

# Connecting Transit with Urban Development to Achieve 21st Century Goals for Perth

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## Abstract:

This paper imagines a Transit Oriented Region. It will imagine the region from the micro, the scale of Placemaking, to the macro of overall city structure. This paper attempts to calculate the costs and benefits a proposed expansion of the commuter rail for the Perth Metropolitan Region supplemented by light rail and bus rapid transit in a step by step methodology. The results show the combined proposals enable a doubling to tripling of the Perth public transport system. Urban development opportunities near the stations in the whole system could then absorb the next 30 years of medium density housing and over 50 years of commercial work space without any further greenfield development or entering far into the established residential neighbourhoods. The results demonstrate residential infrastructure costs saved, tonnes of greenhouse gas saved, transportation costs over 50 years and others. External benefits would include health and productivity benefits from living in the new highly walkable centres. The heavy and light rail system costs estimates vary and financing via a ring-fenced value capture fund could significantly defray the costs of the rail system.

Will such a plan make Perth a 21<sup>st</sup> Century global city? How much walking, transit, density, and mixed-use 'complete community' does a region require, precinct by precinct, to make any noticeable difference? The results of this paper will make suggestions towards the scale of the operation necessary and the frank discussions required if Australian Cities are to make appreciable changes to their form, mode splits, ecological impact and their citizen's lifestyles.

## Introduction

Currently, Perth has a very successful rail transit network which, despite many dire predictions over the last 40 years, has survived and is thriving. The southern Mandurah Line alone moves daily the same numbers of persons as would be required by 8 lanes of free flowing freeway and is quite often at full capacity during peak hours (Newman et al., 2013). This is a world-class example of pent up demand for higher-order transit in the existing background of car-based cities. It is also an example of how transit provisions may spur housing and job-related developments along its length while providing the transit network with patrons. It brings mass-transit to the masses and masses to the transit. Everything presented in this paper takes Perth as it is currently and imagines using its underlying skills, talents, cadastre and infrastructure to its best advantage.

This paper will focus on Transit Oriented Development as a mechanism to achieve Transit Oriented Regional (TOR) goals. Goals such as lower greenhouse gas emissions, lower Vehicle Kilometre of Travel, decreased parking ratios, increased transit use, increased Public Open Space, maintained ecological services from forest and farm land, avoided costs for expensive infrastructure and transport, captured value from the increase in property to help pay-down the costs of the transit and to, ultimately, combat the rise in obesity and lost workplace productivity due to excessive car dependence. All these 21<sup>st</sup> century Green Economic (UNEP, 2011a, UNEP, 2011b, UNEP, 2012, Urban Land Institute, 1998)goals will be assessed with their quantum outcomes, in dollars or tonnes, under a future focused vision.

The future vision is that Perth will craft a ring rail around its middle suburbs and create a network of street-level Light Rail Transit (LRT) intersecting with the future and current rail network. These visions are based on previous plans such as:

- Stephenson Hepburn plan in 1955 which suggested a ring rail in the south;
- Directions 2031 which suggested a Ring Rail; and,
- Public Transport Plan for Perth 2031 which further suggests a range of potential light rail lines.

The results will also clearly show that investing in a ring rail and a light rail network has large potential savings to tax-payers, despite the initial capital and ongoing operational expenses. Capital budgets devoted to rail transport will have to be created to keep Perth from halting due to private vehicle traffic congestion. It is far preferable to invest in the future, early while it is inexpensive, than continue with a development pattern of the expensive past. What is really at question though, is what type of region does Perth want to be?

Rail Transit investments, such as a Ring Rail for Perth, will not only provide for regional trips by mass transit but also spur these benefits:

- redevelopment of ideally suited sites to house the new and changing demographics,
- this new housing can provide for a lower carbon lifestyle, lower Greenhouse Gas emissions and lower Vehicle Kilometres of Travel,
- improve local air quality and global carbon quantity as less carbon is produced from tail-pipes,
- provide for urban forms which are more conducive to walking and cycling,
- enable the current infrastructure, already built, to provide more service,
- avoid costs to households and State/Local infrastructure costs,
- gain social amenities such as recreation, medical and educational facilities in close proximity to residents to help make more destinations closer to home,
- protect and maintain ecosystem services at the urban fringe of farm and forest,
- enable value capture to pay down capital rail expense,
- increase global competitiveness as lifestyle options are broadened,
- be an incentive to build less single occupant vehicle infrastructure, and
- be a part of the globally significant shift for car-based cities to a more rail-based future.

