APPENDIX 2 Economic Analysis of Urban Forms

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Introduction

Many policy analyses of the "economics" of urban consolidation vis-à-vis fringe development have focused on comparative public infrastructure costs.

However, any economic analysis of future development scenarios for the Sydney region should be concerned with all economic costs and benefits of alternative development scenarios, including developer and environmental costs and benefits. Developer margins are important in determining whether strategies can be implemented and whether taxation and similar strategies are feasible.

The technique that economists use to examine the economic costs and benefits of alternative policy scenarios is benefit cost analysis (BCA). BCA is founded on the principles of market supply and demand and weighs up all the incremental benefits and costs of policy options compared to a base case to determine which alternative provides the greatest net benefit to society. The scenario that provides the greatest net benefit is said to be the most economically efficient.

In the absence of resources to examine detailed alternative scenarios for future urban expansion of Sydney, some of the comparative costs and benefits of urban consolidation vis-à-vis greenfields expansion on the urban fringe have been identified through a literature review. The relative costs/benefits that are examined in this report are summarised in Table 1.

TABLE 1 Potential Economic Costs and Benefits of Greater Urban Consolidation vis-a-vis Fringe Development

Potential Benefits/Costs
ECONOMIC INFRASTRUCTURE such as sewerage, water, stormwater, electricity, and telecommunications
SOCIAL INFRASTRUCTURE such as education, recreation, community health and welfare
DEVELOPERS' NET BENEFITS (producer surplus) (revenues minus costs net of infrastructure costs already referred to above)
Private and public **TRANSPORT COSTS AND BENEFITS**
AMENITY/CONGESTION effects
ENVIRONMENTAL effects associated with ecological footprinting including land, water and air pollution.

Economic infrastructure

As pointed out by the Industry Commission[1] the direct costs of economic infrastructure of infill compared to fringe development hinges on the extent of excess capacity. For some infrastructure, such as sewerage and water, there may be excess capacity and hence little incremental infrastructure costs of urban consolidation. For other infrastructure items such as stormwater or roads, capacity constraints may result in high costs because of the expense of retrofitting/expanding infrastructure in developed areas.

1 Industry Commission (1992) Taxation and financial policy impacts on urban settlement, Volume 1 Report, Industry Commission, Canberra

Travers Morgan Pty Ltd[2] and Applied Economics Pty Ltd undertook an economic analysis of fringe development and urban consolidation in Sydney. The study involved comparing costs and benefits of developing the Parklea Precinct of Rouse Hill Development Area to urban consolidation in middle ring suburbs of Parramatta, Ryde and Hornsby.

The study suggested considerable infrastructure cost savings from urban consolidation largely due to the availability of excess capacity in existing infrastructure. The Water Board advised that its' existing water and sewerage infrastructure in middle suburbs of Sydney was capable of accommodating development densities in the order of 80 to 100 equivalent person per net hectare. This is far in excess of the Sydney average of 18.93 person per ha (UITP[3]), or the suburbs with the highest urban densities up to 65 person per ha (Industry Commission 1992).

Electricity, gas and telephone service providers also indicated that there was generally spare capacity in existing distribution networks whereas green fields development at Parklea Precinct would require some additional capital costs to establish infrastructure.

Additional stormwater infrastructure for urban consolidation was considered likely to be able to be dealt with by way of small scale onsite works such as onsite detention compared to a requirement for additional substantive offsite stormwater infrastructure for fringe development[4].

The study suggested little, if any, significant effect on the road system of increasing urban densities in existing built up areas[5].

The suggested infrastructure cost savings of urban consolidation at Parramatta/Ryde/Hornsby compared to fringe development at Parklea are summarised in the following table.

TABLE 2 Economic Infrastructure Cost Savings from Urban Consolidation at Parramatta, Ryde and Hornsby Compared to Fringe Development at Parklea

Economic Infrastructure Cost Savings Per Net Ha ($1991)	Infrastructure
Water	$10,000
Sewerage	$14,000 to $25,000
Stormwater	$17,000
Electricity	$16,400
Gas	$7,500
Telephone	$18,700
Sub-arterial Roads	$121,500
Total	$205,100 to $216,100

At an average of 10 dwellings per ha on the fringe this infrastructure cost saving was equivalent to $20,500 to $21,600 per dwelling.

A similar study compared physical infrastructure costs for urban development on the fringe of Sydney (namely Erskine Park/St Clair and Rouse Hill) and urban consolidation of differing densities (ranging from 18, 25, 50 and 150 dwellings per net hectare) at Bankstown and Hurstville Stations[6].

2 Travers Morgan Pty Ltd and Applied Economics Pty Ltd (1991) Housing cost study no. 2: Evaluation of fringe development and urban consolidation, Australian Building Research Grants Scheme. pp109-121

3 Union Internationale des Transports Publics (2002) Millennium Cities Database for Sustainable Transport,

4 If stormwater retention cannot be dealt with via onsite works it has the potential to be a major component of urban consolidation infrastructure costs (Travers Morgan Pty Ltd and Applied Economics Pty Ltd (1991)

5 The exception they considered was where large infill areas are to be developed, requiring new road construction and possible traffic management devices where they meet the existing road system.

