The Management of Water in Australian Cities

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Characteristics of the Urban Water Systems of Australian Cities

The management of water in Australian cities essentially remains locked in a nineteenth century approach to meeting the demand for water.

In essence the approach is i) to sequester water from a surface source beyond the city limits and store it in large reservoirs; ii) to transport the water to the city, usually by a large piped system, to a treatment plant at which the water quality is monitored and harmful bacteria and other organisms and suspended particles are removed by filtration processes or destroyed by chlorination; iii) the water thus brought to potable water standards is then delivered by a piped reticulation system to residential developments, commercial and industrial undertakings and recreational facilities including parks and gardens.

The water that falls on the urban area as rain is regarded as a 'problem' and drainage systems are developed to drain the catchments on which the cities are built with the storm water drained to a waterway.

The water delivered to users is largely used once, although some commercial and industrial undertakings recover and recycle some of their consumption for re-use in their activities. Some of the water is used as irrigation for residential gardens and public parks. About half the water delivered is used to transport wastes, including domestic wastes, which are collected by a piped sewerage system that conveys the waste-water to sewage treatment plants at which the waste-water is processed to varying degrees depending on the city and how close it is to the ocean. The 'effluent' is then discharged, usually, to the ocean.

The systems have changed little over the last 120 years. Some advances have been made in treatment of both the water supplied and the sewage wastewater and there have been significant advances in the measurement and control of flows within the system. Latterly, changes in pricing strategies with water increasingly being supplied on a 'user pays' basis, has reduced consumption.

The systems of collection, storage, treatment and distribution of water and the collection, treatment and discharge of sewage rely on 'big engineering' approaches to the demand.

The institutional structures created to manage the systems are large, highly centralised hierarchic authorities.

Environmental consequences of present approach
The approach, however, results in several serious environmental consequences.

The first is that the approach of simply withdrawing increasing volumes of water from surface flows significantly adds to the stresses on the ecological systems from which the water is sequestered.

The second is that ignoring the water that falls as rain on the cities themselves not only creates problems within the built space of the city it has become the single most important source of pollution of the water bodies around or on which the cities are developed. The major sources of pollution in Sydney Harbour, Botany Bay, Port Hacking, the Hawkesbury River, Port Phillip Bay, the Swan and Brisbane rivers are the storm water flows drained from the respective cities.

The third is that, in most cases, the sewage flows from the cities receives limited treatment and its discharge to the ocean results in large and increasing point sources of pollution in the near off shores of the major cities.

Future demand
It is clear that even assuming low rates of population increase that we cannot continue to meet the demand for urban water in this way.

There are few surface waters left to be able to be sequestered without serious environmental damage to the river systems in the near regions of the cities. Moreover, there are few opportunities to exploit ground water resources to meet the demand.

The situation is further compounded because large elements of the reticulated water supply sewerage and drainage systems are reaching the end of their effective lives and will need to be replaced if the present approach to meeting the demand for urban water supplies is to be continued.

Policies designed to reduce urban water use have relied heavily on economic mechanisms, particularly pricing water usage. There is no doubt that these measures have reduced water consumption but they are very ‘clumsy’ instruments that do not recognize the opportunities for spatial and location policy initiatives nor do they lead to any fundamental re-consideration of the nature of the demand for urban water and how the demand might be met. Moreover, heavy reliance on economic mechanisms simply means that wealthy residents can buy their way out of having to cope with the environmental problems their behaviour creates.

To the extent that the health of the community is at risk in any reduction in water standards it is important that all members of the community, regardless of their wealth and income, share both the burdens and obligations associated with the maintenance of high quality water supply, sewerage and drainage systems.

Storm water runoff

Current urban development policies that change the hydrological characteristics of catchments result in increased storm-water runoff. This effect is the consequence of increasing the roof areas of buildings, including housing, increasing the proportion of the new urban area covered by impervious surfaces such as roofs, pavement and hard standing. Any expansion of the area covered by urban development changes the 'natural' runoff from catchments and may be seen in new development at the fringe of the city. The drainage systems of new areas are designed to cope with such local stormwater loads but still lead to increasing loads on the receiving waters.

The major storm water drainage problems now occur in areas undergoing redevelopment to higher densities and site coverage that increases the runoff, frequently resulting in flows above those for which the original developments were designed. Redevelopment projects rarely include the costs of amplification of the stormwater drainage in their costs. The effect of the increase in runoff from redevelopment projects is magnified because the area available for soakage and water retention is reduced. The resulting nearly 'instantaneous' runoff frequently leads to peak localised flooding as the runoff exceeds the design capacity of the drainage systems. The costs of amplification of the stormwater drainage system are high. The changes to the hydrology of catchments also reduces the recharging of acquifers and the opportunities to use rainfall as garden or park watering.

