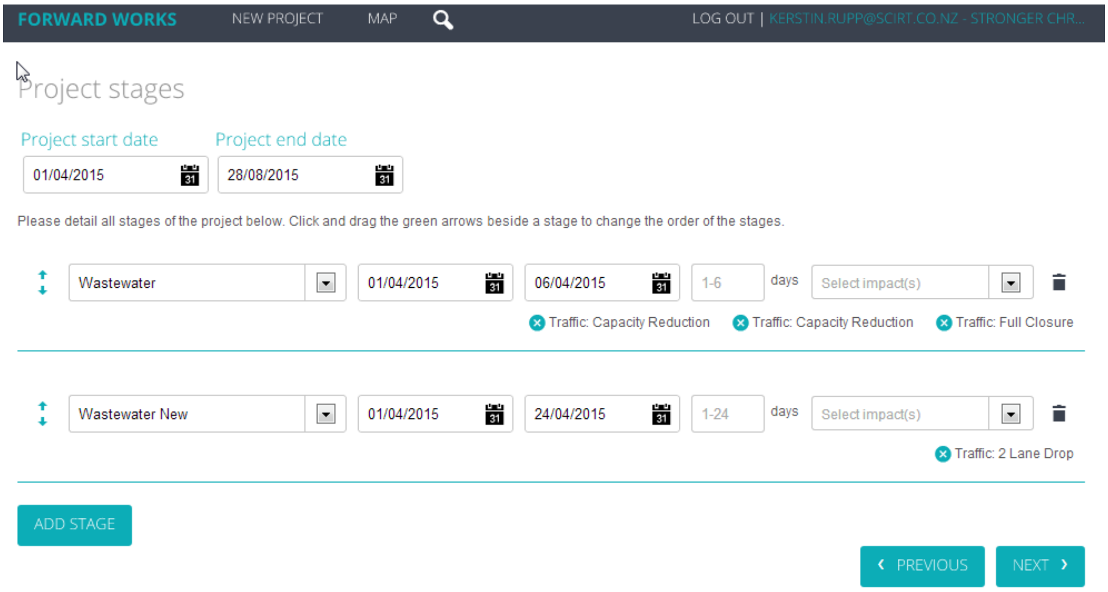


Figure 26: Third screen template

This screen also allows entry for other stage impacts e.g. water supply, sewer, parking. For the purpose of this report only the traffic impacts function of the FWV is of interest and described in further detail.

The number of stages can be as few as one stage, but there is no pre-imposed maximum limit. The traffic impact severity varies considerably with the duration of the works, for example if a full closure is proposed for one day compared to a few weeks. Consequently, guidance is given to the traffic impact schedulers to split up the works using reasonable break-downs. These break-downs avoid artificially constraining the network (spatially or time-wise). The traffic impact schedulers are requested to split up the works between intersections, to keep crosslinks to other roads unimpeded as much as possible, to reduce the overall impacts and to reflect actual construction behaviour more closely.

- Fourth screen: Traffic impact refinement

  This stage allows the on-screen selection of road sections to allocate the traffic impacts onto a stretch of road.

  Firstly, the top right corner drop box presents the stage of the traffic impact refinement.

  Secondly, each impact is worked through by clicking on the road where the traffic impact will occur. An “A” and “B” point appears, marking the length of the work sites. OSM restricts the entry mostly between intersections, but if required, multiple sections of road can be collected under one stage. The “A” and “B” points can also be moved closer together if long stretches of roads are clustered together in OSM, but these interim selectable points will mostly be between intersections as well.

  When a road is selected the “A” and “B” points are also shown on the right hand side of the screen and connected by the number of lanes in each direction (if the number of lanes as illustrated by OSM is not correct (e.g. following a recent road upgrade), then the edit lane count function can be used to adjust the number of lanes per direction).

  This screen is very interactive and the grey buttons saying “lane drop”, “stop/go” and “direction priority” contain the following different traffic impact selections:

- Lane drop: allows for capacity reduction, one-way closures and full closures (depends on the number of clicks undertaken per road lane direction);
- Stop/go: is used to illustrate temporary traffic lights; and
- Direction priority: gives priority to one direction - by clicking the symbol that pops up again the priority can be displayed in the opposite direction.

Figure 27 illustrates a full closure example by having clicked twice on each directional lane. Once impacts have been loaded, it is crucial to subsequently press the “save impact” button. If another impact is required under the same stage this can then be conducted and subsequent impacts saved. As discussed previously, the traffic impact selection has to be undertaken for all stages where traffic impacts occur (as chosen in the third screen). This can be done by either clicking on ‘Next Stage’ or choosing the next stage from the drop box above it. If an impact or a stage gets missed, the whole project boundary defaults for the chosen impact (as per third screen), commonly indicating a data entry error.

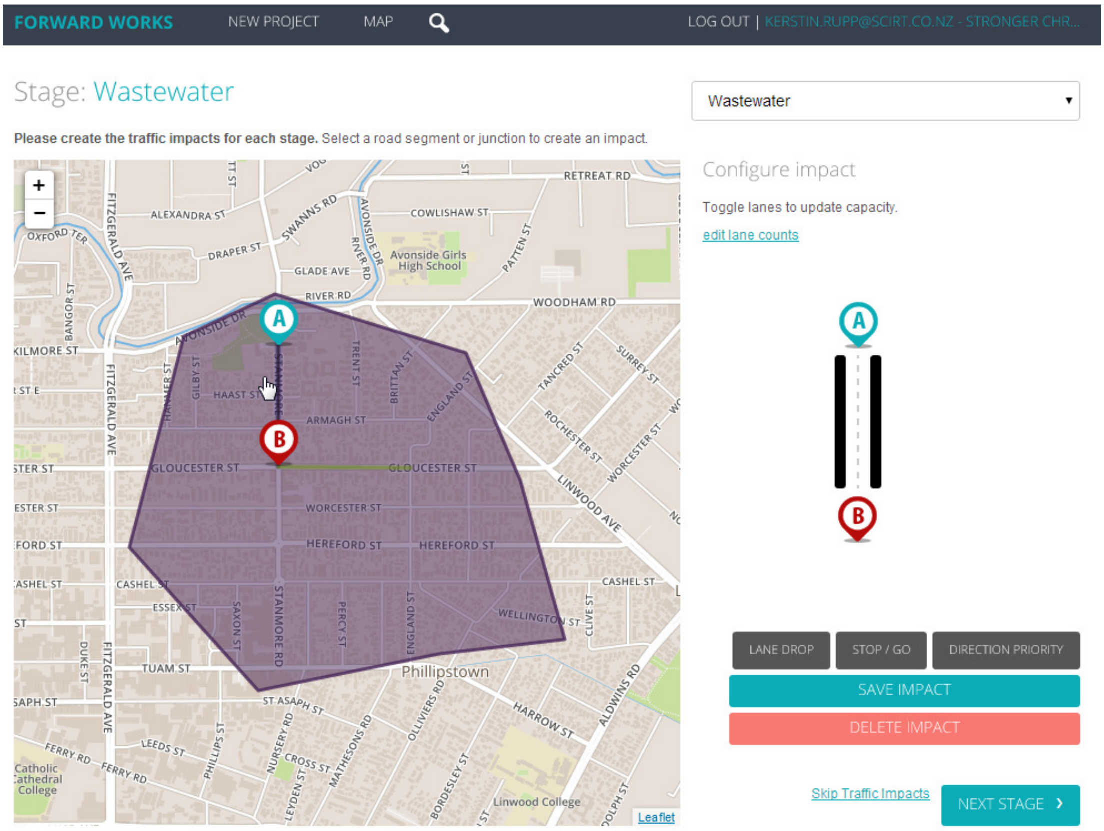


Figure 27: Fourth screen template

It was identified that the original third and fourth screen connection may be confusing and hence these screens were modified to simplify the entries. The new screens are shown in **Figure 28** and **Figure 29** respectively.

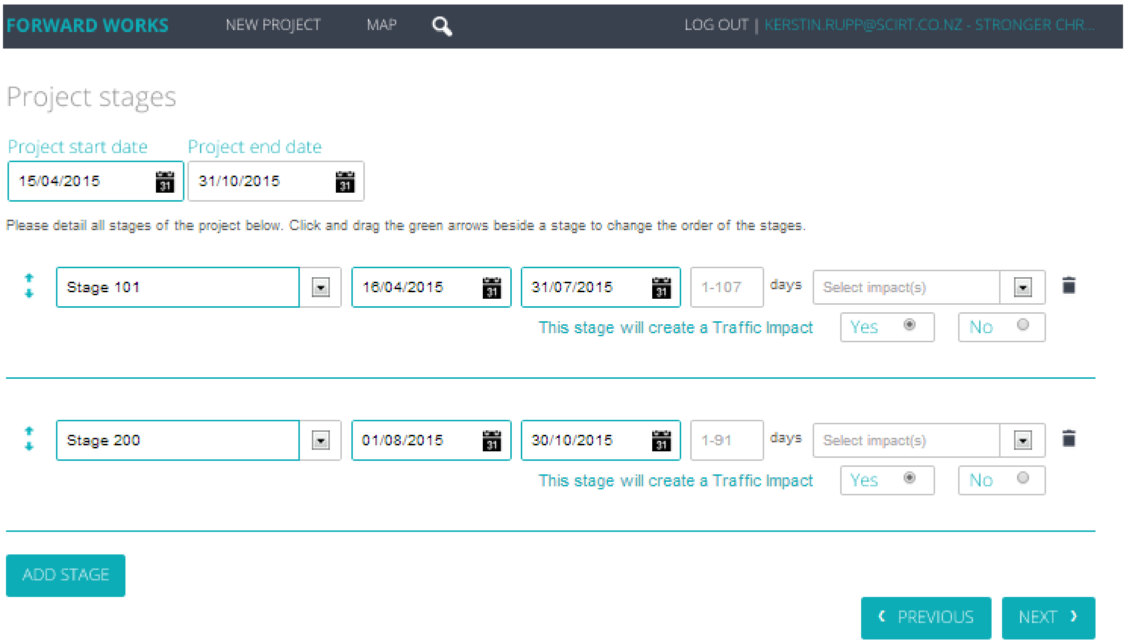


Figure 28: New third screen template

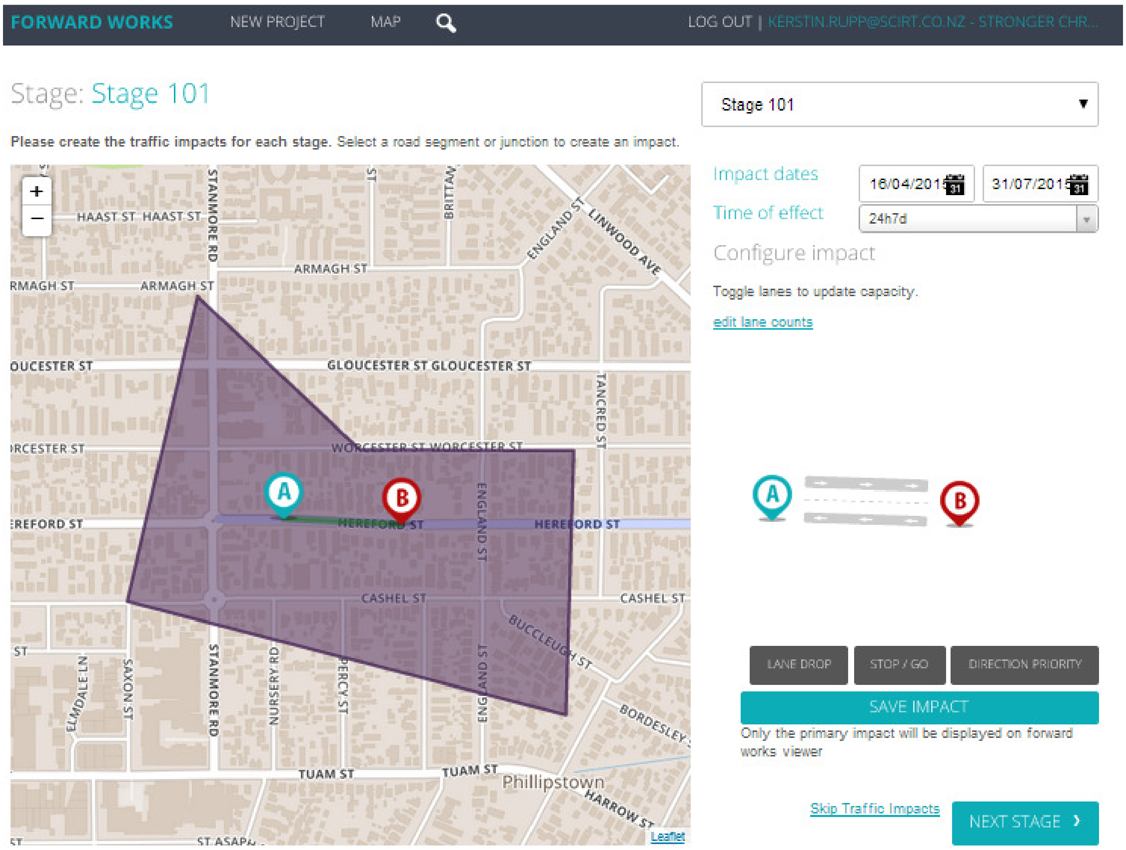


Figure 29: New fourth screen template

The changes to the third and fourth screens may seem minor, but such tweaks to the interface are important. Changes like these continuously improve the user-friendliness and flexibility of the system going forward. The original system needed some workarounds when entering the information (e.g. no forwards and backwards movements possible between the third and fourth screens). The third screen was known to be confusing for inexperienced users, who are liable to make mistakes that cause project boundaries to be allocated a traffic impact by default. With the more simple use of the third screen these issues do not arise, as all impacts are worked through in the fourth screen. The improvements also allow for more information being entered, e.g. night works and off-peak works can be distinguished. The user-friendliness is crucial, as only if the tool is perceived as being easy to use will the users enter their data.

The FWV was established to display all work, both current and proposed, in an on-line viewer available to all stakeholders. The viewer processing also provides 'back-end' analysis of the raw data to ensure the transport network always has sufficient capacity to accommodate the planned work, and will alert the transport planning and communication stakeholders when excessive congestion may result from a specific work activity. The FWV displays the same information as the SCIRT viewer, but also comprises programmes from other sources, e.g. CCC events team, CERA or NZTA.

The SCIRT viewer is well-utilised and over time users such as the TIM group have adjusted the colour coding. It became logical to use the same colours as the SCIRT viewer for ease of assessment. A screenshot of the FWV display is presented in **Figure 30**.

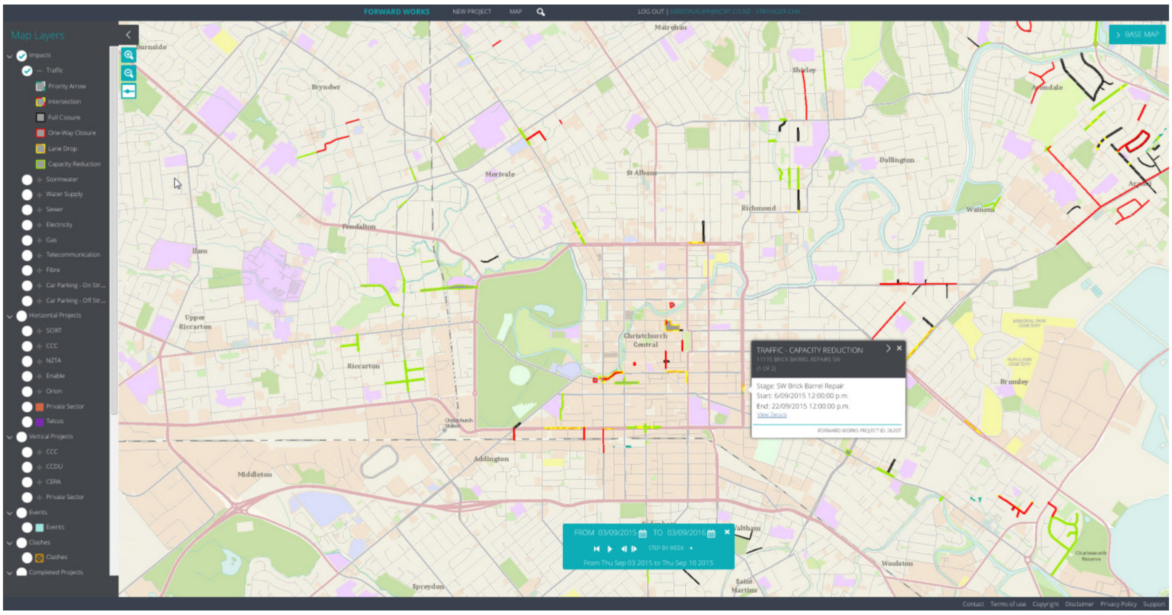


Figure 30: FWV traffic impact display

The FWV has a user guide available that is accessible through the website and explains all functions, including the project set-up which covers the traffic impact layer.

As part of the weekly updates, not only the visual traffic impact update occurs but also a process is run to create files which create additional outputs to assess the transport network. These are used by the TIM group to inform decisions as well as to communicate with the delivery teams, to advise of approved works and also to prompt the delivery teams to check their data input (data validation).

This process is undertaken using the software FME (Feature Manipulation Engine) and the overall process is illustrated in **Figure 31**. This software is operated within the Geographic Information Systems (GIS) team at SCIRT. The process has developed over time and can be improved further where new data or mapping requirements are identified.

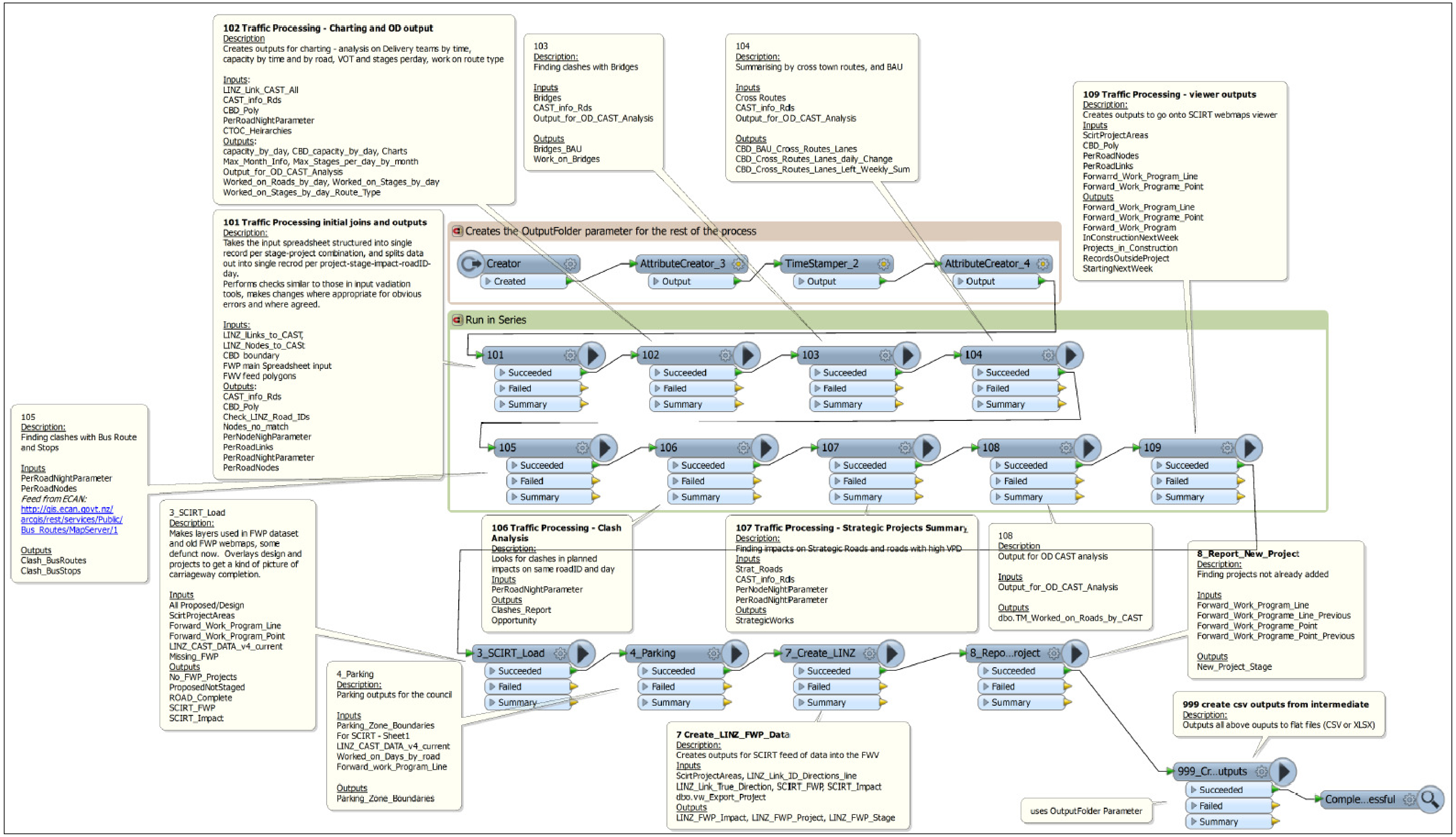


Figure 31: FME Traffic Process (SCIRT internal, 2015)

Before the overall process is run, an input check is carried out on the master programme (input spreadsheet) to make sure incorrect or missing inputs can be rectified (e.g. one-way closure direction incorrect or time of effect missing, etc). When the input information has been rectified, the overall traffic process is set off. The process is split up into 14 sub-tasks (annotated as 101-109, 3, 4, 7, 9 and 999) and uses CAST model information, such as number of lanes and capacities per peak hour on a road segment as input information.

- Task 101: Data on-boarding and information break down

  The master programme is further refined from a project stage record to a record being broken down into single traffic impact per road segment per day. Also, this step uses a set of pre-defined rules to undertake a sense check of the master programme against CAST input information. This aids in identifying incorrect data entries and overwrites inputs, such as one lane drops on a one lane road, which will be changed to a one-way closure.

  Also, information from the FWV is incorporated into the process to make sure third party traffic impact entries are also included in the subsequent process.

- Task 102: Impact analysis

  Uses CAST information, road hierarchy information and CBD classification (link located on or within the four Avenues), and applies a set of assumptions, such as 1 lane drop reduces capacity by 50%, to create outputs stating the expected capacity per day by road, and number of works on strategic routes etc. Some of these outputs are also used as inputs in subsequent tasks.

- Task 103: Bridge works programme consideration

  This step considers the bridges and creates outputs specific to work on them. This is required as work on bridges is considered strategic in nature and having a special set of information is helpful in further analysis.

- Task 104: CBD specific analysis

  This task assigns works to specific routes within the Christchurch CBD and the created outputs are used to illustrate the expected capacity reductions within the CBD.

- Task 105: Bus route analysis

  Uses the bus route information provided by a spatial data feed from Environment Canterbury (ECan) (a live link means always the latest available information is used), to identify when proposed road works will cause clashes with passenger service bus routes and bus stops. This information can then be used to inform ECan to make sure the buses can still operate and to help inform when and where buses need to detour from their regular routes.

- Task 106: Opportunities and Clash Analysis

  During this step opportunities for combining work, and clashes are identified. If proposed works are on the same day and overlap spatially (per road segment) then this is identified so the consequences of the overlap can be identified. This could be an opportunity meaning two tasks can occur together and reduce the overall impact on road users, or it might mean one of the tasks needs to be rescheduled. For example, rescheduling is required when work on different asset types is carried out, such as wastewater versus water supply, where works need to be done in isolation to avoid potential contamination of drinking water. This function is also available in the FWV, and clashes and opportunities are flagged when a new project is created and should be used by the affected parties to initiate discussions.

- Task 107: Strategic road impacts

  This step creates an output to identify any work that occurs on roads which are classified as strategic, using the road hierarchies provided by CTOC. The outputs are created no matter the time of the effect, including day and night works. Outputs created from this allow clustering into peak and off-peak works, which is important when analysing traffic impacts.

- Task 108: TI model outputs

  This step outputs the input files into the Traffic Interruption (TI) model. This model is explained in more detail later (see section 3.4.5).

- Task 109: Webmaps viewer updates

  This step creates all the files required to update the spatial display of the traffic impacts, including creating the information required to produce output maps later in the process.

- Task 3: Completion analysis

  This creates a visual layer to determine if works are currently underway, still proposed or already completed, per asset type. This is important to make sure the client and other organizations can see the status of the overall programme, considering each asset type.

- Task 4: Parking analysis

  CCC is interested in understanding how the road works impact on the available parking spaces within the four Avenues. CCC provided an input file containing the car park supply per precinct. The traffic impact types are used to calculate the amount of car parking that needs to be removed due to the road works. This analysis is carried out on a precinct level for each day. This is a coarse approximation of the loss of parking based on the impacted road space area and predicted traffic impact, and only forms one input into CCC's car parking analysis tool.

- Task 7: FWV feed

  The output of this step creates data for a spatial data feed used by LINZ to upload the latest data into the FWV. This upload is done on a weekly basis.

- Task 8: New project report

  This part of the process provides an overview of new work on a project stage level.

- Task 999: File dump

  This step creates the output flat files from database records saved throughout the rest of the tasks, and saves them in a time stamped folder. This folder is used for all subsequent updates to outputs. These outputs are discussed in more detail in the following sub-chapters.

3.4.1. Detailed CBD Analysis

This output is created after the traffic process is run. This output gets updated weekly. The output gives a broad picture of the level of service of the roads inside the CBD, see output example provided in **Appendix C**. There are two elements to the file: traffic information from the CAST model, and impact information from the FWV outputs (task 104). An excerpt of the overall output is provided in **Figure 32**.

CAST model outputs are:

- number of lanes
- link and turn capacities per peak
- link and turn actual flows per peak

Route Name				Deans Avenue		Park Terrace, Rolleston Avenue, Antigua Street		Montreal Street		Durham Street (incl. Cambridge Terrace)	
Direction				NB	SB	NB	SB	NB	SB	NB	SB
Bealey Ave to Kilmore St	Capacity			3,400	3,400	2,800	2,800	2,800			2,800
	Lanes			2	2	2	2	2			2
	Volume		AM	958	1,791	907	689	530			774
			PM	1,831	1,006	1,134	519	1,201			377
	Next 5 Weeks in FWP	7/09/2015	Capacity	3,400	3,400	2,800	2,800	2,800			2,800
			Lanes	2	2	2	2	2			2
		14/09/2015	Capacity	3,400	3,400	2,800	2,800	2,800			2,800
			Lanes	2	2	2	2	2			2
		21/09/2015	Capacity	3,400	3,400	2,800	2,800	2,800			2,800
			Lanes	2	2	2	2	2			2
		28/09/2015	Capacity	3,400	3,400	2,800	2,800	2,800			2,800
			Lanes	2	2	2	2	2			2
		5/10/2015	Capacity	3,400	3,400	2,800	2,800	2,800			2,800
			Lanes	2	2	2	2	2			2
	CCC Traffic Count		AM	877	1,966						1,238
			PM	1,841	1,069						626
	Date of Count			23/05/2012	23/05/2012						10/02/2011
	% Difference in Volume		AM	-8%	10%						60%
			PM	1%	6%						66%
	Min Required Lanes		AM	1	2	1	1	1			1
			PM	2	1	1	1	1			1
	Max Residual Capacity		AM	500	1,200	300	500	700			400
			PM	1,200	500	100	700	0			800
	Max % Traffic Increase		AM	60%	70%	40%	80%	140%			60%
			PM	70%	50%	10%	140%	0%			>200%
Kilmore St to Armagh St	Capacity			3,400	3,400	1,400	1,400	2,800			2,800
	Lanes			2	2	1	1	2			2
	Volume		AM	958	1,791	302	402	1,086			1,612
			PM	1,831	1,006	586	268	1,787			1,105
	Next 5 Weeks in FWP	7/09/2015	Capacity	3,400	3,400	1,400	1,400	2,800			2,800
			Lanes	2	2	1	1	2			2
		14/09/2015	Capacity	3,400	3,400	1,400	1,400	2,800			2,800
			Lanes	2	2	1	1	2			2
		21/09/2015	Capacity	3,400	3,400	1,400	1,400	2,800			2,800
			Lanes	2	2	1	1	2			2
		28/09/2015	Capacity	3,400	3,400	1,400	1,400	2,800			2,800
			Lanes	2	2	1	1	2			2
		5/10/2015	Capacity	3,400	3,400	1,400	1,400	2,800			2,800
			Lanes	2	2	1	1	2			2
	CCC Traffic Count		AM	972	1,783						2,005
			PM	1,997	957						1,348
	Date of Count			23/05/2012	23/05/2012						10/02/2011
	% Difference in Volume		AM	1%	0%						24%
			PM	9%	-5%						22%
	Min Required Lanes		AM	1	2	1	1	1			2
			PM	2	1	1	1	2			1
	Max Residual Capacity		AM	500	1,200	900	800	100			900
			PM	1,200	500	600	900	700			100
	Max % Traffic Increase		AM	60%	70%	>200%	>200%	20%			60%
			PM	70%	50%	110%	>200%	40%			10%

Figure 32: Excerpt of detailed CBD output – North South direction

This output is created for the northbound and southbound direction as well as the eastbound and westbound direction. Each output contains the information for five weeks in advance. These outputs are run using week offsets, creating a 20 week forecast in each direction.

As shown in **Figure 32** the North/South routes are shown in the columns named Deans Avenue, Park Terrace and others, Montreal Street, Durham Street and these routes are subdivided into sections of road for consideration. In **Figure 32** above, it can be seen the sections are Bealey Avenue to Kilmore Street and Kilmore Street to Armagh Street.

Both directions are presented individually, and shaded in grey if the road is a one-way street. For each road section the capacity, number of lanes and AM and PM peak volumes are presented. The colour coding means that the darker the blue the smaller the capacity of a section of road e.g. along Deans Avenue. The darker the orange the higher the traffic volumes. The information shown in blue writing indicates the assumed minimum capacity per road section and number of lanes when making allowance for proposed road works.

If the traffic capacity in comparison to traffic volumes is within 90% [3]of the maximum capacity, and lane requirements are not met, then the cells are highlighted in red with yellow fill. This is shown below in **Figure 33,** which illustrates an example of a proposed full closure of Manchester Street around the 21st September to the 4th of October.

Route Name				Manchester Street	
Direction				NB	SB
Armagh St to Hereford St	Capacity			1,200	1,200
	Lanes			1	1
	Volume		AM	289	515
			PM	564	405
	Next 5 Weeks in FWP	7/09/2015	Capacity	840	812
			Lanes	1	1
		14/09/2015	Capacity	840	812
			Lanes	1	1
		21/09/2015	Capacity	0	0
			Lanes	0	0
		28/09/2015	Capacity	0	0
			Lanes	0	0
		5/10/2015	Capacity	840	812
			Lanes	1	1
	CCC Traffic Count		AM		
			PM		
	Date of Count				
	% Difference in Volume		AM		
			PM		
	Min Required Lanes		AM	1	1
			PM	1	1
	Max Residual Capacity		AM	700	500
			PM	500	600
	Max % Traffic Increase		AM	>200%	110%
			PM	90%	170%

Figure 33: Road closure illustrated in detailed CBD output

If traffic count information is available then this information is provided below the “Next 5 Weeks in FWP [Forward Works Programme]” information. This is followed by a percentage difference calculation for the AM and PM peak when comparing the AM and PM traffic volumes. This provides an additional piece of information if detailed CBD analysis is carried out.

The last block of information states the minimum number of lanes required per peak to facilitate the estimated traffic volumes without exceeding 90% of the maximum capacity, followed by the maximum residual capacity rounded down to the closest 100 when considering the minimum required number of lanes. The last information available is the maximum residual capacity (as a percentage) to illustrate the allowed fluctuation in traffic volumes when the section of road is reduced to the minimum number of lanes.

[3] Maximum allowed percentage of capacity set at 90%. The software SATURN calculates the capacities based on a number of elements (eg form of intersections, road hierarchy, speed etc) but the resulting capacity contains an element of uncertainty. The ‘maximum allowed percentage of capacity’ factor is set as a safety measure to account for some of that uncertainty. Capping the maximum allowed capacity to a percentage below 100 (in this case 90%) minimizes the risk of flow break downs resulting in delays and provides an additional buffer to avoid grid locking the network.

The cumulative information for all North/South routes (and in the East/West spreadsheet the respective All East/West route) is also calculated. This is undertaken to present a holistic CBD overview per section of road.

At the bottom of the sheet (as illustrated in **Figure 34**) the impact level for the whole route is provided. The maximum demand along the route per AM and PM peak hour is shown, as well as the minimum capacity and minimum capacity capped at 90%.

Complete North South Route	Max Demand		AM	1,086			1,838	370	415	289	622
			PM	1,792			1,553	573	349	564	519
	Min Capacity			2,800			2,800	800	800	1,200	1,200
	Min Capacity - cappped			2,520			2,520	720	720	1,080	1,080
	Next 5 Weeks	7/09/2015	Impact								
		14/09/2015	Impact								
		21/09/2015	Impact								
		28/09/2015	Impact								
		5/10/2015	Impact								
	Next 5 Weeks	7/09/2015	Max V:C	1.07	0.00	0.00	0.66	0.48	0.38	R.Closure	0.63
		14/09/2015	Max V:C	1.07	0.00	0.00	0.66	0.48	0.38	R.Closure	0.63
		21/09/2015	Max V:C	0.64	0.00	0.00	0.66	0.48	0.38	R.Closure	R.Closure
		28/09/2015	Max V:C	0.64	0.00	0.00	0.66	0.48	0.38	R.Closure	R.Closure
		5/10/2015	Max V:C	0.64	0.00	0.00	0.66	0.48	0.38	R.Closure	0.63

Figure 34: Complete North South route information example

The 'Next 5 Weeks - Impact' rows indicate the expected severity of the forecasted road works on the whole North South route. If a section of road indicates that a traffic impact exists then the impact gets marked in green, orange or red, depending on the severity of the expected impact. The severity of the impact is determined as follows:

If the assumed minimum capacity for each road section is below the 'normal' capacity then the following calculation is undertaken:

$$\max(road\ section(\frac{\max(Volume\ AM, volume\ PM)}{\max(Max\ demand\ AM\ volume, Max\ demand\ PM\ volume)}))$$

*The resulting max factor is getting ranked using the factors stated in **Table 3** and conditional formatting is applied to automatically indicate the severity.*

Impact	Ranking
no or negligible impact	NONE
less than 35% of max demand is impacted by works	LOW (<0.35)
35% -75% of max demand is impacted by works	MEDIUM (0.35-0.75)
more than 75% of max demand is impacted by works	HIGH (>0.75)

Table 3: Traffic impact rating

The rating provided in **Table 4** shows the maximum volume to capacity (V/C) ratio ranking. The maximum V/C ratio per section of road is extracted after accounting for proposed traffic impacts due to road works.

Impact	Ranking
Max V/C ratio below 50%, spare capacity available	<0.5
Max V/C ratio between 50-90%, impacts on road users increase	0.5 – 0.9
Max V/C ratio greater than 90%, running close to capacity	>0.9

Table 4: Max V/C rating

The complete route consideration from the detailed CBD analysis is presented in a 'dashboard' (a summarised version) to show overall CBD impacts for each direction. It is used to flag severe traffic impacts and allows for individual assessment of road sections.

3.4.2. Project approvals and scheduling Gantt-chart

Gantt-charts are provided for each of the four directions (northbound, southbound, eastbound and westbound) as well as an off-peak overview. The directional Gantt-charts are structured street by street and are a collection of works that impact on the capacity of Christchurch's roading network. The impact is collated over all delivery teams and third party entries made through the FWV's 4th screen.

Figure 35 illustrates the Gantt-chart for the northbound direction. Each street has an assigned colour as shown in the legend on bottom left. The project number, stage number, timelines, descriptions, impacts, and approximate location on a map, as well as the pre-approval tracking, are all contained within this chart. The number of lanes as well as capacities are shown on the bottom-right, to track over time how the proposed works will affect the capacity and number of lanes. Indicators are provided for the minimum acceptable number of lanes and capacity. A safety factor is applied to both of these indicators. The minimum number of lanes is one lane in addition to that required to handle the traffic flows. As for the capacity indicator a safety factor of an additional 10% is applied. These target numbers replicate minimum capacities and lanes required for the whole of the CBD for each direction and were agreed by the TIM group as the system was developed.

The Gantt-charts are also used as a pre-approval tool for works to ensure the level of service within the CBD is maintained at an adequate level at all times. These approvals are given on a bi-weekly cycle by the TIM group. Projects that have been declined are shown in red (NO) and approvals are shown in green (YES). If the works need to be better understood or discussions need to occur regarding the impacts and timings, then the work stage is marked in orange for a project level discussion (PLD).

The FME traffic process described above produces a number of files that are used to update these Gantt-charts. The Gantt-charts are updated semi-automatically using a set of macros to import the latest information, on a weekly basis.