6 Department of Planning, Sydney Water Board, Department of Industry Technology and Development (1991) Urban Consolidation: Public Sector Savings.

Economic infrastructure costs of consolidation were found to be significantly lower than for fringe development. Connection costs per dwelling dominated urban consolidation infrastructure cost, but reduced substantially with the number of dwellings in the scheme. The only infrastructure that required augmentation in consolidation areas was telephone services at high densities and sewer at Bankstown where because of local topography and the configuration of the sewer system augmentation was required, even at densities as low as 25 dwellings per ha.

Again it was considered that stormwater drainage in urban consolidation areas could be handled by retention on site rather than augmentation of Council or Water Board systems.

Overall the study found significant economic infrastructure cost savings associated with urban consolidation vis-à-vis fringe development with the magnitude of the cost saving sensitive to the lot size at the fringe and the density of consolidation options, refer to Table 3. The analysis excluded public transport and main roads infrastructure.

TABLE 3 Total Cost Differences in Physical Infrastructure between Consolidation and Fringe Development by Infrastructure Type and Density Level ($ per dwelling, 1989/90 prices)

	Maximum difference		Minimum difference	
Fringe:	840 m2 lot	840 m2 lot	450 m2 lot	450 m2 lot
Consolidation:	50 dw/ha	18 dw/ha	50 dw/ha	18 dw/ha
Infrastructure component				
Sewer	$8,422	$7,752	$4,551	$3,881
Water	$4,171	$3,601	$3,411	$2,841
Stormwater	$7,276	$7,276	$3,898	$3,898
Gas	$1,753	$1,492	$1,369	$1,108
Power	$2,248	$2,152	$1,885	$1,789
Telecom	$1,031	$795	$659	$423
Local Roads	$4,635	$4,635	$2,483	$2,483
Miscellaneous	$1,148	$1,148	$615	$615
TOTAL SAVING	$30,684	$28,851	$18,871	$17,038

Reference: *Department of Planning, Sydney Water Board, Department of Industry, Technology and Commerce (1991), p v.*

A study of the preferred pattern of urban development for south east Queensland (**SEQ2001**)[7] identified that its preferred more concentrated pattern of growth would make use of existing capacity in centrally located human and physical services. Compared to the projected trend pattern of development, the preferred more concentrated pattern of development was estimated to result in a cost saving of in the order of $3,000M over a 20 year planning period in the basic capital works program for roads.

Other estimated infrastructure cost savings of a more concentrated pattern of development in south east Queensland was $54M in water supply headwork costs.

It should be noted that in NSW some physical infrastructure costs are recouped from developers while some are borne by the public purse. Nevertheless, all economic infrastructure costs are costs to the community and hence need to be included in the analysis. To avoid double counting of these costs, however, the component of above infrastructure costs borne by developers

7 SEQ2001 The Preferred Pattern of Urban Development for South East Queensland - Regional Planning Advisory Group 1993

is omitted from the consideration of costs and benefits to developers, later in the report.

Social Infrastructure

In addition to physical infrastructure requirements associated with urban development there are costs associated with the provision of social infrastructure such as education, recreation, community health, policing etc. The capital cost of most social infrastructure does not get recouped from developers and hence is a separate economic cost that needs to be considered when comparing urban consolidation and greenfields development. The recurrent costs of social infrastructure are assumed to be the same for urban consolidation and fringe development and hence are ignored in most analyses.

Travers Morgan Pty Ltd and Applied Economics Pty Ltd (1991) identified that for health and education services fringe development would require additional capital expenditures relative to consolidation in middle ring suburbs where aging of the population has led to a decline in the need for existing level of medical/health and education facilities leading to spare capacity. Consolidation is therefore likely to contribute to greater viability for existing human service facilities in existing urban areas by making use of current spare capacity.

A study by Keys Young Consultants[8] examined social infrastructure capacity and costs between a number of case study area representing inner/middle ring suburbs (Warringah, Land Cove, Hurstville, Bankstown) and fringe areas (St Clair/Erskine Park). The study found that in a number of circumstances developed areas of Sydney have under-utilised human services which may be less costly to make use of to support intensified residential development in the developed areas than to build and staff new facilities in peripheral areas in support of low density fringe development. For instance there was found to be:

- excess permanent capacity of government primary schools in developed areas;
- lesser but ample spare capacity in government high schools in all of the developed case study areas except Bankstown;
- physical overcapacity of hospitals in developed areas;
- full commitment of police resources in each case study area;
- high utilisation of community development and support services in all case study areas;
- some capacity in rails services apart from North Shore to the CBD in peak hour.

A case study by the ACT Government examined the comparative costs of two options for accommodating growth:

- A greenfields option that assumed that for five years development in Gungahlin would accommodate 2,500 households per year and infill and redevelopment would accommodate 500 households per year;
- A consolidation option that assumed that for five years greenfields development would slow to 1,500 households per year and infill and redevelopment would increase to 1,500 per year.