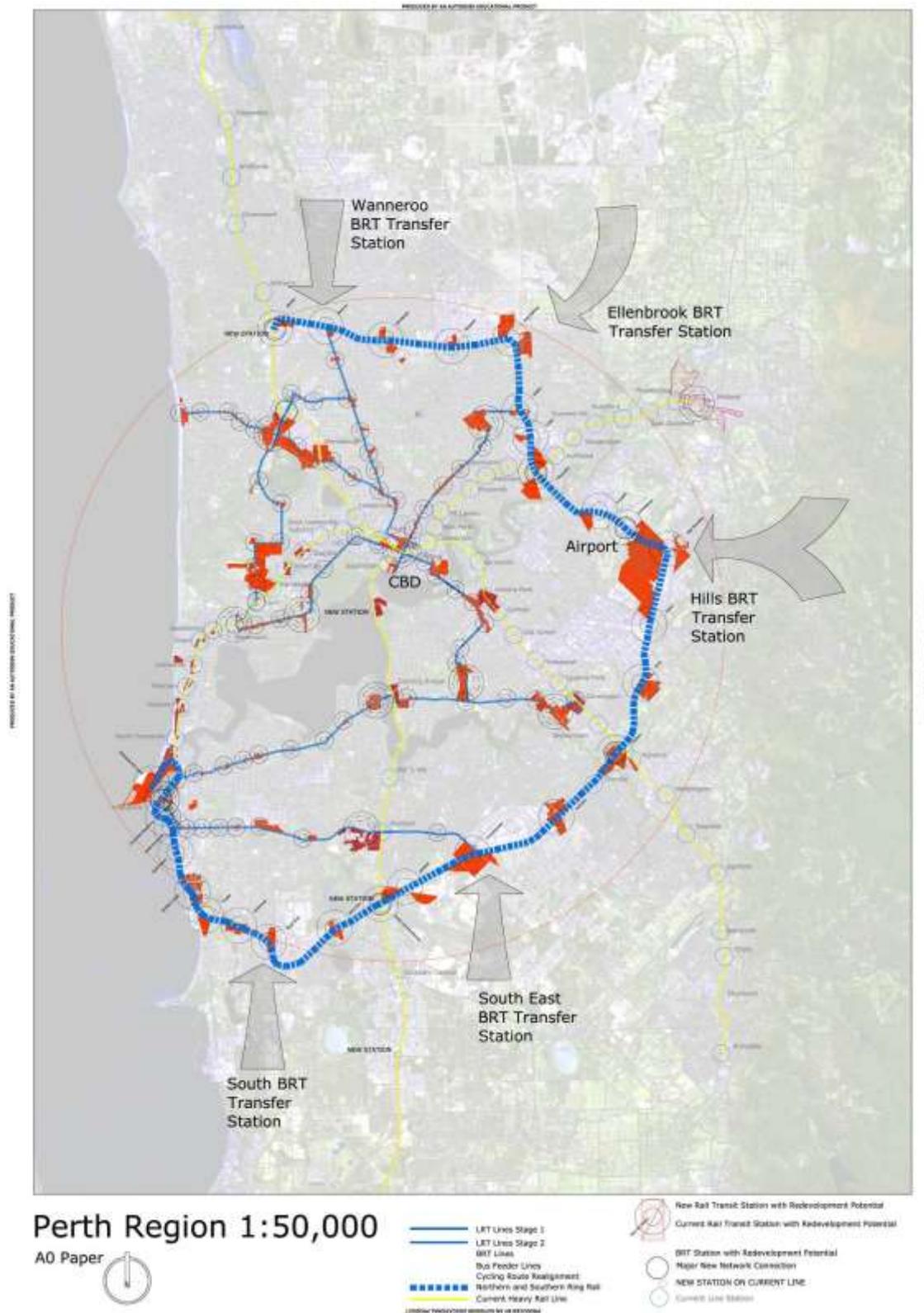
This project shows how to make these aspirations implementable in the urban fabric. These acts inherently improve the economy of daily life for the majority of Australians, most of who live in cities.

**Table 1 Benefits of transit investments**

### **Rail in Perth**

Rail Transit is successful in Perth; patronage has risen from 7 million in 1992 to 31 million a year in the 2003 to 63 million in 2011 (PTA WA, 2012c, Australian Government, 2012b p.49, Mees and Groenhart, 2012). Despite many expectations of failure in the past (Newman, 2011) and despite earlier efforts to remove rail from Perth's urban patronage is on the rise. As more people become familiar with the transit system's existing benefits, as traffic congestion worsens, and as the cost to own and operate a Single Occupancy Vehicle (SOV) increase (OzInsure, 2012) patronage is expected to rise.

Perth has been effective with its completion of several major rail projects to the north and south. Heavy rail mixed with an efficient feeder bus network has been very successful beyond the expectations of many transport planners who worry about transfer penalties between modes. Perth's success has been based on fast heavy rail (average speed of over 90kmph compared to 45 kmph in Melbourne for example) as well as efficient integration between the modes (80% of the Southern Rail patronage is bus transfer). This mixed mode aspect means one can leave the car at home or even not need to own a private car. Though road capacity increase (road widening) is often discussed in terms of 'easing congestion', road capacity fills as soon as more is built (Litman, 2012). The building of Single Occupancy Vehicles (SOV) infrastructure has only momentary gains in capacity (Cervero, 2003) and long term losses in air quality (Kozawa et al., 2012) and land use quality (Kenworthy and Laube, 1999).



**Figure 1 A future Perth of a highly connected networked of rail lines and urban development**

All of the red polygons of rail based redevelopment as seen on Figure 1, including some land along the present heavy rail line, have a sum total of over 3045 hectares of land. Not only is this land removed from greenfield development, this is enough area to support the policy goals of Directions 2031 if appropriately

developed. This demonstrates a Green Economic and Transit Oriented Region of polycentric, transit served locales where the focus on public health, affordable housing, green technologies and quality public realm amenities may cluster.

### ***Rationale for Ring Rail***

Many cities have ring rail and or at least a highly integrated network which offers multiple destination choices on several lines. This connectivity offer multi-dimensional destination choice as well as multi-dimensional redevelopment opportunities. It maximises the nexus of land use policy and transportation planning to its ultimate end. It links the ideas of up-zoning, to create higher-density and higher-amenity delivery in planned centres, with rail transport as a means to move the residents and workers. It supplies mass to the mass-transit and mass-transit to the well-housed masses. When this is commonly spoken of in contemporary academic literature and professional planning circles it is described as Transit Oriented Development (TOD) or more broadly as Land Use and Transport Integration (LUTI). Ring rail brings together the functional aspects of a transit system and makes them more than the sum of their parts.

The linkages possible with a genuine network, rather than having all transport focussed on one CBD, mean that many more business opportunities are possible as businesses may have a broader range of choice to locate according to their needs for space, rents, prestige, amenities which employees may wish to have access to, or other such reasons. People likewise have a wider choice of places to live, to be closer to work, closer to extended families, parks, waterfronts or price-points. It opens the market to fulfil many of the latent needs of businesses and people to achieve what they need of an urban environment: choice.

The one-centre focus in a radial transit system has three effects:

- congestion on board the transit service in one direction with near empty haul-backs at peak;
- a great deal of trips are not served by transit as the bulk of investment is in one direction rather than broadly across the region. These trips then become car based by necessity; and
- people may not have housing choices adjacent to fixed-guide transit meaning they must, then, travel by car or be 'captive' on a CBD oriented bus transit system which forces long winding routes in mixed traffic.

Ring rail won't solve all these issues, but will certainly help to alleviate a great deal of congestion as cross city transit trips may avoid the CBD and serve to open areas for real estate investment. Real-estate, that is, which will be richly transit served and with a high degree of walkability to close amenities. Rail-based development, as illustrated, have multiple advantages: they will have an impact on lowering Greenhouse Gas (GHG) contributions through compact shared-wall housing and less driving, they reduce Vehicle Kilometre Travel (VKT) thereby reducing costs to individuals and governments, they avoid costly greenfield expansion expenditures while preserving farm and forest land, and provide for Value Capture (VC) (McIntosh et al., 2011) of the developments to help pay down the cost of the Rail Infrastructure. There are therefore many reasons why ring rail should be pursued as a planning policy in Perth. The full lists of benefits are in Table 1 above.

