Road Costs Associated With Differing Forms of Urban Development*

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ABSTRACT

This paper presents some preliminary results from PhD research being undertaken which, more broadly, considers infrastructure costs associated with differing forms of urban development available to policy makers within Australia. It is thus a component of the 'compact' versus 'dispersed' city debate. The bulk of the international (mainly US) literature suggests that infrastructure (including road) costs for compact cities are generally less than for cities which are permitted to 'sprawl'. A policy of urban consolidation has been effectively pursued in Sydney, the major component of the GMR, but less effectively in the Central Coast, the Lower Hunter and the Illawarra.

A sample of sixteen recent and projected residential developments within the Greater Metropolitan Region (GMR) of NSW has been undertaken. Attributable costs of road construction, maintenance and use have been estimated from a variety of approaches and sources.

The paper argues that, whilst greenfields road costs are expensive, it is not necessarily the case, unlike US cities, that there is substantial road capacity in inner city networks. Whilst there is support for the contention that road costs are higher in greenfields locations, road infrastructure provision for new housing in brownfields locations, if it continues to be pursued, may approach costs near or at the fringe. In particular, 'leap-frogged' fringe development will likely incur earlier and possibly higher capital costs than would otherwise be necessary and should be avoided. There are, of course, substantial policy and funding implications from this research.

Keywords

Road costs, Compact Cities, Urban sprawl.

1 INTRODUCTION

By 2008, according to the United Nations (2009), half of the world's population lived in cities and the prediction is that this figure will have risen to seventy per cent by 2050, with the bulk of growth occurring in developing countries. In contrast, each of the Australian colonies and then States have had their economies dominated by a single city since their foundation.

These dominant Australian cities have, with some exceptions, exhibited high rates of population growth over the past two decades. More recently (in 2011-12) Melbourne's population increased by 77,242 people, Sydney's by 61,291, with Brisbane and Perth showing increases of between 43,301 and 65,434 respectively. Australia's four largest cities are growing at a rate between 1.3 and 3.6% (ABS, 2013, p8). These rates of growth are generally higher than other major 'Western' cities (see for example, the City Mayors' website, http://www.citymayors.com/statistics/urban_growth2.html) and may be expected to continue, albeit at inconsistent rates) into the foreseeable future, assuming current levels of net migration.

In the context of this rapid growth there are two questions – what is the spatial distribution of that growth within each city, and does that distribution matter in terms of costs to the community, including government, households and industry?

A combination of high population growth and reduced household size generate significant demands for available land. Land markets in Australian cities have typically responded with a combination of (i) higher densities in established areas, particularly in locations adjacent to their central cores, and (ii) low density development at or beyond the periphery (see, for example, Buxton and Scheurer (2007).

The latter form of development is perceived by many observers as having significant costs, notwithstanding generally more 'affordable' housing costs considered in isolation. Increased transport costs, emissions and reduced levels of health are all cited in the literature as issues with peri-urban growth (see, for example, Ewing, (1997) and Trubka, Newman and Bilsborough (2007)).

On the other hand, attempts to increase densities in established areas have met with considerable and growing opposition from existing residents (see, for example, the Sydney Morning Herald editorial reproduced here), generally on the basis of claimed losses in amenity. It may also be the case that augmentation of infrastructure to support increased demands in central areas is prohibitively expensive.

2. THE POLICY POSITION – CONSOLIDATION VERSUS SPRAWL

The 2005 Sydney Metropolitan Strategy DoP, (2005) adopted an objective of encouraging more compact development, with higher densities than are current in the existing urban footprint and a 30% target for greenfields development – 30% of new housing. In reality, the Sydney housing market in recent years has exhibited significantly higher proportions of development in the existing urban area – currently 74% versus 26% for greenfields sites (DP&I, December 2012). It is well to note the disparity between planning targets and the behavior of markets. The Sydney Metropolitan Plan (DoP, 2010), produced whilst the previous Labor administration was in government, continued that target but put greater emphasis on the development of centres.

The most recent draft Metropolitan Strategy for Sydney (DP&I, 2013) has dropped the reference to a 70/30 split but does set new housing targets for metropolitan subregions. This less specific approach reflects the policy position of the succeeding Coalition government.

Notwithstanding the change in policy direction above for Sydney, other Australian governments display a varying, but generally lesser, commitment to urban containment than Sydney.

