Information Systems for Strengthening Australian Urban Management

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EXECUTIVE SUMMARY

This study assesses Australia's urban housing and infrastructure information systems with the aim of enabling a more comprehensive analysis of land use decisions for housing and community facilities.

The study finds Australia is well endowed with data sources that can be used to manage urban change. The means of integrating and analysing these various data sources are available and affordable and some agencies are highly advanced in using urban data for decision making. It is therefore surprising that the study has found that this high quality urban information is under-used in two key ways. The data lend themselves to deeper analysis and insufficient of the evidence base for urban decision making is used by the public and private sectors.

The following recommendations are proposed to address these issues:

- **Promote national consistency in urban management systems**
  We argue in this report that there are clear benefits to individual States, the Australian Government and the private sector from the development of a more consistent and integrated approach to urban decision making. We suggest that improved networks, protocols, exchange of information on structures and data management systems and sharing of good practice strengthens decision making.

  Our view is that the first step to achieving a more integrated approach is to convene a national forum on urban information management. This forum would include information agencies and urban stakeholders. Its purpose would be to share current practice and consider the recommendations of this report. Once the proposals in this report are more fully developed an implementation plan can be presented at a national meeting of Planning Ministers that proposes concrete action steps for joint data and decision management tools.

- **Develop enhanced roles for urban research networks**
  Research organisations with national networks can contribute directly to improving information systems. Two that are identified are the Australian Housing and Urban Research Institute (AHURI) and the Centre for Research into Sustainable Urban and Regional Futures (CR-SURF). AHURI already conducts research to an agenda negotiated between government and scholars and seeks to broaden its charter beyond the current emphasis on social aspects of housing. It has an ideal operational and governance model and a range of strategies to encourage capacity building within the professional sector. The strength of CR-SURF lies in its emphasis on advancing expertise in the use of spatial data and its funded network of urban researchers.

- **Build capacity in core professions**
  Professional skills required to both produce and analyse urban data need to be improved. This responsibility should be shared between educators, professional associations and employers. The higher education sector is attempting to be more relevant to government and societal needs with university based institutes increasingly being brought into current policy considerations on urban management. The academic community should play a larger part in designing and acting as a custodian of urban information systems.

- **Protect the knowledge base on urban management**
  The maintenance of high quality urban information systems depends on people with highly specialised data management skills and systems knowledge. Small information units are especially vulnerable to staff turnover which results in information systems being unused or data not maintained. Staff succession planning and the documentation of procedures and protocols are required to ensure that core capacity continues to be available. Greater research and higher numbers of academic publications will allow for peer review and an exchange of ideas on data management.

- **Extend data coverage**
  Notwithstanding the data coverage that is available, there are important deficiencies. The most significant of these is information on people's preferences, experiences and aspirations that are relevant to housing and urban services. It is recommended that annual or biennial surveys of consumer preferences, experience and aspirations are conducted in conjunction with agencies that monitor changes to land, property and demographic change. The cost of these surveys would approximate $0.5m per state per survey and should be funded at partly by contributions from industry which would be major beneficiaries.

  There are also significant enhancements that need to be made to government recording of property transactions so as to allow more detailed and timely information about the level of market activity and especially the important segments of the market such as new and used dwellings, dwelling types, and owner-occupiers and investors.

- **Move further towards data commercialisation**
  The US and local experience suggests that there are further opportunities to commercialise data which should lead to wider use and better recovery of the costs involved. Commercialisation will increase the level of funding for research on urban data management in areas more likely to be of direct benefit to key decision makers.

By improving the quality of urban information, the quality of decision making by both the public and private sectors will be enhanced. Much of the data is already available and therefore relatively modest investment in coordination and additional research will leverage considerable gains. The Australian Government, State Governments, local councils, the housing industry and land agencies all stand to benefit from access to timely and comprehensive data on Australian housing and infrastructure.

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1   INTRODUCTION

1.1   BACKGROUND

Investment in infrastructure and buildings accounts for two-thirds of gross fixed capital formation in the economy; housing alone accounts for about one sixth. The majority of that expenditure occurs in urban areas of Australia. Wise decisions about the delivery of housing and infrastructure in an environmentally sustainable way are self-evidently essential and have consequences that may last for generations. Such decisions need to be based on sound information and the capacity to use that information intelligently. There are concerns amongst industry and professional groups about whether we have the data we need, whether we have the skills to analyse it and whether what we have is used effectively.

The purpose of this study is to identify ways to improve information systems for urban management in Australia focussing particularly on New South Wales, Queensland and Western Australia, but formulating principles that can be applied in all jurisdictions. The focus of this study is housing, infrastructure and related environmental issues. It does not cover commercial property sectors, but the approach and findings could be extended to these sectors.

The broader context of this study is urban management, a whole of government activity that envisages the city as a sort of spatial corporation. Government has the responsibility of enabling the city to serve the interests of its citizens and business as well as it can in the global economy, especially as it is usually the instigator of the major city forming investment decisions in physical and social infrastructure. Urban management therefore is much more than urban planning, though that profession has an important role to play. A range of influences are driving demand for improvements in information systems for urban management. These include infrastructure development and funding models, corporatisation of the property industry and the desire to capture the potential of technological advances.

The report begins with an outline of the way the study was conducted. Section 2 then outlines the structure of an information system to provide a framework for understanding where deficiencies might arise and the changes needed to be effective.

A review of the categories of data used in urban management follows in Section 3, where the gaps that this study has found will be important to fill are also identified. This section includes an account of current practice in each of the three States mentioned above.

Section 4 considers the areas where further improvements might be made and proposes a set of guiding principles for their implementation. These principles will be applied differently within the States for good and understandable reasons. Some of these improvements are of a general nature and could be addressed in various ways. But there are a number of specific actions that could be taken promptly and could bring clearly defined benefits. These are described in detail and form the basis of the recommendations that are made.

1.2   METHOD

The study began with a review of the NSW urban management system. The review drew on several decades of experience by one of the authors complemented by discussions with key people

responsible for information systems in that state. International practice was also assessed via a web search, and discussion with overseas experts in the field, familiar to the authors. Interstate practice was derived from documentation and interviews with managers of information systems. Recent and current projects undertaken by the authors involving the use of data to address an array of housing questions contributed valuable insights. The understanding gained through these investigations was then tested against the views of the steering committee, a stakeholder workshop and consultation with practitioners.

1.3   THE STRUCTURE OF AN INFORMATION SYSTEM

The structure of an information system refers to the stages that are passed through between data collection and its final use in policy, evaluation or monitoring of activity. The quality of the system is to a significant extent driven by the understanding of the final users of the information and their inclination to monitor and evaluate policies and forecasts, as shown in the shaded areas in Figure 1.
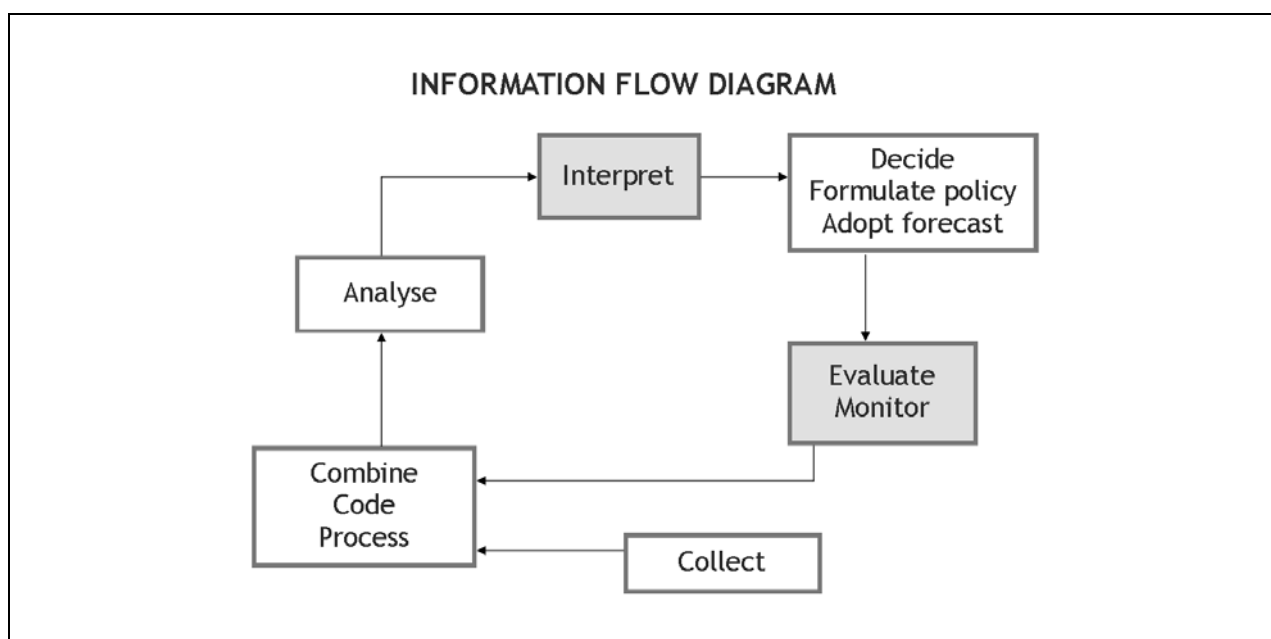
Figure 1: Information flows