These strategic investments can be accurately called 'Green Economic' (UNEP, 2012, UNEP, 2011b) as they serve to achieve many of the sought targets while making sound business sense for individuals, private developers and governments. The Green Economy will be comprised of business operating in the free market producing wealth, as usual, but with preferred societal and environmental values coming to the fore. As Perth becomes a more highly connected and transit-oriented region there will also be significant flow on effects as persons and businesses will choose to relocate to Perth due to its greater number of options in residence and work. The economy in Perth with its new opportunities in energy, minerals for the Asian market will become even broader with a variety of options for housing, workplaces and lifestyles.

Beyond even the base of personal and regional benefits which may accrue, Perth needs to use its latent opportunities for it to compete with the top-tier of cities in a globally competitive world for talent and investment. Demonstrating that Perth can plan and deliver some very fundamental spaces linked by mass

transit will raise the Perth region in the ranks of globally important cities. At present Perth is delivering fewer apartments than any of the other major urban regions in Australia (SOAC, 2012). An assessment of Directions 2031 has found that redevelopment at higher densities within the suburbs has been the least successful of its policies (SOAC, 2012, Western Australia Department of Planning, 2012c). The Ring Rail and associated sub centres that it will facilitate can enable this to be reversed.

That a Ring Rail is even a possibility is due to two existing factors in its favour. The first is an availability of highways and current freight reserves and the second is an already announced Airport rail line (PTA WA, 2012a). This Ring Rail will support the regional goals of healthy living in more compact and complete communities, with less SOV dependence, with cleaner local air and lower global ecological impact. How a Ring Rail and a light rail network will help Perth achieves these diverse goals is discussed below.

### ***Rationale for LRT***

Light Rail transit has become a very important part of the global transport mode mix. It provides areas, cities, regions with high quality, reliable, comfortable public transport. LRT provides much greater ridership capacity and requires less labour (drivers) per kilometre than buses and less construction expense than conventional underground 'metro' rail transit. LRT can provide great advantages to cities intent on developing compact, walkable, mixed use network of neighbourhoods where personal car ownership is not a prerequisite. However, LRT is only a mode-choice; it takes legislated re-zoning of land, underground service upgrades, clear incentives to develop and a marketplace ready for the advantages of urban living. The city building LRT needs to have a clear land use and transport integration policy, be prepared to carry the additional passengers in the short term and to have the patience to bear the fruits of urban redevelopment in the medium to long term.

LRT services ranges from street running 'tram/streetcar' type operations with low speed but high accessibility in central city areas, to street median operating on semi separated Right-of-Ways with moderate amounts of mixing with traffic and queuing at traffic lights and variable speeds, to completely separated RoW matching high speed with very reliable timetables and high mobility across metropolitan areas. One of the distinct advantages LRT retains over other modes is that one line might have any or all of these three operating conditions; it is flexible and can fit into most urban settings. Perth has many forms of urban settings and as such Light Rail will be an optimum transit mode to reinforce the redeveloping urban-infill areas of the Perth region.

### **Discussion Questions**

Three questions underlay this paper:

#### ***Where is the land available for the 47% infill target of Directions 2031?***

The land is all around the metro region in all forms, if one takes a moment to look for it. The following lists the array of places to look for infill opportunities.

- on land already zoned to be higher density;
- empty lots along highway arterials;
- other lots along arterials which are oriented to the corridors, rather than backing onto it as most dendritic street layouts most often do;
- used and new car lots and other land uses that are possible to shift to less important sites;
- buildings set back with parking in front, as we see especially at fast-food restaurants, national grocers and others;
- urban decay areas, which are usually old building stock either not maintained and losing value or from an era when poor workmanship and a poor orientation to the street and its neighbourhood has never led to success;
- brownfield, being ex-industrial lands;
- greyfield, being older housing stock reaching its lifespan and calculated to be due to rebuilding (Newton et al, 2012); and
- high valued land adjacent to highly prized amenities, such as a beach, but which remain locked in its current zoning for a variety of local political reasons.

There are likely to be other subcategories not fully explored, but undoubtedly there are plenty of spaces for infill once they are looked for and mapped. This equates to the long sought after 'land-supply' of Developer's future projects and Governments locations for affordable housing. These types of lands are especially prevalent across North America and Australia where automobile planning has dominated, leaving behind great swathes of disfigured urban lands as vehicle speed, parking and turning radii have triumphed over 'urbanity'.

***How will the people access the services of their neighbourhood and find the mobility to move about their region?***

Rail, as the highest order public transit, will be the lead amenity in these new precincts. But to get people in Perth to use the new trains, it may be necessary to use the 'carrots and sticks' approach to delivering the train service. If Perth, or any city, is to dedicate capital budgets towards infrastructure projects such as trains there will have to be an expectation of a return in the medium to long term. If any city is expecting returns, it is well served to make equally hard and equally far-sighted decisions regarding land use minimums and SOV infrastructure maximums:

- minimum residential density thresholds everywhere but especially at train stations (Newman and Kenworthy, 2009);
- minimum ranges of mixed use including street fronted retail, commercial office, commercial light industrial, institutional and appropriate parks and (Jacobs, 1961);
- maximum parking ratios (Shoup, 1999).

***At 47% redevelopment, this does slow greenfield expansion into productive farm and forest land, but does it provide reason enough to indeed build better urban spaces with greater all-round amenity?***

Rail based public transit will be one of many amenities along with other provisions such as libraries, swimming pools and recreation centres, parks, and a sufficient level of commercial work spaces and retail destinations, such as grocers, to make the communities genuinely 'complete' (Smart Growth BC, 2012). These places need to be affordable, clean, walkable, be attractively well appointed with street trees and other design elements. They must also have a sense of belonging to the site by preserving what is good, like views and water-bodies, while sharing what is great through distinctive architecture or use of materials which are honest about the history of the region. While aesthetics and amenities are very important, there are many other targets and goals the region must achieve to be a part of national and global goals. The goals of the new transit network will be evaluated along these criteria:

- Potential transit mode split increased;
- lowered Greenhouse Gas (GHG) emissions;
- lowered Vehicle Kilometre Travel (VKT);
- improved quantity and quality of Public Open Space (POS)
- lowered infrastructure costs to build and to maintain;
- improvements in healthy lifestyles;
- increased quantum of housing and jobs mix in compact walkable neighbourhoods;
- increased affordable housing either as a set program or as a function of a greater quantum of housing available (scarcity of any product has never created equitable distribution);
- increased value of land near stations to then be 'value captured' and used to pay-down the construction costs of the rail and other utility costs.

