Development of Storm Water Quality Improvement Strategy Plan for Local City Councils in Western Australia

Ranjan Sarukkalige and Dinushi Gamage

***Abstract*—**The aim of this study was to develop a storm water quality improvement strategy plan (WQISP) which assists managers and decision makers of local city councils in enhancing their activities to improve regional water quality. City of Gosnells in Western Australia has been considered as a case study. The procedure on developing the WQISP consists of reviewing existing water quality data, identifying water quality issues in the study areas and developing a decision making tool for the officers, managers and decision makers. It was found that land use type is the main factor affecting the water quality. Therefore, activities, sources and pollutants related to different land use types including residential, industrial, agricultural and commercial are given high importance during the study. Semi-structured interviews were carried out with coordinators of different management sections of the regional councils in order to understand the associated management framework and issues. The issues identified from these interviews were used in preparing the decision making tool. Variables associated with the defined "value versus threat" decision making tool are obtained from the intensive literature review. The main recommendations provided for improvement of water quality in local city councils, include non-structural, structural and management controls and potential impacts of climate change. .

***Keywords*—**Storm water quality, Storm water Management, Land use, Strategy plan

I. Introduction

STORM water Quality Improvement Strategy Plans (WQISP) are documents that detail policies, strategies and regulations for storm water quality improvement in a defined area. These plans provide a ways of prioritizing recommendation and resources to improve storm water quality in local councils [1]. Several research have been highlighted in the literatures in drafting storm water quality improvement strategies (SQIS), which are used by local city council officers, managers and decision makers as technical guidelines in developing Storm water Quality Improvement Strategy Plans (WQISP). SQIS consists of discussion of existing storm water management system and the activities involved as well as the values, threats and issues within a local council. In order to prepare SQIS, it is important to analyze the land use types, existing storm water management systems and current issues related to storm water quality within the councils. This project aims to prepare such storm water quality improvement strategies (SQIS) which can assist local councils in Western Australia in preparing WQISP to improve their storm water quality.

Activities in a catchment that changes the land use patterns can directly impact the quality of runoff and hence the receiving environment [2]. Therefore, activities, pollution sources and their pollutants in local council catchments were identified during the literature review. Most of the urban pollutants are initiated from impervious street surfaces; Heavy metals are one of the pollutants generate from residential activities [3], [4]. Nutrients introduced to environment by landscape maintenance activities in both residential and commercial lands [5].

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II. Methodology And Materials

Research approach is categorised in to four phases to ensure proper attention is given to appropriate issues. First phase is the preliminaries which includes understanding of SQIS. Data collection is the second phase in which existing WQISPs and other documents are collected from various sources. Figure 1 shows the summary of collected information. Semi structured interviews were also carried out with several sections in local councils. Third phase is analysing the collected data. This phase includes reviewing existing SQIPs from local councils and other countries, reviewing management structures of local councils and identifying issues associated with councils in terms of storm water. The last phase is results and discussion and providing recommendations for local councils which is the SQIS.

III. Case Study from City of Gosnells

Taking data availability and motivation into account, City of Gosnells has been selected as the main study area. City of Gosnells is located within South East Metropolitan area in Western Australia. It is located 17km away from Perth, the State Capital. City of Gosnells consists of eleven suburbs within 127 square kilometres. The suburbs include commercial, industrial and residential areas as well as rural areas in the east and south of the City. The population growth resulted in new residential developments and commercial growth in the City. Most of the land use types were changed to residential to accommodate the increased population. Also,