Figure 1 outlines the steps in translating raw data into useful information. The first step of collection involves editing, coding, tabulating and summarising the data in ways that facilitate analysis. Combining data means bringing data from different sources together to assist analysis. Geographical Information Systems (GIS) provide the best example with layers of data representing different variables and sources. Analysing data here refers to numerically and statistically manipulating data according to acceptable methods. It can range from constructing tables or charts to advanced modelling. Even the simple methods require an appreciation of how the data are obtained. Statistical analysis involves the exercise of judgement, and therefore the prospect of difference or error.

Interpretation is distinguished from analysis. It is a crucial distinction because people who use the same methods of analysis may interpret the same body of data differently. But more importantly, professionals differ in the way they interpret data because of the overarching conceptual framework within which they operate and, also, simply because they ask different questions of the data. So, those who subscribe to orthodox economics will interpret increases in house prices as most likely reflecting an increase in willingness to pay, whereas those who question such orthodoxy may see a

tendency for producers to ask more than they should. Or the tendency to view a metropolitan plan as a speculator's guide clashes with the principle that speculation is a response to uncertainty, and a plan reduces uncertainty and so should therefore reduce speculation. The best interpretation may result from a blend of these perspectives rather than an emphasis on one.

Figure 2 provides an example of the coverage of the stages in the development of information for urban management purposes by different agencies such as the Metropolitan Development Program in NSW (MDP), the Australian Bureau of Statistics (ABS), the Housing Industry Association (HIA) and the Australian Housing and Urban Research Institute (AHURI).
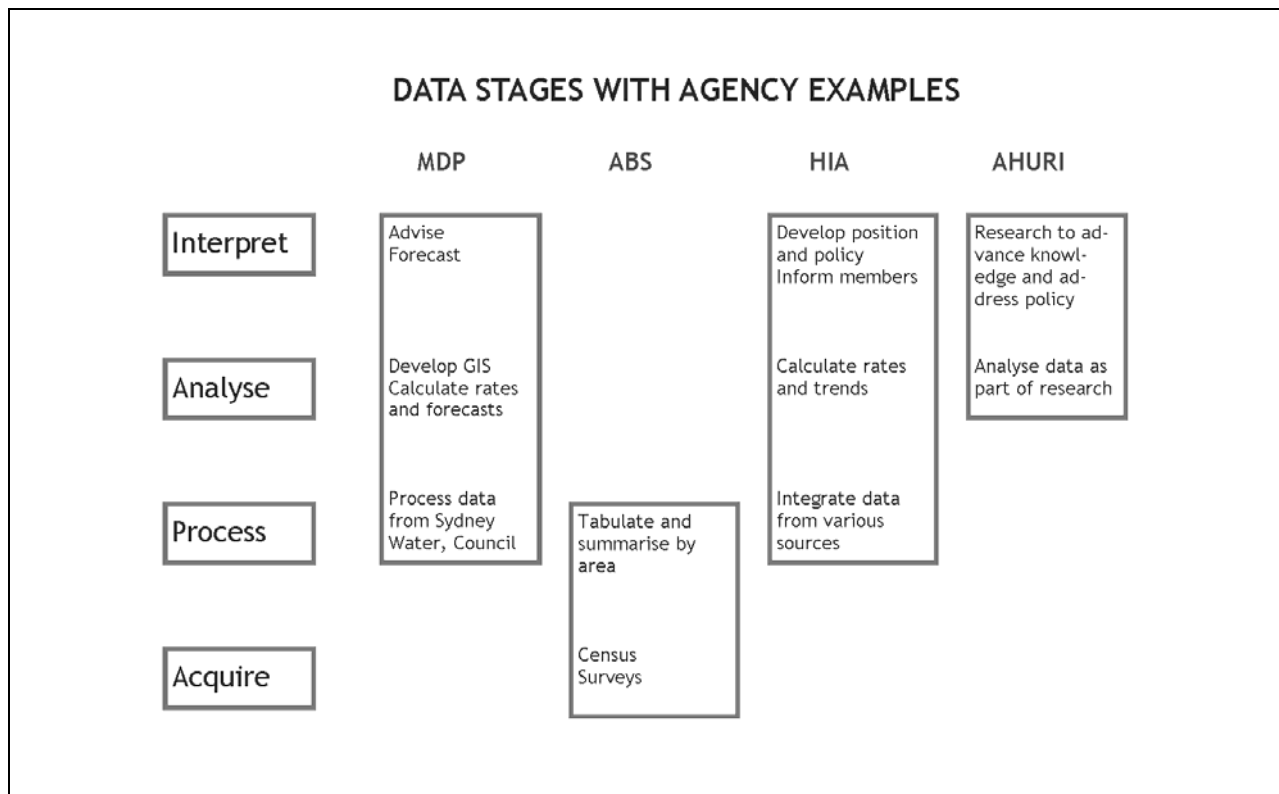
Figure 2: Data stages with agency examples

An information system is a coalition of data collection and analysis units serving a range of stakeholders. The array of data and agencies and clients for the data is such that any vision of establishing an integrated database for urban management as a single entity is impractical. It will always be an alliance of entities. Modern technology is able to overcome most of the problems of combining databases for particular purposes. Nevertheless, there remains considerable scope for better integration within the existing system.

The stakeholders include the property sector, planning agencies, transport and other physical and social infrastructure agencies, financial institutions and the community. Some of these sectors are represented by industry, civic and professional associations. Each collects and uses data for its own purposes and the collection, analysis and interpretation reflects the perspectives and experience of the professions that dominate these agencies. Although there is a certain amount of sharing and networking, fundamental and philosophical differences, just discussed, have a very strong bearing on the performance of a system. To the extent that they are not recognised, ignored or allowed to remain barriers to communication and understanding, they retard the performance of a system.

1.4   DATA CATEGORIES

There is no ideal classification of data used in urban management. Property, people, activity, finance and the environment offer ways of capturing the scope of information that influences urban management decisions as well as those of firms and individuals, as shown below in Figure 3.

Figure 3: Data categories, sources and issues

The distinguishing category of urban data is property based information, which is essentially spatial and preferably captured in a GIS. Yet demographic and social data obtained from the Census of Population and Housing as well as periodic surveys are more widely used in urban analysis than property based data. Some idea of the range of data and array of agencies that collect, process, analyse or interpret it are given in Figure 4, using NSW as an example.

