STORMWATER MANAGEMENT PLANS IN SOUTH AUSTRALIA – THEIR EVOLUTION AND THEIR FUNCTION

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Abstract

Stormwater Management Plans (SMP) are intended to become the major tool in determining the planning and investment strategies for all things related to urban stormwater in SA. Ultimately it is intended that all applications for funding from the Stormwater Management Authority must be supported by a SMP that has been formally endorsed by the relevant Natural Resources Management Board. This is intended to ensure that planning for stormwater infrastructure is done on a catchment or whole of town basis and that there is degree of uniformity in the plans produced. The SMP has to set objectives for stormwater management and to focus on flood risk, water quality and reuse. It also has to allow for the way in which urban land use will affect stormwater in future years.

This paper will discuss the primary issues relating to the introduction of the concept of SMPs. It will highlight the problem areas experienced in preparing these plans and how they were overcome. The paper will conclude with some proposals to provide better guidance in the development of future SMPs

1. Introduction

Stormwater Management Plans (SMPs) in South Australia are intended to become the major tool in determining the planning and investment strategies for all urban stormwater actions and measures. The management of stormwater is undertaken by local councils (with the exception of arterial road drainage), and has in the past often been carried out in a piecemeal manner by individual councils. With the creation of the Stormwater Management Authority in July 2007, funding support is now available from the Authority to implement stormwater infrastructure identified in an SMP. It is eventually intended that all applications for funding from the Stormwater Management Authority must be supported by a SMP that has been formally endorsed by the relevant Natural Resources Management Board. The objective is that planning for stormwater management in Adelaide is done on a catchment basis, rather than by individual councils and that there is active consideration of multi-objective stormwater outcomes and a degree of consistency in infrastructure development. In country areas, where urban areas (towns) are surrounded by rural areas, the same principles will apply but SMPs will be a whole of town basis. Stormwater reuse has become an important consideration (emphasised by the recent drought) as has stormwater quality. There is a requirement that flood risk, stormwater reuse and water quality be considered when developing an SMP. This paper provides the background to stormwater management in SA and considers the value and effectiveness of SMPs.

2. History of Stormwater Management in South Australia

The more settled areas of South Australia experience a Mediterranean type climate of cool wet winters and hot dry summers. It is not a true Mediterranean climate in that cold fronts arising from the southern ocean can pass over the state at any time during the year though more commonly in winter. In summer time such cold fronts can be the source of the much anticipated cool change after a week or more of heatwave conditions. There are occasional severe thunderstorms more typically in summer. Experience has shown

that flooding can occur in any season in response to different types of storms and the different hydrological responses of urban and rural catchments.

In the immediate Adelaide area, severe flooding occurred in February 1925, June/July 1981, March 1983, August 1992 and November 2005. Characteristically the floods develop in less than 12 hours, and in some circumstances can continue for several days. Flood risk from watercourses arising on and beyond the Para and Eden escarpments, that form the hills backdrop to Adelaide, have been mitigated by the modification of water supply dams (Kangaroo Creek and Little Para) and the construction of flood mitigation dams, (Turretfield, Cobblers Creek, Sturt and other smaller dams largely in the Para Hills area.) Urban development and urban infill has resulted in increasing volumes of runoff. There is a history of private land ownership of the creeks in the more established parts of Adelaide (eg. numbered creeks flowing into the River Torrens and Brown Hill Creek) which makes management of creek channels, and maintaining flood capacity extremely difficult. By contrast for more recent land development in the outer suburbs (Salisbury / Tea Tree Gully, Playford and Onkaparinga Councils), the creek lines were retained or returned to public ownership, and are much more easily managed.

Originally the development of stormwater systems in SA took place gradually, on a needs basis, with the intent of getting rid of nuisance stormwater by the simplest means possible - usually discharge down a street, eventually into some form of open channel thence to the nearest river or the sea. It was clearly seen to be a local government responsibility.