The study concluded that with greater consolidation the ACT Government could defer over $58M in capital expenditure over five years and would save $6M in recurrent costs. Refer to Table 4.

8 Keys Young Consultants (19xx) Analysis of public sector cost savings in human services through urban consolidation, AGPS, Canberra.

TABLE 4 Comparison of "greenfields" and consolidation options over five years for Canberra, $1992 ($M)

	Greenfields Option	Consolidation Option	Savings
Capital Costs			
Electricity, sewerage and water	Neutral	Neutral	-
Public Transport	8.7	6.6	2.1
Community Facilities	88.0	53.0	35.0
Open space	Neutral	Neutral	-
Arterial roads, ponds, estate access etc.	76.0	55.0	21.0
Total Capital Costs	**172.7**	**114.6**	**58.1**
Operating Costs			
Public transport	7.1	5.5	1.6
Community services			
Schools	39.6	36.9	2.7
Fires stations	2.0	-	2.0
Open Space	6.3	6.3	-
Maintenance	Neutral	Neutral	-
Total operating costs	**55.0**	**48.7**	**6.3**
Government Revenues			
Sales	158	135-185	-23/+27
Total Revenues	**158**	**135-185**	**-23/+27**
Community Benefits			
Access to facilities	Limited	Immediate	Positive
Travel time	Increases with development	Depends on location of redevelopment/infill	Expect to be reduced

Source: *Industry Commission (1992) p B.23T*

A number of other Australian studies that compared the costs of development at the fringe and urban consolidations have concluded that physical and/or social infrastructure costs savings would result from urban consolidation:

- Travers Morgan (1987) in a Melbourne study suggested costs savings of $29,000 per additional household (physical and social infrastructure) (referred to in Travers Morgan Pty Ltd and Applied Economics Pty Ltd (1991);
- Neilson Associates (1987) in a Melbourne study suggested cost savings of $41,640 per household (physical and social infrastructure) (referred to in Travers Morgan Pty Ltd and Applied Economics Pty Ltd (1991);
- Hughes Trueman Ludlow/Dwyer Leslie (1990) in a Sydney study suggested cost savings of $17,000 to $31,000 per lot for physical

infrastructure (referred to in Travers Morgan Pty Ltd and Applied Economics Pty Ltd (1991);

- EPAC (1991), Adrian *et al* (1991), Kenworthy and Newman (1992) referred to in Newman *et al.*[9] suggest cost savings of $40,000 to $50,000 per block;
- Hughes *et al* (1991) referred to in Newman *et al.* 1992) suggest cost savings of $17,000 to $31,000 per dwelling;
- Newman *et al.* (1992) suggest infrastructure savings of $53,000 per dwelling;
- Newman *et al* (1992) suggest road infrastructure costs of $20,700 to $27,000 per lot for Werribee, South East Growth Area and Plenty Valley Fringe Regions in Melbourne.

While social and physical infrastructure cost savings of urban consolidation have been indicated by many studies, a spatial analysis of social and economic infrastructure capacity across Sydney would be a necessary prerequisite for a broad scale analysis of urban consolidation options for Sydney.

Net Benefits to Developers

Travers Morgan Pty Ltd, Applied Economics Pty Ltd (1991) also estimated that there may be potential gains in producers surplus (net revenue) to developers (net of new infrastructure costs referred to above) from urban consolidation policies. This study examined house prices, building costs and opportunity cost of land per dwelling for fringe development compared to inner/middle suburbs. For Sydney it was found that producer surplus per dwelling for urban consolidation in inner/middle ring suburbs was to 20% to 50% higher than for fringe development.

As is the situation for physical and social infrastructure, this result is likely to be sensitive to location since where dwellings are relatively new or have not reached the end of their economic life the opportunity cost of land may be too high to make urban consolidation financially viable for developers. A case by case assessment of different regions within Sydney would be required to identify those areas where it would be profitable for developers to undertake urban consolidation on a large scale.

There are signs from local and international sources that 'green' developments can be more profitable as buyers may be willing to pay a green premium.

TABLE 5 Comparative Producer Surplus to Developers.

	Fringe	Inner/Middle
House prices (Revenues/Benefits)	$135,000 (600m2 lot)	$210,000 (3 bedroom unit)
	$125,000 (400m2 lot)	
Costs		
Building costs per dwelling	$54,500	$97,000
Ancillary costs (open space, landscaping, fees)	$6,000	$6,000
Opportunity cost of land	$25,000 (value of undeveloped land i.e. before servicing costs and profit are added)	$47,500 (value of a developed lot)
Total Cost	**$85,500**	**$150,500**
Producer Surplus	**$39,500 to $49,500**	**$59,500**

Source: *Travers Morgan Pty Ltd, Applied Economics Pty Ltd (1991) p121*

9 Newman P., Kenworthy J. and Vintila P. (1992) The National Housing Strategy: Housing, Transport and Urban Form (AURDR).