Two different types of Gantt-chart outputs are sent to the SCIRT delivery teams. Firstly, the outputs are sent on a weekly basis, to check all relevant information has been provided to the TIM group and to undertake a check that all information is included. Secondly, after the TIM group has met, TIM approved Gantt-charts are sent to the delivery teams for them to see which works are approved (YES), not approved (NO), and which works have triggered a PLD request. If projects cannot be facilitated at the proposed time with the requested traffic impact (e.g. full closure, one-way closure etc) then the proposed work stage needs to be rescheduled. Either to a different time (when the roading network is less impeded) or the traffic impact needs to be minimized by changing the work methodology (if this is possibility). It is the responsibility of the delivery teams to schedule the required PLDs.

These TIM approved Gantt-charts are also provided to the SCIRT approving engineers as well as the CTOC TMCs for use when processing TMPs, to make sure the traffic impact is acceptable and TMPs can be approved.

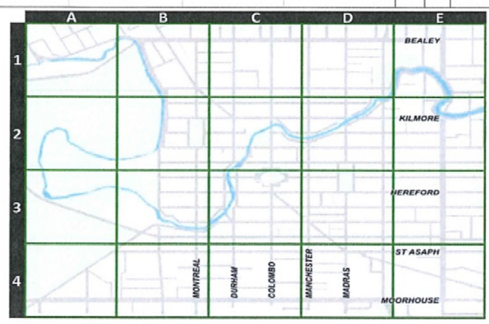
NORTHBOUND **PAGE 1 OF 1**

FULL PROJECT SCHEDULE — 6 MONTH OUTLOOK

Last updated on: 7/11/2014

Project	Stage	start	end	Project name	Description	Delivery Team	Road Name	FWP Traffic Impact	Level	Map	Pre-approved?
11061	15	17/10/2014	10/11/2014	Central City Sout...	St Asaph 1 lane from Manchester, northbound traffic on Colombo and Man...	Downer	COLOMBO ST	ONE-WAY CLOSURE	SEC	C4	YES
10952	72	17/11/2014	21/11/2014	CBD South Core (W...	L45 - 601 Colombo Street (WWMH13610 - WWMH10952.6)	McConnell Dowell	COLOMBO ST	ONE-WAY CLOSURE	PRI	C3	Date +OK+
10952	72	17/11/2014	21/11/2014	CBD South Core (W...	L45 - 601 Colombo Street (WWMH13610 - WWMH10952.6)	McConnell Dowell	COLOMBO ST	ONE-WAY CLOSURE	PRI	C4	Date +OK+
11104	116	22/11/2014	10/12/2014	Central City Sout...	Centre contraflow on St Asaph, with colombo street restricted to one-w...	Downer	COLOMBO ST	ONE-WAY CLOSURE	SEC	C4	PLD:Y
10953	181	12/12/2014	15/12/2014	CBD Central Core ...	3.1 Submain Colombo St (Tuam St - St Asaph St) - 34.9 m	McConnell Dowell	COLOMBO ST	ONE-WAY CLOSURE	PRI	C3	YES
10953	182	15/12/2014	17/12/2014	CBD Central Core ...	3.2 Submain Colombo St (Tuam St - St Asaph St) - 97 m	McConnell Dowell	COLOMBO ST	ONE-WAY CLOSURE	PRI	C3	YES
10953	183	17/12/2014	17/12/2014	CBD Central Core ...	3.3 Crossover Colombo St - 14.6 m	McConnell Dowell	COLOMBO ST	ONE-WAY CLOSURE	PRI	C3	YES
10953	183	17/12/2014	17/12/2014	CBD Central Core ...	3.3 Crossover Colombo St - 14.6 m	McConnell Dowell	COLOMBO ST	ONE-WAY CLOSURE	PRI	C4	YES
10953	185	19/12/2014	19/12/2014	CBD Central Core ...	4.1 Submain Colombo St (St Asaph St - Mollett St) - 47.5 m	McConnell Dowell	COLOMBO ST	ONE-WAY CLOSURE	PRI	C4	YES
10953	186	12/01/2015	12/01/2015	CBD Central Core ...	4.2 Crossover Colombo St - 5.2 m	McConnell Dowell	COLOMBO ST	ONE-WAY CLOSURE	PRI	C4	not_assessed
10953	23	14/01/2015	16/01/2015	CBD Central Core ...	S2 - Colombo St (SWMH5757 - SWMH5795)	McConnell Dowell	COLOMBO ST	ONE-WAY CLOSURE	PRI	C3	not_assessed
10953	192	16/01/2015	20/01/2015	CBD Central Core ...	5.1 Submain Colombo St (Lichfield St - Tuam St - 104.5 m)	McConnell Dowell	COLOMBO ST	ONE-WAY CLOSURE	PRI	C3	not_assessed
10953	24	19/01/2015	21/01/2015	CBD Central Core ...	S3 - Colombo St (SWMH5795 - SWMH5797)	McConnell Dowell	COLOMBO ST	ONE-WAY CLOSURE	PRI	C3	not_assessed
10953	22	22/01/2015	26/01/2015	CBD Central Core ...	S15 - Hereford St (SWJC4782 - SWMH16703)	McConnell Dowell	COLOMBO ST	ONE-WAY CLOSURE	PRI	C3	not_assessed
10953	196	22/01/2015	26/01/2015	CBD Central Core ...	6.1 Submain Colombo St (Lichfield St - Cashel St - 77.8 m)	McConnell Dowell	COLOMBO ST	ONE-WAY CLOSURE	PRI	C3	not_assessed
10953	198	27/01/2015	28/01/2015	CBD Central Core ...	51.1 Submain Colombo St (Cashel St - Hereford St - 64.1 m)	McConnell Dowell	COLOMBO ST	ONE-WAY CLOSURE	PRI	C3	not_assessed
11062	28	8/12/2014	14/12/2014	CBD - South Area ...	One Lane dropped Eastbound on Moorhouse Ave including the turning lane...	Downer	FITZGERALD AVE	1 LANE DROP	SEC	E4	YES
11028	A55250	1/07/2014	11/11/2014	CBD North of Avon...	New watermain switching traffic at the Peterborough intersection	Fletcher Construction	MADRAS ST	1 LANE DROP	PRI	D2	Date =X+
11028	A55310	16/09/2014	16/12/2014	CBD North of Avon...	K&C and carriageway reinconstruction	Fletcher Construction	MADRAS ST	1 LANE DROP	PRI	D2	Date =X+
11028	A55310	16/09/2014	16/12/2014	CBD North of Avon...	K&C and carriageway reinconstruction	Fletcher Construction	MADRAS ST	1 LANE DROP	PRI	D1	Date =X+
11024	A56900	18/09/2014	12/12/2014	Central Bridges -...	1 lane drop on madras st, kilmore street bridge closed	Fletcher Construction	MADRAS ST	1 LANE DROP	PRI	D2	YES
11061	28	17/10/2014	10/11/2014	Central City Sout...	Lane drop on St Asaph from Barbadoes to Madras, Lane drop on barbadoes	Downer	MADRAS ST	1 LANE DROP	SEC	D4	YES
11061	98	17/10/2014	10/11/2014	Central City Sout...	Contraflows on Allen St and Manchester St, Lane drop on Madras St	Downer	MADRAS ST	1 LANE DROP	PRI	D4	YES
11061	91	17/10/2014	10/11/2014	Central City Sout...	Southwark reduced to 1-way eastbound, lane drop on Madras, contraflow ...	Downer	MADRAS ST	1 LANE DROP	PRI	D4	YES
11061	209	25/10/2014	10/11/2014	Central City Sout...	Contraflows on Allen St and Manchester St, Lane drop on Madras St	Downer	MADRAS ST	1 LANE DROP	PRI	D4	YES
11061	210	25/10/2014	14/11/2014	Central City Sout...	Contraflows on Allen St and Manchester St, Lane drop on Madras St	Downer	MADRAS ST	1 LANE DROP	PRI	D4	YES
11061	216	3/11/2014	28/11/2014	Central City Sout...	MADRAS and St. Asaph Intersection No of laterals (3) both sides of the...	Downer	MADRAS ST	2 LANE DROP	PRI	D4	YES
10952	463	14/11/2014	14/11/2014	CBD South Core (W...	L46 - Madras St (WWMH15241 - WWMH15239)	McConnell Dowell	MADRAS ST	1 LANE DROP	PRI	D3	YES
11061	77	17/11/2014	1/12/2014	Central City Sout...	One lane dropped on Madras at St Asaph, right turn movement combined w...	Downer	MADRAS ST	1 LANE DROP	PRI	D4	YES
11061	82	17/11/2014	1/12/2014	Central City Sout...	Footpath closure with contraflow around diverted footpth	Downer	MADRAS ST	1 LANE DROP	PRI	D4	YES
10953	135	28/11/2014	28/11/2014	CBD Central Core ...	17.1 Crossover Madras St - 14.3 m	McConnell Dowell	MADRAS ST	1 LANE DROP	PRI	D2	YES
10953	136	28/11/2014	28/11/2014	CBD Central Core ...	17.2 Crossover Madras St - 5 m	McConnell Dowell	MADRAS ST	1 LANE DROP	PRI	D2	YES
10953	137	1/12/2014	1/12/2014	CBD Central Core ...	17.3 Submain Madras St (Gloucester St - Armagh St - 55.3 m)	McConnell Dowell	MADRAS ST	1 LANE DROP	PRI	D2	YES
10952	19	1/12/2014	5/12/2014	CBD South Core (W...	Drg WW2016c Madras St (WWMH10952.4 - WWMH15242) - on hold "Bolt of Clo...	McConnell Dowell	MADRAS ST	1 LANE DROP	PRI	D3	YES
10953	138	2/12/2014	2/12/2014	CBD Central Core ...	17.4 Submain Madras St (Gloucester St - Armagh St - 34 m)	McConnell Dowell	MADRAS ST	1 LANE DROP	PRI	D2	YES
10953	139	3/12/2014	3/12/2014	CBD Central Core ...	18.1 Crossover Madras St - 19.3 m	McConnell Dowell	MADRAS ST	1 LANE DROP	PRI	D2	YES
10953	140	3/12/2014	3/12/2014	CBD Central Core ...	18.2 Crossover Madras St - 14.6 m	McConnell Dowell	MADRAS ST	1 LANE DROP	PRI	D2	YES
10953	141	4/12/2014	4/12/2014	CBD Central Core ...	18.3 Submain Madras St (Armagh St - Chester St East - 56.4 m)	McConnell Dowell	MADRAS ST	1 LANE DROP	PRI	D2	YES
10953	10	13/01/2015	21/01/2015	CBD Central Core ...	Drg SW2002 Madras St (SWJC3278 - SWSP27274)	McConnell Dowell	MADRAS ST	1 LANE DROP	PRI	D4	Date +X+
10953	146	9/02/2015	10/02/2015	CBD Central Core ...	20.1 Submain Madras St (Lichfield St - Bedford Row - 43 m)	McConnell Dowell	MADRAS ST	1 LANE DROP	PRI	D3	not_assessed
10953	227	2/03/2015	13/03/2015	CBD Central Core ...	Drg RD2004 Madras St - Overlay, footpath repair and bebuild Gloucester...	McConnell Dowell	MADRAS ST	1 LANE DROP	PRI	D2	not_assessed
10953	228	16/03/2015	7/04/2015	CBD Central Core ...	Drg RD2005 Madras St - Overlay, footpath repair and bebuild Armagh - C...	McConnell Dowell	MADRAS ST	1 LANE DROP	PRI	D2	not_assessed
10953	168	17/03/2015	17/03/2015	CBD Central Core ...	21.1 Submain Madras St (Cashel St - Hereford St - 107.7 m)	McConnell Dowell	MADRAS ST	1 LANE DROP	PRI	D3	not_assessed
10953	177	18/03/2015	18/03/2015	CBD Central Core ...	57.1 Crossover Madras St - 3.8 m	McConnell Dowell	MADRAS ST	1 LANE DROP	PRI	D3	not_assessed
10953	178	19/03/2015	19/03/2015	CBD Central Core ...	57.2 Submain Madras St (Tuam St - Lichfield St- 30.4 m)	McConnell Dowell	MADRAS ST	1 LANE DROP	PRI	D3	not_assessed
10953	174	20/03/2015	23/03/2015	CBD Central Core ...	19.1 Submain Madras St (Tuam St - Lichfield St - 90.5 m)	McConnell Dowell	MADRAS ST	1 LANE DROP	PRI	D3	not_assessed
10953	229	8/04/2015	21/04/2015	CBD Central Core ...	Drg RD2006 Madras St - Overlay Chester Street East - Oxford Trc	McConnell Dowell	MADRAS ST	1 LANE DROP	PRI	D2	not_assessed
10953	134	13/04/2015	7/05/2015	CBD Central Core ...	Drg WS1001 Madras Street Installation of new watermain between Glouces...	McConnell Dowell	MADRAS ST	1 LANE DROP	PRI	D2	not_assessed
11087	144	20/05/2014	28/03/2015	CBD - North Core ...	Pump Station A Construction Machester St	McConnell Dowell	MANCHESTER ST	ONE-WAY CLOSURE	SEC	D2	PLD
11028	A55180	1/09/2014	26/11/2014	CBD North of Avon...	Multipe road switchs to complete kerb to kerb restoration	Fletcher Construction	MANCHESTER ST	ONE-WAY CLOSURE	PRI	D2	PLD:Y: Dte =X+
11028	A55180	1/09/2014	26/11/2014	CBD North of Avon...	Multipe road switchs to complete kerb to kerb restoration	Fletcher Construction	MANCHESTER ST	ONE-WAY CLOSURE	PRI	D1	PLD:Y: Dte =X+
11028	A55168	1/09/2014	10/12/2014	CBD North of Avon...	Multipe road switchs to complete kerb to kerb restoration	Fletcher Construction	MANCHESTER ST	ONE-WAY CLOSURE	PRI	D2	Date =X+
11028	A55170	1/09/2014	17/12/2014	CBD North of Avon...	Multipe road switchs to complete kerb to kerb restoration	Fletcher Construction	MANCHESTER ST	ONE-WAY CLOSURE	PRI	D2	Date =X+
11061	15	17/10/2014	10/11/2014	Central City Sout...	St Asaph 1 lane from Manchester, northbound traffic on Colombo and Man...	Downer	MANCHESTER ST	ONE-WAY CLOSURE	TER	D4	YES
11061	21	17/10/2014	10/11/2014	Central City Sout...	Works in Cetre of St Asaph for most part extending into Manchester int...	Downer	MANCHESTER ST	ONE-WAY CLOSURE	SEC	D4	YES
10953	2	28/10/2014	12/11/2014	CBD Central Core ...	Drg SW2005 Oxford Trc (SWMH6133 - SWMH6168)	McConnell Dowell	MANCHESTER ST	ONE-WAY CLOSURE	PRI	D2	YES
10952	70	17/11/2014	21/11/2014	CBD South Core (W...	L36 - Manchester St (WWMH13620 - WWMH13594)	McConnell Dowell	MANCHESTER ST	ONE-WAY CLOSURE	PRI	D3	Date +OK+
10952	452	17/11/2014	19/12/2014	CBD South Core (W...	Drg WW2006 Tuam St (WWMH13610 - WWMH13611) - on hold due to Odeon	McConnell Dowell	MANCHESTER ST	ONE-WAY CLOSURE	SEC	D3	Date +OK+
10952	448	9/12/2014	11/12/2014	CBD South Core (W...	L41 - Machester Street (WWMH27485 - WWMH13596)	McConnell Dowell	MANCHESTER ST	ONE-WAY CLOSURE	PRI	D3	YES
10952	68	9/12/2014	11/12/2014	CBD South Core (W...	L21 - Manchester St (WWMH13595 - WWMH27485)	McConnell Dowell	MANCHESTER ST	ONE-WAY CLOSURE	PRI	D3	YES
10953	151	17/02/2015	18/02/2015	CBD Central Core ...	24.1 Submain Manchester St (Tuam St - Lichfield St - 29.4 m)	McConnell Dowell	MANCHESTER ST	ONE-WAY CLOSURE	PRI	D3	not_assessed
10953	152	18/02/2015	18/02/2015	CBD Central Core ...	24.2 Crossover Manchester St - 5.8 m	McConnell Dowell	MANCHESTER ST	ONE-WAY CLOSURE	PRI	D3	not_assessed
10953	153	19/02/2015	19/02/2015	CBD Central Core ...	24.3 Crossover Manchester St - 5.7 m	McConnell Dowell	MANCHESTER ST	ONE-WAY CLOSURE	PRI	D3	not_assessed
10953	170	3/03/2015	4/03/2015	CBD Central Core ...	25.1 Submain Manchester St (Tuam St - St Asaph St - 107.6 m)	McConnell Dowell	MANCHESTER ST	ONE-WAY CLOSURE	PRI	D3	not_assessed
10953	170	3/03/2015	4/03/2015	CBD Central Core ...	25.1 Submain Manchester St (Tuam St - St Asaph St - 107.6 m)	McConnell Dowell	MANCHESTER ST	ONE-WAY CLOSURE	PRI	D4	not_assessed
10953	171	5/03/2015	5/03/2015	CBD Central Core ...	25.2 Crossover Manchester St - 6 m	McConnell Dowell	MANCHESTER ST	ONE-WAY CLOSURE	PRI	D3	not_assessed
10953	171	5/03/2015	5/03/2015	CBD Central Core ...	25.2 Crossover Manchester St - 6 m	McConnell Dowell	MANCHESTER ST	ONE-WAY CLOSURE	PRI	D4	not_assessed
10953	172	5/03/2015	9/03/2015	CBD Central Core ...	25.3 Submain Manchester St (Tuam St - St Asaph St - 109.3 m)	McConnell Dowell	MANCHESTER ST	ONE-WAY CLOSURE	PRI	D3	not_assessed
10953	172	5/03/2015	9/03/2015	CBD Central Core ...	25.3 Submain Manchester St (Tuam St - St Asaph St - 109.3 m)	McConnell Dowell	MANCHESTER ST	ONE-WAY CLOSURE	PRI	D4	not_assessed
10953	173	9/03/2015	9/03/2015	CBD Central Core ...	25.4 Crossover Manchester St - 13.5 m	McConnell Dowell	MANCHESTER ST	ONE-WAY CLOSURE	PRI	D3	not_assessed
10953	173	9/03/2015	9/03/2015	CBD Central Core ...	25.4 Crossover Manchester St - 13.5 m	McConnell Dowell	MANCHESTER ST	ONE-WAY CLOSURE	PRI	D4	not_assessed
10953	163	10/03/2015	10/03/2015	CBD Central Core ...	22.2 Submain Manchester St (Bedrod Row - Cashel St - 23.6 m)	McConnell Dowell	MANCHESTER ST	ONE-WAY CLOSURE	PRI	D3	not_assessed
10953	165	11/03/2015	13/03/2015	CBD Central Core ...	34.2 Submain Cashel St (Manchester St - Madras St - 72.7)	McConnell Dowell	MANCHESTER ST	ONE-WAY CLOSURE	PRI	D3	not_assessed
10953	166	13/03/2015	13/03/2015	CBD Central Core ...	34.3 Crossover Cashel St - 8.0 m	McConnell Dowell	MANCHESTER ST	ONE-WAY CLOSURE	PRI	D3	not_assessed
10953	210	2/04/2015	7/04/2015	CBD Central Core ...	32.5 Submain Gloucester St (Manchester St - Madras St - 31.1 m)	McConnell Dowell	MANCHESTER ST	ONE-WAY CLOSURE	PRI	D2	not_assessed
10953	212	8/04/2015	8/04/2015	CBD Central Core ...	50.1 Crossover Manchester St - 5.6 m	McConnell Dowell	MANCHESTER ST	ONE-WAY CLOSURE	PRI	D3	not_assessed
10953	213	8/04/2015	9/04/2015	CBD Central Core ...	50.2 Submain Manchester St (Worcester St - Hereford St - 50.2 m)	McConnell Dowell	MANCHESTER ST	ONE-WAY CLOSURE	PRI	D3	not_assessed
11104	121	22/11/2014	10/12/2014	Central City Sout...	Centre contraflow on St Asaph with one lane dropped on each of Montrea...	Downer	MONTREAL ST	1 LANE DROP	TER	B4	PLD:Y
11173	8	12/01/2014	19/01/2015	Health Precinct O...	Includes Antigua St/St Asaph St Intersection and signal hardware chang...	Downer	ANTIGUA ST	FULL CLOSURE	PRI	B4	not_assessed
11173	8	12/01/2014	19/01/2015	Health Precinct O...	Includes Antigua St/St Asaph St Intersection and signal hardware chang...	Downer	ANTIGUA ST	FULL CLOSURE	PRI	B3	not_assessed
11173	9	19/01/2015	23/01/2015	Health Precinct O...	Sandblast/remove road markings and install of new road markings	Downer	ANTIGUA ST	FULL CLOSURE	PRI	B3	not_assessed

- MONTREAL
- MADRAS
- FITZ
- COLOMBO
- MANCHESTER
- PARK TCE
- N/A
- OTHER NORTHBOUND ROUTES



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Printed on 7/11/2014

Figure 35: Gantt-chart for northbound direction

The current date is shown as the orange horizontal line and the green line indicates the end of the consideration period.

Every two weeks, in preparation for the TIM meetings, the scheduled project stages are also compared to the previous signed-off impacts and dates, to track changes made to the programme.

If changes have occurred to the scheduled project stages since the last TIM group sign off was given, these are typically marked in blue and shown in the '*Pre-approved?*' column in **Figure 35** (approximately located in the middle of the output, to the left of the timeline bars). The logic shown in **Figure 36** is used to evaluate and determine the display of the changes. If a PLD was scheduled or has occurred, the changes are still indicated but the colour does not change from orange. Orange is the colour assigned to all works that have had or need a PLD.

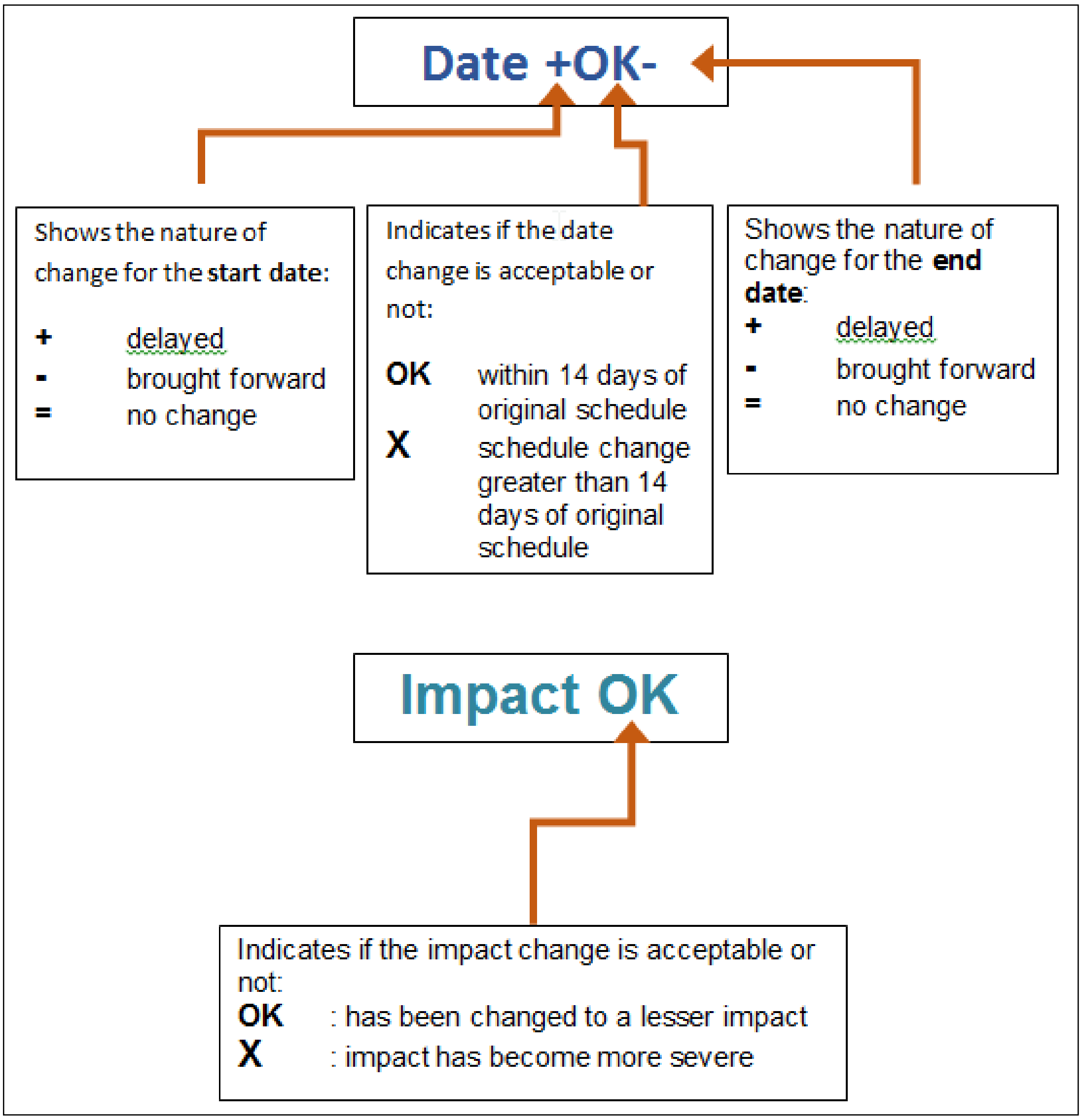

Figure 36: Gantt-chart two weekly comparison logic (SCIRT internal, 2014)

The *Pre-approved?* column (**Figure 35**) shows the type of change (date or impact), the marker for traffic impact upgrade or downgrade, as well as the date shifted if it is more or less than 14 days for both start date or end date.

To illustrate this logic and the colour coding, three examples are provided:

1) Change to the date

   PLD:Y Dte =OK+ means a PLD was required and has occurred and impact and scheduled time accepted (PLD:Y). Since this sign off, the date has changed (Dte) with the start date staying the same (=) and the end date has been extended out by less than 14 days (OK+).

2) Change to the impact

3) Impact X means that the impact has become more severe (e.g. 1 lane drop scheduled before, latest schedule shows 2 lane drops).

4) Change to date and impact

   Date -X+, Impact OK means that the start date has been brought forward and the end date pushed out by more than 14 days. In addition, the impact has become less severe (e.g. one-way closure previously, latest schedule requires capacity reduction only).

Work stages that are new, or scheduled outside the stated consideration period, are carried forward as 'not assessed' without any colouration. Requested PLDs are marked in orange and kept in orange after sign-off but a 'PLD:Y' is added. If subsequent changes occur these are illustrated as previously discussed but still kept in orange.

3.4.3. Long term traffic impact dashboard

The dashboard provides a summary of the roading network capacities based on traffic impacts over time within the wider Christchurch area, and inside the CBD in particular (see **Figure 37**).

It is based on the FWV and spreadsheet data processed in FME, and also incorporates information from other outputs, such as the Gantt-charts and detailed CBD analysis.

The top left corner of the dashboard provides a forward works programme summary. This uses information extracted from Hiviz[4] to show how many works are currently in construction, which particular delivery team they are allocated to, and how many of these projects have a traffic impact schedule supplied. Note that not all projects cause traffic impacts, hence the number of projects in the SDI should always be smaller than the overall project number carried in Hiviz. Following the overall project stocktake the number of significant work stages is listed, and lastly an indicator is given for bus route impacts.

Below the forward works programme summary information, the North/South routes and East/West routes information is provided with the legend above. How this information was created has been explained in the detailed CBD analysis.

[4] SCIRT's reporting tool, providing information to various groups of people.

In the top right hand corner, historical and estimated capacities in the CBD and entire city are provided from the middle of 2011 until the end of the SCIRT programme[5]. It shows that the CBD capacity is starting to increase again, which makes sense as the SCIRT works are winding down, and to this date not all the third party works in the CBD are accounted for through the FWV. This is an area that is currently being worked on to provide a better overall picture to avoid underestimating the traffic impacts and therefore overestimating the capacities within the CBD.

The capacities in the entire city on the other hand have started to decrease considerably. This is due to SCIRT works moving more into areas outside the CBD and into the outlying suburbs to undertake work, e.g. Fendalton catchment and eastern suburbs work. But it is also a reflection of the recently introduced requirement that outside-CBD works need to be planned ahead, with TMP approval only given when this has occurred. CTOC are leading the development of an approval tool to capture the approvals online. This means that the outside-CBD works are treated the same as the inside-CBD works. As discussed previously, the CBD works needed to be facilitated first, due to other parties needing to get into the CBD for the vertical rebuild (and therefore tools and outputs were focussed on this area first). Now that the outside-CBD work is ramping up, these tools and learnings can be used for the outside-CBD also.

The bottom half of the dashboard provides the critical routes summary. The right-hand side shows the capacity and number of lane reductions due to the forecast traffic impacts, as per the project approval and scheduling Gantt-charts. The directional outputs from the Gantt-charts are provided here and combine capacity and lane information into one chart per direction.

The left-hand table provides a long-term forecast starting from the current week. It provides the number of lanes per direction within the CBD and the number of bridges across the Avon and Heathcote Rivers. The bridge information is bi-directional. It shows over time if traffic lanes will be closed. The information is also shown as percentage reductions. The information provided in **Figure 37** (updated on 4th September 2015) shows that there are no bridge works proposed that impact on the number of lanes available for vehicular traffic until the end of November 2015[6].

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[5] A fixed scale is used so as the vertical axis. These plots are used as capacity trend lines. These plots are compared from week to week and provide a general overview of how the capacities are tracking. Especially the capacity reductions between the CBD and the entire network are of interest to evaluate the amount of outside-CBD work that is scheduled in comparison to inside-CBD works. Inside-CBD works was the focus of the analysis undertaken until around August 2015, when a greater focus was given to the outside-CBD works.

[6] The closure of the Gloucester Street bridge is not taken into consideration as it is a long term closure and the future of the bridge is uncertain. It is not known to date, if the bridge will be kept closed or will open again in the future.

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Last Updated 4/09/2015 9:19:51 p.m.

Traffic Impact: For the Week Beginning 07/09/2015

Forward Works Program Summary	Fletcher Construction	MacDow	City Care	Downer	Fulton Hogan	Total
Number of Projects in Asta (in construction)	22	32	21	23	24	122
Number of Projects in SDI	18	14	11	12	18	73
% of Projects in FWP	82%	44%	52%	52%	75%	60%
Number of Stages in FWP	249	127	165	160	369	1070
Number of Significant Stages in FWP	454	75	160	280	175	1144
Full closure on roads with more than 5,000vpd (two-way)	10	1	5	4	0	20
One-way closure on roads with more than 10,000vpd (two-way)	19	30	18	16	5	88
Lane closure on roads with more than 12,500vpd (one-way)	0	0	0	0	0	0
Any work on strategic route	425	44	137	260	170	1036
Number of Bus Routes Affected	10	24	10	6	13	63
Bus Routes With Full Closure or One-way Closure	10	24	10	6	13	63
Bus Routes With Any Road Works						0

LEGEND

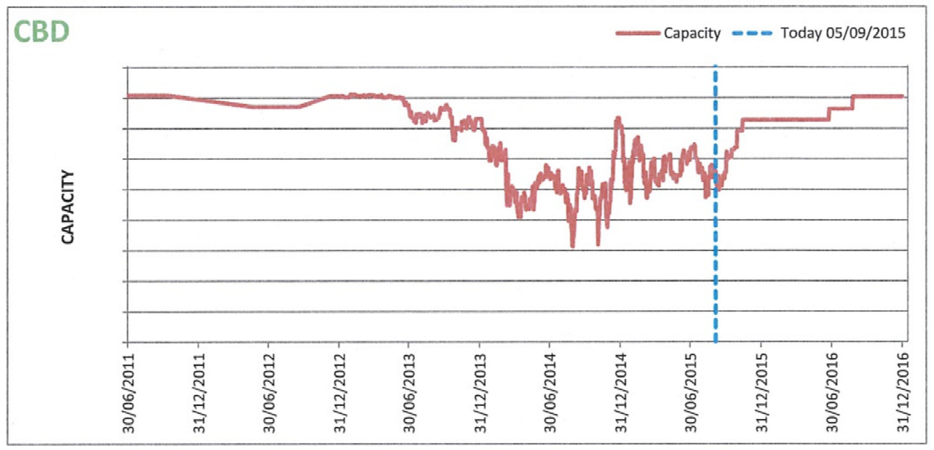
Strategic route?	Strategic routes are defined as routes that have significant impact on the network and full closures are not recommended
Nett Lane impact	Impact to number of lanes on route compared number of through lanes
Max % Dem/ Cap	Maximum volume to capacity ratio by segments along route
Through lanes	Minimum number of lanes available on route from start to end

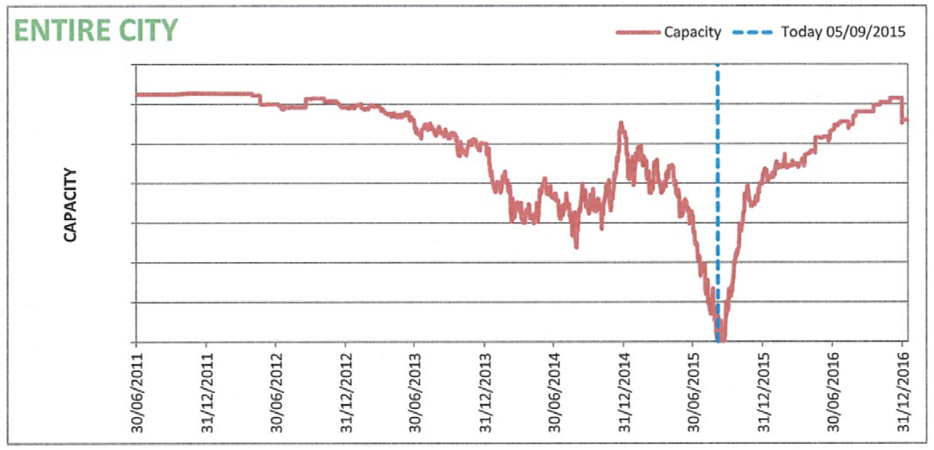
Impact on demand	Impact of road works to vehicles (analysed by individual route segments)
	no impact
LOW	less than 35% of max demand impacted by works
MEDIUM	35 - 75% of max demand impacted by works
HIGH	more than 75% of max demand impacted by works

North/South Routes	NORTHBOUND Strategic route?	No works Through lanes	No works Route Capacity	No works Max Veh Demand	Wk Beginning 07/09/2015 - (next week) Nett Lane impact	Max % Dem/ Cap	Impact on demand	Wk Beginning 14/09/2015 - (2 weeks from now) Nett Lane impact	Max % Dem/ Cap	Impact on demand	SOUTHBOUND Strategic route?	No works Through lanes	No works Route Capacity	No works Max Veh Demand	Wk Beginning 07/09/2015 - (next week) Nett Lane impact	Max % Dem/ Cap	Impact on demand	Wk Beginning 14/09/2015 - (2 weeks from now) Nett Lane impact	Max % Dem/ Cap	Impact on demand
Montreal St (Bealey Ave to Moorhouse Ave)	YES	2	2800	1792	0	107%		0	107%											
Durham St/Cambridge Tce (Bealey Ave to Moorhouse Ave)											YES	2	2800	1838	0	66%		0	66%	
Colombo St (Bealey Ave to Moorhouse Ave - exclude Cathedral Sqr)		1	800	573	0	48%		0	48%			1	800	415	0	38%		0	38%	
Manchester St (Bealey Ave to Moorhouse Ave)		1	1200	564	-1	R.Closure		-1	R.Closure			1	1200	622	0	63%		0	63%	
Madras St (Bealey Ave to Moorhouse Ave)	YES	2	3400	1724	0	105%		0	51%											
Barbadoes St (Bealey Ave to Moorhouse Ave)											YES	2	3400	1639	0	48%		0	48%	
Fitzgerald Ave (Bealey Ave to Moorhouse Ave)	YES	2	3400	1635	0	R.Closure		0	R.Closure		YES	2	3400	1987	0	R.Closure		0	R.Closure	
Total		8	11600	6288								8	11600	6501						