Prior to the Second World War most of Adelaide's urban development had taken place on the higher ground surrounding the parklands. The only exceptions were the transport corridor to Port Adelaide and the beachside suburbs of Grange, Henley, Glenelg and Brighton. The lower lying areas to the west and south west of the city were notably absent of development, probably due to poor drainage.

However the runoff being generated by the then established inner suburbs coupled with the natural runoff from the Adelaide Hills must have already been causing sufficient problems for the State Government to become involved with the passing of the Metropolitan Drainage Act in 1935. This is the Act that resulted in the construction of the Torrens Outlet channel and the concrete lining of the lower reaches of the Keswick and Brownhill Creeks that exist today.

As the population increased, and with increasing resources for providing infrastructure, a more planned approach was taken to the development of stormwater drainage infrastructure. Rivers, creeks and other natural drainage features were used where possible and where such features did not exist, extensive artificial drainage systems both underground and open channels had to be developed. Major drainage / flood mitigation projects included the South Western Suburbs Drainage Scheme, the Henley Fulham Gardens Drainage Scheme, Torrens Road Drainage Scheme, Eastern Councils Drainage Board (Second Creek), River Torrens Flood Mitigation and the Dry Creek and Little Para Drainage Authorities (Dry Creek and Little Para River). Such developments were paralleled in country towns that were also experiencing drainage and / or flooding problems.

However such projects were in response to a situation that had developed. Urban development was generating stormwater and in large quantities and / or it was prone to flooding from runoff originating elsewhere. Stormwater certainly wasn't considered to be a resource; instead it was causing economic loss and human suffering. It was being generated by urban development that had few controls placed upon it (the first really effective planning and development legislation was not enacted until 1966). The developers themselves were not interested in trying anything different as demand was outstripping supply and they had no responsibility for the consequences of their development.

So, not dissimilar to other government infrastructure provision, stormwater infrastructure provision quickly became a "catchup" game, responding largely to problems that were a consequence of past decisions. In such an environment, the provision of single purpose infrastructure that disposed of all stormwater from the minor flows right up to and beyond the design event was often the only option left. This "catchup" game is not finished, as the provision of adequate stormwater drainage infrastructure is by no means complete in SA, and the upgrading of inadequate systems continues.

The standards used for drain capacity varied. In the late 1980s Professor John Argue promoted the principle of Major-Minor drainage design (UWRC, 2005), where it was explicitly acknowledged that it is neither economic nor practical to design the formal drainage network for rare recurrence interval flows (eg. 100 year ARI). Rather such systems should be designed to a lower standard (eg 5 or 10 year ARI, which they mostly were in practice), and at the same time take account of times when the capacity will be exceeded (this was what was new in the principle of Major-Minor drainage design). This generally meant allowance for overland flow, along roads and swales to a main drainage line.

With the Adelaide metropolitan area at one time having over 30 separate local councils having jurisdiction (it still has 18), some stormwater drainage networks were developed in a piecemeal manner and to different standards. Cooperation has improved over the years, helped by financial incentives from previous State Government subsidy arrangements, but until recently there was no legislative backing to require cooperation. The newer outer suburbs, where there are less Councils in the first place, have a better history of cooperating than the older inner suburbs. In the inner suburban Brown Hill and Keswick Creeks catchments, full cooperation is only now starting to be achieved.
With increasing urbanisation, sealing and kerbing of roads and the advent of the consumer society, stormwater drains increasingly acted as carriers for gross pollution; leaf litter, sediment, plastic and other consumer debris, shopping trolleys and lawn clippings.

The most recent Report Card by Engineers Australia (July 2010) gives South Australia a score of "D". This is one level below Tasmania, New South Wales and Victoria which are all "C-" The report indicates the following challenges for South Australia:

- Provision of adequate stormwater infrastructure to ensure that all urban areas have adequate drainage and flood protection;
- Reducing the volume of stormwater and pollutants entering coastal areas and inland waterways;
- Maintaining and improving asset quality;
- Impacts on stormwater volumes arising from increased urban density;
- Accelerating the implementation of water sensitive urban design principles;
- Addressing climate change risks;
- Increasing stormwater use;
- Working cooperatively where stormwater catchment areas span multiple councils;
- Providing additional funding for stormwater projects.