All current policy positions reflect the interplay of government objectives, housing and other markets and are, of course, subject to change. The level of greenfields development, loosely described as 'sprawl' is the subject of past and some current debate as is its corollary, the level of higher density in-fill development, or containment (e.g..Gordon and Richardson, (1997) and Gordon and Cox (2012)).

3 OVERALL METHODOLOGY

In order to test the road costs associated with differing forms of development, sixteen individual developments (see map, over) in the Sydney Greater Metropolitan Area (GMA) have been investigated in detail and attributable costs of various infrastructure elements calculated. The costs include (i) capital and (ii) use costs for a variety of infrastructure types. The cost of maintenance of road facilities is a difficult issue to quantify and will be the subject of further research.

Date: Feb 20, 2012; Section: Opinion; Page: 10

Costs expand with the city

WHEN Brad Hazzard, the Planning Minister, announced a new approach to the zoning of land for residential development last month, the western Sydney councils likely to be most affected were up in arms. Now, from the full details of a report commissioned by the previous Labor government comparing the cost of developing homes on the urban fringe with the cost of infill housing in developed areas, the public can see why.

Labor sought for cost reasons to limit the growth of new fringe suburbs, and planned that 70 per cent of the new homes needed in the next 25 years would be in existing suburbs, and the rest in new growth areas to the north west and south west. But the pressure to increase population density, particularly near existing railway lines produced a backlash. In Ku-ring-gai, the Premier's electorate, long-time residents rebelled at planning policies and insensitive developments in which the character of parts of their suburb would be altered forever. Heightened feelings in the Liberal heartland made less intense infill development an urgent goal for the Coalition. During the election campaign, the Premier stated a preference for something closer to a 50-50 split between infill and greenfield development. He has not restated the ratio precisely since then. Perhaps reality is starting to dawn.

Other things being equal, his policy would be justifiable – even preferable.

But other things are not equal. Labor's consultants found the extra cost of greenfield development to be $5 billion over the 25 years. Considering the transport needs of large areas of western Sydney, the figure seems optimistically low, particularly given Hazzard's new approach, in which developers would nominate where they think land should be rezoned for housing, whether close to existing services or not. New suburbs will need water, power, roads – and where possible, railways – as well as schools, police stations and hospitals.

Perhaps reality is starting to dawn.

The government already faces a vast backlog of infrastructure spending. It might push the cost of services and infrastructure on to developers with levies but then the price of new houses will rise – probably beyond a point at which they are affordable. And if developers believe they cannot sell houses, they will not build any.

This is not a new problem. It is why NSW has persistent unmet demand for houses, and world-beating real estate prices. One solution must be to increase infill housing – hoping that improved planning rules may lift the quality of developments and reduce local opposition. Another may be to reduce the standard of services on new housing developments. Sydney's outer suburbs once had unsealed roads and septic tanks. Perhaps they will again.

The sample was chosen on the bases that the locations provide a range of inner, middle and outer ring locations, developments close to, and distant from, public transport and low and high density developments. Availability of information was also a factor in choosing the sample

population

Costs are borne by developers/purchasers/tenants, and by each level of government (including the Federal Government) in varying proportions depending on the infrastructure element considered.

Calculated costs on a per household or per gross hectare basis have been derived. From this point conclusions with respect to infrastructure costs for future development of differing city forms are made

4 ROAD COSTS

Consideration in this paper is given to attributable costs of the development, irrespective of who ultimately pays for those costs. Typically the provision of roads involves (i) local roads often provided by the developer within the development and (ii) connector roads from the development to the arterial road network, paid through a variety of mechanisms including contributions (monetary and/or works in kind), or by Councils. Importantly, however, there are impacts on the arterial and motorways networks for which the road authority is the New South Wales, Roads and Maritime Services (RMS). These latter impacts are part of the calculations herein, with the bulk of funding for major roads provided by the State Government with, in some cases, funding provided by the Federal Government, as part of the National Network.

4.1 Road Capital Costs

The method employed to determine capital costs attributable to each development is essentially the first stage of the traditional four step transport modeling process. Road provision is still heavily dependent on peak hour trip generation. Thus the first stage is to determine the net peak hour trip generation from each development site. 'Net' development is used because many sites have existing land uses which generate traffic. This rate is deducted from the new level of trip generation to determine the number of trips generated by the developed site. Two new development sites are provided by way of example. The first is a low density greenfields development in Sydney's south west, the second a proposed high density inner suburban site, located in close proximity to rail and bus.