## **Methodology**

The method developed for this paper aims to locate ideal transit served development plots, ascribe a land use mix and floor heights and to produce population and employment results by station precinct, transit line and for the entire metropolitan region. This is a very daunting task. We start with space as a fundamental question: how much is available where we need it? Then we must ask: what might this space, land, provide in terms of housing and jobs, parks and shopping? Then, we might wonder about what are the benefits or creating new neighbourhoods around the transit stations which are walkable, mixed use, amenity rich and desirable place to live.

### **Step 1: Current planned land redevelopment**

To help answer these and other sub questions the researcher and author, Cole Hendrigan, first began a search through the available planning documents and social media sources to trace where preferred lands redevelopments and rail alignments are across the Perth Region. The current planned areas of redevelopment, such as Curtin Town, Stirling, East Perth, Fremantle, Cockburn Coast, South Perth and many others were traced over as well, giving more coherence to where rail might want to serve. (see below) AutoCAD was used to insert the image files into a properly scaled base plan of the Perth region made available through the Western Australia Department of Planning and the Australian Urban Design Research Centre. Area figures were recovered by querying drawn polygons.

### **Step 2: Preferred rail transit alignments**

It was then important to check the various proposed rail alignments for sufficient dimensions in the cross-section to support a low-floor Light Rail or conventional heavy rail carriages, see Figure 3. A 500 meter buffer was placed alongside these lines to then delineate the areas for discussion. Only the land areas within or reasonably adjacent to this buffer were under consideration, not the entirety of Perth. AutoCAD was able to dimension the RoWs as presented in the base plan.

### **Step 3: Current zoning**

The third step was to see how large areas across the region were already zoned for use (see Figure 4) and for density along the R-Coded (Residential Codes) (see Figure 5) to give shape to what has already been discussed and agreed on at the local and state levels. Where they appear darker, the more amenable the areas are for intensification.

### **Step 4: Places for infill developments**

There was lastly an 'objectively subjective' process to look for brownfield (ex-industry), urban decayed (car yards), underused (wide open campus-like settings) and opportune (lots arranged facing towards corridor) sites to redevelop within the buffered areas surrounding the proposed rail lines. These were added to the list of redevelopment polygons alongside the existing official plans. All these sites, as traced, were given a potential station location within their bounds, a name and a place on a list in which the redevelopable areas were to be scrutinised. This process examined lot by lot, site by site, by station precinct and transit line to come to the totals presented in the results.

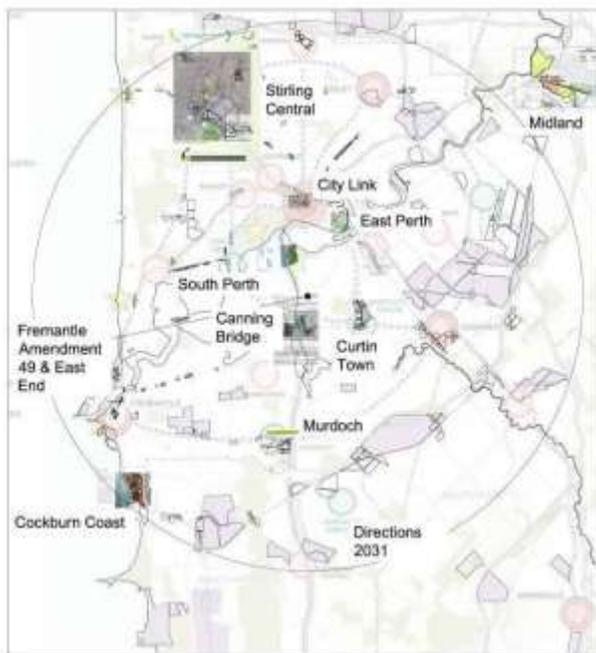
### **Step 5: Gross and net developable land**

The land, which was both close to rail current or future and likely to be redeveloped, was measured to the nearest square meter, lot by lot. Land area was removed from the gross land total at 10% for Public Open Space (plaza, beach, park, ecological reserve, waterfront) and 15% for utility and road Rights of Way as well as for any building set-backs. These numbers for POS and RoW can be lessened in practice depending on specific local interactions of adjacent park land or combined utility and road corridors, but as a first step of due diligence, this is assumed to be a correct course of action. This was done to all the land parcels discussed.

The types of places ideally suited to infill developments:

- Sites already zoned for higher intensity or higher built form;
- empty lots along highway arterials;
- other lots along arterials which are oriented to the corridors, rather than backing onto it as most dendritic street layouts most often do;
- used and new car lots and other land uses that are possible to shift to less important sites;
- buildings set back with parking in front, as we see especially at fast-food restaurants, national grocers and others;
- urban decay areas, which are usually old building stock either not maintained and losing value or from an era when poor workmanship and a poor orientation to the street and its neighbourhood has never led to success;
- brownfield, being ex-industrial lands;
- greyfield, being older housing stock reaching its lifespan and calculated to be due to rebuilding (Newton et al, 2012); and
- high valued land adjacent to highly prized amenities, such as a beach, but which remain locked in its current zoning for a variety of local political reasons.

**Table 2 List of available land types for urban infill**



**Figure 2 Planned areas of expansion**



**Figure 3 Right of Way Dimensions and the LRT in the street**



**Figure 4 Local Planning Scheme**



**Figure 5 Residential Codes (R-Codes)**

**Step 6: Building height**

The land parcels were also given a graduated zoned height (see Table 3) so that precincts with small redevelopable lot areas were not overburdened with out-of-scale buildings (Shoup, 2009).

- a station precinct site was less than 40,000 M<sup>2</sup> in size, or 4 Hectares, the maximum height allowed on that size was 5 stories;
- for building sites over 40,000 M<sup>2</sup> but less than 100,000 M<sup>2</sup> the maximum height was set at 6 stories; and
- a station precinct's redevelopable area over 100,000 M<sup>2</sup> was permitted a maximum of 10 stories.

**Table 3 Maximum heights for rail transit serviced urban land redevelopments**

This was conceived as a method to limit relatively small station area precinct's impact on the surrounding urban fabric so that one small site might not have a single towering built form far outside of the local context. If there was only a small area available, this speaks to an existing tight urban fabric of notable character or a limiting factor such as water bodies, both of which should be brought into a careful orchestration of building masses. In this way the large precincts can grow very high, taking the bulk of the load for space provisions, while the smaller precincts may still contribute to the regional growth but stay proportional to their extant urban form. Ideally the built forms (buildings) will be massed to create strong sense of an active street with passive surveillance, multiple-openings and a series of façade setbacks.

