THE ROUGE RIVER PROJECT
A WORLD CLASS EFFORT
BRINGING OUR RIVER BACK TO LIFE

Rouge River National Wet Weather Demonstration Project

Wayne County, Michigan

TECHNICAL MEMORANDUM
Pilot Structural Best Management Practice Site Selection and Assessment

RPO-NPS-TM-31.00

December 1994

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MISSION STATEMENT

The mission of the Rouge River National Wet Weather Demonstration Program is to restore the water quality in the Rouge River as necessary to:

- provide a safe and healthy environment for ourselves and future generations,
- protect downriver water resources such as the Detroit River and Lake Erie, and
- re-establish a healthy and diverse ecosystem within the Rouge River Watershed.

This will be accomplished through the development, implementation, and financial integration of a technical, social, and institutional framework leading to cost efficient, and innovative, watershed based solutions to control the wet weather problems in the Rouge River Watershed.

PREFACE

The Rouge River has historically suffered and continues to suffer from the combined stress of pollutant loadings from various sources. The vast majority of continuous point sources have been eliminated through the issuance and enforcement of National Pollutant Discharge Elimination System (NPDES) permits for municipal and industrial dischargers. Yet, as established in the Rouge River Remedial Action Plan (RAP), the river remains polluted primarily because of sources associated with wet weather flow.

The Rouge River National Wet Weather Demonstration Project (Rouge Project) is intended to evaluate each of the various sources of wet weather pollution; implement alternative remedial measures; investigate wet weather waste load allocations; establish associated pollutant load reductions; examine the financial and institutional impediments to wet weather pollution control; and recommend a plan and procedure for watershed-wide pollution control which is "implementable" in the Rouge and can be readily transferred to similar urban watersheds throughout the country.

The effort is not being conducted in isolation. The Rouge RAP provides a baseline from which Rouge Project efforts have begun. In fact, the Rouge Project can be viewed as the key component of the initial implementation of the RAP. In addition, ongoing regulatory efforts aimed at controlling Combined Sewer Overflow (CSO) discharge have also been integrated into the Rouge Project and all construction facilities will be in accordance to NPDES permits.

It is widely recognized, and reinforced by RAP recommendations, that CSO control by itself will not be sufficient to restore water quality to acceptable levels in the Rouge River and other similar urban rivers. The project has established a watershed-wide concept as its focus. Within the Rouge River Watershed, a range of pollution sources have been identified. They include: traditional urban runoff, illicit connections to drainage facilities, abandoned dumps within the river flood plain, wet fall and dry fall air deposition, and contaminated sediments within the river channel and impounded lakes.

The Rouge Project has incorporated efforts to develop analysis tools, organize existing and future data, conduct field surveys, collect and analyze water quality samples, develop and implement water quality models, design and test structural and nonstructural best management practices (BMPs), and establish loadings from nontraditional wet weather sources. Additionally, it includes components that will involve watershed residents in pollution control planning, and will study the institutional structure and financial capabilities of those entities responsible for long term implementation of the recommended watershed plan.

To efficiently manage an effort with diverse objectives, the project has been divided into ten program elements. Each of these has a specifically defined technical or operational purpose. Within each of these elements, work plans are developed to define specific activities to be performed as part of the project. These work plans define the Tasks and level of effort.

The program elements that have been established are as follows:

Geographic Information System (GIS) and Mapping
Data Collection and Management
Sampling and Analytical Program
Modeling and Decision Support System (DSS)
Nonpoint Source (NPS) Pollution Control
Combined Sewer Overflow (CSO) Design, Build and Test
Value Engineering
Public Information and Involvement
Financial and Institutional
Project Management, Coordination and Reporting

This document has been generated as a task product under 319 Grant Work Plans 2A and 2B of the Nonpoint Source (NPS) Pollution Control Work Element. Its purpose is to summarize the process used to select the pilot structural control best management practices (BMPs) and locations, and to present a preliminary assessment of the BMP types and locations selected.

This memorandum highlights many of the difficulties experienced in selecting and implementing pilot structural control BMP projects within the Rouge River Watershed. As a result of these implementation difficulties, including necessary county/owner agreements, the sites recommended in this memorandum are tentative and subject to change.

ABSTRACT

The technical memorandum titled "Pilot Structural Best Management Practice Site Selection and Assessment" (RPO-NPS-TM31), summarizes the methodology used to select and recommend nine pilot structural control best management practice (BMP) demonstration projects. The primary authors of this memorandum include Mr. Richard A. Wagner, Mr. James A. Wineka, and Ms. Kelly A. Cave.

Construction of these projects will be funded by the Rouge River National Wet Weather Demonstration Project. Coordination and preparation of this memorandum has been funded under a Clean Water Act Section 319 grant received from the Environmental Protection Agency by Wayne County. The overall effort is being coordinated by the Michigan Department of Natural Resources and the Wayne County Rouge Program Office.

Conclusions and recommendations of the nonpoint source technical peer review conference (TPRC) are summarized in this memorandum. TPRC attendee's considered the study of the following BMP types to be the most desirable: extended detention ponds, dry detention ponds, wet detention ponds, media filtration devices, swales, and oil / water separators.

A detailed evaluation of Rouge River Watershed structural BMP types is presented for three categories of BMP types including: existing detention ponds, existing detention pond retrofits, and innovative structural BMPs (e.g., swales, media filtration, oil/water separators, multi chamber treatment train). For existing detention ponds, typical design criteria for ponds in the Rouge River Watershed is documented. An analysis of retrofit detention ponds has resulted in the development of several alternative methods of retrofitting which are presented in this memorandum. For innovative BMPs, nonpoint source literature data on each innovative BMP is summarized.

The following nine BMP types are recommended for pilot demonstration projects within the Rouge River Watershed:

- Extended Dry Detention Pond - Existing (DPE-ED)
- Wet Detention Pond - Existing (DPE-W)
- Dry Detention Pond Retrofit - Retrofit to Extended Detention (DPR-ED)
- Dry Detention Pond Retrofit - Retrofit with Outlet Polishing Device (DPR-OPD)
- Swale - Constructed Swale Evaluation (SE)
- Sand Filter Evaluation (SFE)
- On-Line Media Filter (OLMF)
- Multi Chamber Treatment Train (MCTT)
- First Flush Sedimentation Pond (FFSP)

ABSTRACT (cont.)

Potential sites for implementation of these recommended BMP types were identified through inspection of aerial mapping, field reconnaissance, and coordination with local jurisdictions, regulatory agencies, and consultants. The sites were then evaluated using site selection criteria and ranking procedures that were developed based on techniques reported by the Environmental Protection Agency (EPA). Recommended locations for each of the nine pilot structural BMP types are as follows:

- Cedar Lake Village: Extended Dry Detention Pond - Existing (DPE-ED)
- Novi School Detention Pond: Wet Detention Pond - Existing (DPE-W)
- Metro West Detention Pond: Dry Detention Pond Retrofit - Retrofit to Extended Detention (DPR-ED)
- Maple Hill Detention Pond: Dry Detention Pond Retrofit - Retrofit with Outlet Polishing Device (DPR-OPD)
- I-696 / Minnow Pond Drain: Swale - Constructed Swale Evaluation (SE)
- Ford Motor Company: Sand Filter Evaluation (SFE)
- Westland DPW Yard: On-Line Media Filter (OLMF)
- SUNOCO Gas Station: Multi Chamber Treatment Train (MCTT)
- Novi Sedimentation Basin: First Flush Sedimentation Pond (FFSP)

These nine recommended sites are subject to revision, based on the status of county/owner agreements required for implementation. If agreements cannot be obtained at one or more of the recommended sites, then alternative sites will be selected, using the same criteria discussed earlier.

Implementation issues associated with each of the nine pilot BMPs is highlighted in this memorandum and include factors such as construction requirements; installation, operation and maintenance of monitoring equipment; operations and maintenance of the structural BMPs themselves; and a summary of the capital and operations and maintenance costs associated with each BMP.

A preliminary assessment of hydraulic conditions at each of the nine sites is presented. For detention ponds, the assessment quantified the range of expected water depths, inflows, outflows, and tailwater conditions for a range of storm sizes, under <u>existing</u> pond conditions. The analysis of swales revealed the range of expected swale inflows, velocities, and design widths required to limit flow depths to optimal levels. For the media filters and the first flush sedimentation pond, peak flows were evaluated and summarized.

Each of the nine recommended BMP demonstration sites was also evaluated to establish a preliminary estimate of pollutant removal efficiencies for the site. These estimates are based on monitoring data collected and analyzed in local and national nonpoint pollution studies.

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1.0 INTRODUCTION

1.1 BACKGROUND. A Nonpoint Source (NPS) Technical Peer Review Conference (TPRC) was held on Wednesday, March 24, 1993, at the Rouge Program Office (RPO). Organizations represented at the TPRC included Wayne County, the RPO, the Southeast Michigan Council of Governments (SEMCOG) the U.S. Environmental Protection Agency (EPA), the Michigan Department of Natural Resources (MDNR). In addition, recognized NPS urban runoff experts Gail Boyd, Jack Hartigan, Dr. Wayne Huber, Dr. Jerry Keeler, Michael Terstriep, Dr. Don Tilton, Dr. Larry Roesner and Ben Urbonas participated in the TPRC. The meeting was chaired by Dr. Roesner, Technical Director for the Rouge Program Office (RPO).

One of the meeting objectives was to provide direction such that the Rouge River National Wet Weather Demonstration Project (Rouge Project) monies would be used to further the science and technology associated with nonpoint source pollution control while avoiding duplicate efforts and/or academic exercises. Peer review members were asked to determine which structural control Best Management Practice (BMP) demonstration types being implemented under the NPS structural control Work Plan 2, would be the most appropriate for meeting the goals and objectives of the NPS structural control demonstrations, which are as follows:

- Evaluate innovative and traditional structural control technologies and assess their water quality effectiveness and applicability in this geographic region.
- Refine current design data for structural BMP's and obtain local monitoring data on BMP effectiveness through pilot area demonstration projects.
- Obtain cost/benefit information on existing facility retrofits to improve pollutant removal efficiencies.
- Prorate water quality benefits watershedwide for various structural control BMP implementation scenarios.
- Document operations and maintenance requirements including costs for existing, retrofitted, and innovative structural BMP types.
- Summarize demonstration results in technical documents for distribution throughout Michigan and nationwide.
- Develop a Southeast Michigan Structural Control BMP guidance manual which meets the water quality objectives of the Rouge Project.

Table 1.1 lists the structural BMPs that were considered at the TPRC. The BMPs listed in the table are separated into two groups: traditional structural control BMPs, and innovative structural control BMPs. The traditional BMPs are the most commonly implemented BMPs, and performance of these BMPs for water quality control is documented to varying degrees in the current literature. In contrast, the innovative BMPs are relatively new and/or not widely implemented, resulting in little water quality performance documentation in the nonpoint source literature.

Upon review of the BMP list, the TPRC attendees indicated that the following BMPs were considered to be most desirable for demonstration projects:

- **Extended detention dry ponds.** Detention ponds are generally required for new developments in the watershed. However, many storm water ponds in the Rouge River Watershed are designed for peak flow attenuation only, with no consideration of detention for water quality control. Therefore, the retrofit of an existing dry detention basin, in order to enhance pollution removal, would be informative. The influent and effluent of the demonstration could be monitored to assess the effectiveness of the pond in terms of pollutant removal efficiency. Water quality and cost data from the retrofit site could be extrapolated to evaluate the potential costs and pollution loading reductions associated with watershed-wide retrofitting.

  Potential detention pond retrofitting may include the modification of pond outlet structures to provide different residence times, and modifications to incorporate the use of filter media as a storm water polishing device. Attendees at the TPRC discouraged the use of geotextile filter media, because of its tendency to plug frequently. Several suggested media types included hay bales, activated carbon, sand, and oil absorbent materials.

  Maintenance was identified as a problem with extended detention ponds, and it was suggested that maintenance schedules be varied and compared with operating costs and water quality effectiveness to achieve a series of cost benefit relationships for decision making purposes.

- **Wet detention ponds**. Though TPRC attendees agreed that considerable pollutant removal efficiency data exist for conventional pollutants removed by wet detention ponds during wet weather events, there was disagreement about the quality of the data and its suitability for the Rouge River Watershed. Therefore, the monitoring of several existing wet detention ponds within the watershed was recommended, to better quantify existing long-term pollutant removal efficiencies and to investigate the suitability of existing prevalent design criteria.

Table 1.1
Structural BMPs Considered by the Technical Peer Review Conference

Traditional Structural BMPs	**Innovative Structural BMPs**
Wet Detention Ponds	Inlet Filters
Extended Dry Detention Ponds	Oil and Sediment Treatment Chambers
Porous Pavement	Yard Debris Compost
Infiltration Ponds and Trenches	Alum Injection
Vegetated Swales and Filter Strips	Duckweed in Ponds
Media Filtration	Sand Filter System Enhanced with Peat Moss
Oil/Water Separators	Detention Pond Retrofits
Miscellaneous Soil Erosion Controls	First Flush Diversion Structures
	First Flush Detention Tanks
	Detention Pond Water Reuse
	Treatment Trains (i.e., BMPs in series)

- **Media Filtration.** Media filtration was identified as a new, innovative, untested, technology that needs further analysis, especially in terms of operation and maintenance requirements and potential applications. Media types such as hay bales, activated carbon, sand, and oil-absorbent materials were discussed. Media filtration could be implemented as an "outlet" filtering device, or as an "on-line" filtering device located in standard storm sewer catch basins or manholes. In the second scenario, the filter media could be placed in a basket and dropped into the manhole for filtration until it becomes clogged and requires maintenance. TPRC attendees placed emphasis on documenting operations and maintenance requirements (including the potential for flooding) of these treatment controls as well as identifying new innovative media types. Potential applications include gas stations, detention pond outlet structures, commercial facilities, and other areas where excessive erosion and siltation is not expected to prematurely clog the filter.
- **Swales.** There is potential for swale retrofits within the Rouge River Watershed in new residential subdivisions and existing State and County road drainage facilities. Problems with swales in residential subdivisions - typically due to maintenance, size requirements, and public relations - were discussed. The TPRC attendees concluded that swale retrofits are more applicable in the Rouge River Watershed in existing right-of-ways where swales currently exist but may not have been designed for quality control. It was agreed that a swale retrofit could be constructed and monitored to gather valuable information regarding pollutant removal efficiencies, implementability, operations and maintenance requirements, and basinwide cost effectiveness.