The first site has an estimated peak one hour trip generation of 1.32 trips per household. Thus the 4,500 ultimate houses are estimated to generate 5,940 current trips. Given that there is no current trip generation on this site that figure also represents the net generation. The second inner city site comprises 790 apartments with a peak one hour trip generation rate of 0.20 per household. The gross generation is thus 158 peak hour trips. The site has, in the past, been estimated to generate 50 trips. The net rate is thus 108 trips.

The second and third stages are then to (ii) estimate average vehicle trip length of each peak journey and (iii) from this, calculate total vehicle kilometres (VkT) of travel generated by the development. In the examples above average estimated trip lengths are 15.4 kilometres and 10.5 kilometres repectively. Thus total VkT for the greenfields site is estimated at 91,476 (15.4x5,940) and, for the inner suburban site 1,134 VkT. On this basis, it would appear that the greenfields site generates a significantly higher traffic load (80x) than the inner suburban site. However, the preceding does not allow for spare capacity and the cost of building new capacity.

Noting the point made earlier, that traffic generated by each development will impact all roads on the network, an estimate of current lane occupancies is necessary. In the case of the greenfields site, average occupancies for each lane traversed by the 15.4 kilometre trips, is estimated at 500 vehicles (noting that the bulk of travel is on the arterial network). In the inner suburban site current peak hour lane occupancies are estimated to be 850 vehicles (noting that just about all of the travel will be on the arterial network, and that the network suffers greater congestion than the greenfields example).

Roads requirements will differ from development to development so a simplifying assumption is made that lane kilometers of road space will provide a surrogate of requirements. On this basis, the greenfields development will generate the need for (91,476/500) lane kilometers of road space, i.e. 183 kilometres. The inner suburban site will require (1,134/850), i.e. 1.3 kilometres. Note however, that these figures reflect current usage. If a lesser standard of service (so-called Level of Service (Los) 'D' is required for the greenfields site (and this would seem to be appropriate) the road space impacts are then 107 kilometres and 1.3 kilometres respectively. Levels of Service criteria were devised in the 1950s as a shorthand method of describing traffic conditions, LoS 'A' being freeflow, LoS 'F' being total congestion.

This then brings us to the fourth stage of estimation, the cost of provision. Average lane kilometer costs for the greenfields site are in the region of $5 million, and for the inner suburban site $25 million, if the road space is to be provided on the surface. Thus the greenfields capital cost impacts are in the order of $538 million (107 kms x $5m), and $33 million for the inner suburban location (1.3kms x $25m).

On a per household basis these figures bring us to ($538m/4,500) $120,000 for the greenfields site and $33m/790) $42,000 for the inner suburban site.

Note that the variables in these calculations are:

- Trip generation per household. The best source for these data are surveys conducted by the NSW Roads and Maritime Services' Guide to Traffic Generating Developments (RTA, 2010) and (RMS, 2012).
- Peak hour trip length. Data from the NSW Bureau of Transport Statistics' Household Travel Survey provides the source of these data.
- Peak hour lane occupancies are derived from the author's experience of the Sydney road network.
- Capital costs per lane kilometre are similarly drawn from the author's experience.

