The Potential for Transit Oriented Development (TOD) in Greater Christchurch

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1. Abstract

As a city currently dominated by private motor vehicles, Christchurch is beginning to investigate mass rapid transit and the development that occurs around it. This paper aims to determine what parts of Christchurch would be suitable for the construction of transit-oriented development (TOD) and the suitability of value capture in those areas. Using a systematic review of the literature a set of criteria was developed for a TOD and value capture suitable environment. The areas of Christchurch Central, Belfast/Northwood, Linwood, Hornby, North Halswell, Papanui/Northlands, Riccarton and Shirley/Palms were all found to be suitable for TOD.

2. Introduction:

As cities develop and incomes rise, a city's focus turns to liveability and efficient use. Many cities however, developed in an era of private motor vehicles, use space inefficiently and contribute to emission surpluses. These problems contribute to higher travel times, reduced access to amenities, and increased pollution. As such, there is a growing global movement for transit and development to exist harmoniously in an efficient urban environment. Christchurch, in the South Island of New Zealand, currently faces this problem. Consisting predominantly of low-density developments and based around Private Motor Vehicles (PMVs) (Kusumastuti & Nicholson, 2018), it has limited public transit options and a low-density population.

Transit Oriented Development (TOD) is an urban form describing the development of housing, amenities or economic activity around new or existing transit services (Knowles, 2012). A TOD based community can result in a dense, compact area with improved access to amenities and reduced social harm when compared to an automobile dominated environment (Loo, Chan & Chen, 2010). While Christchurch has a history of TOD, around the historic tram network that once moved the city, little can be seen in the present day. Limited TOD does exist around the local bus network but is not expansive. In conjunction with TOD, value capture quantifies the

increase in value of houses that are close to transport and uses this to contribute to the cost of TOD (Mcintosh, Newman, Trubka & Kenworthy, 2017).

TOD gives an opportunity for cities to become more efficient and provide a higher quality of life to its residents. This project outlines the potential that Christchurch has for TOD in the future, as well as potential value capture methods in the future.

Research Problem:

Christchurch's automotive dependency has various negative impacts on its residents and the physical environment. Heavy PMV reliance coupled with low density development result in many negative externalities that span a range of areas. As such, it must be investigated how Christchurch can develop in the future to remove these externalities. A heavy implementation of TOD in the existing city boundaries could have positive results. This research project aims to determine what areas within Christchurch are suitable for TODs, as well as potential value capture methods.

Research Hypothesis:

Areas within Greater Christchurch are suitable environments for TOD to be implemented and that value capture mechanisms could be effectively employed on any TOD constructed.

Research objectives:

To test the hypothesis (above) several objectives exist in this project:

1. Establish the benefits that Christchurch stands to gain from the implementation of a TOD network.
2. Determine the circumstances in which TOD can be successfully implemented
3. Determine the circumstances in which value capture can be successfully implemented.
4. Establish the areas of Christchurch that could accommodate TOD.

3. Literature Review:

This literature review analyses the body of literature on TOD. This review focuses on literature that identifies case studies where TOD projects have been successful and effective, and the factors that contributed to their success. This literature review aims to address the first three research objectives, by establishing the benefits of TOD; identifying the circumstances that

have contributed to their successful implementation and identifying where value capture has been successfully implemented. In line with the scope of this project, this literature review will not seek to identify the most appropriate form of transit for Christchurch, or the best way that a TOD in Christchurch could be funded.

This literature review includes only peer-reviewed work, primarily articles from scholarly journals alongside academic books. The literature on TOD case studies is generally from the last 15 years, but earlier theoretical literature has also been included. This literature review will first focus on the benefits of TOD to establish why investment in TOD is desirable and will then explain methods of TOD implementation and value capture, followed by various factors for success that are identified in the case study literature on TOD.

3.1. **Benefits of TOD**

Economic benefits

Auto-dependency causes a large quantity of external costs that are not realized by the drivers of PMVs; nor are they internalized by the market for automobile transport. These can include costs of vehicle emissions, health costs from vehicular accidents, noise and others (Delucchi, 2000). A TOD environment can reduce these externalities by reducing participation in the automobile transport market. A successful TOD coincides with a higher uptake of public transport (Suzuki, Cervero & Iuchi, 2013) and as public transport can be considered a substitute good to private transport, this results in a reduced use of private transport. The removal of external costs is greatest is the transit network involved is electric based (Newman, 2009).