Data category	Public sector	Private sector	Industry/professional associations
Title and property parcel characteristics	Cadastre, LG, Rental Bond Board, MDP, stamp duty	Residex, RPData, Rent rolls, company sales	
Transactions (i.e. sales, prices, leases)	Titles office, LG, Sydney Water (LADS)	Residex RPData, REI	REI
Production of land for development	MDP, LADS, Utilities		Design elements of products not covered
Production of building	MDP, LG, ABS, Utilities	Secondary providers, BIS-Shrapnell	Design elements of products not covered
Preferences for housing attributes including location	ABS housing surveys, DoH	Private research and internal data	HIA
Demography	ABS,TPDC, DoP, Depts. of Health and Education	Secondary providers, e.g. Census uses	
Financial flows (lending, developer charges, levies, taxes)	ABS, LG, Sydney Water, RTA, Reserve Bank	Banks, other financial institutions.	
Transport	ABS, DoT, RTA, TPDC	Bus companies	
Other infrastructure networks	Energy, communications, health education	Energy, communications, health and education	
Employment by location	ABS Census and surveys, employment lands, LG	Rent rolls	
Land use	Cadastre, MDP, LG GIS, LIS	Satellite imagery, Aerial photography	

Figure 4: Summary of databases by data categories

2   CURRENT POSITION

Each of the States seeks information on similar issues and so it is convenient to consider the current status by the data categories in Figure 3.

2.1   PROPERTY UNIT BASED DATA

In Australia a central register of property is held in each State. The register records the survey details, current holder of the bundle of rights that constitutes property ownership, and any encumbrances on those rights such as mortgages and covenants. The information on ownership is updated on receipt of documents that are submitted after a transaction is finalised, which is normally two or more months after the initial commitment to the transaction. Local government and infrastructure agencies receive the same information. This cadastre or record is held in GIS format and in NSW is made available free to State and local government agencies. Recently, NSW passed legislation enabling electronic submission of property transaction information. Some users of the State Cadastre such as local government that keeps comparable records and also receives the State Cadastre find that its accuracy can be improved

Infrastructure agencies and local government hold similar property records either based on the State Cadastre or compiled by the infrastructure agency from information it captures in the course of its business, e.g. supply of water and sewer.

In Queensland a broad hectare analysis study covers land suitability, availability and serviceability and includes an expected timeframe for development and lot yield. Lot yield can be used to estimate population capacity. The program includes all land within the local authority and classifies it by existing and future use. Contaminated, flood liable and good agricultural land is identified, ie there are some environmental measures within this property unit data base.

In both other States this information is mostly generated on a project by project basis as required by existing regulation, and is only occasionally subject to comprehensive baseline study but usually not on a property unit basis. The equivalent studies for NSW began in the 1970s and covered most of the Greater Metropolitan Area by the end of the 1980s (e.g. the Sydney Land Audit). They were less detailed, and not based on property units or recorded in a GIS.

The property unit data are used to track the land development pipeline from early commitments to conversion from rural to urban use through infrastructure planning and subdivision to completion of dwellings. New South Wales has the Metropolitan Development Program, Queensland the Planning Information and Forecasting Unit and Western Australia the Spatial Information and Research Unit. Further comments on these activities are provided in section 2.2 below.

2.2   PEOPLE DATA

The Australian Bureau of Statistics (ABS) is the primary source for people based data that are then analysed by demographic and transport units as well as many others in each state. Periodic surveys, some conducted by ABS, supplement these data, and through the property unit data agencies some market information is obtained. Beyond these sources, the consulting industry and firms, public housing agencies and community organisations generate other data that are used.

The ABS is reviewing their role and seeking to become a gateway to data as much as a collector and compiler of data, and does this by establishing the protocols for providing access to and linking data held by government agencies. Other examples of national databases on housing and related matters are the Australian Institute of Health and Welfare (AIHW), various Australian Research Centres and the Centre for Research into Sustainable Urban and Regional Futures (CR-SURF), at the University of Queensland.

In NSW, demographic analysis and forecasting functions are now contained within the Transport and Population Data Centre, whereas in Queensland and Western Australia the demographic functions are in the same unit as the property unit data. Transport data is separate in Queensland and partially in Western Australia, where the State government initiated an arrangement that requires collaboration between four universities and government agencies. The property data unit in Sydney (the MDP) is separate and the number of people employed is much lower than the equivalent units in the other States. The present level is extremely vulnerable to unexpected loss of staff. The Western Australian unit is large enough to serve an important role in building capacity of junior staff, with the result those planners are believed to be competent in quantitative analysis of urban development activity, probably more so than their counterparts in other States (point made in interview with WA staff).

2.3 ACTIVITY

This category overlaps with the previous categories in so far as that it refers to information generated from all three categories and focuses on the performance of the whole market, whereas the agencies in the other categories tend to focus on major segments. So there is value in defining a category that points to how the main segments might move toward integration. It suggests a way that begins with the property unit data agencies.

The development pipeline is tracked by the property data agencies already mentioned. The development pipeline is the term used to describe the stages through which land proceeds from conversion from non-urban to residential use - basically designation for urban use, zoning, servicing, detailed planning, subdivision, sale and construction of dwellings. These are the core units for planning and urban management. The activity includes the quantities of land produced and consumed for housing, but not in all cases the consumption of housing for occupancy. Vacancy rates are usually left for others to monitor and completion statistics are only available from infrastructure agencies.

Turnover of property is measured by transactions of property (sales, leases, etc) which can be monitored by the property data agencies from information sent to the State agencies that register title to land and property and to the collector of stamp duties, or internally captured by infrastructure agencies (water, utilities and communication). The stamp duty data include property leases. In NSW the Rental Bond Board (RBB) serves all residential tenancies where a bond is required and so offers a comprehensive record of changes in the private rental sector, where bonds apply. The NSW Department of Housing publishes rent and sales transaction data on a quarterly basis, some disaggregated to postcode level, using data provided by the RBB and land titles office. The MDP and equivalent units in other States are able to receive transaction data but as yet make only partial use of it. The Reserve Bank of Australia also makes use of these data to monitor economic activity but relies on a private firm to compile the data from the government agencies.

Transaction data include prices and rents and these are available from the sources mentioned in the previous paragraph. Raw land price data are regarded by the industry as unreliable because the

terms and conditions of sale are highly variable and the date of settlement can be years after an option for purchase is taken out. Nevertheless, the high level of land fragmentation at the urban fringe may provide sufficient numbers of observations to uncover reliable prices.

Economic variables that influence prices, such as interest rates, wages, materials prices, sentiment etc are usually left to industry and financial institutions to track and interpret rather than planners or property unit database agencies. Consulting firms and financial institutions are important suppliers of these services under contract to industry, but also through public seminars, e.g. BIS Shrapnell and the publications of finance institutions and industry associations.

Production cost data are easily obtained for building from agencies which publish very detailed information (eg Cordell's Building Cost Guide: www.reedconstructiondata.com.au) but land cost data are limited and more variable, and developers exercise more confidentiality over these costs than other aspects of the industry. The reality is that profitability varies considerably in land development, i.e. risk is high. Site conditions can contribute to significant variation even on adjacent land parcels. But timing of development and sales in relation to final prices is very influential on the financial bottom line.

Combining all this information with demographic data can provide a comprehensive understanding of how the market works and it can be added to the property unit database. But this process is likely to take some years to come to fruition. There are various obstacles.

While all systems are GIS based, NSW and WA have the most detailed systems for tracking activity because they can rely on metropolitan wide infrastructure agencies to provide pipeline data in a consistent format suited to the requirements of the units. In Queensland, the growth of the urban region beyond Brisbane City Council and consequent reliance on information from 18 local government areas has prevented them being able to match other States. These local government areas are responsible for planning and hydraulic infrastructure. Their systems are not yet able to produce geo-coded data on the development pipeline for a majority of the metro area, including many of the large growth areas. The great need is for a means of requiring the infrastructure agencies to provide the Queensland Planning Information and Forecasting Unit with data equivalent to the other States.

Western Australia receives and tabulates the most detailed information from the development industry, with details by project, which are held in confidence. NSW has a long history of industry consultation, but does not catalogue as much detail. However, they track all major sites in Sydney at the fringe and in the established areas as well.