East/West Routes	EASTBOUND Strategic route?	No works Through lanes	No works Route Capacity	No works Max Veh Demand	Wk Beginning 07/09/2015 - (next week) Nett Lane impact	Max % Dem/ Cap	Impact on demand	Wk Beginning 14/09/2015 - (2 weeks from now) Nett Lane impact	Max % Dem/Cap	Impact on demand	WESTBOUND Strategic route?	No works Through lanes	No works Route Capacity	No works Max Veh Demand	Wk Beginning 07/09/2015 - (next week) Nett Lane impact	Max % Dem/Cap	Impact on demand	Wk Beginning 14/09/2015 - (2 weeks from now) Nett Lane impact	Max % Dem/ Cap	Impact on demand
Hagley Ave (Moorhouse Ave to Oxford Tce)		1	1400	1409	-1	R.Closure		-1	R.Closure			1	1400	829	-1	R.Closure		-1	R.Closure	
Bealey Ave (Park Tce to Fitzgerald Ave)	YES	3	3400	2413	0	64%		0	64%		YES	2	3400	1565	0	46%		0	46%	
Salisbury St (Park Tce to Barbadoes St)	YES	2	2800	748	0	27%		0	27%											
Kilmore St (Park Tce to Fitzgerald Ave)											YES	1	1400	1787	0	64%		0	64%	
Hereford St (Rolleston Ave to Fitzgerald Ave)		1	1200	1717	0	123%		0	123%			1	1200	362	0	26%		0	49%	
Oxford Tce/Lichfield St (Riccarton Ave to Fitzgerald Ave)		2	1400	1409	-2	R.Closure		-2	R.Closure											
Tuam St (Riccarton Ave to Fitzgerald Ave)		1	1200	1024	0	37%		0	37%			1	1200	1120	0	80%		0	80%	
St Asaph St (Hagley Ave to Fitzgerald Ave)											YES	1	1400	1327	0	47%		0	47%	
Moorhouse Ave (Deans Ave to Fitzgerald Ave)	YES	3	3400	1821	0	57%		0	57%		YES	3	3400	2245	0	62%		0	62%	
Total		13	14800	10542								10	13400	9234						

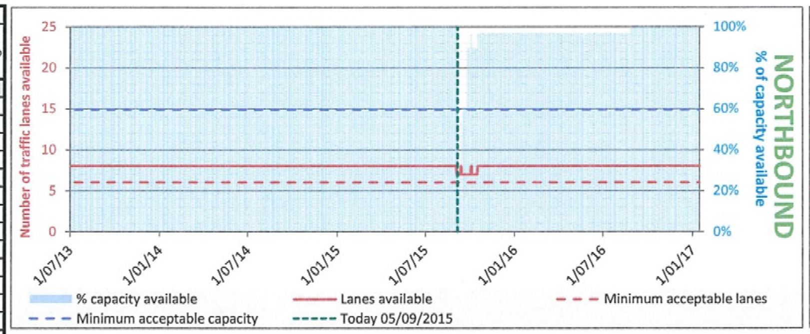
Capacity and Value of Time: From Mid 2011 to End of 2016

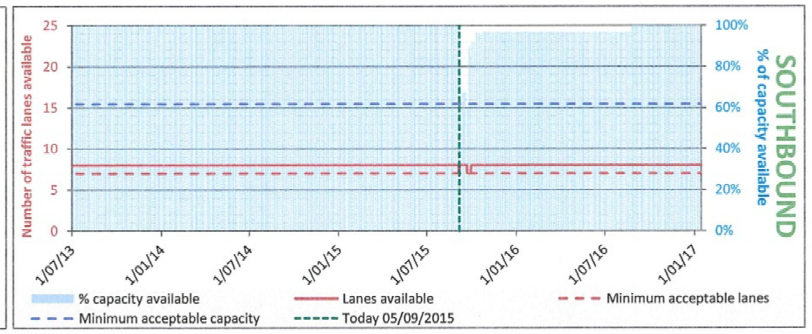


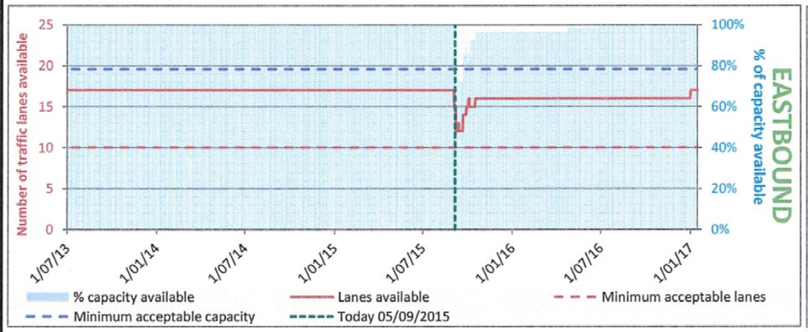


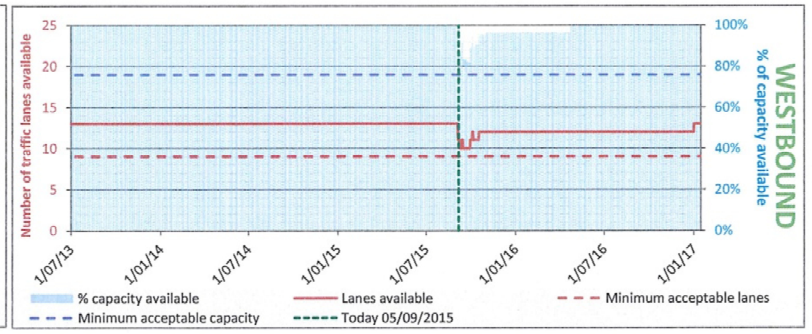
Critical Routes Weekly Summary (for 31 weeks, starting from current week)

Week	Starting Day	Number of Traffic Lanes - with FWP: CBD (NB)	CBD (SB)	CBD (EB)	CBD (WB)	Bridges (Avon)	Bridges (Heathcotte)	% Drop in Number of Traffic Lanes: CBD (NB)	CBD (SB)	CBD (EB)	CBD (WB)	Bridges (Avon)	Bridges (Heathcotte)
Without FWP		8	8	17	13	55	20						
0	2/09/2015	7	7	12	10	55	20	-13%	-13%	-29%	-23%	0%	0%
1	9/09/2015	7	8	12	10	55	20	-13%	0%	-29%	-23%	0%	0%
2	16/09/2015	7	7	12	10	55	20	-13%	-13%	-29%	-23%	0%	0%
3	23/09/2015	7	7	14	10	55	20	-13%	-13%	-18%	-23%	0%	0%
4	30/09/2015	7	8	15	11	55	20	-13%	0%	-12%	-15%	0%	0%
5	7/10/2015	7	8	15	11	55	20	-13%	0%	-12%	-15%	0%	0%
6	14/10/2015	7	8	15	11	55	20	-13%	0%	-12%	-15%	0%	0%
7	21/10/2015	8	8	16	12	55	20	0%	0%	-6%	-8%	0%	0%
8	28/10/2015	8	8	16	12	55	20	0%	0%	-6%	-8%	0%	0%
9	4/11/2015	8	8	16	12	55	20	0%	0%	-6%	-8%	0%	0%
10	11/11/2015	8	8	16	12	55	20	0%	0%	-6%	-8%	0%	0%
11	18/11/2015	8	8	16	12	55	20	0%	0%	-6%	-8%	0%	0%
12	25/11/2015	8	8	16	12	53	20	0%	0%	-6%	-8%	-4%	0%
13	2/12/2015	8	8	16	12	53	20	0%	0%	-6%	-8%	-4%	0%
14	9/12/2015	8	8	16	12	53	20	0%	0%	-6%	-8%	-4%	0%
15	16/12/2015	8	8	16	12	53	20	0%	0%	-6%	-8%	-4%	0%
16	23/12/2015	8	8	16	12	53	20	0%	0%	-6%	-8%	-4%	0%
17	30/12/2015	8	8	16	12	53	20	0%	0%	-6%	-8%	-4%	0%
18	6/01/2016	8	8	16	12	53	20	0%	0%	-6%	-8%	-4%	0%
19	13/01/2016	8	8	16	12	53	20	0%	0%	-6%	-8%	-4%	0%
20	20/01/2016	8	8	16	12	53	20	0%	0%	-6%	-8%	-4%	0%
21	27/01/2016	8	8	16	12	53	20	0%	0%	-6%	-8%	-4%	0%
22	3/02/2016	8	8	16	12	53	20	0%	0%	-6%	-8%	-4%	0%
23	10/02/2016	8	8	16	12	53	20	0%	0%	-6%	-8%	-4%	0%
24	17/02/2016	8	8	16	12	53	20	0%	0%	-6%	-8%	-4%	0%
25	24/02/2016	8	8	16	12	53	20	0%	0%	-6%	-8%	-4%	0%
26	2/03/2016	8	8	16	12	53	20	0%	0%	-6%	-8%	-4%	0%
27	9/03/2016	8	8	16	12	53	20	0%	0%	-6%	-8%	-4%	0%
28	16/03/2016	8	8	16	12	53	20	0%	0%	-6%	-8%	-4%	0%
29	23/03/2016	8	8	16	12	53	20	0%	0%	-6%	-8%	-4%	0%
30	30/03/2016	8	8	16	12	53	20	0%	0%	-6%	-8%	-4%	0%
31	6/04/2016	8	8	16	12	53	20	0%	0%	-6%	-8%	-4%	0%









G:\Delivery\Transport Planning\Output\2013 04 19 Traffic Impact Summary - FWP\Programme TIA Template_v14.xlsm

Printed on 5/09/2015

Figure 37: Weekly dashboard overview

This dashboard provides a good overview over time and can be used to paint an overall picture of how planned works are impacting on the roading network, mainly in the CBD.

3.4.4. Maps

A set of maps are created during the FME traffic process.

- Governance Stakeholder Maps:

  These are a set of maps for the CBD showing the new works starting in any one week for the coming four weeks. Each week is time stamped and only shows the new work for that particular week. The maps always depict the Monday to Sunday period and are created 1.5 weeks in advance, meaning if the update is undertaken on a Friday, the first map is created for Monday the week-after-next (10 days later).

- Week Ahead Summary Maps:

  These are a set of maps that are created for the entire city, and also include a CBD focus. The works which are starting are presented for the week ahead. These are the same as the CBD maps discussed above, however they show only one week ahead for both the CBD and entire city. A second set of maps are created that include the works which are proposed to begin, but also incorporate work which is already underway. This information for works which are already underway is provided in lighter colours. **Figure 38** contains an example for the CBD current and proposed road works for the week 14th - 21st September 2015.

These maps are provided to the delivery teams for them to validate their data and to see what other works are planned in the vicinity of their work. The maps are also sent to the CTOC Real Time Operations (RTO) team, TMCs, ECan, and to CTOC's traveller information team.

These sets of maps are quite useful to inform of upcoming work. However, the FME traffic process contains numerous information sources and other maps, such as high-resolution maps for inclusion in AutoCAD that can assist with VMS placement. The information available allows for a wealth of mapped data (such as completed works) that can easily be extracted if required.

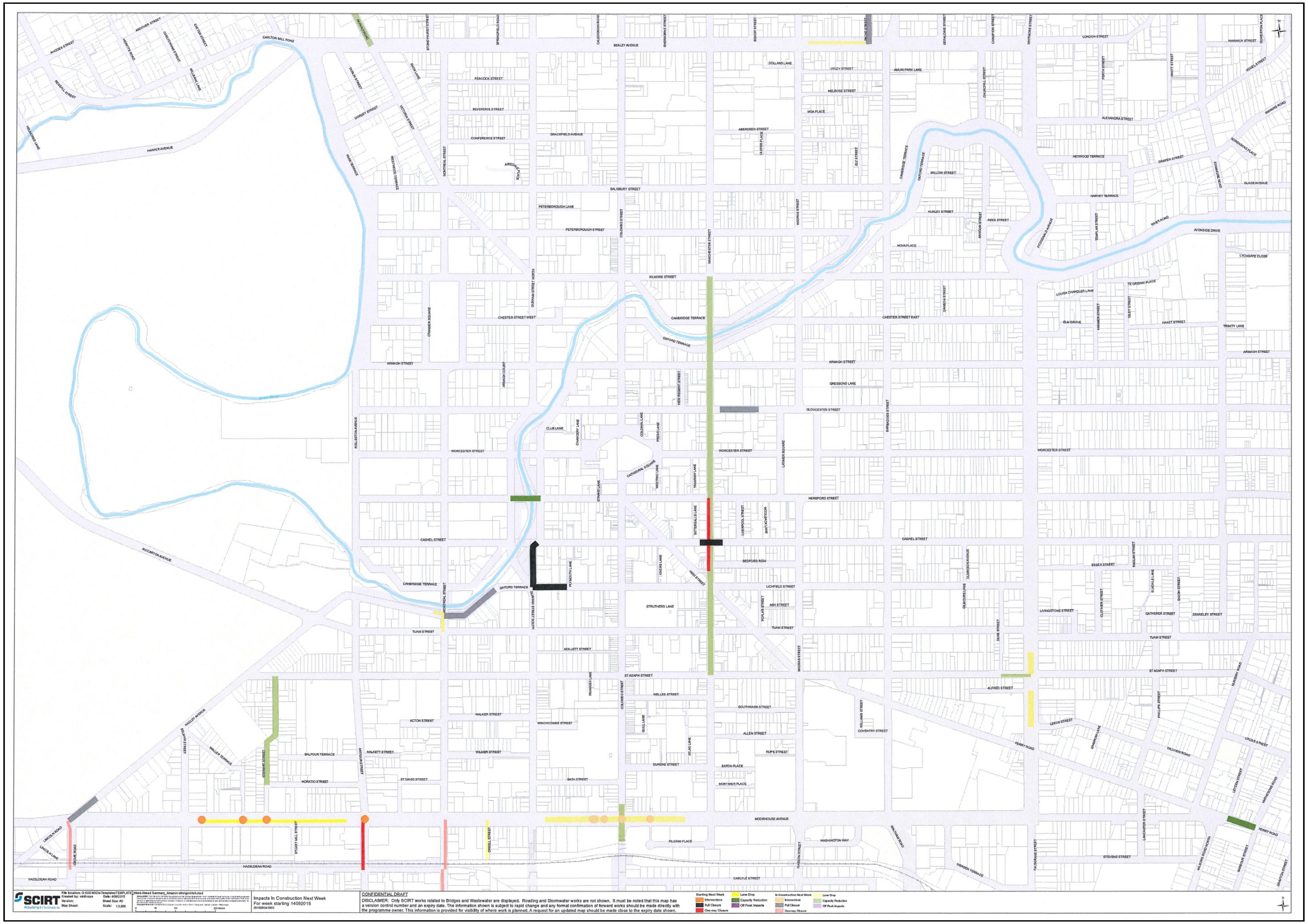


Figure 38: Current and proposed road works in CBD for week starting 14th September (SCIRT internal, 2015)

3.4.5. Traffic interruption model (TI model)

This model was developed on a Structured Query Language (SQL) server platform. It uses SQL and Python scripting and is based on the assigned paths from the CAST model. It is compatible with the GIS FWP database, and each day it automatically reads in the road works as scheduled by the delivery teams[7]. This model is capable of modelling daily scenarios faster than the CAST model as it does not use an equilibrium assignment solution. The TI model re-assigns the traffic supressed by road works onto alternative paths. This means weeks' worth of scenarios can be modelled in a few hours instead of days.

The TI model logic is following is as follows:

- The assigned paths between origins (O) and destinations (D) under a business-as-usual or base-case scenario are extracted from CAST. These paths are based on an equilibrium assignment. The available capacity on each link is also extracted from CAST as input information into the TI model.
- The daily scheduled traffic impacts from the FWV traffic process is overlayed, indicating where capacity impacts such as closures, lane drops or capacity reductions occur. The traffic volume needing removal from the affected link is calculated based on the link capacity and road work impact impeding on the capacity of the link.
- The affected paths are identified based on the links affected and the traffic volume is removed from the affected paths for all impeded OD pairs.
- The removed traffic volume is then re-assigned to other paths between the same OD pair as the removed traffic. This re-assignment is done in proportion to the existing volumes on all paths between the OD pairs available, excluding the impeded path(s). The re-assigned volume is added to the alternative paths existing volumes.
- The new volume is compared to the available capacities on the links to identify over-capacity links in the network. No further re-assignment of over-capacity links is undertaken. Thus this analysis estimates the initial response of traffic to the road works rather than a steady state.
- If there are no alternative paths between OD pairs in the original CAST data the Dijkstra shortest-path algorithm, weighted by CAST link travel costs, is used to determine new routes.
- This logic is undertaken for all road works encountered at the same time.
- The changes in volumes are colour-coded (green show reductions, red show increases relative to the available capacity per link) and mapped to provide a visualisation of the road works and resulting traffic volume impacts.
- The resulting over-capacity links are mapped to visualise where road works may cause immediate traffic congestion.

[7] The compatibility with the GIS FWP database means no manual network coding is required. Manual coding of all proposed road works on a daily basis would be time consuming and daily outputs not achievable due to the amount of processing time required.

To illustrate the above logic, a simple example is presented below:

Assume that currently three routes exist between an OD pair with the following traffic distributions:

Route A: 50%
Route B: 30%
Route C: 20%

Road A, due to a road closure, is not available anymore. Route A carried 50% of the traffic and this traffic gets re-assigned to the remaining two other routes. The new traffic proportions are:

$$Route\ B\ = \frac{30\%}{100\%-50\%} = \ 60\%$$

$$Route\ C = \frac{20\%}{100\%-50\%} = \ 40\%$$

This methodology requires that at least one alternative route exists. For situations when no alternative routes are available, the Dijkstra shortest-path algorithm is applied to create a new route onto which traffic can be redirected.

As a sense check and to evaluate the robustness of the TI model, a warm start assignment was undertaken in the CAST SATURN model. The SATURN model test results were compared to the response achieved by the TI model. This comparison showed that the TI model responded as expected and was in line with the CAST response when using the warm start technique[8].

Figure 39 shows a sample TI model output. The road works are overlayed using black lines, dots or crosses. The resulting traffic flow changes (in vehicles/hour) relative to the capacities are shown as reductions in flows greater than 300 as dark green with lighter shades of green for lesser reductions between 299 and 20. Minimal changes in flows relative to capacity (between reductions of 20 and increases of 20) are not shown to not convolute the output. Small increases between 20 and 60 are indicated by light orange, with dark orange showing increases in traffic between 60 and 300, and red showing increases in flows greater than 300, indicating that the route is highly impacted by re-assigned traffic due to road works[9].

This model is kept up to date by providing new OD paths and capacity outputs when new CAST models are officially released by CCC.

[8] The warm start technique is based on stored cost and flow information from a previously converged model run and used as the starting point for the new assignment (Atkins, 2014). To create a 'worst case' situation, only one assignment iteration was allowed to occur using the new network information (accounting for road closures and other road works). By not allowing SATURN to reach a new equilibrium by looping over several iterations to achieve the lowest generalized costs an approximation is replicated of encountering road works at the point when you start your journey and no full network knowledge is achieved.

[9] These bands were chosen based on initial TI model results and kept constant to be able to use the output as a comparative result going forward.

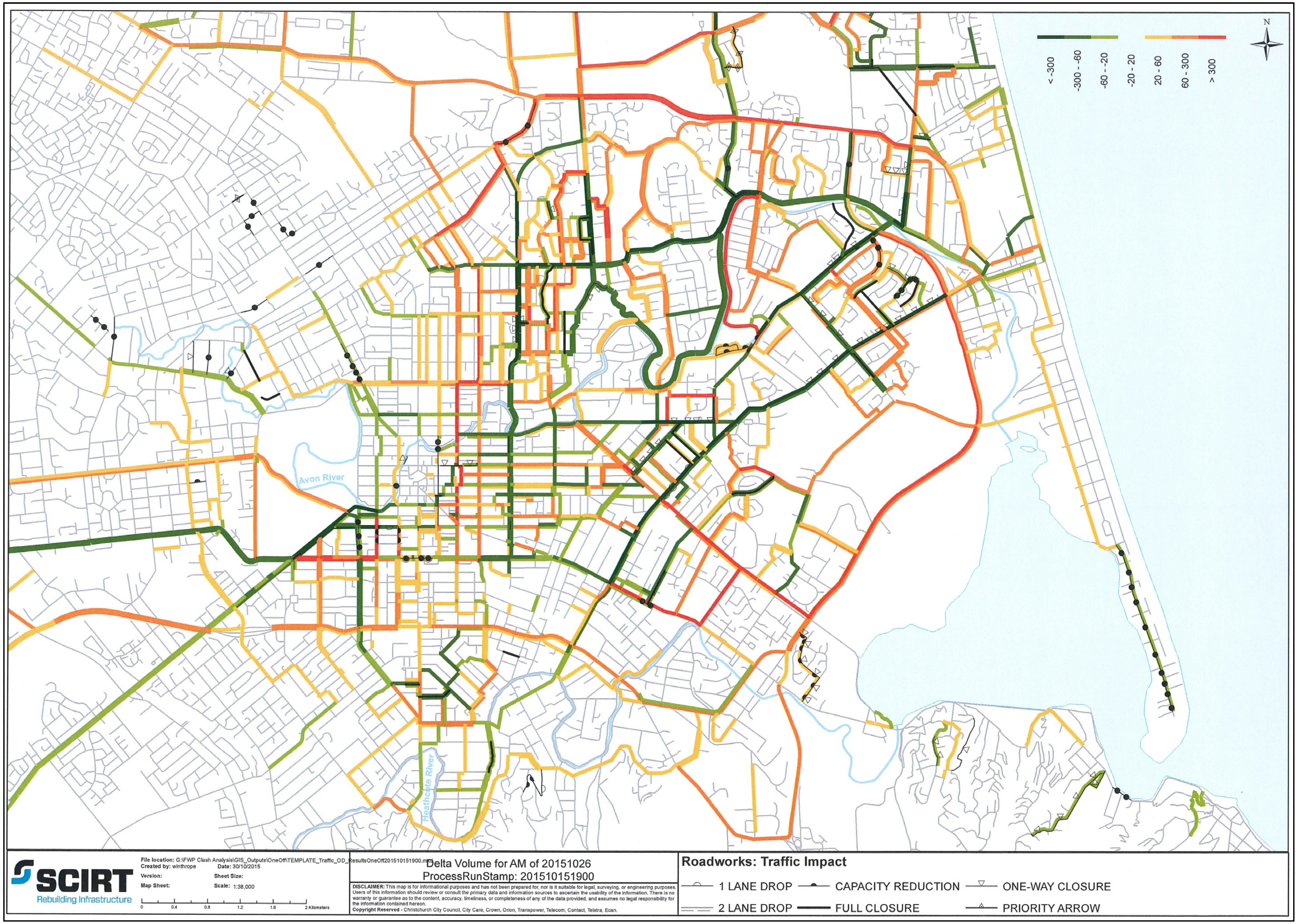


Figure 39: TI model output (SCIRT internal, 2015)

3.4.6. Impedance tool

The impedance tool is used to map the day-to-day average delay on the network at a property level (using post-earthquake property information). This impedance data is shown in the form of a heat map and determines areas impacted with high impedance due to SCIRT's road works. It is used as an index of accessibility for the whole of Christchurch.

To create this heat map the following steps are undertaken:

- A unique identifier is assigned to each street property (street addresses spatially available). The distance calculator tool embedded in the MapInfo software package calculates the distance from each individual property to the closest street front replicating the road network link each property connects to.
- The coordinates for each property are calculated and properties that are located more than 1km away from the closest streets are removed[10]. The distance to each end of the closest road link is also calculated.
- The distances to the closest road calculated prior are used to find the closest LINZ node to attach the property to this node. The property gets connected to the nearest node as shown in **Figure 40**.

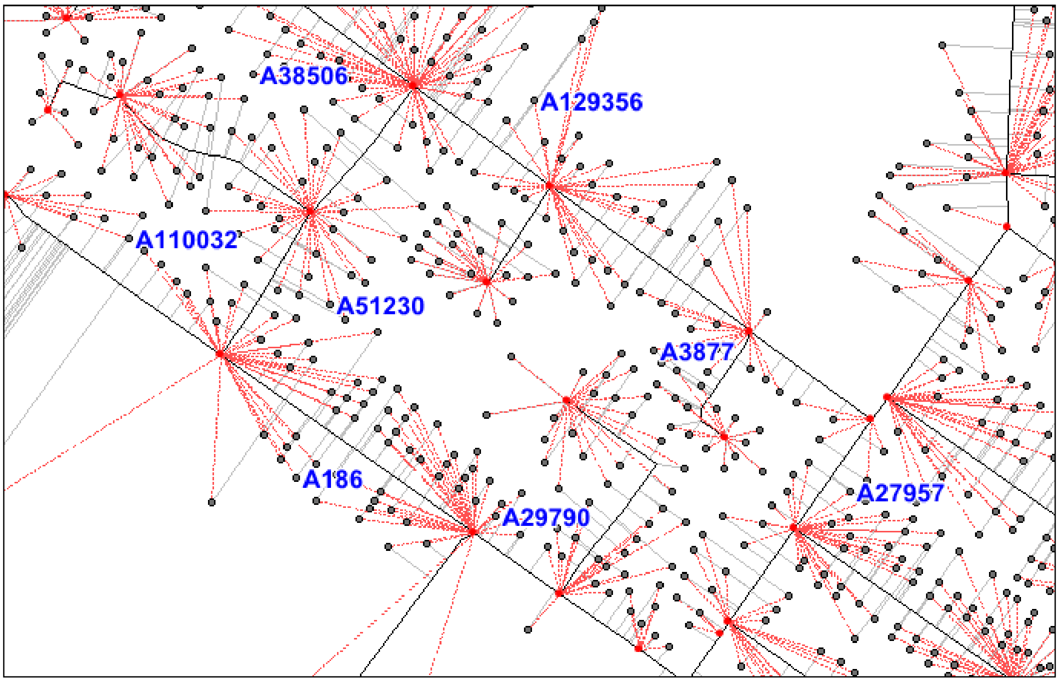


Figure 40: Properties connected to closest LINZ node (SCIRT internal, 2014)

- CAST model information, such as actual flows, cruise speed, capacities, number of lanes, distances etc are incorporated into the model using the business-as-usual or base-case information.
- Whilst updating the TI model, an output file for the Impedance Tool is created using a Python script which calculates the lowest cost paths based on link travel times under business as usual travel conditions. The overlayed road works in the TI model cause

[10] To remove postal addresses located outside the LINZ network coverage.

interruptions and the Akcelik volume delay function[11] is used to recalculate the link travel times based on the capacity impacts and volume changes to the network. The original link travel times are overwritten with the new link travel times due to re-assigning traffic to different paths.

- The lowest cost paths between all nodes are calculated by creating a matrix database of travel times between every possible OD combination. An averaged travel time is calculated from each origin to all destinations. This is compared back to the business-as-usual scenario, and based on the differences in average delays, the heat map is created.
- The tool is run for each time period (AM, IP, and PM peak) for as many forecast weeks as desired; the default is two weeks.

An example of an impedance heat map is illustrated in **Figure 41**. These maps are helpful in identifying hot spots (areas inaccessible because of road works) and areas where the average delay increases by more than one minute (indicated by yellow to red areas).

[11] See Akcelik & Associates Pty Ltd (2000) for the fundamental Akcelik volume delay function.

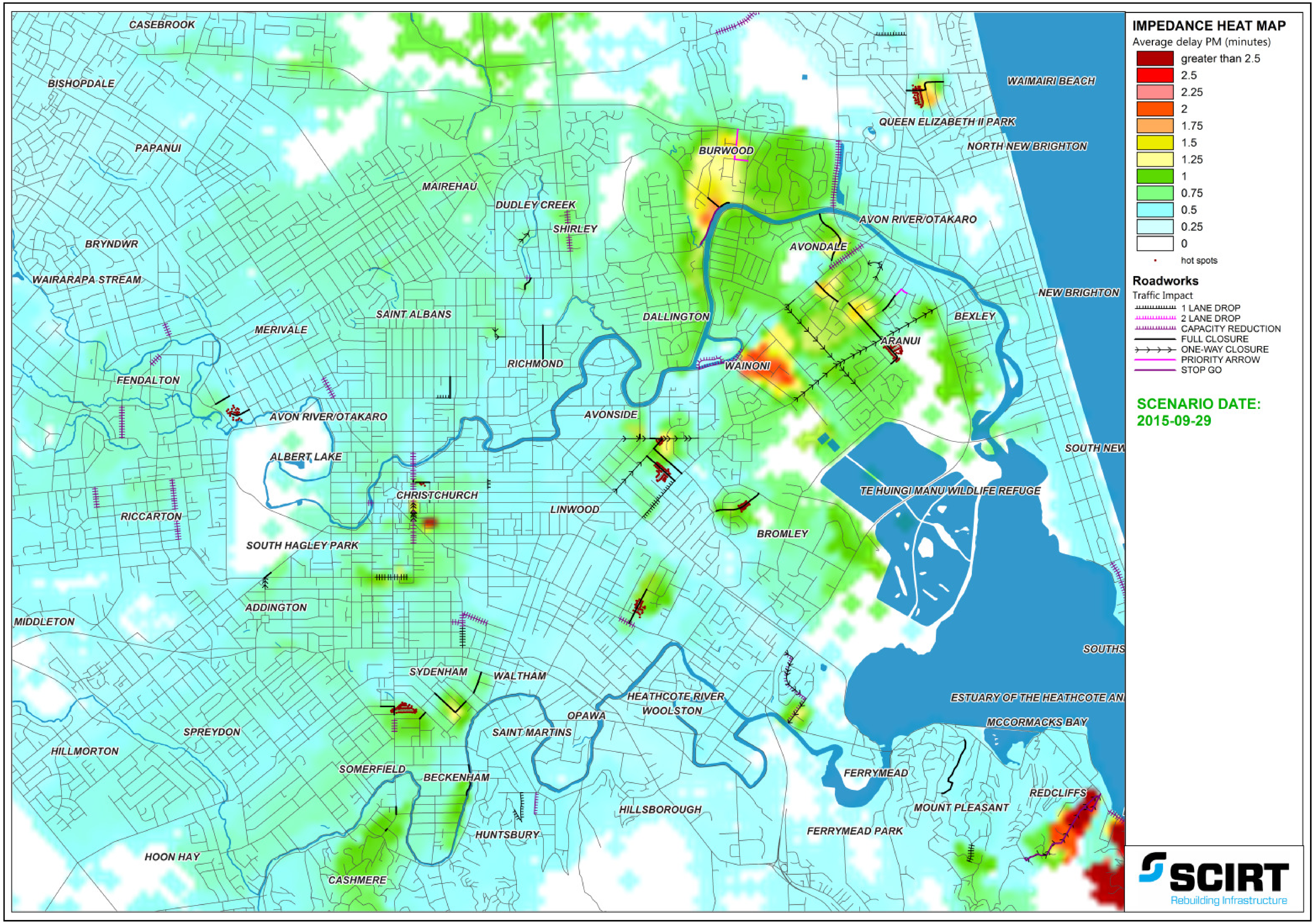


Figure 41: SCIRT impedance tool – heat map (SCIRT internal, 2014)

4. Traffic Management

Traffic management is used to safely move motorists, cyclists and pedestrians past work sites, and if required, accompany road users through work sites. The objective for SCIRT's traffic management was to provide a standardised approach across all delivery teams when carrying out the temporary traffic management required.

The Code of Practice for Temporary Traffic Management (CoPTTM) is the primary reference standard when undertaking road works. It sets out the requirements of temporary traffic management based on the road levels as well as provides standards for signs and forms as well as some generic TMPs (NZTA, 2014b). The provided standards are applicable on all State Highways and the local roading network.

Christchurch Improvements to Temporary Traffic Management (CITTM) was established to rationalise traffic management in an environment that was far in excess of what was ever anticipated to be dealt with using CoPTTM. This allowed innovations which are applicable only during the rebuild, but also some innovations which are being considered for future best practice.

These innovations were included in the Local Operating Procedures (LOPs) and are variations to the CoPTTM standards that are acceptable to the respective regional Road Controlling Authorities (RCAs). Canterbury's RCA is CTOC[12]. The LOPs can be in excess of the CoPTTM stated requirements or it can reduce the requirements.

As part of the LOPs some further requirements were put in place such as the SWIF flowchart (as stated in **Chapter 3.3**) and relevant mitigation measures when road impacts are not avoidable. CoPTTM allows the use of service agreements and CTOC have provided a flowchart about how to use them. **Appendix D** contains the mitigation measures and how to use service agreements, as examples for some of the requirements set out by CTOC. These flow charts need to be worked through by the delivery teams when logging a TMP and SCIRT's role is to ensure all requirements are covered before a TMP is submitted to CTOC for road space approval. There are a number of further CTOC guidelines and procedures which can all be accessed through the TMP for Christchurch website.

4.1. TMP approvals

The SCIRT approving engineers look through lodged TMPs collectively to achieve a common standard across all delivery teams and to make sure sites are combined if required. This TMP review process also ensures the TMPs are up to standard and are CoPTTM or LOP compliant[13] before they are submitted to CTOC for formal acceptance. The following are some traffic management statistics in relation to the SCIRT works to demonstrate the vast scale of works:

- ~ 250 traffic management personnel and associated people involved
- ~ 150 work sites at any one time in the wider Christchurch area, with approximately 40 sites within the Christchurch CBD at the height of the SCIRT rebuild efforts

[12] CTOC was set up by CCC, NZTA and ECan.
[13] The LOPs replace some COPTTM requirements due to its local context.

- 24 hour a day; seven days a week operation on the roads, where needed
- as of September 2015 approximately 3,450 TMPs were submitted and processed to date
- as of September 2015 approximately 7,850 TMP revisions were received
- approximate processing times for TMPs are:
    - less than 2 days for SCIRT
    - less than 5 days for CTOC

Figure 42 provides a screenshot of the 'on-the-ground activities' within and around Christchurch's CBD. Given the large amount of work occurring, this activity level could not be managed without the *TMPforchch.govt.nz* website to keep track of all the work locations, detours and methodologies. This website is essential when dealing with a large number of road works, as experienced in Christchurch.

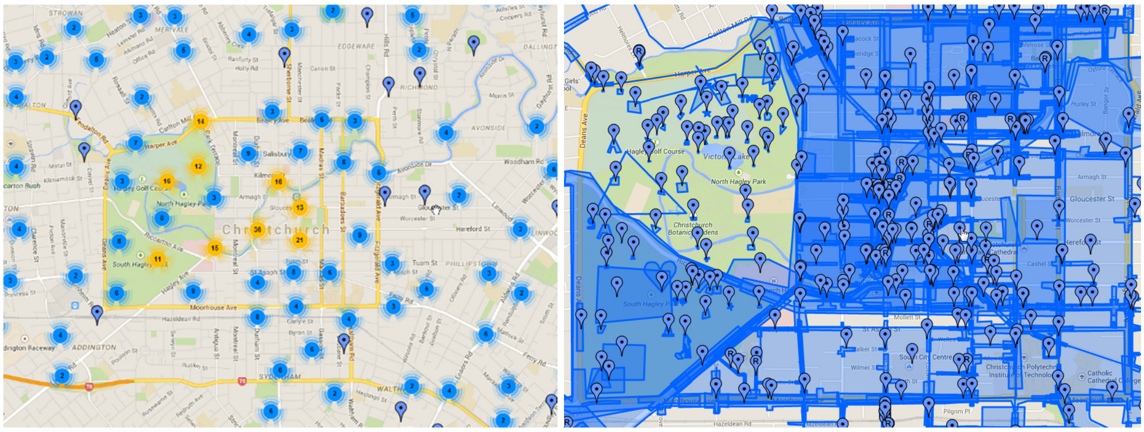


Figure 42: On-the-ground activities (TMP for Christchurch website, 2015)

As part of the day-to-day work some possible areas for improvement became apparent and were considered in detail. These improvements had the potential to make processes more efficient, increase safety or contribute to an overall better outcome due to cost savings**. Chapter 4.2** describes the strategies and innovations developed by SCIRT. Some of these innovations have been adopted by CTOC as LOPs and are to be complied with going forward, and are not SCIRT special procedures.

4.2. Innovations

The traffic managers within SCIRT have developed several strategies to improve safety and efficiency. These innovative strategies are:

4.2.1. Site compliance

The SCIRT traffic managers undertake regular site checks to ascertain the SCIRT work sites are safe and in compliance with the CoPTTM and CTOC's LOPs. The site compliance check is undertaken using the CoPTTM full audit sheet (see **Appendix D**).

CTOC's procedures differ considerably in comparison to other RCAs due to the earthquake rebuild context, and are generally more relaxed, due to the amount of work needing facilitation, but without compromising the public and workers safety (as stated in CTOC's 'balance diamond'). The STMS can be issued with a non-conformance notice and work sites shut down if the public or workers safety is deemed to be at excessive risk when a site compliance check is carrying out.

In turn, awards are presented to recognise the best work sites and where the STMS has a well-organised site.

A “super STMS” role was also introduced to help improve the overall setup of work sites and to provide a “go to” person for queries and issues for the delivery teams, as well as third parties such as CTOC and ECan. The function of the super STMS was not to undertake audits or issue non-conformances, but to have an educational function to help upskill the workforce, and also ensure that nearby work sites function well together.