TOD based communities also see an improvement in overall wealth. Newman and Kenworthy (1999) found that the more a city commits to public transport the less it spends on overall transport. This was confirmed by research facilitated by the Australian House of Representatives (2005) finding car travel costs around 85c per passenger per kilometre when compared to public transport at 50-60c per passenger per kilometre (in 2005 Australian dollars). TODs have also been found to improve wealth on the individual household level. The STPP and Centre for Neighbourhood Technology (2005) found that TOD communities and non-TOD communities in the US have the same median age and income; although, TOD-community households operated an average of one less car which equated to a 20% higher disposable income.

Environmental benefits

The environmental benefits of TOD include less traffic congestion and smaller footprints for housing which conserves open space (Cervero et al., 2004). People living close to a transit hub are also more likely to switch to public transport which reduces automobile travel. This reduces fuel consumption and air pollution. There is an observed link between TOD and a reduction in both vehicle kilometres travelled (VKT) and vehicle use in peak hours which reduces congestion (Cervero et al, 2004). TOD has shown the ability to "lower annual rates of driving by 20 to 40 percent for those living, working, and/or shopping near major transit stations" (Parker et al., 2002). This relationship is also corroborated by a number of other studies (Cervero and Murakami, 2010).

Encouraging dense developments will reduce the conversion of green space into housing/ commercial developments. Compact development can reduce land use with 10-40% compared to sprawl-like developments (Landis, 1995) as seen in Christchurch. This decreases both a city's environmental footprint and pressure on natural resources. By saving open land the amount of impermeable surface runoff will be reduced which improves water quality and biodiversity conservation (Cervero et al., 2004).

Social benefits

Diversity and equity can also be enhanced through TOD. Mixed-income TOD can reduce disparities and limit clustering of socio-economic groups. Mixed-income TOD ensures different housing choices are provided to a range of people with different income levels (CTOD, 2009). This broadens access to conveniently located housing as well as public transit and commercial amenities. This method is being used in the Bay Area in San Francisco (CTOD, 2009). Mixed-income TOD helps to build neighbourhood social cohesion and social capital by increasing resources communities can access (Cramm, van Dijk & Nieboer, 2012). It also enhances bridging social capital by helping to build connections between different socio-economic groups through more diverse communities. Social capital and social cohesion contribute to community resilience, which is the collective ability of a neighbourhood to deal with shocks and stressors (Aldrich & Meyer, 2014). Socially inclusive neighbourhoods allow networks of people to coordinate disasters responses more effectively with enhanced access to information, emotional support and disaster warnings (Aldrich & Meyer, 2014).

Urban mobility and resilience

The concept of TOD is rooted in urban mobility, and as such has complex implications on an area's mobility patterns and resilience. A TOD based community sees its residents often using more than one mode of transport in their journeys, whereas an auto-dominated area sees a whole journey using only a PMV (Huang, Moudon, Zhou, Stewart, & Saeles, 2017). TOD encourages mixed transport methods, especially active transport. Huang et al. (2017) find a remarkable increase in active transport near public transport nodes. The availability of multiple transport modes increases resilience, as does the improved social networks provided by TODs.

3.2. Successful methods of TOD implementation

Analysis of successful TOD case studies in the literature has shown there are generally two methods for implementing TOD in a city. TOD can be retrofitted into existing urban areas, to encourage further growth in proximity to transit lines. TOD can also be used as a framework that underpins urban development, with transit built first to channel growth along new transit corridors. Both require land availability as TOD needs land to be available, or land to have the potential to be made available, to build the transit stations, lines, and/or residential and commercial developments that make up TOD projects.