- **Oil/Water Separators.** The pollutant removal efficiency of oil/water separators treating storm water runoff is not well-documented. The general recommendation of the attendees was to install a separator in a truck stop or gas station parking lot. The pollutant removal effectiveness and operations and maintenance requirements of the separator could then be monitored and documented. Other potential locations are large commercial parking facilities, but concerns were raised about excessive runoff volumes. Problems related to mixing and inadequate hydraulic surface loading rates were discussed and should be evaluated in the monitoring of the separator.

1.2 SELECTION AND ASSESSMENT OF PILOT AREAS FOR DEMONSTRATION BMPs. Using the TPRC recommendations as a starting point, the NPS team conducted an in-depth evaluation of alternative structural BMPs and potential BMP sites. Each of the recommended BMP types was evaluated for application in the Rouge River Watershed, based on a literature review and storm water ordinance review. Specific sites were then identified and evaluated through field reconnaissance, and interaction with agencies including EPA, MDNR, Wayne County, SEMCOG, RPO, local communities and their consultants. As a result of the evaluation, nine sites were recommended for structural BMP implementation and monitoring.

For each of the nine recommended BMP sites, analyses were conducted to develop preliminary estimates of water quantity, water quality, and cost impacts. The water quantity analysis was designed to determine the range of inflows and outflows that may be encountered at each site, and the potential for any backwater or flooding. The water quality analysis focused on available literature values to estimate the ranges in expected pollutant removal efficiencies for each BMP. The cost analysis established estimates of capital costs and operations and maintenance costs.

This memorandum highlights many of the difficulties experienced in selecting and implementing pilot structural control BMP projects within the Rouge River Watershed. As a result of these implementation difficulties, including necessary county/owner agreements, the nine sites currently recommended are tentative and subject to change.

2.0 STRUCTURAL CONTROL BEST MANAGEMENT PRACTICE TYPES.

The in-depth evaluation of structural BMPs was conducted for three separate categories of BMP types. These include the following:

- Existing detention ponds
- Existing Detention Pond Retrofits
- Innovative structural BMPs (e.g., swales, media filtration, oil/water separators)

For existing detention ponds, local storm water ordinances were reviewed to determine typical design criteria for ponds in the Rouge River Watershed. In addition, inventories were conducted to determine the relative number of dry and wet ponds in the watershed. The analysis of retrofit detention ponds resulted in the development of several alternative methods of retrofitting. For innovative BMPs, nonpoint source literature data and discussions with various agencies were used to determine appropriate methods and conditions for applying the BMPs.

2.1 EXISTING DETENTION PONDS.

The value of monitoring existing detention ponds has been recognized by the Technical Peer Review Conference (TPRC) attendees and by the Nonpoint Source Technical Advisory Group (TAG). Monitoring of existing ponds would provide local information regarding the pollutant removal efficiencies associated with local design criteria. This information would allow the Rouge Program Office (RPO) to verify watershed-wide loading estimates by accounting for the efficiencies of the existing ponds. It would also provide a baseline condition from which benefits of retrofitting can be evaluated.

Regardless of the jurisdiction, existing detention basins within the watershed are generally designed for flood control purposes only. The local storm water detention requirements are generally similar in the jurisdictions within the Rouge River Watershed. Of the three counties that comprise the watershed, Oakland and Washtenaw counties have county-wide detention requirements for new development, and many communities within these counties have adopted even more stringent detention criteria. Wayne County does not have county-wide detention requirements. However, several communities within the county require detention for new development, with detention requirements similar to those of Oakland and Washtenaw Counties. Water quality benefits, if any, cannot be quantified from the limited, available monitoring data.

Dry detention ponds are prevalent within the Rouge River Watershed. These ponds are generally designed to briefly detain the drainage area runoff from a 10-year storm event (approximately 0.8 inches for residential land use), while allowing a peak outflow rate of 0.2 cubic feet per second (cfs) per acre of developed land. The pond design typically includes a low flow channel that enhances the pond drawdown after the storm, thereby preventing ponding and associated maintenance problems.

The dry detention ponds are designed exclusively for water quantity control and no provisions are incorporated for water quality consideration. When three dry detention ponds were monitored in the Southeastern Michigan Council of Governments / Oakland County National Urban Runoff Program, the results indicated that the ponds were ineffective in removing pollutants because of turbulence and short circuiting.

Wet detention ponds in the Rouge River Watershed are generally designed to provide the same water quantity benefits (e.g., peak flow attenuation) as dry detention ponds, but include a permanent pool which may provide some water quality benefits as well. However, permanent pool storage volume, in most cases, was established based on aesthetics rather than specific water quality design criteria. Consequently, the residence time in the permanent pool may not be sufficient to maximize pollutant removal efficiency in the pond.

Regional detention ponds refer to structures that are strategically located to serve a number of individual developments. The regional pond concept has been used on several occasions in the Rouge River Watershed. The City of Novi, a rapidly-developing community, implemented a Storm water Master Plan in 1983 which was based on the regional detention pond concept. Since the master plan was implemented by the City, many regional detention ponds have been constructed within the city.

Although the regional approach to storm water detention was once encouraged in the Rouge River Watershed by local regulatory officials, these facilities are now discouraged. Officials believe that the regional concept results in wetland deterioration, due to storm water sediment loadings. Monitoring data and/or documented qualitative data to substantiate these beliefs are not currently available.

2.2 EXISTING DETENTION POND RETROFITS. Approximately two thousand existing storm water detention ponds are located throughout the Rouge River Watershed. Therefore, there are numerous opportunities for retrofitting these facilities to enhance pollutant removal.

The NPS team has identified a variety of methods that may be used to enhance pollution removal in existing ponds. These methods were identified through literature review, field reconnaissance and discussion with the TAG members. Though specifically designed for the Rouge River Watershed, the identified retrofit methods are believed to be appropriate for urban watersheds throughout the nation. A description of the most promising detention pond retrofit methods is presented below:

- **Addition of outlet polishing device to dry detention pond.** The typical dry detention pond outlet device, which generally is designed to pass 0.2 cfs per acre of developed drainage area during a 10-year storm event, would be modified so that the outflow passes through media which captures outflow pollution loadings via filtration and sorption. Potential media include sand, compost, shredded tires, fiberglass, polyester fabric, and oil absorbents and adsorbents. The media would be contained in a structure that receives the outflow from the existing dry pond. This structure would be designed hydraulically to pass the peak outflow from the existing basin, and would include an overflow bypass to convey the flow if the normal hydraulic routing is disrupted due to media clogging. The structure containing the media could be divided into several parallel test cells, each containing a different type of media. By splitting the pond outflow between the parallel test cells, the storm water pollutant removal efficiencies for each media type could be evaluated simultaneously.

Applicability of this retrofit method in the Rouge River Watershed is substantial, considering the number of existing dry ponds within the watershed. Operations and maintenance requirements for this method may be significant, due to the potential for clogging of the media.

- **Conversion of dry detention pond to wet detention pond, with permanent pool sized to provide an average residence time of 14 days.** This retrofit method would require the excavation of approximately 5 to 6 feet of soil below the elevation of the existing dry pond to create a permanent pool of water that would enhance pollution removal. Within the permanent pool, removal of pollutants will occur through processes which include settling of particulate pollutants, as well as biological breakdown, chemical breakdown, and plant assimilation of soluble pollutants.

  The average residence time of 14 days is based on previous studies, which conclude that the volume of the permanent pool (and the associated average residence time in the pool) affects the pollutant removal efficiency of wet ponds. The average residence time is defined as the permanent pool volume divided by the average annual runoff volume from the pond drainage area. Up to a point, the pollution removal efficiency of a wet pond will increase as the size of the permanent pool (and the associated average residence time) increases. A permanent pool with an average residence time of 14 days, and a length-to-width ratio of between 4 to 1 and 7 to 1, provides nearly optimal pollutant removal efficiency, with additional pool volume providing little additional benefit.

  There may be several constraints which limit the watershed-wide applicability of this retrofit method. In some cases, the boundaries of the existing dry detention pond would have to be enlarged in order to accommodate a permanent pool with a 14-day residence time and a depth of 5 to 6 feet. If additional land is not available, then this retrofit method would not be appropriate. In other cases, the drainage area may not be large enough to provide the stream flow necessary to maintain the permanent pool volume. In addition, soils in the detention pond may not be impermeable, making it difficult to maintain the permanent pool. For these sites, a synthetic liner may be required to prevent leakage and maintain the pool volume.

- **Conversion of dry detention pond to wet detention pond, with permanent pool**

sized according to existing pond limits. This potential retrofit method is similar to the previous method, except that the permanent pool size is limited to the area available at the existing site. Thus, the consideration of additional land requirements is eliminated. However, the size of the pond drainage area and the permeability of the underlying soils are still concerns with respect to maintaining the permanent pool.

- **Conversion of dry detention pond to dry extended detention pond.** This method involves the modification of the dry detention pond outlet device to provide water quality treatment while maintaining the water quantity (i.e., flood control) benefits of the existing pond. Whereas a typical dry pond outlet consists of a single opening at the bottom of the pond, designed to draw down the water level in the pond rapidly after a storm event, the extended dry detention pond outlet would have openings at several different stages. The outlet opening(s) near the bottom of the extended dry detention pond would be designed to draw down the water quality volume over a duration that is considered sufficiently long to achieve effective settling of particulate pollutants under relatively quiescent conditions. The outlet opening for water quantity control is located at the elevation below which the desired water quality volume is stored. The combined outflow from this opening and the low-level opening(s) must meet the storm water management peak flow requirements in the local ordinances.

  The SEMCOG/Oakland County NURP study monitored three dry detention ponds for 10 storm events, and then retrofitted the ponds with gravel outlet filters to provide extended detention. After the retrofitting was completed, however, monitoring was limited due to insufficient rain, and the effects of the extended detention retrofits could not be determined.

  Applicability of this retrofit method in the Rouge River Watershed could be substantial, considering the number of existing dry ponds within the watershed. One potential constraint is that additional storage volume is typically required in the pond due to the incorporation of water quality storage. Northern Virginia Planning District Commission (1979) indicates that the storage required for an extended dry detention pond is 15 to 25 percent greater than for a dry detention pond.

- **Addition of inlet and outlet settling pools to dry detention pond.** This method would include the installation of settling pools at both the inlet and the outlet to the dry detention pond. The inlet settling plunge pool, or forebay, would encourage the settling of relatively large particulate matter, and would also provide erosion control and energy dissipation benefits. The pond outlet structure would be preceded by another settling plunge pool which would provide similar water quality benefits. The plunge pools could be designed with vegetative wetland shelves to enhance removal of dissolved pollutants as well.

  Applicability of this retrofit method in the Rouge River Watershed is substantial, considering the number of existing dry ponds within the watershed. However, the effectiveness of these measures is unknown.

- **Convert dry detention pond to wetland treatment pond.** This retrofit method would involve the modification of a typically well-drained dry detention pond to create areas that are constantly wet. Some excavation and regrading of the existing pond bottom would be required to create one or more wet areas where wetland vegetation could thrive. The wetland areas may enhance pollution removal through processes such as settling and filtration (for particulate pollutants) and plant assimilation for dissolved pollutants. However, plants may take in pollutants during the growing season and release the pollutants during the die-off phase, resulting in little net removal benefit.

  Applicability of this retrofit method in the Rouge River Watershed is substantial, considering the number of existing dry ponds within the watershed. However, the effectiveness of these measures is unknown. One potential constraint is aesthetics, particularly in residential areas where residents are likely to prefer well-kept turf grass to wetland vegetation in detention ponds.

- **Add low flow swale conveyance system to dry detention basin.** This retrofit method would replace the typical dry detention pond low-flow conveyance system (e.g., concrete channel, pipe, open ditch) with a vegetated swale. The swale may enhance pollution removal through the processes of filtration, infiltration, and vegetative uptake. Regular mowing of the swale and proper disposal of the clippings would be required to optimize removal.

  Applicability of this retrofit method in the Rouge River Watershed is substantial, considering the number of existing dry ponds within the watershed. However, the effectiveness of these measures is unknown.

2.3 INNOVATIVE STRUCTURAL BMPS. Structural BMP types that could not be classified as existing detention ponds or retrofits to existing detention ponds, and which are believed to be applicable within the Rouge River Watershed, are included in the Innovative Structural BMP category. In general, the storm water pollutant removal effectiveness of these measures is not well-documented. Therefore, implementation of these measures in the Rouge River Watershed pilot structural BMP study could provide useful information for local and nationwide applications.

The review of these innovative BMPs included such considerations as the interest of various agencies (e.g., EPA, SEMCOG) in applying the methods, and the extent of applicability to the Rouge River Watershed. The results of the review for each innovative BMP are presented below:

- **Swales.** Both the TPRC attendees and the Michigan Department of Transportation

(MDOT) have expressed interest in evaluating the effectiveness of swales. The TPRC attendees recommended the monitoring of a retrofitted swale and one other swale (either existing or constructed as part of the study). Potential retrofit methods would include installation of check dams and establishment of more dense vegetative cover. Both methods would reduce velocities and thereby enhance settling and infiltration. MDOT has worked with the program's NPS team to identify pilot BMP sites, as will be discussed later in this memorandum. In addition to swale pollutant removal efficiencies, MDOT is interested in developing a database of local highway runoff event mean concentration (EMC) data. Presently, MDOT uses highway runoff EMC data from other states to estimate highway runoff pollutant loadings, and would like to establish a local EMC database for use in several Municipal National Pollutant Discharge Eliminating System permit applications throughout Michigan. The program's NPS team could also use this local highway runoff EMC data in estimating existing and future Rouge River Watershed NPS loadings.