Western Australia and Queensland both have much faster peripheral rates of growth than Sydney, particularly WA. The growth rate of Perth is about twice that of Sydney and a much higher proportion of that growth occurs at the urban fringe than in Sydney. Both Queensland and WA monitor development in urban areas throughout the State, whereas Sydney has concentrated upon the Sydney Basin, which excludes the Central Coast and Illawarra.

Whilst each State in Australia can provide similar measures of activity the way they report and the measures they use differ. Part of the reason for this is the nature of the questions asked of the data by others and the need to make best use of the data they have. So Queensland has measures not used in other States but they are ones other States could produce. It is an opportune time for States to compare notes as discussed in more detail in section 4.1.

2.4   FINANCE

Financial institutions such as banks, building societies, home lending firms and superannuation funds record information on lending for housing and make some available directly and other information indirectly through returns to the Australian Bureau of Statistics. Lending for new and existing dwellings as well as lending for owner-occupancy and investment is available. ABS also records household expenditure on mortgages and rents at each census and asks for income information. Institutions record the extent to which mortgages are used to finance other consumption and investment activity at the time of the loan where this information is available. .

Housing affordability is a widespread concern. It is commonly measured by actual mortgage or rental commitments as a percentage of household income. In the owner-occupied sector, it can be measured by calculating the deposit required to limit the mortgage payments to a threshold percent of income and then observing how this 'deposit gap' changes over time. Affordability measures require reliable income and price (including rent) data to enable assessment across the income distribution, which can be hard to obtain for small areas.

2.5   ENVIRONMENT

Environmental data are collected by agencies responsible for monitoring air and water quality, managing areas of environmental significance, or designing systems to protect against natural hazards. State of Environment Reporting (NSW) is a system designed to coordinate this data collection and analysis, but it has produced variable results. Both State and local governments in NSW are required by legislation to perform this task, but Local Government does not find it easy to do this in a detailed and comprehensive fashion. GIS, which integrate cadastral information satellite and even low level aerial photography, can provide the starting point for this work. Delineation of areas of interest together with mathematical models that predict prospective areas of interest represent the current leading edges of local government information systems.

There may be organisational separation between the people who do this work in environmental units, e.g. those attached to storm water management, and the urban planning units that carry the responsibility for environmental assessment of projects through environmental impact statements, reviews of environmental factors or statements of environmental effects. The data generated by these studies, on which millions of dollars are spent each year in each metropolitan area, are not consistently captured in the data bases of agencies, environmental or otherwise.

In some cases where the information is gathered systematically and comprehensively it does not help to reduce uncertainty about urban development because the interpretive stage of the information is not taken to the point where strategic decisions are made. The outstanding example in NSW is the Cumberland Plain bushland. Rather than adopt a strategic approach, decisions were left to a process that was applied to each land parcel being developed in the form of an eight part test. That test used the word significant to determine whether conservation should occur, but there were no clear criteria for determining significance, or weighing up that significance against competing claims. So uncertainty remained and could be exploited by the local political processes.

3 ANALYSIS

3.1 DATA GAPS

The largest and most important gap in the data, especially in the housing market, relates to knowing what is in the mind of people as they make decisions about location and housing attributes in relation to employment and access to other urban services. Firms and occasional surveys, such as those conducted by the Australian Bureau of Statistics (ABS), obtain this information sporadically, but not regularly or systematically. By way of contrast, the transport sector in NSW conducts regular surveys to complement the information generated by other means on trip behaviour.

The second important gap is in transaction data, something even the Reserve Bank appears to be concerned about and has addressed partially. This gap could be filled by more timely measures of transactions in property markets. Existing data lags the transaction decision by several months to years. Moreover, most tracking of activity focuses on the land development pipeline and dwelling construction (i.e. new building) and less attention is paid to turnover of existing stock. New building represents only approximately 10% of turnover, and 20% or more of new building may be replacement of existing dwellings.

Transaction data involving change of ownership are received by property unit data agencies that monitor the development pipeline. It may help them to include all transaction data and monitor prices and turnover. The long term trend may be for this to occur. More timely measurement of transactions of property and housing and surveys of consumers should respond to the requirements of both primary and secondary users. Though government agencies do most of this work, involvement of both the property and financial sectors in sharing the tasks of compilation, analysis and interpretation is important.

The third area where gaps arise is in the integration of environmental data. In spite of the emphasis given to baseline studies, integrated databases and monitoring by the scientific environmental community, environmental data are unevenly integrated into urban monitoring systems. The failure to integrate lies partly with the reliance on environmental assessment by the development proponent, and the absence of systems to capture these data for further use. More generally the system struggles to cope with the holistic approach to urban management that requires integrating knowledge and expertise across the sciences and non-sciences.

Existing data are captured for multiple purposes, and for some of the data its use for urban management is a secondary purpose. Consequently it may not be collected in quite the form that is most useful to urban managers. Strengthening the claim of the secondary users, ie urban managers would be an improvement. Ways to address these deficiencies are presented in section 4.

3.2 INTERNATIONAL COMPARISON

Australia is among a small group of countries in the world with good data on commercial and residential property, and financial markets that operate in sufficiently deregulated fashion to allow market processes to be used as reliable indicators of performance. The USA, Canada and the UK are the countries most commonly compared but the list could be extended to half a dozen European countries such as Germany, France, the Netherlands, Sweden and Norway, and to Singapore.

Australia compares favourably with the USA, which is perceived to be the leader. For other data, such as transport, European countries might be favoured.

Agencies established by government are the primary collectors of data, but private providers also collect from these agencies and on-sell the information. The role of companies selling urban and housing information varies between countries. They are most prominent in the USA where the property market is relatively deregulated and public sector information is fragmented by virtue of complex local jurisdictions. GIS are widely used.

While many urban tracking projects are based on specific administrative areas within a country, some governments are moving towards a more holistic approach, which will deliver a consistent standard of planning data for all areas. The United Kingdom is aiming to bring its data collection in line with international standards such as ISO 19115 (2003) which 'defines the schema required for describing geographic information and services (www.iso.ch), and to improve the availability of data at sub-local council level. The local area level is being addressed by compiling Neighbourhood Statistics, also known as NeSS, under the auspices of the National Statistics Office (www.neighbourhood.statistics.gov.uk). New statistical gathering areas to be known as 'Super Output Areas' or SOAs are proposed for the collection and publication of small area statistics on a wide range of themes, including population, crime, health and housing.

In the United Kingdom there is a complex set of over-lapping boundaries and stronger privacy controls over use of information than in Australia and some other countries. Until these boundaries are agreed, data sharing via GIS between various public agencies is being hampered.

Urban modelling
There is a long history of using models in urban planning to forecast land use: from the late 1950s computer technology was being used to simulate urban growth, usually based on the notion that access to transport was the main determinant of the shape of cities. Again the US provided the lead in this activity, but the UK and some continental European countries, notably the Netherlands, have developed expertise. Traditionally the approach has been to project the population growth of a city or region then calculate impacts on smaller areas. Early hopes for the use of urban land use models faded, in part due to a loss of faith of rationalism in planning (Wagener 1994), though the transport planning sector continued to develop models to assess the performance of transport networks.

In the current decade it is difficult to track developments in land use modelling because it has developed into a large yet geographically dispersed topic of research. Modelling techniques have become increasingly complicated, in part due to the application of new technologies (see Batty et al. 2005 for a recent review) and in part due to theoretical developments in how urban form is understood. Two models that have been used in several jurisdictions in the USA are the California Urban Futures model developed by John Landis and colleagues at the University of California Berkeley and SLEUTH, a model developed by the University of Maryland. Both have been applied to metropolitan regions to predict urban expansion.

Overview of international practice
Internationally, no country appears consistently to have more data than Australia across the relevant sectors. For property data perhaps only the USA has more than Australia, and more experience in its use, but some European countries have better transport data and expertise than the USA. Commercialisation of data sources has been taken further in the USA than elsewhere. The review undertaken for this study suggests that Australia has the potential to achieve international best practice for information systems for urban management.