Retrofitting TOD

Retrofitting of TOD involves creating new TOD projects within existing urban areas. This usually involves adding or redeveloping transit lines in existing developed areas. This method has been used for example in parts of Hong Kong (Suzuki, 2015) and in parts of California,

Virginia and Mississippi (Reconnecting America, 2012). A particularly successful example of retrofitting TOD is in Subiaco, Perth with a redevelopment project known as Subi-Centro. Subi-Centro is centred around Subiaco's underground railway station. Its development was guided by a vision to use TOD to revitalize the area. The project now houses 1500 new residents, with an additional 90,000 m2 of commercial space employing 3200 workers (Howe, Glass & Curtis, 2009)

Using transit to guide new development

TOD can also be used to guide new development by building transit lines and hubs first to encourage growth along or around these corridors. This can be further encouraged by zoning to steer growth along these desired axes. Copenhagen's Finger Plan is a textbook example of this (see Appendix A). Long-term planning visions have shaped rail investment which in turn has driven urban growth (Suzuki, Cervero & Iuchi, 2013). In 1947 the Finger Plan designated five corridors for urban development along existing or future planned rail lines from Copenhagen's CBD out to the suburbs (Knowles, 2012). Each railway station was intended to be a hub for high density housing as well as commercial and retail use. This formed a linear urban development pattern concentrated along these transit corridors. The newest development finger, Ørestad began development in the 1990's and has resulted in the TOD Ørestad New Town. Ørestad New Town is a 5km long, 600m wide linear development with the Metro at its core (Knowles, 2012). Copenhagen's Finger Plan has used rail to concentrate urban development along its transit corridors.

3.3. Characteristics of successful TODs

Political commitment

A key factor frequently identified in the literature as playing an important role in successful TOD projects is consistent political commitment from all levels of government. Governance arrangements are key to the success of TOD (Searle, Darchen & Huston, 2014). Political commitment and supportive policy is identified in a number of case studies as being one of the most important factors for facilitating development (Boarnet & Compin, 1999; Hess & Lombardi, 2004; Searle et. al, 2014; Suzuki, Cervero & Iuchi, 2013; Thomas & Bertolini, 2014). This is due to the critical role that the public sector plays in integrating transport policy with urban development, as well the resources and authority to change policies and zoning that political bodies have.

The long-term vision of political leaders to base land-use planning on transit is considered a key success factor for renowned TOD projects like those in San Diego, Arlington County and Copenhagen (Boarnet & Compin, 1999; Cervero, 2004; Suzuki et al., 2013). Governments in many successful cities have also incentivized the private sector to develop along transit corridors (Hess & Lombardi, 2004). These case studies are useful in demonstrating the different ways in which supportive policy can be used to facilitate TOD.

Stakeholder leadership

Another factor commonly identified in the literature is stakeholder leadership in developing, planning and maintaining TOD projects. There are many stakeholders with different interests involved in TOD including government, private sector groups and residents. It is necessary for

one group to take the lead and take ownership of TOD policy (Cervero, 2004; Hess & Lombardi, 2004; Thomas & Bertolini, 2014). This allows for consistent, expert guidance that enables more effective coordination of transport and urban development policy (Hess & Lombardi, 2004).

Many researchers conclude that regional transit agencies are the best stakeholders to take the lead, but local government can also do the same (Hess & Lombardi, 2004; Suzuki, Cervero & Iuchi, 2013; Searle, Darchen & Huston, 2014). In Washington, TOD's success is partly credited to the approach taken by the Washington Metropolitan Area Transit Authority (WMATA) to TOD (Suzuki et al., 2013). The WMATA has given its staff authority to purchase real estate in potential development zones (Suzuki et al, 2013). This has allowed the agency to pursue joint development projects with the private sector and achieve highly successful value capture (Suzuki et al, 2013). As a result, the WMATA owns $2 billion worth of land containing 30 TOD projects. This demonstrate s how a leading stakeholder can operate in the context of TOD as a vehicle of coordinated land-use and transport policy.

Density

The literature also commonly identifies density as playing a key role in the success of TOD. Density determines how many residents and workers are in the area and therefore the demand for transit and the long-term economic viability of a project. The literature identifies adequate density requirements within a certain range of around 10-15 units per acre/ approximately 24.7 dwellings per hectare for residential development (Boarnet 1998; Hess & Lombardi, 2004). One way of achieving higher densities around TOD projects is through zoning laws. In Curitiba, Brazil, local government has mandated that all medium and large-scale developments must occur along a BRT corridor (Cervero & Dai, 2014). The levels of density required for viable TOD projects are not needed at the beginning of development if there is a commitment to increasing densities along transit corridors for example as seen in Curitiba. Over the long-term however this density must be reached for TOD projects to be viable.

