INTRODUCTION

This edition of the Rules of the Washtenaw County Drain Commissioner continues a storm water management philosophy that considers stream channel protection and stormwater quality management in addition to flood control. These revisions are based upon the most current body of knowledge concerning stormwater management from across the state and country, modified as appropriate for application in Washtenaw County.

The following discussion outlines basic ideas and principals of stormwater management, and provides a conceptual foundation for the design standards contained in this document.

IMPACTS OF DEVELOPMENT ON WATER QUANTITY

The hydrology of a watershed changes immediately in response to site clearing and development of the natural landscape. A site's existing storm water storage capacity is quickly lost as vegetation is removed, natural depressions are graded and both topsoil and wetlands are eliminated. As the soil is compacted and resurfaced with impervious materials, rainfall can no longer penetrate into the ground and so runs off of the land. These modifications, along with the installation of "efficient" drainage facilities, such as catch basins and pipes, greatly alter natural drainage patterns. Hydrological changes will eventually cause changes in stream morphology.

Changes in Watershed Hydrology

- Volume of runoff increases. This raises the magnitude and frequency of severe flood events.
- Frequency of bankfull floods increases. These floods fill the stream channel to the top of its banks, but do not spill over into the floodplain. Increased bankfull flooding subjects the stream channel to continual disturbance and scour.
- Flow velocities increase. This is due to the combined effect of greater discharge, rapid time of concentration, and smoother hydraulic surfaces.
- Stream flow fluctuations increase dramatically. As runoff is concentrated into sharper, faster and higher peaks, equally abrupt returns to pre-storm level discharges will follow. Increased flow fluctuations disrupt habitats and reduce the diversity of aquatic species regardless of water quality.
- Infiltration into the underlying water table is reduced. This in turn lowers the level of surface waterbodies that are dependent on groundwater to maintain base flows during dry periods.

Changes in Stream Morphology

- Channel widening and downcutting are the primary consequences of increased runoff and flow fluctuations.
- Streambank erosion is accelerated, as channels are severely disturbed by undercutting, tree-falls and bank slumping.
- Sediment loads increase sharply due to streambank erosion and construction site runoff. These sediments settle out and form shifting bars that often accelerate the erosion process by deflecting runoff into sensitive bank areas.

- Increased sedimentation and channel widening modify aquatic habitats. Pools and riffles are eliminated as the gradient of the stream adjusts to accommodate frequent floods. Sediment deposition destroys insect and benthic organism habitat as well as fish spawning areas.

IMPACTS OF DEVELOPMENT ON WATER QUALITY

As development occurs, changes in land use contribute new or additional pollutants to storm-water runoff. In addition, the accompanying impervious surfaces provide efficient delivery of these pollutants into receiving waterways. Leaves, litter, animal droppings, exposed soil from construction sites, fertilizer and pesticides are all washed off of the land. Vehicles and deteriorating urban surfaces deposit trace metals, oil, and grease onto streets and parking lots. These and other toxic substances are carried by storm water and conveyed through creeks, ditches and storm drains into our rivers and lakes. The major categories of pollutants and their specific impacts are included within Appendix B.

In short, the ecology of urban streams may be completely re-shaped by the extreme shifts in hydrology, morphology and water quality that can accompany the development process. The stresses that these changes place on the aquatic community, although gradual and often not immediately visible, are profound: Michigan Department of Environmental Quality (MDEQ) has identified streams in the urban and urbanizing portions of the County as requiring special initiatives to restore degraded habitats, and to improve water quality.

To mitigate stream impacts, it is necessary to reevaluate the way that stormwater and land development are managed. The following discussion provides a framework for this reevaluation, which must encompass the entire development process from land use planning and zoning to site design and construction.

FRAMEWORK FOR THE DESIGN OF STORM WATER MANAGEMENT SYSTEMS

Note: The Rules of the Washtenaw County Drain Commissioner govern only the design of storm water management systems within certain new development projects; the following discussion applies to all aspects of managing land and storm water.

Thoughtful site planning can substantially reduce environmental impacts associated with development. Towards this end, communities, regulatory agencies, and designers must begin to evaluate the impact of each individual development project over the long term, and on a watershed scale. Such an approach requires consideration of Best Management Practices (BMPs) that function together as a system to ensure that the volume, rate, timing and pollutant load of runoff remains similar to that which occurred under natural conditions. This can be achieved through a coordinated network of structural and nonstructural methods, designed to provide both source and site control. In such a system, each BMP by itself may not provide major benefits, but becomes very effective when combined with others.

Source Controls

Source controls reduce the volume of runoff generated on-site, and eliminate initial opportunities for pollutants to enter the drainage system. By working to prevent problems, source controls are the best option for controlling storm water, and include the following key practices:

- Preservation of existing natural features that perform storm water management functions, such as depressions, wetlands, and woodland and vegetative buffers along streambanks.

- The minimization of impervious surface area through site planning that makes efficient use of paved, developed areas and maximizes open space. Encouraging flexible street and parking standards, and the use of permeable ground cover materials can also reduce impervious surfaces.
- Direction of storm water discharges to open grassed areas such as swales and lawns rather than allowing stormwater to run off from impervious areas directly into the storm water conveyance system.
- Careful design and installation of erosion control mechanisms and rigorous maintenance throughout the construction period. Effective erosion control measures include minimizing the area and length of time that a site is cleared and graded, and the immediate vegetative stabilization of disturbed areas.