Public and Private Transport Costs

The relationship between urban consolidation and transport costs/benefits is complex and hence most of the small case studies that have been referred to in this report have tended to ignore this issue. For instance, Department of Planning, Sydney Water Board, Department of Industry Technology and Development (1991) stated that a rigorous examination of infrastructure costs differences for public transport and main roads is not possible by a simple examination of test fringe and inner area case studies. This is because journey to work patterns are dispersed, and cannot meaningfully be disaggregated for individual schemes and areas. Consequently, detailed analysis of these issues is best left to assessment of large scale full options for Sydney's future development.

One such large scale assessment was that published a decade ago, in the RTA's *Road Transport Future Directions*. Three broad development scenarios for Sydney were evaluated from a transport perspective, in more detail than is presented here:

	2016 Current Trends	2016 Planned	2016 Intervention
Population:			
Sydney	5.5 m	5.0 m	4.5 m
Wollongong/Newcastle	0.7 m	0.8 m	1.2 m
Rural NSW	2.3 m	2.7 m	2.8 m
Employment (m)	2.4 m	2.1 m	1.9 m
Travel Demand (billion person-kms, all modes)	58	47	39
Road Expansion (lane-kms)	473	1,438	356
Rail (million train-km)	34	33	31
Bus (million bus-km)	219	147	146
Peak Trip Length in Sydney	12.9 km	12.1 km	11.5 km
Delay (% of Travel)	15-43%	14-21%	12-13%
Public Transport Share	Does not change significantly but amount of travel increases		
CO2 emissions (mt/p.a., approx)	9 - 9.5	8.8 - 9.7	8.2 - 8.3
Road Vehicle Fuel (B l/p.a.)	8.1 - 8.4	8.1 - 8.3	7.9 - 8.0
Road Deaths ('000)	750 - 790	780 - 800	750 - 760
Transport Financial Performance ($ b)	+ 1.7	+ 2.2	
Air Quality	- 55%	- 17%	+ 12%

NOTES: *The 2016 "planned" figures related to limited decentralisation, with growth centred on Macarthur South, South Creek, Rouse Hill and Warnervale. "Intervention" assumed a lower growth rate in Sydney, more elsewhere, plus various combinations of user pays (for water and sewerage especially) and decentralisation, and strong incentives for residents and employers to locate in the "new towns" (as in the previous option).*

Pricing options (mixed in the scenarios) were "current pricing", current mix of general and user fee revenues; "road pricing", where demand management (not cost recovery) is the goal; and "real pricing" where prices are set to recover social costs and demand and supply-side approaches would be taken. In effect, bus fares were held at current level under all options, rail fares were doubled under "real" pricing, while distance-related charges were introduced at 4.7 cents/km under "road" and 10 cents/km under "real".

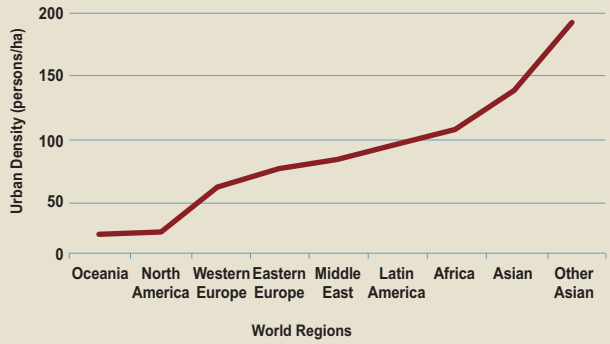
A similar analysis for continuation of the current trends and more urban consolidation across inner and middle ring suburbs would make a valuable contribution.

Despite the absence of a broad scale assessment of the transport impacts of urban consolidation scenarios for Sydney, the Department of Planning *et al* (1991) study considered that transport

efficiencies generally favour urban consolidation as it provides greater opportunities than fringe development for the use of existing or augmented public transport services. From a public transport perspective a more compact better structured city is therefore preferable to a dispersed less structured city. Most new fringe areas are remote from public transport or are poorly connected to employment centres and therefore have high car usage with associated issues of pollution, congestion, stress etc.

UITP (2002) has benchmarked major cities in the world for a range of indicators. This benchmarking indicates that Oceania cities (including Sydney and Melbourne) have the lowest urban densities in the world (refer to Figure 1).

Figure 1: Average Urban Density of Cities in World Regions



This UITP data confirmed the assertion that higher density cities may be better for public transport by showing that higher density cities have lower private passenger vehicle kms per person and higher public transport passenger kilometres per person. It also indicates that total passenger kms (private passenger vehicle kms and public transport passenger kms) tended to decline in more dense cities. Refer to Figure 2.

This lower passenger kms in higher density cities may be associated with considerable travel time savings. This economic benefit is often costed by economists at between 25% and 100% of average wage levels depending on whether time saved would have been used for recreation or work and the level of enjoyment that people derive from the travel. A comparison of travel time per person per year between low density United States and Australian cities and higher density European and Asian cities has been undertaken by Newman *et al* (1992). Refer to Table 6.