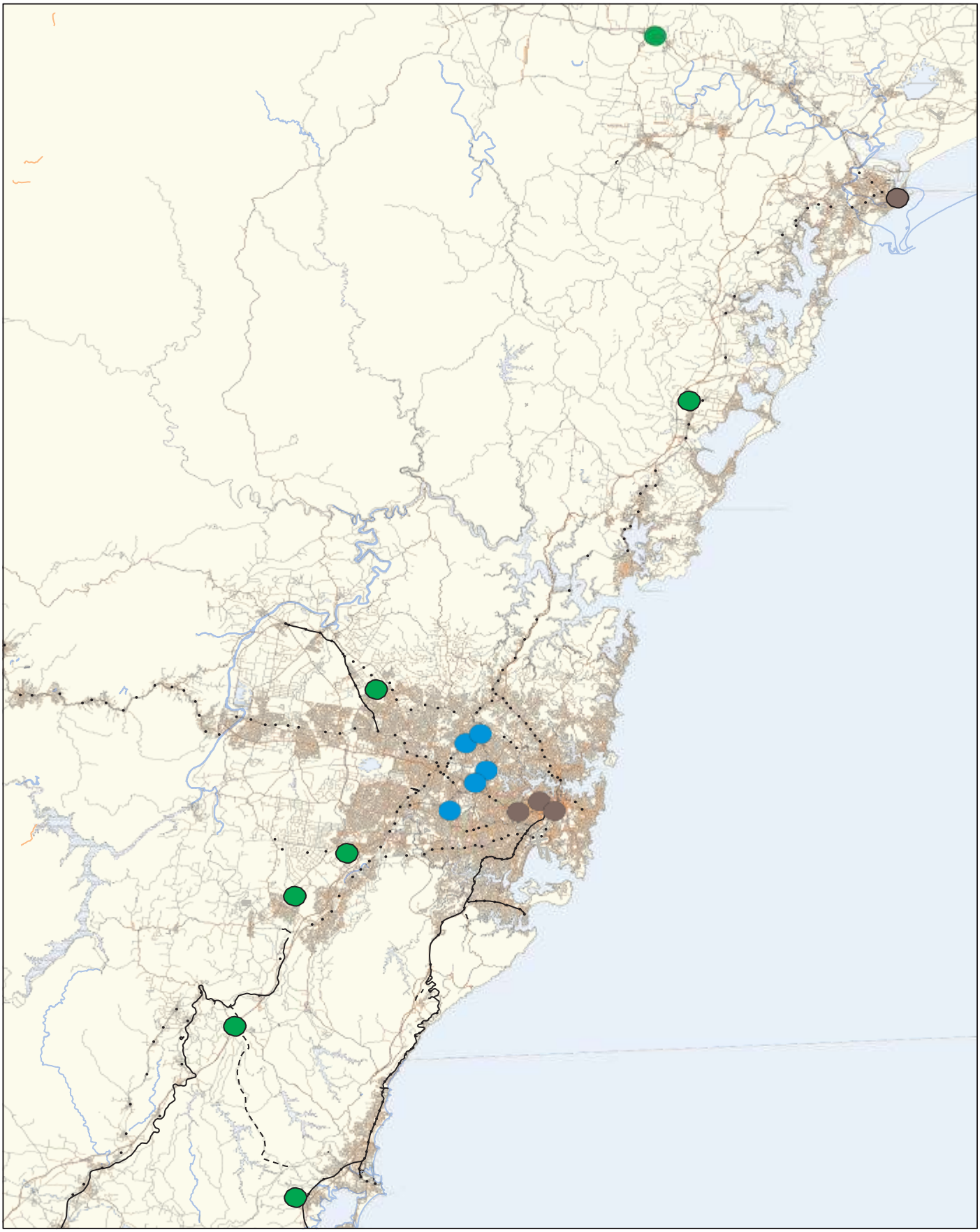

Table 1 – Summary of Attributed Road Capital Costs for Each Development

Development **A**	Locational Type **B**	Distance from relevant CBD (kms) **C**	Housing Units/ Dwellings **D**	Estimated Unit Trip Generation (Range & Median) **E**	Total Peak Generation (trips) (D*E) **F**	Estimated Current Peak Hour Trip Generation **G**	Marginal Peak Hour Trip Generation (F-G) **H**	BTS Est Trip Length (Kms) **I**	Amended Trip Length (Kms) **J**	Total Peak Hour Generation (Vkt) (H*J) **K**	Est LoS D Lane Occupancy (Veh/Lane) **L**	Lane Km to Maintain LoS D (K/L) **M**	Cost per Lane Km **N**	Total Cost (M*N) **O**	Cost per Housing Unit/ Dwelling (O/D) **P**
Sydney CBD	High Density, Inner City	1.7	2,310	0.00 – 0.36 0.12	278	20	258	7.0	7.0	1,806	850	2.13	$30m	$64m	$28k
Honeysuckle (Newcastle CBD)	High Density, Inner City	2.4	1,700	0.20	340	100	240	12.8	9.5	2,280	850	2.68	$25m	$67m	$39k
Sydney Inner	High Density Inner Suburban	4.1	1,251	0.00 – 0.36 0.21	258	20	238	7.0	9.5	2,261	850	2.66	$25m	$67m	$53k
Sydney Inner	High Density Inner Suburban	8.8	790	0.20	158	50	108	10.5	10.5	1,134	850	1.33	$25m	$33m	$42k
Illawarra	Low Density Contiguous Greenfields	13.9	16,000	0.61	9,760	500	9,260	13.7	11.0	101,860	900	113.18	$15m	$1,697m	$106k
Sydney Middle	High Density Suburban Infill	16.3	6,000	0.28	1,680	0	1,680	10.5	10.5	17,640	900	19.60	$15m	$294m	$49k
Sydney Middle	High Density Suburban Infill	21.1	4,000	0.28	1,120	50	1,070	10.5	11.0	11,770	900	13.08	$15m	$196m	$49k
Sydney Middle	High Density Suburban Infill	21.6	98	0.12 – 0.36 0.25	25	13	12	9.4	11.0	132	850	0.16	$15m	$2m	$24k
Sydney Middle	High Density Suburban Infill	22.5	800	0.35	280	200	80	9.4	11.5	920	850	1.08	$15m	$16m	$20k