3.3 IMPLICATIONS OF RESEARCH FINDINGS

Several important lines of argument emerge from the investigations undertaken in this study:

- The shortcomings in the current system lie not only in the data as discussed in section 2 but in the higher order functions of analysis and interpretation including the unevenness in understanding especially across the professional disciplines engaged in urban management. In some quarters the term evidence based planning has emerged to reflect incompatibilities in understanding, implying that insufficient use is made of existing knowledge. So not only are the data underused, but the analytical capacity of the system is limited by the lack of demand for information from those framing policy and strategies to manage urban affairs. A fundamental step is to review the culture of core professions in order to build greater capacity to interpret and analyse data.

- Urban planning is often seen as the core profession in urban management. However, at times it has struggled to convince others and even its closest stakeholders of its understanding of urban dynamics and its capacity to frame expectations and policies about future urban form. Part of the problem is a failure to do adequate urban data analysis and to bring a sufficient understanding of commercial forces to bear on the data analysis that is undertaken. As well, the professional education of planners and the related disciplines have moved away from quantitative analysis informed by an understanding of commerce toward a range of other justifiable social emphases. Moreover, though the planning agencies incorporate the property unit and demographic agencies, in at least two States (NSW and Queensland) the interpretation of the market by these agencies on some elements was at variance to the understanding of the planners and the policies they pursued.

- Although there are numerous agencies that acquire, combine or analyse data for urban purposes there are a few that become core or dominant repositories of knowledge. The pipeline tracking function i.e. the MDP is core to planning, infrastructure and the development industry. In Western Australia the Treasury relies on this unit for budgeting and similar interest is developing in Queensland, but not yet in NSW. Similarly the demographic and transport data agencies build up a considerable understanding of urban patterns because of their familiarity with the data.

- Key weaknesses in the present system arise from two areas, the propensity for planning to operate under a paradigm that places limited emphasis on market analysis (which is reflected in the discussion earlier about the data categories) and the development industry that has relied more on experience than analysis. While there is a case to be made for planning to acquire a better understanding of the commercial aspects of the industry it seeks to regulate, there is also a case for industry to acquire a better understanding of some of core economic principles and methods. This would help large firms in particular to educate the new generation of staff, who lack the experience of existing managers, and to respond more rigorously to the requirements of the finance sector.

- The structure of government in Australia and the urban system, namely State government management of metropolitan areas including the management or regulation of infrastructure agencies, favour the capture and linkage of data in ways that are hard to replicate in some other countries. The infrastructure agencies are generally large enough to cover metropolitan regions or substantial parts of them and the core property unit data that these agencies can furnish are easily compiled in a format suitable for urban management and transferred to the data agency. However, the agencies are often small and hold data in different ways in systems not easily modified and can be reluctant to devote resources to the requests of a

central urban management agency which is a particular problem in Queensland North America and European countries offer examples of opportunities to improve upon practice, but no single location stands out as being far more advanced than operations in Australia.

- Recent re-organisation of government agencies concerned with urban and environmental management have made significant structural improvements to the ways in which urban change might be analysed and understood. Actions that interfere with this process should be carefully considered. In NSW the changes include placing the demographic unit within the TPDC and MDP in one organisation, and the creation of an Office of Knowledge Science and Information led and staffed by people coming from a resource and environmental management perspective. Allied with these developments is more emphasis on skill capacity building within the organisation.

More generally there are forces at work pressing for improvements to monitoring. These include:

- The emergence of infrastructure and development proposals that may involve larger financial commitments by government and business such as public-private partnerships;

- Debt financing of infrastructure, which requires reliable forecasts of revenue flowing from development that is drawn upon to fund that infrastructure via levies and value capture;

- The need for better monitoring of housing activity to assist government policy;

- Uncertainty about future directions in preferences for housing characteristics in an ageing and pluralistic society; and

- The improved capacity of information systems to allow activity to be monitored more easily.

There are important differences between the work undertaken by some States on urban monitoring that in part reflect the culture of the States as well as the structure of both their government and their urban areas. Political sensitivities of significance in some States are absent in others.

3.4   COSTS AND BENEFITS

Rectifying the deficiencies identified above and improving the system should deliver benefits that substantially outweigh the costs. Those involved in agencies that compile and analyse data can easily recognise where multi-million savings occur with improved information for making decisions. The yield on development, the rate of development and receipt of developer charges all affect the timing and pricing of infrastructure charges. Ambitious claims for major projects are made that can be easily exposed with widespread access to good information. A core problem at present is that users rather than those who generate the knowledge capture the main benefits arising, so central agencies tend to have a reluctance to invest in information systems.

Each year millions of dollars are spent on environmental and related studies to satisfy the approval process for the production of land and housing. Most of it is spent project by project and the data probably not reused. Cost-benefit analysis can be used much more widely to help identify where the benefits of better information could be found and perhaps even captured and put into organisations that generate the information and understanding.

3.5 DIRECTIONS FOR CHANGE

In addition to filling the key data gaps already mentioned, a principal direction for change is better integration of information. This does not mean the construction of super agencies but a pushing of boundaries within existing agencies that may involve additional tasks, organisational change, multi-disciplinary cooperation and mergers of functions. Suggestions for change are listed below:

- Networks of people are important mechanisms for integrating information systems. These may be formal, such as regular conferences with stakeholders - a practice used by the property unit agencies - or informal relationships that build between people in data agencies. The value of networks has been recognised in the university sector and the Australian Research Council has funded a number of networks such as in CR-SURF.

- Influencing the culture of the core professions, particularly urban planning, to make more use of information and careful data analysis in decision-making is vital. Better knowledge will not only help to produce more reliable policy, it will strengthen the demand for analysis and relieve the uncertainty associated with policy. Some evidence of change amongst educators is emerging, and a model for capacity building among employers is found in the Western Australian Spatial Information and Research Unit which employs sufficient numbers of staff to allow turnover of junior staff who gained expertise in data analysis.

- Preserving knowledge in an era of high labour mobility (movement of people between jobs within and between organisations), frequent organisational change and rapid economic change is a key risk management issue. Technological capacity to document corporate knowledge is important but not the panacea, the human mind still has to digest that documentation in a way that enables tasks to be performed with confidence. This situation is evident in some of the data agencies already referred to (e.g. the property unit agencies) where a couple of years may be required for a person to become really familiar with the data they are working on.

- Reliability of information is critical to confidence in its use and market efficiency. Recent tendencies to withhold release of core data in NSW because of political sensitivities are a particular concern and highlight the need for agency independence to not only exist but be seen to exist. Confidentiality for commercial reasons can be overdone, but commercialisation of data need not limit its availability.

- Though the States will tend to retain responsibility for data capture and analysis, the importance of efficiently functioning cities to the national economy and the value of being able to make comparisons between the urban systems in each State readily justify a Commonwealth Government interest. Similarly, the corporatisation of the property sector means that firms will undertake more property activity with interests in several States. Both the firms and the financiers will be interested in how opportunities and risks play out comparatively across the States.

- The States will continue to respond differently as they have done for many decades and also because of significant differences in character and culture. Some are better placed to manage information systems about their affairs as researchers have observed (interviews conducted for this study and author's prior observation) and some are more willing to involve third party or independent expert review (e.g. Western Australia and Victoria). However, the benefits of overlaying a national approach would include ensuring national interests are being addressed, fostering best practice and promoting consistency in information management systems and, thereby, greater efficiency in the urban development system.

4   RECOMMENDATIONS

There are many ways in which the ideas developed in this report can be implemented and it can be expected that both individuals and organisations will respond differently. Sustained incremental change will bring significant improvement and there are forces at work in the system generally bringing this about. However, there are also negative influences. The two of most concern are tightening of resources within agencies and increased sensitivity to release of information for either political or commercial reasons.

Ideal markets require complete knowledge. Since no market is ideal, improving knowledge can improve both market efficiency and the decisions made about market regulation that are designed to foster market efficiency and equity. National Competition Policy should oblige agencies to release information to the market place. Otherwise the scope for market distortion, exploitation and speculation are increased.