Figure 2: Private and Public Vehicle/Passenger Kms per person

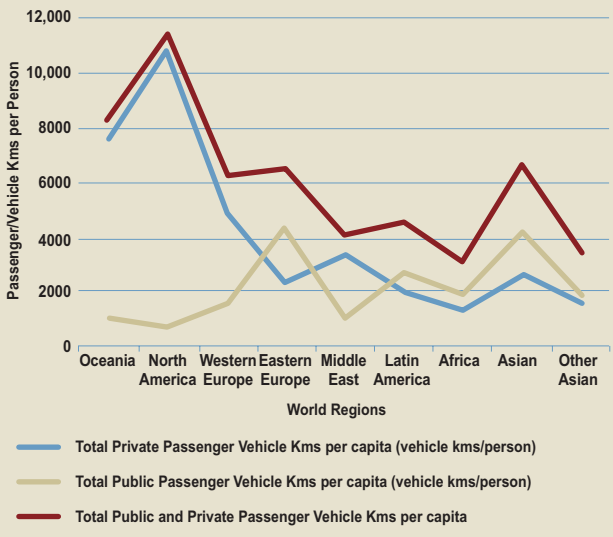


TABLE 6 Comparison of Total Travel Time in Global Cities (1980)

	Travel Time (hours/yr/person)		
Cities by Region	**Traffic**	**Transit**	**Total**
United States cities	286	21	310
Australian cities	244	30	274
European cities	167	68	235
Asian cities	76	127	203

Reference: *adapted from Newman et al (1992), p. 45.*

The study of development patterns in south east Queensland (Regional Planning Advisory Group (1993) suggested that annual travel time cost savings of $6,731M per annum from the preferred more concentrated growth pattern.

Overall, Newman *et al* (1991) found that the relative capital, operating and external costs of rail and buses to be considerably less per passenger km than the use of cars (refer to Table 7). The operating costs of public transport per passenger km also tended to decline in higher density cities while private transport operating costs per passenger km tended to remain above those for public transport in higher density cities (UITP). This indicates a relative transport cost saving associated with higher density cities. Refer to Figure 3.

Figure 3: Private and Public Transport Operating Costs

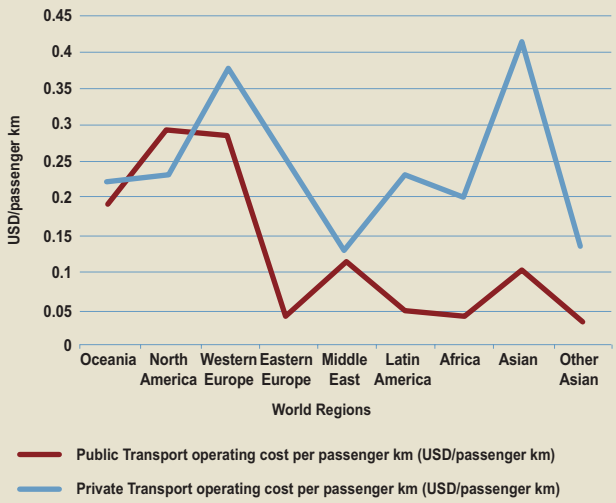


TABLE 7 – Capital, operating and external costs of rail, bus and car modes in Australian cities (cents per passenger km, 1991 dollars)

Cost Item	Rail	Bus	Car
Capital and operating	27.06	21.51	26.65
Depots/car parking	-	1.09	3.42
Roads	-	-	8.89
Road maintenance	-	0.03	0.00
Fatalities	0.12	0.03	0.35
Injuries	0.00	0.00	0.11
Property damage	0.01	0.00	0.18
Air pollution	0.00	0.25	0.43
Noise pollution	0.00	0.20	0.08
Total	**27.19**	**23.11**	**40.11**

Newman (1991) p42

The SEQ2001 review results were used by consultants to PlanningNSW in assessing some of the probable transport benefits arising from the improved planning arrangements implicit in PlanFirst.[10] The overall BCA ratio was estimated at 60:1 based on the following (p14ff):

- more effective regional level settlement patterns savings in transport investment and running costs, reduced pollution and greenhouse gas emissions etc based on stronger regional centres and complementary transport and service infrastructure
- co-ordinated roll-out of infrastructure in releases and better utilisation of existing infrastructure
- improved place management (see chapter 4) by alleviating the risk of social exclusion, formation of district centres and clusters etc
- certainty and transparency in the development approval system.