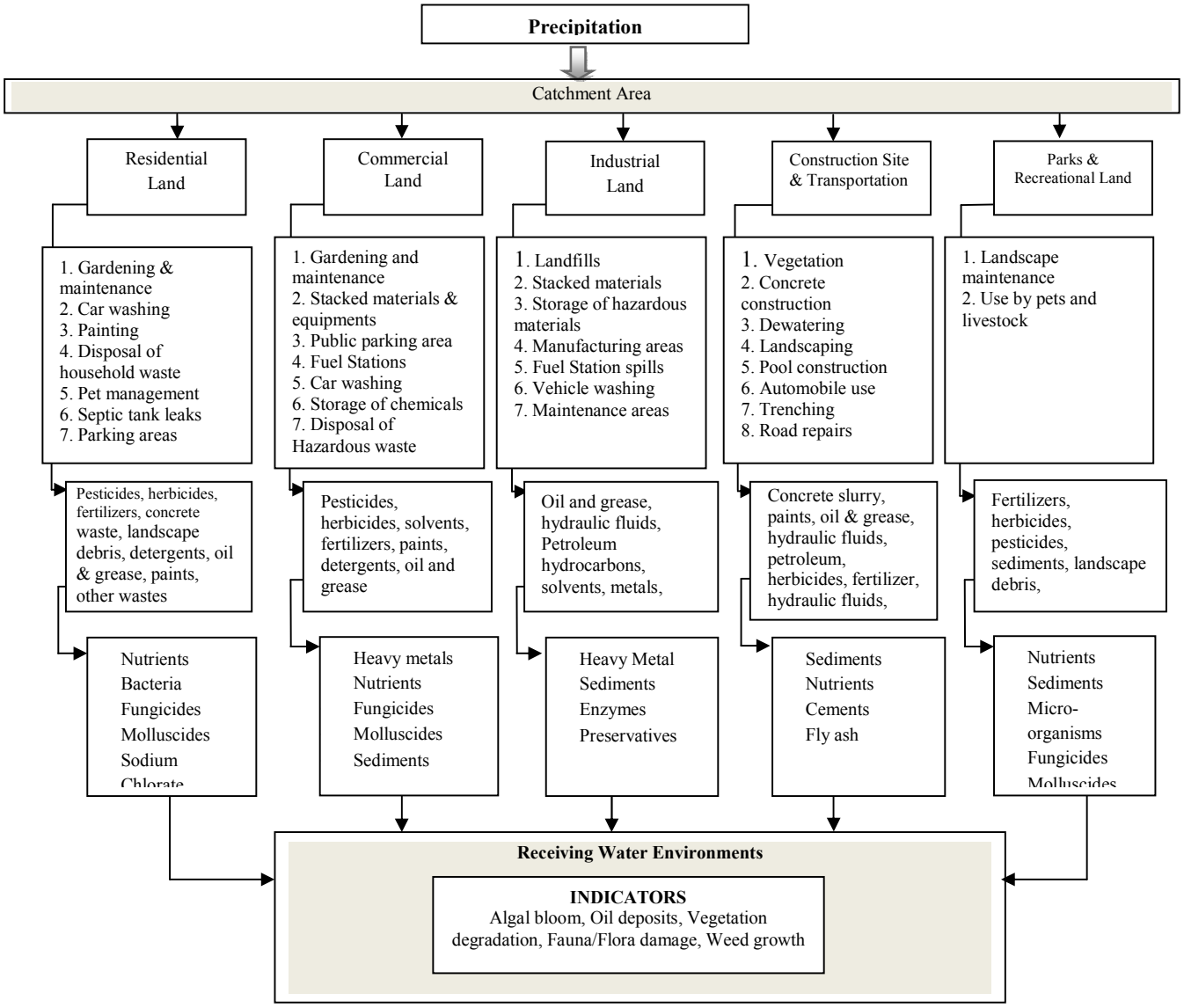

Fig. 1 Activities, sources and their pollutants in catchments in local councils

land use types were changed to commercial and industrial to accommodate the needs of increased population in City of Gosnells. Urbanization results in increasing amount of impervious surfaces and runoff pollutants to receiving water environments [6]. The storm water system in City of Gosnells includes pipes, detention basins, open channels, swales, creeks and lakes. The main method of collecting water from the catchment is open channels. Open channels discharge storm water to Canning and Southern Rivers.

IV. Data Analysis and Results

Figure 2 summarizes the storm water issues associated with City of Gosnells Council. These issues were observed during the semi-structured interviews carried out during the study with coordinators of each section within City of Gosnells. These issues are identified common to most local councils.

As the main purpose of the Storm water Quality Improvement Strategy is to protect and enhance the values of receiving environment, a Values versus Threat tool was developed to assess the impacts of storm water quality on the environment. Values should reflect the uses of receiving environment to the community. The values can include environmental, various types of amenity, places of heritages significance and economical issues related to the receiving environments. Storm water threats include pollutants from land use activities. Table 1 provides the threats and values that can be used as guidance for the preparations of storm water management strategies. Council officers can determine the impact levels related to threats on each values according to the existing storm water guidelines and by visual inspection of sites. These impact levels can be defined for each threat.