Useful information associated with a pilot BMP analysis of swales would include pollutant removal efficiency, operations and maintenance requirements, capital costs, and operations and maintenance costs. Results from the pilot BMP analyses could be used to develop estimates of the costs and benefits that would be associated with watershed-wide implementation of swales in the Rouge River Watershed. The monitoring of the swales may be complicated because of the shallow flows associated with swales.

Applicability of swales in the Rouge River Watershed is somewhat limited. Swale retrofits are limited to the number of existing swales within the watershed. About 35 miles of existing highway swales have been identified in the watershed, and check dam retrofits would only be appropriate for a small percentage of these swales because of slope and freeboard considerations. Implementation of new swales may be appropriate in areas of new development or re-development.

- **Sand Filters.** Region V of the Environmental Protection Agency recommended a demonstration of sand filter technology in the midwest region as part of the Rouge Project. Sand filters have been successfully implemented in the State of Delaware, and in such cities as Austin, Texas and Seattle, Washington. However, the nonpoint source literature reveals no information regarding sand filter performance in the midwestern United States. A sand filter demonstration project was not recommended by the TPRC.

  Useful information associated with a pilot BMP analysis of sand filters would include the applicability of sand filters to this geographic region, operations and maintenance requirements, pollutant removal efficiency, capital costs, and operation and maintenance costs. Results from the sand filter analysis could be used to develop estimates of the costs and benefits that would be associated with the watershed-wide implementation of sand filters in the Rouge River Watershed.

Applicability of sand filters in the watershed is considered to be substantial. Sand filters could be installed in fully-developed areas in which land for more conventional and less expensive BMPs is unavailable. Example locations could include small convenience stores, industrial sites, small tributaries to lakes, and other identified problem areas.

- **On-Line Media Filter.** Evaluation of the on-line media filter, a retrofit for "built-out" areas, was recommended at the TPRC. Conceptually, this device consists of a filtering mechanism that is installed in existing catch basins or storm sewers. For storm sewers, the TPRC attendees pictured the filter structure as a wire basket, containing filter media, which would be lowered into an existing manhole structure without modification. The storm water would receive treatment by filtering through the media. After further investigation of this preliminary concept, however, the NPS team found that an existing manhole without retrofit and modification would probably not work. Since an overflow bypass would have to be installed to prevent flooding when the filter media becomes plugged, an engineered structure would have to house the proposed filter media.

  Useful information associated with a pilot BMP analysis of on-line media filters would include appropriate design criteria, the design of the structure (including flood flow bypass when the filter media is clogged), operations and maintenance requirements, pollutant removal efficiency, capital costs, and operation and maintenance costs. Results from the on-line filter analysis could be used to develop estimates of the costs and benefits that would be associated with the watershed-wide implementation of the filters in the Rouge River Watershed.

  Determination of pollutant removal in the filter may be complicated, depending upon whether or not the inflow and outflow to the filter media are concentrated in a specific area. For example, if the media filter is installed within a catch basin, it will be difficult to estimate the inflow loading, and it may be difficult to isolate the outflow from the filter.
  Applicability of on-line media filters in the watershed would be limited to developed areas with storm sewers, although the technology could be recommended or required for new development as well. Example locations could include parking lots, shopping centers, industrial sites, and other identified problem areas.

- **First Flush Sedimentation Pond.** As discussed in *Section 2.1*, regional detention ponds are presently discouraged in the Rouge River Watershed, due to perceptions that excessive sedimentation in the areas immediately upstream of the basins results in adverse wetland impacts. Based on these concerns, the Michigan Department of Natural Resource's Land and Water Management Division has required the implementation of a First Flush Sedimentation Pond at the downstream end of a 53"x 34" pipe that discharges into a proposed regional pond in the City of Novi (headwaters of the Middle Rouge River). The tributary area to this sediment pond is approximately

90 acres of zoned residential land use (which is currently about 70 percent developed) and 3 acres of major roadway currently under construction.

The sedimentation pond has been designed to capture the first flush of runoff over the impervious upstream tributary area, and diverts flow volumes in excess of the first flush volume to a bypass structure. This bypass structure prevents scouring and resuspension of collected sediments in the sediment basin. A forebay and underdrain system is also provided to enhance sedimentation.

Useful information associated with the analysis of a first flush sediment pond such as the one proposed for the City of Novi would include sediment deposition rates, operations and maintenance requirements, pollutant removal efficiency, capital costs, and operation and maintenance costs. A detailed analysis could be performed to establish guidelines in preventing sedimentation and disruption of existing wetland systems downstream from construction activities. Information obtained could be used as the basis for a comprehensive Rouge River Watershed soil erosion and sedimentation program similar to that implemented in the State of Maryland.

Application of the first flush sedimentation pond in the Rouge River Watershed would be possible in areas where regional ponds are (or will be) used for water quantity control, and additional localized water quality control is desirable. For new development in which both water quantity and water quality control are desired, a wet pond or an extended detention dry pond may be constructed, and a separate first flush sedimentation pond would not be necessary.

- **Oil/Water Separators.** The peer review conference recommended evaluation of an oil/water separator in the storm water management context. Much information exists on oil/water separators in the industrial processing context, but not as a storm water treatment control. Three types of traditional oil/water separators are available: the coalescing plate interceptor (CPI), the American Petroleum Institute (API) standard design, and the common inverted elbow type spill collector.

  Useful information associated with the analysis of an oil/water separator would include storm water oil/water separator design, operations and maintenance requirements, pollutant removal efficiency, capital costs, and operation and maintenance costs. These data could be used to estimate the costs and benefits of watershed-wide implementation of oil/water separators in the Rouge River Watershed.

  Applicability of oil/water separators in the Rouge River Watershed is substantial, particularly in heavy industrial and commercial areas where hydrocarbons are commonly found in storm water runoff. Potential BMP locations include gas stations, maintenance yards, auto repair centers, and major highways.

- **Multi Chamber Treatment Train.** Preliminary research of the multi chamber treatment train (MCTT) has been conducted by Mr. Robert Pitt of the University of Alabama at Birmingham. Mr. Pitt developed the MCTT in conjunction with a 319 grant from the United States Environmental Protection Agency which is being coordinated by Mr. Richard Field.

  Mr. Pitt's preliminary research has examined the design of an underground multi chambered tank to collect and treat storm water runoff from critical urban areas such as gas stations. The collected runoff is first treated in a catch basin chamber where larger particles are settled out. The water then flows into a main settling chamber containing oil and grease sorbent material where it will undergo a much longer treatment period (20 to 70 hours) to settle finer particles and to control oil residues. In addition to housing the plate or tube settlers, the main settling chamber also contains a fine bubbler diffuser for removal of volatile contaminants. The water is then directed into the second chamber consisting of the sand/peat filter.

  Preliminary results show that the treatment unit is likely providing substantial reductions in storm water toxicants (both in particulate and filtered phases), organics, and suspended solids. Slight increases in turbidity and color and about one unit in pH reduction also occurred during the filtration step. According to Mr. Pitt, the filter unit appears to be responsible for most of the toxicity reductions. However, the main settling chamber also resulted in substantial reductions in the dissolved toxicity fraction, total and dissolved COD, suspended solids, turbidity, and color. The catch basin/grit chamber also showed suspended solids reductions. In summary, the use of the MCTT is seen to be capable of reducing a broad range of storm water pollutants that have been shown to cause substantial receiving water problems

2.4 RECOMMENDED BMP DEMONSTRATION TYPES. Considering the recommendation from the TPRC, and the additional review of BMPs as documented above, the following BMP types are recommended for pilot demonstrations:

- Extended Dry Detention Pond - Existing (DPE-ED)
- Wet Detention Pond - Existing (DPE-W)
- Dry Detention Pond Retrofit - Retrofit to Extended Detention (DPR-ED)
- Dry Detention Pond Retrofit - Retrofit with Outlet Polishing Device (DPR-OPD)
- Swale - Constructed Swale Evaluation (SE)
- Sand Filter Evaluation (SFE)
- On-Line Media Filter (OLMF)
- Multi Chamber Treatment Train (MCTT)
- First Flush Sedimentation Pond (FFSP)

These nine pilot BMP types represent a wide range in water quality control technologies that appear applicable in the Rouge River Watershed. However, as a result of many difficulties experienced in selecting and implementing pilot structural control BMP projects within the Rouge River Watershed, including obtaining the necessary county/owner agreements, the nine sites currently recommended are tentative and subject to change.

Once the final list of BMP types was established, alternative sites for these BMPs were analyzed. This analysis is discussed in the next section of this memorandum.

3.0 BMP SITE SELECTION.

After the structural Best Management Practice (BMP) types were selected, the Nonpoint Source team evaluated alternatives sites within the Rouge River Watershed for implementation of the pilot structural BMPs. Potential sites were identified through inspection of aerial mapping, field reconnaissance, and coordination with local jurisdictions, regulatory agencies, and consultants. The sites were then evaluated using site selection criteria and ranking procedures that were developed based on techniques reported by the Environmental Protection Agency (EPA). Ultimately, specific locations were recommended for nine pilot structural BMPs.

3.1 REVIEW OF EPA URBAN TARGETING AND BMP SELECTION PROCEDURE.

The EPA document "Urban Targeting and BMP Selection" (November 1990) was evaluated for applicability to the Rouge Project's structural control BMP demonstration site selection process. This document provides municipalities, regulatory officials, and watershed managers with a procedure for ranking watersheds according to the desirability of pollution abatement. Because the procedures rank watersheds relative to one another, the results do not imply that areas receiving lower rankings do not require remedial controls. The extent to which controls are required can only be determined by the calculation of loadings to receiving waters, and associated receiving water impacts.

The procedure presented in the EPA document requires the assignment of relative weights of importance to specific watershed factors. These factors may include the following:

- Size of tributary area;
- Current receiving water use (i.e., contact recreation);
- Level of receiving water use;
- Pollutant mass loadings to receiving water; and
- Implementability of pollution management program.

Watersheds are ranked against one another for each of the factors, and the ranks are then weighted by the importance assigned to each factor by the evaluator. The overall weighted sum of ranks for each watershed determines the priority for pollution abatement in the watersheds.

The review of the EPA watershed ranking procedure indicated that the procedure was suited more toward receiving water protection than toward selection of specific BMP sites. Therefore, the EPA ranking methodology was used only as a template for the evaluation of alternative BMP sites in the Rouge River Watershed.

3.2 CRITERIA FOR ROUGE RIVER WATERSHED SITE SELECTION.

Like the EPA procedure, the methodology used for the selection of structural control BMP sites in the Rouge River Watershed identifies specific criteria by which alternative BMP sites may be evaluated. The criteria were established to meet the particular goals and objectives of the BMP site selection task, and are as follows:

- **Applicability throughout Rouge River Watershed.** The chosen BMP demonstration site should be representative of many other sites in the watershed, so that the monitoring results at the site can be considered representative of performance that can be expected on a watershed-wide basis.

- **Characteristics of Tributary Area**. Evaluated characteristics include land use distribution, extent of development, and size of drainage area. Relatively large, fully-developed, single land use tributaries areas were considered the most desirable.

  Single land use tributary areas are desirable because local Event Mean Concentration data for specific land uses can be established, whereas mixed runoff from various land uses precludes the establishment of land use EMCs. The selection of the nine BMP sites attempted to represent the full range of single land use types (e.g., residential, commercial, industrial).

  Fully developed areas are preferred because of potential monitoring problems related to soil erosion in undeveloped areas or construction sites. The potentially high sediment loadings from construction sites would result in pollution loadings that are not typical of the tributary area land use after development is completed and the land is stabilized. However, the site for the first flush sedimentation pond was selected because construction **is** occurring in the tributary area. This analysis is designed specifically to evaluate erosion and sedimentation impacts.

  Relatively large tributary areas are preferred for two reasons. One is that a larger area will generate a greater runoff volume than a smaller area for the same rainfall event, which means that the number of storms producing sufficient runoff for storm water monitoring is likely to be greater for the larger area. The other is that a larger area may provide more representative loading results than a small area, which may have atypical loadings due to some local impacts.

- **Monitoring Considerations.** Evaluated characteristics for potential BMP sites included the number of inflow and outflow points, presence of existing structures for flow monitoring, site accessibility, and safety. Considering the labor and equipment required to monitor multiple inflow and outflow points, sites with few inflow/outflow points were favored over those with several inflow/outflow points. Sites having existing structures, which could be incorporated into the monitoring effort, were also considered desirable. Site accessibility is important because frequent visits to each monitored site will be necessary during the monitoring task. Safety of both the monitoring staff and the public was also considered in the site evaluations. The Michigan Department of Transportation had strict requirements regarding traffic safety for the highway swale demonstration projects, such as clear span requirements for all swale monitoring equipment and for any proposed modifications with an obstruction height of six inches or more. The Rouge Program Office complied entirely with MDOT's concerns and worked with MDOT staff closely in choosing a safe demonstration site which met the goals and objectives of the demonstration project. In addition, detention pond sites that are fenced and away from the activities of children were preferred over sites that were not fenced.

- **Geographical Distribution.** Because the Rouge Project is a cooperative effort that involves several jurisdictions, municipalities, and agencies, demonstration sites should be distributed throughout the Rouge River Watershed to encourage active participation and public involvement from all participants. The demonstration sites also need to be distributed throughout the watershed to facilitate analysis of spatial differences in pollution loadings.

- **Cost.** The cost of constructing structural BMP demonstration projects was an important consideration when ranking potential site locations. Some sites are well suited for construction or retrofitting, whereas others require costly improvements that make the site less desirable.

- **Implementability.** Implementability, or likelihood for successful implementation, was also evaluated during the site selection process. Time constraints were one consideration. At some sites, the time period required to construct and then monitor the BMP would not fit within the project schedule. Site owner cooperation and compliance was also considered. A county/owner agreement is needed from each property owner prior to initiation of any BMP demonstration sampling or construction activity.