Development **A**	Locational Type **B**	Distance from relevant CBD (kms) **C**	Housing Units/ Dwellings **D**	Estimated Unit Trip Generation (Range & Median) **E**	Total Peak Generation (trips) (D*E) **F**	Estimated Current Peak Hour Trip Generation **G**	Marginal Peak Hour Trip Generation (F-G) **H**	BTS Est Trip Length (Kms) **I**	Amended Trip Length (Kms) **J**	Total Peak Hour Generation (Vkt) (H*J) **K**	Est LoS D Lane Occupancy (Veh/Lane) **L**	Lane Km to Maintain LoS D (K/L) **M**	Cost per Lane Km **N**	Total Cost (M*N) **O**	Cost per Housing Unit/ Dwelling (O/D) **P**
Sydney Middle	Low/Medium Density Suburban Infill	32.5	450	0.20 – 0.60 0.43	192	20	172	10.5	13.0	2,236	850	2.63	$10m	$26m	$58k
NW Sydney	Low Density Contiguous Greenfields	42.2	5,500	1.22	6,710	50	6,660	12.8	13.5	89,910	900	99.90	$7m	$699m	$127k
SW Sydney	Low Density Contiguous Greenfields	44.3	6,750	1.32	8,910	50	8,860	15.4	14.0	124,040	900	137.82	$7m	$965m	$143k
Lower Hunter	Low Density Leap-frogged Greenfields	54.0	7,200	0.78	5,616	0	5,616	12.8	15.0	84,240	900	93.6	$5m	$468m	$65k
SW Sydney	Low Density Leap-frogged Greenfields	58.2	4,500	1.32	5,940	0	5,940	15.4	15.4	91,476	850	107.62	$5m	$538m	$120k
SW Sydney	Low Density Leap-frogged Greenfields	83.9	12,130	0.50 – 1.32 1.25	15,115	0	15,115	15.4	18.0	272,070	900	302.30	$5m	$1511m	$125k
Central Coast	Low Density Leap-frogged Greenfields	105.0	7,000	1.32	9,240	50	9,190	17.2	20.0	183,800	900	204.22	$5m	$1021m	$146m

4.1.1 Summary Results

Table 1 provides summary results for the sixteen developments. Inner ring, high density developments appear to offer the lowest road capital cost impacts with per household costs higher density varying from $28,000 to $53,000. High density, middle ring developments appear to generate slightly lower costs – in the order of $20,000 to $49,000 per household. Despite the higher road building costs associated with these areas, the lower generation rates of higher density dwellings appear to be the primary driver of lower costs. The Potts Hill development is the only middle ring, lower density site considered. It's estimated road capital cost impacts are in the order of $58,000 per household. In sum, capital costs are in the order of $44,000 per household for in-fill developments.

Low density contiguous greenfields developments appear to generate significantly higher road capital costs, with costs varying from $106,000 to $143,000 per household. Leap-frogged developments generate cost figures in the order of $65,000 to $146,000 per household with an average cost of $135,000 per household. The lower bound for this category is generated by the Huntlee development, with the driver for the lower figure being estimated generation rates.

The apparent disparity between greenfields costs and the costs of providing road space in inner city locations demands an important caveat, however. The calculations above assume costs that reflect building roads on the surface. In reality, little of this is happening in these locations within Sydney and Australian cities because of, in part, community resistance. In Sydney particularly, but also in Melbourne, the response has been to tunnel with per lane kilometre capital costs not in the order of $25 to $30 million but more in the order of $80 million. The impact for the conclusions drawn above are significant. If the higher figure is applied to these calculations, then per household road costs in inner-city locations approach those of greenfields sites. The suggestion is that middle distance and peripheral development, within the current urban footprint, clearly provide cost advantages.