Funding

The final factor found in the literature is that a viable source of funding is required to develop and maintain successful TOD projects. There are multiple funding methods used across different case studies. For example, TOD's in Washington rely on a mix of central and local government funding and passenger fares (Cervero, 2004). Alternatively, in Hong Kong funding primarily comes from income from real estate owned by Hong Kong's transit agency. Hong Kong is one of the few places in the world where public transit makes a profit (Suzuki, 2015). The case studies outlined in the literature show that funding for TOD is generally achieved through a combination of different income streams, including public and private funding, returns from passenger fares and various methods of value capture. In line with the scope of this research project, this literature review has not attempted to find the best or more appropriate funding method for TOD but acknowledges that a viable funding method is needed for a TOD to be successful.

Value Capture

Value capture can help finance a public transportation project through capturing the increased value of the land from TOD. Land value in and near a TOD increases from the improved access to amenities it provides. A governing body can capture the increased value that finance a TOD project. Some of the methods of value capture include: tax increment financing, special

assessments and taxes, developer contributions or public sector real estate transaction, where value capture is the developer contributions (Mathur et al, 2016). These methods of value capture can be used to recoup some of the cost of the creation of a TOD (Kemp & Mollard, 2013). Studies in North America shows that increasing for residential value is 5-10% and commercial value increases with 13-30% within proximity of a TOD (Doherty, 2005). Transit is shown to induce value creation and predevelopment speculation (see Appendix B).

As Kemp & Mollard (2013) describes, New Zealand has a number of value capture mechanisms available to it that can work under current legislation, these are as follows: Development contributions (under the Local Government Act 2002), Financial contributions (under the Resource Management Act 1991), Targeted rates (under the Local Government Act 2002).

In order to have a successful value capture mechanism on a TOD, establishing an early dialogue among public entities and between the public and private sectors must be achieved for an even understanding of the development. There must also be coherent value capture strategies with any investment partners sharing the same goals. A large factor of success is from overcoming the differences in culture, perspective and institutional norms. These have all helped to overcome the complexity and risks that comes this using of value capturing within TOD (Page, 2016). Therefore, in New Zealand there a number of value capture methods that could be implemented.

4. Methodology

To test the hypothesis, a criteria has been created for a TOD and value capture suitable environment. This criteria has been created from the observed success factors that were observed during our systematic review and is as follows:

An environment is considered suitable for Transit Oriented Development if it has:

- Consistent **political commitment** to TOD
- A **leading stakeholder** with the ability to coordinate land-use and transport policy (or a mechanism to create a leading stakeholder
- A plausible **funding method** for the planning, development and maintenance of TOD
- **Land available** for development and/or new transit links
- A **density** of at least 24.7 dwellings per hectare (or sufficient projected population growth and/or commitment to achieving this growth in future)

One observation of the criteria is that it does not have any points directly relating to value capture. The systematic review determined that, due to the many different value capture methods, it was found that if an environment is suitable for TOD there will be a value capture mechanism that could be implemented. Therefore, the assumption was made that all TOD suitable environments are also suitable for value capture.

For the purpose of this research, an environment that is suitable for TOD and value capture is defined as an area with the necessary characteristics to implement a successful TOD project. The developed criteria does not evaluate what kind of TOD should be developed as this is a point for future research. To test the hypothesis, areas within Greater Christchurch will be tested

against the developed criteria; if any area is found suitable for TOD and value capture as per the criteria the hypothesis will be found true.

5. Data

Data used for this research is sourced from the Christchurch City Council (CCC) as well as the New Zealand Government and it's agencies. The Christchurch City Council is the local authority for Christchurch City, which houses the vast majority of the Greater Christchurch region. Data sourced from the CCC includes the 2018 District Plan, the Transport Strategic Plan and population projections for the Greater Christchurch area. The district plan outlines the zonings and current housing information in Christchurch while growth projections run from 2013 to 2043 for Christchurch, Selwyn and the Waimakariri. Information within the district plan and transport plan can be considered accurate as the CCC is the local authority in Christchurch. Population projections are also considered reliable due to the governmental role of the CCC in Greater Christchurch. A number of pieces of information have been sourced from the New Zealand Government and its agencies including: The Ministry of Transport General Policy Statement and information on the Public Works Act from Land Information New Zealand. All information on governmental plans or powers sourced from governmental organisations can be considered accurate due to their roles.