4.2.2. Cycle strategy

This strategy was formed to make cycling through work sites safer and give cyclists a better experience. Signage from New Zealand and other countries, such as the UK, was being trialled in Christchurch and monitored to determine whether it improves the merge behaviour between cyclists and motorists. This cycling strategy aids to achieve a consistent approach over all delivery teams’ work sites treatments, as it sets out clearly how to set up a site that is safe for cyclists. To create the strategy the Christchurch cyclist advocate group, SPOKE, were consulted and their input used to create guidelines. The *“Best Practice for Cyclists - Christchurch”* guide developed by SCIRT has been included as a LOP and these procedures need to followed when lodging a TMP with CTOC (SCIRT, 2013c).

4.2.3. VMS strategy

SCIRT introduced a VMS strategy within and around the four Avenues (Bealey, Fitzgerald, Moorhouse and Deans) which surround the CBD. SCIRT managed the location and messages on the VMS boards to communicate area-wide coverage of upcoming work and preferred routes. This allowed for a better area-wide communication as opposed to site-specific warnings.

To finance this initiative, unspent VMS allowance was re-allocated to SCIRT using a work scope change. The available budget for the VMS strategy was calculated based on the actual VMS allowance, as received by the estimator team, as well as reducing the Temporary Traffic Management (TTM) allowance by a certain percentage (based on average VMS Target Outturn Cost (TOC) allowance over all projects in CBD) if the VMS allowance was not listed in the TOC as an individual line item. Using this methodology, sufficient budget could be retrieved to undertake the VMS strategy. The strategy was rolled out for six months during which a lot of road works were facilitated on strategic routes needing an area-wide VMS strategy to keep Christchurch moving.

4.2.4. CBD perimeter

A perimeter was established around the Four Avenues due to the large number of work sites within the CBD. The concept behind the perimeter was to reduce the need for excessive temporary advance warning signs and reduce the orange signage overload on drivers, given the busy context. See **Figure 43** for CBD perimeter signage.

Figure 43: SCIRT signage (SCIRT internal, 2014)

This initiative was covered under the LOPs for the reduction of T1 road work signs and was for the CBD area within the Four Avenues (CTOC, 2014a).

Not only T1 road sign changes were introduced but there were also changes to detour requirements and outside-CBD sign reductions. A cost analysis was undertaken by SCIRT to provide an indication of how much TTM money could potentially be saved due to introducing those LOPs. These figures were based on labour reduction and item reductions, such as cones. The latest analysis showed that major savings were realised; about 35% for low volume and L1 roads and about 50% on L2 roads (the analysis looked at 9 TMPs for L1 and L2 roads to get a cross section of average TMP layouts). It is of note that these are not percentages of the overall TTM costs, but only the labour and TTM signs and cones portion.

4.2.5. Universal TMPs

The SCIRT traffic managers developed some universal TMPs that are generic in nature. These generic TMPs, termed 'universal TMPs', allow the STMS to establish one shift work site on CCC local roads and State Highways within the wider Christchurch area without any additional approvals or submission requirements. Prior to the establishment of the universal TMPs, only some basic TMPs were able to be used in this fashion by mostly maintenance contractors. Universal TMPs cover all types of traffic management from inspection activities to dig down repairs, which can be completed within one work shift. With the use of a one page road space booking form, the TTM can be approved to remain in place unattended for the duration of the work. The universal TMPs can be received upon request with the road space booking form being downloadable from the TMP for Christchurch website (CTOC, 2014b).

4.2.6. Speed management

SCIRT noticed that speeding motorists had become an emerging safety issue at most SCIRT sites and decided to look at ways to encourage speed compliance. SCIRT trialled various speed treatments on site, and used speed radar to gather base data and post- treatment data to evaluate how effective various treatments were. Several trials were undertaken using different treatments such as increasing side friction, VMS messaging, and speed humps. Once all the information was collated, it was issued as a speed management guideline for STMSs, to help them to reduce speeding past work sites (SCIRT, 2014b). This document was not issued only for SCIRT STMSs, but was put out by the local RCA as a LOP to all TTM providers in Christchurch, and some companies have now asked that this guideline be used nationally.

4.2.7. Traffic management strategy

This strategy promotes coordination across multiple work sites in close proximity with each other. The SCIRT traffic managers make sure communication occurs between the delivery teams and provide area-wide TMPs if required. PLDs are also often requested to discuss work methodologies and to seek a balance between safety, network efficiency, economic outcomes and business viability.

Project level discussions are meetings with representatives from the delivery teams, ECan, CTOC and IST and discussions can span over multiple work sites or for an individual site. The aim of these meetings is to discuss work methodologies and traffic impacts, as well as potential mitigation measures, certainty around the work and economic assessments. The aim is to leave the meeting feeling satisfied that the right balance has been achieved. The PLD discussion topics were released by CTOC (2014f) and SCIRT has provided a PLD discussion template, in which the delivery teams state the outcomes of the PLD meeting and send it to CTOC and SCIRT for record keeping. If a balance between all four variables is achieved, the TMPs can get lodged and the normal TMP procedures will then apply to gain TMP approval.

5. Communications

The overall transport and traffic management processes aim to ensure that the rebuild work is scheduled, optimised, and overlaid with external programmes (such as an Accessible City works from CERA, vertical rebuild works, or the utilities network repairs). Once all the information is compiled, a thorough analysis commences. Based on the analysis of the balance diamond, the works methodology is confirmed and the traffic impacts communicated to the general public. This involves working closely with the SCIRT communication teams and the delivery teams' communication representatives, as well as CTOC's traveller information team. This overall process is illustrated in **Figure 44**.

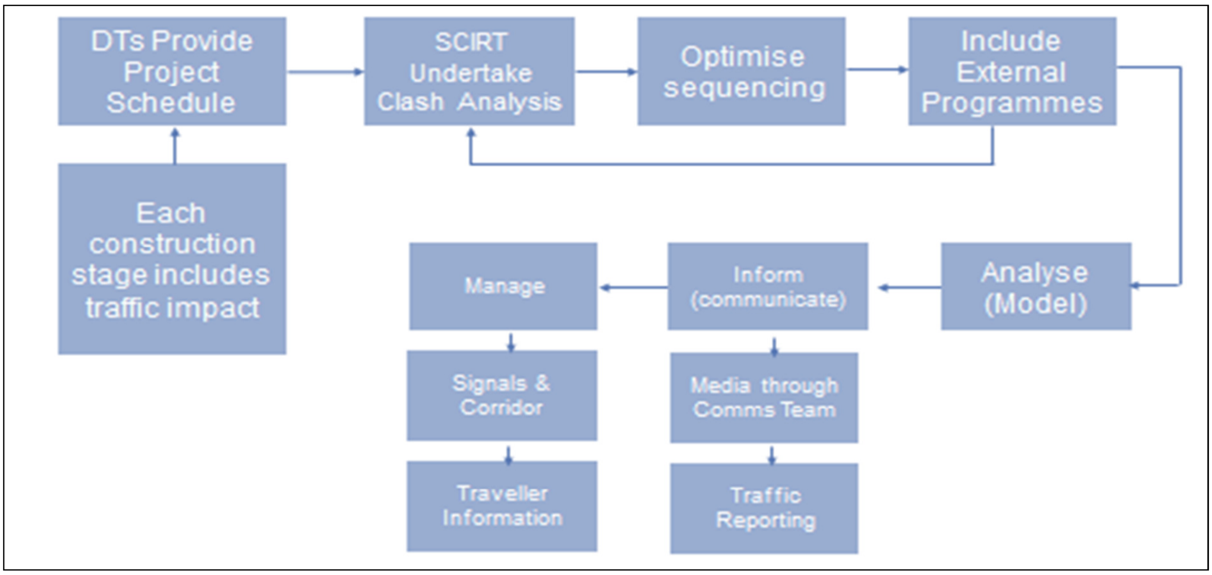


Figure 44: Transport planning and traffic management process (SCIRT internal, 2014)

Being open and transparent in communications is essential in gaining trust and maintaining a positive public image of SCIRT and the rebuild work in general. Informing the residents, businesses, emergency services, schools and buses is undertaken through several different media, such as door knocking, letterbox drops, radio announcements, newsletters, school visits, stakeholder and community group meetings. This engagement is important to achieve behaviour change and traffic rerouting in the intended way and to gain acceptance for the works undertaken, and helps in setting expectations. It is possible to successfully divert road users around road sites, keep traffic flowing and avoid gridlock only by achieving strong communication with road users. It is also essential that messages such as "Open for business" are communicated for the businesses to minimise the impacts the road works have on businesses and therefore peoples' livelihoods.

The SCIRT website provides a link to CTOC's Transport for Christchurch website (www.tfc.govt.nz). CTOC's website provides weekly updates on recommended main routes by taking into account all road works on the ground, sourcing information from the TMP for Christchurch website. Furthermore, the current road conditions and active work sites (differentiated between general road works and identifying road closures separately) are continuously updated on CTOC's website. This is a publicly accessible website allowing the public to plan their journeys to avoid road works and know of required detours. SCIRT also shares work notices with CTOC and these are made available to the public as well[14]. The website access has grown over time as initially the public was not aware of the website's existence.

The website also provides a congestion indicator, as well as providing a traffic dashboard providing travel times on key routes, in combination with illustrating free flow times and average travel times, based on the past three months and using Bluetooth technology. This provides road users with the opportunity to make a route choice based on the current conditions on the road.

It is important that all parties convey the same information as only if the information provided is trustworthy will the public believe the message and a functional communication channel can be maintained. The following is a progress update on the information the SCIRT communications team has released so far:

- More than 5,400 work notices have been produced with about 1,273,000 copies of work notices being delivered to residents and businesses to inform about SCIRT's road works.
- More than 200 electronic newsletters have been produced.
- About 150 schools were visited.
- More than 31,500 face to face meetings were undertaken.
- More than 4,500 non-traffic related signs about SCIRT works have been put up.
- About 89% of the community indicates that they are satisfied with SCIRT's way of communicating with them.

The communication team is working closely with the transport and traffic team. The transport and traffic team notifies upcoming work, as well as helping the communications team to address customer queries and complaints. The working relationship between traffic and communications is of particular importance when road works on strategic routes need to be undertaken. Notifying the public, to achieve changes in travel patterns, is crucial to successfully deliver these projects and keep Christchurch moving.

SCIRT examples of work notices, radio announcements and newspaper adverts on works occurring on some Christchurch's strategic routes are provided in the following **Chapter 6**.

[14] As described above the public gets also informed through letterbox notifications and other media to not rely on website access to convey information.

6. Case Studies

This chapter comprises descriptions of different types of works which were undertaken using tools described above. It is of note that all three elements (traffic planning, management and communications) are required to successfully undertake the work. The following four case studies dealt with different goals, pressures and requirements but by working together all four projects have been or are still being undertaken successfully.

6.1. Hospital Corner / Health Precinct early works

The hospital corner project was different from the typical transport planning work within SCIRT. The project and associated analysis was requested by CERA and was not solely related to repairing or replacing horizontal infrastructure. All work undertaken is reported in the SCIRT report (SCIRT, 2013a). The information below is based around the inputs SCIRT's transport and traffic team contributed to this work.

SCIRT were requested to undertake the interim design to facilitate fast tracking the roading network transformation around the Health Precinct and Avon River projects. The Health Precinct early works was included in the first stage of the "An Accessible City" project developed by CERA.

This project was proposed to be undertaken in two stages:

- Stage 1: Interim solution which was expected to stay in place for about 12 months.
- Stage 2: Ultimate solution which was procured by CERA, with the design and construction being a completely separate project from stage 1 and SCIRT not being involved in this stage.

The objective of the works, carried out as the "interim solution", was to enable the closure of Oxford Terrace for the Avon River Precinct Project and introduce a one-way system along Tuam Street and St Asaph Street, between Hagley Avenue and Montreal Street. The one-way conversion was to be implemented with minimal changes to the existing road and footpath layouts, given the short term nature of the project and limited budget. An exception to the minimal changes approach was only made if absolutely required to achieve safe and effective intersection and roading designs (e.g. the Hagley Avenue/Riccarton Avenue intersection required more extensive modifications than only line markings).

Representatives from CERA and CCC were involved as a project control group and their responsibility was to review and approve the concept design before moving into detailed design. The overall project cost for stage 1 was approximately $1.5M.

SCIRT's transport planning got involved in undertaking the transport modelling of the intersections within the study area (see **Figure 45** below) and at a later date, when the traffic impacts during construction needed to be understood. However, as part of this chapter, the transport modelling work to inform the intersection designs is of central interest.

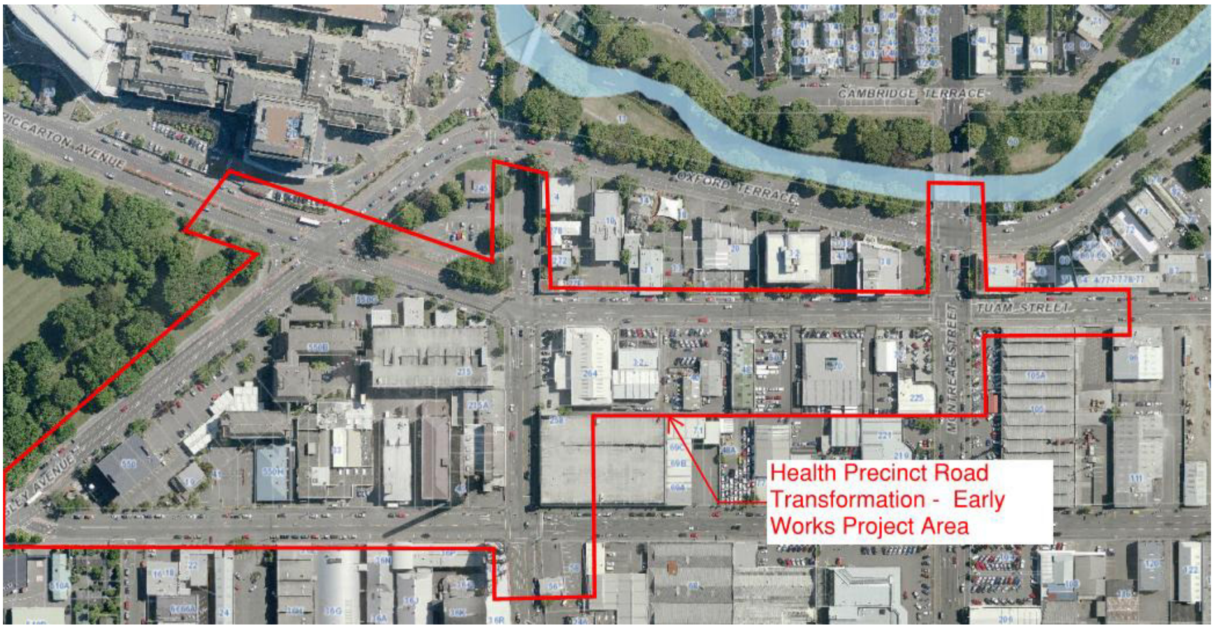


Figure 45 Hospital corner early works study area (SCIRT, 2013a)

The timeframes for this project were very tight and the short lead up time meant that site specific traffic counts and the development of a project specific transport model were not feasible. Only information that was readily available could be utilized, such as the CAST SATURN model and historical traffic counts.

Due to the earthquakes, traffic patterns have significantly changed and therefore the uncertainty around current and future traffic demands for all modes was exaggerated. To mitigate some of the uncertainty regarding the traffic demands, several meetings with transport specialists were held to discuss, confirm and document assumed demands. These demands were subsequently used to optimise the intersection signal timings, not only for vehicular traffic but also for cyclists and pedestrians. Furthermore, the modelling was used to inform the road designers about the intersection performance based on their designs by conducting Level Of Service (LOS) assessments of the individual intersections within the study area. Working with the designers to develop different layouts, to improve the overall performance of these intersections and ultimately reach an acceptable intersection design, was an iterative process.

The following outlines the traffic assessment undertaken. The assessment was performed using the traffic modelling software SIDRA Intersection[15]. The proposed new intersection layouts and demand flows were modelled individually and the performance evaluated. The models were not calibrated, and assumptions were made to derive the likely demand flows for vehicles and pedestrians; these limitations had to be documented and taken into consideration when interpreting the model outputs. SIDRA was used as a tool to indicate the likely performance of the proposed intersections and identify performance issues. SIDRA does not allow for cyclist considerations and an allowance for cyclists was made by altering the signals timings and phasings to allow for cyclist movements.

The models were built using three demand scenarios. It was agreed that these demands were applied after analysing historical traffic counts for these intersections and making reasonable

[15] SIDRA Intersection 5.1 was used for the analysis.

adjustments, such as shifting westbound traffic on Tuam Street onto St Asaph Street due to the proposed new one-way layout. The analysis was therefore undertaken on the following demand assumptions:

1. 2013 CAST v6 post-earthquake model demands (adjusted to interim network changes)
2. 2021 CAST v6 post-earthquake model demands (adjusted to interim network changes)
3. 2021 modified CAST v6 post-earthquake model demands (where turning movement demands are adjusted to reflect the most realistic situation for the interim earthquake recovery phase).

Given the uncertainty about future demands it was important to evaluate a range of different demand scenarios, to mitigate the risk of over or under-designing intersections based on one set of information. Given a constrained budget and a life-time of only about one year, it was important to recognise that the design would not be able to solve all performance issues and some shortcomings would need to be accepted until the ultimate design would be implemented. When the modelling indicated issues with the intersection performance persisted in all scenarios, then emphasis could be given to a particular intersection to improve the overall performance of the scheme.

The following five intersections were evaluated for the project:

- Riccarton Avenue / Hagley Avenue / Tuam Street
- Hagley Avenue / St Asaph Street
- St Asaph Street / Antigua Street
- Tuam Street / Antigua Street
- Tuam Street / Montreal Street

The Montreal Street / Oxford Street intersection, even though located within the study area, was not modelled as this intersection was expected to function well, due to good coordination with the Tuam Street / Montreal Street intersection signals and fewer remaining entry approaches.

The analysis was undertaken for the AM and PM network peaks, as these two traffic demand peaks were deemed to have the greatest impact on these intersections.

The modelling was based on New Zealand specific SIDRA default values. A model calibration to replicate Christchurch specific driver behaviour was not possible due to the lack of information available. No counts or queue length surveys were available to calibrate the models due to the time constraints. Even if the information could have been collected, the changing demands due to the number of road works in the area did not allow for meaningful information gathering and would only give a snapshot of one particular situation in a moment of time. It was therefore considered appropriate to use the default values to undertake the modelling in the absence of more refined information.

The proportion of Heavy Commercial Vehicles (HCV) was assumed to be 5%. Where bus-only movements were allowed, the HCV percentage was increased to 100% to account for the greater impacts (e.g. slower acceleration, vehicle length etc) compared to light vehicles[16].

[16] This was necessary as SIDRA Intersection 5.1 differentiates between light and heavy vehicles only.

For the purpose of this modelling exercise a 78 second cycle time for the traffic signals was applied, as requested by the signals operator.

The modelling results were reported for all three different demand scenarios. However, the results for the third scenario are provided only when modifications to the demand were applied.

The traffic analysis showed that a critical element in the proposed hospital corner interim solution is the change to the intersection of Moorhouse Avenue / Hagley Avenue, which is an accompanying CERA project. It is recommended to change this intersection to left-out-only for the Hagley Avenue approach for the interim solution, as is already proposed for the ultimate intersection design. The recommended change will reduce the number of northbound through movements on Hagley Avenue, at the Hagley Avenue / St Asaph Street intersection and right turners from Hagley Avenue into Tuam Street at the Riccarton Avenue / Hagley Avenue / Tuam Street intersection. The recommended earlier left-out-only change at the Moorhouse Avenue / Hagley Avenue intersection is a pivotal element to the operation of the surrounding intersections.

The interim solutions with the assumed demands are expected to work satisfactorily when based on the 2021 modified CAST scenario. However, some queuing and blocking back should be expected immediately after the introduction of the new roading layouts, before drivers become accustomed to the changes.

The initial Tuam Street / Montreal Street intersection model was performing unsatisfactorily due to the large number of left turning vehicles, impeding on the through movement capacity as the queue was extending back. It was recommended to extend the left turn bay at Tuam Street West for as long as possible to reduce the likelihood of blocking back into the through movement lanes along Tuam Street.

Following the analysis and feedback loops the following design was proposed as the interim solution, as depicted in **Figure 46**.

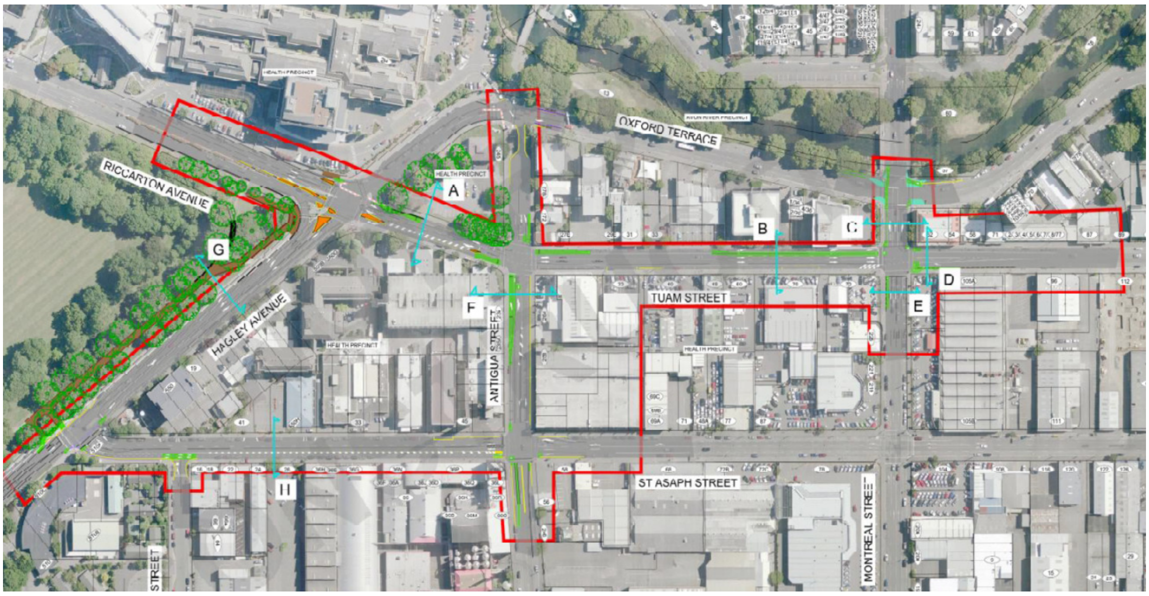


Figure 46: Proposed interim layouts

Given the coarseness of the transport models created and the uncertainty with the traffic demands the following transport modelling related risks were documented and distributed:

- The land use and transport network in the Christchurch Central Business District had changed considerably. Changes in demands had the potential to alter the performance of these intersections considerably. This may result in significant queues, driver frustration and adverse media coverage.
- SIDRA intersection analysis was undertaken on the intersections in isolation, instead of a micro-simulation model of the combined area. Considering a network compared to individual intersections accounts for blocking back and demonstrates the likely 'knock-on' effects. For the analysis undertaken, it was assumed that the intersections were well coordinated via the signal timings and phasings, which mitigated but did not eliminate the identified risk.
- SIDRA cannot account for all road users appropriately. The inclusion of cyclists was considered by making adjustments to the vehicular signal phasings to account for the cycle movements. A software package (such as Commuter) considering vehicles, cycles and pedestrians would have been the more appropriate tool to evaluate performance of these intersections. But due to time constraints this was not an option.
- The modelling was based on un-calibrated SIDRA models due to the lack of time, resources and information.
- There were intensive roading works occurring in the vicinity of the intersections. At the time of the analysis it was not clearly understood how these works would impact upon the interim roading solutions. The lack of clarity posed a risk to the operation of the intersection designs.
- Given the number of adjacent SCIRT, CCDU and other private construction projects anticipated within the Central City, poorly coordinated traffic management has the potential to cause disruption to road users. There is also the potential for project delivery timescales to be affected.

Given the high profile project and the potential risks involved, the delivery team participated in the risk workshop and representatives provided input into the Risk Register. In addition to the delivery team being involved in the workshop, early contractor involvement was carried out in the form of discussions around the proposed construction methodology and a suitable staging programme for the work. This also involved the SCIRT approving engineers, to make sure the traffic impact during construction was captured appropriately and the SCIRT transport planners to be able to undertake an impact analysis for the construction methodology.

In the case of this project, SCIRT and CCDU were working on a combined construction programme to enable area-wide traffic management and a combined message to road users. To facilitate the roading network changes in combination with all other rebuild work, regular meetings involving all parties were proposed to be undertaken during the construction phase of the project.

The project went to consultation and received approval on 13th November 2014 with construction commencing on the 21st November 2014 (CCC, 2015b). Public communication for this project was a collaboration between CCC and SCIRT. CCC developed the 'brand' and supporting materials (e.g. flyers, advertisements and so on) while SCIRT developed the consultation strategy and material for directly affected stakeholders. The delivery team took the lead to manage day-to-day direct stakeholder communication with nearby affected residents, businesses and the hospital. Communication was undertaken through regular work notices, newspaper updates and face to face conversations. The collaboration worked through weekly meetings between CCC and SCIRT personnel to ensure information and activities were consistent and co-ordinated. The work notice for these works is included in **Appendix E**. Communication to inform the public about the immediate traffic impacts and permanent changes were crucial in avoiding chaos and undertake the work safely.

This analysis, as coarse as it may be, was the best that could be done in such short time frames and the resources available. It was important to me, as the transport planner, to clearly state the risks and short-comings of the analysis undertaken to set expectations and make sure the risks were well understood.

6.2. CBD North - accelerated programme

This chapter sets out an economic analysis carried out for one of the delivery teams. As part of completing the central city works, the reconstruction of sections of Manchester Street, Madras Street and Barbadoes Street needed to be undertaken. All of this work was located north of the Avon River.

The delivery team identified that the works could be carried out using two different methodologies, which had a direct impact on the construction costs:

1. longer programme, with less road user impacts but given the more constrained work environment and longer programme, this came at an additional construction cost

2. accelerated programme, with increased road user impacts, but due to more space on the road to conduct the works, time and construction cost savings were possible

The works were proposed to be carried out between August and October 2014, which was a very intensive period in the CBD's rebuild phase. The TIM group had given some conditions around working on Manchester Street and Colombo Street. These conditions were:

- no work to commence at the same time and on the same block on Manchester Street and Colombo Street
- if both of these streets are worked on simultaneously, then the one-way arterials (Madras Street and Durham Street) needed to be open (two lanes available in each of Madras Street and Durham Street in the block of interest)

Even though the delivery team did not want to work on Colombo Street at the same time the works proposed would result in simultaneous road works affecting the north-eastern corner of the CBD with limited cross-links available to connect to Colombo Street. In addition, Durham Street and Montreal Street had works occurring and Colombo Street was impeded south of Cathedral Square.

The delivery team knew the work in hand and the budget they had, but the additional work in the CBD and restrictions upon what traffic impact would be acceptable meant the project would either need to have a greater construction budget, to account for the longer programme, or the TIM group needed to give approval to the works after weighing up project efficiency versus transport efficiency. In this instance the businesses were still accessible and under all possible methodologies the works were able to be carried out safely.

The delivery team provided four scenarios ranging from A) worst case to D) best case with respect to available road space to conduct the work meaning increased traffic impacts on the road.

The four options available are:

- **Option A:** One-way closure of Manchester Street, shoulder closures on Madras Street and Barbadoes Street
  - ➔ worst case as least road space for road works available but with least traffic impact on road users (one-way closure on Manchester Street)
- **Option B:** One-way closure of Manchester Street, one lane drop on Madras Street and shoulder closure on Barbadoes Street
  - ➔ road space for road works increases, traffic impact on road users increased due to additional lane drop Madras Street
- **Option C:** One-way closure of Manchester Street, one lane drops on Madras Street and Barbadoes Street
  - ➔ road space for road works increases further, traffic impact on road users increased due to additional lane drop on Barbadoes Street
- **Option D:** Full closure of Manchester Street, one lane drops on Madras Street and Barbadoes Street
  - ➔ Best case for delivery team as amount of road space occupied by construction work the greatest, leading to greatest traffic impact on road users

Table 5 to **Table 7** provide realistic estimates for work duration and cost changes for the three roads using different work methodologies.

Table 5: Different work methodology impacts - Manchester Street

Option	Road impact	Original Programme	Changes to Construction Duration	Changes to Construction Cost
A	One-way closure	17 weeks		
B	One-way closure	17 weeks		
C	One-way closure	17 weeks		
D	Full closure	17 weeks	-4 weeks	-$85K

Table 5 shows that the original programme had a duration of 17 weeks, but by closing Manchester Street completely and increasing the work area a time saving of four weeks was anticipated, saving approximately $85,000 in construction costs.

Table 6: Different work methodology impacts – Madras Street

Option	Road impact	Original Programme	Changes to Construction Duration	Changes to Construction Cost
A	Shoulder closure	10 weeks	+2 weeks	+$63K
B	One lane closure	10 weeks		
C	One lane closure	10 weeks		
D	One lane closure	10 weeks		

Table 6 shows that keeping two through lanes open at all times on Madras Street was expected to increase the work duration to 12 weeks instead of the originally anticipated 10 weeks, and would cost an additional $63,000.

Table 7: Different work methodology impacts – Barbadoes Street

Option	Road impact	Original Programme	Changes to Construction Duration	Changes to Construction Cost
A	Shoulder closure	18 weeks	+6 weeks	+$188K
B	Shoulder closure	18 weeks	+6 weeks	+$188K
C	One lane closure	18 weeks		
D	One lane closure	18 weeks		

Table 7 indicates that the work programme would need to be extended by six weeks, with approximately $188,000 in additional construction costs. It was also of note that the delivery teams had concerns that the methodology would not produce a quality result and strongly recommended dropping Barbadoes Street by one lane to facilitate their works.

The information above was used to identify a number of different option scenarios. Twelve scenarios were identified and coded in SATURN for further analysis, as well as the 'Do Minimum'. The 'Do Minimum' refers to the base case, which excluded any of the road impacts to be tested but included already approved closures[17] in the vicinity of the proposed additional works. This was done to understand the scheme road user impacts (dis-benefits) instead of the accumulated overall road user impacts (including dis-benefits caused by other road works). The one-way closure on Manchester Street could have been facilitated in either direction; hence the testing was undertaken for both northbound (NB) and southbound (SB) one-way closures.

As this modelling was undertaken prior to receiving any TMPs and the level of detail available was limited, as sub-consultants were not engaged at this point in time, only coarse modelling could be undertaken and the following assumptions were made:

- Madras Street one lane closure between St Asaph Street and Lichfield Street considered in Do Minimum (DM)
- No other already approved TMP works were included in the DM and option modelling

[17] Works that are already approved to be rolled out or are established on the road when work on Manchester Street, Madras Street and Barbadoes Street are proposed to be introduced too. For this project a one lane closure on Madras Street between St Asap Street and Lichfield Street was included into the Do Minimum as this work was already established on the road.

- No adjustments made in the models for potential need of shared lanes due to the proposed works
- Barbadoes Street one lane drop between Kilmore Street and Salisbury Street
- Madras Street one lane drop between Salisbury Street and Otley Street
- Manchester Street closure between north of Kilmore Street and the Peterborough Street (northbound and southbound closures along the same length)
- No speed reductions assumed in the modelling as not known if speeds have to be reduced to meet CoPTTM requirements

The SATURN results were subsequently used in the CAST economics tool to estimate the road user dis-benefits for the different scenarios. The results are shown in **Table 8**.

Table 8: Daily road user dis-benefits

WEEKDAY ONLY (7am - 6pm)	Total
DM: Madras St (1 lane btw St Asaph and Lichfield only), no other road works included	$6,428,638
Opt 1: Barbadoes St (retain 1 lane), Madras St (retain 1 lane), Manchester St (full closure)	$6,432,271
Daily Benefit	**-$3,633**
Opt 2: Barbadoes St (retain 1 lane), Madras St (retain 2 lanes), Manchester St (full closure)	$6,431,398
Daily Benefit	**-$2,759**
Opt 3: Barbadoes St (retain 1 lane), Madras St (retain 1 lane), Manchester St (NB closure)	$6,431,067
Daily Benefit	**-$2,429**
Opt 4: Barbadoes St (retain 1 lane), Madras St (retain 2 lanes), Manchester St (NB closure)	$6,430,105
Daily Benefit	**-$1,467**
Opt 5: Barbadoes St (retain 1 lane), Madras St (retain 1 lane), Manchester St (SB closure)	$6,431,259
Daily Benefit	**-$2,621**
Opt 6: Barbadoes St (retain 1 lane), Madras St (retain 2 lanes), Manchester St (SB closure)	$6,430,933
Daily Benefit	**-$2,295**
Opt 7: Barbadoes St (retain 2 lanes), Madras St (retain 1 lane), Manchester St (full closure)	$6,430,578
Daily Benefit	**-$1,940**
Opt 8: Barbadoes St (retain 2 lanes), Madras St (retain 2 lanes), Manchester St (full closure)	$6,429,686
Daily Benefit	**-$1,047**
Opt 9: Barbadoes St (retain 2 lanes), Madras St (retain 1 lane), Manchester St (NB closure)	$6,430,453
Daily Benefit	**-$1,814**
Opt 10: Barbadoes St (retain 2 lanes), Madras St (retain 2 lanes), Manchester St (NB closure)	$6,429,086
Daily Benefit	**-$448**
Opt 11: Barbadoes St (retain 2 lanes), Madras St (retain 1 lane), Manchester St (SB closure)	$6,430,226
Daily Benefit	**-$1,587**
Opt 12: Barbadoes St (retain 2 lanes), Madras St (retain 2 lanes), Manchester St (SB closure)	$6,429,915
Daily Benefit	**-$1,276**

Following this, the accelerated and decelerated scenarios were calculated to show the overall impact of an accelerated programme, taking into account additional construction costs and savings for longer and shorter programmes, as well as the road user dis-benefits.

The following programme and cost assumptions were made:

- Accelerated: congestion cost during the whole length of the programme (18 weeks with various impacts)
- Decelerated: congestion cost used for **Manchester Street NB** closure as long as Manchester Street is worked on (17 weeks), due to having Madras Street and Barbadoes Street at two through lanes, no additional congestion dis-benefits expected

- Calculated dis-benefits for **five days** a week as weekend traffic patterns considerably different
- Barbadoes Street and Madras Street incur **additional costs** if worst case scenario need to be rolled out
- Manchester Street full closure has a **cost saving** associated with it

It was not known at the time of the analysis if all three projects would start at the same time or if they would start slightly offset. This was caused by not knowing about the overall resourcing (i.e. crew availability) when the analysis was undertaken. It was assumed that the works would happen within the longest forecast duration of each individual road. The longest individual programme was scheduled for Barbadoes Street which indicated a duration of 18 weeks for the accelerated and 24 weeks for the decelerated scenario. The assumption that all road works would start up at the same time was deemed the most conservative approach as reductions in traffic impacts are beneficial to the road users.

The resulting programmes for the accelerated and decelerated scenarios are provided in **Table 9** and **Table 11** with the associated cost differences provided in **Table 10** and **Table 12**.

Table 9: Accelerated Programme

Accelerated Programme	Barbadoes Street	Madras Street	Manchester Street
Disruption duration (weeks)	10	10	10
	3	-	3
	5	-	-
Total	18	10	13

Table 10: Accelerated Costs

Accelerated Costs	Road User Dis-benefits	Construction Cost Savings	Total Cost
Costs	$181,600		
	$41,400		
	$36,700		
Total	$259,700	$85,000	$174,700

Table 11: Decelerated Programme

Decelerated Programme	Barbadoes Street	Madras Street	Manchester Street
Disruption duration (weeks)	12	12	12
	5	-	5
	7	-	-
Total	24	12	17

Table 12: Decelerated Costs

Decelerated Costs	Road User Dis-benefits	Additional Construction Costs	Total Cost
Costs	$26,900		
	$11,200		
Total	$38,100	$251,000	$289,100

The accelerated scenario, where Barbadoes Street and Madras Street were both reduced by one traffic lane and Manchester Street is fully closed, has associated road user dis-benefits of approximately $259,700 and assumed cost savings through accelerating the programme of $85,000. This resulted in overall dis-benefits of approximately $174,700, as presented in **Table 10**.

For the decelerated scenario, additional construction costs of $251,000 were forecast and road user dis-benefits were comparatively low with approximately $38,100. This accumulated to overall additional costs of $289,100.

The analysis indicated a potential overall cost saving of approximately $114,400 for the accelerated scenario. This accounts for the work activity across the three roads being reduced by approximately 12 weeks and not accumulating additional construction costs given the more intrusive traffic impacts (increased road user dis-benefits) due to the proposed work methodology.

