# Storm Water Management Plan

Trenton Area Storm Water Management Project
Butler County, Ohio

**Prepared for:**
**Butler County Storm Water District**
**Hamilton, Ohio**

**August 1, 2006**

August 1, 2006 O.1.1.CN2004074R03

Mr. Gregory Wilkens, PE, LS
Butler County Storm Water District
1921 Fairgrove Avenue
Hamilton, Ohio 45011-1965

Re:
Storm Water Management Plan
Trenton Area Storm Water
Management Project
Butler County, Ohio

Dear Mr. Wilkens:

The consultant team of Fuller, Mossbarger, Scott and May Engineers, Inc. (FMSM), XCG Consultants (XCG), and Eagon and Associates (EAGON) is nearing completion of the watershed study and storm water management plan for the Jackson Ditch watershed located west of the City of Trenton, in Butler County, Ohio. For the final phase of the project, FMSM has prepared a draft Storm Water Management Plan (SWMP) for the watershed. The SWMP is based on the goals outlined in the "Butler County Storm Water District Storm Water Management Plan (February 25, 2003)", that was prepared with assistance from FMSM and includes additional recommendations customized to the unique needs of the Jackson Ditch watershed.

The storm water issues in the Jackson Ditch watershed can be summarized into water quality protection and the minimization of flood impacts. Based on our visual observations, the storm water runoff in the watershed does not appear to be heavily polluted, but some degree of minor pollution is present in the form of sediment and debris. Long term protection of storm water runoff from pollution is critical for the watershed to maintain good surface water quality and more importantly to protect the aquifer as a water supply source. Pollution potential in the watershed appears to be primarily a function of land uses and control of pollutants at their source. There also appears to be some current minor flooding issues in the watershed, and the modeling performed for this study suggests a risk of overbank flooding in several areas in the southern portion of the watershed. Flooding issues appear to be directly related to structures along the Jackson Ditch channel and reduced infiltration in the upper portion of the watershed.

Enclosed is a narrative report and supporting exhibits that describes storm water issues in the watershed, outlines several types of activities that were explored to help mitigate these issues, and provides recommendations that form the framework of the SWMP. Some discussion of structural options to address flooding issues is included in the enclosed report, but given the geometry of the watershed, these options are likely to be targeted solutions and have limited impact on a watershed wide scale. The overall solution for the majority of storm water issues for both flooding and water quality in the Jackson Ditch watershed revolves around control of land uses, management practices, and infiltration patterns in the watershed. The SWMP presented herein has recommendations directed toward practices that promote onsite infiltration, control of potential pollution at its source, and key practices associated with the various land uses that seek to protect and enhance surface water quality.

Our goal for the SWMP is to provide guidance materials and concepts to support decisions in the watershed that protect and enhance water quality and lessen impacts due to flooding. From our perspective, the most effective approach for a SWMP is one that is flexible to allow for changes to storm water control and management practices and techniques resulting from changes in the needs of the community, including a variety of proposed developments. Therefore, this document should not be considered as an all encompassing prescriptive document, but should be used more as a "living" guidance document to support ongoing storm water management in the watershed.

The concepts described herein are based on our knowledge of storm water management throughout the region and nation. We have focused the recommendations specifically toward the Jackson Ditch watershed, but this should not preclude potential applications in other areas of Butler County as well. Lastly, stakeholder involvement is expected to play a factor in many of the stormwater management decisions described in this SWMP and FMSM looks forward to helping Butler County guide the implementation process in the Jackson Ditch watershed by assisting with public outreach through a stakeholder meeting to help achieve that goal.

On behalf of the FMSM Project Team, we appreciate the opportunity to work with the Butler County Storm Water District on this project and to assist with storm water management efforts in the area. Please review the enclosed report and contact FMSM should you have any questions or comments.

Sincerely,

FULLER, MOSSBARGER, SCOTT AND MAY
ENGINEERS, INC.

Erman L. Caudill, PE, CFM
Senior Project Engineer

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Senior Water Resources Engineer

/cmp

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# Storm Water Management Plan

# Trenton Area Storm Water Management Project Butler County, Ohio

## 1. Introduction

The Butler County Engineer's Office retained the consultant team of Fuller, Mossbarger, Scott and May Engineers, Inc. (FMSM), XCG Consultants (XCG), and Eagon and Associates (EAGON) to perform a watershed study and prepare a storm water management plan for a developing watershed located on the west side of the City of Trenton in Wayne and St. Clair Townships of Butler County, Ohio.

The first phase of the Jackson Ditch watershed study consisted of a data gathering effort to characterize the current conditions in the watershed. A report describing that phase of work was submitted by FMSM on July 27, 2005. The second phase of the project developed water quantity and quality models to simulate current and future conditions in the watershed. A draft report describing those efforts was submitted by FMSM and XCG on February 6, 2006 and the final version of that report is being submitted under separate cover. The third and final phase of the project is to develop a storm water management plan (SWMP) for the watershed.

The Butler County Storm Water District with assistance from FMSM previously developed a "Storm Water Management Plan" (BCSWMP) for its entire jurisdiction that was published February 25, 2003. A copy of that document is included with this report in the support data in Appendix A. That document outlined the activities required to meet National Pollutant Discharge Elimination (NPDES) Phase II permit provisions and meet the six minimum control measures required by the Ohio and U.S. EPA. The SWMP for the Jackson Ditch watershed for the present study was developed with the larger program organization and goals in mind and includes additional activities that support those policies, while specifically enhancing and protecting the Jackson Ditch watershed.

This report is organized progressively where the watershed's storm water issues are discussed and characterized, several types of mitigation options are explored, general management concepts are presented, and lastly a set of recommendations and implementation activities are discussed in terms of their context within the BCSWMP.

## 2. Watershed Issues

The Jackson Ditch watershed is approximately 10.2 square miles in area and is situated over the Lower Great Miami Valley Aquifer system, which serves as a primary drinking water withdrawal source for residents and industry in the area. Land use in the watershed is predominately comprised of a mix of rural residential, light agricultural, and urbanizing areas; but there are also some light industrial uses such as the Miller Brewing Company facilities and Duke Energy (formerly the Cinergy Corporation).

The City of Trenton is perhaps best described as a bedroom community and most of the development taking place in the area is related to the residential sector. Areas once reserved for rural residential and agricultural land uses are slowly being converted to

urbanized residential neighborhoods. The inclusion of land uses such as restaurants, gas stations, and small scale commercial services is typical with increased urban residential land use and is currently occurring in conjunction with development of nearby residential neighborhoods.

The threats and stressors to storm water associated with urbanization in this watershed are typical for this region of the country, with the increased percentage of impervious area being the largest contributing factor. Urbanized areas are characterized by an increased density of homes, buildings, roads, parking lots, and other areas that ultimately result in an increased percentage of impervious area in the watershed. Increased impervious area leads to less infiltration and a more direct linkage between rainfall and runoff that flows into the stream network. Ultimately, more runoff occurs, and it occurs at a faster rate. Urbanization often leads to increased storm water quality impacts, as urbanizing areas have more sources of potential pollutants and these pollutants have fewer barriers (such as vegetation) to prevent the pollutants from entering the stream network.

The Jackson Ditch watershed is not immune to these issues. The pervious nature of the soils and the importance of the underlying aquifer as a water supply source provide challenges when dealing with potential storm water problems in the watershed.

## 2.1. Recognized Problems

The research and modeling efforts performed for this study indicate two potential storm water quantity issues for the watershed: flooding along Jackson Ditch, and decreased infiltration/recharge of storm water in the upper portion of the watershed. Flooding is characterized as a short-term event based problem that impacts homes and properties and represents a temporary disruption for residents, while the recharge problem is more of a long-term issue that affects overall water recharge to the aquifer.