**Step 7: Land use mixes**

A mixing of uses was aspired to with the remainder of the land. As almost universally agreed on in current literature, and aspired to in current planning practice, that to achieve higher-order sustainability a high-degree of mixed land uses are desirable (Frank and Pivo, 1994, Cervero, 1988, Handy et al., 2002). Ostensibly, this is to bring more destinations closer to more people and shorten the trip to and from a destination. Ideally, then, more trips become a walk or bike trip within one's own neighbourhood as well as support a higher density of persons which then further the case for higher-order transit service provisions. (see Tables 4 & 5)

Principle type of buildings discussed in this paper:
<ul style="list-style-type: none"> <li>• Residential = assumed to be townhouses, stacked town homes or apartments</li> <li>• Commercial = Office, Institutional, light Industrial;</li> <li>• Retail = Ground floor both street-oriented and large-format.</li> </ul>
Each of these has unique layouts, stairwells, elevator, water and sewer service provisioning, parking requirements and traffic generation.

**Table 4 Three Principle building types used in this paper**

Name	Resi	Comm	Retail	1.00
University Precinct	0.50	0.40	0.10	1.00
Residential Mixed	0.60	0.25	0.15	1.00
Residential + Mixed	0.75	0.15	0.10	1.00
Residential	0.90	0.00	0.10	1.00
Commercial	0.20	0.60	0.20	1.00
Commercial-	0.20	0.40	0.40	1.00

**Table 5 Land use mix by development types**

**Step 8: Person Activity**

The Land-Use Mixes with floor heights on parcels of land which might be well served by rail transit formed the basis for the results. The results took the form of floors of buildings which then gave floor areas which in turn related the numbers of people (ABS, 2012c), jobs, shops, traffic generation and parking requirements (RTA, 2002). Once the land area was established after a percentage removal for POS and RoW, the land use mix and maximum building heights were assigned and this produced floor areas which were accorded a number of 1 (one) persons per 50M<sup>2</sup> for residential (ABS, 2012c), 25M<sup>2</sup> for retail, or 20M<sup>2</sup> for Commercial space (Western Australia Department of Commerce, 2012, Hillier, 2001). The numbers for retail and commercial were, however, averaged upwards to 40M<sup>2</sup> and 50M<sup>2</sup> to take into account the varying types of educational and large format workspaces being developed. These numbers of people then formed the basis for the calculating the benefits and costs which may be accrued over the next 50 years.

**Step 9: Traffic Generation and Parking**

Traffic and parking rates were derived from the Roads and Traffic Authority of New South Wales multiplied against per meter of per 100 M<sup>2</sup> units of land use in the ultimate build out scenario. For example, each dwelling was expected to produce 5 trips per day and have .9 parking stalls, each commercial 100M<sup>2</sup> was to produce 10 trips per day and have 2.5 parking stalls per unit while Retail units

of 100M<sup>2</sup> were expected to produce 50 trips per day with 5.1 parking places per unit. (RTA, 2002 p. 3-3, 5-4)

**Step 10: Cost Avoided**

The total Cost Avoided was calculated by calculating the number of dwellings possible in all residential floor space (520,645 dwellings) (100 M<sup>2</sup> units for 2 people are assumed to be the average dwelling) multiplied by the findings derived as per dwellings costs avoided by Trubka et al. in 2009 (\$378,553). (Trubka et al. nominated a per 1,000 dwelling figure below) (Trubka et al., 2009)

Figures are per 1000 dwellings	Inner	Outer	Difference
<b>Infrastructure Costs</b>			
Roads	\$5,086,560	\$30,378,880	\$25,292,320
Water and Sewerage	\$14,747,620	\$22,377,460	\$7,629,840
Telecommunications	\$2,576,110	\$3,711,850	\$1,135,740
Electricity	\$4,082,120	\$9,696,510	\$5,614,390
Gas		\$3,690,840	\$3,690,840
Fire and Ambulance		\$302,510	\$302,510
Police		\$388,420	\$388,420
Education	\$3,895,460	\$33,147,270	\$29,251,810
Health (Hospitals, etc.)	\$20,114,870	\$32,347,330	\$12,232,460
<b>Total Infrastructure</b>	<b>\$50,502,740</b>	<b>\$136,041,070</b>	<b>\$85,538,330</b>
<b>Transport Costs</b>			
Transport and Travel Time	\$206,542,060	\$342,598,100	\$136,056,040
Roads and Parking	\$46,937,540	\$154,826,100	\$107,888,560
Externalities	\$2,219,880	\$9,705,380	\$7,485,500
<b>Total Transport</b>	<b>\$255,699,480</b>	<b>\$507,129,580</b>	<b>\$251,430,100</b>
<b>Greenhouse Gas Cost</b>			
Offset Cost (\$25/t)	\$2,500,000	\$5,400,000	\$2,900,000
Social Cost (\$215/t) (NB. not included in total)	\$21,500,000	\$46,440,000	\$24,940,000
<b>Total Greenhouse</b>	<b>\$2,500,000</b>	<b>\$5,400,000</b>	<b>\$2,900,000</b>
<b>Physical Activity Costs</b>			
Healthcare Cost		\$4,229,950	\$4,229,950
Productivity Loss		\$34,454,900	\$34,454,900
<b>Total Activity Costs</b>		<b>\$38,684,850</b>	<b>\$38,684,850</b>
<b>Total (excluding social cost)</b>	<b>\$308,702,220</b>	<b>\$687,255,500</b>	<b>\$378,553,280</b>

**Table 2: Estimated development costs for an urban redevelopment compared to a fringe development**

**Figure 6 Table of Cost Avoided in Trubka et al.**

The dwellings numbers were calculated after a lot by lot search for space in new and current rail station precinct along the proposed and current rail transit lines. The dwelling numbers are the result of the net land available divided into land use types which best suit its context (Table 6) multiplied by the maximum number of floors (Table 3) for each type of built form.

Trubka et al. counted all the costs, including the loss of productivity due to traffic congestion and the expenses of building new schools and hospitals per thousand dwellings in a report published in 2009. This report deals primarily with the costs associated with constructing urban areas in Perth, Western Australia showing there are clear savings to be accrued by making the infrastructure already in place work harder to support the increase in population<sup>1,2</sup>.