The Stormwater Management Plans address all of these issues.

3. Development of stormwater management guidelines

Since 1967 the South Australian Government has provided financial support to councils for developing stormwater infrastructure, initially through the Stormwater Drainage Subsidy Scheme, later the Catchment Management Subsidy Scheme (CMSS). A severe funding cut to the CMSS in 2001 eventually resulted in a joint State and Local Government review of stormwater infrastructure needs (KBR, 2004). This demonstrated that there were at least a further $200 million (2004 $) needed to be invested in stormwater drainage / flood mitigation infrastructure alone, without considering other emerging aspects of stormwater

management. Eventually the State Government agreed to provide funding to a new Stormwater Management Authority (SMA) which was to be a jointly managed body by both State and Local Government. The State committed to funding of $4million per annum (indexed at CPI) for 30 years – thereby potentially allowing borrowing for major works. This was done under the Local Government (Stormwater Management) Amendment Act 2007

One of the SMA's first actions was to commission the preparation of a set of guidelines for stormwater management planning (Stormwater Management Authority, 2007). The guidelines have six key policy goals for achieving collaborative and forward looking urban management in South Australia local government council areas as follows:

- Apply risk management framework for hazards/flooding based on catchment characteristics and rigorous data collection;
- Facilitate more productive use of stormwater;
- Manage the environmental impacts of stormwater as a conveyor of pollution;
- Manage stormwater as part of the urban water cycle recognising natural watercourses and ecosystems where feasible;
- Achieve responsible stormwater management locally by making better use of the statutory development planning system;
- Gain innovative stormwater policy outcomes through the most effective funding and procurement arrangements. (SMA,2007)

It is notable that while the basic requirement for flood management is unchanged; the guidelines are looking for a more comprehensive approach to stormwater management. Community consultation must be part of the process. Environmental and water quality issues must be considered. In recent drought-ridden times, the recovery and reuse of stormwater has increased in importance. It has also entered the public's imagination as the solution to the State's water supply problems.

It is intended that if local councils want SMA funding support for stormwater infrastructure, they must have an approved Stormwater Management Plan. The plan is required to conform to the guidelines, and it must be endorsed by both the relevant Natural Resources Management Board and the SMA. This means that eventually all future investment in stormwater infrastructure with State Government support will be in infrastructure that has been justified through the stormwater management plan process.

In essence a Stormwater Management Plan should include the following:

A) Flood Risk and Mitigation

- The risk of flood inundation and hazards; using flood mapping techniques, drainage and hazard assessment for a range of ARIs, from the more frequent events, up to the Probably Maximum Flood. The "Industry Standard" 100-Year event is always included.

- A plan to mitigate any flood risk – could be structural or non-structural mitigation.
  - Designate acceptable level of risk for each flood-risk area
  - Measures to mitigate the risk; could be structural, dams, bridges, channels, or non-structural, planning constraints, flood warning, insurance, community flood awareness.
  - Costs to mitigate, over time

B) Infrastructure Management

- An inventory of existing stormwater assets; what investment/change is required to the creeks, channels, pipes eg: Lay back banks, protect against scour, replacement, open space initiatives, on-site detention.

C) Water Reuse

- What opportunities are available for;
    - Stormwater storage; long or short-term, surface or underground (space for dams, suitable aquifers, special tank storage);
    - Amenity; environment and the community;
    - Water reuse – for irrigation, replacing River Murray water.

D) Water Quality Improvement

What requirement or opportunity is there for water quality improvement;

- Source control to minimise movement of pollutants into the stormwater stream;
- Wetland development to remove turbidity, suspended solids, nitrogen and heavy metals.
- Gross pollution traps to capture larger objects from stormwater and dispose/recycle
- Sediment collection and disposal.

E) Monitoring Requirements

- What is the requirement for monitoring water quantity and quality to enable efficient management of stormwater?

It is clear from the range of issues and requirements that each catchment and community will have a unique set of problems and opportunities. Each plan will need to carefully dovetail together a diverse range of issues and situations.