Based on the water quality modeling, the overall water quality associated with the storm water runoff appears to be good from a drinking water source perspective, but surface water quality may be slightly impacted by development and could be improved. In the context of this study, surface water quality relates to the presence of contaminants that affect overall health and vitality of aquatic organisms and plant life in and along the stream. Since the underlying aquifer system is so important as a drinking water source, long-term protection of the quality of the water that feeds the aquifer must be a fundamental goal of the SWMP for the Jackson Ditch watershed.

Several areas of the watershed have been identified as particularly sensitive to storm water quality and quantity issues. These areas should be targeted for the SWMP and are shown on the Planning and Protection Map included as Figure 1.

### 2.1.1. Flooding

The flooding experienced by residents of the watershed and predicted by the modeling efforts for this study is comparatively minor and more of a nuisance rather than a permanent threat to life or property. There are, however, several properties and homes currently affected by flooding or at risk of flooding and it appears that some limited repetitive damages frequently occur. With increased development in the watershed, potential flooding risks and damages are realized in the form of increased flood magnitudes that occur on a more frequent basis. Two areas of particular flood concern are the area just north of the railroad

culvert located south of Hamilton-Trenton Road where Riverside Drive previously crossed Jackson Ditch and the area located southwest of that location along the north side of Hamilton-Trenton Road. Flooding occurs throughout the southern end of the watershed as well, but this flooding does not affect any existing structures.

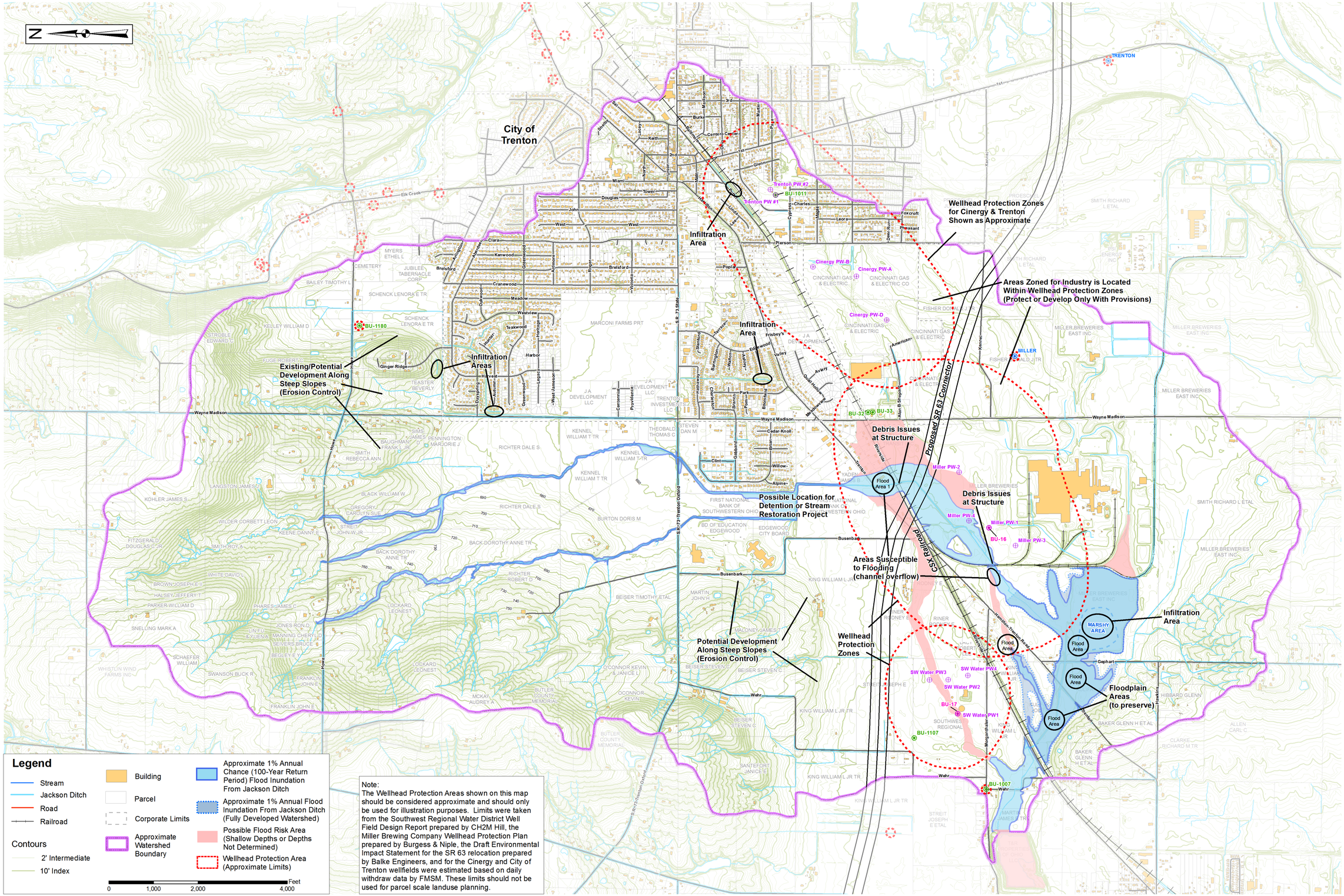
Several factors contribute to these flooding issues including: insufficient capacity of the channel and hydraulic structures along the reach, accumulation of debris upstream of the structures, and a channel geometry that promotes overland flow into adjacent areas during large events. Excess debris seems to clog the channel and structures frequently, and removing this debris to maintain positive drainage continues to be a maintenance burden for the City of Trenton, local townships, Butler County, and nearby property owners and residents. In addition, development in the upstream watershed continues to increase the amount of storm water runoff contributed to Jackson Ditch.

Flooding attributable to specific sources is discussed below. The numbers associated with the problem areas correspond to the areas indicated on the Planning and Protection Map shown as Figure 1.

Area #1 experiences flooding due to the adjacent railroad embankment and a significant restriction of flow caused by the culvert. The dual 5' x 6' concrete box culvert that is in that location now, may have been adequate when it was installed, but over the years as changes in the watershed have occurred, the culvert does not appear to have sufficient capacity for larger storm events. The geometry of the culvert is also conducive to trapping debris, which tends to reduce the capacity even more. Adding to this problem is the fact that the railroad embankment functions in a manner similar to a dam during large flood events that would ordinarily overtop the culvert. The embankment is higher than the surrounding topography and causes a backwater effect that floods the lower area upstream of the fill.

Area #2 is basically located in a low lying area away from the Jackson Ditch channel. The flooding experienced here is primarily shallow overland flow attributed either to spillover from Jackson Ditch across the farm field at the northwest edge of the Miller Brewing Company property or from roadside drainage along Hamilton-Trenton Road.

Area #3 is the area surrounding the low lying marshy area of the Miller Brewing Company property, referred to herein as the Miller Sink. This low-lying area essentially acts as a detention basin for storm water flows from Jackson Ditch. During low intensity events, it greatly attenuates downstream flows. Unfortunately, during large events, the inflow channel is overwhelmed and much of the flow from Jackson Ditch bypasses the Miller Sink and continues downstream towards Gephart Road. Additionally, a large tributary stream flows along the west side of Gephart Road northward to Jackson Ditch.