### **Step 11: Value Capture**

With the next generation of transport projects we need the land and parking to be zoned to take best advantage of the demographic changes happening in Perth (or any city). The real estate market needs to function freely in this regards, but with a series of simple to implement and 'nothing hidden' charges to help pay down the expense of the PT infrastructure. Some of these fees, charges, rates or taxes exist in a format which can be 'ring-fenced' to this end. All new land rezoned along these transit lines will contribute at the price they can bear on the open market. The results demonstrated in this model are therefore highly indicative and to be taken as an illustration only of the Value Capture concept.

The Value Capture numbers derive from using the several possible **passive**<sup>3</sup> funding streams. Many of these streams exist already (MRIF, Land Tax, Parking Levy) (McIntosh et al., 2011) and can be amended to suit the purposes of building the next generation of rail transit. The streams discussed below only apply to the **new** transit served developments; if these streams were applied to the **existing** property stock the Value Capture fund could be even larger. These numbers are conservative as they only calculate the development occurring in up-zoned land adjacent to rail transit. None of these funds will begin deliver the estimated result until the land is rezoned, the real-estate market takes up the opportunities and the units are under construction.

Using the same dwelling numbers as found for the Costs Avoided (520,645 dwellings) , multiplied by the possible average housing value rounded to \$500,000 (Realestate.com.au, 2013), multiplied by a 10% premium (the premium can be as high as 20%) for being near or in rail station precinct and multiplied by a 10% 'rate' applied to the increase in the properties values:  $(520,645 \times \$500,000 \times 1.1 \times 1)$ . This is equal to 1% of the dwelling units' value being applied towards a Value Capture ring-fenced fund. If this were applied just one time, at sale as a 'Stamp Duty', on each dwelling this fund could raise \$2.6 billion dollars. This stream could be applied each time the dwelling is sold, capturing the resale of dwellings between 'off plan' speculators and the ultimate homeowners. Were this stream applied as a special rate per year at a lower rate, it could raise multiples of billions per decade. This is contingent on at least these two factors: that there is a hedonic price rise for these units due to being adjacent to public transit service; and that the property market is active and moving upwards in value.

If the same 1% were applied to the rise in Commercial properties, valued at a conservative average of \$300 per M<sup>2</sup> (Realcommercial.com.au, 2013), as a one-time fee this could ring-fence another \$60 million. Similarly this stream could be applied at a lower rate per year to generate funds for decades to help pay down the expense of transit infrastructure. This is contingent on at least these two factors: that there is a hedonic price rise for these units due to being adjacent to public transit service; and that the property market is active and moving upwards in value.

A \$5 per working day charge on all new **Commercial** parking spaces could raise \$627 million per year. Pricing parking reduces induced driving demand. (Calculated on 250 working days per year.) This number does not reflect existing parking and could therefore produce a many fold increase contribution to

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<sup>1</sup> The current capacity of the underground services is upgraded on a regular half to full century schedule.

<sup>2</sup> Infrastructure costs can vary widely depending on what is counted and costs change from year to year as between states and cities. For a complete understanding of Trubka's methodology, please view the papers as per the works cited. TRUBKA, R., NEWMAN, P. & BILSBOROUGH, D. 2009. The Cost of Urban Sprawl - Physical Activity Links to Healthcare Costs and Productivity. . *Environment Design Guide*, GEN 85, 1-13.

<sup>3</sup> For more on passive versus active value capture, see McIntosh et. al. 2011. MCINTOSH, J., NEWMAN, P., CRANE, T. & MOURITZ, M. 2011. Alternative Funding Mechanisms for Public Transport in Perth: The Potential Role of Value Capture. *In: COMMITTEE FOR PERTH* (ed.). Perth.

the fund. This will be applied to the owners of parking to be recouped through daily paid parking, yearly fees or absorbed by the owners of the properties. It is preferred this volume of parking is not built, see 5.2.1 above.

A \$5 per day charge on all new Retail parking spaces could raise \$297 million per year. Pricing parking reduces induced driving demand. (Calculated on 365 days per year.) This number does not reflect existing parking already available and could therefore produce many folds increase contribution to the fund. Applied to the owners of parking and to be recouped through paid parking, by yearly fees or absorbed by the owners of the properties. It is preferred this volume of parking is not built, see 5.2.1 above.

A 1% tax per meter on the sale of land, valued at a conservative \$200 per meter, in these transit-served lands could bring in approximately \$61 million in one-time fees. These extra fees would be clearly evident to the purchaser/developers by the zoning in effect which allows their development. This stream could be applied each time the land is sold thereby capturing the resale of land between developers. If the land were valued higher, it would bring in more to the ring-fenced fund. A 1000 M<sup>2</sup> lot (1/4 acre) is more likely to be valued, conservatively, at between \$250 and \$500 per M<sup>2</sup> in Perth currently.

These totals were added together to give the potential Value Capture of \$3.6 billion once the real-estate with parking is constructed and occupied.

The Value Capture mechanisms above have been, admittedly, simply and conservatively estimated but do indicate nearly enough revenue to pay for the overall infrastructure just from the land of the new TODs. Building the rail will benefit all of Perth and defining the areas that would benefit most can provide a value capture fund that could easily pay for the new rail system in its entirety over many years.

### **Step 12: Capital costs**

Martin in 2011 described the costs to construct major transit projects in “Reviewing the last decade of public transport infrastructure projects in Australasia”. It is described that per kilometre the average to build heavy rail projects in Australia with no tunnelling, grade separation, inner city costs or bridges, has an “average construction cost ....(of) \$17M per-kilometre.” (Martin, 2011 p.11)

Light Rail: “Based on the sample of projects, the average per-km construction cost for a light rail project in Australia based on actual costs from the previous decade is \$11.9M.” (Martin, 2011 p.9)

To be conservative, the dollar figure used in the calculations was \$28 and \$24 million per kilometre respectively. The kilometres were derived by reading the length of each transit line segment from the scaled region wide base plan in AutoCAD.

### **Step 13: Floor Area Ratio**

Floor Area ratio is an indication of the gross area to be built on and the relation to the ultimate volume of building on that footprint. In the instances modelled in these scenarios the FAR will vary between 1 and 5 Floor Area Ratio (FAR), which is modest in global terms.<sup>4</sup> The Floor Area Ratios (FAR), or Plot Ratios, were recovered as well this methodology. An FAR is a widely used figure to have frank and open dialogues with communities and developers about what may be permitted on a given site.