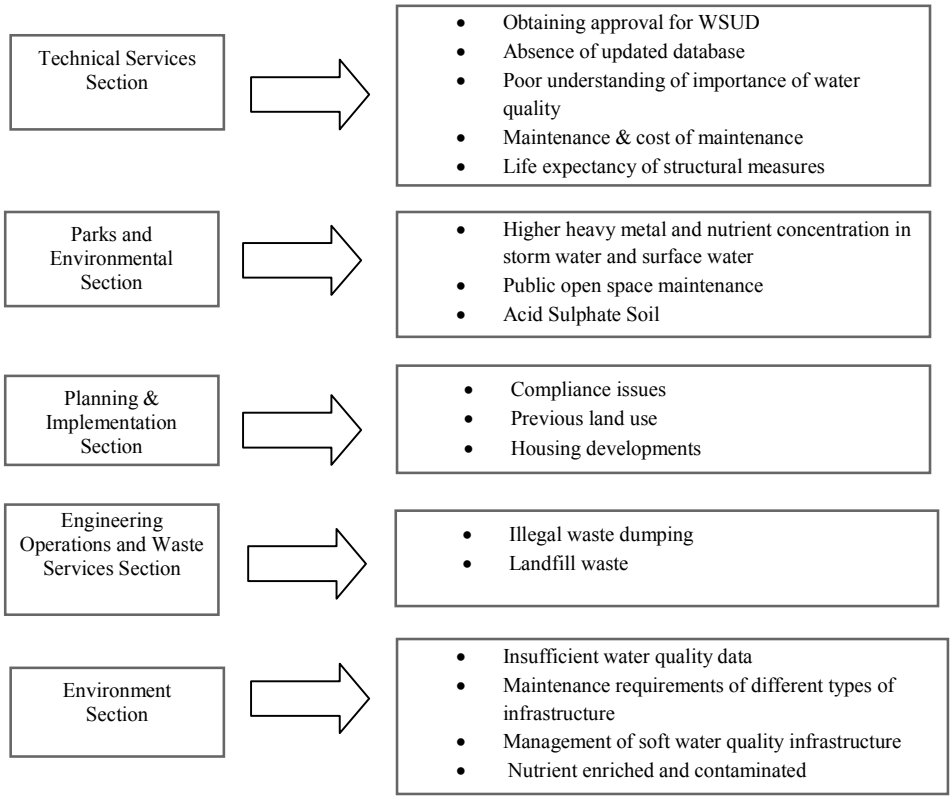

Fig. 2 Storm water issues associated with City of Gosnells

TABLE I
VALUE VS. THREAT DECISION MAKING TOOL

	Threats							
Values	Residential land use runoff	Industrial land use runoff	Commercial land use runoff	Major road runoff	Public Open space runoff	Residential development runoff	Contaminated Sites	Sewer leakage
Environmental								
Amenity								
Economic								
Social/Cultural								
Impact Level								

The impact level for a site can be determined by adding the threats values. Table II provides a classification of impact levels. However, these impact levels should be defined appropriately by the councils according to their storm water quality issues and according to the recommendations by this study and future studies. During site inspections, compliance officers can assess the impact on a particular site by marking number one in the cells related to the inspection site. Summation of numbers will provide an impact level for each site. The necessary actions and related fund allocations can be obtained according to the impact levels for the particular site (Table II).

TABLE II
CLASSIFICATION OF IMPACT LEVELS

Impact level	Description
0	Insignificant impact - No action required
1	Minor impact - Action required
2	Moderate impact - Action required
3	High impact - Action required
4	Extreme impact - Action required immediately

V. PROPOSED ACTIONS FOR SPECIFIED PROBLEMS

A. Structural Controls

The following BMPs are essential in managing the storm water quality in City of Gosnells. As the City contains some of these BMPs, retrofitting programs should assist in improving the effectiveness of these BMPs.

1) Gross Pollutant Traps (GPT) –Source control is an effective way of treating the storm water. GPTs can be employed in achieving source control for gross pollutants. The hotspots within City of Gosnells should be identified for the construction of new GPTs.

• *Buffers* – Buffers can be used to minimise polluted storm water runoff entering receiving environments such as Southern River and Canning River. Also, buffer strips can be used around constructed wetlands and other storm water treatment infrastructure to reduce the frequency of maintenance due to sediments and litter.

• *Bioretention System* – Bioretention systems include rain gardens and retention basins. Main purpose of constructing rain gardens is to uptake the excessive nutrients in storm water runoff which will then be used for growth of vegetation.