Note:
The Wellhead Protection Areas shown on this map should be considered approximate and should only be used for illustration purposes. Limits were taken from the Southwest Regional Water District Well Field Design Report prepared by CH2M Hill, the Miller Brewing Company Wellhead Protection Plan prepared by Burgess & Niple, the Draft Environmental Impact Statement for the SR 63 relocation prepared by Balke Engineers, and for the Cinergy and City of Trenton wellfields were estimated based on daily withdraw data by FMSM. These limits should not be used for parcel scale landuse planning.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# Planning & Protection Concept Map

Watershed Study and
Storm Water Management Plan
Butler County Storm Water District
City of Trenton, Butler County, Ohio

| | |
|---|---|
| PROJECT NO. | CN2004074 |
| DATE | APRIL, 2006 |
| DRAWN BY | MAE/ELC |
| CHECKED BY | JR |
| CHECKED BY | |
| SCALE | 1" = 2000' |
| REVISED | |
| 1. | |
| 2. | |
| 3. | |
| 4. | |

SHEET

**FIGURE 1**

I:\2004proj\CN2004074\MXDs\Planning_Protection_Map.mxd

Area #4 encompasses the southern end of the watershed from Riverside Drive and the CSX Railroad in a southeast direction to the west side of Gephart Road. As in Area #1, problems here are associated with culverts and structures, but the problems in this reach are far less specific. The general contribution of storm flows from Area #3 is the first problem in the area. The channel and structures are essentially overwhelmed due to the magnitude of contributing flow. The topography of the reach also contributes to the problem. The reach is located in a portion of the watershed with an overall mild downstream slope that does not drain well and serves as the natural floodplain for the watershed. In addition, several of the culverts in the area have been installed with grades not conducive to efficient drainage. For example, the dual 24" corrugated metal culverts beneath Hamilton-Trenton road in this area have inverts that are situated approximately 2-3 feet above the grade of the upstream channel. Portions of this channel also exhibit adverse slopes over short reaches.

### 2.1.2. Aquifer Recharge

During the initial research phase of the project, much of the research data suggested a continuing pattern of reduced groundwater levels in the upper portion of the aquifer. Many of the area residents that have shallow wells have had water supply problems over the years. The Miami Conservancy report, "Groundwater Elevation Trends in the Buried Valley Aquifer near Trenton, Ohio", (M. Bamberger, Dave Bean, Mike Ekberg), July 2001 explored the issue. The report concluded that the effect is caused by a combination of increased withdraw from the aquifer by major facilities and a cycle of reduced groundwater recharge associated with intermittent drought periods.

Based on the results of the modeling, it is apparent that reduced stormwater recharge in the upper reaches of the aquifer and the Jackson Ditch watershed may also be a contributing factor to the downward trend in water levels. The upper extents of the watershed historically have been characterized by agricultural, pasture, and wooded areas which are conducive to storm water infiltration. As development occurs in the upper portions of the watershed increased impervious area is created. Instead of local infiltration, storm water increasingly is transmitted directly to the channel network and flows downstream towards the south end of the watershed where it ponds and causes flooding. There does appear to be significant infiltration capacity in the Miller Sink, but this area is down gradient of much of the effective shallow well withdrawal zones from the aquifer.

### 2.1.3. Water Quality

There can be numerous potential contaminants in urban storm water runoff, but increased levels of a few select constituents often serve as an indicator of overall water quality. As development occurs in a watershed it is reasonable to expect that the stream would have increased levels of phosphorus, copper and zinc (trace metals), along with chloride, and suspended solids. This is the typical trend for urbanizing watersheds and these parameters have been included in the HSPF modeling performed for this study. The HSPF model results reflect this increasing trend, however increased contaminant levels are not anticipated to occur in concentrations that would significantly impact groundwater in the aquifer. This does not necessarily signify an unpolluted stream system. As the in-stream concentrations of these constituents increases it is possible that they could affect the streams' ability to provide adequate surface water quality.

Phosphorus and nitrate impairment in streams generally relates to excess nutrients and contributes to eutrophication, which negatively affects aquatic organisms and upsets the algal balance in the stream. The source of phosphorus loading in this watershed is primarily fertilizer application associated with agricultural and residential land uses. Nitrate loading is also often associated with fertilizer application, however nitrate loading is usually much higher with agricultural land uses than residential ones. Since much of the agricultural areas in this watershed are expected to develop towards more urbanized residential type land uses, phosphorus and nitrates are not a significant concern at this time.

Another related item to fertilizer application worth noting is the application of pesticides and herbicides. Depending on the nature of the chemicals used, these substances can pose a threat to surface water quality wherever they're applied, even in small quantities, because they are usually slow to degrade. Though not specifically modeled, the assumption that pesticides and herbicides generally do not degrade indicates the need for control of their application in the watershed because it does not have a formal outlet and these materials would tend to accumulate and infiltrate in the southern portion of the watershed.

Zinc and copper were modeled for this watershed to serve as surrogates for a larger group of metals that are potential surface water pollutants. As areas become more urbanized there is an increased risk of this type of metal pollution, mainly due to the increased number of automobiles. The addition of large commercial parking lots centralize this risk. Industrial areas that use metals or have large outdoor storage areas can also be a source for metals. The metal loading in this watershed is not expected to greatly exceed surface water quality standards, but long term protection should be a priority.

Chloride loading is believed to be a relatively minor issue at this point, but it's feasible that it could eventually affect surface water quality. Chloride loading often comes from natural sources, but in this case the source is expected to be associated primarily with road salt and deicing applications during the winter months. As the area develops and becomes urbanized, an increase in the number of roads and streets will likely lead to an increase in the required winter maintenance and an increased need for road salts and deicing chemicals to be applied. The application or roadway salt and deicing compounds during winter is a large, but necessary, expense for the county, and proper application both protects surface waters and leads to cost savings for the county.

Suspended solids is a measure of particulate loading in a stream and primarily relates to the amount of sediment in the stream. Any metals contained in the stream would also be included as part of the suspended solids measure, but those particles are usually at much smaller concentrations than sediment and are only a small proportion of the suspended solids measure. Sediment from a developing watershed is typically associated with bare land that often accompanies development and the erosion of in-stream channel features. Suspended solids is a substantial part of the Ohio EPA's NPDES permit initiative and will continue to be an issue for the watershed and Jackson Ditch as development continues.

For the modeling efforts for this study, FMSM performed a conceptual analysis of a developing tract of land located northwest of the intersection of S.R. 73 and Wayne-Madison Road using the Revised Universal Soil Loss Equation (RUSLE) approach. This analysis predicted that converting a tract of land that previously had cover similar to a pasture into a bare construction site resulted in an increase in erosion potential as much as 100 times the undisturbed state. Additionally, increased slope corresponds directly to increased erosion potential. The conclusion is that erosion potential and sediment control are significant issues

with new development and particularly in steeply sloped areas, but the analyses also showed that the application of BMPs, interim cover, silt controls, and other management practices could reduce this erosion potential by 70-80%. Based on these analyses, the erosion and sediment issues demonstrated here are no more significant than those occurring in other developing areas of this region and should not require any special provisions other than the typical BMPs and management practices specified in development manuals such as the forthcoming "Ohio Department of Natural Resources (ODNR) Rain Water and Land Development Manual".

## 2.2. Other Observations

The flooding, aquifer recharge, and water quality issues described above are directly supported by the modeling efforts performed for this study. The last category of problems in the watershed are less tangible and relate to things that the FMSM team observed during the process of developing the storm water management plan and preparing the models.

### 2.2.1. Stream Stability

FMSM has extensive expertise dealing with stream restoration, natural channel design, and field assessment of stream morphology. As part of the modeling and assessment efforts for Jackson Ditch, FMSM reviewed topographic and soils data for the area and performed a visual assessment of the Jackson Ditch stream corridor from a stream morphology perspective.