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<sup>4</sup> For example, The Beasley building in Yaletown, Vancouver, Canada is a mixed use, mixed income, heritage conserving, street-front retail building of over 30 floors and comes in at 7.22 FAR, which will not be even noticeable within its urban context: <http://forum.skyscraperpage.com/showthread.php?t=147928> . While Floor Area Ratios of 16.4 are achieved in Manhattan, one might think that all tall buildings have high FAR, but this is not so; the Brasilia Superblocks are only FAR 1.1 due primarily to the great areas of anti-urban, not even ecological, ‘open space’ left between the buildings. In other words, if all the floors of any one of these buildings in Brasilia were laid out across the lot in which they sit, they would only just cover the entire lot with building mass whereas the building in Manhattan would cover the site 16.4 times. <http://densityatlas.org/casestudies/>

### **Significance:**

Other results followed similar paths of relating a known impact or benefit and multiplying it across the resultant  $M^2$  of floor space, per dwelling or by person.

What this model demonstrates is: were Perth to strategically aim for the outlined 47% infill policy in Directions 2031 it could house all the new residents along current and new transit lines in a maximum 10 storey, some 5 or 6 storey depending on site redevelopment size, chain of nodal developments. These developments would occur only in the red polygons on the Figure 1 and not in the established suburbs. Likewise these developments will be happening where urban development ought to; near rail transit lines and in areas rich with amenities rather than as dispersed car-dependent Greenfield developments.

### **Results:**

The Ring Rail has been divided into two sections – Northern Circumferential Line and the Southern Circumferential Line.

NCL: The Northern Circumferential Line (NCL) will accommodate 88,674 dwellings for 177,347 residents, providing 5.2 years of housing at a Floor Area Ratio of 2.6 with a maximum building height of 10 floors on precincts over 100,000 square meters (10 hectares). This will provide retail spaces for 31,300 workers and commercial office space for almost 208,000 workers. All this while reducing 194,000 tonnes of GHG from transport per year, saving an estimated \$445 million in transportation costs over 50 years, providing an additional 104,000 km of walking trips per year with \$7,500,000 in health benefits accrued due to improved health from living in highly walkable environments and \$68,600,000 benefits due to higher productivity.

SCL: The Southern Circumferential Line (SCL) will be able to accommodate 150,000 dwellings for 300,000 residents, providing 8.8 years of housing at a Floor Area Ratio of 2.9 with a maximum building height of 10 floors on precincts over 100,000 square meters (10 hectares), providing retail spaces for 21,500 workers and commercial office space for almost 130,000 workers. All this while reducing 329,000 tonnes of GHG from transport per year, saving an estimated \$756 million in transportation costs over 50 years, providing an additional 176,000 km of walking trips per year with around \$12,000,000 in health benefits accrued due to better health from living in highly walkable environments and \$116,000,000 of benefits due to higher productivity.

The overall new system – with the Light Rail network in the inner city areas working in combination with the Ring Rail – will provide 3045 hectares of urban land. This will accommodate 531,440 dwellings for almost 1,063,000 residents, providing 30.6 years of housing at a Floor Area Ratio of 2.3 with a maximum building height of 10 floors on precincts over 100,000 square meters (10 hectares). This will provide retail spaces for almost 80,000 workers, and commercial office space for over 400,000 workers while reducing 1,164,000 tonnes of GHG from transport related activities per year, save an estimated \$2,622,000,000 in transportation costs over 50 years, providing 622,000 walking trips per year with \$45,000,000 of benefits and savings accrued to improved health from living in highly walkable environments and \$411,000,000 of benefits due to higher productivity.

The total number of residents and jobs attracted to these rail-based locations can thus absorb around 30 years of Perth's present expected growth without another strictly car-dependent house or job being placed on the urban fringe. It will save over \$3.9 billion in residential infrastructure costs required to subsidise urban fringe development (paid for over the next half century at current known expenses).

An estimate of the costs of construction for the rail systems that would catalyse these changed urban development patterns has been made using recent Australian infrastructure project budgets (Martin, 2011). This cost estimate, based on \$28 million/km for heavy rail and \$24 million/km for light rail, arrives in the range of \$4.4 billion for all the heavy rail and light rail upgrades. The true economic value of planning transit-oriented developments around train stations is that it can enable a financing mechanism through value capture (alongside the social and environmental benefits of living in more compact and complete neighbourhoods). A cursory value capture has been estimated at \$3.6 billion, based on 1% of the value of the land as well as parking fees, and could be used to pay for the new system. When a detailed

assessment is made of the costs and benefits of these rail systems a highly positive outcome is expected as there are significant savings in time made when redevelopment of middle and inner city locations are created compared to outer development, as well as improved time savings for the whole network that would flow through to the rest of Perth's population.

## **Conclusion**

As "only through a full accounting and weighing of social costs and benefits" (Cervero, 2003) will we be able to say that the costs to construct the new network of proposed light rail and heavy rail multidirectional network may or may not be worth the investment. If Scott Martin's public transport infrastructure costs from 2011 are any indication, if the work by Trubka et al. (Trubka et al., 2009) are to be carried forward into real time mixed-use developments adjacent to high order transit, if the likelihood that the urban form and fabric of Perth will change with market demand and active upzoning somewhat akin to the proposed scenario of this paper, then there is a strong case to be made for the rail and bus investments. These investments in the transport network will be for the next generation of residents with spaces to live, work, shop and play with a car reduced lifestyle. This paper demonstrates the benefits accrued for a region by following a comprehensive land-use and transport integration policy.

Perth can achieve at least the minimum of infill housing as the policy in Directions 2031 indicates. Perth can become a polycentric, multimodal, multi-family, shared infrastructure city of note which lives within its ecological bounds in the emerging Knowledge and Green Economic era.

An answer to the fundamental question regarding the best possible future for Perth is illustrated in this paper. This Plan enables Perth to choose to augment its rail transport network and thus achieve a major step forward in achieving regional and national 21<sup>st</sup> Century goals while remaining a competitive and liveable Transit Oriented Region.