Data collection: Recent years have seen a significant improvement in the data available for flood estimation and for catchment yield:

- Collection of time-series rainfall and drain / river flow data has expanded greatly over the past 20 years. Currently more than 150 pluviometers are in operation in the Greater Metropolitan Adelaide region, which is a far cry from less than 10 that were in operation as recently as the 1980s. There are 65 flow gauging station sites on rivers / creeks and drains in the same region. The availability of such data has greatly improved the capabilities of hydrological modelling of surface flows through the Adelaide metropolitan area, particularly the various rivers and creeks with their sources in the Mt Lofty Ranges. (See Addendum 1 for additional information)Unfortunately the availability of such data in the country areas of the state is yet to reach and may never reach the same level that the Adelaide region now enjoys
- Rating curves, which convert water levels to rates of flow, are improving in quality.
- Similarly the ability to estimate catchment yields for management of stormwater is improving.

Flood Estimation: Skills in flow estimation both in real time and for stormwater drainage / flood mitigation design, have improved significantly in recent years, with enhanced computer models and better quality input data for model calibration.

Floodplain Mapping: Improved aerial survey techniques, and the advent of digital data capture have enabled much better Digital Terrain Models (DTM) with vertical accuracy 100 mm or better. The current generation of computer-processors are capable of handling the huge quantities of data generated / calculated not only in creating the DTM models but in undertaking floodplain mapping using two-dimensional floodplain models. Indeed two-dimensional floodplain mapping is now becoming the benchmark not only for the traditional riverine type floodplain mapping but for floodplain mapping in urban area where the runoff is generated "on-site". This has given a whole new visual meaning to the Major – Minor drainage design principle described above.

Changing community standards: Concurrent with these changes, has been a greater community expectation that protection against floods is a right not a privilege. After the floods of November 2005, the Premier of SA was embarrassed at the anger expressed by local people living close to Brown Hill Creek who had been flooded. Severe floods occur infrequently in South Australia, but when they do, the community increasingly demands explanations. Deaths due to floods in South

Drought Conditions and increased interest in stormwater reuse: Water shortages and restrictions particularly in 2006-2009, have stimulated interest in stormwater re-use. The seasonal nature of rainfall in South Australia means that regular runoff is largely available in the winter, but water for irrigation is not needed until the dry hot conditions of summer. Surface storage structures (dams) are generally cheap (if there is land available) but tend to be inefficient, since they lose large amounts of water to evaporation, and seepage. Groundwater storage around Adelaide is potentially good in the tertiary aquifers that occur under the northern and western parts of the Adelaide Plains. These aquifers are particularly productive in the Salisbury and Playford areas, but diminish in capacity rapidly towards the south and east. These factors, combined with land being more readily available, have seen the City of Salisbury become a leader in the development of wetlands for water quality improvement, and storage of treated stormwater underground using Managed Aquifer Recharge (MAR) techniques. In less favourable areas where the choice is largely fractured rock aquifers, the potential is much more variable and more likely to be poor. In such areas MAR schemes tend to be more expensive and of lower capacity.

An unusual example of aquifer recharge and recovery on the south side of the city is at Scotch College which has been in operation for some 30 years. Water is pumped out of Brown Hill Creek during the winter months and flows into a recharge bore (under gravity). The geology of the specific location is favourable, with an intersection of 2 fault zones, leading to reasonable storage in fractured rock. The water is recovered by pumping from the bore in the summer. Annual yields of 40 to 50 mega litres have been obtained.

A similar project, nearby, at the Urrbrae Wetlands on Cross Road was unsuccessful. The different geology and target aquifer, Carisbrook Sands rather than Fractured Rock, meant that the drilling of the bore did not produce satisfactory yields, and the well is not used for MAR.

Water Sensitive Urban Design (WSUD): Water Sensitive Urban Design (WSUD) is an approach which integrates the management of all water resources and the total water cycle into the urban development process.