The area's topography and soil characteristics are key to understanding the stream stability and conditions along Jackson Ditch. In the upper, northern reaches of the Jackson Ditch watershed, the topography is somewhat steep and soils are primarily clays or silt loams situated over shallow bedrock. The stream channels in this area were formed by erosion and natural runoff. Towards the central and southern portion of the watershed, the topography is flatter and the soils are predominantly shallow silt loams underlain by sand and gravel. The natural tendency for storm water runoff in this portion of the watershed is to pond and infiltrate. The stream channels that are there have only a slight gradient and generally have been created as positive drainage pathways for adjacent areas. This is evident by Jackson Ditch, which was originally created as a dredged channel to promote drainage of the adjacent farm fields.

The setting of the Jackson Ditch corridor is an excavated channel that has silty banks that are typically vegetated with trees and woody brush. The channel bottom is characterized by clayey soils and has localized thin depositions of sand or small gravel (pebbles). The clayey soils appear to have origin in the upper reaches of the watershed, while the sand and gravel appear to come from the exposed underlying gravelly-cobbly substrate in the immediate vicinity of the stream channel. Observations of well logs and geologic data for the area support the trend of surface soils comprised generally of silt loams or loams to a depth of 6-8 feet with sands and gravels underlying, which supports the visual assessment.

Some small deposits of fine sand were also observed in lower portions of the watershed, primarily in the channel bed areas. This sand formed ripples in pools, was embedded in and found below the pebbles, and formed sand bars around debris blockages. Deposits of sand along the channel banks were conspicuously absent. This observation is indicative of a low gradient stream channel that can carry some fine sand and small pebbles as bed load, but is incapable of generating enough turbulence to suspend fine sand and deposit it along the

banks. Based on the nature of the deposits observed in the southern portion of the watershed, the predominate sediment transport mechanism for this channel appears to be the suspension of fine silt and clay particles during large flow events. The cobble and large gravel found in the headwater areas does not appear to be transported downstream to a significant extent.

Finer sediment of the nature found in this stream generally is attributed to the channel itself or from adjacent overland areas. Erosion of the channel appears to be localized and does not appear to be severe, as the channel commonly had a "U" shape at the bottom of its banks. In the central and upper portion of the watershed, neither branch appears to have severe bank erosion problems, while in the lower watershed the channel banks look to be stable in form. The plowed farm fields nearby were conspicuously absent of rill erosion. Therefore, if these fields are loosing significant amounts of sediment, it is by sheet flow mechanisms. A more likely explanation for the sediment in the southern portion of the watershed is due to accumulation over the years associated with transport during storm events.

Overall, sediment loading does not appear to be severely impacting the stream and the Jackson Ditch channel is in good condition for an urbanizing watershed. However, erosion and sedimentation should be monitored for long term conditions and changes in the watershed. This is perhaps most evident in the Miller Sink portion of the watershed. As a sink, this marshy area must absorb water into the ground and naturally collects debris, sands and silts. There is an existing porosity and transmissivity of the area's soils that establishes the loading rate for storm water infiltration. Intuitively the collection of debris, sand and silt can only lower this area's transmissivity and porosity due to clogging. The shedding of leaves and branches in this marshy area likewise would intuitively reduce transmissivity and porosity. As infiltration gradually decreases at this infiltration location, the frequency and duration of floods that divert water to the Gephart Road culvert could increase. As changes in the watershed occur, performance of the Miller Sink infiltration system along with any increases in the rate of meandering bank erosion along Jackson Ditch should be noted as indicators that the stream is experiencing stress due to excessive sediment loading or increased velocity gradients.

### 2.2.2. Debris

Although, the Jackson Ditch stream corridor appears to be fairly stable with relatively minor sediment loading issues, our observation indicates that excess debris appears to be an issue in this watershed. A significant amount of heavy debris such as concrete rubble, fence post foundations, metal pipes and bricks were noted along the stream corridor. These materials were most likely discarded or deliberately placed in the stream channel. Additionally, discarding floating debris into the system appears to be widespread, including lawn cuttings, brush disposal, leaves, and cut tree trunks and branches. One of the most egregious locations for floating debris and trash appears to be near the school district property east of Busenbark Road. This debris tends to accumulate upstream of the bridges and culverts along the reach. Only the largest bridges and culverts on this stream system seemed to be unaffected by debris jams, with the smaller railroad culverts being most affected.

### 2.2.3. Source Water Protection

Another important issue in the watershed that should not be overlooked is the importance of protecting it as a drinking water source watershed. The number and quantity of withdrawals from the aquifer are often highlighted and most people realize the importance of not taking water away from the aquifer, but good housekeeping practices to keep potential pollution from entering the aquifer is also imperative. The wellhead protection plans prepared for the Southwest Regional Water District, Miller Brewing Company, Duke Energy, and the City of Trenton all focus on these types of issues. The approximate wellhead protection zones from those reports have been captured and are indicated on the Planning and Protection Map presented as Figure 1.

### 2.2.4. Development Practices

The last item noted by the FMSM team during the project is the somewhat inconsistent application of certain development practices and storm water controls in the watershed. The City of Trenton seems to do a good job managing local storm water management issues, but many of its policies differ from those applied to other parts of Butler County. As an example, dry wells are used throughout the City of Trenton. The dry wells function well as storm water control facilities and are cost effective, but they are not applicable to other parts of Butler County. Historically, these facilities have worked well for the area, but due to their direct-connect relation to the aquifer they do pose a water quality contamination risk, particularly near commercial and industrial areas. Land uses such as gas stations and restaurants, along with others that have large parking areas, require more stringent water quality controls. Gas stations pose a particular risk due to the potential for non-degradable hydrocarbon and volatile organic pollutants. Mechanical filtration devices can help alleviate this threat, but there does not appear to be a regulatory mechanism in place to require these types of facilities to be installed. Additionally, the varying jurisdictions make it difficult to assure such requirements are uniformly and consistently applied and enforced.

## 2.3. Summary of Issues

As outlined above, through the modeling efforts, field reconnaissance visits, interviews, literature review, and research the following issues were identified as having particular importance for the Jackson Ditch watershed:

- Recognized existing flooding or risk of flooding in at least four (4) areas
- A trend of reduced aquifer recharge
- Surface water quality concerns associated with future development
- Contribution and accumulation of debris in the stream
- Aquifer/groundwater source water protection
- Development practices

# 3. Potential Solutions

Solutions to the issues observed in the Jackson Ditch watershed that help alleviate or ease their impacts include: structural facilities and mitigation options related to capital improvement projects, education initiatives, pollution prevention through good housekeeping practices, adoption of common development and construction practices, and increased public outreach.

## 3.1. Structural Options

The concept of a structural storm water solution or mitigation option refers to any of a number of facilities that can be constructed or installed to ease or eliminate storm water pollution and/or flooding impacts in the watershed. These solutions have a relatively short time frame for implementation, generally require a large up-front expenditure, and require cooperation by property owners. The most practical applications in this watershed appear to be channel and culvert improvements along Jackson Ditch, the construction of one or more detention/retention basins, and retrofits of existing storm water catch basin facilities.

### 3.1.1. Channel Improvements

To relieve flooding along a stream such as Jackson Ditch one option is to enlarge the channel to provide additional capacity or improve conditions along the channel to increase downstream conveyance. The goal of such a channel improvement would be for flood flows to remain in the channel and be transported efficiently downstream out of the watershed. These types of channels typically have a uniform rectangular or trapezoidal section and are often constructed of concrete or other durable material to promote efficient flow and channel stability. The alignments are usually as straight as possible for economic reasons and the transition from a condition of little or no flow to full channel flow during a storm event can occur rapidly. The large trapezoidal concrete channels now found in many urban areas are a classic example of this approach.