There is a fundamental tension between the desire to drain storm water as quickly as possible and the need to allow time for stormwater to slowly make its way to the receiving waters. Stormwater 'picks up' and transports detritus and waste discarded by people, animal faeces, herbicides and insecticides for parks and gardens, etc. This results in a heavy load of material with high BOD being deposited in receiving waters which often have low turnover rates or are themselves low in volume with consequential damage to the ecology of the receiving waters. Much of the waste 'picked up' and transported by stormwater can biologically degrade in situ if it lies for sufficient time.

Opportunities

The present situation offers a number of opportunities to re-think what we want from an urban water supply and how those desires might best be met.

The first point that has to be made is that the water falling on Australian cities as rain is sufficient in most years to meet the demand for water at current levels of consumption. The issue then becomes: How do we capture that water and store it while ensuring that it is of potable quality?

At this point it is important to recall that for all cities established in the nineteenth century domestic water capture was a, and in many cases the, most important source of water on which they relied. We ceased relying on those supplies once reticulated water supply schemes were developed. The transition to reticulated, or 'scheme water' as it was popularly called, was largely due to the perceived need to secure the finances of the water supply authorities. As a result the back yard water tank attached by its umbilical to roofs of houses quickly disappeared from the cities. Various claims were made that the water stored in the tanks was not of adequate standard but these claims were rarely well based.

Modern water tanks do not have the disadvantages of the older household tanks. Moreover, the simple devices now available to ensure that detritus or dust collected on roofs is washed off before water enters the tank removes the dangers once claimed to be associated with household tank water supplies. The insertion in the line from the tank to house of a modern simple but sophisticated filtration device such as that designed to eliminate cryptosporidium, legionella, giardia, ecoli and all the known harmful bacteria as well as any suspended particles would result in the delivery of water of a quality higher than that currently delivered by the reticulated systems.

A dwelling with a roof area of about 150 square metres could capture enough water to meet the average water consumption of the populations of Sydney, Melbourne, Brisbane, Adelaide, and Perth for most years assuming current patterns and levels of consumption and for all years assuming recycling of water for toilet flushing and garden watering. (The average size of new houses is significantly greater than 150 square metres meaning that modern houses could have greater probability of being self sufficient in water supply.)

Domestic harvesting of water for household consumption is more difficult in high density housing although there are experimental developments of medium density housing that meets a high proportion of their demand from water harvesting and recycling.

One immediate benefit of this approach is that it would reduce the storm water runoff problem. Another is that it would greatly reduce domestic demand from large-scale water storage systems and it would greatly reduce sewage flows.

Changing gardening practices could also reduce storm water runoff. Using garden and green kitchen waste to produce compost that is then applied to the soil in domestic gardens not only improves the tilth of the soil it reduces the water needs of gardens and improves the ability of the garden to absorb rainfall thus reducing the runoff or attenuating the peak. Planting gardens with more consideration of their water demands would also reduce the demand for irrigation water thus reducing demand for water from either the reticulated systems of from domestic capture.

Domestic sewage is relatively benign. That is, it is relatively simple to process. The development of small scale biological treatment plants that can be installed in single houses or small groups of houses now makes it feasible to introduce recycling systems for small scale subdivisions. Encouraging occupants to use only washing or cleaning agents that have no or reduced amounts of phosphates greatly increases the efficacy of small scale biological treatment plants.

That is, it is now feasible to install and operate small scale water supply and recycling systems that harvest sufficient rainwater to allow direct use of clean rainwater for drinking and cooking and to then recycle water used in showers and laundry for toilet flushing and gardening – the water recycled can be of high enough standard for domestic consumption although aesthetic objections to the use of recycled water for consumption might still be voiced.

One objection to the use of recycled water has been that it is not economical to do so. Recent research indicates that once the embodied and operational energy costs of such systems are taken into account the domestic harvesting and recycling of water is cheaper than large scale reticulated schemes. Charging a modest 'environmental royalty' on water sequestered from surface water flows would also make the economics of recycled water even more attractive.

Another objection has been that the quality of recycled water cannot be assured. The development of modern filtering systems virtually guarantees that recycled water can be brought to the highest standard. Regular, say annual, inspection by water authority personnel could ensure that recycling/filtration systems were maintained at the appropriate level.