Site Controls

Site controls are the subject of this document. After the implementation of source controls, site controls are then required to convey, pre-treat, and treat (e.g., detain, retain or infiltrate) the storm water runoff generated by development. The range of engineering and design techniques available to achieve these objectives is to some degree dictated by site configuration, soil type, and the receiving waterway. For example, flat or extremely steep topography may preclude the use of grassed swales, which are otherwise preferable to curb and gutter systems. Likewise, sites upstream of cold-water fisheries may not be suitable for permanent wet ponds that discharge heated surface waters. But while each site will be unique, some universal guidelines for controlling storm water quality and quantity can be stated.

Preferred Hierarchy of Structural Site Controls

1) In general, the most effective storm water quality controls are infiltration practices, which reduce both the runoff peak and volume. But to date, structural infiltration devices such as basins and, to a lesser degree, trenches have suffered extremely high failure rates due to clogging. Therefore, an aggressive maintenance program and extensive upstream pre-treatment measures, such as oil/grit separators, sedimentation basins and grass filter strips, must be incorporated into any storm water management system that employs these devices. In addition, these practices are only feasible for smaller drainage areas with suitable soils and no potential for groundwater contamination.

2) The next most effective storm water site controls reduce the runoff peak, and involve storage facilities such as retention and detention ponds. In the selection of an appropriate storm water pond design, wet ponds and extended detention ponds are generally preferable to dry detention ponds, since they hold storm water much longer, allowing more particulate matter to settle out. In addition, the aquatic plants and algae within wet ponds take up soluble pollutants (nutrients) from the water column. These nutrients are then transformed into plant materials that settle to the pond floor, decay, and are consumed by bacteria. Since this biological process is dependent upon the presence of water, it does not occur in dry ponds.

3) Where site conditions make the use of a wet pond infeasible, dry ponds should be designed to provide extended detention of storm water, again to promote as much settling of particulate matter as possible. A notable exception to this preference exists within areas where thermal impacts are a concern. Since they hold storm water longer, wet and extended detention ponds tend to increase the exposure of runoff to solar warming before releasing it. Where thermal impacts are of primary concern, a balance must be struck

between the goals of pollutant removal and the reduction of thermal impacts. Source controls and infiltration of storm water, where feasible, are preferable approaches.

4) Once all possible methods of reducing and treating storm water on-site have been implemented, excess runoff must be discharged into conveyance systems and carried off-site. Discharges must be at rates, velocities and volumes that will not cause adverse downstream impacts to land or waterways. For this purpose, vegetated swales with check dams are generally preferred to curb and gutter systems and enclosed storm drains.

5) Regardless of the design, any storm water system will lose effectiveness without regular maintenance. Depending on the specific BMP, maintenance must be performed at regular intervals. This may include inspection, sediment removal, maintenance of vegetation and structures, replacement of filters, et cetera. Maintenance plans should be developed concurrent with the system designs. The design must include adequate maintenance access.

Pond Design

1) Storm water must be pre-treated prior to entering a retention or detention pond, by passing first through a sediment forebay. Sediment forebays function to reduce incoming water velocities, and to trap and localize incoming sediments, making their removal easier during maintenance. Sediment forebays also extend the flow path of storm water, increasing its residence time. Infiltration systems require more extensive pre-treatment, including grassed channels, grassed filter strips, filter fabric and/or other methods.

2) Whereas detention basin design for flood control is concerned with relatively infrequent, severe runoff events, such as the 25-, 50- or 100-year storm, design for water quality benefit is concerned with controlling the more frequent storm events (e.g. 1.5-year storm or less). The negative impacts of erosive "bankfull" floods are effectively avoided by capturing and detaining the 1.5-year storm.

3) Also of primary importance to water quality is the capture and treatment of the "first flush", a term used to describe the initial washing action that stormwater has on impervious surfaces. Pollutants that have accumulated on these surfaces are flushed clean by the early stages of runoff, which then carries a shock loading of these pollutants into receiving waterways. The majority of all pollutants that are washed off the land can be removed from storm water before it leaves the site by capturing and treating the first 1/2-inch of runoff.

4) Treatment of the "bankfull" flood and "first flush" may be accomplished via the design of "dual detention basins". These basins control storm water discharge rates for both extreme events to prevent flooding and more frequent runoff events to mitigate water quality impacts and channel erosion.

THE ROLE OF THE WASHTENAW COUNTY DRAIN COMMISSIONER

The preferred hierarchy discussed above and summarized in Table 1 provides a comprehensive framework for evaluating the place and function of individual BMPs within a storm water management system. While the most important BMPs are source controls that preserve and protect the natural environment, the Washtenaw County Drain Commissioner cannot mandate these. We must look to the staff and officials of local governments, as well as to developers and their design engineers and planners, to implement source reduction approaches described earlier.

The Office of the Drain Commissioner exercises authority over the design and construction of structural facilities that convey and treat storm water runoff that will be generated from a site as a result of its design. The Drain Commissioner's Rules will govern the design of such management facilities with the following objectives:

- Incorporate design standards that control both water quantity and quality
- Encourage innovative storm water management practices that meet the criteria contained within these rules
- Ensure future maintenance of facilities by planning for it as a part of system design
- Make the safety of facilities a priority
- Strengthen the protection of natural features
- Encourage more effective soil erosion and sedimentation control measures

Table 1. Hierarchy of Preferred Best Management Practices

Non-Structural (Source) Controls

1) Preservation of the natural environment
2) Minimization of impervious surfaces
3) Use of vegetated swales and natural storage

Structural (Site) Controls

1) Infiltration of runoff on-site (trenches, etc.)
2) Storm water retention ponds
3) Storm water detention structures
4) Conveyance off-site
5) Proper maintenance