There are several advantages to channels of this construction type such as: increased flood protection, reduced maintenance, efficient debris handling capabilities, and overall durability, but unfortunately there are also several disadvantages including: cost, increased risk associated with flash flood events, and an increased risk of downstream flooding. Concrete and constructed channels quickly and efficiently convey storm water runoff out of the watershed, but in doing so increase the risk for downstream areas.

In the Jackson Ditch watershed, it is possible that a constructed or improved channel could overwhelm the capacity of the gravel pit areas downstream and pose an increased flood risk to downstream areas towards the community of New Miami. Transferring the majority of stormwater runoff directly downstream is also contrary to the goal of maintaining aquifer recharge in the upper portions of the watershed. Due to these two factors and through conversations with the Butler County Engineer's Office, it was determined that channel improvement of this nature was not desirable for Jackson Ditch.

### 3.1.2. Natural Stream Restoration

An alternate channel reconstruction technique that could be used for Jackson Ditch is the natural stream restoration approach. This method of channel improvement has similar goals of maintaining flow within the constructed areas of the channel, but the channel design is greatly enhanced to provide a more natural floodplain area and includes meanders and stream bottom features such as riffles and pools that eliminate much of the need for durable channel lining. The addition of an adjacent floodplain area also would promote infiltration of flood waters. The absence of channel lining and the aesthetic benefits of this type of channel makes natural stream restoration a more economical and viable alternative.

### 3.1.3. Culvert Improvements

Improving culverts along Jackson Ditch could be a solution as a flood mitigation option, however, the most effective implementation of this approach would involve replacing the two culverts beneath the CSX Railroad at crossings along Riverside Drive. Construction associated with critical railroad facilities such as this one can be extremely costly, and interruptions to rail service usually must be minimized or avoided. That limits the types of culvert replacement techniques to installation in place, via pipe jacking or similar technologies, or construction of a temporary bridge/realignment to maintain service to the rail line. Given the scale of the culverts involved and the fact that construction would be required in two locations, replacement of these culverts would not seem to be a practical mitigation option. Unfortunately, according to the hydrologic and hydraulic modeling, without replacing these two structures improving or replacing the other structures along Jackson Ditch does not appear to be an effective solution for flood reduction.

Essentially, the anticipated costs and difficulty of culvert improvements are believed to out-weigh any benefits gained through flood risk reduction. In addition, increased culvert capacity could have the same negative effects as the channel reconstruction discussed above and increase the risk of flooding to downstream areas. Through conversations with the Butler County Engineer's Office, it was agreed that culvert replacement was not a desirable option.

### 3.1.4. Regional Detention Basin

A practical option for reducing flooding in the southern portion of the watershed is to simply reduce the flow in Jackson Ditch. This is accomplished through reduced volume of runoff or through reduced peak flow values associated with prolonged runoff time periods. Reducing the volume of runoff is achieved through onsite capture and retention usually associated with management practices. These types of activities are discussed below. Reduced peak flow values and prolonged runoff times are accomplished with detention facilities.

The function of a detention facility is to capture runoff occurring at a rapid rate, store it for a short time, and then slowly release it over a longer time frame than would naturally occur. The net volume of storm water runoff usually does not change significantly, but the peak discharge rate changes because of the storage and timing effects. As an example, a detention basin may function to capture runoff from a storm with a six hour duration and release it slowly at a reduced rate for the following 24-hours. The increased detention time not only promotes a reduction in flood flows, it also provides a greater opportunity for

pollutant removal through settling and plant uptake, and reduces stream velocity and erosion potential downstream. Depending on the construction of the facility, it could also promote infiltration into the groundwater, thus reducing flood volumes and peak flood flows to an even greater extent.

Detention facilities can function effectively on small and large scale applications with a variety of different design criteria and goals. A large regional facility provides the most efficient use of property, requires less aggregate maintenance, and is easier to manage from a performance perspective. However, large regional facilities can be costly to construct and require a significant tract of land. In this watershed there is an existing tract of land situated between the two branches of Jackson Ditch near the middle of the watershed south of S.R. 73 and east of Busenbark Road that appears to be a good potential location for a basin of this nature.

Design criteria and goals for detention basins vary greatly. The most common goal is to reduce post-construction peak flow values for a given return period to be at or below existing conditions for that same return period event. For example, to reduce the fully developed 100-year 6-hour storm peak flow in Jackson Ditch near Hamilton-Trenton Road at Busenbark Road to that of the existing conditions would require approximately 25 acre-feet of storage. Unfortunately, since flooding in the area just downstream (Area #1 from the discussion above) already occurs for existing conditions, a basin sized to control fully-developed or future development to that of existing conditions would provide little net benefit and additional storage is required to reduce the flooding. According to our analyses, there are approximately 21 homes and associated structures in the existing 100-year floodplain in this area. Completely eliminating flood risks to the structures this area would essentially require the peak runoff from a 100-year 6-hour storm to be reduced to that of approximately a 5-year 6-hour storm.

For planning purposes, FMSM performed conceptual analyses for regional detention facilities that would accomplish the goal of removing the 21 structures from the floodplain. A facility located on either branch of Jackson Ditch alone was found to be insufficient for flood control purposes, so a conceptual basin was developed at the junction of the two branches of Jackson Ditch. A detention basin with storage on the order of 150 acre-feet located east of Busenbark Road at the confluence of the two stream reaches was found to be sufficient to meet the area's flood control requirements. The conceptual basin geometry, conceptual hydraulic data, along with pre- and post-detention floodplain inundation limits is included in Appendix B.

To evaluate the cost effectiveness of the conceptual detention basin, FMSM used property value data from the Butler County Auditor's office and construction cost data based on industry knowledge to develop a conceptual project cost derivation for the basin. This analysis is included in Appendix B. When comparing capital improvement project costs of a detention basin, the baseline of comparison is typically the cost of the buy-out alternative. In that scenario, the existing conditions are assumed, but the problem is solved by purchasing the properties in the floodplain and demolishing the structures. Conceptual buy-out project costs are also included in the cost derivation.

Based on the analyses performed by FMSM a regional detention basin located east of Busenbark Road and north of Hamilton-Trenton Road functionally appears to be a viable option for flood control, but economically would depend on the funding mechanisms employed and the community's desire to construct the facility. Based on our preliminary

analyses, it is estimated that the construction costs for a regional detention basin would be on the order of $5.6 million with corresponding direct buy-out costs on the order of $3.3 million.

### 3.1.5. Water Quality Retrofits

Another structural option worth considering for this watershed is the incorporation of mechanical filtration devices for certain high-risk catch basins and storm inlets. The current practice in the City of Trenton is to route storm water runoff through catch basins to dry wells, where the water is allowed to infiltrate. This practice has been applied at numerous locations throughout the watershed and poses a particular pollution risk for gas stations and commercial areas with heavy traffic patterns. Retrofitting catch basins and dry well inlets in these high risk areas with mechanical pretreatment devices to protect groundwater quality associated with infiltration may be worth considering. These types of devices should certainly be considered for new development or re-development scenarios.

## 3.2. Non-Structural Options

In contrast to structural solutions that are often related to capital improvement projects, non-structural mitigation options are more related to storm water management practices and construction/design techniques that promote desirable storm water runoff characteristics. Non-structural options usually take the form of Best Management Practices (BMPs) or programmatic concepts like storm water design, construction, and inspection programs. Examples of a few of the BMP options include mowing, fertilizer and pesticide application practices as well as a number of other land use and construction site BMPs. These solutions are usually implemented on a smaller scale, sometimes on a parcel-by-parcel basis, and the effects are realized cumulatively throughout the watershed. Due to the small scale implementation and the cumulative nature of their impact, non-structural mitigation options must be applied broadly across the watershed and it often takes several years before any tangible results, such as decreased sediment loading, are achieved on a watershed scale. The greatest benefits are achieved by implementing appropriate measures during times of high impact, such as during construction and new development.