  Several residential detention ponds proposed for retrofit and sampling are owned by a subdivision association consisting of many members. It has been the RPOs experience that owners of proposed BMP facility are generally very skeptical in regards to allowing water quality monitoring to occur at their facility. Owners are primarily concerned with the liability associated with RPO monitoring results. In many cases, the owner has requested financial indemnification from Wayne County in regards to potential problems identified by RPO monitoring.

  The RPO has concluded that it is much more difficult to obtain agreements from privately owned sites and associations with multiple membership, and therefore, emphasis was placed on selecting sites owned by municipalities or other single-owners.

3.3 BMP SITE DATA COLLECTION. Once criteria were developed for the site selection screening process, an extensive local coordination and field reconnaissance effort was initiated by the Nonpoint Source team. The goal of this effort was to thoroughly evaluate existing structural BMP sites as well as potential BMP demonstration sites within the watershed. For each site, physical data relating to the evaluation criteria were obtained so that the merits of alternative potential sites could be compared.

Gathering of data through document reviews and field reconnaissance was achieved in cooperation with Wayne County, Oakland County, Washtenaw County, the 48 watershed municipalities, the MDNR, the MDOT, the TAG, Ford Motor Company, and various consultants. The coordination with each of these entities is presented below.

3.3.1 **Wayne, Oakland and Washtenaw Counties.** Staff from the offices of the Drain Commissioner for each county were consulted regarding implementation of detention ponds in the counties. As discussed previously in *Section 2.1*, the results indicated that detention basins within the watershed are generally designed for flood control purposes only, with no consideration of water quality benefits. For each county, several days were spent reviewing detention pond plans and specifications, with follow-up field investigation for those ponds that appeared most suitable with respect to the established evaluation criteria.

3.3.2 **Local Municipalities**. In order to locate and characterize each detention pond within the Middle Rouge subwatershed, the RPO coordinated with the city engineer (or equivalent) of each community in the subwatershed. The engineer was interviewed to obtain information on the number of detention basins, and to coordinate a literature search and plan review of detention basins within that community. The interviews, literature reviews, and plan reviews were performed for the following municipalities:

- Northville Township
- Plymouth Township
- Canton Township
- Garden City (through Westland, McNeely & Lincoln Associates, Inc.)
- City of Northville (through Westland, McNeely & Lincoln Associates, Inc.)
- Livonia
- Dearborn Heights (through Wade Trim & Associates, Inc.)
- Redford Township
- Walled Lake
- Wixom
- Salem Township
- City of Novi (through JCK & Associates, Inc.)
- Novi Township
- City of Plymouth

The RPO located a total of 259 storm water detention ponds in the Middle Rouge 1, Middle Rouge 2, and Middle Rouge 3 subwatersheds, but found that the available information for some of these detention ponds was limited. A comprehensive detention pond inventory matrix was compiled for each city in the Middle Rouge subwatershed. In addition, a detention pond design criteria matrix was developed which summarizes existing detention design criteria in each of the Rouge River Watershed communities. Information included in this matrix includes time to obtain peak storage, maximum storage volume, allowable discharge, free board provided, fencing requirements, soil erosion provisions, maintenance requirements, inflow/outflow structures, and design rainfall intensities. Both the detention pond inventory matrix and the detention pond design criteria matrix are presented in a previous technical memorandum titled "Middle Rouge Detention Basin Inventory" (RPO-NPS-TM27).

As for the counties, data from the municipalities were tabulated to determine which facilities were most desirable with respect to the established selection criteria. Field reconnaissance was then conducted on some of the more promising sites.

3.3.3 Michigan Department of Transportation. The NPS team coordinated with MDOT representatives from the Lansing office (Environmental Section, Design Engineering and Utilities Section, Utilities and Permits Section) and the MDOT Metro Detroit District Office in the discussion and site selection for a highway swale demonstration project. After RPO field personnel received a permit to perform field work within MDOT's right-of-way, field staff initiated an inventory of highway swales located within the Rouge River Watershed. The intent of this highway swale inventory was to evaluate watershed-wide applicability of potential swale retrofits and to identify potential sites for swale demonstration.

Typically, the highways currently served by swales have curb and gutter construction which directs highway runoff into storm water conduits, that convey the runoff into the highway swales. The swales are generally located within the median of the divided highways, and on each side of the two opposing lanes within the existing right-of-way. Thus, a typical stretch of highway treated by swales will have three separate swales that may be retrofit for water quality considerations. Potential retrofit methods include installation of check dams for increased infiltration and erosion control, slope regrading to encourage infiltration, and installation of desirable vegetation for filtration and optimal nutrient uptake.

Once this inventory was performed by RPO field personnel, a list of seven desirable swale sites was tabulated. These sites were then visited by RPO and MDOT staff to determine the relative merits of each site, based on established criteria. Criteria considered for ranking purposes included those previously presented in *Section 3.2*, plus criteria specific to highway swales. The specific criteria included storm water conduit inlet diameter, traffic volume and number of lanes of traffic for the tributary highway, super elevation, existing vegetation, slope, length, and clear span requirements.

After the most desirable site was selected based on the evaluation criteria, the constructability of the demonstration swale was verified in the field with MDOT's construction supervisor. Based on this field investigation, construction of the demonstration swale appeared to be feasible. Details of the selected swale sites are presented in *Appendix A* of this memorandum.

3.3.4 Michigan Department of Natural Resources. Coordination between the RPO and the MDNR occurred through TAG meetings, individual meetings and field investigations. To identify areas with perceived water quality problems, the NPS team reviewed the current MDNR list of water quality complaints within the Rouge River and its tributaries. This helped to identify areas where demonstration BMPs would be desirable to improve water quality. In addition, the NPS team explored the MDNR's concern about the impacts of regional detention basins.

In order to better understand the MDNR's concerns regarding regional detention, and to evaluate the potential of a regional pond demonstration project, several existing regional detention sites were visited by MDNR Land and Water Management (Livonia) representatives and a RPO field engineer. The field investigation revealed that the concerns regarding regional ponds include direct impacts on wetland resources (e.g., construction of dam across an existing stream bed, sedimentation behind the dam in existing wetland areas), and secondary impacts such as loss of habitat, hinderance of fish migration, and thermal impacts.

3.3.5 Technical Advisory Group. Since the RPO was initiated, TAG meetings have been held on either a bi-monthly or monthly basis. TAG members include the EPA, Wayne County, Oakland County, MDNR, SEMCOG, RPO and local communities. The purpose of the TAG meetings is to receive local technical guidance as to the overall direction of the NPS Work Element. TAG members have continually been updated on the overall BMP site selection process and screening methodology.

3.3.6 Ford Motor Company. Numerous meetings were held with Ford Motor Company regarding the installation of a sand filter demonstration BMP at the company's Rouge Plant. After initial coordination with the plant's Environmental Services Division, field work was conducted by Ford and RPO engineers in order to locate the best site within the Rouge facility for construction of the sand filter. Storm sewer maps of the Rouge Plant were reviewed before the field visit, and property maps were reviewed to verify ownership of the selected site. Once a site was chosen a field survey was performed to verify the constructability at the site.

3.3.7 Consultants. Engineering consulting firms were often involved on behalf of communities in the Rouge River Watershed to obtain plans and specifications for sites that appeared to be desirable for the demonstration BMPs. Several meetings were held with the consultants to explain the objectives of the Rouge Project, and to specify the required site information.

3.4 SITE SELECTION MATRIX. After the BMP site data collection effort was completed, the data were summarized in a site selection matrix (see *Table 3.1*), in order to screen potential BMP demonstration sites with respect to the evaluation criteria presented in *Section 3.2*. The matrix includes site data such as the location (e.g., township or city), the county, the subwatershed, the receiving water, the existing facility type, the potential BMP demonstration type, and the tributary area. The matrix also indicates whether or not a plan review or field investigation was completed for the site, and may include miscellaneous comments based on field or plan review. In addition, a relative ranking of the site's demonstration potential, and specific reasons for the ranking, are provided.

Sites were given a relative ranking of high (H), medium (M), or low (L), depending on conformance with the criteria. A site was assigned a ranking of "H" if the site was desirable for most of the criteria. If the site was undesirable for most of the criteria, then it received a rank of "L". Sites ranked as "M" had about an equal number of desirable and undesirable characteristics.

Table 3.1

Table 3.1

Table 3.1

Table 3.1

Table 3.1

3.5 RECOMMENDED PILOT STRUCTURAL BEST MANAGEMENT PRACTICE SITES. The sites that are recommended for demonstration BMPs are presented in *Table 3.2*, and the locations of the sites are shown in *Figure 3-1*. The table summarizes the location of the site (e.g., township or city), the county, the subwatershed, the receiving water, the existing facility type, the potential BMP demonstration type, the tributary area and land use. As shown in the table, the demonstration BMP sites will include two extended dry detention ponds, two wet detention ponds, one dry detention pond with an outlet polishing device, two swales, one sand filter, one on-line media filter and one first flush sedimentation pond. Details regarding each site are presented in *Appendix A* of this memorandum. Considerations for implementation are addressed in *Section 4.0.*

It should be noted that the recommended sites are subject to revision, based on county/owner agreements required to implement the pilot BMPs. If the agreements cannot be reached at one or more of the recommended sites, then alternative sites will be selected, using the same criteria discussed earlier.

Table 3.2

Figure 3-1

4.0 IMPLEMENTATION OF PILOT STRUCTURAL BEST MANAGEMENT PRACTICES.

The implementation of the nine selected pilot structural Best Management Practices (BMPs) will include consideration of factors such as construction requirements; installation, operation and maintenance of monitoring equipment; operations and maintenance of the structural BMPs themselves; and the capital and operations and maintenance costs associated with each BMP. The following sections briefly discuss each of these considerations.

4.1 CONSTRUCTION.

Table 4.1 summarizes the construction requirements for the pilot structural BMP sites. The table shows that some construction will be required at six of the nine sites. No construction is necessary at the Cedar Lake Village and Novi School detention basins since they are existing ponds which will be monitored only. Although construction is necessary for the Novi sedimentation basin, the City of Novi will be responsible for construction and not the RPO.

Construction activities for the Metro West Industrial Park detention pond and the Maple Hill Subdivision detention pond will consist of modifying each of the existing pond's outlet structures and minor regrading. Construction activity at the I-696 / Minnow Pond Drain swale includes constructing a swale, a diversion structure, and installing monitoring flumes at the upstream and downstream end of the swale for water quality sampling. For the sand filter, the on-line media filter, and the multi chamber treatment train (MCTT), full construction of the pilot BMP is required.

4.2 MONITORING AND MODELING.

Considerations in site monitoring and laboratory analysis include sampling location and frequency, sampling methods, field documentation, sample designation, and sample handling and shipping. All of these topics are addressed in detail in the RPO document titled "Field Sampling Plan, Nonpoint Pollution Storm Event Monitoring Program, Nonpoint Pollution Source Program Element, July 1994" (RPO-SAM-FSP11). A summary of site monitoring goals and methods is presented below.

The nonpoint source (NPS) storm event monitoring program is designed to provide field data for computer simulation models such as the Watershed Management Model (WMM), the U.S. Corps of Engineers Storage-Treatment-Overflow-Runoff-Model (STORM), and the Environmental Protection Agency Storm Water Management Model (SWMM). All three models will be applied in the Rouge River Watershed analyses, to simulate runoff quantity and quality associated with wet weather events, and to evaluate various NPS control alternatives.

The RPO storm water modeling methodology is summarized in the RPO technical memorandum titled "The Approach to Simulating the Water Quantity and Quality in the Rouge River" (RPO-MOD-TM26). The WMM is a spreadsheet-based modeling tool that uses event mean concentration (EMC) data and long-term average rainfall and

runoff values to determine long-term average NPS loadings. The WMM can also be used to evaluate the effects of BMP implementation, given the level of BMP implementation in the study area and the removal efficiencies associated with the BMPs.

In contrast, STORM uses a continuous time series of rainfall and runoff data to determine the effectiveness of treatment facilities (e.g., Best Management Practices) with various treatment rates and storage volumes. The "Storm Water Management Model" (SWMM) will be used to develop runoff quantities and associated pollutant loadings (using a simple first-order buildup/washoff relationship), for input to riverine models such as the EPA model "Water Quality Analysis Simulation Program" (WASP).

One of the major goals of the monitoring is to establish the water quality characteristics of runoff from different land use classifications. Generally, the selected pilot BMP sites have a drainage area which consists of a single dominant land use. Therefore, the runoff quality data monitored at the BMP inflow points will be used to establish EMC values for land use classifications in the Rouge River Watershed. The EMC values will then be compared to EMC values that are based on national data, to identify similarities or differences. Ultimately, a final set of Rouge River Watershed EMC values will be developed based on some combination of local and national monitoring data. The RPO technical memorandum titled "Selection of Storm water Pollution Loading Factors" (RPO-NPS-TM34) should be referenced for EMC analysis and development. The EMC values will be used to analyze existing and future watershed loadings, with various control strategies, using a model such as WMM.

Another goal of the monitoring program is the evaluation of removal efficiencies for the pilot structural BMPs. In general, the removal efficiency for a particular storm event is determined as the difference in pollutant loadings associated with the BMP inflow and outflow. Because the efficiencies achieved by BMPs vary from one storm to the next, long-term monitoring data (i.e., data from 15-20 storm events) are typically required to characterize the average removal efficiencies.

At each of the pilot BMP sites, both inflow and outflow during storm events will be monitored using continuous flow meters and automatic samplers. Flow rates at the inflow and outflow points will be measured to quantify the runoff entering and leaving the BMP, and to allow for the collection of flow-weighted water quality samples. Existing or constructed flow control structures (e.g., pipes, weirs, flumes) will be used where possible to facilitate flow measurement.

It may be difficult to quantify the inflow to the sand filter or the on-line media filter, because of the diffuse nature of the inflow. In addition, it may be difficult to measure inflows and outflows for the swales because of the small flow rates associated with these structures. The number and type of samples to be taken at each site is presented in report titled "Field Sampling Plan-NPS Storm Event Monitoring Program" (RPO-SAM-FSP11).