Storm water runoff may not be easily reduced but its peaking may be. Design of roadways with drainage swales is one techniques currently used. Greater use could be made of this technique by greater use of 'nature strips' or median strips as part of the retention system. New subdivision can be designed to ensure that the runoff after development is as close as possible to the 'natural' runoff before development. This usually entails use of retention basins, drainage swales along roads, use of open block paving wherever possible and using parks and playing fields as part of the drainage system.

It should be noted that the pollution load of storm water runoff can also be reduced by encouraging changes in behaviour such as reducing littering, collection by pet owners, especially of dogs, of their faeces and reduced use of fertilisers, herbicides and insecticides in domestic and public gardens.

In most cases stormwater management is the responsibility of local government. This inevitably means that, with the exception of Brisbane, the storm water 'problem' is not approached on a city-wide basis.

Australian cities are all facing situations in which:

1. The water supply systems of the older parts of cities have now reached the end of their operational life and need to be replaced.
2. The sewerage systems of the older parts of cities have now reached the end of their operational life and need to be replaced.
3. The costs of replacing elements of both water supply and sewerage systems in existing cities are extremely expensive.

4. The development and management of the stormwater drainage system of many of the cities needs to be reorganised.
5. There is a shortage of capital for extension of water supply, sewerage and drainage systems on green-field sites in urban areas.
6. All cities continue to grow.
7. The residents of none of the cities want to reduce their standard of living, including their access to potable water.
8. The residents of all cities desire to reduce the environmental stresses they create and under which they live.

Discussion

While it is important to continue to use the suite of economic policy measures to reduce total water consumption it is at least as important to take measures to encourage local resolution of demand and supply issues. That is, every opportunity should be taken to reduce reliance on centralised supply systems. This does not mean that there would be a reduced requirement for centralised strategic planning and management to ensure the safety and security of water supplies, sewerage and drainage systems. It would mean a high degree of decentralisation and micro-management of the three systems. This would require a more detailed and spatially based water, sewerage and drainage information system than currently employed.

There are many ways of reducing demand by improving efficient use of water in gardening and in other domestic activities but, assuming we want our cities to continue to have at least the present level of urban amenity, without a fundamental re-examination of the way demand for water is met these efficiencies will simply be relatively small scale palliative measures.

Significant economies can be achieved in commercial and industrial processes by appropriate recycling measures. These are often taken in conjunction with the requirement to reduce the toxicity or pollution load of effluents discharged to the sewerage system.

At present the knowledge of what areas of cities are best suited to different policy options is limited because we have little location specific information about demand and less about the location specific drainage load either for storm water runoff or for waste water.

The first step would be to develop regularly updated maps of the water consumption of the city to identify areas in which different water supply strategies might be most efficacious. Similar maps could be used to identify different drainage strategies.

Planning and water supply authorities would then identify new areas for development in which only urban development that was self-sufficient would be allowed. In this way the investment needed to maintain water for fire fighting and other emergencies and drainage systems could be minimised. Areas suitable for redevelopment as basically self-sufficient in their demands for water supplies and drainage could also be identified.

The extension of this information base coupled with local management would enable all sources of water including that from 'domestic harvesting' to be efficaciously used to meet the demand.

One benefit of a decentralised system, which retained some centralised elements, is that new technology in water capture, treatment and recycling could be incrementally introduced. One function of a decentralised management system would be to certify the quality of water treatment for both rainwater capture and local recycling. Such a system would also certify compliance of the design of developments with the natural drainage of the catchment in which development was proposed.

Another advantage of the decentralisation of management is that it would tend to make residents more aware of their own responsibilities in relation to the demand for water, the generation of wastewater and the management of storm water.

Conclusions

1. Australian cities cannot continue to increase their capture and use of surface water in their surrounding regions.
2. Australian cities cannot continue to ignore the water that falls as rain on them.
3. Australian cities must reduce their production of wastewater to reduce the point sources of pollution in receiving waters.
4. Australian cities cannot rely overly on market mechanisms to moderate demand for water.
5. Australian cities need to follow policies which make areas within them more independent
6. New demand management, water quality and recycling measures need to be introduced in each city on a decentralised basis within an overall strategic framework.

Proposed Action

A. Introduction of a regularly updated, spatially based water consumption, sewerage and drainage production information system which would allow detailed small area analysis of water supply, sewerage and drainage demands for the city.

B. Creation of new decentralised water supply, sewerage and drainage authorities to manage the three elements of the water system for each city.

C. Introduction of 'environmental royalty' charges for all water sequestered from surface water or abstracted from aquifers in the regions surrounding the city for urban water use.

D. Sponsor research into and development of small-scale water treatment and recycling plants for use in domestic, commercial and industrial processes.

E. Sponsor research into and development of water independent housing.