### 3.2.1. Best Management Practices

Storm water BMPs are any of a number of facilities or construction techniques that are often incorporated into new development to promote effective control of storm water runoff. Practices such as vegetated filter strips, grassy swales, and low-impact development techniques are examples of BMPs that fit well with this approach, and there are numerous others. FMSM has researched and identified a number of these BMPs that have particular application to this watershed.

As an example BMP application, consider a new development where grassy swales are used instead of constructing drainage pathways as straight rigid lined channels. These swales are geometrically designed to minimize flow depth and velocity, thus decreasing flood and erosion potential. The swale is lined with thick vegetation which is more cost effective than rip-rap or concrete channel lining and more aesthetically appealing. The vegetative lining is generally selected to be adequate for preventing channel scour and protecting the surrounding area, but it also has benefits as a pollution removal mechanism. Plant cover

that has storm water flowing over or through it is effective as a pollution control mechanism because it can remove particulate matter through filtration and capture, and it removes pollutants through biological uptake of the materials.

Table 1 includes an application matrix that categorizes a number of commonly used BMPs that may be applicable to the watershed, and includes the types of benefits and relative costs associated with their application. In addition, Appendix C contains references to several sources of additional information including reports, websites, online databases, and the like. Section 4.3 of this report contains recommended criteria and goals for different land uses that describes where particular BMPs should be applied.

The Butler County Engineer's Office retained the consultant team of Fuller, Mossbarger, Scott and May Engineers, Inc. (FMSM), XCG Consultants (XCG), and Eagon and Associates (EAGON) to perform a watershed study and prepare a storm water management plan for a developing watershed located on the west side of the City of Trenton in Wayne and St. Clair Townships of Butler County, Ohio.

The first phase of the Jackson Ditch watershed study consisted of a data gathering effort to characterize the current conditions in the watershed. A report describing that phase of work was submitted by FMSM on July 27, 2005. The second phase of the project developed water quantity and quality models to simulate current and future conditions in the watershed. A draft report describing those efforts was submitted by FMSM and XCG on February 6, 2006 and the final version of that report is being submitted under separate cover. The third and final phase of the project is to develop a storm water management plan (SWMP) for the watershed.

**Table 1. BMP Application Matrix**

| BMP or Storm Water Management Measure | Effectiveness: Quantity: Peak Flow | Quantity: Runoff Volume | Quality: Floatables & Debris | Quality: Sediment & Particulates | Quality: Dissolved Oxygen | Quality: Nutrients (Phosphorus & Nitrogen) | Quality: Metals | Quality: Conservative Pollutants | Relative Cost |
|---|---|---|---|---|---|---|---|---|---|
| **Storm Water Program & Design Practices** | | | | | | | | | |
| Adopt-A-Watershed | | | • | | | | | | $ |
| Education and Outreach | | | • | • | | | | | $ $ |
| Illicit Discharge Detection and Elimination | | | • | • | • | • | • | • | $ $ $ |
| Lawn Care / Debris Education Program | | | • | • | | | | | $ $ |
| Low Impact Development | • | • | • | • | • | • | • | • | $ $ $ |
| Source Water Protection Program | | | | | | • | • | • | $ $ |
| Storm Drain Inlet Stenciling | | | • | • | • | | | • | $ |
| Stream Cleanup | | | • | | | | | | $ |
| Waste Recycling Programs | | | • | | | | • | • | $ $ $ |

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| BMP or Storm Water Management Measure | Effectiveness: Quantity: Peak Flow | Quantity: Runoff Volume | Quality: Floatables & Debris | Quality: Sediment & Particulates | Quality: Dissolved Oxygen | Quality: Nutrients (Phosphorus & Nitrogen) | Quality: Metals | Quality: Conservative Pollutants | Relative Cost |
|---|---|---|---|---|---|---|---|---|---|
| **Storm Water Controls** | | | | | | | | | |
| Bank Stabilization (Willow Trees, etc.) | | | | | | | | | $ $ |
| Basins | | | | | | | | | |
| Bioretention Basins | ● | ● | ● | ● | ● | ● | ● | ● | $ $ $ |
| Detention Basins | ● | ● | ● | ● | ● | ● | ● | ● | $ $ $ |
| Infiltration Basins | ● | ● | ● | ● | | ● | ● | ● | $ $ $ |
| Retention Basins | ● | ● | ● | ● | ● | ● | ● | ● | $ $ $ |
| Channel Design | ● | ● | ● | ● | ● | | | | $ |
| Check Dams | | | ● | ● | | | | | $ $ |
| Constructed Wetlands | ● | ● | ● | ● | ● | ● | ● | ● | $ $ $ |
| Dry Wells | | ● | ● | ● | | | | | $ $ |
| Earth Dikes & Filter Berms | | | ● | ● | | | | | $ $ |
| Impervious Area Management | | | | | | | | | |
| Green Parking Lots & Sidewalks | | ● | | ● | | | ● | ● | $ |
| Narrower Residential Streets | | ● | | ● | | | ● | ● | $ |
| Porous Pavements | | ● | | ● | | | ● | ● | $ $ |
| Infiltration Trenches | | ● | ● | ● | | ● | ● | ● | $ $ |
| Inlet / Outlet Protection | | | | ● | | | | | $ |
| Mechanical Pretreatment Devices | | | ● | ● | ● | ● | ● | ● | $ $ $ |
| Media Filters(Sand filter, Organic filter) | | | ● | ● | ● | ● | ● | ● | $ $ |
| Pipe Slope Drains for Steep Slopes | | | | ● | | | | | $ $ $ |
| Riprap Channel and Area Stabilization | | | | ● | | | | | $ $ $ |
| Sediment Basins | ● | | ● | ● | | | | ● | $ $ $ |
| Sediment Traps | | | ● | ● | | | | ● | $ $ |
| Surface Roughing (Terracing) | ● | | | ● | | | | | $ $ |
| Vegetated Filter Strip | | ● | | ● | ● | ● | ● | ● | $ |
| Vegetated Swale / Grassed Swale | | ● | | ● | ● | ● | ● | ● | $ |

## Table 1. BMP Application Matrix

| BMP or Storm Water Management Measure | Effectiveness | | | | | | | | Relative Cost |
|---|---|---|---|---|---|---|---|---|---|
| | Quantity | | Quality | | | | | | |
| | Peak Flow | Runoff Volume | Floatables & Debris | Sediment & Particulates | Dissolved Oxygen | Nutrients (Phosphorus & Nitrogen) | Metals | Conservative Pollutants | |
| **Construction Site Storm Water Management** | | | | | | | | | |
| Clearing and Grubbing Practices | | ● | | ● | ● | ● | | | $ |
| Construction Entrance Stabilization | | | | ● | | | | | $ $ |
| Construction Phasing | ● | ● | | ● | ● | ● | | | $ |
| Dust Control | | | ● | ● | ● | ● | | | $ $ |
| Geotextile Slope Control | | | | ● | ● | ● | | | $ $ |
| Mulching and Vegetation Mats | | | | ● | ● | ● | | | $ $ |
| Preservation of Existing Vegetation | ● | ● | ● | ● | ● | ● | | | $ |
| Seeding and Sodding (Temporary and Permanent) | ● | ● | ● | ● | ● | ● | ● | ● | $ $ |
| Silt Fences | | | ● | ● | ● | ● | | | $ $ |
| Topsoil Stockpiling | | | ● | ● | ● | ● | | | $ |
| **Storm Water System Operation & Maintenance** | | | | | | | | | |
| Automotive Product Disposal & Recycling | | | | | | | ● | ● | $ $ |
| BMP Maintenance | | | | | | | | | |
| Catch Basin Cleaning | | | ● | ● | ● | ● | ● | ● | $ $ |
| Sediment and Floatable Removals | | | ● | ● | | | | | $ $ |
| Vegetation Maintenance | | ● | | | ● | ● | ● | ● | $ $ |
| Culvert Maintenance | ● | | ● | ● | | | | | $ $ $ |
| Fertilizer Application Control | | | | | ● | ● | | ● | $ |
| Good Housekeeping - Residential Areas | | | ● | | ● | ● | ● | ● | $ |
| Good Housekeeping - Commercial & Industrial Areas | | | | | ● | ● | ● | ● | $ |
| Household Hazardous Material Disposal | | | | | | | ● | ● | $ |
| Land Use Modification | ● | ● | ● | ● | ● | ● | ● | ● | $ $ $ |
| Lawn Debris Management | | | ● | ● | | | | | $ |
| Material Handling and Storage | | | ● | ● | | ● | ● | ● | $ $ |
| Parking Lot and Street Sweeping | | | ● | ● | | ● | ● | ● | $ $ |
| Pesticide/Herbicide Application Control | | | | ● | ● | ● | | ● | $ |