In addition to the storm event sampling, the automatic samplers and continuous flow meters will be used to collect long-term inter-event samples between storm events at the wet detention pond sites. The automatic samplers will be used to continuously sample (during wet and dry periods) over a period of seven days. The objective of this sampling is to provide information on the long-term pollutant removal effectiveness of wet pond BMPs. *Table 4.2* lists the constituents that will be analyzed in the monitoring study. As shown in the table, the samples collected by the automatic samplers will be analyzed for constituents which include the following:

- Sediment (Total Suspended Solids, Volatile Suspended Solids).
- Oxygen Demand (BOD5).
- Nutrients (total phosphorus, ortho-phosphorus, TKN, nitrite nitrogen, nitrate nitrogen, ammonia nitrogen).
- Metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, zinc)
- Other (alkalinity, hardness).

The flow-weighted discrete samples for each storm event will be combined into a single composite sample, which will be analyzed for the constituents listed above. For the metals, both the dissolved and the total metal concentrations will be determined.

The discrete samples obtained from the automatic samplers will also be analyzed for up to five storm events. The analysis will evaluate constituents which include TSS, total phosphorus, total nitrogen, lead and zinc. The results will characterize the changes in concentrations of runoff pollutants over time during a storm event, testing the hypothesis that the majority of the runoff pollutant loading is associated with the "first flush" from a storm event.

In addition to automatic storm event sampling, manual grab samples will be collected during up to two wet weather events, and analyzed for the full suite of priority pollutants. Certain parameters such as bacteriological indicators and volatile organic compounds require manual sampling and cannot be analyzed from samples collected by automatic sampling equipment. Field crews must be prepared to mobilize rapidly to capture the "first flush" of runoff during the storm events.

Other required data for the storm events include precipitation data. These data are necessary in cases where quantity and quality simulation models will be calibrated and verified. The precipitation data will also be used to verify that the measured BMP inflow and outflow rates are reasonable. A tipping bucket rain gage, with a minimum sensitivity of 0.01 inches, will be installed at each pilot BMP site.

Table 4.2
Structural BMP Monitoring Program Constituents

Type of Sample	Parameter
Flow	Biochemical Oxygen Demand (5-day)
	Ammonia as Nitrogen
	Total Kjeldahl Nitrogen as Nitrogen
	Nitrate as Nitrogen
	Nitrite as Nitrogen
	Ortho-Phosphrous as Phosphorus
	Total Phosphrous as Phosphorus
	Total Suspended Solids
	Volatile Suspended Solids
	Total and Dissolved Arsenic
	Total and Dissolved Cadmium
	Total and Dissolved Chromium
	Total and Dissolved Copper
	Total and Dissolved Mercury
	Total and Dissolved Nickel
	Total and Dissolved Lead
	Total and Dissolved Zinc
	Alkalinity as $CaCO_3$
	Hardness as $CaCO_3$

Table 4.2 (cont.)
Structural BMP Monitoring Program Constituents

Type of Sample	Parameter
Discrete	Total Suspended Solids
	Total Phosphorus
	Total Nitrogen
	Total Lead
	Total Zinc
Priority	Volatile Organic Compounds[(1)]
	Pesticides
	Acid Compounds
	Base/Neutral Compounds
	Total Cyanide[(1)]
	Total Phenols[(1)]
	Total Petroleum Hydrocarbons[(1)]
	Benzene, Toluene, Ethylene, and Xylene[(1)]

Notes:

(1) Parameter collected as a manual grab sample only

4.3 **OPERATIONS AND MAINTENANCE**. The required operations and maintenance at each site are largely a function of the BMP type. For the detention ponds, routine maintenance may include mowing, and removal of debris and litter. These may be done simultaneously, and should be done at least twice a year. However, since the site must be visited after each storm event to collect the water quality samples, the site should be inspected for litter and debris problems after each storm.

In addition, areas that exhibit signs of erosion or slope failure should be filled and reseeded as soon as possible. Swales also should be mowed and litter and debris removed periodically. For the sand filter, the on-line media filter, the multi chamber treatment train, and the dry detention pond outlet polishing device, the frequency of maintenance will depend upon the performance of the BMP. The filtering material must be cleaned, and possibly replaced, when the treatment rate of the filter media becomes unacceptable due to clogging.

4.4 **PROJECTED CAPITAL AND OPERATIONS AND MAINTENANCE COSTS**. *Table 4.3* summarizes the projected capital and operations and maintenance costs for each of the nine proposed structural BMP projects. The table also indicates the factors considered in estimating the costs.

Table 4.3

5.0 PRELIMINARY WATER QUANTITY ASSESSMENT FOR BEST MANAGEMENT PRACTICE SITES

5.0 PRELIMINARY WATER QUANTITY ASSESSMENT FOR BEST MANAGEMENT PRACTICE SITES. A preliminary assessment of hydraulic conditions at the proposed sites was conducted. In addition to the nine proposed sites, several additional sites were hydraulically assessed during the site screening phase discussed earlier in this report. For detention ponds, the assessment quantified the range of expected water depths, inflows, outflows, and tailwater conditions for a range of storm sizes, under existing pond conditions. (Note: When final design of retrofit Best Management Practices is completed, further analyses will be conducted to ensure that the retrofit does not result in any adverse flooding impacts.) The analysis of swale revealed the range of expected swale inflows, velocities, and design widths required to limit flow depths to optimal levels. For the filters and the first flush sedimentation pond, peak flows that must be passed by the pilot BMP were evaluated. The generated data will be useful in implementing monitoring equipment and techniques which are capable of making measurements over the identified range of hydraulic conditions.

5.1 DETENTION PONDS. Flows, storage volumes, and flood stages were evaluated at each of the detention pond demonstration sites, using the EPA's SWMM. For each pond site, the RUNOFF block of SWMM was used to estimate flow hydrographs from the drainage area, and the EXTRAN block of SWMM was used to route these hydrographs through the existing storm drain system and detention pond.

The physical data required for the hydrologic modeling (e.g., drainage area size, percent imperviousness and slope) was compiled from site grading plans, storm sewer plans, and aerial photographs. For a given site, the first step in data collection was the delineation of the total drainage area. The total area was then divided into subareas which drain into the storm sewer network, and the physical characteristics of each subarea were determined. For some parameters such as Manning's roughness coefficient or depression storage volumes, typical literature values were used in lieu of detailed model calibration.

Hydrographs were developed in RUNOFF for a variety of storm events. The events include the 2-year, 5-year, 10-year, 25-year, 50-year and 100-year design storm events (with an assumed 24-hour SCS Type II distribution), as well as the average watershed storm. The design storms vary in depth from 2.4 inches (2-year) to 4.8 inches (100-year), based on a September 1990 Michigan Department of Natural Resources (MDNRs) rainfall frequency publication (Sorrell, Hamilton 1990). The average watershed storm was characterized based on the EPA report, "Storm Water Discharges Potentially Addressed by Phase II of the National Pollutant Discharge Elimination System Storm Water Program" (October 1993). The storm has a 9.5 hour duration, a cumulative rainfall amount of 0.55 inches, and an average intensity of 0.087 in/hr.

The RUNOFF results (i.e., the hydrographs from the pond site drainage area) served as input to the EXTRAN block, which routed the flows through the existing storm sewer system and detention pond. The physical data required to describe the hydraulic routing system (e.g., conduit lengths, conduit diameters and stage-area-storage data for the detention ponds) were obtained from storm sewer and construction plans.

Tables 5.1 through 5.5 summarize the results of the detention pond hydraulic analyses. For each of the six extreme storm events, the tables list the maximum values for inflow, outflow, water surface elevation, used detention storage volume, and storage depth. The time required for complete drawdown of the detention storage is also presented. Note that the parameters listed in *Table 5.2* are somewhat different than those listed in the other tables, to account for the fact that the site summarized in *Table 5.2* is a wet detention site. For the average storm event, the tables list the inlet and outlet conduit sizes, and the peak flow rate and depth for each conduit.

Tables 5.2 and 5.3 summarizes the results of hydraulic analysis for two ponds, which were initially selected as BMP sites. These two ponds were removed from the list of recommended pilot structural BMP sites due to difficulties in obtaining the necessary county/owner agreements. The Novi School basin was recently added to the recommended BMP sites list to replace the Country Club Corporate Park wet pond which was eliminated. Similar hydraulic analysis will be conducted for the Novi School basin before the start of the monitoring program.

Again, the results represent existing design conditions at the pond sites. Once the final designs are completed, the SWMM representations of the sites will be changed as necessary to reflect pond modifications. Subsequent evaluations will then determine whether or not the projects result in any adverse flooding impacts.

It is interesting to note that none of the five existing ponds limit the 10-year outflow to the specified goal of 0.2 cfs per acre of drainage area. The 10-year outflow values presented in *Tables 5.1 through 5.5* ranged from 0.4 to 1.1 cfs per acre of developed area. Consequently, further review of the County detention pond design standards may be appropriate.

5.2 **SWALE**. Because the swale site has a relatively small drainage area (2.4 acres), simpler modeling tools such as the Rational Method and the Soil Conservation Service (SCS) TR-55 method were used to estimate peak inflows to the swale site.

Inflow values for several different design storms were calculated. Because the swale is not designed for flood control, the analyzed storms represent less extreme events than were analyzed for the detention ponds. The return periods assessed for swale designranged from the average watershed storm to a 2-year event. For the SCS TR-55 analysis, the 24-hour, type II distribution was used, and total rainfall depths were established based on a September 1990 MDNR rainfall frequency publication (Sorrell, Hamilton 1990). The average watershed storm was characterized based on the EPA

Table 5.1

Table 5.2

Table 5.3

Table 5.4

Table 5.5

report, "Storm Water Discharges Potentially Addressed by Phase II of the National Pollutant Discharge Elimination System Storm Water Program" (October 1993). The storm has a 9.5 hour duration, a cumulative rainfall amount of 0.55 inches, and an average intensity of 0.087 in/hr. The rainfall intensity values used in the Rational Method calculations were based on data published in Technical Paper #25 (TP-25).
The inflow values calculated using the Rational Method and the TR-55 method were evaluated in a spreadsheet, which determines appropriate swale width and velocity values associated with the inflows. The spreadsheet assumes that the swale is a trapezoidal channel, with a bottom slope of 0.02 ft/ft in the direction of flow, side slopes of three horizontal to one vertical, and a Manning's roughness coefficient of 0.200. In the spreadsheet, the Manning's equation is used to calculate the channel flow and velocity, given the coefficients presented above, plus the bottom width of the trapezoidal channel and the maximum flow depth in the channel. For this analysis, flow depths of two inches and three inches were assumed. These depths are considered to be appropriate for effective pollutant removal in swales. Flow depths in excess of three inches may result in the matting of the grasses growing in the swale (Horner 1990).

The results of hydraulic analysis are presented in *Table 5.6* for the I-696/Minnow Drain swale. In the table, a range of swale inflows are listed, based on different peak flow calculation methodologies and different storm event return periods. For each flow, the trapezoidal channel widths required to pass the flow at depths of two inches and three inches are presented, along with the associated velocity values. All data required to conduct the calculations are presented in the table.

The table show that the design bottom width of the swale may be highly variable, depending upon the return period of the storm used for swale design. The required bottom widths range from six to 77 feet for the I-696 swale.

In contrast, the velocities tend to be relatively constant because of the shallow flow depths, and range from 0.3 to 0.4 feet per second. These low velocities would not cause erosion problems.

5.3 SAND FILTER. The sand filter site analysis used the Rational Method to determine a design peak flow. The ten-year storm event was considered appropriate for the analysis. The intensity value used in the Rational Method was taken from Technical Paper #25, assuming a time of concentration of ten minutes. This time of concentration corresponds to a overland travel length of 250 feet (width of parking lot) and overland flow velocity of 0.5 feet per second. For a runoff coefficient of 0.95, a rainfall intensity of 5 inches per hour and a drainage area of about 1 acre, a 10-year peak flow of 4.8 cfs was calculated.

Table 5.6

The sand filter has not been designed, but it is expected that the design will be similar to that described by EPA (1992). These facilities are designed to capture the runoff from small and medium events, and to divert any additional runoff from extreme events into a filter bypass conduit. Thus, in the course of the design, the bypass should be sized to pass the 10-year peak flow of 4.8 cfs without causing any flooding impacts.

During final design of the sand filter, the filter bed capacity should be evaluated to determine the percent of runoff that is treated by the sand filter. The U.S. Army Corps of Engineers' STORM can be used to perform this analysis. The required data would include the following:

- The treatment rate of the sand filter (i.e., the rate at which the water travels through the sand).
- The maximum storage volume above the filter.
- The drainage area to the filter.
- The runoff coefficient for the drainage area (i.e., the ratio of runoff to rainfall).
- Long-term rainfall data (hourly or daily) for the watershed.

Using a time step consistent with the rainfall data, the model can conduct a flow balance over the entire period of record, determining the flow through the filter, the bypassed flow, and increases or decreases in storage of water above the filter. In this way, the percentage of flow that is treated by the filter over the period of record can be determined. The overall efficiency of the filter would be the product of the percentage of inflow treated by the filter and the percentage of pollutant that is removed in passing through the filter.

5.4 ON-LINE MEDIA FILTER. This pilot BMP project will be constructed at the City of Westland Department of Public Works (DPW) Yard. Final design has not been completed to date, however, the intent is to provide both sedimentation and filtration in a compact unit that would replace an existing catchbasin. The device will be designed so that the filter media can be removed and replaced quickly once it becomes plugged and ineffective.

It is expected that the analysis of the on-line media filter would be similar to that for the sand filter. The design will allow for the capture and treatment of the "first flush" of runoff, and the safe bypass of additional runoff.

5.5 MULTI CHAMBER TREATMENT TRAIN. This multi chamber treatment train (MCTT) pilot BMP project will be constructed at an existing SUNOCO gas station located in the City of Livonia at the southwest corner of Schoolcraft Road and I-96. Final design has not been completed to date, however, the intent is to provide a design developed by Dr. Robert Pitt of the University of Alabama at Birmingham. Dr. Pitt developed the MCTT with funding from a United States Environmental Protection Agency grant under Section 319 of the Clean Water Act.