Based on the analysis SCIRT's preferred method was a one-lane drop of Madras and Barbadoes Street together with a full closure of Manchester Street. The analysis was presented to CTOC for comment and subsequently discussed in the TIM meeting. Based on this analysis and subsequent discussions with the TIM group the following pre-approvals were given (as recorded in the TIM Meeting minutes, section 5 Gantt-chart review, dated 29th July 2014), see **Appendix F** for the extract of the TIM meetings for the northbound and southbound directions:

1. One lane drops on Barbadoes Street and Madras Street approved

2. Full Closure of Manchester Street approved with the following conditions:

a. Colombo Street, north of Square needs to remain open during the Manchester Street closure

b. Cross-links (detour routes) need to be available to shift traffic from Manchester Street to Colombo Street for the duration of the works

c. Closure approval granted only if the duration of the works does not exceed the forecasted 10 weeks that all three roads are simultaneously being worked on (see **Table 9**)

Following the approval by the TIM group, it was up to the delivery team to confirm with their sub-contractors if the conditions imposed upon them could be met to undertake the accelerated programme (best case scenario).

This example provides an illustration of how road user dis-benefits compared to additional construction costs or potential savings can be used to inform discussions with the TIM group members, to achieve an overall balanced outcome consistent with CTOC's 'balance diamond'.

In this case, construction costs could be saved due to imposing greater traffic disruptions on the road users, but considering both transport network as well as project efficiency this was the overall preferred approach for this project.

6.3. Kahu Road bridge

During the February 2011 earthquake the Kahu Road bridge was damaged and repair works were required. The delivery team expected the repair work to take approximately three months and requested a full road closure of Kahu Road, which connects the western suburbs and the CBD and is a strategic route in Christchurch's roading network.

CCC, as part of their annual traffic counting scheme, had tube counts from May 2011 showing the 4-day averages as approximately 10,800 vehicles per day, as shown in **Table 13.** This matches well with the CAST AADT of approximately 11,100. Kahu Road is classified as a Level 2 road with AADT > 10,000.

Table 13: Kahu Road Volume Counts (CCC, 2015c)

CCC VOLUME COUNT DATA									
Street: Kahu									
Location: N Deans Bush									
Start Date: 01/05/2011									
Direction: Combined									
Period	**Mon**	**Tues**	**Wed**	**Thur**	**Fri**	**Sat**	**Sun**	**Averages**	
Ending	2/05/2011	3/05/2011	4/05/2011	5/05/2011	6/05/2011	7/05/2011	1/05/2011	4Day	7Day
1:00	20	16	22	27	40	77	78	21	40
2:00	6	9	19	8	15	32	53	11	20
3:00	6	4	18	13	6	20	42	10	16
4:00	9	7	10	12	17	9	22	10	12
5:00	8	9	9	7	8	6	12	8	8
6:00	31	29	21	17	30	17	14	25	23
7:00	100	99	95	118	111	36	27	103	84
8:00	600	627	560	598	597	138	56	596	454
9:00	1,083	1,095	996	1,115	1,140	452	99	1,072	854
10:00	602	602	803	677	629	593	263	671	596
11:00	525	572	566	563	609	841	389	557	581
12:00	581	602	684	616	699	1,008	457	621	664
13:00	678	709	729	750	815	950	560	717	742
14:00	667	712	666	746	825	948	593	698	737
15:00	859	816	772	815	870	908	561	816	800
16:00	1,111	1,038	1,007	1,087	1,192	788	598	1,061	974
17:00	1,027	1,125	1,118	1,116	1,192	702	564	1,097	978
18:00	1,138	1,341	1,230	1,266	1,057	494	424	1,244	993
19:00	496	542	644	655	621	367	315	584	520
20:00	276	301	327	481	351	254	185	346	311
21:00	215	228	232	274	229	150	160	237	213
22:00	140	166	207	184	178	119	126	174	160
23:00	92	95	125	130	119	113	46	111	103
24:00	36	32	51	51	97	112	28	43	58
Totals									
12hr 7:00 - 19:00	9,367	9,781	9,775	10,004	10,246	8,189	4,879	9,732	8,892
24hr 0:00 - 24:00	10,306	10,776	10,911	11,326	11,447	9,134	5,672	10,830	9,939
Comments:									

Figure 47 shows the AADT bands for the Christchurch roading network as predicted using the CAST SATURN model around Kahu Road without road work disruptions. This figure also shows that the closest major detour routes for Kahu Road are Fendalton Road and Riccarton Road. Both of these roads already carry considerable traffic flows. As indicated by the orange colour, both these roads have AADTs greater than 15,000 vehicles per day, with Fendalton carrying more than Riccarton Road. Kahu Road carries on average approximately 11,000 vehicles per day. The work site could be bypassed using the local roading network, for example Weka Street, however this was not deemed a suitable sign-posted detour route. Straven Road is already congested during

peak times and the form of intersection (Give Way) at the Straven Road / Weka Street intersection as well as the amount of traffic to be facilitated additionally meant this was not a practical solution. Concerns were raised that traffic might get stuck at the intersection, not finding suitable gaps to turn onto Straven Road. Using this detour by installing additional temporary signals was also not deemed a suitable solution, as the queuing on Straven Road would potentially hinder the vehicles from Weka Street to turn into Straven Road due to the lack of space for right turning vehicles joining Straven Road. Another issue is the lack of coordination of manual signals with coordinated signals upstream and downstream, due to the inability to change the signal timings based on demand, which may lead to further disruptions on Straven Road. Furthermore, directing an additional 10,000 vehicles per day down a local road, which is not designed to carry such flows, would impact adversely on the safety of residents and likely result in complaints and driver frustration.

Figure 47: Google map with AADT bands around Kahu Road Bridge (based on CAST SATURN model)

Given the strategic nature of the road, the proposed works for Kahu Road triggered an initial analysis. This analysis was carried out by providing flow change plots and an indicative road user dis-benefit for the proposed work methodology using the CAST model. **Figure 48** and **Figure 49** show the AM peak and PM peak changes in flows. Reduction in flows are indicated in blue and increases in green.

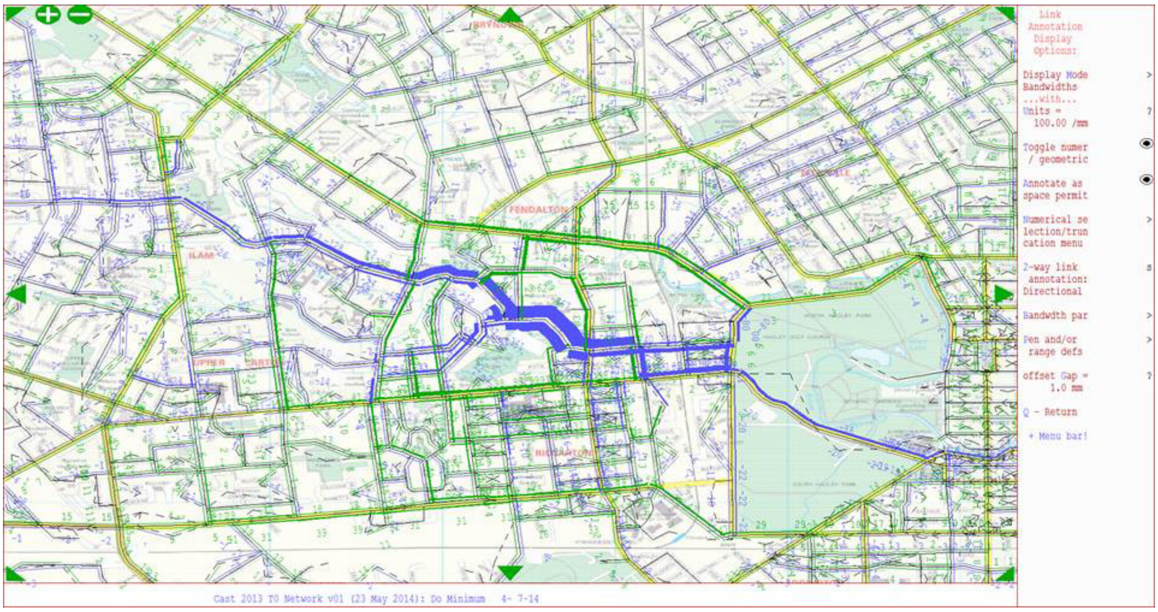


Figure 48: Kahu Road closure during AM peak

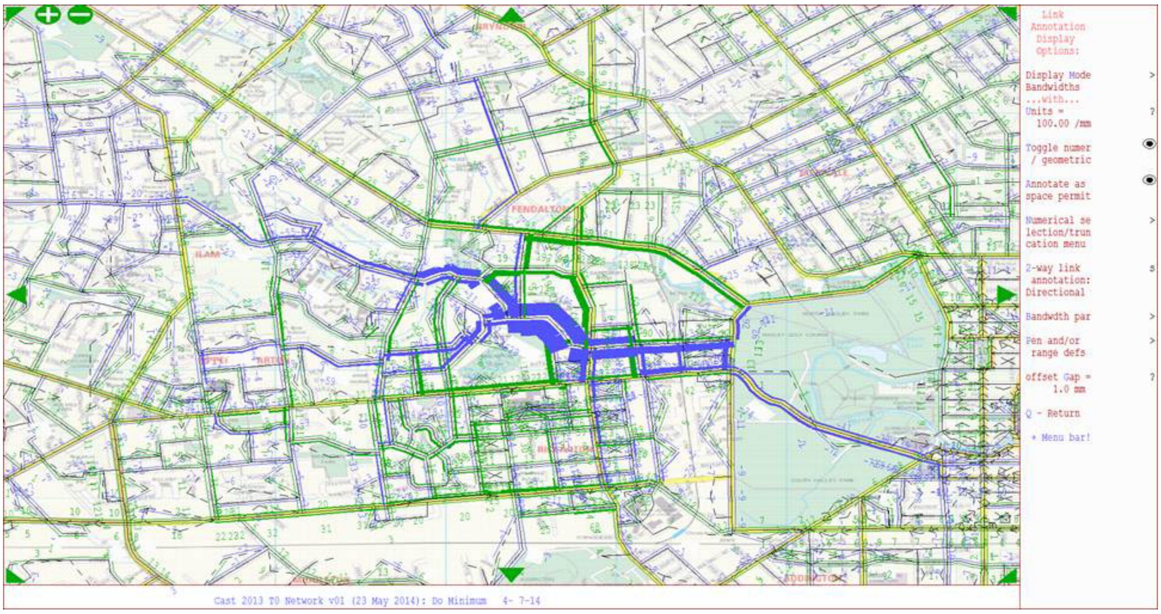


Figure 49: Kahu Road closure during PM peak

Both peak hours are congested and after analysis the following remarks were given to the delivery team based on the CAST modelling outcomes:

- No already approved works have been included in this comparison.
- AM peak two-way traffic approximately 800 - 850 vehicles per hour.
- PM peak two way traffic approximately 1,100 - 1,150 vehicles per hour.
- Main detours range from Fendalton Road to Blenheim Road. There is not one predominant detour route shown by the model which indicates that the available detours in the area are not having a lots of spare capacity left.[18]

[18] The CAST model uses a function based on travel time and distance (generalized costs) to reach a new equilibrium.

- Delays especially on the local roads in the vicinity of the bridge will increase.
- It is crucial to get good communication out early with VMS along the route to make people aware of the works, with static signs around Riccarton Avenue and Harper Avenue as well as on Creyke Road to achieve area-wide rerouting to give people the choice and avoid experiencing significant delays.
- Indicative road user dis-benefits equate to approximately $8,900 per day (based on the use of the CAST economics tool).

Based on the proposed methodology and the initial analysis a PLD requiring a conversation regarding alternative methodologies was called. The PLD included representatives from the delivery team as well as SCIRT IST.

Six further work methodologies were subsequently discussed and evaluated in addition to the 12 week full closure proposal. As part of the investigation the initial full closure analysis using the CAST modelling and economics tool was extended to include testing of eastbound and westbound one-way closures.

A list of the alternative methodologies is provided below in conjunction with a statement regarding the feasibility and costs of the assessed methodology. This is taken out of the PLD_Kahu_Rd.pdf (SCIRT internal, 2014) write up prepared by the delivery team's site engineer and SCIRT's structural engineer as well as SCIRT's transport planner.

1. Keep the bridge open during the work repair

   Completing the required repairs with the bridge open was ruled out due to crack injection not being able to be carried out due to the vibrations from vehicles continuing to use the bridge. During the operation, some brick elements may be found to be loose and unstable along and around the crack and need to be replaced. The soffit is only three-bricks thick and the safety of road users (pedestrians, cyclists and motorists) as well the crew carrying out the works would be seriously impaired.

2. Limit the extent of works

   Limiting the scope to only grout injection and replacement of brick elements where necessary without the installation of cross pins and horizontal stitching bars across the cracks was considered. However, this would require a two week closure and would provide an uncertain level of effectiveness in the repair. A monitoring programme would need to be put in place in order to check the behaviour of the structure at the crack locations. This approach does not comply with required design standards and cracks could open up in the future and require full repairs at a later date. For these reasons this option was ruled out.

3. Build a bailey bridge

   SCIRT considered using a bailey bridge, however, this was ruled out as the cost for a one lane bridge was $260,000 and would require a three weeks full bridge closure to build and de-construct.

4. Work outside of peak hours

   Limiting the closure on the bridge to off-peak hours was considered but ruled out due to the same reason explained under item 1.

5. Carry out the grout injection/brick replacement and installation of cross pins/horizontal stitching bars in two separate stages

   SCIRT considered this option, in which the bridge would be completely closed during the first stage [for the same reason as provided in item 1] and partially closed during the second stage, with just light vehicles allowed to cross the bridge. This option was eliminated due to a lesser degree of effectiveness in the repair. Another reason is the additional cost for temporary works beneath the bridge. This option would not satisfactorily mitigate the traffic disruption impacts as a full closure would still be required.

6. Carry out the work using double shift work

   Indications are that double shifting the works will decrease the proposed closure from 12 weeks to eight weeks. The additional cost is estimated to be approximately 25% of the bridge repair cost (~$50,000).

A coarse economic evaluation was undertaken to understand the increased cost for the road users on a daily basis. This coarse analysis was undertaken for a full closure, eastbound and westbound closure (see **Table 14**). Note that no additional road works were considered in addition to the proposed closures. This information showed that there are considerable dis-benefits in closing the bridge, therefore from a transport point of view it was desirable to expedite the works.

Table 14: Daily dis-benefits per scenario

Scenario	Approximate daily dis-benefits
Full closure	-$8,900
One-way closure eastbound (EB)	-$3,650
One-way closure westbound (WB)	-$4,150

The delivery team was prepared to reduce the programme of works on the Kahu Road bridge repairs from the original twelve week programme to eight weeks using additional crews. This was dependent on obtaining a road closure from 22/09/2014 to 15/11/2014, with the intention of opening the road again prior to Show Week. Show Week is a contributor to additional traffic in the area and avoiding a closure during Show Week was deemed important.

The proposed Kahu Road bridge closure was for light and heavy vehicles only. Access was maintained for pedestrians and cyclists over the bridge at all times. Also, access to and from the Riccarton Bush was maintained for all road users. Comprehensive communications were proposed as part of the TMP and the work in general, including CBD VMS boards and SCIRT radio and written announcements, to achieve area-wide rerouting when the works were carried out. A collection of the comprehensive communications information can be found in **Appendix G**.

The Kahu Road bridge closure was programmed as part of the larger SCIRT programme. After reviewing all possibilities the proposed closure dates were considered appropriate. An advantage was that the school holidays were scheduled from the 26th September to 13th October, which overlapped with the proposed closure dates (school is only open for 6 weeks during the bridge closure).

It was concluded that if the delivery team was to commence work later in the year to coincide repairs with the Christmas and New Year breaks, the original programme of twelve weeks would need to be reinstated. The twelve week programme would have excluded the Christmas shut down period which potentially would have pushed the programme to fourteen weeks. School holidays were scheduled from the 19th December to 2 February and the works would cause the school to be impacted for eight weeks. The extended closure period required was due to a combination of a lack of available resources during the Christmas break and restrictions on sub-contractor availability during the same period.

It was the delivery team's strong recommendation to go ahead with the closure on the 22/09/2014 with the shortened 8 week programme. SCIRT proposed to complete the full scope of works and reducing the original twelve week closure to an eight week closure by engaging with sub-contractors to work longer shifts (18 hour shifts six days per week). It was believed this would achieve a higher quality bridge repair whilst keeping the traffic impact as short as possible, as well as achieving the lowest overall costs when considering construction and road user costs. It was illustrated that the additional cost of the repairs using double shifts would be more than offset by the decrease in road user impact duration (four weeks).

Several meetings were held at the IST exploring the cost and benefits of the above alternatives and the impact on the community. The combined consensus was that the recommended option was the most prudent to ensure the long term effectiveness of the repairs and this was recommended to the TIM group.

The TIM group was satisfied that the overall best outcome was reached by double-shifting the works to reduce the programme to eight weeks. Also the determined closure points at Creyke Road and Straven Road, as shown below in **Figure 50**, worked well in not overloading the local roading network with a large amount of detoured vehicles and made sure staff and public were safe around the work site.

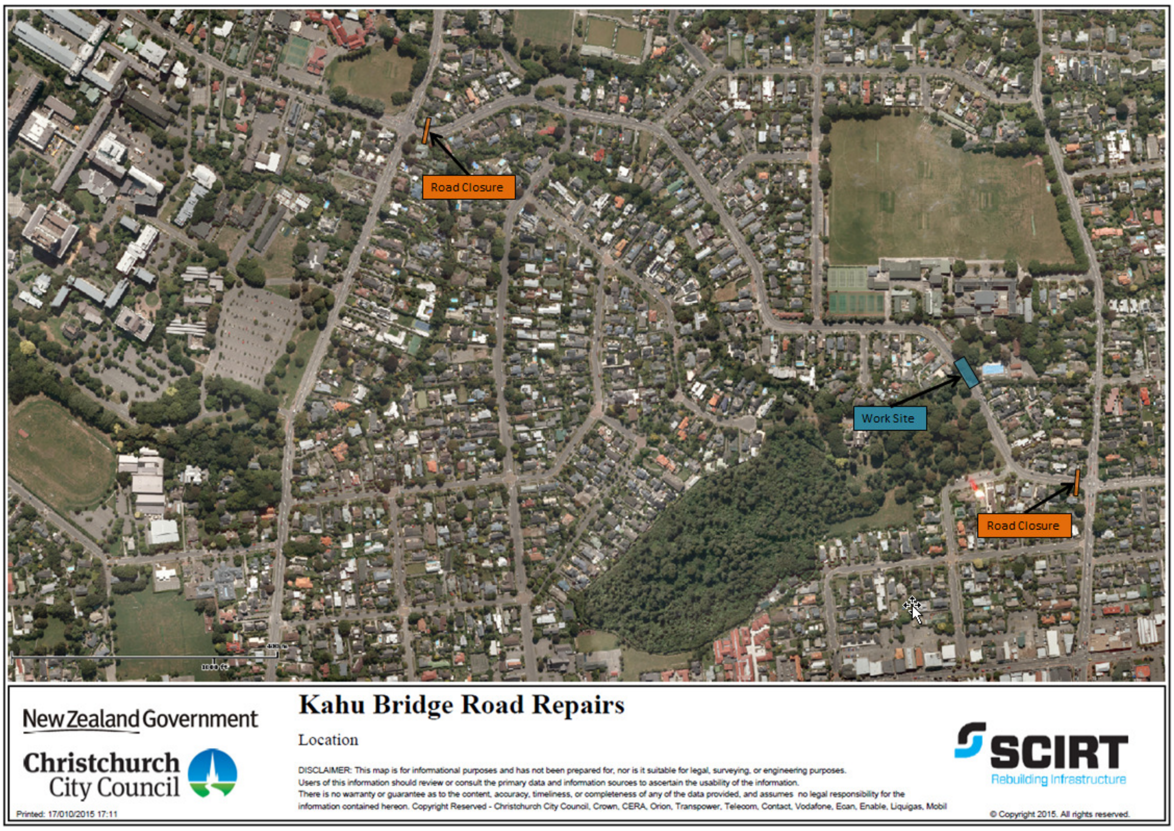


Figure 50: Closure Locations (SCIRT viewer, 2015)

The information, as illustrated in **Appendix G**, was released to the public to inform about the upcoming works and closure points. When the work notices and media announcements were aired, it became apparent that there was public interest in the closure of this road, as anticipated. SCIRT worked with CTOC to answer customer queries even before the works had started. The communication teams ensured all schools and business were aware of the restrictions imposed and informed them that cycle and pedestrian access was still possible.

Following the introduction of the road closure two lessons learnt were taken from this project:

The signage for businesses around the Riccarton Bush area was increased, after the project coordinator met with a business representative to reduce the impacts the road works had on the businesses. Surprisingly, a request was submitted to keep the road closure permanently deployed as it improved the cycling experience through the area.

From a SCIRT viewpoint, this collaborative approach and subsequent presentation to the TIM group helped in deploying these works without delays and ensuring the school holiday period was used effectively.

The delivery team struggled with unforseen issues during the construction phase. Damage to the bridge was greater than anticipated. The delivery team used some programme time contingency[19] and still achieved opening Kahu Road bridge only one day after their proposed

[19] The delivery team gave themselves a time contingency of approximately two weeks. All going well the bridge would have been opened earlier than advertised but given the damage under the bridge was only fully discovered when the bridge was exposed when work had commenced, the delivery team gave themselves a time contingency. In the end, the contingency was needed to undertake all required work within or slightly over the eight week timeframe.

eight week programme. This was a high profile project and the team was proud of the delivery and the absence of negative publicity.

The positive feedback received and the lack of complaints illustrated how effectively the communications teams dealt with residents, businesses and other road users. Area-wide rerouting was achieved and no significant delays were experienced. Traffic management and transport planning worked hand-in-hand to determine the best closure points, considering strategic route choice and best traffic management roll-out possibilities. All parties worked together collaboratively and achieved a safe work environment and a good customer experience given the significant adverse impact imposed on the vehicle road users.

6.4. Eastern suburbs

The Christchurch eastern suburbs[20] provides SCIRT with ongoing challenges. This is due to the vast amount of work that needs to be carried out in the area as well as the number of delivery teams working in the area. The eastern suburbs are approximately bounded by Linwood Avenue in the southwest, Anzac Drive in the south east, and the Avon River looping around the northeast to the northwest, as depicted in **Figure 51**.

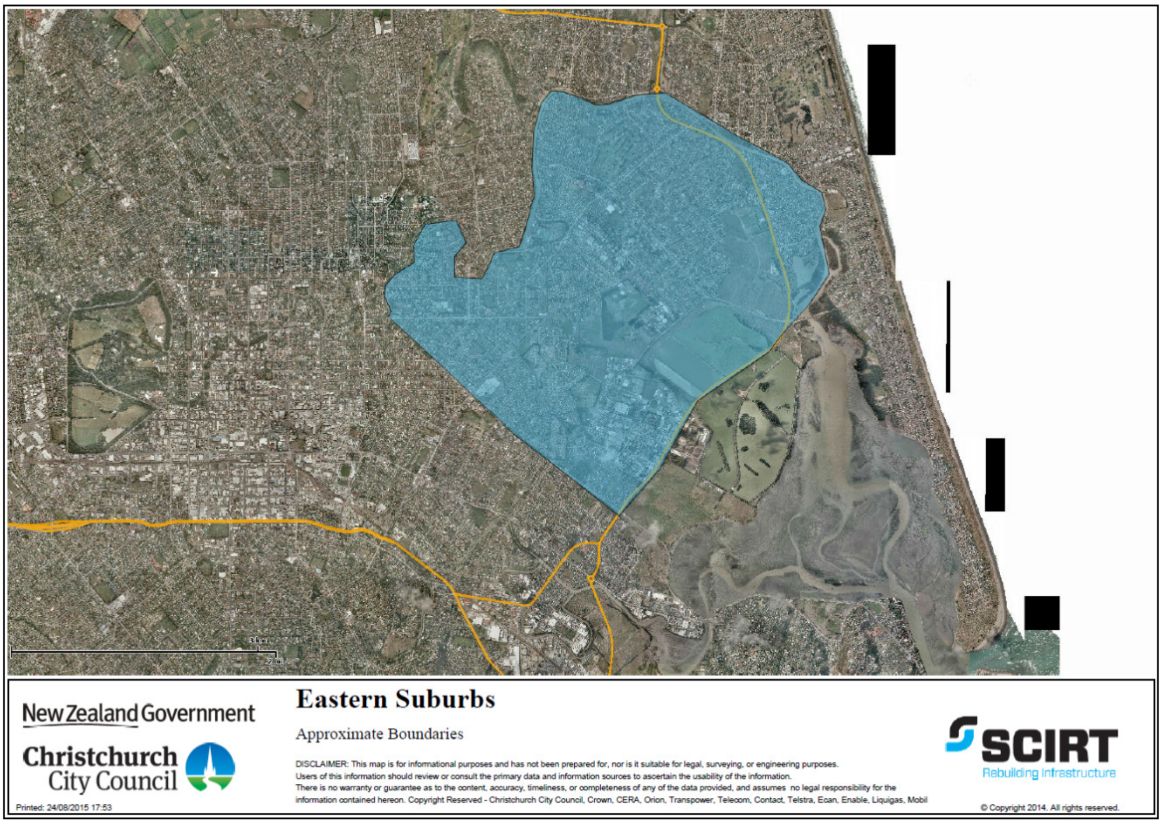


Figure 51: Eastern suburbs boundaries (SCIRT viewer, 2015)

[20] The coastal area in the east is not included as this piece of work refers to the works required to install the vacuum system in the Aranui area. The coastal area works (if underway or proposed) however are considered in the wider picture and impacts of these works, especially accessibility issues for emergency services and residents.

Before the earthquakes, Christchurch's wastewater system was a gravity system (see **Figure 52**).

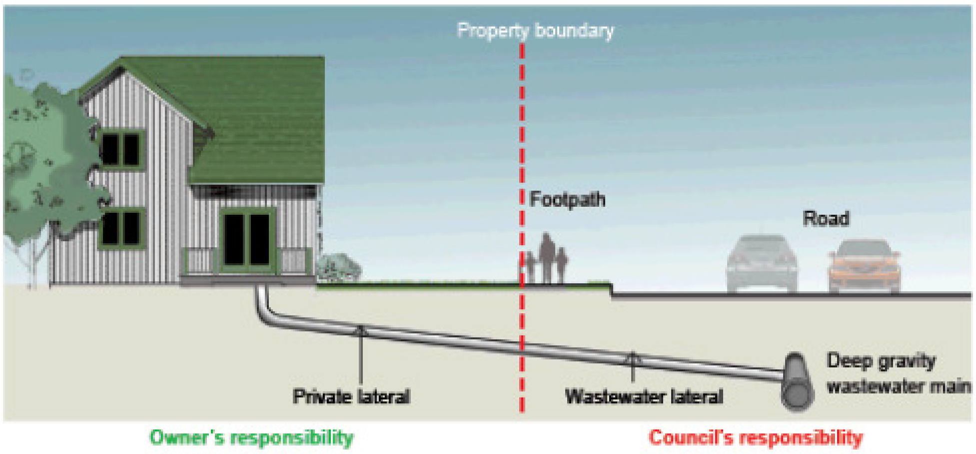


Figure 52: Gravity System (SCIRT, 2014a)

The eastern suburbs gravity wastewater system was badly damaged during the earthquakes and the system in parts of the area (Aranui and Wainoni) was not able to be repaired and had to be replaced. The area is also prone to liquefaction, so to enhance the resilience of the wastewater system, SCIRT determined that a vacuum system would be the best solution. **Figure 53** illustrates the vacuum system. It relies on a vacuum (air pressure) to transport the wastewater from the properties to the pump station.

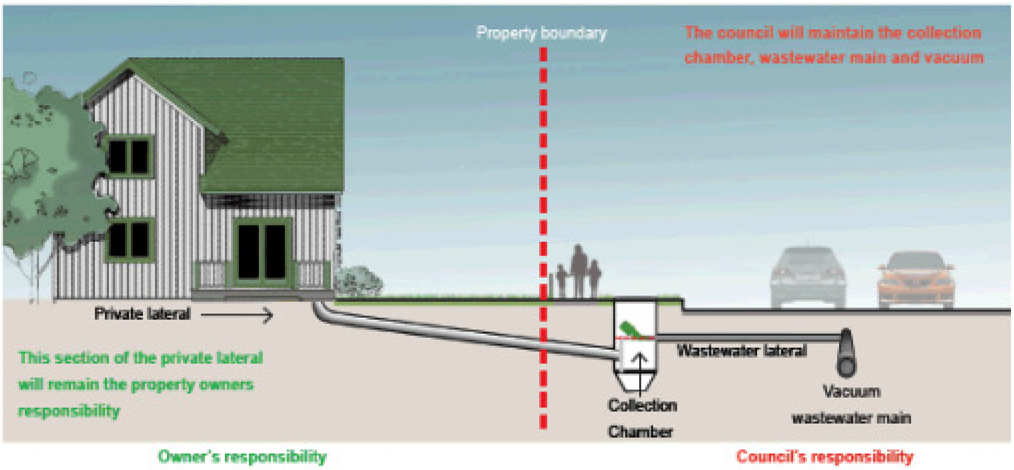


Figure 53: Vacuum System (SCIRT, 2014a)

The new vacuum system caters for approximately 2,600 households and businesses, requiring about 750 vacuum chambers being installed. Six vacuum arms are being installed on Pages Road connecting to the Vacuum Station. The Vacuum Station in turn connects to Pump Station 136 and then via a new wastewater pressure main (800 millimetre diameter), the sewage is transported to the treatment plant in Bromley (SCIRT, 2015c). This process is shown in **Figure 54**.

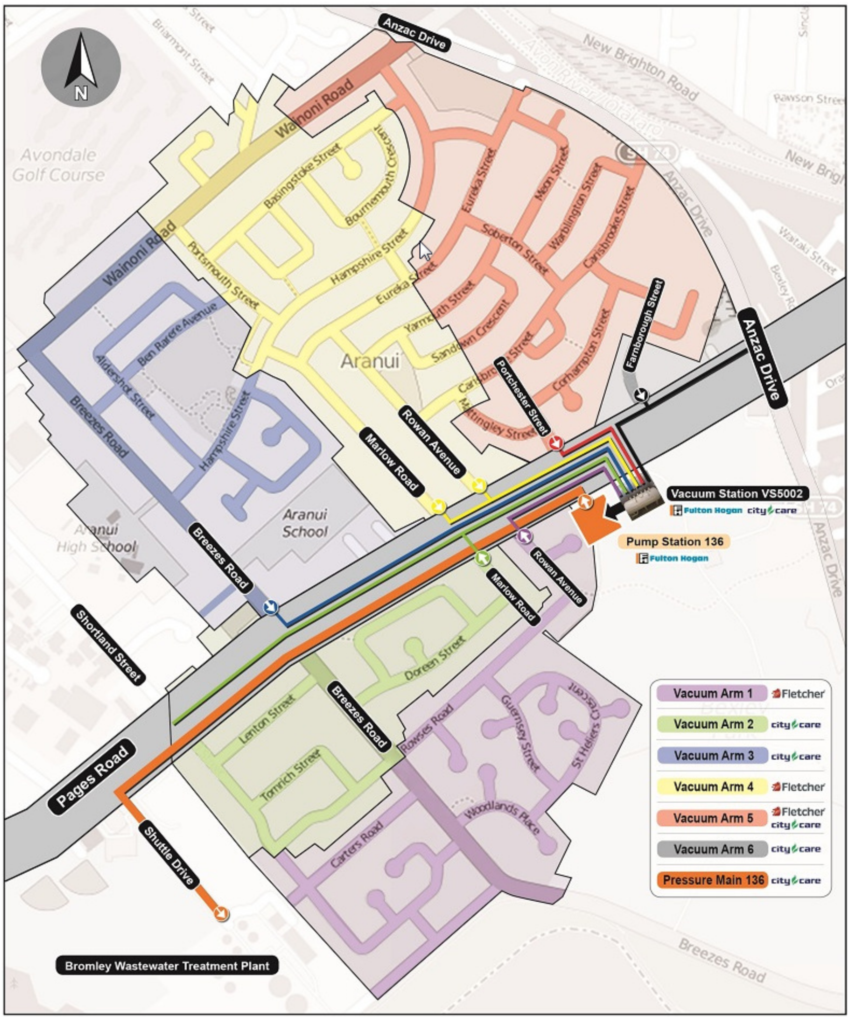


Figure 54: Aranui's six vacuum arms (SCIRT, 2015b)

Not only are parts of the eastern suburbs getting exposed to a whole new vacuum system but also repairs to the existing gravity system need to be facilitated. The wastewater gravity repairs are being carried out around New Brighton Road and Avondale Road, Dyers Road to install a new collector main, as well as the Southern Relief and Woodham Relief repairs located on Woodham Road and Worcester Street are scheduled.

The works started in minor local roads and progressively work sites were added to the area, on both local and strategic road network. PLDs encompassing the delivery teams, SCIRT and CTOC were called regularly to discuss additional work sites. It became apparent that the area was getting more and more saturated with road works and SCIRT prepared a network wide traffic impact report (*Eastern Suburbs Traffic Impacts 2015 - Report to CTOC v02.pdf.doc [SCIRT internal, 2015]*) for the already approved and proposed works. The works being carried out were substantial and had to strike a balance between network efficiency, programme efficiency, safety and business vitality (as per the 'balance diamond' in **Figure 17**). Therefore an economic evaluation assessment was conducted.

The initial map prepared to discuss works in the eastern suburbs is shown in **Figure 55**.

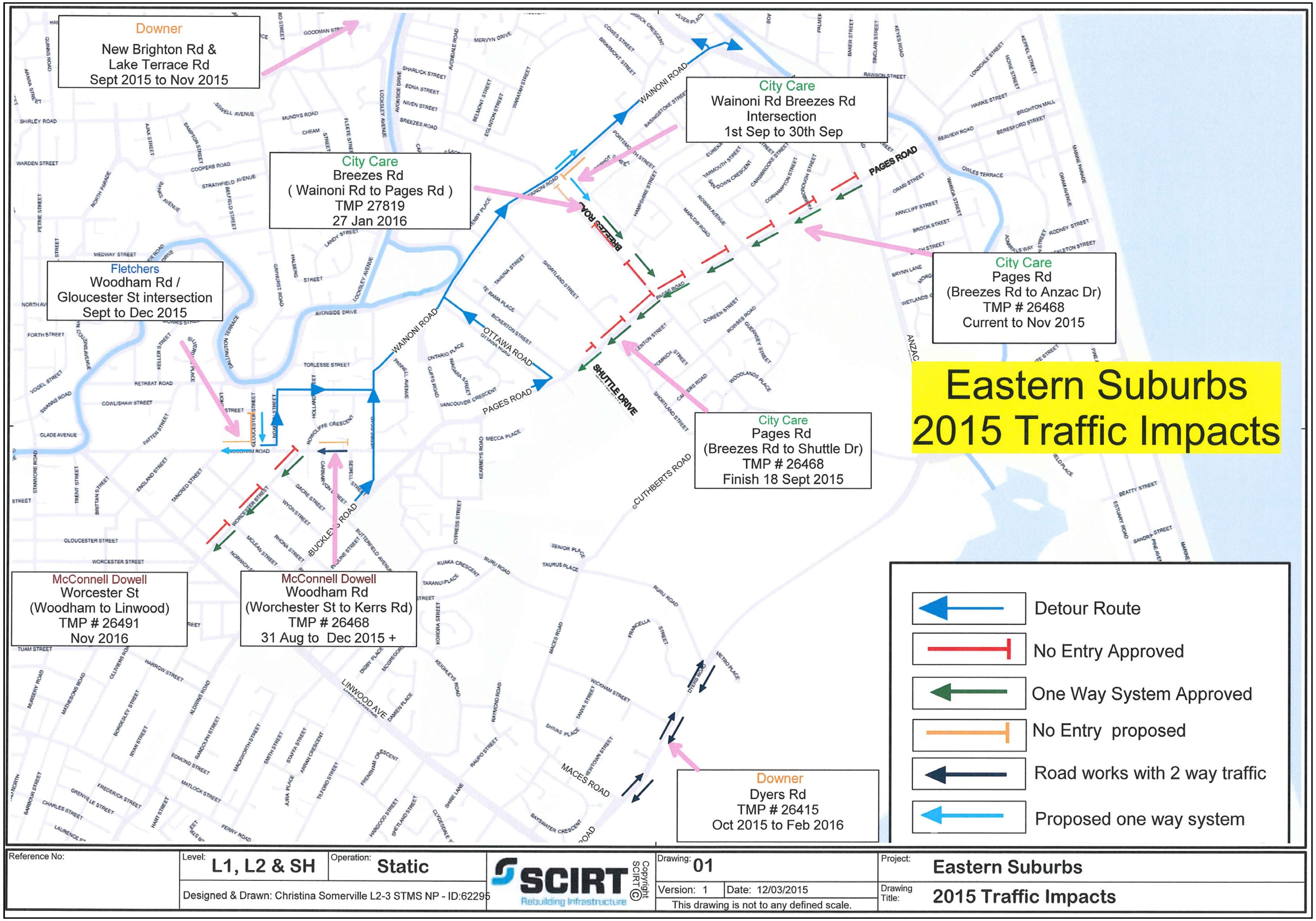


Figure 55: Eastern suburbs 2015 traffic impacts (SCIRT internal, 2015)

Figure 55 shows that four of the five delivery teams are working within this condensed area. The traffic impacts with numerous one-way closures and full closures made it difficult for residents to navigate detours and accessibility was impaired. For the duration of the works the capacity eastbound was reduced and increased delays on Wainoni Road were observed. The above figure shows the proposed detour routes.