Notwithstanding the caveat above we need to consider whether or not the figures are realistic? A simple rule of thumb test is to consider an average cost per household for in-fill developments and for greenfields developments and determine an overall cost impact from the required new dwellings to 2031.

The latter figure is estimated by using the most recent Metropolitan and Strategy dwelling projections for the Sydney area of 545,000. Added to this are the projected requirements for the Lower Hunter, Central Coast and Illawarra of 161,600 additional households (pro-rated from the currently-dated existing Regional Strategies). This provides a total requirement of 706,600 for the GMR to 2031. If we assume 35% of this number in greenfields locations and 65% in in-fill locations, the requirements are 244,000 and 463,000 households repectively.

If each in-fill household requires road improvements worth $44,000 and each greenfields household requires $135,000 the total cost generated by new households in the Greater Metropolitan Region is (244,000x$135,000 + 463,000x$44,000) $32.9b + $20.4b = $53 billion, or $2.65 billion per annum.

Current capital spending on the GMR road network is in the order of $2.2 billion per annum from all sources (see, in particular, NSW Treasury, 2013 and Allen Consulting, 2009), a little over 80% of the requirement from the figures above. Given public arguments that current expenditures are not sufficient to cope with demand, the estimates herein (to satisfy maintaining levels of service) would appear to be supported.

What does this suggest regarding road capital costs for differing future city forms? If the totally unrealistic assumption of nil greenfields development is assumed, the total roads capex requirement over a twenty year period is estimated to be $31 billion for the Greater Metropolitan Area. The alternative, (and extreme) scenario of all development at or beyond the fringe would suggest a cost of $95 billion. The difference over the twenty year period is $64 billion, or $3.2 billion per annum.

More realistically a 'compact' city form is likely to involve 20% fringe development, a 'dispersed' form 50% development. The former suggests a capex road cost of $44 billion, the latter a cost of $63 billion. The difference is $19 billion or a little under $1 billion per annum. The latter two numbers are significantly higher than the calculation provided by the Centre for International Economics (CIE) in recent reports for the NSW Department of Planning and Infrastructure with, admittedly, differing methodologies, differing geography and assumptions regarding future growth of Sydney (CIE, 2010, 2012).

Is it also realistic to attribute all road capex costs to households as the above has done? I would argue yes, notwithstanding that (i) all household trip-making has two ends (including employment) and that (ii) about 10% of all road trips are freight related. In the end, demand for all trips comes down to household growth in urban areas. There is reasonable evidence to suggest that per household mobility has now reached saturation (BITRE, 2012). If there were no growth in Sydney's household numbers, I suggest, there would be no further demands on the network, other than those that currently exist and a modest increase in freight trips related to increasing household wealth.

4.2 Road Use Costs

The previous discussion considered the costs of providing new road space and other roadworks for differing types of development in Sydney. However, road costs do not end there. The costs of road use are very significant as Table 2 indicates.

Development **A**	Locational Type **B**	Housing Units/ Dwellings **C**	Estimated Average VkT per household (km) **D**	Resource Cost (TT & VOC) per kilometre **($)** **E**	Estimated Daily Costs ($) **F**	Estimated Annual Costs (F*365.25) G	Estimated 30 Year Costs (Fx10,957) ($) **H**
Sydney CBD	High Density, Inner City	2,310	2.3	0.76	2	639	19,153
Honeysuckle (Newcastle CBD)	High Density, Inner City	1,700	20.0 (approx)	0.76	15	5,552	166,546
Sydney Inner	High Density Inner Suburban	1,251	29.8	0.76	23	8,272	248,154
Sydney Inner	High Density Inner Suburban	790	17.2	0.76	13	4,775	143,230
Illawarra	Low Density Contiguous Greenfields	16,000	50.0 (approx)	0.76	38	13,880	416,366
SydneyMiddle	High Density Suburban Infill	6,000	30.3	0.76	23	8,411	252,318
Sydney Middle	High Density Suburban Infill	4,000	53.6	0.76	41	14,879	446,344
Sydney Middle	High Density Suburban Infill	98	33.8	0.76	26	9,383	281,463
Sydney Middle	High Density Suburban Infill	800	50.0	0.76	38	13,880	416,366
Sydney Middle	Low/Medium Density Suburban Infill	450	31.5	0.76	24	8,744	262,311
NW Sydney	Low Density Contiguous Greenfields	5,500	104.1	0.76	79	28,897	866,874
SW Sydney	Low Density Contiguous Greenfields	6,750	118.2	0.76	90	32,811	984,289
Lower Hunter	Low Density Leap-frogged Greenfields	7,200	100.0 (approx)	0.76	76	27,760	832,732
SW Sydney	Low Density Leap-frogged Greenfields	4,500	96.4	0.76	73	26,760	802,754
SW Sydney	Low Density Leap-frogged Greenfields	12,130	120.0 (approx)	0.76	91	33,311	999,278
Central Coast	Low Density Leap-frogged Greenfields	7,000	68.2	0.76	52	18,931	567,923