WSUD includes:

- Utilising water saving measures within and outside domestic, commercial, industrial and institutional premises to minimise requirements for drinking and non-drinking water supplies;
- Storage, treatment and beneficial use of runoff (at building and street level, including stormwater);
- Treatment and reuse of wastewater; and

- Using vegetation for treatment purposes, water-efficient landscaping and enhancing biodiversity and amenity. (DPLG, 2010)

Major changes are occurring that will affect stormwater management:

- Urban infill will result in greater volumes of runoff and more rapid times of concentration so that shorter duration and higher intensity storms become more critical;
- Global climate change is expected to result in higher sea levels, lower annual rainfall and perhaps higher intensity storms.

4. Introduction of Stormwater Management Plans

In South Australia Stormwater Management Plans currently being developed are shown in Table 1. Those involved in preparing the plans have encountered a very wide range of situations. Tables 2 and 3 give some of the key factors and likely range of opportunities and difficulties. At Wasleys where there is a small township, with local stormwater drainage issues and an adjacent river catchment, the plan was straightforward and prepared with minimum expense. Options for flood management and stormwater reuse have been documented and costed. A prioritised list of options can then be presented to the council and the SMA for funding. By contrast, the SMP for Brown Hill Creek is very complex. It involves five different local councils, a creek system that is privately owned for much of its length, a major flood risk spread unevenly over the floodplain, limited opportunities for flood storage, and limited opportunities for stormwater reuse. The issues are complicated by the proposal to construct flood control dams in a relatively undeveloped part of the Adelaide Hills.

Rural/Regional	Area Sq Km	Rural	Urban	Popu-lation (appx)	No. of councils	Status	Estimated Cost of studies/Plan ($,000.)
Wasleys	72	98%	2%	300	1	Complete	35
Pt Elliot	7	49%	51%	2,000	1	Under Way	70
Pedler Creek	101	95%	5%	16,000	1	Starting	35
City							
Port Road	7	0%	100%	15,000	2	Complete	300
Brown Hill Creek	69	40%	60%	156,000	5	Under Way	800
Eastern Region Alliance	48	45%	55%	125,000	5	Under Way	400
Marion-Holdfast Bay	25	10%	90%	80,000	2	Under Way	200
Beach Rd - Noarlunga	4	0%	100%	500	1	Starting	35

Table 1: Stormwater Management Plans in South Australia

Rural/Regional	Magnitude of Problem/Opportunity in Stormwater Management				
	Floods	**Stormwater Infrastructure**	**Water quality**	**Stormwater Reuse**	**Managed Aquifer Recharge**
Wasleys	Moderate	Moderate	Minor	Moderate	Poor
Pt Elliot	Moderate	Moderate	Minor	Minor	Poor
Pedler Creek	Major	Moderate	Moderate	Minor	Some potential
City					
Port Road	Major	Major	Major	Major	Good
Brown Hill Creek	Major	Major	Minor	Minor	Limited
Eastern Region Alliance	Major	Moderate	Moderate	Moderate	Poor
Marion-Holdfast Bay	Moderate	Major	Moderate	Minor	Limited
Beach Rd - Noarlunga	Major	Major	Moderate	Minor	Some potential

Table 2: Tasks and Opportunities in developing Stormwater Management Plans

Easy	Difficult
Simple Drainage System	Complex Drainage
Good Records	Poor Records
Single Local Council	Many Local Councils
Adequate space for water storage and wetlands	Fully developed, no room to move
Relatively low cost	High Cost
Few local/community issues	Many and difficult community issues

Table 3: Challenges in developing SMPs

The problem of conflicting objectives is becoming more apparent, as the demand on limited resources increases. The construction of concrete channels, always an efficient means of quickly removing floodwaters, is now unpopular due to:

a) being a one objective solution (drainage / flood mitigation);
b) poor aesthetics;
c) undesirable discharge of untreated stormwater into a natural water body; and
d) a potential hazard to humans and animals who fall into them
e) Being a sterile environment devoid of riparian vegetation and biota.