**Bibliography:**

- ABS. 2012c. *Australian home size is growing* [Online]. Canberra: Australian Bureau of Statistics. Available:  
<http://www.abs.gov.au/ausstats/abs@.nsf/Previousproducts/1301.0Feature%20Article262005?opendocument&tabname=Summary&prodno=1301.0&issue=2005&num=&view=>  
[Accessed January 17 2013].
- AUSTRALIAN GOVERNMENT 2012b. Understanding Australia's urban railways. *In:* TRANSPORT, D. O. I. A. (ed.). Canberra: Bureau of Infrastructure, Transport and Regional Economics.
- CERVERO, R. 1988. Land-Use Mixing and Suburban Mobility. *Transportation Quarterly*, 42, 429-446.
- CERVERO, R. 2003. Road Expansion, Urban Growth, and Induced Travel: A Path Analysis. *Journal of the American Planning Association*, 69, 145-163.
- FRANK, L. D. & PIVO, G. 1994. Impacts of Mixed Use and Density on Utilization of Three Modes of Travel: Single-Occupant Vehicle, Transit, and Walking. *Transportation Research Record*, 1466, 44-52.
- HANDY, S. L., BOARNET, M. G., EWING, R. & KILLINGSWORTH, R. E. 2002. How the Built Environment Affects Physical Activity: Views from Urban Planning. *American Journal of Preventive Medicine*, 23, 64-73.
- HILLIER, S. 2001. 2001 Floor Space and Employment Survey - City of Sydney Local Government Area - Summary Report. *In:* CITY OF SYDNEY (ed.). Sydney: Building Services & Planning Policy Unit.
- JACOBS, J. 1961. *The Death and Life of Great American Cities*, New York, Random House and Vintage Books.
- KENWORTHY, J. R. & LAUBE, F. B. 1999. Patterns of automobile dependence in cities: an international overview of key physical and economic dimensions with some implications for urban policy. *Transportation Research Part A: Policy and Practice*, 33, 691-723.
- KOZAWA, K. H., WINER, A. M. & FRUIN, S. A. 2012. Ultrafine particle size distributions near freeways: Effects of differing wind directions on exposure. *Atmospheric Environment*, 63, 250-260.
- LITMAN, T. 2012. Smart Congestion Relief: Comprehensive Analysis Of Traffic Congestion Costs and Congestion Reduction Benefits. Victoria, BC. : Victoria Transport Policy Institute.
- MARTIN, S. Reviewing the last decade of public transport infrastructure projects in Australasia. *In:* PATREC, ed. Australasian Transport Research Forum 2011 Proceedings, 28 - 30 September 2011 Adelaide, Australia. <http://www.patrec.org/atrf.aspx>.
- MCINTOSH, J., NEWMAN, P., CRANE, T. & MOURITZ, M. 2011. Alternative Funding Mechanisms for Public Transport in Perth: The Potential Role of Value Capture. *In:* COMMITTEE FOR PERTH (ed.). Perth.
- MEES, P. & GROENHART, L. 2012. Transport Policy at the Crossroads: Travel to work in Australian capital cities 1976-2011. Melbourne: RMIT University.
- NEWMAN, P. 2011. The Perth Rail Transformation: Some political lessons learned. Fremantle CUSP.
- NEWMAN, P., GLAZEBROOK, G. & KENWORTHY, J. 2013. The Rise and Rise of Global Rail: Why this is happening and what it means for large and small cities. *Transport Reviews*, (Forthcoming).
- OZINSURE. 2012. *Car Cost Calculator* [Online]. Melbourne: OzInsure. Available:  
<http://www.ozinsure.com.au/Car-Cost-Calculator/> [Accessed November 5 2012].

- PTA WA. 2012a. *Perth Airport rail link route released* [Online]. Perth: State Government WA. Available: <http://www.pta.wa.gov.au/Default.aspx?id=982&tabid=121>.
- PTA WA. 2012c. *Transperth Patronage* [Online]. Perth. Available: <http://www.pta.wa.gov.au/NewsandMedia/TransperthPatronage/tabid/218/Default.aspx> 2013].
- REALCOMMERCIAL.COM.AU. 2013. *Results for properties for lease in Perth, WA 6000* [Online]. Perth. Available: <http://www.realcommercial.com.au/for-lease/in-perth%2c+wa+6000/list-1> [Accessed January 2013].
- REALESTATE.COM.AU. 2013. *Perth Property Data & Trends* [Online]. Available: <http://www.rs.realestate.com.au/cgi-bin/rsearch?a=sp&s=wa&u=perth> [Accessed January 2013].
- RTA 2002. Guide to Traffic Generating Developments. In: ROADS AND TRAFFIC AUTHORITY NSW (ed.). Roads and Traffic Authority NSW,.
- SHOUP, D. C. 1999. The trouble with minimum parking requirements. *Transportation Research Part A* 33, 549-574.
- SHOUP, D. C. 2009. Graduated Density Zoning to encourage Land Assembly for Infill Redevelopment. *Zoning Practice*, 1.
- SMART GROWTH BC. 2012. *10 Smart Growth Principles* [Online]. Vancouver, BC. Available: <http://www.smartgrowth.bc.ca/Default.aspx?tabid=133>.
- SOAC 2012. State of Australian Cities 2012. In: AUSTRALIAN GOVERNMENT (ed.). Canberra: Department of Infrastructure and Transport, Major Cities Unit
- TRUBKA, R., NEWMAN, P. & BILSBOROUGH, D. 2009. The Cost of Urban Sprawl - Physical Activity Links to Healthcare Costs and Productivity. . *Environment Design Guide*, GEN 85, 1-13.
- UNEP. 2011a. *Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication – a Synthesis for Policy Makers*. [Online]. Available: [www.unep.org/greeneconomy](http://www.unep.org/greeneconomy).
- UNEP 2011b. Transport: Investing in energy and resource efficiency. In: DALKMANN, H. & SAKAMOTO, K. (eds.) *Towards a Green Economy*. United Nations Environment Program.
- UNEP. 2012. *What is the "Green Economy"?* [Online]. New York City: United Nations, . Available: <http://www.unep.org/greeneconomy/AboutGEI/WhatisGEI/tabid/29784/Default.aspx> 2012].
- URBAN LAND INSTITUTE 1998. *Smart growth: economy, community, environment*, Urban Land Institute.
- WESTERN AUSTRALIA DEPARTMENT OF COMMERCE. 2012. *Minimum workspace requirements* [Online]. Perth: Western Australia. Available: [http://www.commerce.wa.gov.au/worksafe/content/safety\\_topics/Office\\_safety/Further\\_information/Minimum\\_workspace\\_requirements.html](http://www.commerce.wa.gov.au/worksafe/content/safety_topics/Office_safety/Further_information/Minimum_workspace_requirements.html) [Accessed January, 2013 2013].
- WESTERN AUSTRALIA DEPARTMENT OF PLANNING 2012c. Delivering Directions 2031, annual report card 2012. In: STATE, W. (ed.). Perth: Department of Planning.