E – Costs include, for private vehicle travel, (i) 27.5 cents/km for travel time, (ii) 31.5 cents/km for vehicle operating costs, (iii) 5.8 cents/km for accidents and 11.2 cents/km for environmental externalities. Total costs are 76.0 cents/km. Source: Transport for NSW, 2013

The provision of road space is largely determined by peak demand, either in the morning or afternoon. However, household trip generation throughout the day (including travel during the peak) is determined by a large variety of factors, including location within the broader urban area. A typical household in a low density dwelling will generate about 0.95 trips in the morning peak one hour. (in fact, the average hides significant variation from studies undertaken by RMS with generation rates varying from 0.59 in established middle distance suburbs to 1.39 in remote greenfields locations). Over the course of a day, however, that household will generate about 11 trips which will produce about 60 kilometres of vehicle travel in the day. These latter figures vary with location and it is this data, drawn from the Bureau of Transport Statistics, that are used in the analysis shown in Table 2. In addition, a generic resource cost of travel of $0.76 per kilometer, drawn from Transport for NSW' economic parameters has been used for the calculation. The latter figure varies with, amongst other factors, the levels of congestion encountered but the differences are not significant.

4.2.1 Summary Results

It will be observed that household use costs vary significantly from an annual average calculated cost of less than $1,000 for a high density CBD development to over $30,000 for remote greenfields locations. The results are not unexpected. What is significant, however, is the significant burden this element of road costs places on households.

To illustrate this latter point let us assume two differing scenarios for the GMR's future development; (i) a 'compact' city form with 20% of new development in greenfields locations and (ii) a 'dispersed' form with 50% of development in greenfields locations. In the former case an assumed 141,000 new households at the fringe and beyond will generate use costs of about $25,000 per annum each, with the bulk of new households (565,000) incurring annual use costs of about $10,000 each. Total annual use costs for the new households will be in the order of $9 billion per annum. With the dispersed city form the comparable figure will be in the order of $12.4 billion. This is an annual difference, for the new households alone, of over $3 billion per annum, a significantly greater community cost than that of the $1 billion capex figure.

5 CONCLUSIONS

From the preceding we can draw a number of conclusions:

1. The capital costs of building roads to serve new developments on the fringe is substantial, generally over $100,000 per household. At first glance, inner city development appears to be cheaper. However, if the required road space is in tunnel, then such costs approach those of the fringe. The conclusion is that road capital costs will be minimized by development within the existing urban footprint but at some distance from the CBD, i.e. middle and outer ring existing suburbs. This clearly is not a trivial issue and is a matter that policy makers and strategic planners should clearly address to a greater extent.
2. There are significant differences between road use costs (i) at and beyond the fringe and (ii) in inner city locations. Trip making and trip distances are generally lower in the latter. Typical 30 year costs in inner city locations are in the order of $200,000 to $400,000 per household. At and beyond the fringe such costs exceed $600,000.
3. The differences in the costs of use for new households in Sydney are several times greater than the costs of capital works, assuming current behaviours continue into the future.
4. Road costs cannot be considered in isolation. It is worth considering, for example, the continuation of car trip making in inner city locations without commensurate road works. A reasonable assumption would be shifts to other forms of transport, e.g. rail. Their costs are not considered here and should form part of a total infrastructure analysis as should other utilities and the cost of housing. This latter consideration is the point of my further research which aims to place road costs in the context of broader infrastructure costs.

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