Similarly, the demand for urban land, and its high cost, has led to more and more encroachment on river channels and floodplains. Especially in Adelaide where flooding is infrequent, there is always pressure to constrict waterways and floodways to make room for housing. Urban infill, attractive to governments for many other reasons, also results in less infiltration to the soil, greater stormwater flows and more rapid development of floods.

4.1 Case Studies: A Tale of Two Plans

A review of two recent SMPs indicated how very different the processes can be. Both are located in Adelaide. In one, the Port Road Catchment, has a long history of minor to moderate flooding caused by inadequate drainage and, unusually for the inner city, there was a long wide corridor of land available in public ownership in the form of the Port Road median strip. The planned improvements in flood management, stormwater reuse, water quality improvement and general environmental enhancement of the Port Road median had obvious appeal to the community and the plan was accepted with excellent participation and support. In the other, the Brown Hill Creek and Keswick Creek catchment, which has potential widespread damage for greater than 20 year ARI floods, produces large amounts of rubbish and other pollutants and has plenty of water available for reuse, the process has been plagued by difficulties, most of which are still to be resolved. Table 4 provides a comparison.

Stormwater Management Plan	**Port Road**	**Brown Hill and Keswick Creeks**
Councils Cities of.....	Charles Sturt and Port Adelaide Enfield	Mitcham, Unley, West Torrens, Adelaide & Burnside
Catchment	Urban, quick response	Combination of urban quick response (90 minutes) and rural slow response(>12 hours)
Community	Fairly uniform pattern of mixed urban, industrial , commercial and lower value properties. Equal share of the flood problem, equal interest in water quality and stormwater reuse	Mainly residential, higher value properties upstream part of catchment, lower value properties downstream part. Upstream community have relatively few flood problems, downstream community is at risk. Much of the upper urban part of the creek is privately owned.
Funding	Shared between 2 councils ($50. Million)	Shared between 5 councils ($100 Million)
Flood mitigation	Provision of flood storage in detention basins and wetlands along the Port Road median strip will help alleviate flooding.	Flood mitigation is more complex due to a combination of flash and non-flash flood risk and lack of suitable land. Much of the creeks are in private ownership. The solution is a combination of flood storage, diversion channels and main channel enlargement at discrete locations.
Stormwater Reuse*	Quite good opportunities at the bottom end of the catchment, using wetlands, open channel storage and MAR. This can be done in combination with flood mitigation	Good opportunity at the bottom of the catchment but flooding problems originate further upstream. Hence reuse cannot be easily integrated with flood mitigation
Water Quality Benefits	Direct benefits due to reduced pollution of West Lakes attributable to the SMP proposals.	Water Quality improvement measures largely in place by others, no significant additional benefits from the SMP.

Note: * Reuse of stormwater can be achieved by managing and storing frequent low flows. This is really in contrast to flood mitigation which has to focus on high flows

Table 4: Case Study SMPs for Port Road and Brown Hill Keswick Creeks

Community Engagement

Both study areas have significant heavily urbanised communities which are at risk of floods. However as the threshold (ARI) of flooding is higher on the Brown Hill catchment and the upper reaches of Brown Hill Creek have minimal flood risk, community response to the Brown Hill Creek SMP in terms of risk reduction is muted, while elements of the upstream community have become very actively involved in the decision-making process, focussing on the issues of visual amenity of proposed flood mitigation dams and project

economics. Even residents along Brown Hill Creek who were flooded in November 2005 do not seem to be vocal compared with those who have other concerns.

Funding

Federal funding support has been granted for the first stage of the Port Road project. This was possible because of the stormwater harvesting component. SMA funding is available to local government for flood mitigation works. By contrast, despite the high annual average damage figure for Brown Hill and Keswick Creeks, it has not yet been possible to unite the requirements of all five local councils, and until this is done, the SMA funding, let alone any possibility of Commonwealth funding remains elusive.