The States hold the primary responsibility for implementing improvements. Since the States are sovereign and remain the custodians of property rights, which for the most part are not merit goods, the Australian Government is limited in the extent to which it can operate urban information systems. In the interests of seeking national consistency and also to advance practice a forum to share recent developments in information systems would be beneficial. A number of initiatives or issues in each State are not widely known and could be progressed through a national workshop. The content of this study could offer a framework for the meeting.

Specific proposals to improve urban information management are detailed below:

4.1   PROMOTE NATIONAL CONSISTENCY IN URBAN MANAGEMENT SYSTEMS

There will be clear benefits to individual States, the Australian Government and the private sector from the development of a more consistent and integrated approach to urban decision making. Improved networks, protocols, exchange of information on structures and data management systems and sharing of good practice will assist in strengthening decision making.

The findings of this study suggest that now is an opportune time to convene a workshop for data agencies, especially the property based data agencies, to share knowledge and strengthen networks. There are particular contributions that each State property data and demographic forecasting agency could make based on both operational development and recent experience with patterns of urban development. Moreover, the content of this report could be used to frame a program that could explore ways to implement the recommendations including the development of nationally consistent methods.

Staff members of the Spatial Information and Forecasting Unit in the Department of Planning and Infrastructure in Western Australia have already considered the idea of a forum and may be willing to convene a workshop. Alternatively the idea could be taken to the Planning Ministers Forum as a specific proposal that would thereby add standing to the workshop and ensure appropriate participation by the States. This would provide justification for participation and the workshop could be constructed so that it is self-financed.

An experienced urban modeller from the University of California, John Landis, who will be visiting Australia in the first half of 2006, could be a key contributor. The proceedings could be published in forms that assist capacity building in a number of ways, not simply be a record of presentations but also include examples of systems that could be used for teaching purposes.

Invitations could be extended to related data agencies, but numbers should be kept to a manageable size so that clear progress can be made on key issues. These include formulating a detailed proposal for the behavioural survey, incorporating and analysing transaction and environmental data in property unit databases and developing protocols for national consistency in data.

A function of this forum might also be to address the question of common measures and definitions of the core measures used in urban data. Because the States will retain the primary responsibility for urban management, information systems will differ between States even though they operate under similar principles. Best practice should encourage convergence, a process that would be assisted by interstate agreements, perhaps brokered by the Australian Government, and projects that define protocols and ways to implement them. The National Health Electronic Transition Authority (www.nehta.gov.au) and AIHW (www.aihw.gov.au) provide examples of how this could be done. Both AHURI and the CR-SURF could perform complementary roles in advancing this objective.

4.2   DEVELOP ENHANCED ROLES FOR URBAN RESEARCH NETWORKS

National perspectives should be developed by existing organisations such as AHURI and national oriented research institutions such as the CR-SURF, a network of academics working on spatial data, as well as by the networks established by the data agencies themselves. These agencies usefully complement each other rather than compete. CR-SURF is developing new databases from existing data and seeding the development of research projects, whereas AHURI frames research agendas into projects that merge the interests of practitioners and the expertise of academics. Suggested research agendas are listed in Appendix I.

AHURI has a potentially important role. It is an established organisation that has built a body of knowledge that resides within the network of centres attached to it and provides significant funding for research that conforms to an agenda negotiated between government and researchers. Its charter has been restricted to housing and particularly social aspects of housing by its existing funding sources, but it has sought to give more emphasis to the second half of its title (urban issues) by seeking the support of the Planning Ministers and their agencies in each state. It has an operational and governance model that is suitable to extend to urban issues. It includes a method of framing research agendas and a raft of schemes that encourage capacity building within the professional sector as well as within AHURI. Being national it provides a ready-made forum to foster work that has cross-boundary benefits or strengthens national perspectives.

The role envisaged for AHURI is neither exclusive nor a claim for a monopoly position in urban research as some have feared, because there are roles that AHURI does not contemplate this for good reasons and it would be restricted from doing by its charter. The budget it seeks for urban research is only a fraction of what could be spent usefully in urban monitoring.

The Centre for Research into Sustainable Urban and Regional Futures (CR-SURF) is another organisation of value to this field. It takes a multi-disciplinary approach to the investigation of processes of urban and regional change using advanced spatial information systems, spatial modelling, decision support systems and survey research methods. It has received multi-million dollar funding to support a national network of around 80 researchers and this money is used to

seed research grant applications and maintain close contact between the researchers. Currently it works mostly with social and economic data but would willingly extend this interest to property unit based data and develop analytical capacity of value to business and government. Unlike AHURI, it is interested in hosting and developing databases. CR-SURF could help with the analysis of transactions and the developed of more advanced methods of analysis of property unit data.

4.3   BUILD CAPACITY IN CORE PROFESSIONS

Uncertainties over key aspects of the housing market have arisen partly from differences in approach to questions by different professional groups but also because widely accepted ideas do not all accord with the experience of those close to the action. This, coupled with staff turnover has resulted in some of the basic knowledge having been lost and current ideas have emerged that have not been founded on firm data and its analysis, but what people believe to be the case.

For example, an understanding of long term patterns of household formation and their relationship to demographic, social and economic change was developed during the 1970s and 1980s, first by the Australian Institute for Urban Studies and the Urban Research Group at the Australian National University and carried on by the Indicative Planning Council until the early 1990s. That Commonwealth funded body with State representation was an important repository of knowledge with a wide network of participants. It would do no harm to reinstate this Council or enable an agency like AHURI to take on a number of the important roles that it performed

A course could be designed around several basic urban processes and principles that cover the demographics and commercial aspects of property development, and the curriculum offered to providers of education, perhaps via the professional institutes.

4.4   PROTECT THE KNOWLEDGE BASE ON URBAN MANAGEMENT

Knowledge may be preserved in several ways, internally by systematic recording of understanding and publishing, formal networks that may take various forms and informal networks such as those available through some associations and research centres. However, high labour movement between jobs and regular reorganisation of government agencies limit their capacity to preserve knowledge. Few industry and professional organisations are liberally resourced to preserve knowledge.

In some government departments there has been a tradition of research that has lead to publication of findings in reports and journal articles. The tradition was strongest in areas with a science base, but also characterised the Bureau of Agricultural Economics, probably the Reserve Bank and others. In urban planning the research function has been undertaken unevenly, and regular reports have generally been confined to reporting core material rather than writing about how the understanding developed or building on that material to make further advances in knowledge.

Publishing is time consuming, but it is a way of preserving knowledge in organisations that could be vulnerable to corporate knowledge loss through staff turnover because of their size. The investigations for publication may be undertaken by staff of the agency or by consultants engaged by them. The publications referred to here are not just the primary documents reporting the core activity of the agency, but also articles and books that offer analysis and interpretation of the information. Publications have the benefit of peer review, and will need to detail methodologies.

Allied to the research and publication function are the principles of independence and data integrity. It is vital to ensure access to data and its routine analysis by independent agencies. This becomes particularly important where threats to release of that information occur because of any inconsistency with government policy or expectations, which has become a serious problem in NSW for reasons that could produce similar effects elsewhere. One way of addressing independence is through external review bodies to which the data agencies report or must supply information on request. Western Australia employs this practice with Planning Commissioners.

4.5   EXTEND DATA COVERAGE

Specific strategies for addressing the data gaps identified in section 3.1 are outlined below and summarised in Figure 5.

Behavioural data
It is recommended that the need for behavioural data be addressed by instituting annual surveys or at least biennial surveys of housing intentions and satisfaction levels. Ideally these should be commissioned by agencies that already carry most responsibility for tracking housing activity, ie the property unit data agencies and/or the demographic forecasting agencies. These organisations are in the best position to identify variables that relate to other data sources and ensure complementarity and the accumulated experience of data processing and analysis by these units lead to considerable understanding of the way the urban area develops.

Such data could be supplemented by data collected by producers or by direct support from producers to collect such data. Implementation of this proposal will require additional resources to be allocated to these units.