The evaluation was dependant on accountability arrangements such as performance agreements with infrastructure agencies to ensure that anticipated benefits are delivered, and the like. The logic appears below together with the benefits scaled up from the SEQ basis:

> If the transport benefits shown in Table 8 are scaled up to reflect relative population growth in the Sydney GMR versus SEQ, effective regional planning in the Sydney region could be expected to deliver the following benefits on a 20 year scenario.(pp14ff)
>
> - A reduction in **warranted** Government road expenditure of the order of **$3 billio**n by comparison to a 20 year scenario without effective regional planning.
> - A reduction in daily vehicle travel of the order of **11 million kilometres per day** in Year 20 compared to ineffective regional planning.
> - A reduction in private vehicle operating costs of **$1 billion** per annum in Year 20 compared to ineffective regional planning.
> - Savings in travel time costs of some **$3 billion** per annum in Year 20 compared to ineffective regional planning.
> - Reductions in emissions of some **8 tonnes per square kilometre** per annum in Year 20 compared to ineffective regional planning.

10 SGS Economics and Planning, "Plan First Business Case" (October 2001), provided by PlanningNSW.

TABLE 8 Estimation of Metroplitan benefits in Sydney Scaling up Measured Benefits in SEQ

	SEQ Trend Settlement Pattern at 2011 achieved over 20 year period	SEQ Performed Settlement Pattern at 2011 achieved over 20 year period	SEQ improvement in 2011 compared to trend (A)	Population growth Sydney/population growth Brisbane 1991 - 2011	Estimate benefits in Sydney assuming it will benefit pro-rata according to its relative population growth (A) x (B)
Warranted road investment ($ billion)	15.40	12.60	2.80	1.22	3.43
Vehicle travel (million vehicle Kms per day	87.5	78.2	9.3	1.22	11.39
Vehicle operating costs ($ billion per annum)	5.30	4.40	0.90	1.22	1.10
Travel time costs ($billion per annum)	8.90	6.70	2.20	1.22	2.69
Emissions (tonnes/k2/annum)	32.70	26.20	6.50	1.22	7.96

Amenity/Congestion Effects

Travers Morgan Pty Ltd and Applied Economics Pty Ltd (1991) identified local impacts in amenity, traffic congestion or changes in service levels. As these broad changes are likely to be reflected in changes to house prices in a locality albeit imperfectly, estimated changes in property values may be used as a measure of the total effects of developments on local households. Few studies have empirically examined these effects in relation to urban consolidation versus fringe development.

Environmental Effects

Urban consolidation can also potentially lead to a number of environmental benefits compared to fringe development.

Vegetation and Biodiversity

Much of the future potential development sites on the fringe of Sydney contain remnant native vegetation communities of the Cumberland Plain. This Cumberland Plain woodland is now considered to be among the most threatened in NSW and a priority for conservation[11].

The main potential benefits of growth strategies, such as greater urban consolidation, that minimise the impact on Cumberland Plain Woodland relate to:

- biodiversity conservation;
- catchment protection including controlling land and water degradation including salinity control;
- scenic amenity;
- recreation; and
- carbon sequestration.

These benefits can potentially be measured by how much the community would be willing to pay for them or to avoid negatively impacting them. While there are very few studies of community willingness to pay for vegetation conservation in an urban context, it is evident

11 Gillespie Economics (2001) Socio-Economic Impacts Assessment Of The Cumberland Plain Endangered Ecological Communities, a report prepared for NSW NPWS.

from studies in a rural context that community valuation of these benefits may be significant. Economic valuation studies of the community's willingness to pay for some of these benefits of native vegetation conservation, mainly in a rural context, include:

- $760 per ha with an additional $3.4M for every extra native plant and animal species conserved in the region[12];
- $7.36M per percentage increase in the area of a unique ecosystem conserved with an additional willingness to pay of $22.8M per endangered species protected and an additional willingness to pay of $3.34M per % increase in the population size of non threatened species[13];
- $148 per ha of land restored or protected from degradation with an additional willingness to pay of $170,000 per km of waterways restored or protected from degradation and $14M per endangered species protected[14];
- between $5 and $25 per ML of permanent reduction in groundwater recharge in 'fast' aquifers with salinity of 5,000 mg/L and between $27 and $60 per ML permanent reduction in groundwater recharge in 'fast' aquifers with salinity of 10,000 mg/L;
- $6/t CO2e for forest sequestration credits[15];
- a 5.9% reduction in terrace house prices from a 1km increase in distance from a forest park and a 4.9% increase in terrace house price associated with a view onto forest[16].

Air Pollution

There is also some evidence that higher density cities may be associated with less transport externalities in the form of air pollution per capita than less dense cities. UITP (2002) benchmarking indicated that transport emissions of CO2, VHC and NOx tended to be higher for less dense cities than for higher density cities (refer to Figure 4 and 5). The relationship was less obvious for SO2 emissions. Refer to Figure 6.