The analysis presented here reduces to a fundamental choice of facilitating the SCIRT programme or avoiding excessive disruption to residents and visitors. Given the complexity, analysis was undertaken on the proposed additional road works as well as a scenario without any road works. Quantify the overall road user dis-benefits considering all road works in the area, and not just the incremental additional dis-benefit of one further work site, was deemed necessary to not lose sight of saturated the area already is with work sites.

As with the previous case studies presented, the analysis was undertaken using the CAST model and accompanying Economic Evaluation Framework tool. The tool is able to capture area-wide impacts and is considered the appropriate tool to use to evaluate the incremental and cumulative effects. As previously discussed, the economics tool was modified to account for daily figures compared to the typical 40-year evaluation period. No interpolation between several forecast years is required as the aim is to analyse the impact of temporary traffic management and not a lasting change in the infrastructure. The tool compares only a single pair of scenarios and economic update factors have been used to update to 1st July 2013 dollars in line with the 2013 traffic model updates.

The analysis was conducted in March 2015 and **Figure 56** presents the six month forecast presenting the strategic works already underway and proposed works in the following six months to September 2015.

The programme (**Figure 56**) was established in conjunction with the delivery teams, capturing the main traffic impacts of full and partial closures only. For the purpose of this analysis only the capacity-impacted time frames are stated. Some of these projects are expected to extend beyond their shown impact date on-site, but outside these shown dates works are not expected to impact on the capacity of the affected roads, and therefore are not shown in the Gantt-charts.

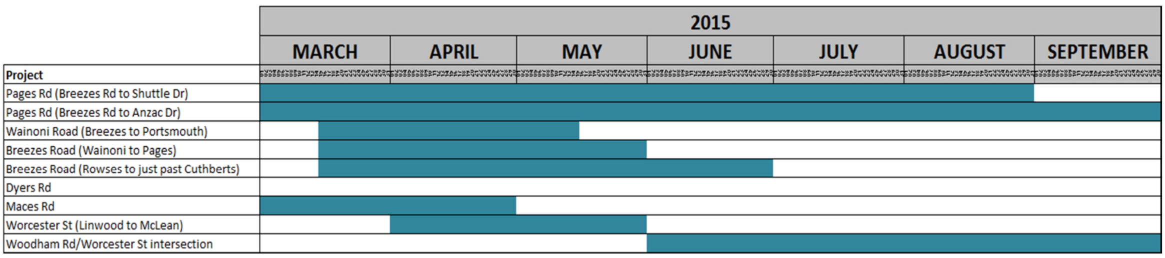


Figure 56: Eastern suburbs 6 month look ahead

When the analysis was undertaken, the most realistic scenario took into account the progress of the rebuild and the need to commission critical assets (e.g. pump and vacuum stations). Lesser considerations were the best sequence of work to avoid potential re-work and to keep work crews occupied.

SCIRT discussed with the delivery teams various scenarios of alternative methodologies to achieve the least impact; the presented impacts are the results of this minimisation. However, the intrusiveness of the works means that one-way closures and full closures were unavoidable due to the road space requirements. For example, the wastewater mains running centrally along Breezes Road meant that connecting property laterals required more than half the road width. Given the kerb to kerb road width is approximately 11 metres, insufficient space remained to facilitate two-way traffic. Another example was the road closures proposed for Worcester Street to facilitate the Southern Relief trunk main. The trunk is approximately 1.5 metres wide and trenches to install the new wastewater trunk would be 6metres wide and 6 metres deep. The wastewater trunk main was located in poor ground conditions and the extensive sheet piling, large plant requirements, and the need for dewatering and over pumping of waste water left no remaining carriageway width for vehicular traffic.

Viable bus routes through the affected areas, without requiring passengers to walk more than 500 metres to or from a bus stop, and providing easily-recognised routes to motorists, were also required. Both the bus routes as well as motorists' routes should not be changed frequently or without sufficient warning.

Providing route consistency and sufficient warning regarding upcoming changes is also crucial for emergency services. The need to fully understand where impacts on the road occur at any one time is crucial for the emergency services. This aids their route planning and provides some level of travel time certainty. This certainty is valued by road users in general, and aids in setting road users expectations.

The analysis was broken down into four consideration periods with the following schemes either included or excluded for both the base case (Do Minimum) and option (Do Something), see **Table 15**.

An alternative way was found to procure the works required in Dyers Road by incorporating them into the NZTA 3-laning project for the section of road between Metro Place and Maces Road. Due to shifting the wastewater repairs in Dyers Road in to the NZTA project, this is now outside the initial 6 month consideration period and NZTA's requirement of the successful tenderer is to keep the State Highway open to two-way traffic. The Maces Road works are expected to finish by the end of April and going forward these works have been excluded from the analysis from May onwards.

Table 15: Option Schemes

Do Minimum (DM) Schemes	**April**	**May**	**June**	**July-September**
Pages Road -> EB closure (Shuttle Dr to Breezes Rd)	✓	✓	✓	✓
Pages Road -> EB closure (Breezes Rd to Anzac Dr)	✓	✓	✓	✓
Maces Road -> SB closure (Ruru Rd to Wickham St)	✓	×	×	×
Do Something (DS) schemes				
Pages Road -> EB closure (Shuttle Dr to Breezes Rd)	✓	✓	✓	✓
Pages Road -> EB closure (Breezes Rd to Anzac Dr)	✓	✓	✓	✓
Maces Road -> SB closure (Ruru Rd to Wickham St)	✓	×	×	×
Wainoni Rd -> WB closure (Breezes Rd to Portsmouth St)	✓	✓	×	×
Breezes Road -> NB closure (Wainoni Rd to Pages Rd)	✓	✓	×	×
Breezes Road -> NB closure (Rowses Rd to south of Cuthberts Rd)	✓	✓	✓	×
Worcester St -> full closure (Linwood Ave to McLean St)	✓	✓	×	×
Woodham Rd/Worcester St intersection works -> full closure	×	×	✓	✓

The economic analysis considers travel time, vehicle operating and CO_2 emissions cost changes. To establish the overall impacts to the road users of the eastern suburbs area, a comparison to the Do Minimum and a Do Nothing scenario has been conducted, using the assumption that no road works are on the ground in the vicinity of the works (Do Nothing [DN]). Although this is not actually the case, it does test the validity of the Do Minimum option and the relativity between the Do Minimum and the Do Something options.

It is also important to note that the CAST model is calibrated to average weekday traffic volumes. Assuming the same dis-benefits for weekends as for weekdays is not recommended, so weekend traffic has been excluded from the analysis. It is noted that this will mean some underestimation of the road-user dis-benefits calculated and needs to be kept in mind when making a decision.

The economic assessment indicated the following dis-benefit (rounded to nearest $100) per consideration period and overall for both the DM and DN scenarios. This is shown in **Table 16**.

Table 16: Scheme Dis-Benefits

Comparison to Do Minimum (additional road works)	April	May	June	July-September	Total
No of days per month	30	31	30	92	**183**
Weekend days	8	10	8	26	**52**
Weekday days	22	21	22	66	**131**
Cost/period (weekdays only)	$147,400	$141,500	$94,200	$177,700	**$560,800**
Comparison to Do Nothing (no road works)					
Cost/period (weekdays only)	$420,400	$390,100	$354,600	$959,000	**$2,124,100**

The difference between the Do-Minimum (already approved TMPs included) and Do-Nothing (no other road works included) is approximately an additional $11,900 per day. This accounts for the road user dis-benefits already borne by the residents of the eastern suburbs due to the works already established (averaged over the 6 month period).

For comparison purposes the following **Table 17** illustrates the daily figures for the road user dis-benefits for both the current works (DM in comparison to DN), and expected additional dis-benefits due to the proposed programme of works (DS in comparison to DM).

Table 17: Daily Dis-Benefits

Daily dis-benefits per consideration period	April	May	June	July-September
Experienced dis-benefits due to current works	$12,400	$11,850	$11,850	$11,850
Expected additional dis-benefits due to proposed works	$6,700	$6,750	$4,300	$2,700
Total/Day	**$19,100**	**$18,600**	**$16,100**	**$14,550**

The analysis above shows that the total dis-benefits for the full programme of works for the period considered (April to September) amounts to a calculated average of approximately $16,200 per day (see **Table 17)** averaged over 6 months daily dis-benefits, or around $2.1M (see **Table 16**) for the programme (excluding weekends). This should be compared with the total dis-benefits due to the current works (which are underway and unavoidable) of approximately $11,900 per day on average, giving a difference of approximately $4,300 per day ($560,000 total excluding weekends). These additional costs relate to travel times, vehicle operating and emission costs.

It is of note that the removal of the Dyers Road works effectively removed around $18,000 worth of daily dis-benefits. This is a considerable amount of additional dis-benefits which is not imposed on the residents in the area given the work methodology chosen by NZTA and the opportunity to take parts of the wastewater rebuild out of SCIRT scope and transfer it into NZTAs programme of works.

The wastewater system in the Aranui catchment is failing and an additional amount of about $50,000 per month alone in this area (over and above the pre-earthquake maintenance costs) are spent on extra cleaning, patching pipe and road collapses, pump maintenance, etc.

The overall project value for the additional works SCIRT was seeking road space approval for is valued at approx. $36M as per the latest revised TOC. The road-user dis-benefits for the additional projects represent approximately 2% of the actual project cost. As previously mentioned this is the lower end of the range as neither business impacts nor weekend road user dis-benefits have been included in this analysis.

The road-space requirements for the proposed works (and subsequent need for one-way and full closures) have been determined using best-practice standards and depend on the types of work being undertaken. The delivery teams were challenged to ensure sites take up as little carriageway widths as possible to allow more room for road users and reduce the impacts of the works. No compromises have been or will be made regarding the safety of the work crews. Safety zones to keep the road workers out of harm are not being compromised to achieve more road space for road users. Similarly, road user safety is also considered by making sure that safe turning opportunities exist at key intersections, and the distance of detours is kept as short as possible. Whenever possible access for cyclists and pedestrians will be made available, sometimes by accompanying pedestrians through the work site to ensure their safety.

While the proposed works come at a cost to the community in the form of road-user dis-benefits, it was deemed economically acceptable to facilitate these works despite their significant impacts. Seeing it in the context of having to delay one or more rebuild works and accepting further ongoing maintenance work, which may cause unplanned emergency repairs and delay the commissioning of the overall new vacuum system in the area, facilitating the works was preferred outcome.

The communication teams work closely with the project engineers, traffic managers and transport planners to be able to inform the residents and business via letter drops, newspapers, door knocking, community meetings and such like. The communication teams are continuously updating the residents and businesses regarding the ongoing and changing environment, creating weekly overviews of the major impacts. They also provide information on the latest bus detours and temporary stops. One example of these print outs is shown in **Figure 57**.

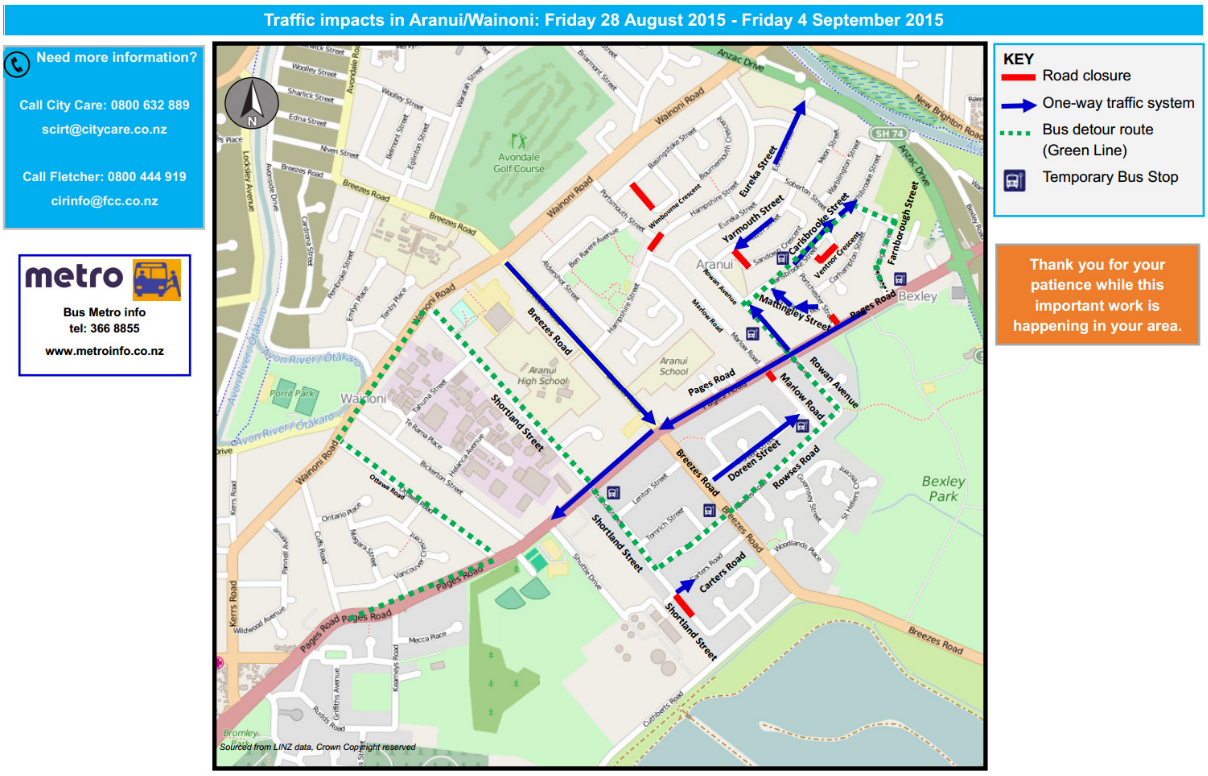


Figure 57: Weekly Communication Update to Aranui/Wainoni Area (SCIRT, 2015d)

These weekly maps are unique to the eastern suburbs and are accessible through the SCIRT website, are being printed in the local newspaper and are being distributed to the businesses and residents using letterbox drops. These regular updates are crucial to keep the eastern suburbs functioning. Any major changes and new work sites are additionally advertised via radio and VMS boards are used to convey the information in advance.

Due to the great impacts caused in the area, Bluetooth and bus Global Positioning System (GPS) data are being used to monitor delays in the area. Also regular site visits are undertaken to observe traffic build up and dispersion, to be able to know what is happening in the area and track the traffic issues over time. Traffic management site audits are undertaken, to make sure any unnecessary impediments are removed and to make sure the different delivery teams work together, and sites and detours do not interfere with each other.

These checks and the monitoring are of interest to both CTOC and SCIRT, and when additional road works are introduced or road works have finished, the changes to the roading network performance is even more closely monitored. Whenever anomalies in the data are noticed, the information is fed to a working group tasked with the eastern suburbs performance. If the impacts are deemed significant, meetings are held to find a way to reduce the impacts; if absolutely required, the decision will be made to close work sites down.

Another tool used to monitor the area is the number of complaints received from residents and businesses. The complaints are dealt with by the communication teams, both within the delivery teams and SCIRT itself. Businesses in the area are acknowledged to be adversely affected by ongoing road works. Accessibility issues means for business that delivery trucks or customers might not find their way to the businesses; this is a serious and threatening situation for businesses. The communication teams are responding to queries and complaints, where meetings or discussions on how to improve situations are held for businesses and residents.

When a large number of projects are undertaken in any one catchment it is crucial that works have been planned, conducted and communicated in a consistent manner. This consistency facilitates an intensive programme and ensures the impacts are minimal. It is also important that every part of the team feels concerns can be raised and worked through.

6.5. Summary

There are other examples illustrating the transport planning undertaken, how traffic management methodologies were modified to reduce impacts, and how the proposed works were communicated. However in general it typically involves the following approach:

- forward works viewer allows for thorough analysis
- meetings to determine how best to do the work and encourage working as one team
- experience of the team members crucial in determining how the work can be undertaken
- site checks to ensure safe and tidy work sites
- monitoring with an ability to respond quickly if issues occur, e.g. if sites are unsafe or if gridlock potential is observed
- involving the communications team to reach residents, set expectations and have a consistent message

7. Surveys

This chapter presents the survey results from a short interview survey with representatives from CERA, CCC, CTOC and NZTA as well as a public survey aimed at residents and re-occurring visitors to Christchurch. The goal of this chapter is to understand how transport planning has been perceived, both at the beginning of SCIRT and how it is currently regarded (about 3-4 years into the rebuild).

Two different surveys were undertaken; firstly an expert survey has been undertaken and secondly a social media survey for the general public.

7.1. Stakeholder survey

This survey was prepared using Survey Monkey and the link to fill out the survey has been sent to the four identified transport experts via emails. **Appendix H** contains the questionnaire and answers. The intent of the survey is to capture how traffic planning, traffic management and communications are perceived to the trained eye.

- SCIRT's Traffic Planning

  The first three questions (Q1 to Q3) relate to traffic planning and try to capture the transport planning aspects undertaken, as discussed in **Chapter 3**. The evolution of traffic planning over time is of interest, as well as identifying the room for improvement.
  The answers indicate that the experts' perception is that the traffic planning at the beginning of the rebuild was undertaken to an average standing with a slight tendency to have not being done well. This is unsurprising, as shortly after the earthquakes a lot of the immediate response was emergency works, which meant no planning was undertaken. The experts' opinions is that the traffic planning currently undertaken has improved considerably from the beginnings, with 3 out of 4 experts ranking it 'moderately well' and one expert rating it as 'very well'.
  The following individual responses were given to Q2 "has it improved?" If yes, how?

  - *"Better thinking early in life cycle of about projects about the need to manage site safety AND minimise impact of SCIRT works on network performance and adjacent land owners; it was at times SCIRT trumps everything"*
  - *"Yes, the planning seems more integrated with the rest of the work, whereas initially the work was approved and not taken into consideration with the wider context"*
  - *"The most significant change relates to pre-planning and coordination enabled through longer lead times. At the beginning the transport planning was reactive/fire fighting in order to resolve individual issues at isolated sites. Now the network wide impacts are much better coordinated"*
  - *"Yes, there is a lot of coordination that is happen between projects that are being delivered by SCIRT and the effects of diverted traffic is taken into account"*

  Q3 is about further improvements to the traffic planning undertaken by SCIRT. The experts were less well aligned however regarding this question, in comparison to Q1 and Q2. All agreed that some level of improvement is possible, with two out of four experts thinking the

traffic planning could be improved 'quite a lot' and one expert each thinking the traffic planning could be 'somewhat' improved or a 'little bit' improved.
The follow up question, as to how the experts think it could be improved, prompted the following responses:

- *"Still opportunities to improve co-ordination between SCIRT sites, work of others and at times think about spending a little more on temporary route works to improve the experience; planning for the vulnerable users still seems to be secondary to vehicle traffic in most sites"*
- *"I think that SCIRT and the An Accessible Cities teams, along with Transfield, could be closer aligned, at least on the key traffic routes"*
- *"The transport planning lead times decreased in 2015 compared to 2014. As a result the ability to perceive opportunity's to reschedule or modify the work programme have decreased"*
- *"Always room for improvement"*

These answers indicate the following three findings:

- A great deal of vehicular traffic planning is undertaken, with cyclists and pedestrians as well as disabled road users not being treated to the same standard. This may be due to vehicular traffic outnumbering the other road users, but it certainly is an area for improvement to look into.
- Coordination over multiple parties (SCIRT, CERA, utilities, private sector) is not as well done as one-party assessments. This is an area where the FWV and its proposed improvements will help. Also, CTOC are getting more stringent when approving plans if forward work planning has not been considered appropriately.
- The funding allocation decisions have been postponed lately, so when funding decisions are made the lead time for forward planning have reduced. The more time given between planning and actioning on the road, the more opportunities exist to optimise the programme and keep the road users moving effectively.

- SCIRT's Communications

Q4 to Q7 deal with the communications put in place by SCIRT to notify the general public of road works around the wider Christchurch area.
Again, as done for traffic planning, the communications at the beginning of the rebuild works is compared to the current communications and questions were raised regarding whether the experts had been exposed to recent SCIRT communications.
At the beginning of the rebuild work, two out of four experts thought the road works were communicated 'moderately well', with one thinking 'not well at all' and one other one perceived the quality of the communications as 'neutral'.
Currently three out of four experts think the communications about road works is undertaken moderately well and one expert thinks it is very well done.
The reasons for improvements were stated as follows:

- *“style of comm[unication]s has adapted to the change in community tolerance for road works - early days there was a lot of tolerance to poor planning and comm[unication]s as everyone accepted it was frantic BUT there is now high expectations for high quality on both fronts - public support for the work of SCIRT is high so that is a sign it is working well”*
- *“Quite a lot of improvement has taken place over the timeline of SCIRT, now advertising on radio and more frequently in newspapers”*
- *“Appears to be similar now to early on”*
- *“Comm[unication]s have improved significantly and the public has learnt that they can trust the information they are being provided with”*

Q6 was about further improvements to the communications about road works. The following specific improvements were provided through the survey answers:

- *“Keep on doing what they are doing BUT keep adapting for changes in community expectation and tolerance especially as we near programme end and some disappointment is likely in the scope of the SCIRT programme. May need to think about use of social networks as these will play a higher role in public complaints”*
- *“The residents may be getting a bit burnt out now, so they may not be reading information as they shoul,. but there will always be opportunities to improve to get residents to engage”*
- *“Further improvements to the quality of information through enhanced data accuracy. This is a combination of project management, traffic planning and comm[unication]s teams”*

> The suggestions above are in general all about how to keep the residents happy due to tolerance to road works dwindling, as well as to improve data accuracy.
> For this section a specific question (Q7) was also asked specifying what SCIRT communications they came across over the last four weeks.
> Not all experts answered all questions, so it was assumed that if a question was not answered this is counted as a “No”.
> All experts indicated they have seen SCIRT newspaper advertisements, weekly SCIRT traffic update emails and SCIRT traffic news in the CTOC updates. The SCIRT traffic updates on the radio and updates through the SCIRT website was only noticed by two out of the four experts.

- SCIRT’s Traffic Management

Q8 to Q10 are about the traffic management and how it was conducted early on, how it is conducted now, and if it is possible to improve it.
The perception of the experts varies, with two out of four thinking the traffic management was initially ‘not well’ done and one expert each thinking it was ‘averagely’ done with one thinking it was ‘moderately well’ implemented. The traffic management implementation has improved over time, with one expert thinking it is done’ very well’, two thinking it is ‘moderately well’ implemented, and one expert thinking it is’ averagely’ implemented. The answers to the question on how it has improved are stated below:

- *"At times in the early days there seemed to be little logic flow for TM [Traffic Management] from one site to another adjacent site if being managed by another NOP [Non-Owner Participant]; partly this seemed to blind adherence to COPTTM rather than thinking about managing a traveller experience at the site. This has improved through thinking holistically about sites and their interaction with others"*
- *"As mentioned above I think that CCC and NZTA need to get a better control over who is working in the road space and force alignment of programs through their governance structure"*
- *"The quality of delivery has improved through enhanced delivery teams culture and behaviours"*
- *"Consistency between sites, reduction of unnecessary traffic management"*

The experts have provided the following suggestions for further improvements regarding traffic management:

- *"At times the TM plan should be thought of more widely in terms of the adjacent network effects with a view to identifying opportunities to invest / spend a little bit more to improve the experience and minimise network effect. Some really good recent examples such as Moorhouse Aves to what can be done with some good thinking even if the site is very complex"*
- *"Alignment of programs"*
- *"There is still a lot of room for enhancements to the behaviour of the delivery teams around active management of sites. Minimising impacts when space is not required and deployment times that are consistent with project works, not hours before or after the works time frames"*

The suggestions above indicate that the current number of site checks might not be sufficient, and not shutting down sites as soon as possible might be a point to focus on going forward. In areas where a large number of sites exist any unnecessary sites should be removed immediately without intervention from SCIRT, but because the delivery teams understand the reduction in impacts on the residents and visitors, this should be considered to be raised in one of the technical catch-up meetings. Also, if delivery teams would have regular catch-ups about proposed works, then opportunities to work together could be identified earlier and not only when works are proposed to SCIRT. These are areas for improvements. Again, the use of the FWV should contribute to establishing these opportunities earlier in the future.

- SCIRT's tools, guidelines and outputs

Questions Q11 to Q12 tried to establish what are the most successful tools, outputs or guidelines created by SCIRT.
Q11 raised the question about which was the most important traffic planning tool. Some tools are specifically stated, such as the FWV, traveller information, transport modelling, VMS strategy. The question allowed an open answer, and it was not required to pick from a list.

The following answers were received:

- *“FWV if well used, it encourages and supports wider network thinking which is critical to managing traveller expectations”*
- *“VMS Strategy seems to be pretty effective and quick to change and really 'in your face'. I am not sure if FWV is the best tool because not everyone is using it”*
- *“All of the above. The transport system is made up of demand and supply elements - both need to be managed to be successful. That said the transport planning and management all starts with the FWV”*
- *“I think all have proven to be important in coordinating works to minimise impact to travelling public and to inform them of the potential impact”*

The answers above confirm that not one tool will be able to solve all the challenges that exist. The FWV provides the platform to know about upcoming works and provides a very crucial element in undertaking the subsequent work. It can be concluded that early knowledge about the work is the key to effectively analyse, communicate and manage the works ahead. It also emphasises the importance of having a tool that is widely used, as if only a fraction of the work is known then all subsequent work is not considering the full picture and is therefore very likely to be sub-optimal.

Q12 asks about awareness of the guidelines/initiatives that have been developed by SCIRT over time. It is of interest to see that not all experts are aware of all guides and initiatives. The initiatives known most are the Speed Management Guide, VMS Strategy and the delegated authority for TMP approvals, with three out of four experts being familiar with them.
Half of the experts are familiar with the cycle treatment guide, service agreements, overarching STMS for site coordination, the traffic management awards, local operating procedures and TM tactical group. The pro-forma TMP template is known by only one expert.
This shows that some more effort should be put into sharing these initiatives and guidelines. It could be argued that if the initiatives and guidelines were really useful then the respondents would have heard about them. However, some of these initiatives and guidelines are very specialised and many would not come across these in their normal day-to-day work. Some of these developments have the potential to be used after the time SCIRT exists, especially the cycling and speed management guidelines. The least known initiative, the pro-forma TMP template, this is very specific in its use and applicability, and unless working in the immediate traffic management space, these detailed documents would not be known.

The overall results are therefore not surprising but also highlights that some more knowledge sharing should be undertaken.

- Travel Demand Management

  Q13 and Q14 deal with travel demand management. In Q13 the experts were asked to answer if more focus should be put on travel demand management, with three out of four experts answering this question with *"Yes"*. The follow-on question (Q14) asked which areas should be focussed on more. All of the experts agree that more focus should be given to getting the population to use public transport more, achieving more peak spreading and informing people about alternative travel routes. Two out of the three experts also mentioned placing more focus on walking and cycling. No other measures were suggested.

  Currently the most used travel demand management tool is to inform the public about alternative travel routes. Only a small amount of work has been done regarding peak spreading or mode shift from vehicles to active modes. This certainly is an area for improvement and it should be considered whether more communication messages should actively promote peak spreading. This could be undertaken by informing the public about historical travel times at certain times of the day, to provide more information to allow the general public to maybe reconsider their time of travel to and from work, or to undertake social trips outside of peak times.
  Achieving adjustments, to people's time of travel or the mode they choose to use to undertake their journey, is very difficult. It is easier to complain about encountered congestions and increases in travel times than realizing that their travel choice is contributing to the problem encountered. Peak spreading and mode shift are areas which do need working on by educating the people but it is not achievable in the short term and hence the continued focus on travel route alternatives.

7.2. Public social media survey

The second survey undertaken was aimed at the general public (see **Appendix I** for the survey questions and answers). This was not intended to be representative survey but instead an indicative survey, to get some understanding of how the road users perceive the road works and to get an idea about the level of satisfaction with the rebuild works. This survey comprises nine questions, all of them multiple choice and not open-ended. The survey was made public via social media, mainly Facebook. Over a period of approximately one month the survey received 131 responses.

The first question (Q1) distinguishes between residents and visitors to Christchurch. Approximately 97% of the responses were from residents of Christchurch.

The survey distinguishes between inside and outside-CBD works, and it was therefore of interest in Q2 where the residents and visitors were/are residing. Approximately 8% of the respondents live within the Four Avenues, with 92% of the respondents living outside the CBD perimeter.

Q3 is evaluating how well the traffic management is perceived within the CBD. About 45%, or almost half of the respondents, think it is being 'poorly' or 'very poorly' undertaken. Approximately 29% are 'neutral' in their answer, leaving about 26% who think the traffic management is undertaken 'well' or 'very well'.

Q4 asks how well the traffic management outside the CBD is perceived. About 37% percent perceive the traffic management being undertaken ‘poorly’ or ‘very poorly’ outside the CBD. This is slightly less than for the inside-CBD works. About 28% are ‘neutral’ in their answer, which is similar to the inside-CBD answers, with approximately 31% thinking the traffic management outside the CBD is undertaken ‘well’ and almost 5% considering the works are undertaken ‘very well’.

> When comparing the answers between Q3 and Q4, it is of note that the traffic within the Four Avenues is considered as being managed slightly worse. This can be explained by the number of different players within the CBD, making it is more difficult to manage the traffic impacts. SCIRT is the only really big player undertaking road works that impact massively on the road capacities outside the CBD, with a few exceptions such as the Ferrymead bridge works. Within the CBD, not only horizontal infrastructure works but also vertical works are carried out within a very constrained area. This calls for a higher degree of organisation and coordination from all players. However without legislative support, such as including the need for forward planning as a consent condition to build within the Four Avenues, a considerable amount of work may only be known shortly before the works are planned to commence, thus not allowing for optimal outcomes. Some of the parties may not realise the consequences their works have on the roading network and may not even lodge TMPs at all. Not knowing and coordinating well may have contributed to the slightly worse result for the CBD compared to outside the CBD.

Q5 and Q6 concerned whether manoeuvring within the Christchurch CBD and outside the CBD has improved when compared to six months ago or whether it has got worse.

For about 27% getting around the CBD has gotten ‘better’, 39% feel it was getting ‘worse’, with approximately 31% stating that getting around town was much the ‘same’ as six months ago.

For the outside-CBD works, about 27% state that it has gotten ‘better’ or ‘substantially better’. About 43% think the outside-CBD works have ‘worsened’ and 28% think it is ‘as expected’.

> When comparing Q5 and Q6 there is a slight tendency for more road users to think the outside-CBD situation is getting worse, in comparison to the inside-CBD situation. This intuitively makes sense, as the SCIRT works are retracting from the CBD as planned to make room for other parties such as the An Accessible City (AAC) works (not impeding on the CBD to the same extent as the SCIRT work did), and with more efforts being put into the outside-CBD works by SCIRT, increasing the amount of work sites deployed.

Q7 to Q9 tries to establish a feeling for how easy it is getting around Christchurch using different modes (car, bicycle and walking).

Almost all respondents answered the question on how they find it getting around Christchurch by car. About 30% find it ‘moderately easy’ or ‘easy’, approximately half of the respondents state they find it ‘moderately difficult’ or ‘difficult’, with about 19% being neutral.

Q8 considered cycling and only 47% answered the question (about 53% chose ‘not applicable’) with about 26% of the cyclists finding it ‘difficult’ or ‘moderately difficult’ (this is about 54% of the cyclists). Approximately 15% of the respondents (about 31% of the cyclists) find it ‘easy’ or ‘moderately easy’, and 7% (about 15% of the cyclists) are ‘neutral’.

Q9 is asking the same question but considering pedestrians and about 87% of the respondents answered this question (about 13% chose 'not applicable'). 35% of the respondents (about 40% of pedestrians) find it 'difficult' or 'moderately difficult', 15% (about 17% of the pedestrians) are 'neutral' and 37% of the respondents (about 43% of pedestrians) find it 'easy' or 'moderately easy' to get around on foot. The general trend seems that going by foot is perceived as being easier than when getting around Christchurch on a bicycle or by vehicle.

The results for Q7 and Q8 are very similar. Given that cyclists and motorist use mostly the same facilities it makes sense that the perception is very similar. Pedestrians have their own facilities and this may have contributed to finding it easier to get around. It may also indicate that as a pedestrian it is possible to walk alongside the works (even if not allowed) or the footpath on the other side of the road is still available for use.

Q9 results show that for pedestrians it is distinctly easier to get around Christchurch than getting around by car or bicycle. With a similar percentage of respondents fining it neutral, this shows a distinctively lower number of respondents finding it difficult to manoeuvre around Christchurch.

Overall it seems the general public, motorists and cyclists in particular, are finding it on average difficult to move around Christchurch, no matter which mode they use. This indicates that some more information may need to be required to be given to the public and that the public may not be aware of all the information available. A lot of information portals are available to be kept informed about the latest road works, however some people may not know where to find out about road works and current travel time forecasts, raising the question whether more advertising is needed. Some traffic impacts are not known well in advance as a consequence of the short lead-up time to the works commencing, and the information has not been available for communication early enough.

The social media survey indicates that cyclists and motorists finding it particularly difficult to get around Christchurch. This may point out that facilitating the rebuild programme in five years may have been ambitious and comes as a loss of facilitating movements. Spreading out the work more, not having as many work sites or reduced impact sites, may have been advantageous for the general public by reducing road user dis-benefits and frustration but would have come at an increased construction cost and slower progress in restoring the horizontal infrastructure.

Facilitating motorists, cyclists and pedestrians through fairly reduced road space bears some risk. And close encounters, especially for cyclists and pedestrians, are frightening and more enforcement shout be put on instilling speed limits and good driver behaviour on one hand but also site shut downs should be ordered if the sites are sub-standard and dangerous for one road users, emphasising on increasing the number of site audits carried out.

Linking this back to the expert survey, it is interesting that the experts have detected the dwindling tolerance of the road users and the issue of data availability from all parties, making coordination difficult and leading to sub-optimal solutions.

This therefore indicates that all possible measures should be considered in making sure all information is provided early in the programmes from all parties. This can be done through education about possible consequences (e.g. unapproved TMPs potentially costing dearly due to trucks not being able to deliver necessary supply, through to making it compulsory through the consenting process to provide a forward plan). Data accuracy is also very important as the general public and businesses need to be able to trust the information provided to them.

8. Conclusion

This report has identified several key processes and procedures which SCIRT has learnt are very valuable in post-disaster rebuild. These are summarized in conclusion as follows. A detailed Forward Works Programme is essential. It effectively manages the impacts of SCIRT work sites on the Christchurch roading network and helps to keep traffic flowing during the rebuild activities. **Figure 58** shows the progress to date of the SCIRT programme at approximately 76% complete, with 96% of the Christchurch CBD horizontal infrastructure restored (see **Figure 58**).