It is expected that the analysis of the Multi Chamber Treatment Train filter will be similar to that for the sand filter and the on-line media filter. The design will allow for the capture and treatment of the "first flush" of runoff, and the safe bypass of additional runoff.

5.6 FIRST FLUSH SEDIMENTATION BASIN. The first flush sedimentation basin in the City of Novi was designed by the consulting firm of J.C.K. and Associates Inc. The MDNR has reviewed the design and issued a permit for construction of this project. The RPO has also reviewed the design and agreed that the design was acceptable.

The storm sewers draining to the sediment basin are designed to handle the 100-year storm event, based on peak flows calculated using the Rational Method. The sewer capacities were estimated using the Manning's equation.

The sedimentation pond is constructed at the downstream end of a 53"x 34" storm sewer pipe that discharges into a regional detention pond. The tributary area consists of 90 acres of residential land (which is currently about 80 percent developed) and 3 acres of road drainage (for which construction began in the spring of 1994). The pond captures the first flush of runoff from the impervious tributary area and allows flows in excess of this first flush volume to bypass the sediment basin through a diversion structure. The water quality storage volume provided by the pond is 1.4 acre-feet, which corresponds to 0.6 inches of storage per impervious acre in the drainage area. The bypass prevents scouring and resuspension of collected sediments in the sediment basin. A forebay and an underdrain system are also provided to enhance sedimentation. A 6-inch perforated PVC outlet is provided for a 24-hour drawdown of the water quality volume. The detention period of 24 hours should provide enough time for settling of the particulate matter conveyed by the storm water runoff.

6.0 PRELIMINARY WATER QUALITY ASSESSMENT FOR BEST MANAGEMENT PRACTICE SITES.

Each of the Best Management Practice (BMP) demonstration sites were evaluated to establish a preliminary estimate of pollutant removal efficiencies for the sites. These estimates are based on monitoring data collected and analyzed in local and national nonpoint pollution studies. As data are collected at the BMP sites, the data will be compared with the preliminary removal efficiency estimates, to determine whether or not the findings of this study are consistent with the other studies. Additional analysis may be required for BMP sites at which results are not consistent with previous studies. Ultimately, a combined data set of Rouge River Watershed BMP monitoring data and data from previous nonpoint pollution studies will form the basis for the development of a strategy for cost-effective nonpoint pollution control in the Rouge River Watershed.

A summary of pollution removal efficiencies, based on review of various monitoring studies, is presented in *Table 6.1*. Average percent removal values are presented for the 12 constituents that are most commonly monitored as part of the National Pollutant Discharge Elimination System storm water permit requirements. The pollutants include sediment (TSS, TDS), oxygen-demanding substances (BOD, COD), nutrients (total phosphorus, dissolved phosphorus, total Kjeldahl nitrogen, nitrite + nitrate nitrogen) and metals (lead, copper, zinc, cadmium).

The footnotes at the bottom of the table indicate that these values are representative for BMPs that are designed for effective pollutant removal. For extended dry detention ponds, the removal values are based on the assumption that at least 80 percent of the annual runoff volume is captured and treated by the pond, and that the pond design prevents short-circuiting or turbulence that would limit its effectiveness. Wet detention pond efficiencies are based on an average hydraulic residence time of at least two weeks, and design that prevents short-circuiting. Similar to extended dry detention ponds, the efficiency values for swales were established assuming a capture of at least 80 percent of the annual runoff from the drainage area. It was further assumed that the length, slope and geometry of the swale are designed to limit velocities and encourage infiltration of the captured runoff. Finally, the values for filters are also based on the assumption that at least 80 percent of the annual runoff is captured and treated by the filter. For the Rouge River Watershed, a treatment rate of about 2 gallons per minute per square foot of filter surface area should be sufficient to achieve the desired percent capture.

For ponds, the required water quality volumes for various land use classifications are presented in *Table 6.2*. The wet pond storage volumes are based on a mean residence time of two weeks in the permanent pool, and a length-to-width ratio of between 4 to 1 and 7 to 1.

Table 6.1

Table 6.2

Annual runoff volumes for pervious areas were estimated by analyzing long-term streamflow records for undeveloped local watersheds, and annual runoff volumes for impervious areas were estimated based on the average annual rainfall and a runoff coefficient of 0.95. Knowing the annual runoff from pervious and impervious areas, and the percent of imperviousness for a particular land use, the average annual runoff for the land use can be calculated. The recommended permanent pool volume is calculated as 1/26 of the annual runoff (i.e., the average two-week runoff volume). The extended dry detention storage values were developed by Northern Virginia Planning District Commission (1979), based on detailed continuous simulation modeling for a year of "average" wetness. The analyses assumed that a detention time of 24 hours would provide sufficient opportunity for settling in the pond. The Northern Virginia Planning District Commission report notes that a drawdown time of approximately 40 hours should be sufficient to achieve an average detention time of 24 hours.

The demonstration BMP sites are evaluated in the following sections. For each site, the existing design (or proposed design, in the case of retrofits or new construction) is discussed with respect to the design criteria discussed above.

6.1 DETENTION PONDS. Previous monitoring studies have indicated that the typical pollution removal efficiencies vary depending upon the type of detention basin. The standard detention pond in the Rouge River Watershed - a dry pond designed strictly for peak flow attenuation - generally is ineffective in reducing nonpoint pollution loadings. When a dry pond includes storage volume area for extended detention (e.g., 24 hours or more), particulate pollutants can settle from the detained runoff in relatively quiescent conditions, but soluble pollutants are basically unaffected. In wet ponds, which have a permanent pool of water, both particulate and soluble pollutants are typically removed. Particulate are removed through settling, whereas soluble pollutants are removed through biological, chemical, and/or physical processes.

The **Cedar Lake Village Detention Pond** is an existing extended dry detention pond, which serves a drainage area of 18 acres, primarily multi-family condominiums. The extended dry detention water quality volume in the existing pond is 1.47 acre-feet, which is 0.98 inches of storage over the entire drainage area. This volume is sufficient to capture the "first flush" of runoff from the drainage area. In addition, the hydraulic analysis in *Section 5.0* showed that the pond takes several days to completely drain after a storm event, allowing ample opportunity for particulate matter to settle.

The **Novi School Wet Detention Basin** is an existing wet detention pond, which serves a drainage area of 85 acres, primarily public land use (e.g., school, police department, civic center). The permanent pool volume for the existing pond is estimated as 7.8 acre-feet, or 1.1 inches over the entire drainage area. This value is equal to the required 1.1 inches which will provide an average two-week residence time, based on local rainfall and hydrology. Therefore, the wet pond is expected to provide effective treatment of storm water runoff inflows.

The **Metro West Industrial Park #3 S.W. Detention Pond** is an existing dry detention pond that, through retrofit, will be converted into an extended detention pond. The pond serves a drainage area of 38 acres of light industrial land use. The existing pond volume is 4.5 acre-feet, which is 1.4 inches of storage over the entire drainage area. Since only 0.5 inches of storage over the entire drainage area, or 1.58 acre-feet of pond volume is necessary to provide the optimal extended detention volume, the existing dry pond has adequate volume to be retrofit into an extended detention pond. Approximately one third of the ponds volume will be used to provide extended detention for water quality control, the volume remaining will be used for traditional water quantity control. Plunge pools at the two inlets and one outlet to the pond will also be constructed to improve water quality by reducing erosion and resuspension of settled constituents.

The **Maple Hills Subdivision Detention Pond** is an existing dry detention pond that, through retrofit, will provide additional treatment through the implementation of a multi-media polishing device. The pond serves a drainage area of 66 acres, primarily single family residential land use. The size of the device (i.e., the surface area) will depend upon the hydraulic capacity of the media, the design treatment flow and the available land area at the site. In addition, the polishing device must include an overflow structure to pass extreme storm events that will not be treated completely by the device. The overflow structure may also be required if the polishing device is clogged.

Due to land area limitations, it is unlikely that the polishing device will achieve the sand filter efficiencies shown in *Table 6.1*. Because optimal values of surface area per acre of drainage area will not be possible, the results for the filter will illustrate how the removal efficiencies are affected by design that is less than optimal. The actual removal efficiencies will depend upon the fraction of runoff that is treated by the polishing device. Because the values in *Table 6.1* reflect the capture of 80 percent or more of the drainage area runoff, the expected efficiencies for devices that capture a smaller fraction of runoff should be adjusted accordingly. For example, if the device is expected to capture 20 percent of the long-term runoff, then the expected efficiencies may be estimated as 25 percent (i.e., 20 percent divided by 80 percent) of the values of *Table 6.1*.

6.2 SWALES. Swales are grassed conveyance systems which provide storm water pollutant removal through physical filtration of runoff through the grass cover, and infiltration of runoff into the underlying soil. To provide effective removal of pollutants, the following design criteria have been recommended (Horner, 1991; FHWA, 1989);

- Minimum hydraulic residence time of about 10 minutes for the average rainfall event.
- Maximum flow depth of 3 inches for the average rainfall event.
- Maximum swale width of 8 feet.

- Minimum swale length of 100 feet (for bottom slopes less than 2 percent) to 150 feet (for bottom slopes in excess of 2 percent).

The maximum swale width is specified because it may be difficult to spread incoming runoff equally throughout the swale for widths greater than 8 feet. The other criteria all relate to maximizing effectiveness by minimizing flow depths and maximizing the residence time in the swale, to promote filtration through the grass and infiltration into the soil.

The **I-696/Minnow Pond Drain Swale** will be constructed at a location where highway storm water runoff currently discharges directly to the Minnow Pond Drain. The design will include a 160 foot swale at a slope of 2 percent or less, that should provide an average hydraulic residence time of more than 10 minutes. The design will also include a diversion structure to bypass some of the runoff from extreme storm events directly into the Minnow Pond Drain. The diversion should protect the swale against erosion that could occur during high flow conditions.

6.3 **SAND FILTER**. The City of Austin, Texas is recognized as a national leader in the development of sand filters for urban storm water quality control. The City has conducted extensive monitoring programs to evaluate the effectiveness of sand filters. Sand filtration systems designed in accordance with the City's criteria are assumed to achieve the pollutant removal efficiencies listed previously in *Table 6.1*.

The **Ford Motor Company Sand Filter** will be constructed at Ford's Rouge Plant, to serve a heavy industrial parking lot with a drainage area of one acre or less. The filter is expected to be a two-stage design, as described by EPA (1992). The first stage consists of a sedimentation chamber, which captures the larger particulate matter (e.g., sand, gravel, debris), and the second stage is the sand filtration chamber. In the filter chamber, smaller particulate matter (e.g., fine silts and clays) will be captured. Pollutants such as metals or some organic chemicals, which adsorb to particulate matter, are most often associated with fine particles rather than sand or gravel. Therefore, though much of the sediment load may be removed in the sedimentation chamber, most of the particulate pollutant loading reduction will occur in the sand filter chamber.

The EPA sand filter document described earlier included specific design criteria, which are as follows:

- 1,080 cubic feet of volume per acre of drainage area (0.024 inches over the drainage area), split equally between the sedimentation chamber and the sand filter chamber.
- A total surface area requirements of 720 square feet per acre of drainage area, split equally between the sedimentation chamber and the sand filter chamber.
- Sand depth of at least 18 inches.
- Drainage area of less than 5 acres impervious area.

For these design conditions, the sand filter should treat more than 80 percent of the annual runoff from the drainage area.

6.4 ON-LINE MEDIA FILTER. The on-line media filter, which has not yet been designed, would be expected to achieve efficiencies similar to the sand filter, assuming that the media filter captures and treats the same fraction of the annual runoff and the media is identical to that of the sand filter. However, since the objective of the on-line media filter is to provide a compact filtration device, it is expected that a sand with a larger diameter and hydraulic conductivity will be used for filtration. This larger hydraulic loading rate is expected to lower the removal efficiency, but information regarding this phenomena is not currently documented. Also, as discussed previously, the removal efficiencies for other media types are not well-documented.

6.5 MULTI CHAMBER TREATMENT TRAIN. Preliminary research of the multi chamber treatment train (MCTT) has been conducted by Dr. Robert Pitt of the University of Alabama at Birmingham. Dr. Pitt developed the MCTT in conjunction with a 319 grant from the United States Environmental Protection Agency which is being coordinated by Mr. Richard Field.

Dr. Pitt's preliminary research has examined the design of an underground multi chambered tank to collect and treat storm water runoff from critical urban areas such as gas stations. The collected runoff is first treated in a catchbasin chamber where larger particles are settled out. The water then flows into a main settling chamber containing oil and grease sorbent material where it will undergo a much longer treatment period (20 to 70 hours) to settle finer particles and to control oil residues. In addition to housing the plate or tube settlers, the main settling chamber also contains a fine bubbler diffuser for removal of volatile contaminants. The water is then directed into the second chamber consisting of the sand/peat filter.

Preliminary results show that the treatment unit is likely providing substantial reductions in storm water toxicants (both in particulate and filtered phases), organics, and suspended solids. Slight increases in turbidity and color and about a unit in pH reduction also occurred during the filtration step. According to Dr. Pitt, the filter unit appears to be responsible for most of the toxicity reductions. However, the main settling chamber also resulted in substantial reductions in the dissolved toxicity fraction, total and dissolved COD, suspended solids, turbidity, and color. The catch basin/grit chamber also showed suspended solids reductions. In summary, the use of the MCTT is seen to be capable of reducing a broad range of storm water pollutants that have been shown to cause substantial receiving water problems

6.6 FIRST FLUSH SEDIMENTATION POND. The City of Novi's proposed "first flush" sedimentation pond is designed for 24-hour drawdown of the first flush detention volume. A bypass structure will allow flows in excess of the first flush volume to bypass the basin to prevent resuspension of settled contaminants. The basin's first flush detention volume is sized per MDNR's design guidelines (i.e., three times the runoff volume from the mean rainfall event, for all impervious drainage area). Given the values of 28 impervious acres in the drainage area, an average storm of 0.21 inches, and an impervious area runoff coefficient of 0.95, the required pond water quality volume is 1.4 acre-feet (0.6 inches over the impervious area). The efficiency values in *Table 6.1* for extended dry detention ponds should be appropriate for the first flush sedimentation basin.