Stormwater Harvesting vs Flood Mitigation

Given the availability of a continuous land corridor the proposed Port Road development was able to integrate the needs for flood mitigation, water quality improvement and stormwater harvesting into a single concept plan. The whole project can be seen as a single unit. By contrast, the proposed components to mitigate flood risk on Brown Hill and Keswick Creek system are at ten discrete locations across both catchments and don't easily fit into an integrated flood mitigation / reuse strategy. Given their discrete locations each particular component can be viewed (and costed) individually. It has therefore been possible to attack the proposed construction of flood mitigation dams by separating them from the other components of the plan and questioning their economic viability.

Port Road SMP

The SMP has established specific objectives from which management strategies are to be developed (Connell Wagner, 2007). These are:

> ***Flood management***. The protection of property floor levels from inundation in a 100-year ARI event is a key objective. The underground drainage system (the minor system) will be designed to a 5 year ARI standard, with limited flooding only during a 100 year ARI event (the major system).
>
> ***Urban Infill.*** It is important to ensure that runoff from any new development does not increase the degree of flood risk to other properties. Strategies are as follows:
>
> - Control floor levels of new development;
> - Upgrade existing underground drainage system;
> - Provide detention basins at key locations;
> - Provide on-site detention / retention systems;
> - Monitor development
>
> ***Water quality.*** Because of the high recreation use at West Lakes (the downstream receiving water body), it is important to improve the quality of discharged water. This includes assisting to prevent algal blooms, protecting aquatic ecosystems and minimising the quantity of gross pollutants leaving the catchment. A significant reduction in sediment and nutrient loads was sought.
>
> It was also an endorsed objective that pollutants and activities having a high potential for pollutant generation be managed at or within land uses. Strategies are:
>
> - Wetlands at strategic sites
> - Interception of gross pollutants at strategic sites;
> - Management of pollutants at point sources

Stormwater reuse: Objectives included encouraging the on-site use of stormwater to reduce the runoff to the downstream stormwater system, and the development of an MAR scheme to ease the local strain on groundwater resources. Since the publication of the plan, the stormwater reuse component has been strengthened and integrated with other reuse proposals, including pumping water from the River Torrens at the top end of the system to augment the yield from the Port Road catchment itself. The drain also allows the River Torrens water to be transported to an area closer to likely demand sources for recycled stormwater.

Environmental protection and enhancement: When new stormwater management facilities are constructed in open spaces, the design should maximise opportunities for biodiversity, amenity and environmental enhancement.

The Brown Hill and Keswick Creeks:

A Flood Management Master Plan was produced in December 2006 (Hydro Tasmania, 2006), a few months before the Stormwater Management Act (2007) came into force. The flood management plan was adapted to become an SMP. Not surprisingly it focuses on flood mitigation, with limited emphasis on water quality improvement and stormwater reuse. This was because these other aspects were already addressed in the Patawalonga Catchment Water Management Plan. Since then more specific investigations have been undertaken into stormwater reuse opportunities on both catchments and these findings will be incorporated into the existing plan.

The plan identifies major flood risks, and outlines a series of mitigation measures.

The structural measures included:

- Two flood control dams in the rural portion of Brown Hill Creek.
- A flood detention basin in the South Parklands
- A major diversion to transfer flow from Keswick Creek into Brown Hill Creek, relieving flood risk along lower Keswick Creek.
- Channel widening along the lower reaches of Brown Hill Creek
- Other channel improvements and detention storages.

Non-structural components included:

- Community awareness and flood preparedness (community information on flood maps, advisory information on flood response for individual properties, flood warnings, flood preparedness for all landholders; and emergency management response.);
- Planning Policy and Development Assessment: (development assessment; land use planning; codes and development guide; and neighbourhood planning/master planning).

The current Plan does not contain all the provisions required for an SMP, and is about to be modified to take account in particular of:

- Previously identified opportunities for stormwater recovery and reuse;
- Water quality issues (gross pollution and other sources of pollution);
- Local opposition to the proposed flood mitigation dams, requiring further investigations.

See Addendum 2 for further details.