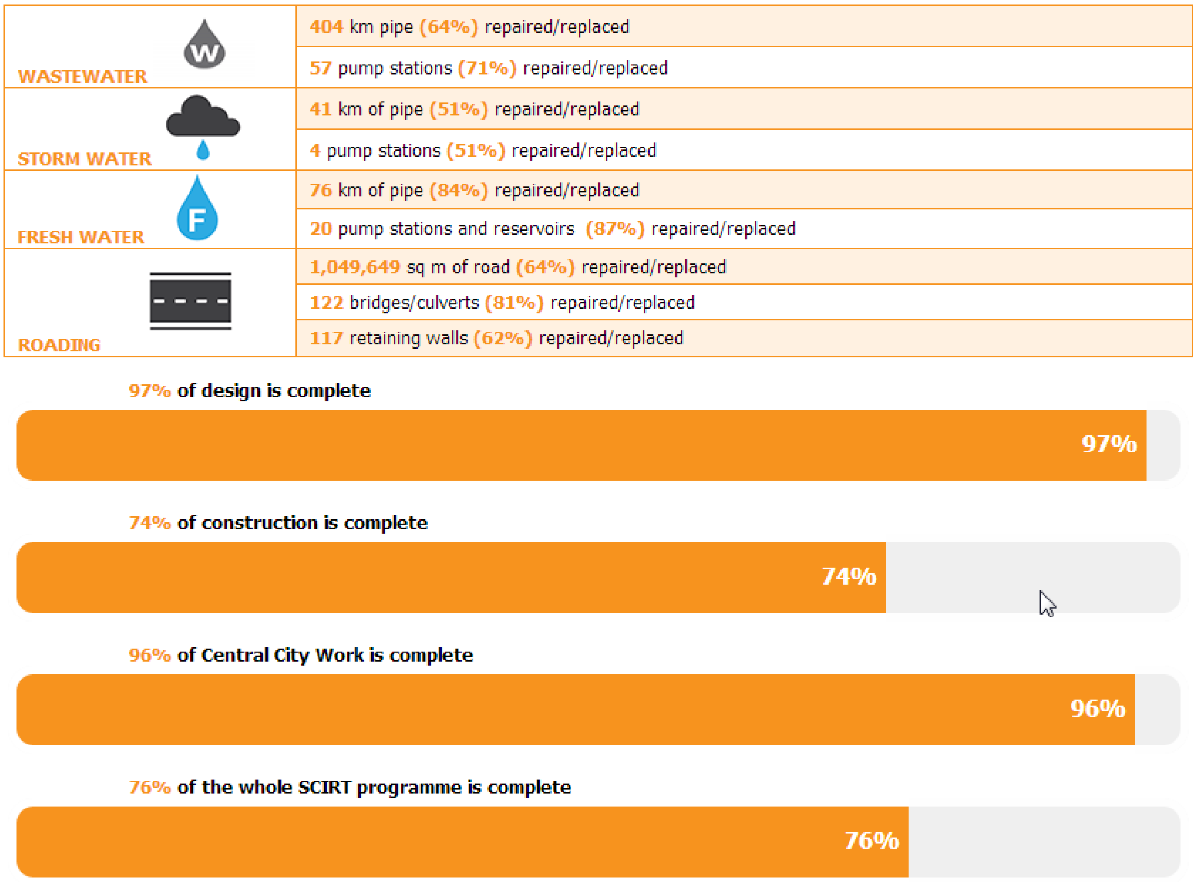


Figure 58: Progress to date (SCIRT resources, 2015)

A common spatial system and regular data capture is essential in undertaking transport planning with multiple work sites in close proximity to each other. This is especially true within the CBD and other highly impacted areas such as the eastern suburbs.

Having a tool that produces standardised outputs, such as the FWV, and is able to adapt to new innovations and developments is crucial to keep up with demands and new requirements. The standardised information feed can also be used for other processes and semi-automatically create additional outputs. These outputs help to analyse the transport system and make decisions.

If required, further in-detail analysis can be undertaken, using either SATURN or SIDRA software, to understand changes in flows and delays or to calculate different signal timings and phasings. Daily road user dis-benefit calculations, using SATURN modelling outputs, can be determined for works where different work methodologies exist and the modelling is used to determine the preferred option. Also calculating user dis-benefits for alternative work methods can be used to determine which option is best when compared to the construction cost.

The SCIRT traffic management process provides a first valuable review of the TMPs to be submitted to CTOC. The team ensures a consistent standard over all plans is achieved. Before plans are provided to CTOC these plans have been checked, and mistakes or missing information rectified (e.g. format issues, incorrect traffic management set ups, or missing devices). To further ease the TMP process some LOPs were developed and endorsed by CTOC. Considering the challenging times with heightened road work activities, these procedures achieved a better overall level of traffic management and make it easier for road users manoeuvring through a number of sites. This was achieved by reducing the number of required signs and cones per work site, as well as improving site safety. Due to the use of service agreements and generic plans the number of TMPs to process was reduced, and this ultimately reduces the cost of traffic management.

Well-coordinated and good traffic management is essential in safely guiding road users through work sites and keep areas and properties accessible. Re-occurring site checks are undertaken but should be done more frequently to make sure not only individual sites are compliant but also that area-wide traffic management is coordinated and not misleading or confusing for the general public.

The SCIRT approving engineers have the authority to close down sites if deemed unsafe and to hand out non-conformance notices. These powers can make sure the site checks are having enough bearing to achieve good work site standards, without CTOC having to substantially increase the number of audits undertaken to achieve the same coverage.

Good communications with stakeholders, businesses and the public is essential to help set public expectations and to successfully carry out the work. Due to the good communications to date, the people of Christchurch view SCIRT road works mostly as a sign of progress, accept the importance of these works and the disruption they create, and are happy with the amount of information they receive from the communications team. This is shown by an 89% satisfaction rate with SCIRT communications which is considered outstanding when comparing to industry peers. This, by no means, is to be mistaken with the difficulties and frustrations the public experiences when manoeuvring through work sites as patience starts to wear thin, especially in the worst affected areas and it being the fifth year of impacts endured.

All parties involved should convey the same message and be coordinated if applicable (e.g. combined work sites). This avoids confusion and frustration to the road users, be it pedestrians, cyclists or motorists. Setting expectations for the road users is also important. CTOC as well as SCIRT are putting the message out to “allow extra time for your journey”. When road works on strategic routes start, an emphasis is put on this message to avoid making the news and to achieve reductions in traffic flows on the strategic routes by altering some users’ routes and/or timings. Not encountering negative publicity is taken to be a sign of a successful delivery of SCIRT works.

To keep Christchurch traffic flowing, it is essential that accurate information is provided and used by the affected road users. Trustworthy information about road works is required to achieve changes in route choices, times and modes to facilitate the SCIRT and third party programmes.

Only if traffic planning, management and communication teams work together collaboratively is it possible to deploy the magnitude of work sites required to rebuild Christchurch.

As part of this project a public and stakeholder survey was undertaken. Firstly, four experts were surveyed about the initial and current work undertaken in the traffic planning, management and communications space within SCIRT, including some specific initiatives that SCIRT has developed over time. The consensus over all three areas is that since the establishment of SCIRT, all work areas are perceived to have improved over time, but there is still room for improvement.

The FWV seems to be of particular importance due to being able to interface and coordinate beyond SCIRT works. Some initiatives and communication tools were not known by all and indicates some more effort is required to be put into knowledge sharing with the wider transport industry.

Secondly, an indicative survey was undertaken to establish how road users perceive the road works and to get an understanding about the level of satisfaction with the rebuild works. Overall, it seems the general public believe it is difficult to move around Christchurch. This indicates that the public may not have enough information provided to them or they do not know where to find the relevant information regarding works outside their residential areas. It may also mean that the balance between reducing construction costs and not causing extra road user dis-benefits needs more attention. However, given the costly nature and the timeframes provided to rebuild the city, the reduction in road user dis-benefits may not be achievable for all road work sites but is taken into consideration and balanced out during the TMP approval process.

In conclusion, this report has identified that forward works programme knowledge facilitates traffic planning, allowing detailed roading network impact analysis to be undertaken, to determine if the roading network is able to cater for the works whilst still facilitating existing traffic volumes. Knowing the upcoming works also helps to deploy area wide traffic management and communicate ongoing changes to the general public. The developed processes and procedures in traffic planning and management as well as the created communication strategies are not only suitable for post-disaster rebuild response but are also applicable to situations where increased construction activities occur in residential and/or business districts where accessibility and manoeuvrability needs to be ensured whilst the work is being undertaken.

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Appendix A Magnitude of damage

The condition assessment classifies the State Highway and local authority roads damage into minimal to severe, see **Figure 59**. The waste and stormwater pipes are shown as pipes that need repairs or no action is required as the level of service of these pipes is deemed acceptable, see classification in **Figure 60**. Bridges are classified into low and high priorities for repairs and retaining walls are classified into minor and major damage, as shown in **Figure 61**.

These three maps show that there has been extensive damage to the horizontal infrastructure which should come as no surprise given the repair price tag of approximately $2.2 billion to reinstate the horizontal infrastructure in Christchurch to pre-earthquake level of services.

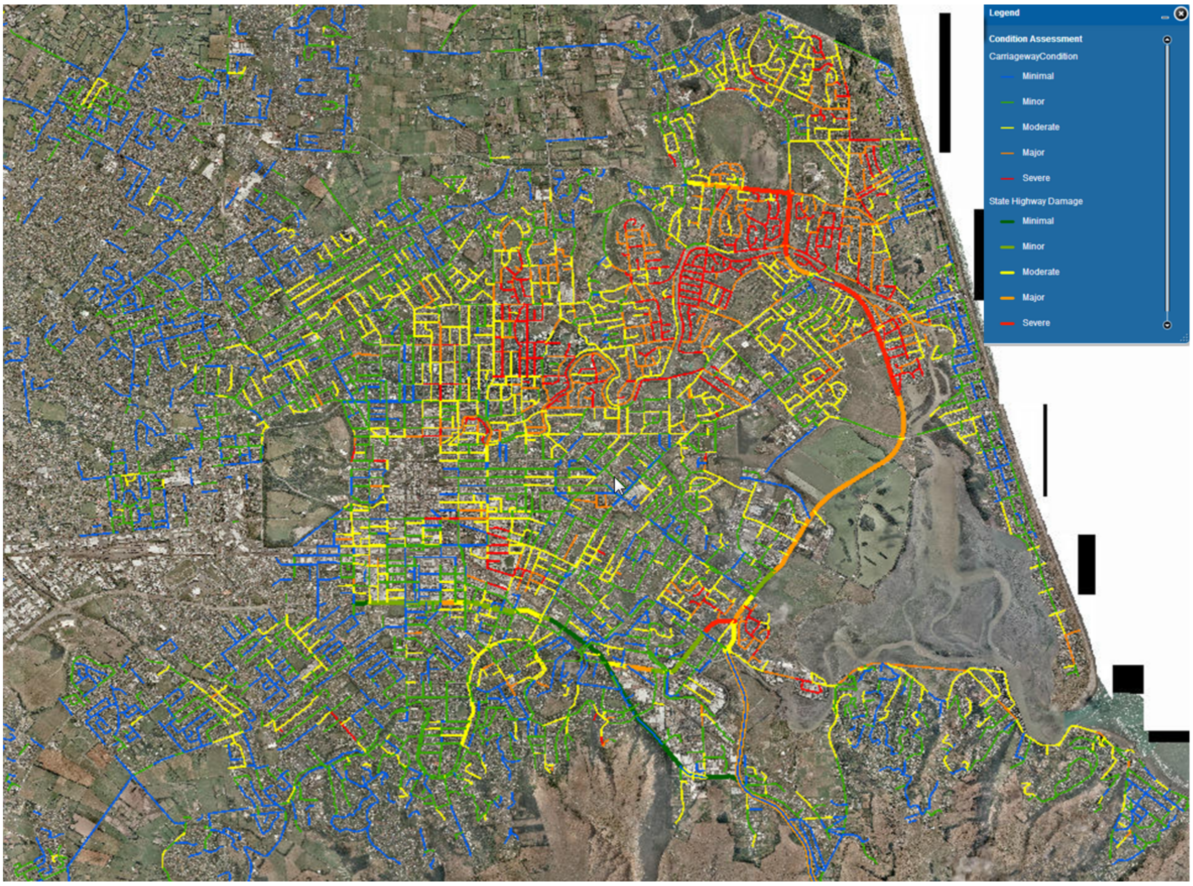


Figure 59: Pavement damage (SCIRT viewer, 2015)

Figure 60: Wastewater and stormwater damage (SCIRT viewer, 2015)

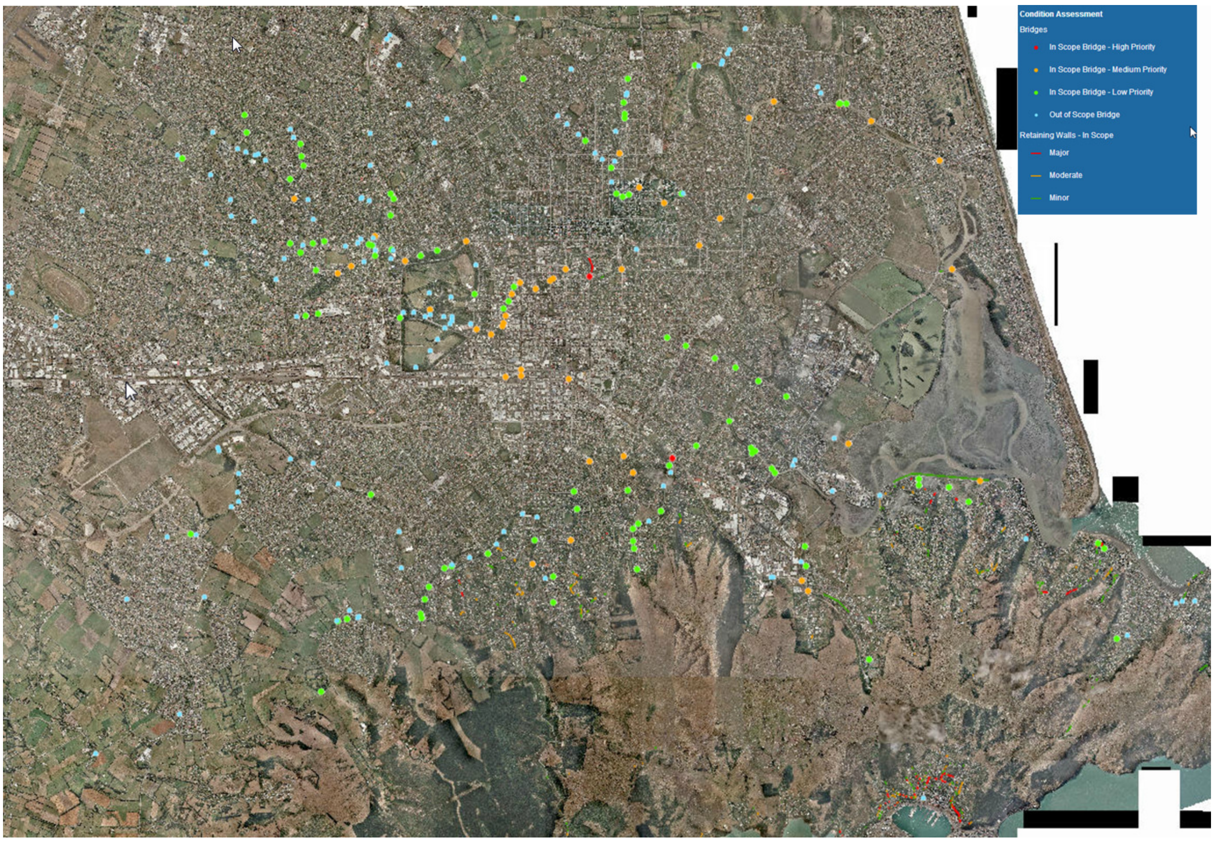


Figure 61: Damaged structures (SCIRT viewer, 2015)

Appendix B Monthly progress by gate

Figure 62 shows the monthly progress by value and gate. It can be seen that during 2014 the value of works in construction was the greatest. The future forecasts shows more and more projects being handed into practical and project completion showing that SCIRT has started to wind down. It is of note that construction is forecast to finish by the end of 2016, the end of the SCIRT programme, with handover, practical and project completion being finished by June 2018.

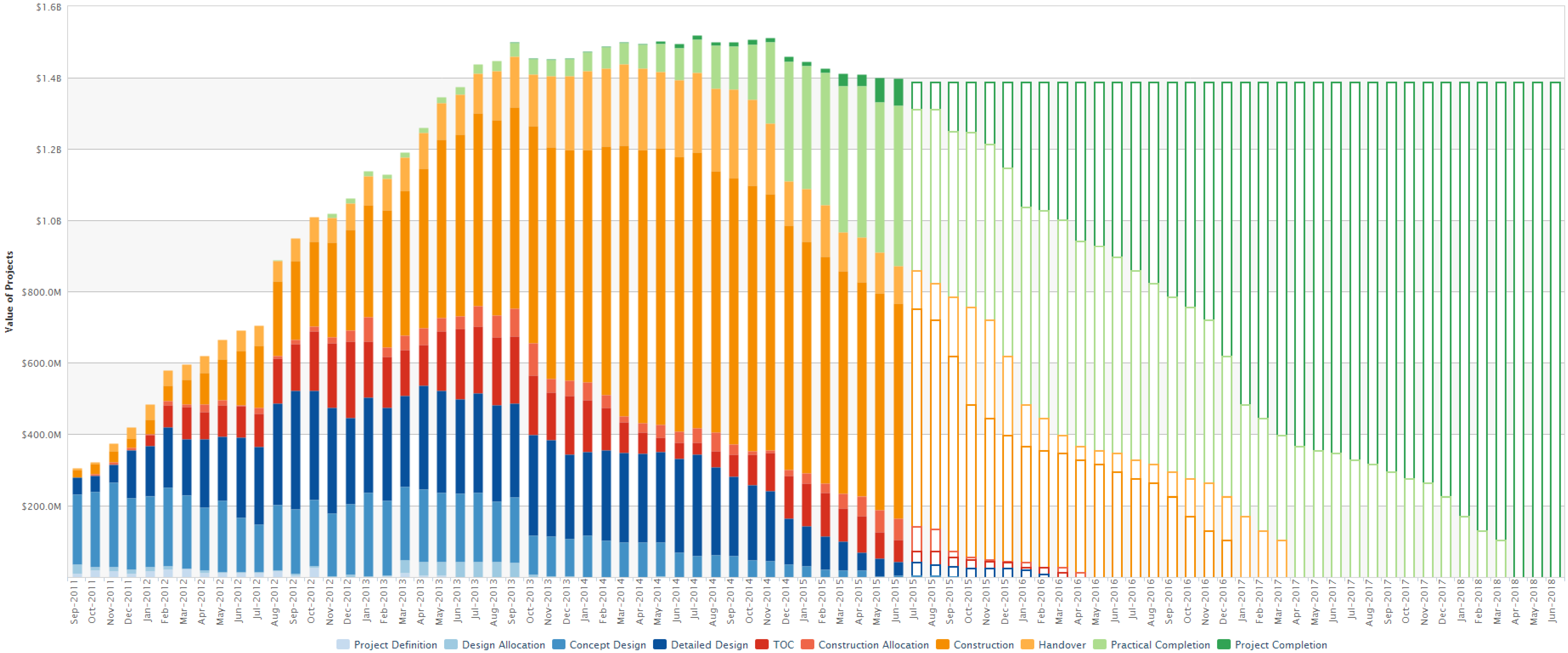
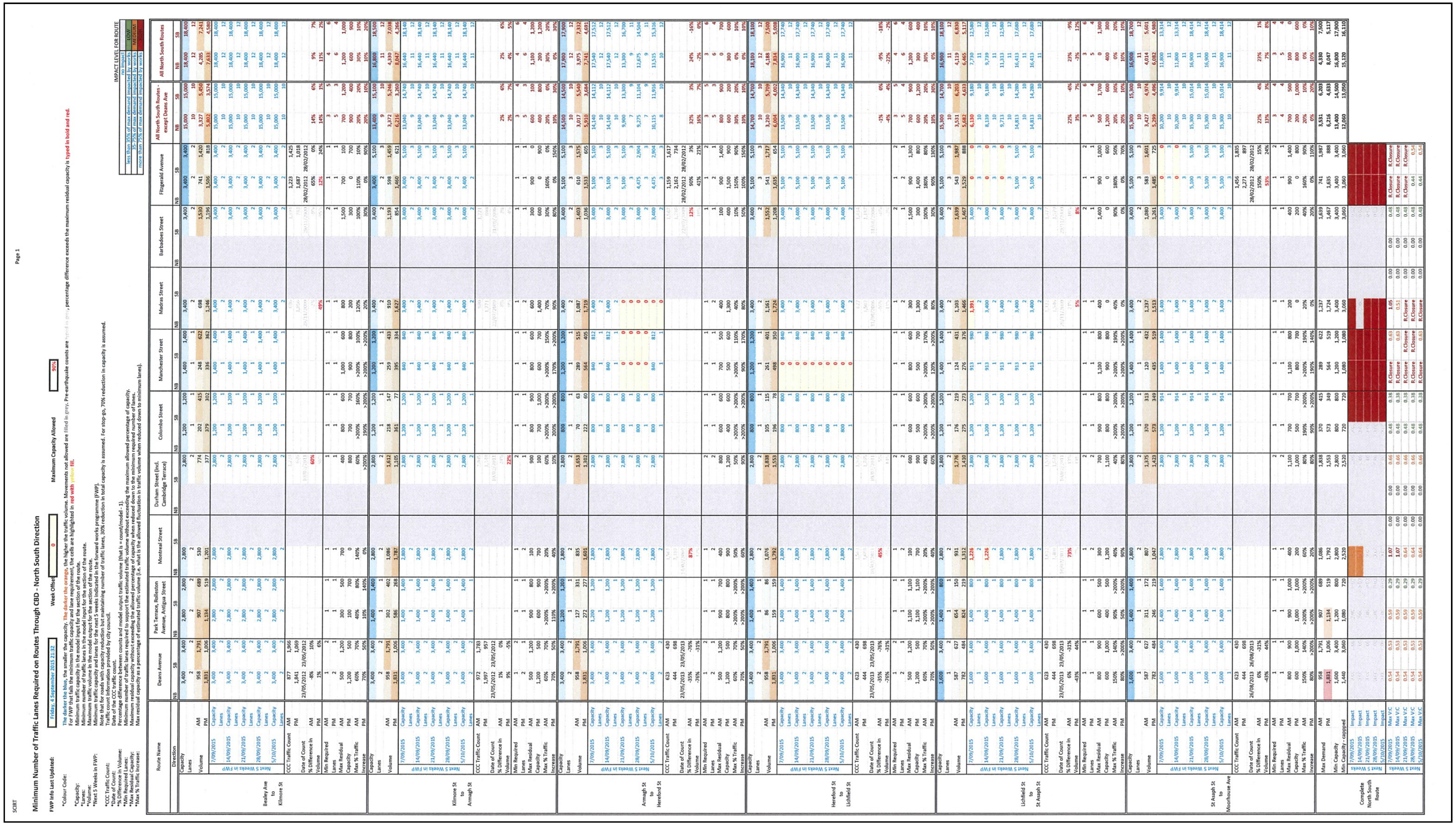


Figure 62: Monthly progress report by Gate (SCIRT internal, 2015)

Appendix C Detailed CBD Analysis Example


Minimum Number of Traffic Lanes Required on Routes Through CBD - North South Direction

Appendix D CTOC requirements

The following flowcharts set out some of the procedures and information required by CTOC to make decisions on submitted TMPs. The delivery teams need to illustrate that the appropriate steps have been undertaken. SCIRT are aware of these requirements and work with the delivery teams to provide the information as requested. CTOC also have some resources and tools to provide information such as Bluetooth data that can be used to provide historical delay information and suchlike.

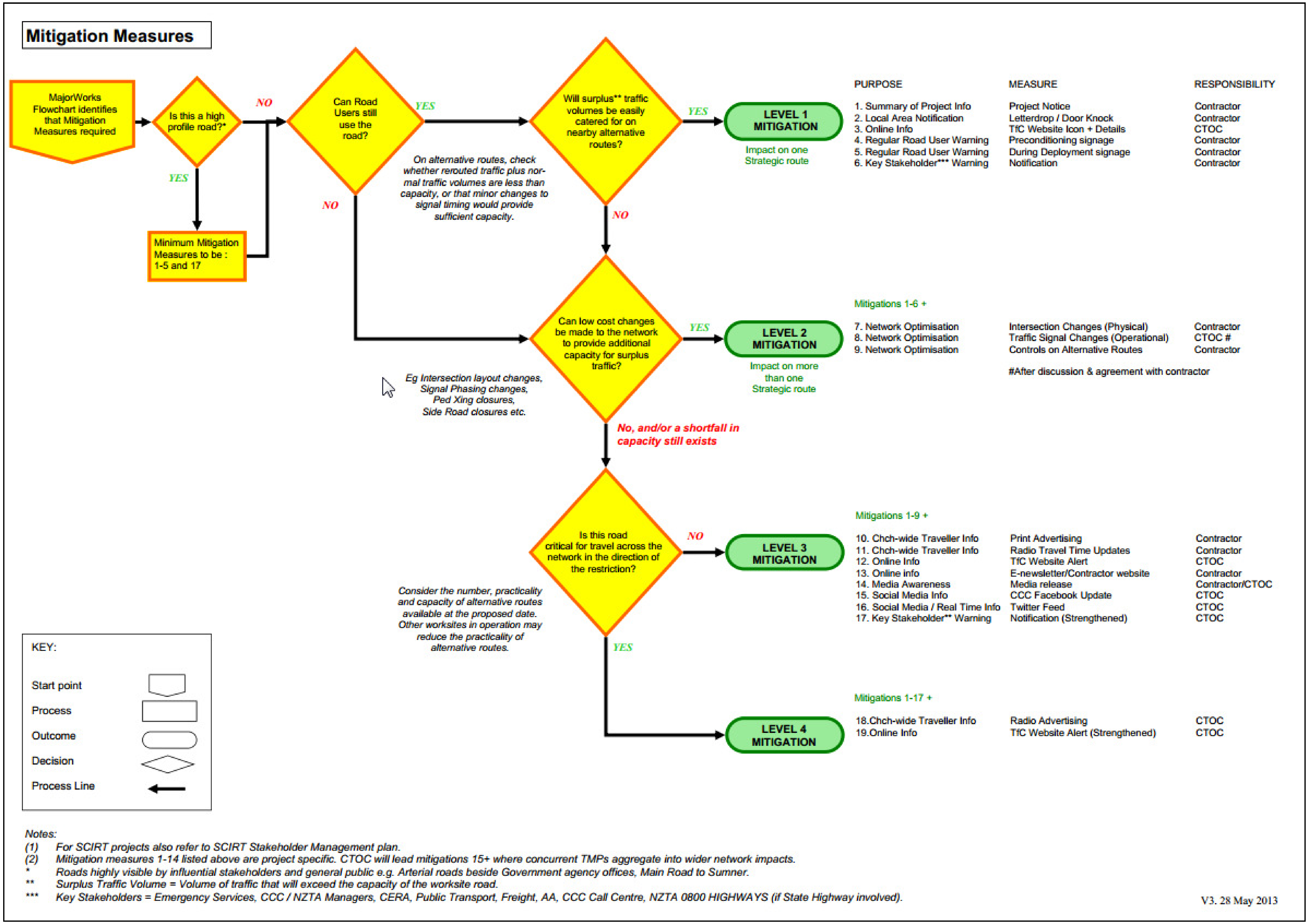


Figure 63: Mitigation Measures (CTOC, 2013)

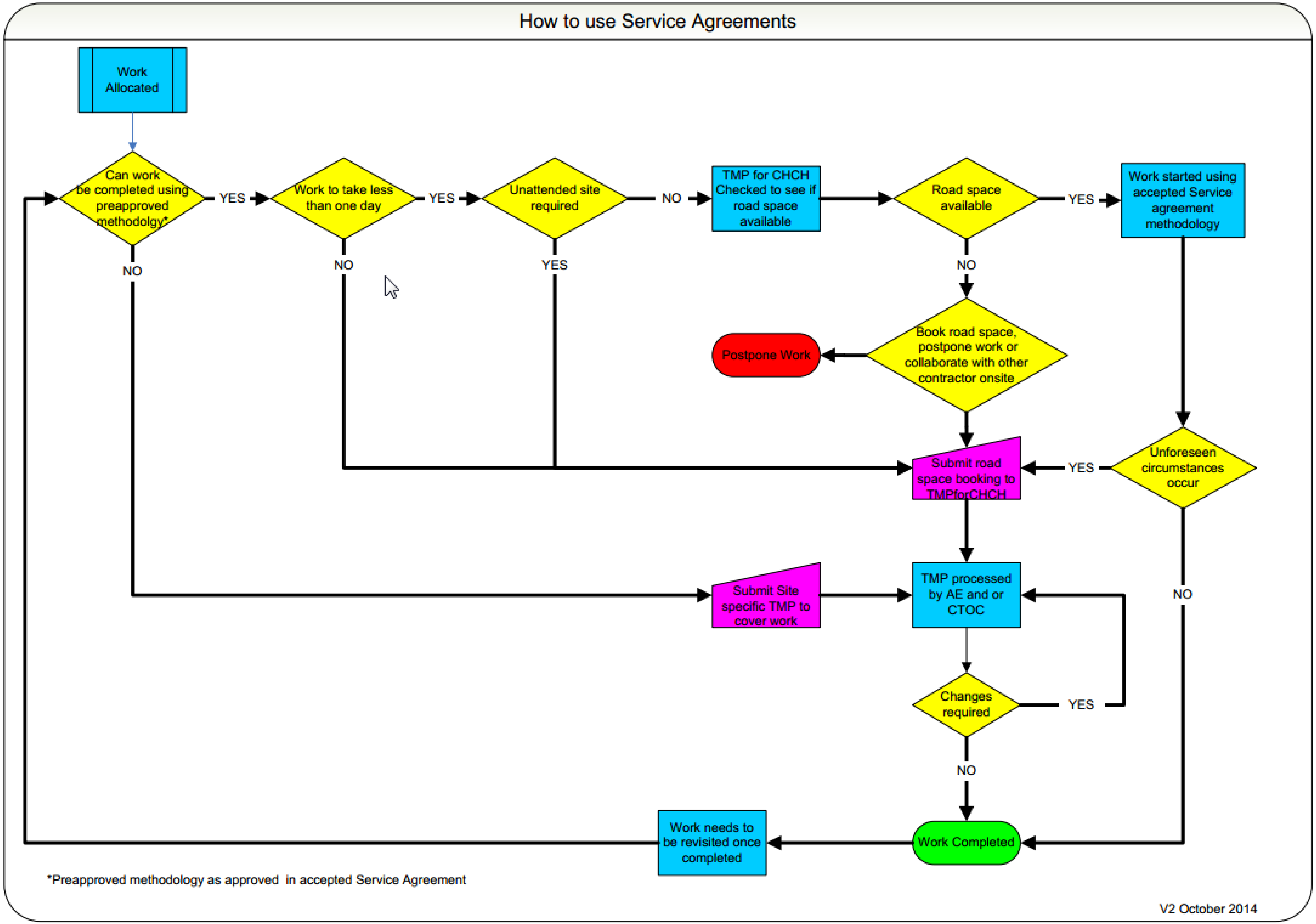


Figure 64: How to use Service Agreements (CTOC, 2014d)

SITE CONDITION RATING (SCR) FORM – FULL AUDIT

Auditor							
Phone		Location					
Name		Activity				Level of TTM	
Qualification/Registration number		RCA	CTOC	Client	SCIRT	Date/Time	

Audit SCR	0-10: High	11-25: Acceptable	25-50: Needs improvement	51+: Dangerous

Audit result (SCR)		TMP sighted	Yes No	TMP appropriate to site	Yes No
Action taken					

Contractor			
Name		Phone	
Qualification/Registration number		STMS/TC	

Signs	Points	Tally	Total
Missing (including side road and TSL)	5 for each sign		
Spacing (too close/far)	2 for each sign		
Not visible	3 for each sign		
Wrong sign	5 for each sign		
Condition marginal	1 for each sign		
Condition unacceptable	4 for each sign		
Permanent signs not covered	2 for each sign		
Unapproved signs used/too small	4 for each sign		
Sign on wrong side	2 for each sign		
Sign too low	1 for each sign		
Faulty TSL	5 for each occasion, 51 if contravenes section C4 of CoPTTM		
Speed limit not correctly aligned	2 for each occasion		
Sign not upright	1 for each sign		
Non-compliant support	2 for each support		
Lateral location wrong	1 for each sign		
		Subtotal	

Delineation devices	Points	Tally	Total
Missing (including chicane) when required	30 where delineation is missing		
Tapers too short	5 for each shifting taper, 20 for each merging taper		
Spacing between multiple tapers	5 for each missing or inappropriate space		
Spacing in tapers	3 for each taper where spacing too great to be effective		
Spacing in lanes	2 where spacing in lanes / around work area is too great		
Condition marginal	1 for each device where classified in marginal condition		
Condition unacceptable	5 for each device where classified in unacceptable condition		
Using non-approved device	4 for each non-approved device		
Road marking incorrect	30 where not adjusted at long term sites		
Inadequate site access	10 where there is inadequate site access where required		
		Subtotal	

Miscellaneous	Points	Tally	Total
Working in live lanes	20 for each occasion		
Flashing beacons not used/not compliant	1 for each vehicle		
High visibility garment not worn/not acceptable	5 for each individual		
Parking/stopping features not relocated	5 for each occasion where required		
Unsafe and/or illegal parking of plant/equipment	20 for each occasion		
Poor surface condition	30 for each occasion		
Safety (lat and/or long) zone insufficient	20 for each safety zone compromised		
Excavation not protected	10 if excavation protection not acceptable		
VMS message incorrect	10 for displaying incorrect information		
Barrier defects	10 for each barrier defect		
TMP not approved/not on attended site	Non-conformance unless produced within 30 min		
No qualified person on attended site	Non-conformance		
Inadequate property access	20 if no arrangement made when entrance blocked		
		Subtotal	

Pedestrians/cyclists	Points	Tally	Total
Inadequate provision for pedestrians	10 where inadequate provision made		
Inadequate provision for cyclists	10 where inadequate provision made		
		Subtotal	

Mobile operations	Points	Tally	Total
Tail pilot vehicle omitted	30 for missing or incorrect location		
Lead pilot vehicle omitted	20 for missing or incorrect location		
Shadow vehicle omitted	20 for missing or incorrect location		
Signs omitted	5 for missing or incorrect signs		
TMA missing or non-compliant	20 for each occasion		
Arrow board missing	20 for each occasion		
Arrow board message	20 for no message or incorrect message		
		Subtotal	

Total of each section = SITE CONDITION RATING		
SITE INDUCTION	5 Bonus points - deducted from total if induction is carried out	
OVERALL SITE CONDITION RATING		

Audit comments:

Traffic control devices manual part 8 CoPTTM Section E, appendix C: Procedures for safety audit of worksites Edition 4, May 2013

Page 1

Figure 65: Site compliance form [amended] (NZTA, 2014b)

Appendix E CERA Work notice for Hospital Corner and Hagley/Moorhouse corner and surrounding streets

An Accessible City

Overview Works Notice

17 November 2014

Changes to road layout at:

- Hagley / Moorhouse Corner and surrounding streets
- Hospital Corner, including Oxford Terrace and Tuam Street

An Accessible City – transport projects

Christchurch has taken the first steps towards a modern central city transport network that works for all kinds of travel.

Christchurch City Council has approved designs for the first two Central City transport projects under the umbrella of *An Accessible City* – the transport chapter of the Christchurch Central Recovery Plan.

An Accessible City is being delivered by the Council and Canterbury Earthquake Recovery Authority, and has been developed in partnership with the New Zealand Transport Agency, Environment Canterbury (ECan) and Te Rūnanga o Ngāi Tahu.

These projects aim to improve traffic flow and provide safer, more people-friendly and enjoyable ways for people to get around our Central City.

For more information about *An Accessible City*, visit
www.ccdu.govt.nz/the-plan
www.ccc.govt.nz/AACtransportprojects

Hagley / Moorhouse Corner and surrounding streets

Friday 21 November to Friday 4 April 2015

The changes at the Hagley Avenue / Moorhouse Avenue intersection and surrounding streets include:

- There will be no entry to Hagley Avenue at the Moorhouse Avenue intersection except for a left turn out of Hagley Avenue onto Moorhouse Avenue.
- Hagley Avenue from Selwyn Street to Moorhouse Avenue will be one-way southbound from late Friday 21 November.
- The existing path in Hagley Park will be widened to a four metre wide shared pedestrian/cycle path.
- There will be no exit from Grove Road onto Moorhouse Avenue.
- A new signalled cycle crossing between Grove Road and Hagley Park will be installed.

Throughout the work there will be changes in on-street parking. There will be no on-street parking within the work sites.

Access to businesses will be maintained during the project.

There will be traffic delays associated with this work, please allow extra travel time for your journey.

There will also be changes to the road layout during the work. Please be on the lookout for detour marked signage and VMS boards.

Further information about the project will be distributed throughout the life of the project.