• *Vegetated Swales* – Swales can be constructed either sides of roads as road reserves to minimise runoff from major roads. Vegetated swales are effective in sites where the longitudinal slopes are steeper.

• *Porous Pavements* – Porous pavements are similar to vegetated swales. City of Gosnells Council can implement these porous pavements in low traffic areas such as car parks and driveways.

• *Wetlands* – The City consists of several constructed and natural wetlands. However, the management and maintenance of wetlands are not properly carried out by the City of Gosnells. Regular maintenance of wetland is required to avoid the growth of unnecessary aquatic plants.

B. Non-structural Controls

Lack of community awareness of the importance of storm water quality is an issue which can be solved by introducing education campaigns. The following education campaigns can be commenced in local councils.

• *Fertiliser Wise Program* - City of Armadale in Western Australia has started this program in order to reduce the amount of fertiliser in storm water runoff. It is aimed to reduce fertiliser application in residential gardening. It also suggests the growth of native plants and type of fertiliser to be used for each soil type. This will also prepare community to adjust to decreased water usage due to climate change.

• *Green Gardening Program* - The residents can be educated about alternative landscaping techniques which reduce the use of fertiliser. City councils can initiate the program by providing free gardening classes and donating plants for residents in the houses closer to waterways and surface water bodies, as they would have a significant impact on storm water quality compared to other residents.

• *Business Education Campaign* - The purpose of this campaign is to educate the industrial and commercial sectors. This is very useful as Cities contain larger proportion of industrial and commercial lands. The campaign can be targeted to ensure the business organisations comply with the existing storm water management guidelines.

C. Management Controls

• *Maintenance & Cost* –Maintenance of roads, street sweeping, litter collection and maintenance of storm water network is essential in improving the storm water quality. The maintenance of vegetated swales, buffers and rain gardens include watering them during dry periods, gross pollutant removal, weed control and litter removal. The cost of maintenance can be reduced by using native plants in vegetated swales, buffer strips and rain gardens which require less attention and fertiliser. Reduction of maintenance can be achieved by using biodegradable erosion control matting in swales.

• *Managing information* - The absence of a database is an issue when considering the storm water treatment measures. A master database consisting locations, capacities, design drawings, dimensions and other technical information about the City's structural storm water management as well as the other useful information for the staff should be compiled for the use within the Council.

• *Water quality monitoring* - Water quality monitoring in different locations incorporating all the land use types within the city councils is important in understanding the water quality issues.

D. Adoption to Climate Change

As climate change affects the water quality changes and deterioration of water quality, climate change is one of the key areas to be considered. Climate change assessments should be carried out to identify the impacts of climate change on storm water quality and necessary management and adaptation processes should be started. Not only quality aspects, quantitative changes of storm water should be taken into account. Assessments of the impacts of climate change on storm water are important on basin level and local council level. Local city councils should also upgrade their drainage structures to adopt rainfall variations due to climate change.

VI. Summary, Conclusions and Recommendations

A. Conclusion

Storm water runoff quality is an important aspect of natural water cycle. The main factor affecting the storm water quality as identified during this study is land use types. The main issues identified from interviews conducted with local councils, are lack of understanding of the community regarding the storm water quality, maintenance and cost of maintenance of existing storm water structure and lack of communication among different management sections in councils.

The decision making tool will assist local council officers to determine whether or not the inspection site needs storm water management actions to improve the storm water quality and to determine the impact level. The storm water improvement strategies suggested in this study includes non- structural, structural and management controls. It is identified through the literature review that non-structural and management controls contribute to larger improvements in storm water quality.

B. Recommendations

It is discovered from the study that the impacts on storm water quality are mainly due to nutrients and heavy metals. Therefore, it is essential to manage the release of these nutrients and heavy metal concentrations. Public education campaigns can be utilised to control the fertiliser usage as discussed.

The drains need regular maintenance and attention in order to prevent the pollution in receiving water environments. The gross pollutants should be trapped prior to discharging into receiving water environments. It is also recommended to identify gross pollutant hotspots prior to the installations of GPTs. The community involvement in the identification process is very useful and cost effective.

The lack of maintenance of structural controls in local councils indicates the lack of understanding of the importance of storm water management within the Council itself. Therefore, staff in the Council should be educated regarding the impacts of poor quality of storm water runoff. Also, preparing a maintenance plans with detailed maintenance steps will assist in achieving the best possible outcome from above mentioned education programs.

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