**Table 1. BMP Application Matrix**

| BMP or Storm Water Management Measure | Effectiveness: Quantity: Peak Flow | Quantity: Runoff Volume | Quality: Floatables & Debris | Quality: Sediment & Particulates | Quality: Dissolved Oxygen | Quality: Nutrients (Phosphorus & Nitrogen) | Quality: Metals | Quality: Conservative Pollutants | Relative Cost |
|---|---|---|---|---|---|---|---|---|---|
| Pet Waste Disposal | | | | | • | • | | | $ $ |
| Road and Ditch Maintenance | | | | • | | | • | • | $ $ |
| Road Salting and Deicing | | | | • | | | • | • | $ $ $ |
| Structural Improvements / Mitigation Options | | | | | | | | | |
| Channel Modification | • | | • | • | • | • | | | $ $ $ |
| Culvert/Bridge Replacement | • | | • | | | | | | $ $ $ |
| Regional Basin | • | • | • | • | • | • | | | $ $ $ |
| Stream Restoration | • | • | • | • | • | • | | | $ $ $ |

Although these options are not a "quick fix" for problems in the watershed, they do have several benefits that make them attractive storm water management techniques including: generally low ongoing maintenance requirements, ease of construction, and improvement potential for both storm water quantity and quality. Additionally, BMPs are usually required for new developments, which means the developer, land owner, home owner's association, or similar group would bear the cost of installation and maintenance, which reduces the economic burden on the local municipalities involved.

### 3.2.2. Storm Water Management Program Elements

The Butler County Storm Water District was originally formed in 2002 to address NPDES water quality permit issues. In February, 2003 a Storm Water Management Plan (SWMP) was issued that includes activities that BCSWD will undertake to address and effectively manage water quality within its jurisdiction. Of particular note from the SWMP was the development of common construction and post-construction site storm water runoff control guidelines that will be implemented throughout the entire BCSWD jurisdiction.

Through discussions with the Butler County Engineer's Office it is our understanding that they are currently reviewing requirements of the ODNR "Rain Water and Land Development Manual" and the Ohio Department of Transportation (ODOT) "Location and Design Manual" for storm water and other development practices that will be used to enhance the county's current subdivision regulations. As a part of that effort, the Butler County Engineer's Office is currently developing additional design guidance for aspects of storm water quantity control.

Expanding the development control concepts outlined in the BCSWMP to include detention basin design criteria and other quantity aspects would greatly benefit effective storm water management, but could make varying jurisdictional design criteria an issue if not

implemented correctly. The Jackson Ditch watershed is currently situated in five different jurisdictional areas: Butler County; Madison, St. Clair, and Wayne Townships; and the City of Trenton. Each of these areas could feasibly have different storm water design criteria under current ordinances. The consequence is that development in different parts of the watershed would be held to varying standards. Alleviation of these types of issues was one of the motivators for communities to participate in the BCSWD. For fairness to the development community and more importantly to enforce a common set of storm water controls, the common development guideline proposed in the BCSWMP is particularly warranted for this watershed.

# 4. Additional Considerations

## 4.1. Butler County Storm Water Management Plan

The BCSWMP is based on a series of activities that fall under the six minimum control measures specified by the Ohio and National EPA.

### 4.1.1. Public Education and Outreach for Storm Water Impacts

The goal of this category is to educate the general public and members of the community on the impacts of pollution on storm water. Activities already proposed include developing outreach materials, implementing an outreach program, and a storm drain stenciling program. To address the problems in the Jackson Ditch watershed, the BCSWD should expand the efforts to include quantity issues, such as the impact of impervious areas, and the importance of well head protection zones for groundwater protection. It's also important for the BCSWD to include members of the development community and local industries in their outreach efforts. Continued communication with local municipalities and stakeholders regarding storm water issues should also be encouraged. Communications can take the form of media advertisements, stories and articles in local newspapers, direct mail newsletters, websites, roadside signs, direct public meetings, and a variety of other formats.

### 4.1.2. Public Involvement/Participation

The overall goal here is to develop a public involvement program to get stakeholders involved in storm water issues. Planned activities include public meetings and hearings, a citizen storm water advisory panel, volunteer based public education programs, volunteer monitoring, volunteer stream clean-up activities, and establishment of a storm water hotline. With the debris noted in the Jackson Ditch watershed, it would be an excellent candidate for a volunteer stream clean-up effort. This could occur through one or more publicized events or through getting already established volunteer groups involved through adopt-a-watershed programs and similar efforts.

### 4.1.3. Illicit Discharge Detection and Elimination

The focus of illicit discharge detection and elimination programs is often on individuals, industries, and properties where pollution is being introduced intentionally or negligently into the stream network. These discharges often involve conformance to established discharge rates or pollutant levels and involve permits and other controlled activities. Control and regulation of these processes is important for maintaining good water quality, but it is important to recognize the underlying theme is to eliminate pollution, even if it is within

acceptable permit levels. Following that logic, an illicit discharge program could be expanded to address not only discharges that are truly illicit, but also watershed wide issues like debris, fertilizer/pesticide application, good housekeeping practices, etc.

For the Jackson Ditch watershed, the education and outreach initiatives can contribute to this goal. The BCSWD should also encourage local authorities and volunteer groups to be aware of potential sources of pollution and actively seek out ways of reducing or eliminating that pollution. From a practical implementation standpoint, this might take the form of having local authorities and volunteer groups that are "storm water aware" assist with focusing education and outreach activities towards certain types of properties or activities that are impacting the watershed. This could be described as analogous to a neighborhood crime watch, but in this case it would be a watershed pollutant source watch.

This program could also apply to water quantity and flooding issues and development practices. As an example, consider excess runoff from paved areas flowing directly to the stream as being similar to a pollution source. A solution might be to provide information to the property owner on ways to reduce excess runoff through vegetation and landscaping practices. Another example might be to have residents in new neighborhoods help identify potentially avoidable pollution sources that are particularly problematic and notify proper authorities to help focus outreach activities toward contractors and the like. These examples may seem extreme, but the overall concept of making citizens aware and having them assist with the focusing of pollution elimination programs could be a valuable storm water management tool.

### 4.1.4. Construction Site Storm Water Runoff Control

Planned activities for controlling storm water runoff from construction sites revolve primarily around the development of ordinances and design guidance to use for new development and the implementation of BMPs to address runoff, erosion, and sediment control. These goals correspond with the needs of the Jackson Ditch watershed for new development. A number of the BMPs listed in the BMP Application Matrix in Table 1 have benefits that support these goals. Section 4.3 includes specific applications that should be used for individual land use categories.