For further information please contact Fulton Hogan on 0800 277 3434 or email: rebuildinfo@fultonhogan.com

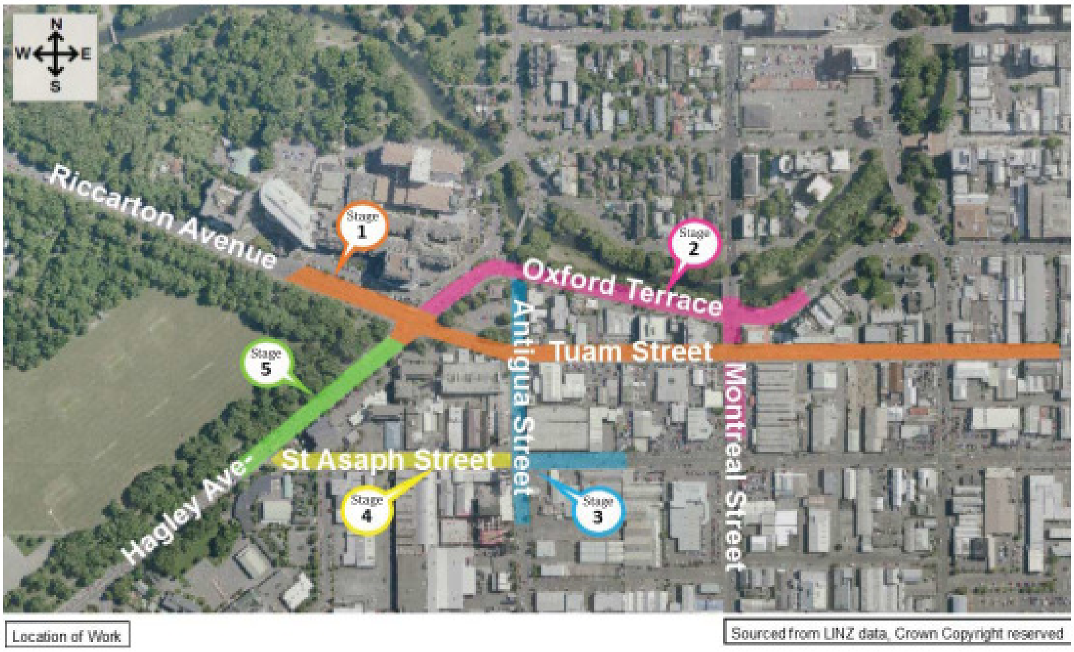
Work area: Hagley / Moorhouse Corner and surrounding streets

Te Rūnanga o NGĀI TAHU | NZ TRANSPORT AGENCY | CERA | Environment Canterbury Regional Council | Christchurch Central Development Unit | Christchurch City Council

An Accessible City

Hospital Corner, including Oxford Terrace and Tuam Street

Monday 24 November to Thursday 5 February 2015



Work will be done in five stages:

Stage One

Part A: Work will start at the Hagley Avenue, Riccarton Avenue, Tuam Street and Oxford Terrace intersection. This work will start on Monday 24 November 2014 and take about three weeks to complete.

We will be changing the layout at this intersection. The work will involve:

- Replacing the existing traffic islands, footpaths and kerb and channel
- Trenching to allow the installation of new traffic signals
- Replacing sections of the road surface
- Removing and replacing line marking

Traffic Impacts: Traffic flow will be maintained throughout construction. There will be times when there will be lane width reductions and diversions.

Part B: Work will take place at the same time as Part A, on Tuam Street between Colombo Street and Hagley Avenue.

We will be changing Tuam Street to a one-way system with east bound traffic. This work will include:

- Removing existing line marking and installing new line marking
- Modifications to traffic signals and signage

Traffic Impacts: We will be working east to west, between intersections. Each block will take about one week to complete. We will close each block to traffic while we are working, however access to businesses will be maintained.

Permanent Changes:

- Tuam Street will be converted to one-way east bound traffic flow.

Te Rūnanga o NGĀI TAHU · NZ TRANSPORT AGENCY · CERA · Environment Canterbury Regional Council · Christchurch Central Development Unit · Christchurch City Council

Stage Two

We will be working on Oxford Terrace, between Hagley Avenue and Montreal Street. Work will include:

- A temporary pedestrian route will be installed, using water filled barriers
- Temporary crossing points will be constructed for pedestrians
- Removing existing line marking and installing new line marking

Traffic Impacts: There will be road closures and lane restrictions in place while we are working. Taxi bays will be maintained and relocated to a temporary position. This work will take about one week to finish.

Permanent Changes:

- There will be changes to on street parking
- Oxford Terrace will be converted to one way west bound traffic flow between Montreal Street and Antigua Street.

Stage Three

We will be working on Antigua Street, between St Asaph Street and Oxford Terrace. We will be changing the road layout. This work will start when Stage One is finished. This work will include:

- Removing existing line marking and installing new line marking
- Modifications to traffic signals and signage

Traffic Impacts: We will be working from the south to the north, between intersections. We will close each block to through traffic while we are working, however, access to businesses will be maintained. This work will take about two weeks to finish.

Stage Four

We will be working on St Asaph Street between Antigua Street and Hagley Avenue. Work will include:

- Removing traffic islands
- Removing existing line marking and installing new line marking
- Modifications to traffic signals and signage

Traffic Impacts: We will be working between intersections. There will be road closures and lane restrictions in place while we are working, however, access to businesses will be maintained. This work will take about one week to finish.

Permanent Changes:

- The existing west bound one way traffic direction on St Asaph Street will be extended between Antigua Street and Hagley Avenue.

Stage Five

We will be working on Hagley Avenue from Riccarton Avenue to just past St Asaph Street. Work will include:

- Removing traffic islands and minor footpath work
- Removing existing line marking and installing new line marking

Traffic Impacts: We will be working between intersections. There will be road closures and lane restrictions in place while we are working, however, access to businesses will be maintained. This work will take about one week to finish.

Permanent Changes:

- There will be two left hand turn lanes from Hagley Avenue to Riccarton Avenue.
- There will be changes to on-street parking

Overall

Throughout the work there will be changes to on-street parking. There will be no on-street parking within the work sites.

Be aware of changes to the road layout – if there are road closures, there will be sign marked detours. Please follow on site signage and VMS boards in each work area.

Access to businesses will be maintained.

The city's transport partners are working together to make the city more accessible. There are major changes for Hospital Corner and Hagley / Moorhouse Corner.

Downer, as part of SCIRT, is delivering the Hospital Corner changes between November 2014 and February 2015.

For further information about construction please contact Downer by email at **eqinfo@downer.co.nz** or by phone on **0800 400 310**.

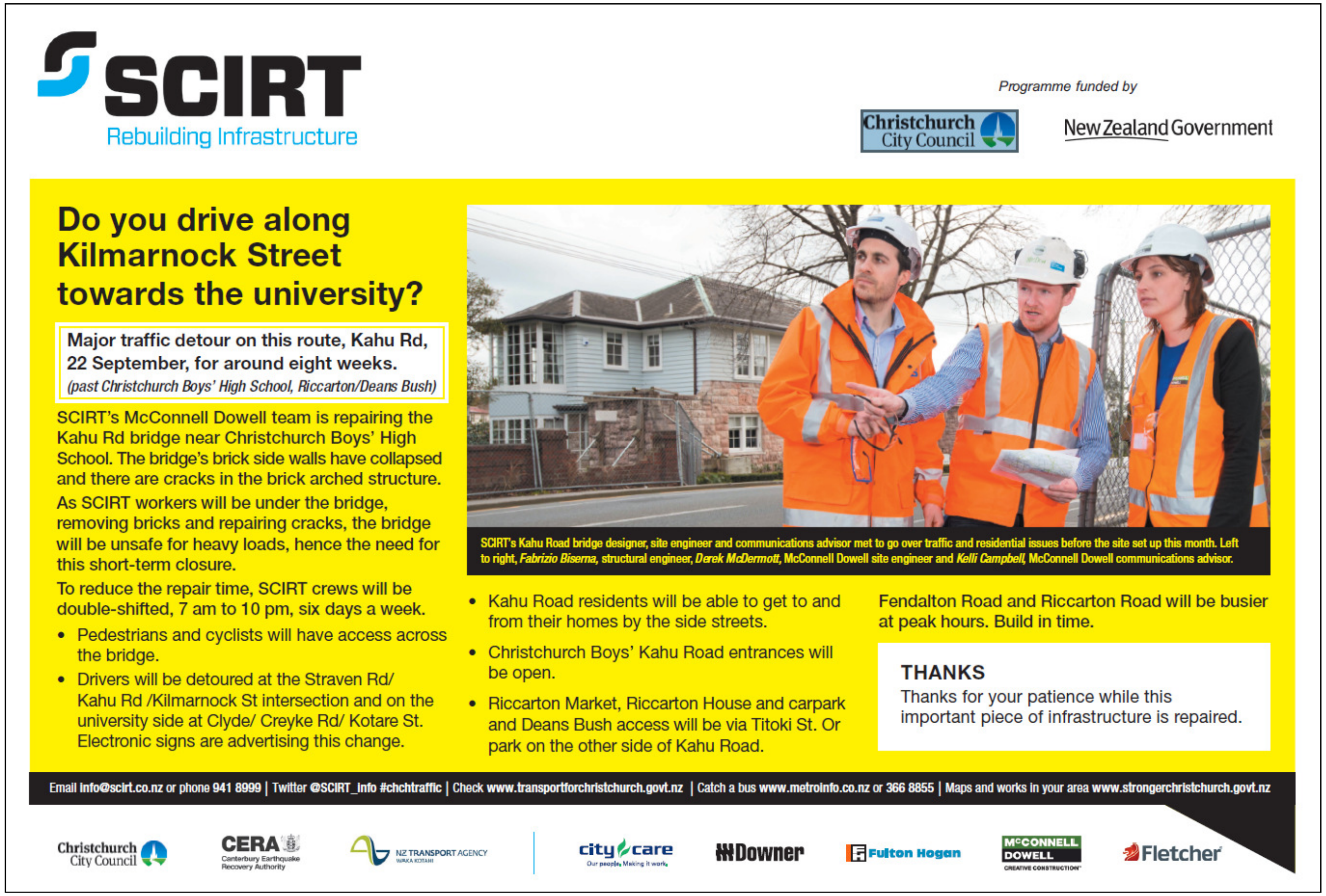
Appendix F TIM meeting minutes excerpt (5 Gantt-chart review)

5	Gantt Chart Review	Objective: To preapprove as many project sites as possible. Reviewed from: 29 July 2014 to end September 2014 Pre-approvals given to: end-September Pre-Approvals were based primarily on Tier 1 analysis (Network Capacity) – interconnecting routes and access provisions were not specifically considered. Therefore some 'Pre-Approved' projects may need to be re-sequenced where necessary to maintain reasonable access through network. **PEAK HOUR IMPACTS:** **SOUTHBOUND:** Barbadoes St 1. Pre-approval given to all 1-lane drops. Colombo Street 2. Outside of assessment period Durham Street North / Cambridge Tce 3. Pre-approval given to 1-lane drops. Durham Street South 4. 11062 / 13 PLD requested for 1-lane drop to confirm methodology.	
		Fitzgerald Ave 5. Pre-approval given to 1-lane drops. Manchester Street	**PLD – Downer**
		6. 11028 / A55320, A55168, A55170, A55180 – Data Validation requested on length of programme	**Data Validation – Fletcher**
		7. Full Closure of Manchester Street given pre-approval in principle under the following conditions: Colombo Street open north of Square, cross-link detour routes to Colombo are open (e.g. Cambridge, Oxford, Armagh, Gloucester), data validation on programmed duration above (understood to be 10 weeks or less), and that construction is completed efficiently. ECan notes that Manchester becomes "signed" bus route from Dec forward. Antigua Street 8. Pre-approval given to one-way closures.	

	NORTHBOUND: Colombo Street 9. One-way closures pre-approved for assessment period Fitzgerald Ave 10. Outside of assessment period Madras St 11. 1-lane drops pre-approved for assessment period. 12. Long term work noted until Jan 2015. Manchester St 13. One- way closures pre-approved for assessment period 14. Full closure, see conditions as noted above southbound (pt 7) Montreal St 15. 11062 / 14, 19, 20 – Urgent PLD request for 1-lane drop. 16. 10953 / 286 – Urgent PLD request for 1-lane drop Antigua Street 17. 11062 / 12 – PLD request for one-way closure to consider interaction with Southbound 18. 10953 / 263, 284, 285 – PLD request for one-way closure to consider interaction with Southbound	**Urgent PLD - Downer** **Urgent PLD - MacDow** **PLD - Downer** **PLD - MacDow**

Appendix G Kahu Road Bridge Repairs Communications

Newspaper adverts



Work Notice

SCIRT

Rebuilding Infrastructure

Rebuilding earthquake damaged roads, water, wastewater and storm water pipes.

Ref: 10971

2 September 2014

Overview notice: Kahu Road Bridge, Fendalton, bridge repair

What	**Repair of the earthquake damaged Kahu Road Bridge.**
When	**From mid September 2014 for around two months.**
Traffic	**Bridge closure. Vehicles will be detoured via the surrounding streets.**

What we are doing-

The Kahu Road Bridge suffered damage in the February 2011 earthquake and needs to be repaired. This work is scheduled to begin mid September and will take approximately two months.

There are two main sections of work to repair the bridge. The first section of work involves repairing two cracks under the bridge. To undertake this work we will be removing bricks and grout injecting the cracks, we will then re-insert the bricks. Alongside this, to improve the bridge's structural integrity, we will be cross pinning bars horizontally under the bridge and cross stitching bars on angles.

The second section of work involves repairing the walls of the bridge. This will be done at the same time as the cracks are repaired.

Traffic impacts-

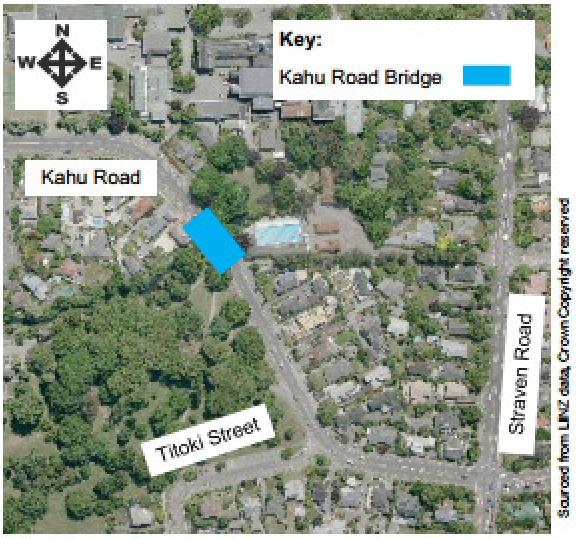
We will need to close Kahu Road bridge to vehicles for the duration of the work.

At this stage, we are looking at a closure date of Monday 22 September 2014.

We need to close the bridge because we need to take bricks out from under the bridge and restore the mortar. This will mean that the bridge cannot withstand heavy loads. As our workers will be under the bridge repairing the cracks, it is for their safety and the safety of the public that the bridge is closed.

During the week beginning Monday 1 September, you may see our crews working around the bridge. Our crews will be doing preliminary works and there will be no traffic impacts. By establishing a site early we will be able to speed up our works on the bridge.

Where we are working-



Map 1: Location of works

Pedestrian Impacts-

The bridge will remain open to pedestrians and cyclists for the duration the works. While we work on the walls, we will need to close the footpath on one side of the bridge at a time. The other side of the bridge will remain open. Please follow all on-site signage.

Keeping informed

If you would like to keep informed about the progress of the bridge while it is repaired please send an email to **christchurch.comms@mcdgroup.com** with Kahu Road Bridge in the subject line.

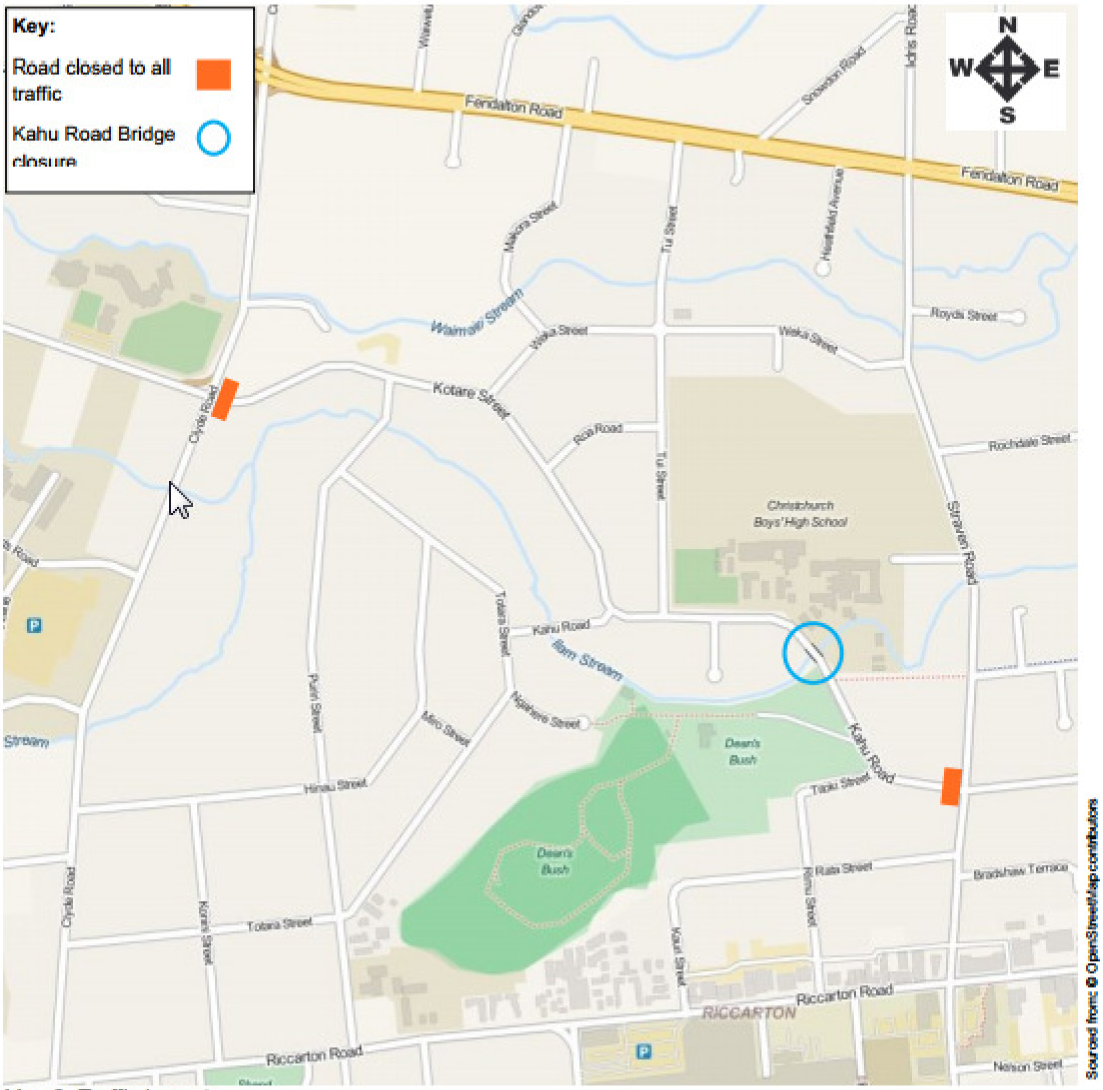
Email: info@scirt.co.nz
www.strongerchristchurch.govt.nz
Visit our website and sign up to receive our e-newsletter for the latest information.
Follow us on Twitter @SCIRT_info

McCONNELL DOWELL CREATIVE CONSTRUCTION

Programme funded by

Christchurch City Council

New Zealand Government



Map 2: Traffic impacts

How this work will impact you-

The intersections of Clyde Road and Kotare Street and Straven Road and Kahu Road will be closed to all through traffic. Motorists are advised to use Fendalton Road or Riccarton Road. Residents within the road closure will be able to enter and exit their homes using side streets.

Residents south of the bridge-

Residents to the south of Kahu Road Bridge will be able to access their homes via Kauri Street or Rimu Street from Riccarton Road or Rata Street from Straven Road.

Residents north and west of the bridge-

Residents to the north and west of Kahu Road Bridge will be able to enter and exit their homes from Konini Street or Puriri Street off Riccarton Road or Totara Street or Hinau Street from Clyde Road or Makora Street or Tui Street from Fendalton Road or Weka Street from Straven Road.

Cyclists and pedestrians-

The intersections and the bridge will remain open to cyclists and pedestrians.

Email: info@scirt.co.nz
www.strongerchristchurch.govt.nz
Visit our website and sign up to receive our e-newsletter for the latest information.
Follow us on Twitter @SCIRT_info

McCONNELL DOWELL CREATIVE CONSTRUCTION

Programme funded by

Christchurch City Council

New Zealand Government

GO THE EXTRA MILE
FOR BUSINESSES AFFECTED BY REBUILD ROADWORKS

During this and other rebuild work we encourage you to help keep Christchurch moving by:

- Allowing extra time for your journey
- Combining activities in one trip and walk or cycle for shorter trips
- Using the bus. Visit **www.metroinfo.co.nz** or phone 366 88 55 for more information
- Finding the quickest and safest routes around Christchurch at **www.transportforchristchurch.govt.nz**
- Supporting your local businesses

While the bridge is closed, access will be maintained to properties, businesses and Christchurch Boys High School via side streets.

History of the bridge-

Kahu Road Bridge was built in 1946. We have worked closely with Environment Canterbury and Christchurch City Council (CCC) archeologists to ensure the works are carried out with safety and the history of the bridge in mind.

We plan on using as many of the old bricks as we can by taking the bricks next to the cracks out and placing them back in with mortar and strengthening them. Where this is not possible, due to damage to the bricks, we will need to use new bricks.

General information -

For this work we will be working Monday to Saturday between 7am and 10pm.

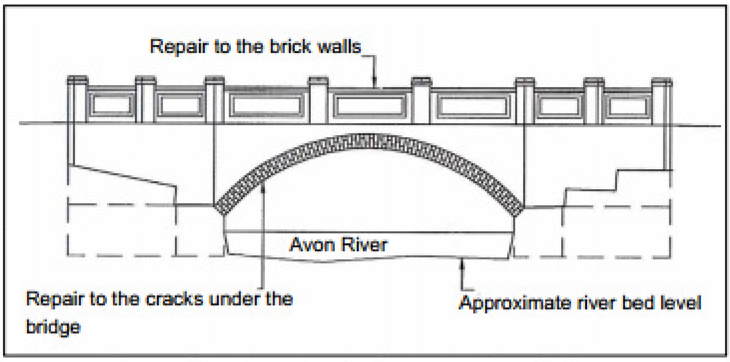
Safety is our number one priority. Safety is your priority too. Stay clear and stay alert - keep children and pets a safe distance from the work site.

All our works are subject to favourable weather and on-site conditions.

As part of this work we will be working close to trees. To avoid damaging trees, we will consult with a CCC arborist. If we need to remove a tree, we will work closely with the CCC to meet any removal and replacement requirements.

Works will have no planned impact on current power, telecommunications, water or gas services. However, the network is still fragile so please be prepared in case there is an unexpected outage.

There will be increased noise, dust and vibration levels associated with this work.



Picture of the planned repairs for the Kahu Road Bridge

Need more information?

Contact the McConnell Dowell Infrastructure Rebuild Team

Call McConnell Dowell on: 0508 718 719 (8.30am - 5pm, Monday - Friday)

Email McConnell Dowell : Christchurch.comms@mcdgroup.com

Visit the SCIRT Website: www.strongerchristchurch.govt.nz

Email: info@scirt.co.nz
www.strongerchristchurch.govt.nz
Visit our website and sign up to receive our e-newsletter for the latest information.
Follow us on Twitter @SCIRT_info

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Radio Announcements

EDITED for Duncan: Two adverts for radio – Kahu Road closure pre and post Sept/ Oct 2014 school holidays.

– SCIRT intros and outros

DRAFT: Duncan Gibb on Kahu Road closure

30-ish words - 15 second advert

SCIRT TRAFFIC UPDATE:

> Duncan Gibb here, from SCIRT, with a headsup. From Monday, 22 September, Kahu Road, near Boys High, is closing to traffic for two months. Fendalton and Riccarton Roads will be busy, so plan your trip.
>
> 35 words

SECOND advert for when the school holidays come to an end:

SCIRT TRAFFIC UPDATE:

> Duncan Gibb here, from SCIRT, with a headsup. Kahu Road, near Boys High, is closed for a few more weeks. Fendalton and Riccarton Roads will be busy so please plan your trip.
>
> 33 words

Appendix H Expert Survey

Questionnaire and Responses:

Stakeholder Survey
Intent of this survey
My name is Kerstin and I am studying towards my Masters in Engineering (Transportation). As part of my masters I am writing a project about the traffic management and transport planning undertaken by the Stronger Christchurch Infrastructure Rebuild Team (SCIRT). This survey has been created for a small panel of transport experts who have been involved in the rebuild over a prolonged period of time. This survey is about the work undertaken by the Stronger Christchurch Infrastructure Rebuild Team (SCIRT) in the traffic and transport space. The aim is to get an opinion from the experts on how the traffic and transport has been conducted at the beginning of the rebuild and how it is conducted now. I would appreciate it if you could fill out this short survey to the best of your knowledge. Please use the provided link to log your survey results or use the provided form and send the completed form back to Stinchen79@yahoo.com. Thank you in advance for completing this survey. Please feel free to get in contact with me if you would like to discuss or clarify anything (mobile 021 214 9424). Definitions: Traffic Planning refers to the application of planning techniques to aid in the assessment of proposed road works. Road works can impact on the network capacity and to avoid grid locking the city a balance need to be achieved between network efficiency, safety and economic efficiency. Traffic Management is required to clearly control traffic disruptions caused by works impacting on the road corridor (footpath and live lanes). It requires a coordinated approach undertaken through Traffic Management Plans (TMPs). TMPs determine the placement of cones, signs etc for the duration of the road works. TMPs aim at facilitate safe work areas as well as safe manoeuvring through road works. Communications refers to traveller information. Traveller information keeps the public informed about upcoming and ongoing work. Travel Demand Management is the application of strategies and/or policies to reduce travel demand (specifically single occupancy car travel), or the redistribution of the demand to alternative routes and/or time periods.

Total number of respondents:	4

Q1: How well do you think SCIRT undertook Traffic Planning at the start of the rebuild work?

	Very well	Moderately well	Neutral	Not at all well	Poorly	Total answered
Absolute values	0	0	3	1	0	4
Percentages	0%	0%	75%	25%	0%	100%

Q2: How well do you think SCIRT's Traffic Planning is currently undertaken?

	Very well	Moderately well	Neutral	Not at all well	Poorly	Total answered
Absolute values	1	3	0	0	0	4
Percentages	25%	75%	0%	0%	0%	100%

Has it improved? If yes, how?

Respondent	Answer
1	Better thinking early in life cycle of about projects about the need to manage site safety AND minimise impact of SCIRT works on network performance and adjacent land owners; it was at times SCIRT trumps everything.
2	Yes, the planning seems more integrated with the rest of the work, whereas initially the work was approved and not taken into consideration with the wider context.
3	The most significant change relates to pre-planning and coordination enabled through longer lead times. At the beginning the transport planning was reactive/fire fighting in order to resolve individual issues at isolated sites. Now the network wide impacts are much better coordinated.
4	Yes, there is a lot of coordination that is happen between projects that are being delivered by SCIRT and the effects of diverted traffic is taken into account.

Q3: Do you think SCIRT's Traffic Planning in Christchurch could be improved?

	Not at all	A little bit	Somewhat	Quite a bit	A lot	Total answered
Absolute values	0	1	1	2	0	4
Percentages	0%	25%	25%	50%	0%	100%

If you think it could be improved please tell me how.

Respondent	Answer
1	Still opportunities to improve co-ordination between SCIRT sites, work of others and at times think about spending a little more on temporary route works to improve the experience; planning for the vulnerable users still seems to be secondary to vehicle traffic in most sites.
2	I think that SCIRT and the An Accessible Cities teams, along with Transfield, could be closer aligned, at least on the key traffic routes.
3	The transport planning lead times decreased in 2015 compared to 2014. As a result the ability to perceive opportunity's to reschedule or modify the work programme have decreased.
4	Always room for improvement.

Q4: How well do you think SCIRT's road works were communicated to the public at the beginning of the rebuild work?

	Very well	Moderately well	Neutral	Not at all well	Poorly	Total answered
Absolute values	0	2	1	1	0	4
Percentages	0%	50%	25%	0%	0%	100%

Q5: How well do you think the traffic updates are communicated to the public now?

	Very well	Moderately well	Neutral	Not at all well	Poorly	Total answered
Absolute values	1	3	0	0	0	4
Percentages	25%	75%	0%	0%	0%	100%

Has it improved? If yes, how?

Respondent	Answer
1	Style of comms has adapted to the change in community tolerance for road works - early days there was a lot of tolerance to poor planning and comms as everyone accepted it was frantic BUT there is now high expectations for high quality on both fronts - public support for the work of SCIRT is high so that is a sign it is working well.
2	Quite a lot of improvement has taken place over the timeline of SCIRT, now advertising on radio and more frequently in newspapers.
3	Appears to be similar now to early on.
4	Comms have improved significantly and the public has learnt that they can trust the information they are being provided with.

Q6: Do you think there is room for further improvement regarding SCIRT's traffic communications with the public?

	Not at all	A little bit	Somewhat	Quite a bit	A lot	Total answered
Absolute values	0	2	2	0	0	4
Percentages	0%	50%	50%	0%	0%	100%

Please specify what to improve.

Respondent	Answer
1	Keep on doing what they are doing BUT keep adapting for changes in community expectation and tolerance especially as we near programme end and some disappointment is likely in the scope of the SCIRT programme. May need to think about use of social networks as these will play a higher role in public complaints
2	The residents may be getting a bit burnt out now, so they may not be reading information as they should. But there will always be opportunities to improve to get residents to engage.
3	Further improvements to the quality of information through enhanced data accuracy. This is a combination of project management, traffic planning and comms teams.
4	.

Q7: Which of the following communications from SCIRT about traffic conditions have you seen or heard in the past month?

		Yes	No	Total answered
"SCIRT Traffic News" newspaper advertisements	Absolute values	4	0	4
	Percentages	100%	0%	100%
Weekly "SCIRT Traffic Update" email	Absolute values	3	0	3
	Percentages	100%	0%	100%
"SCIRT Traffic Updates" on radio	Absolute values	2	1	3
	Percentages	67%	33%	100%
SCIRT website	Absolute values	2	1	3
	Percentages	67%	33%	100%
SCIRT traffic news in CTOC updates	Absolute values	4	0	4
	Percentages	100%	0%	100%
None of the above	Absolute values	0	0	0
	Percentages	0%	0%	0%
Other	Absolute values	0	0	0
	Percentages	0%	0%	0%

If you said "Yes" to Other, please specify.

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Q8: How well do you think Traffic Management was implemented at the beginning of the rebuild works?

	Very well	Moderately well	Neutral	Not at all well	Poorly	Total answered
Absolute values	0	1	1	2	0	4
Percentages	0%	25%	25%	50%	0%	100%

Q9: How well do you think Traffic Management is implemented now?

	Very well	Moderately well	Neutral	Not at all well	Poorly	Total answered
Absolute values	1	2	1	0	0	4
Percentages	25%	50%	25%	0%	0%	100%

Has it improved? If yes, how?

Respondent	Answer
1	At times in the early days there seemed to be little logic flow for TM from one site to another adjacent site if being managed by anther NOP; partly this seemed to blind adherence to COPTTM rather than thinking about managing a traveller experience at the site. This has improved through thinking holistically about sites and their interaction with others.
2	As mentioned above I think that CCC and NZTA need to get a better control over who is working in the road space and force alignment of programs through their governance structure.
3	The quality of delivery has improved through enhanced delivery teams culture and behaviours.
4	Consistency between sites, reduction of unnecessary traffic management.

Q10: Do you think there is room for further improvement regarding Traffic Management?

	Not at all	A little bit	Somewhat	Quite a bit	A lot	Total answered
Absolute values	0	2	0	2	0	4
Percentages	0%	50%	0%	50%	0%	100%

Please specify what to improve.

Respondent	Answer
1	At times the TM plan should be thought of more widely in terms of the adjacent network effects with a view to identifying opportunities to invest / spend a little bit more to improve the experience and minimise network effect. Some really good recent examples such as Moorhouse Aves to what can be done with some good thinking even if the site is very complex.
2	Alignment of programs.
3	There is still a lot of room for enhancements to the behaviour of the delivery teams around active management of sites. Minimising impacts when space is not required and deployment times that are consistent with project works, not hours before or after the works time frames.
4	.

Q11: What do you think is the most important traffic planning tool used by SCIRT? Eg: Forward Works Viewer, Traveller Information, Transport Modelling, VMS Strategy, else. Please specify which tool and why.

Respondent	Answer
1	FWV if well used it encourages and supports wider network thinking which is critical to managing traveller expectations.
2	VMS Strategy seems to be pretty effective and quick to change and really 'in your face'. I am not sure if FWV is the best tool because not everyone is using it.
3	All of the above. The transport system is made up of demand and supply elements - both need to be managed to be successful. That said the transport planning and management all starts with the FWV.
4	I think all have proven to be important in coordinating works to minimise impact to travelling public and to inform them of the potential impact.

Q12: Are you familiar with any of the SCIRT Guidelines or initiatives that have been released/developed?

		Yes	No	Total answered
Cycle Treatment Guide	Absolute values	2	2	4
	Percentages	50%	50%	100%
Speed Management Guide	Absolute values	3	1	4
	Percentages	75%	25%	100%
Service Agreements	Absolute values	2	2	4
	Percentages	50%	50%	100%
VMS Strategy	Absolute values	3	1	4
	Percentages	75%	25%	100%
Delegated Authority for TMP Approval	Absolute values	3	1	4
	Percentages	75%	25%	100%
Overarching STMS for Site Coordination	Absolute values	2	2	4
	Percentages	50%	50%	100%
Temporary Traffic Management Awards	Absolute values	2	2	4
	Percentages	50%	50%	100%
Local Operating Procedures	Absolute values	2	2	4
	Percentages	50%	50%	100%
Pro-forma TMP Template	Absolute values	1	3	4
	Percentages	25%	75%	100%
Traffic Managers Tactical Group	Absolute values	2	2	4
	Percentages	50%	50%	100%

Q13: Do you think there should be a greater focus on Travel Demand Management?

	Yes	No	Total answered
Absolute values	3	1	4
Percentages	75%	25%	100%

Q14: If you answered "Yes" in Question 13., please specify in which areas?

		Yes	No	Total answered
Increase public transport use	Absolute values	3	0	3
	Percentages	100%	0%	100%
Increase number of cyclists	Absolute values	2	0	2
	Percentages	100%	0%	100%
Increase number of walkers	Absolute values	2	0	2
	Percentages	100%	0%	100%
Inform about alternative travel times (peak spreading)	Absolute values	3	0	3
	Percentages	100%	0%	100%
Inform about alternative travel routes (detours)	Absolute values	3	0	3
	Percentages	100%	0%	100%
Other measures	Absolute values	0	0	0
	Percentages	0%	0%	0%

If you said "Yes" to Other measures, please specify.

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Appendix I Public Survey

Questionnaire and Responses:

Keep Christchurch Moving Social Media Survey
Intent of this survey
Hi, my name is Kerstin and I am studying towards my Masters in Engineering (Transportation). As part of my masters I am writing a project about the traffic management and transport planning undertaken by the Stronger Christchurch Infrastructure Rebuild Team (SCIRT). I would appreciate it if you could fill out this short survey. This is an indicative survey and is undertaken to achieve an understanding as to how the road users in Christchurch perceive and tolerate the rebuild works. The results are intended to be used in my project to get an understanding of the level of satisfaction. Thank you in advance for completing this survey.

Total number of respondents:	131

Q1: Are you a Christchurch resident or a visitor?

	Resident	Visitor	Total answered
Absolute values	126	4	130
Percentages	97%	3%	100%

Q2: Have you been staying or do you live within the Four Avenues in the city centre (Fitzgerald/Moorhouse/Deans/Bealey) or further outside?

	City Centre	Outside	Total answered
Absolute values	10	119	129
Percentages	8%	92%	100%

Q3: How well do you think the traffic is being managed in the CBD?

	Very well	Well	Neutral	Poorly	Very poorly	Total answered
Absolute values	7	26	38	43	15	129
Percentages	5%	20%	29%	33%	12%	100%

Q4: How well do you think the traffic is being managed outside the CBD?

	Very well	Well	Neutral	Poorly	Very poorly	Total answered
Absolute values	6	40	37	32	16	131
Percentages	5%	31%	28%	24%	12%	100%

Q5: Is getting around the CBD better or worse than six months ago?

	Substantially better	Slightly better	As expected	Slightly worse	Substantially worse	Not applicable	Total answered
Absolute values	8	27	40	29	22	4	130
Percentages	6%	21%	31%	22%	17%	3%	100%

Q6: Is getting around Christchurch, outside the CBD, better or worse than six months ago?

	Substantially better	Slightly better	As expected	Slightly worse	Substantially worse	Not applicable	Total answered
Absolute values	3	32	37	36	20	3	128
Percentages	2%	24%	28%	27%	15%	2%	100%

Q7: How do you find getting around Christchurch by car?

	Easy	Moderately easy	Neutral	Moderately difficult	Difficult	Not applicable	Total answered
Absolute values	8	31	24	45	20	1	129
Percentages	6%	24%	19%	35%	16%	1%	100%

Q8: How do you find getting around Christchurch on a bicycle?

	Easy	Moderately easy	Neutral	Moderately difficult	Difficult	Not applicable	Total answered
Absolute values	7	12	9	17	16	68	129
Percentages	5%	9%	7%	13%	12%	53%	100%
Percentage of users	11%	20%	15%	28%	26%		

Q9: How do you find getting around Christchurch on foot?

	Easy	Moderately easy	Neutral	Moderately difficult	Difficult	Not applicable	Total answered
Absolute values	22	27	19	32	14	17	131
Percentages	17%	21%	15%	24%	11%	13%	100%
Percentage of users	19%	24%	17%	28%	12%		