6. Results

An assessment of Greater Christchurch against the five criteria show that Greater Christchurch meets four of the five criterion- political commitment, potential for stakeholder leadership, potential for a viable funding method and land availability. Projected housing densities in some areas in Greater Christchurch mean that these certain areas also meet the fifth criteria for density. As some areas meet all five criteria for an environment suitable for TOD, this proves the hypothesis to be true.

Political commitment:

Currently, both local and central government transport strategies support a long-term policy direction that is supportive of TOD. The Ministry of Transport's 2018 Government Policy Statement (GPS) on Land Transport sets out how central government will allocate transport funding over the next ten years. The GPS emphasizes that the integration of land use and transport policy is essential (Ministry of Transport, 2018). It also highlights key investment strategies, such as using transport and land use planning to reduce peoples need to travel by PMV's; supporting mixed use developments in high growth areas and using investment in transport infrastructure to support urban growth and new housing developments (Ministry of Transport, 2018). The GPS also supports investment in public transport both to support new housing development and to support the regeneration of existing housing (Ministry of Transport, 2018). These investment areas all contribute to an environment that is supportive of TOD.

At local government level, there is a similar focus on integrating land use and transport planning. The Christchurch City Councils 2012-2042 Transport Strategic Plan contains a key objective to integrate land use policy and planning with transport. It specifically identifies TOD to achieve this (CCC, 2012). The plan also mentions as part of its TOD strategy that value capture could be used to proactively invest in transport corridors with the potential for rapid transit, to provide infrastructure funding at a later stage (CCC, 2012). The commitment by both local and central government to integrate land-use and transport planning and policy, and to use public transit to support both new and old urban development areas create a political environment that is conducive to TOD.

Stakeholder leadership:

The political support from central and local government for integrated land use and transport policy mean there are multiple government agencies/bodies with the potential to lead TOD in Christchurch. Both the Ministry of Transport and the New Zealand Transport Agency (NZTA) are national-level transport authorities with a stake in transport policy. At the local level, the Christchurch City Council has shown its support for TOD. Environment Canterbury oversees the provision of Christchurch's bus services while the Council is largely responsible for the rest of Greater Christchurch's transport policy and planning. The Council has already shown its interest in TOD and has the authority to coordinate land-use with transport planning in Christchurch. This, alongside its experience and knowledge in terms of local context means it has the most potential as a leading stakeholder.

Funding method:

The commitment of funding in the 2018 GPS to various areas of land use and transport policy that could support TOD mean there is potential for a viable funding method, primarily from government funding. The CCC has also demonstrated an interest in looking into how value capture can be used to fund transport infrastructure. These along with passenger fares represent the potential for a viable funding method.

Land Availability:

In the Greater Christchurch area land either is available for TOD development or can be made available across the whole city. As a relatively low-density environment, areas can be privately redeveloped to develop a high-density TOD. Alternatively, the Public Works Act can be utilised by central or local government to acquire land (Land Information New Zealand, 2019). Either method of private or public development would be able to develop the amount of land needed to create TOD.

Density:

As the entirety of Greater Christchurch meets the first four points of the developed criteria, what becomes apparent is that density determines what parts of Greater Christchurch are suitable for TOD. The criteria requires an area to have a density above 24.7 Houses/Hectare or have sufficient growth/commitment to become that density.

Suburb:	**Houses/Hectare:**
Bishopdale	15
Hornby	16
Linwood	16

Merivale	14
Papanui	18
Riccarton	20
Shirley	16

Table 1. Population densities in main Christchurch Suburbs (CCC, 2018).

As table 1 shows, none of the key suburbs outlined in the CCC District Plan (2018) currently meet the population density requirements for a TOD suitable environment. The same is true for other suburbs around Christchurch (CCC, 2018). Looking toward 2043 the area has a median projected growth of 32.9% from 2013 levels (CCC, 2019) as the region's population increases from 499,000 to 663,600 between 2013 and 2043 (CCC, 2019). Therefore, the areas that this population goes will increase in density. The LURP outlined the 2013 city boundaries and a number of greenfield sites as shown in Appendix C.