5. Conclusions

Stormwater Management Plans, prepared on a whole-of-catchment basis or whole of town basis in country areas, are seen to be the best way of identifying the needs and in planning for better management of stormwater in the future. We are suffering not only from obvious poor decisions made in the past (eg. housing development in flood prone areas) but from decisions made for other quite reasonable causes which now have other adverse consequences (eg providing kerb and gutter and street sealing of all suburban streets together with extensive tree planting of deciduous species, has resulted in a large amount of leaf litter finding its way into the drainage system and eventually receiving waters), but we must manage the consequences in the most effective way possible.

The comparison between two SMP approaches shows that critical success factors rely on wide ranging and frank community information provision and involvement and on presenting an integrated package of stormwater management outcomes where possible.

It is essential that inter-council issues are resolved. The plan must ensure equity between councils / communities for cost of identified infrastructure.

It is concluded that properly undertaken, the SMP model which is starting to gain momentum in South Australia should be a good way of planning for and coordinating stormwater management in the state. Each Stormwater Management Plan is unique and reflects the particular situations in the catchment. It will necessarily be a best possible compromise between many conflicting demands and situations.

6. References

1. Stormwater Management Authority (2007). "*Stormwater Management Planning Guidelines*". Natural Resources Management Council. Adelaide, Stormwater Management Authority: 18 pp.

2. *Local Government (Stormwater Management) Amendment Act 2007*, Government of South Australia

3. Tonkin et al (2007). "Port Road Rejuvenation Stormwater Management Plan". *Revision 4a Report*. Adelaide, City of Charles Sturt: 800 pp.

4. HYDRO Tasmania Consulting, A.W.E., QED P/l (2006). "*Brown Hill and Keswick Creeks Flood Mitigation Study Flood Management Master Plan*". Adelaide, AMLR NRM Board.

5. Australian Water Environments (2009). "Eastern Region Urban Stormwater Management Plan (ERUSMP"). *Final Report*.. Adelaide: 135 pp.

6. Parliamentary Standing Committee on Public Works (1981). "River Torrens Linear Park and Flood Mitigation Scheme": *Interim Report*, 163 pp.

7. KBR (2004). "*Metropolitan Adelaide Stormwater Management Study - Part A -Audit of existing information*". Adelaide, Local Government Association and State Government of South Australia. Part A: 180 pp.

8. Engineers Australia (2010). "Infrastructure Report Card 2010" *Part 3: Water*. Canberra.

9. Urban Water Resources Centre (2005) *"Water Sensitive Urban Design: A Handbook for Australian Practice"* University of South Australia in association with the Stormwater Industry Association and the Australian Water Association. April.

10. Department of Planning and Local Government (2010). *"Water Sensitive Urban Design (WSUD) Technical Manual for Greater Adelaide"*, Government of South Australia. Adelaide.

Addendum

1. The greater amount of times-series pluviometer and water level records available for design, (23 years since publication of Australian Rainfall and Runoff (ARR) 1987), includes several major flood events and has enabled many catchments to be investigated using runoff routing models. These models have been calibrated to actual flood events and there is some confidence that they will simulate design floods satisfactorily. For design purposes it is still necessary to use the ARR standardised storm data, derived from the Intensity Frequency Duration (IFD) statistics, areal reduction factors and temporal distribution patterns. The new version of ARR, to be available in 2012, will update the IFD statistics and provide additional information on appropriate areal reduction factors and storm temporal patterns.

2. In the late 1990s each then existing Catchment Water Management Board created a Catchment Water Management Plan for its catchment, covering the whole of the catchment and including all aspects of stormwater management planning at a broad level. The plan for the Patawalonga Basin catchment recognised a need to quantify and identify solutions to the known flooding problems on the Brown Hill and Keswick Creek catchment (part of a larger catchment draining to the Patawalonga basin). A Flood Management Master Plan was eventually developed. With the creation of the Stormwater Management Authority and the *Stormwater Management Planning Guidelines*, the current drought and increasing interest in water reuse, there was a need to expand the scope of the Flood Management Master Plan. The SMA required that the "Master" plan should consider potential for water reuse before it could be re-endorsed. This, together with concerns by a group within one local council area about construction of flood mitigation dams, has led to a new study to develop a Brown Hill Creek SMP, fully compliant with the Guidelines.