Figure 4: Average Transport Emissions of CO2

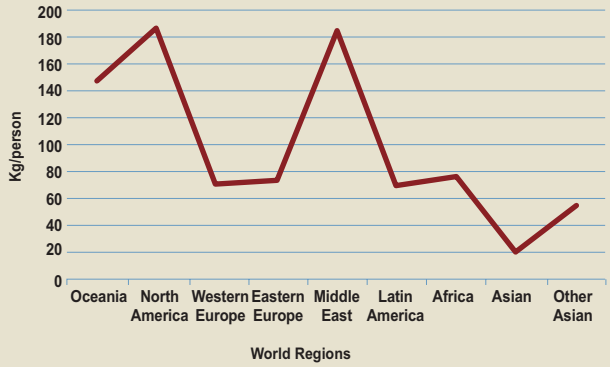


Figure 5: Average Transport Emissions of VHC and NOx

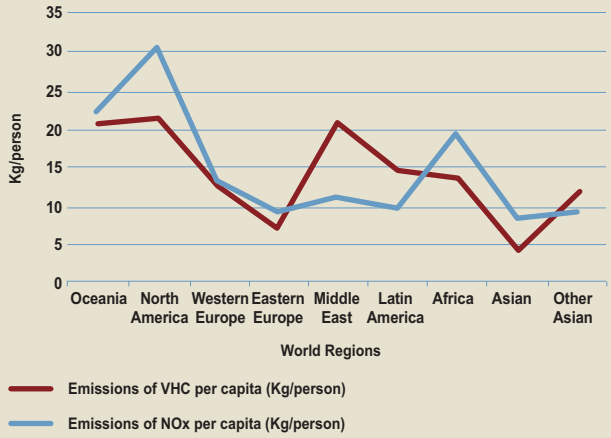
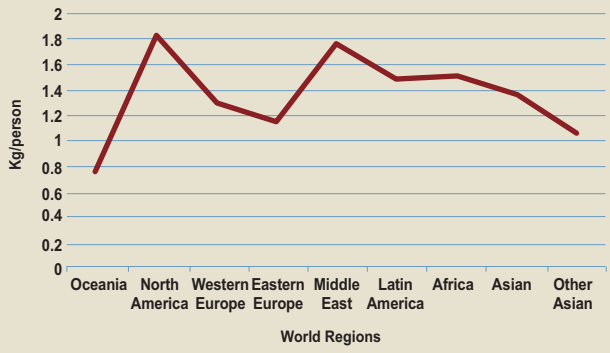


Figure 6: Emissions of SO2



12 Lockwood, M. and Carberry, D. (1998) State Preference Surveys of Remnant Native Vegetation Conservation, Johnstone Centre Report No.104, Charles Sturt University, Albury.

13 Rolfe, J., Blamey, R. and Bennett, J. (1997) Remnant Vegetation and Broadscale Tree Clearing in the Desert Uplands Region of Queensland, Choice Modelling Research Bennett 2000.

14 Van Bueren, M. and J. Bennett (2000) Estimating Community Values for Land and Water Degradation Impacts, Draft Report to the National Land and Water Resource Audit, Unisearch Pty Ltd, Canberra.

15 BDA Group and Gillespie Economics (2001) Valuing Environmental Services at the Farm Level, a report prepared for NSW DLWC.

16 Tyrvainen, L. (2000) Property prices and urban forest amenities, Journal of Environmental Economics and Management, Vol. 39, pp. 205-223.

Economists use a range of valuation methods to place values on the benefits of greenhouse gas (CO2) reduction and reductions in air pollution. These methods include examining market data, the productivity approach, cost of illness method and stated preference techniques such as choice modelling and contingent valuation.

For greenhouse gas emissions it is possible to examine market data relating to carbon credits to estimate an indicative value for reducing carbon dioxide emissions. BDA Group and Gillespie Economics (2001) stated that it appears that the market is valuing carbon credits in the range of $4/t CO2e to $10/t CO2e, with forest sequestration credits probably at around $6/t. While there is no price information for non-forest sequestration credits from developed countries, it is likely that potential prices would be less than $1/t CO2e.

With respect to air pollutants such as NOx, SO2 and VHC economist have generally used the cost of illness method to estimate the value of reducing emissions. The cost of illness method measures the physical linkage between pollution levels and incidence of mortality and morbidity and places a dollar figure on lost productivity, direct costs of medical treatment and care etc. However, the full measure of value is how much people are willing to pay to reduce adverse health effects or risks. Willingness to pay go beyond cost if illness estimates to also include concerns about discomfort, pain and lost ability to engage in non-work activities.

Most studies relating to vehicle related air pollution tend to focus on vehicle sourced ozone and particulates however there have been a number of studies relating to NOx, SO2 and VHC.

Spitzer suggested that in the USA there would be a 4% to 13% reduction in annual incidence of cancer from the use of reformulated gasoline and oxyfuel contain the additive MTBE which reduced VOC emissions from vehicles[17].

Zkaynak and Thurston suggested that an increase in ambient concentration of sulphates of 1% is associated with an increase of 0.086% in total mortality in the USA[18].

Voorhees, Araki, Sakai and Sato[19] estimated that there had been substantial avoided medical costs and avoided productivity losses in Tokyo, Japan from the adoption of past NO2 control policies.

Overseas Perspectives

There have been a number of examples where overseas reviews have assessed several or all of the above parameters (footprinting is dealt with in the next chapter).