The survey of behavioural data should cover recent movers and recent investors as well as people in both categories that have not moved recently. A sample size of 1200 to 1500 for each category and for the metropolitan area would provide reliable information for about 8 sub-regions. The cost would be about $500,000 per annum

Figure 5, on page 24, expresses the idea in diagrammatic form. The central object shown in the diagram is an agency that conducts the social survey research with funding provided by the private sector perhaps in the form of a levy and the public sector.
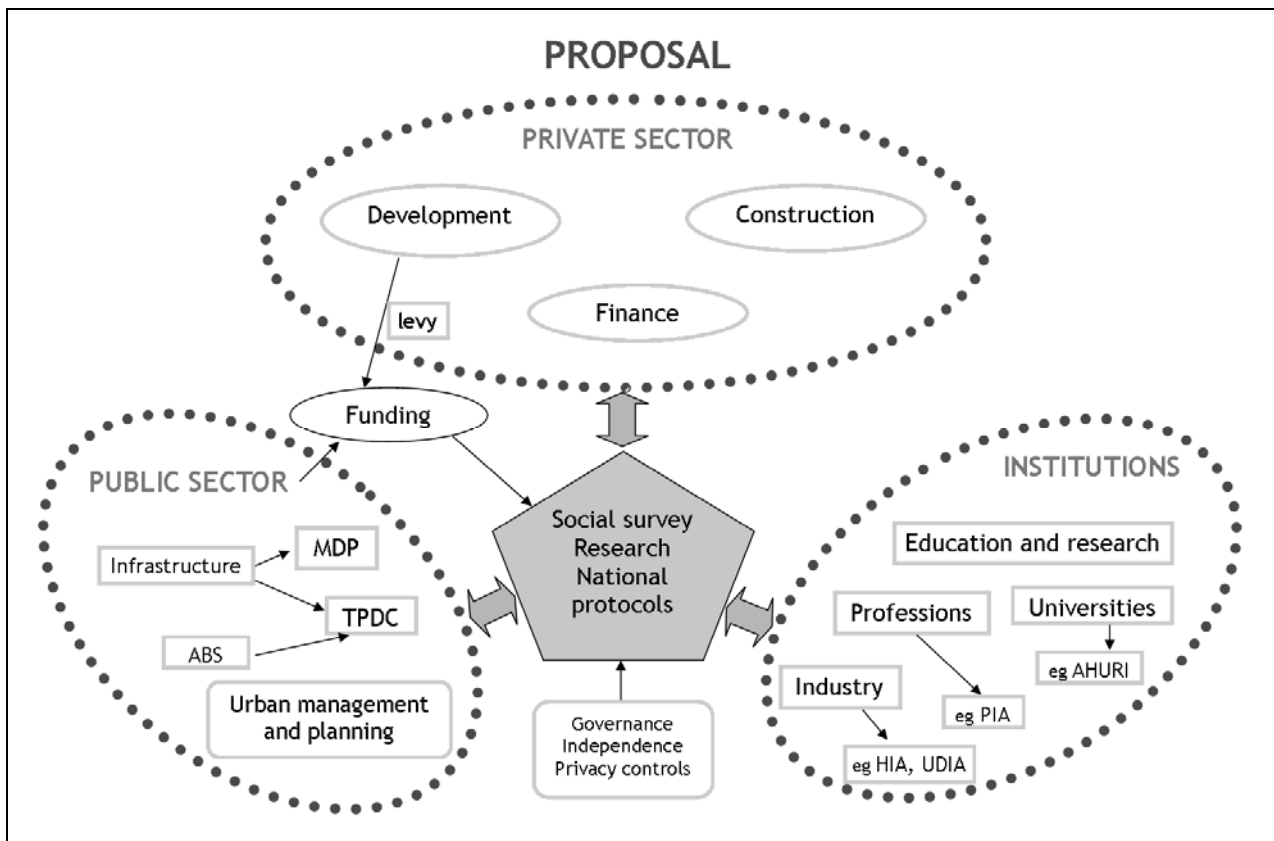
Figure 5: Addressing behavioural data gaps

If a separate agency to obtain behavioural data is adopted, it could immediately satisfy the independence criterion and be used formally to link private and public sector agencies in housing market information. A levy (such as the Plan First levy in NSW) could be allocated to this purpose, and indeed the formal participation of the private sector may increase their support for the proposal. A governing board could be established that provided appropriate representation. The finance sector should be included on this body as well the development and construction sectors.

Higher order functions for this agency would ensure the value of the data collection was maximised and the profile of the agency was high. Specific higher order functions would include data processing and regularly published research, a component that addressed the issue of protocols for national consistency, and capacity building through education and employment.

Transaction data
There are several aspects to the requirements for transaction data, which includes prices, rents, terms of sale, eg mortgages and caveats, by property and parties to the transaction:

- Its regular inclusion in monitoring and analysis so that the focus is extended beyond physical production to turnover and prices

- Improved timeliness of capture by agencies (see section 3.1),

- Spatially disaggregated price and rent data that enables finer measurement than median or average values for sub-LGA level areas, and

- Analysis of both price and turnover of properties in the market (see section 3.1)

These data are best obtained by an existing property unit agency (see section 2.1) because they have the GIS systems that can accept the geo-coded data from a title registering office. The data are already available on a monthly basis and additional resources for people and office space is all that is required to make use of them.

The lag between the transaction decision and capture by a recording agency remains a problem, which is of concern to other agencies such as the Reserve Bank. The transaction is recorded after date of settlement, which may average 2-3 months after the initial transaction decision date, i.e. agreement to buy property. Although the Reserve Bank of Australia is able to obtain a record of transactions by date of exchange of contract via a private firm it only obtains these data after settlement has occurred. The finance sector would learn of a large proportion of transactions earlier because finance needs to be arranged to commit to a transaction. So that sector could be approached as a source of information about the transaction. The finance sector could provide price, property and purchaser characteristics, so its data overlap with the behavioural data mentioned earlier. Procedures to protect privacy would have to be employed with the use of these data.

The records of property transactions received by state government agencies mainly serve the purpose of registering changes to property titles. Even though the agencies also use the data to provide valuation of land using the comparable sales technique, there has been little change to the nature of data obtained over a long period of time at least in NSW. There is room for considerable enhancement so that it becomes possible to distinguish between dwelling type, new and existing dwellings, owner-occupiers and investors and developers. Such improvements would not only be of considerable help to industry and other analysts but would no doubt refine the valuation practices of the agency Distinguishing between new and existing dwellings is also important to understand the effect of GST on prices because the latter are exempt, the former are not. Landcom has made a submission to the NSW Departments of Lands along these lines and been advised that the Department of Lands lack the resources currently to make these changes.

Environmental data
Environmental data are unevenly integrated into urban information systems. Criteria for data selection and protocols to incorporate such data into GIS need to be developed. The starting point could be the development industry. A range of environmental studies has to be conducted before major land development and redevelopment occurs. A project that identified the common elements and the issues that influenced decisions could generate a set of data categories that could be added to a property unit database. The next stage would involve discussion with agencies already responsible for environmental monitoring to see how interfaces could be established between the data suggested by this study and the data and modelling undertaken by those agencies.

Other data
Queensland is disadvantaged relative to other States in having to rely on multiple infrastructure agencies for its property unit data base in order to keep track of the development pipeline. Other States also have this problem where the metropolitan area extends beyond the territory of the water and sewerage agency, eg the Central Coast of NSW.

4.6 MOVE FURTHER TOWARDS DATA COMMERCIALISATION

A number of firms already make use of data for urban management. Transaction data are obtained directly from local government by two firms (Residex, RPData) and then provided by subscription or special request. ABS data are made available through secondary providers who offer both analytical software and analysis. High resolution satellite imagery is being readied for offer to urban

users on a commercial basis, and low resolution imagery is already available through Google. Property unit databases may have unrealised commercial value, especially as analytical methods are developed to yield more information from these databases. It is theoretically possible to do first cut redevelopment feasibility on complete metropolitan regions and examine the impact of land use regulation on that feasibility. The commercialisation of data is well advanced in the US.