High Density (50 H/H):	**Medium Density (30 H/H):**	**Low/Medium Mix (15 H/H):**
Christchurch Central	Belfast/Northwood	Greenfield Sites
	Linwood	Other Areas
	Hornby	
	North Halswell	
	Papanui/Northlands	
	Riccarton	
	Shirley/Palms	

Table 2. Current zonings (in terms of density) of Christchurch areas (CCC, 2018).

To accommodate future growth within the boundaries outlined in the LURP the CCC developed the density zonings, shown in table 2, in the 2018 District Plan. This outlines where the projected growth will inhabit and what areas will increase in density. The areas zoned for high and medium density in table 2 meet the criteria for developing to 24.7 H/H.

TOD Suitable Environments

The areas of Greater Christchurch that passed the criteria and are TOD/value capture suitable environments are as follows: Christchurch Central, Belfast/Northwood, Linwood, Hornby, North Halswell, Papanui/Northlands, Riccarton, Shirley/Palms; these areas are indicated in Appendix D. As at least one area in Greater Christchurch proved to be a TOD/value capture suitable environment the hypothesis can be considered true.

7. Discussion

These findings show the areas of Christchurch that would be suitable for TODs and value capture methods. The research serves as a first step to transitioning Christchurch from a PMV dominated environment to one where mass rapid transit can be built around. These results do come with limitations though. They only comment on the suitability of TOD in terms of the physical characteristics of an area, there is no measure on the population's opinion on TOD. Due to limited resources and the inability to complete a comprehensive and accurate survey, our research did not account for public perception. This research method is externally valid and can be replicated in different cities around the world. As the criteria stemmed from global

literature and did not count for public opinion, cultural differences should affect the accuracy of the methodology should it be replicated in a different area. Therefore, future research can also be done in other cities thinking about implementing TOD. As such, while an area identified has the physical characteristics of a suitable environment, there may be a low public interest and uptake in any TOD that is developed. Research on public opinion is needed in the areas identified to determine how to develop a TOD that would be accepted by its residents. This must be done in conjunction with research on transit options for the city as the Christchurch requires a transit network to successfully develop around. Any research on future transit mechanisms should use the areas identified in this research as a guide for where to develop transit.

Thomas et al (2018) identified some barriers to TOD in their analysis of Dutch TOD projects such as fragmented land ownership, lack of consensus on TOD and unattractive TOD nodes as demonstrated by a high amount of vacant offices near them. Assuming a TOD project was undertaken in Christchurch, a public consultation period for support and opposition to be voiced would be required. There also needs to be consensus between government bodies, transport agencies and financers to move forward in any potential project.

8. Conclusion

Throughout the research, all the research aims have been achieved. The research undertaken found the hypothesis to true as areas within Greater Christchurch were identified as being suitable environments for TOD and value capture. By identifying these areas as Christchurch Central, Belfast/Northwood, Linwood, Hornby, North Halswell, Papanui/Northlands, Riccarton and Shirley/Palms, a transit system can be developed in Christchurch that link these areas with TOD being developed inside of them. While it does not include public opinion, it is a useful starting point for the transition of Christchurch toward mass transit and value maximising development.

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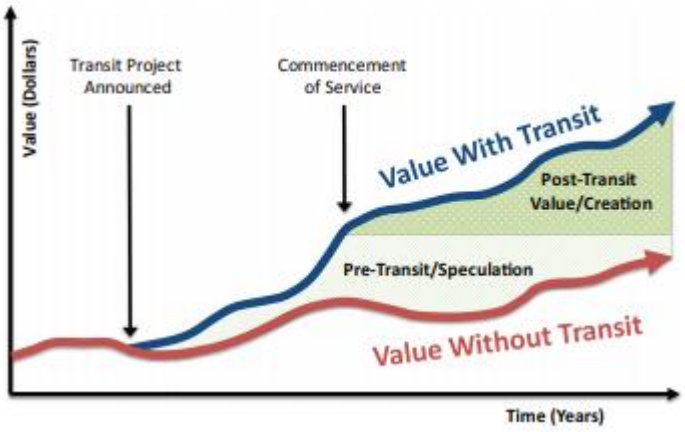
Appendix A:

1947 Finger plan of Copenhagen (Knowles, 2012).

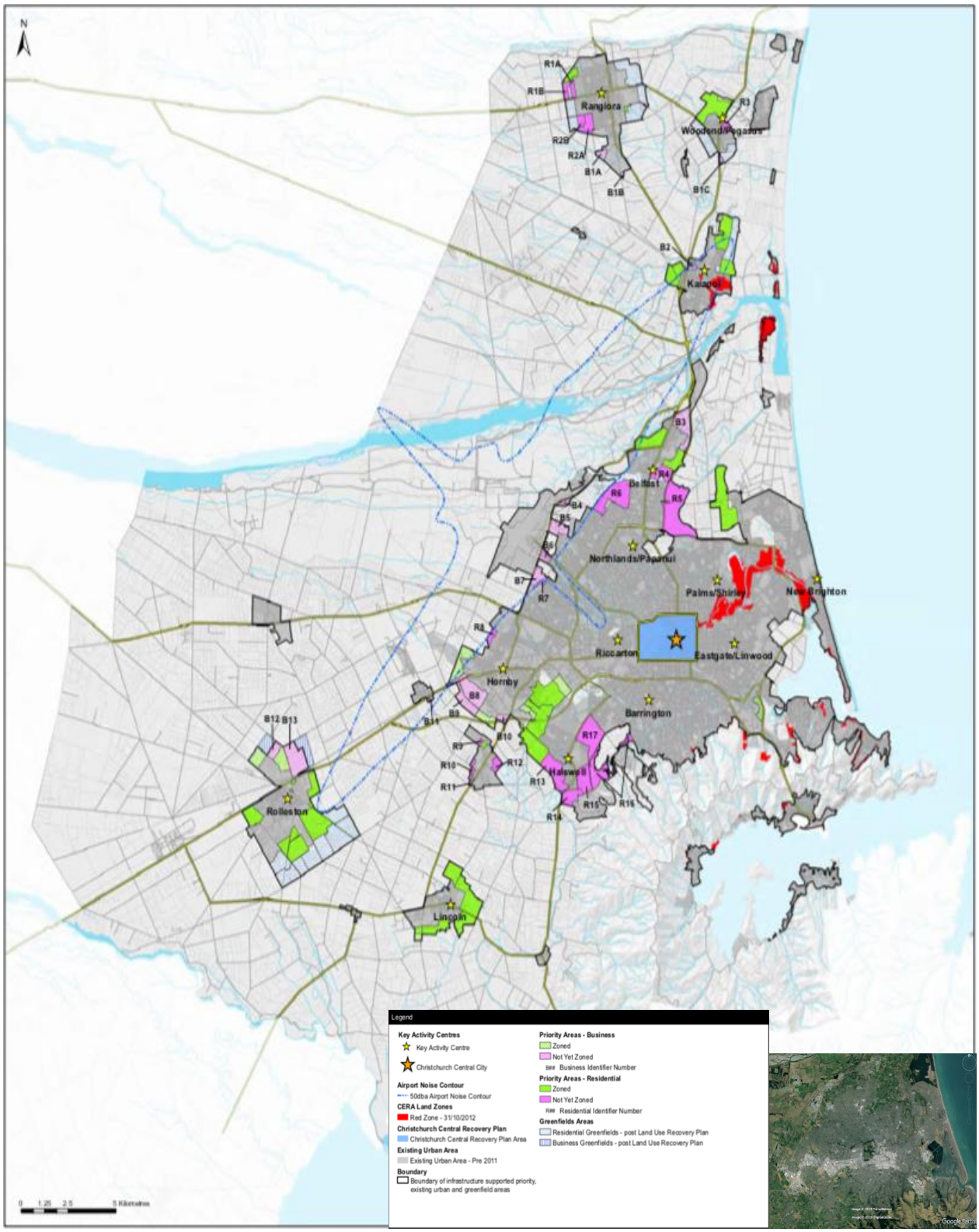
Appendix B:

The value creation of transit and predevelopment speculation (Page et al. , 2016).



Appendix C:

Designated greenfield development areas and city boundaries (LURP, 2013).



Appendix D:

Indicative map of TOD suited environments (Google Earth, 2019).