The Urban Land Institute in America argued in Environment and Development, Myth and Fact (2002)[20] that compact development can minimise impervious services and direct growth away from environmentally sensitive areas. It gave many examples in support of its logic, one of which follows:

- The Greater Wasatch region of northern Utah is facing a population growth rate of more than twice the national average with a very limited supply of developable land. Envision Utah, a non-profit partnership of state and local government officials, business leaders, developers, conservationists and landowners developed four alternative growth scenarios for the next 20 to 50 years for community consultation purposes. The preferred scenario, the Quality Growth Strategy (QGS) emphasises infill development and better patterns of new growth on the urban fringe, with reduced emphasis on roads and more investment in transit.
- The modelling of the QGS predicts that more infill development and a reduction of lot sizes from 0.35 of an acre to 0.29 of an acre could

17 Spitzer, H.L. (1997) An Analysis of the Health Benefits Associated with the Use of MTBE Reformulated Gasoline and Oxygenated Fuels in Reducing Atmospheric Concentrations of Volatile Organic Compounds, Risk Analysis, 17: 683-691.

18 Zkaynak, H. and Thurston, G.D. (1987) Associations between 1980 US Mortality Rates and Alternative Measures of Airborne Particle Concentrations, Risk Analysis 7(4): 449-461.

19 Voorhees, A.S., Araki, S., Sakai, R. and Sato, H. (2000) An Ex Poste Cost-Benefit Analysis of the Nitrogen Dioxide Air Pollution Control Program in Tokyo, Journal of the Air and Waste Management Association, 50:391-410.

20 This is the source of the following examples. See www.uli.org.

lower per capita water consumption from 298 gallons per day to 267 gallons. Under this growth scenario, total vehicle miles travelled would be reduced by 2.4 million per day, average speeds could increase by 12.5 percent, and commute times could increase by 5.2 percent. The reductions in traffic congestion and automobile use would, in turn, lower mobile source pollutants by 7.3 percent.

The ULI gave three examples of significant "concentrated developments" all involving community-based planning with various 'savings' identified:

- Atlantic Station, Georgia – the former steelworks was redeveloped for mixed use development with 3,000 to 4,000 residential units, about 2 million square feet of commercial and entertainment space, 3 hotels and 7 million feet of commercial space. This will be linked with mass transit, cycling and pedestrian networks, reducing VKTs by 15 to 52% and nitrous oxide emissions by 37 to 81%.
- Reston Town Centre, Virginia – a pedestrian-oriented mixed-use town centre which sees 70% of the evening patronage of restaurants and 40% of total cinema attendance come from within the centre, generating nearly 50% less car traffic than CBDs of a comparable size taken with associated factors.
- San Mateo, California – the City and County Association launched a density incentive scheme in 1999, allocating State Transport Improvement Program funds of $2,000 per bedroom built where residential projects where projects have a minimum density of 40 units per acre and are within one-third of a mile of a train station. The participating municipalities pass these requirements and incentives on – to be paid only after projects are completed to the required standard.

The ULI has pursued practical ways of achieving effective reform. It has argued that suburban large lot residential development often is both ecologically and financially inefficient, for example Prince William County in Virginia found that providing municipal services to a house on a large lot cost the County $1,600 more than is returned in taxes and other revenues. The State of Rhode Island found it would save $142 million in sewer infrastructure costs if development were more dense and continuous to existing development.

The ULI has also argued that affordable housing depends on the provision of more higher-density development, for example in one Los Angeles community where there is a housing deficit about 30,000 units per year, one project based on mixed use and providing 13,000 housing units at about 43 units per acre, with 25% preserved for low and moderate income renters and buyers, delivered quality housing with nature conservation and a sustainable transit pattern.

In 1992 New Jersey passed a plan to reduce sprawl on a state-wide basis as Oregon had done with its Urban Growth Boundaries. This was advisory only. A Rutgers University study concluded that $1.3 billion could be saved in infrastructure and $400 million in annual operating expenses.

In 1995 the American Farmland Trust focused on the costs of sprawl in California's Central Valley. The region would lose 1 million acres of productive farmland by 2040 if current patterns (3 homes per acre) continue, but if density doubled the agricultural economy would 'benefit' to about $70 billion and public infrastructure costs would be $29 billion lower.

A Rutgers University study of a New Jersey plan to reduce sprawl on a state-wide basis concluded that $1.3 billion could be saved in infrastructure capital costs and $400M in annual operating expenses. Similarly, the State of Rhode Island has found that it would save $142 million in sewer infrastructure costs if development were more dense and continuous to existing development.

Conclusions

Most of the literature evidence in Australia relates to small case study comparisons rather than broad strategic directions for urban growth. Some of the benefits such as infrastructure cost savings and net benefits to developers may also be quite site specific. The apparent benefits of greater urban consolidation in Sydney would need to be examined at a larger scale to determine the location and extent to which they can be realised. Parramatta City Council has done work in this area as will be seen, and a larger effort is needed as was done by the Cumberland County Council in the 1950s.