7.0 SUMMARY.

This technical memorandum summarizes the methodology used to select and recommend nine pilot structural control best management practice (BMP) demonstration projects. These projects will be implemented in the Rouge River Watershed by the Rouge Project. This analysis and site selection effort is funded by a United States Environmental Protection Agency grant under Section 319 of the Clean Water Act, and is being coordinated by the Wayne County Rouge Program Office.

A detailed evaluation of Rouge River Watershed structural BMP types is presented for three categories of BMP types including, existing detention ponds, existing detention pond retrofits, and innovative structural BMPs (e.g., swales, media filtration, oil/water separators, multi chamber treatment train). For existing detention ponds, typical design criteria for ponds in the Rouge River Watershed is documented. An analysis of retrofit detention ponds has resulted in the development of several alternative methods of retrofitting which are presented in this memorandum. For innovative BMPs, nonpoint source literature data on each innovative BMP is summarized.

The following nine BMP types are recommended for pilot BMP demonstration projects within the Rouge River Watershed:

- Extended Dry Detention Pond - Existing (DPE-ED)
- Wet Detention Pond - Existing (DPE-W)
- Dry Detention Pond Retrofit - Retrofit to Extended Detention (DPR-ED)
- Dry Detention Pond Retrofit - Retrofit with Outlet Polishing Device (DPR-OPD)
- Swale - Constructed Swale Evaluation (SE)
- Sand Filter Evaluation (SFE)
- On-Line Media Filter (OLMF)
- Multi Chamber Treatment Train (MCTT)
- First Flush Sedimentation Pond (FFSP)

Potential sites for implementation of these recommended BMP types were identified through inspection of aerial mapping, field reconnaissance, and coordination with local jurisdictions, regulatory agencies, and consultants. The sites were then evaluated using site selection criteria and ranking procedures that were developed based on techniques reported by the Environmental Protection Agency (EPA).

Recommended locations for each of the nine pilot structural BMP types are as follows:

- Cedar Lake Village: Extended Dry Detention Pond - Existing (DPE-ED)
- Novi School Detention Pond: Wet Detention Pond - Existing (DPE-W)
- Metro West Detention Pond: Dry Detention Pond Retrofit - Retrofit to Extended Detention (DPR-ED)
- Maple Hill Detention Pond: Dry Detention Pond Retrofit - Retrofit with Outlet Polishing Device (DPR-OPD)

- I-696 / Minnow Pond Drain: Swale - Constructed Swale Evaluation (SE)
- Ford Motor Company: Sand Filter Evaluation (SFE)
- Westland DPW Yard: On-Line Media Filter (OLMF)
- SUNOCO Gas Station: Multi Chamber Treatment Train (MCTT)
- Novi Sedimentation Basin: First Flush Sedimentation Pond (FFSP)

Table 7.1 summarizes site characteristics of each of these nine recommended sites including, site location, sub-watershed, receiving water, existing facility type, proposed BMP demonstration, drainage area, and land use.

Please note that these nine recommended sites are subject to revision, based on the status of county/owner agreements required for implementation. If agreements cannot be obtained at one or more of the recommended sites, then alternative sites will be selected, using the same criteria discussed earlier.

Table 7.1

8.0 REFERENCES

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APPENDIX A

GLOSSARY

GLOSSARY

API	AMERICAN PETROLEUM INSTITUTE
BMPs	BEST MANAGEMENT PRACTICES
CFS	CUBIC FEET PER SECOND
CPI	COALESCING PLATE INTERCEPTOR
CSO	COMBINED SEWER OVERFLOW
DPE-ED	DETENTION POND EVALUATION-EXTENDED DETENTION
DPE-W	DETENTION POND EVALUATION-WET DETENTION
DPR-E	DETENTION POND RETROFIT-EXTENDED DETENTION
DPR-OP	DETENTION POND RETROFIT-OUTLET POLISHING DEVICE
DSS	DECISION SUPPORT SYSTEM
EMC	EVENT MEAN CONCENTRATION
EPA	ENVIRONMENTAL PROTECTION AGENCY
EXTRAN	EXTENDED TRANSPORT MODEL
FFSP	FIRST FLUSH SEDIMENTATION POND
GIS	GEOGRAPHICAL INFORMATION SYSTEM
MCTT	MULTI CHAMBER TREATMENT TRAIN
MDNR	MICHIGAN DEPARTMENT OF NATURAL RESOURCES
MDOT	MICHIGAN DEPARTMENT OF TRANSPORTATION
NPDES	NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM
NPS	NONPOINT SOURCE
NURP	NATIONWIDE URBAN RUNOFF PROGRAM
OLMF	ON-LINE MEDIA FILTER
RAP	REMEDIAL ACTION PLAN
RPO	ROUGE PROGRAM OFFICE
RRNWWDP	ROUGE RIVER NATIONAL WET WEATHER DEMONSTRATION PROJECT
SE	SWALE EVALUATION
SEMCOG	SOUTHEASTERN MICHIGAN COUNCIL OF GOVERNMENTS
SFE	SAND FILTER EVALUATION
STORM	STORAGE TREATMENT OVERFLOW RUNOFF MODEL
SWMM	STORM WATER MANAGEMENT MODEL
TAG	TECHNICAL ADVISORY GROUP
TPRC	TECHNICAL PEER REVIEW CONFERENCE
WASP	WATER QUALITY ANALYSIS SIMULATION PROGRAM
WMM	WATERSHED MANAGEMENT MODEL

APPENDIX B

PILOT STRUCTURAL BEST MANAGEMENT PRACTICE SITE SUMMARIES

EXTENDED DRY DETENTION POND EVALUATION (DPE-ED): CEDAR LAKE VILLAGE DETENTION POND

PROPOSED DEMONSTRATION ACTIVITIES:

- Evaluate the pollutant removal efficiency of an existing extended dry detention pond with a standpipe/gravel filter outlet structure.
- Assess operations and maintenance requirements associated with this existing practice.
- Prorate benefits to estimate watershed-wide mass loading reductions.
- Develop cost/benefit information for use in developing a watershed-wide nonpoint source pollution management plan for the Rouge River Watershed.

SUMMARY OF CHARACTERISTICS:

- Location: North side of 6 Mile Road east of Northville Road in the Middle-1 subwatershed, Northville Township, Wayne County.
- Receiving Water: Middle Rouge River-Waterford Pond.
- Ownership: Property management company.
- Drainage Area: 18.0 acres.
- Tributary Land Use: Multiple family condominiums.
- Inlet: One 36-in inlet pipe.
- Outlet: One 36-inch standpipe with ten 1-in weep holes and gravel filter for attenuated dewatering, draining to a 36-inch pipe.
- Design Criteria: Oakland County Simplified Method (10-year storm).
- Fencing: Completely fenced.
- Residences in Vicinity: Two condominium buildings.
- Year Constructed: 1987.

- Existing Pond Surface Area: 0.40 acres at elevation 766.0.

- Extended Dry Detention Volume: 1.45 acre-feet (0.87 inches over the drainage area), at elevation 765.0.

- Total Pond Volume: 1.81acre-feet at elevation 766.0.

Elevation (ft.)	Surface Area (acres)	Incremental Storage Volume (acre-feet)	Cumulative Storage Volume (acre-feet)
757	0.05	0.0	0.0
760	0.10	0.23	0.23
762	0.25	0.35	0.58
765	0.33	0.87	1.45
766	0.40	0.37	1.81

- Monitoring Considerations:

  - Access to pond between buildings.
  - Power availability unknown.
  - Fenced completely.
  - Two monitoring stations required - monitor outlet within standpipe or downstream manhole, and monitor inlet in existing upstream manhole.
  - Outlet pipe drop structure to lake (verify hydraulics).
  - No lighting.

- Issues to be Resolved:

  - Contact condominium association and Northville Township supervisor.
  - Receive all applicable approvals.
  - Design and implement demonstration project.

WET DETENTION POND EVALUATION (DPE-W)
NOVI SCHOOL BASIN

PROPOSED DEMONSTRATION ACTIVITIES:

- Evaluate the long term pollutant removal efficiency of an existing wet detention pond.
- Assess operations and maintenance requirements associated with wet ponds.
- Prorate benefits to estimate watershedwide mass loading reductions.
- Develop cost/benefit information for use in developing a watershedwide nonpoint source pollution management plan for the Rouge River Watershed.

SUMMARY OF CHARACTERISTICS:

- Location: Located south of the Novi Civic Center behind the softball fields. The site is south of Ten Mile Road between Taft Road and Novi Road. Access from Ten Mile Road, Middle-1 subwatershed, City of Novi, Oakland County.
- Receiving Water: Middle Rouge River.
- Ownership: City of Novi
- Access from Ten Mile Road and parking lot next to the track and football field.
- Drainage Area: 85.0 acres.
- Tributary Land Use Characteristics: Quasi public
- Inlets: One 42-in pipe from the west, one 36-in pipe from the northwest, and two small ditches from the north and northeast. The two ditches are expected to carry negligible flows and these flows will be field verified during wet weather.
- Outlet: One 15-in outlet pipe at the southwest corner.
- Design Criteria: Oakland County Drain Commission method.
- Fencing: No fencing.
- Year Constructed: 1983.

- Pond Surface Area: 1.24 acres at elevation 899.0.
- Existing Permanent Pool Volume: 7.8 acre-feet at elevation 899.0.
- Total Pond Volume: 22.8 acre-feet at elevation 908.0.

Area and volume data above permanent pool elevation 899.0:

Elevation (ft.)	Surface Area (acres)	Incremental Storage Volume (acre-feet)	Cumulative Volume (acre-feet)
899	1.24	0.0	0.0
900	1.30	1.27	1.27
902	1.46	2.76	4.03
904	1.70	3.16	7.19
906	1.94	3.64	10.83
908	2.23	4.17	15.0

- Monitoring Considerations:

  - Access to pond from the Novi Civic Center parking lot.
  - Power availability unknown.
  - Not fenced.
  - Three monitoring stations required. Monitor outlet in existing 15-in pipe at downstream manhole. Monitor 42-in inlet pipe in upstream manhole, and 36-in inlet pipe in upstream manhole.
  - Manholes are relatively new and have access stairs.
  - Lighting from softball field parking lot.

- Issues to be Resolved:

  - Obtain County/Owner agreement.
  - Check facility operation during wet weather.
  - Receive all applicable approvals.
  - Design and implement demonstration project.

EXTENDED DETENTION POND RETROFIT (DPR-ED)
METRO WEST INDUSTRIAL PARK #3

PROPOSED DEMONSTRATION ACTIVITIES:

- Retrofit an existing dry detention pond to an extended detention pond.
- Evaluate the pollutant removal efficiency attributable to the above retrofit by monitoring the two influents and the effluent.
- Assess operations and maintenance requirements associated with this retrofit.
- Prorate retrofit benefits to watershedwide mass loading reductions.
- Develop cost / benefit information for use in developing a watershedwide nonpoint source pollution management plan for the Rouge River Watershed.

SUMMARY OF CHARACTERISTICS:

- Location: North of M-14 between Beck Road and Sheldon Road at the S.W. corner of Port Street and Keel Street in the Metro West Industrial Park # 3, Middle-2 subwatershed, Plymouth Township, Wayne County.
- Receiving Water: Tonquish Creek - Middle Rouge River.
- Ownership: R.A. DeMattia Development Inc.
- Detention facility is a privately owned easement.
- Access to northeast corner of easement from corner of Keel Street and Port Street
- Drainage Area: 38 acres.
- Tributary Land Use: 38 acres light industrial.
- Inlets: (1) A 42-in pipe from the north that drains 30 acres, and (2) an 18-in inlet from the south that drains 2 acres.
- Outlets: One 30-in outlet into Tonquish Creek. Existing pond has 2.6 ft high gravel dam in front of outlet pipe, which will be removed when the pond is converted to an extended detention pond and replaced with a standpipe with weep holes.

- Design Criteria: Plymouth Township requirements.

- Fencing: Completely fenced.

- Year Constructed: 1982.

- Pond Surface Area: 1.2 acres at elevation 816.5.

- Existing Total Pond Volume: 4.5 acre-feet (1.69 inches over the drainage area) at elevation 816.5.

Elevation (ft.)	Surface Area (acres)	Incremental Storage Volume (acre-feet)	Cumulative Storage Volume (acre-feet)
811	0.0	0.0	0.0
812	0.2	0.1	0.1
813	1.0	0.6	0.7
814	1.0	1.0	1.7
816.5	1.2	2.8	4.50

- Recommended Extended Detention Volume (based on capture of long-term mean storm rainfall runoff: 1.3 acre-feet.

- Recommended dewatering period: 24 hours (average detention time of 12 hours)

- Monitoring Considerations:

    - Access to pond off Port Street.
    - Fence with lock.
    - Three monitoring stations required - monitor both inlets in existing upstream manholes and monitor outlet in constructed manhole on outlet pipe.
    - Tailwater effects appear to be minimal based on field reconnaissance.
    - No overhead obstructions.
    - No lighting.

- Issues to be Resolved:

    - Check facility operation during wet weather.
    - R.A. DeMattia agreement.
    - Receive all applicable approvals.
    - Design, implement, and monitor demonstration project.

DRY DETENTION POND RETROFIT
OUTLET POLISHING DEVICE (DPR-OPD)
MAPLE HILL SUBDIVISION

PROPOSED DEMONSTRATION ACTIVITIES:

- Retrofit the outlet of an existing dry detention pond with a multi-media polishing device.
- Evaluate the pollutant removal efficiency attributable to the above retrofit by monitoring both influent and effluent.
- Assess operations and maintenance requirements associated with this retrofit.
- Prorate retrofit benefits to estimate watershedwide mass loading reductions.
- Develop cost / benefit information for use in developing a watershedwide nonpoint source pollution management plan for the Rouge River Watershed.