4.7 FUNDING

There are a variety of funding sources that could be used to support this report's recommendations:

- Commonwealth government funding for research to the higher education sector is designed to serve business and community issues, and business can include government organisations. That funding can be obtained on an ad hoc basis but also systematically through organisations like the CR-SURF, AHURI and urban research units of universities.

- Levies and or hypothecation of government revenue from licensing and regulatory fee income could be used. The US provides many examples of this practice.

- In NSW a unique opportunity exists to use funds collected for the Plan First program for filling the data gaps and especially to implement a regular behavioural survey.

- In some cases, however, a larger commitment of funds to the agency from its parent organisation may be involved. In NSW the number of people allocated to the MDP program is much less than its counterparts in other States, despite this function being valued by infrastructure agencies and the development industry alike.

- Direct sponsorship of agencies for specific functions such as a research agency that provides value-added analysis and interpretation and in return for sponsorship offers access to special advice or early information, e.g. Fisher Centre for Real Estate, University of California, or one of the several Lusk Centres in USA institutions.

- Commercialisation of data. (See section 4.5)

4.8 SUMMARY OF RECOMMENDATIONS

The ideas presented in this section are summarised in Figure 6.

Recommendation	Action	Agency/s to initiate and/or manage	Cost	Funding source
4.1 Promote national consistency	Hold a workshop to review advice in this report, establish a program for developing national protocols	Could be a State initiative or coordinated nationally via Planning Ministers Meeting	For 2 days & 40 people, 100K	State government direct and via participant charge
4.2 Extend function of AHURI	Broaden charter and scope of research Assist development of national protocols Replicate Indicative Planning Council functions	Australian and State governments Establish links with research centres where appropriate	1m+ pa	Mostly government but also industry participation
4.3 Build capacity in core professions	Develop courses Offer short employment/work experience Research	Universities, professional associations Employers Universities and agencies	Modest per course Modest per person Variable	Self funding largely Employer Various
4.4 Protect the knowledge base	Establish publishing programs in agencies Establish independent review boards	Agencies and universities Parent organisation, planning authority	100k+ /state/pa >100k /state/pa	Various, especially if linked with universities State government
4.5 Data gap Behavioural Transactions Environmental	Annual or biennial survey and analysis Include in property unit data base Improve database and capture EIA data	Property unit data agency or separate agency linked Property unit data agency Local government, EPAs, link to property unit data agency	0.5m per state per survey Modest, less than 100k per state Substantial	Industry mostly, in NSW PlanFirst levy on industry Existing agency Local government and EPAs,
4.6 Data commercialisation	Seek expressions of interest, be entrepreneurial Negotiate with existing providers to determine scope for expansion	Data agencies	Modest, some seed funding Minimal	Self-funding Self-funding

Figure 6: Recommendations

APPENDICES

I   RESEARCH TOPICS

Small area forecasting
Techniques for small area forecasting are in regular demand and clients rely on the approach of individual firms or consultants, with the result that wide variations in estimates occur. Although such modelling is imprecise there are some quite fundamental characteristics of urban change that might be employed in highly disaggregated models that might also employ micro-simulation techniques.

Hedonic pricing and other economic modelling
Hedonic or pricing of property characteristics could be much more widely employed in a range of urban management fields such as marketing and urban policy in regard to all aspects of residential design. The real estate literature is replete with examples, particularly in the USA and Asia. The data could be related to behavioural survey data recommended in this study. Other forms of economic modelling that could be developed further in relation to activity data are leading indicators, particularly by market segment and area, as well as short term price elasticities.

Housing stock change
Probably the most significant issue is the rate of loss of housing stock through demolition and conversion to other uses, a phenomenon that may be seriously under-estimated, especially for multi-unit dwellings. Allied to this question is the filtering pattern of the stock and vacancy chains. Better answers to these questions could also contribute to small area population forecasting techniques.

Long term supply of redevelopment sites
The last decade or two have seen a high proportion of residential construction occur on brownfield sites. The long term availability of such sites is not known. Planning policy has encouraged widespread redevelopment and also the use of small lot development in new estates. Future generations may have to rely more heavily on site amalgamation for redevelopment than any previous generation because of Strata Title provisions, small lot development and limited supply of brownfield sites.

Integrated analysis of property markets
Surprisingly, the relationships between commercial property markets - retail, office and industrial - are rarely related even in the extensive literature in real estate or property studies. The extent to which there is a relationship is an open question but one made more relevant in the last decade or so of re-urbanisation that coincided with a growth in CBD employment, in turn related to the effect of globalisation of the economies of cities.

Long term perspectives
In each of the topic areas mentioned the issue has a long term dimension. The propensity for so much of the future character of urban change to be based on recent, relatively short-term experience is a cause for concern. Much urban modelling is based on 5-10 year trends often extrapolated for several times that interval. The finance sector analysts employing inductive approaches to property market trends are not comfortable with less than 20 years of data. Opportunity to combine people with experience with those who are keen to speculate on long-term futures should make useful contributions to the system.

II   GLOSSARY

Behavioural data – in this report refers to the housing and related infrastructure preferences people say they have, which may be different to the preferences they have been able to achieve for the same willingness to pay. These can be compared with revealed preferences to identify mismatches in the market place.

Cadastre – the record of property by title, ie entitlement to use

Database – refers to a set of data stored in such a way that it is accessible for use as required, usually implies that it is stored electronically

Demographic – refers to the population and its characteristics

Econometric models – are models that employ conventional economic analysis with moderately to very advanced statistical techniques

GIS – geographic information system, basically software that enables a very wide range of data to be stored in a type of map form and analysed in fairly unlimited ways.

Housing preference – the housing or housing characteristic desired by the purchaser or potential tenant. Orthodox economics assumes that if markets work efficiently the preferences can be inferred from the properties traded or occupied.

Land-use model – see also urban model, a model for explaining or predicting the pattern of land use expansion associated with urban development

Merit good – an economics term that refers to a commodity or a service that society regards should be available to all regardless of capacity to pay, e.g. basic health and education.

Model – a set of statements about how some system works and arranged in sequence. Usually numerical or statistical procedures are applied

National Competition Policy – a policy adopted by the Commonwealth Government to improve market efficiency by requiring all business and government agencies to be exposed to competition in order to reduce the capacity of any them to unilaterally set prices.

Property based data – refers to data that refers to a property by its size, shape, location and title, commonly the unit of the GIS used for analysis of property data.

Protocol – terms of an agreement or rules for obtaining consistency

Transport model – a model for explaining or predicting the performance of a transport network, system or propensity to use the system. These are usually distinguished from land use models and generally rely on land use to be given in the model (exogenous).

III   ABBREVIATIONS

ABS	Australian Bureau of Statistics
AHURI	Australian Housing and Urban Research Institute
AIHW	Australian Institute of Health and Welfare
CR-SURF	Centre for Research into Sustainable Urban and Regional Futures, University of Queensland
DoH	Department of Housing, New South Wales
DoP	Department of Planning, New South Wales
DoT	Department of Transport, New South Wales
EIA	Environmental Impact Assessment
EPA	Environmental Planning Agencies
GIS	Geographical Information Systems
HIA	Housing Industry Association
LADS	Land Area Data System
LG	Local Government
LIS	Land Information System
MDP	Metropolitan Development Program, New South Wales
PIA	Planning Institute of Australia
RBB	Rental Bond Board, New South Wales
REI	Real Estate Institute, Australia
RTA	Roads and Traffic Authority, New South Wales
TPDC	Transport Population Data Centre, New South Wales
UDIA	Urban Development Institute of Australia

IV REFERENCES

Wagener M (1994) Operational urban models. State of the art. *Journal of the American Planning Association* 60:17-30

Wurtzbach C H & Miles M E with Cannon S E (1995) *Modern Real Estate*, 5th Ed. Wiley.

Longley, P A and Batty, M, Eds (2003) *Advanced spatial analysis: the CASA book of GIS,* ESRI, Redlands California.

NSW Department of Planning, 1989 *Sydney Land Audit*, the Department, Sydney.