SUMMARY OF CHARACTERISTICS:

- Location: North side of 6 Mile Road and west of Haggerty Road in the Upper-2 subwatershed, Northville Township, Wayne County.
- Receiving Water: Upper Rouge River (Bell Branch).
- Ownership: Homeowners Subdivision Association.
- Detention facility is a permanent private easement.
- Access to east side of detention pond provided with temporary access road from Six Mile Road.
- Drainage Area: 66 acres.
- Tributary Land Use: 62 acres single family residential, 4 acres roadway.
- Inlets: (1) A 30-in pipe inlet from the west, draining residential and roadway land uses, and (2) a 36-in pipe inlet from the north, draining residential land use. A base flow concrete channel is provided to keep the pond dry for lawn maintenance purposes.

- Outlets: One multi-stage outlet structure with (1) a 15-in low flow pipe outlet and (2) a 48-in overflow standpipe. Both the 15-in pipe and the 48-in standpipe discharge to a 27-in pipe. 2.4 feet of hydraulic head are available for filtration and filter media head loss considerations.

- Design Criteria: 0.64 inches of storage volume over entire tributary area (10 year storage)

- Fencing: None.

- Residences in Vicinity: Six

- Year Constructed: 1985.

- Pond Surface Area: 1.1 acres at elevation 795.0.

- Total Pond Volume: 4.2 acre-feet (0.74 inches over the drainage area) at elevation 794.0.

Elevation (ft.)	Surface Area (acres)	Incremental Storage Volume (acre-feet)	Cumulative Storage Volume (acre-feet)
786	0.0	0.0	0.0
788	0.2	0.2	0.2
790	0.3	0.5	0.7
792	0.8	1.1	1.8
794	1.0	1.8	3.6
795	1.1	0.6	4.2

- Design Recommendations: Size of the polishing device will be limited by available space at the existing pond site.

- Monitoring Considerations:

  - Access to pond from 6 Mile road right-of-way.
  - Power availability - local residences.
  - Three monitoring stations required - monitor both inlets and outlet in upstream and downstream manholes respectively.

- No overhead obstructions.
- No lighting.
- Basin was completely full during extreme rainfall /snow melt conditions (verify inlet surcharging frequency and its effect on inflow monitoring results).

- Issues to be Resolved:

  - Contact subdivision association and Northville Township Supervisor.
  - Receive all applicable approvals.
  - Design, implement, and monitor demonstration project.
  - Conceptual design of retrofitted outlet structure.
  - Continue to observe backwater conditions during more frequent rainfall events.

SWALE EVALUATION (SE)
I-696 / MINNOW POND DRAIN SWALE RETROFIT

PROPOSED DEMONSTRATION ACTIVITIES:

- Monitor the pollutant removal efficiency of a constructed swale located at an existing storm sewer outfall that currently discharges untreated highway runoff directly to the Minnow Pond Drain.
- Assess operations and maintenance requirements associated with this retrofit.
- Establish a local highway runoff EMC database.
- Better define long term and seasonal pollutant removal efficiencies of swales.
- Prorate retrofit benefits to watershedwide mass loading reductions.
- Develop cost / benefit information for use in developing watershedwide nonpoint source pollution management plan for the Rouge River.

SUMMARY OF CHARACTERISTICS:

- Location: The south side of I-696 between Orchard Lake Road and Farmington Road located next to Minnow Pond Drain and Oakland Community College - Orchard Ridge Campus.
- Receiving Water: Minnow Pond Drain - Upper Rouge River.
- Ownership: Michigan Department of Transportation (MDOT)
- Drainage Area: Approximately 2.4 acres.
- Tributary Land Use: Highway runoff (4 lanes drained).
- Inlets: One 18-inch pipe inlet at elevation 832.0.
- Outlets: Inflow will enter a distribution box with two outlets: (1) a low flow outlet directing flow to the swale, and (2) an overflow outlet that will discharge excess flows to the Minnow Pond Drain via a riprap channel (to prevent erosion).
- Design Recommendations: Flow to the swale should be limited, so that the maximum depth of flow is 3 inches.

- Summary of Minnow Pond Drain flood elevations (i.e., potential backwater impacts):

Return Period (years)	Flood Elevation (feet)
10	832.2
50	835
100	836.5
500	839

- Construction Activities: Complete construction of the swale will be required. Currently an eroded ditch conveys flow from the 18-in inlet to the Minnow Pond Drain. A distribution box will replace the existing pipe end section and this box will control flows into the constructed swale and allow bypass of flows which may cause erosion.

- Monitoring Considerations:

  - Access to monitoring stations from Oakland Community College parking lot. Protection from guard railing provided.
  - Power availability: none
  - Overhead lighting: none
  - Monitor inflows into the swale within the constructed swale diversion box.
  - Monitor outflows from the swale within a constructed control section (i.e. H-flume, V- notched weir).
  - Wet weather flows appear to be adequate for monitoring.
  - MDOT clear space requirements met.

- Issues to be Resolved:

  - Continue to coordinate with MDOT.
  - Receive all applicable MDOT/OCC approvals and permits.
  - Design, construct, and monitor demonstration project.

SAND FILTER EVALUATION (SFE)
FORD MOTOR COMPANY SAND FILTER

PROPOSED DEMONSTRATION ACTIVITIES:

- Design, construct, and monitor a sand filter installed in a parking lot at Ford Motor Company's Rouge Plant.
- Evaluate the incremental pollutant removal efficiency attributable to the above retrofit.
- Assess operations and maintenance requirements associated with this retrofit.
- Prorate retrofit benefits to watershedwide mass loading reductions.
- Develop cost / benefit information for use in developing a watershedwide nonpoint source pollution management plan for the Rouge River.

SUMMARY OF CHARACTERISTICS:

- Location: Ford Motor Company Rouge Plant, East of Miller Road between Rotunda Road and Dix Road in the Main-4 subwatershed, Dearborn, Wayne County.
- Receiving Water: Rouge River.
- Ownership: Ford Motor Company.
- Drainage Area Treated: One acre or less.
- Tributary Land Use: Heavy industrial parking lot.
- Inlet: Parking lot sheet flow will enter the sand filter through a linear steel grating.
- Outlets: The sand filter will discharge to an existing 21-in storm sewer along Miller Road. The sand filter / storm drain connection will consist of 6-in pipes to minimize short-circuiting of the sand bed.
- Design Criteria: Two chambered sand filter, as described by EPA (1992). The first chamber is designed for settling out heavy particulate, and the second chamber is a sand filter bed, where filtration of finer solids particles occurs. Specific design recommendations are as follows:

  - 1,080 cu ft of volume per acre of drainage area.

- 720 sq ft of total surface area per acre of drainage area, split equally between the two chambers.

- Sand depth of at least 18 inches.

- Monitoring Considerations:

  - Inflow quality characterization to be determined by monitoring at a separate representative storm sewer inlet.
  - Sand filter effluent will be monitored at a downstream manhole.
  - Equipment installation to prevent tampering/vandalism.

  - Filter media sampling (determine what pollutants are removed by filter media).
  - Settling chamber sampling (determine size distribution of particles that settle prior to the sand filter chamber).

- Issues to be Resolved:

  - Continue coordination with Ford Motor Company.
  - Obtain County/Owner agreement.
  - Verify the adequacy of overland flow characteristics during wet weather.
  - Design, implement, and monitor sand filter efficiency.

ON-LINE MEDIA FILTER (OLMF):
CITY OF WESTLAND MAINTENANCE YARD

PROPOSED DEMONSTRATION ACTIVITIES:

- Design, construct, and monitor a "on-line" media filter inlet installed within an existing sloped parking lot at the City of Westland maintenance yard.
- Evaluate the incremental pollutant removal efficiency attributable to the above retrofit.
- Test various types of filtering material.
- Assess operations and maintenance requirements associated with this retrofit.
- Prorate retrofit benefits to watershedwide mass loading reductions.
- Develop cost / benefit information for use in developing a watershedwide nonpoint source pollution management plan for the Rouge River.

SUMMARY OF CHARACTERISTICS:

- Location: City of Westland maintenance yard parking lot, on the corner of Marquette Avenue and Herbert Avenue between Newburgh Road and Wayne Road in the Lower-2 subwatershed, City of Westland, Wayne County.
- Receiving Water: Rouge River.
- Ownership: City of Westland.
- Drainage Area Treated: 0.50 Acres.
- Tributary Land Use: Heavy industrial parking lot.
- Inlet: Parking lot sheet flow will enter the "on-Line" media filter through a linear steel grating.
- Outlets: The "on-Line" media filter will outlet to an existing 12" storm sewer which runs through the parking lot and eventually discharges into 36"storm sewer along Herbert Ave.
- Design Criteria: Three chambered sand filter, the first chamber is designed for oil/water separation and settling out heavy particulate, the second chamber consists of a sand

filter bed which accomplishes filtration, and the third chamber is a discharge clear well area.

- Monitoring Considerations:

  - Inflow quality characterization to be determined
  - Sand filter effluent will be monitored at a downstream manhole.
  - Equipment installation to prevent tampering/vandalism.

  - Filter media sampling (what is removed by filter media?).
  - First chamber sampling (what is separated - floatable & settleable - prior to the filter media chamber?).

- Issues to be Resolved:

  - Continue coordination with City of Westland.
  - Obtain County/Owner agreement.
  - Verify the adequacy of overland flow characteristics during wet weather.
  - Design, implement, and monitor sand filter efficiency.

MULTI CHAMBER TREATMENT TRAIN (MCTT): SUNOCO GAS STATION

PROPOSED DEMONSTRATION ACTIVITIES:

- Design, construct, and monitor a multi-chambered treatment train (MCTT) installed on-line of storm sewer that collects runoff from Sunoco gas station in the City of Livonia.
- Evaluate the incremental pollutant removal efficiency attributable to the above retrofit.
- Assess operations and maintenance requirements associated with this retrofit.
- Prorate retrofit benefits to watershedwide mass loading reductions.
- Develop cost/benefit information for use in developing a watershedwide nonpoint source pollution management plan for the Rouge River.

SUMMARY OF CHARACTERISTICS:

- Location: Sunoco gas station on the corner of Schoolcraft Road and Merriman Road in the Upper-2 subwatershed, City of Livonia, Wayne County.
- Receiving Water: Rouge River.
- Ownership: Sunoco.
- Drainage Area Treated: 0.6 Acres.
- Tributary Land Use: Sunoco Gas station and Sunoco food market.
- Inlet: Existing one 8-inch pipe at approximately inlet elevation of 628.5
- Outlets: The multi-chambered treatment train will outlet to the existing 8-inch at an approximate outlet elevation of 628.4. The 8-inch storm sewer discharges into storm sewer system along Schoolcraft Road.
- Design Criteria: Two chambered system. The first one is the main settling chamber with tube settlers, fine bubble aerators, and sorbent pillows. The second chamber is the filtering chamber with sorbent filter fabric, sand and peat layer, sand layer, filter fabric and gravel packed underdrain.
- Monitoring Considerations:

- Inflow quality characterization before any treatment.

- Multi-chambered treatment train effluent will be monitored at a downstream manhole.
- Equipment installation to prevent tampering/vandalism.

- Issues to be Resolved:

  - Continue coordination with Sunoco.
  - Obtain County/Owner agreement.
  - Verify the adequacy of overland flow characteristics during wet weather.
  - Design, implement, and monitor the treatment train efficiency.

SOIL EROSION EVALUATION (SEE)
CITY OF NOVI FIRST FLUSH SEDIMENTATION BASIN

PROPOSED DEMONSTRATION ACTIVITIES:

- Monitor the pollutant removal efficiency of a sedimentation basin which is being constructed to protect existing wetlands upstream of a proposed regional flood control facility.

- Document the sedimentation basin's operations and maintenance costs and capital costs for cost/benefit analysis.

- Monitor the basin's sediment accumulation both during and after upstream construction activities to determine whether or not these basins are effective as temporary and/or long-term water quality devices.

- Demonstrate the first flush water quality treatment approach, including a diversion structure to bypass larger runoff volumes without resuspending sediment that has settled during previous storms.

- Make recommendations for watershedwide application of this practice and evaluate potential mass load reductions.

- Develop cost / benefit information for use in developing watershedwide nonpoint source pollution management plan for the Rouge River Watershed.

SUMMARY OF CHARACTERISTICS:

- Location: Northeast corner of 11 Mile Road and Taft Road in the Middle-1 subwatershed, The City of Novi, Oakland County.

- Receiving Water: Leavenworth Creek, North Branch of the Middle Rouge River.

- Ownership: The City of Novi

- Drainage Area: 93 acres.

- Tributary Land Use: Residential, institutional.

- Inlets: 53" x 34" reinforced concrete pipe.

- Outlets: (1) A 6-in perforated PVC pipe for 24 hour dewatering of water quality volume, and (2) a bypass weir for storm volumes in excess of the first flush volume.

- Design Criteria: The sedimentation basin is sized for three times the runoff volume from the mean rainfall event (0.21 inches). This event is applied to the impervious tributary area only, and a runoff coefficient of 0.95 is assumed. Given the impervious upstream area of 28 acres, and the values above, the required water quality volume is 1.40 acre-feet. Runoff volumes in excess of the mean runoff volume will be diverted around the basin to prevent resuspension of collected sediments. In addition, An oil/water separator is proposed directly upstream of sedimentation basin.

- Monitoring Considerations:

  - Access to proposed monitoring stations from 11 Mile Road.
  - Power Availability: no
  - Overhead Lighting: no
  - Monitor both inlet and outlet to sedimentation basin at proposed manhole locations.
  - Proposed oil/water separator located directly upstream will effect efficiency assessment of sedimentation pond (treatment train effect).
  - Must periodically measure and document sediment accumulation.

- Issues to be Resolved:

  - Receive construction permit from MDNR.
  - Coordinate construction with The City of Novi.
  - After the City of Novi constructs this facility the RPO will begin continuous water quality monitoring.