Based on the issues in the watershed, the most effective BMPs for the Jackson Ditch watershed are those that focus on encouraging infiltration and have the capability of filtering out particulate pollution sources prior to runoff or infiltration. Most of these types of BMPs involve the interface between vegetation and storm water and include: vegetated filter strips, grassy swales, biofilters/bioretention areas, infiltration trenches, and a number of low impact development techniques such as integrated rain gardens or rain barrels. For commercial applications, the appropriate BMPs include these same concepts, but higher risk areas may also require mechanical pretreatment devices such as manhole and catch basin inserts and separated secondary containment or settling basins located on-site prior to discharge to the stream networks. For construction sites, the focus of BMPs should be on erosion and sediment prevention and control, debris management, pollution prevention at construction entrances, and overall spill prevention associated with materials and equipment used on the construction site. On a larger scale, BMPs such as greenways, stream buffers, and green-space preservation can be integrated with land use planning.

Recent trends throughout the industry in the application of BMP programs suggests that the prescription of particular BMPs should be an adaptive approach. The BCSWD should monitor and evaluate installed BMPs and constantly be aware of new technologies and approaches that may be better suitable to Butler County or particular geographic or topographic areas within Butler County. BCSWD is encouraged to seek out new technologies and develop ordinances and development guidelines that allow developers and contractors to propose alternative measures that contribute to the storm water management goals for the immediate area. One solution could be to encourage this creativity and allow the developer to apply the overall concepts within the landscaping and other site development aspects as the site dictates. As an example, rain gardens may be particularly suited for one type of development, while infiltration trenches may be better suited for an alternate type of development or site. The decision of which to include should be a developer decision, and the BCSWD should encourage and adopt performance based standards to allow for that flexibility.

### 4.1.5. Post-Construction Storm Water Management

The key activities described in Butler County's SWMP that address development, other than control of construction activities, are the implementation of ordinances and planning/zoning programs with practices favorable to storm water management.

Implementation of jurisdiction-wide BMPs and design practices requires vigilance on behalf of the authorities involved and cooperation of the developers and landowners that will use the practices. Coordination and communication is the key to the success of the program, and that comes through an effective education and outreach program. Consistency in the program can be achieved through the adoption of effective ordinances and design guidelines. Implementation of BMP requirements as described above and adoption of development manuals similar to the ODNR "Rain Water and Land Development Manual" and the ODOT "Location and Design Manual" will assure facilities are put in place that will promote long term effective storm water management.

One group of facilities, riparian corridors and stream buffer zones, are recommended in the BCSWMP and fit particularly well with the Jackson Ditch stream corridor due to the adjacent residential areas. Incorporating storm water provisions in the long term planning efforts through studies such as this one will allow for green space, riparian corridors, stream buffer zones and the like to be put in place during development and be integrated throughout the watershed. Additional land use and zoning considerations that should be considered are included in section 4.3 below.

### 4.1.6. Pollution Prevention/Good Housekeeping

The activities recommended in the Butler County SWMP for pollution prevention apply mainly to employees and activities associated directly with local governments. The types of activities include training on storm water and pollution issues, and pollution reduction through control of typical activities such as maintenance and material handling. With the education and outreach initiatives described herein, that program could be expanded to include other stakeholders throughout the area. For instance, the BCSWD could conduct a public workshop on storm water pollution prevention to promote keeping debris out of the stream. Another example might be to coordinate with local industries, such as the Miller Brewing Company and Duke Energy, to promote awareness of potential storm water impacts associated with their activities and material handling practices. These industries as well as

organizations such as the Southwest Regional Water District may also be willing to cooperatively conduct workshops to discuss wellhead protection zones and underscore the importance of protecting ground water recharge areas from pollution.

## 4.2. Land Use Considerations

The fundamental assumption for BMP selection and application is that each unique land use has its own unique set of issues and requires selection of the appropriate BMPs to match those issues. There are a few common themes that fit with all the land uses in the Jackson Ditch watershed including: encouraging on-site and near-site infiltration, maximizing vegetation and green space, promoting drainage over and through vegetation, minimizing impervious areas, and focusing on wellhead protection; however, there are also specific recommendations for particular land uses within the watershed. For example, industrial land uses are susceptible to pollution caused by loading dock areas and control of the storm water runoff from these areas is a specific goal for that particular land use. FMSM has developed generalized recommendations for several of the more common land uses in the Jackson Ditch watershed and a summary of each is included in the sections that follow.

### 4.2.1. Industrial / Heavy Commercial Land Uses

This land use category includes industrial properties, large and highly developed commercial properties, and commercial facilities that pose particular risks to storm water runoff such as gas stations and restaurants. In terms of the Butler County Zoning, these properties would be zoned as either Industrial or General Business. The land use is categorized by a high percentage of impervious area and generally has a high rate of vehicular traffic. The increased impervious area leads to high surface runoff rates and makes it relatively easy for conservative particulate pollutants, such as sediment, to be transported across the surface over longer distances to the stream network. Vehicles pose risks due to oil, fuel, anti-freeze, and other fluid leaks and spills. Higher vehicular density also increases the potential for litter and debris. Other potential pollutants of note can include metals generated from stored materials, containers, and vehicles. Properties of particular concern include gas stations, restaurants with grease traps, loading docks with a high percentage of trucks, and industries with large concentrations of exposed metal, especially metal fabrication industries.

Applicable BMPs and Storm Water Management Practices

- Minimize the proportion of impervious areas and limit the extent to which these areas are directly connected to the stream network
- Avoid flow concentration in curb-and-gutter and pipe drainage systems to the extent practical
- Install detention/retention/bioretention facilities for larger sites (> 5 ac.)
- Use catch basin inlet controls such as oil/grit separators, hydrodynamic filters, Vortex units, etc., where applicable. These are especially applicable for gas stations, car washes, truck loading areas, and restaurants.
- Consider retrofits of at-risk sites or sites that pose significant pollutant threats

- Consider adopting more stringent rules for higher hazard sites such as gas stations

- Conventional dry wells are generally not preferred for this land use, but infiltration trenches may be appropriate if adequate pre-treatment and/or filtration is provided

- Support good housekeeping practices and land use controls

- Land use planning and zoning changes may be warranted for some areas

- Emphasize proper material handling and storage for industrial facilities

- Street sweeping of parking lots and loading/unloading areas

- Proper collection and disposal of automotive based pollutants

- Washout facilities and similar controls for commercial car-washes, truck loading facilities, construction equipment parking areas, etc.

- Increased focus on wellhead protection areas

- Industry/commercial education and outreach activities

### 4.2.2. Urbanized Med. to High Density Residential and Light Commercial Land Uses

This land use category relates to those properties zoned as Suburban Residential, High Density Residential, Neighborhood Business, and Incorporated. Areas here are similar to the industrial heavy commercial land use, but with a smaller percentage of impervious area and fewer high risk facilities. Due to the number of roofs, sidewalks, driveways, and streets, impervious areas are still an issue for runoff generation. In addition, the streets and driveways can be a source of pollution associated with automotive sources and chlorides associated with deicing practices during winter months. With urbanized lawns there is also a potential for chemical based pollution associated with herbicides, pesticides, and excess fertilizer applications. Lastly, with much of the area around the City of Trenton trending toward this land use, problems during construction such as sediment and erosion control may become an issue for the watershed.

As vegetation can be the key to preventing pollution from this land use category, the goal of management practices for this land use is to maximize the amount of green space and implement controls that prevent pollution from occurring at the source. Green space and stream buffers should be integral parts of the planning efforts for the community. Construction site sediment and erosion control measures are vitally important as well as good housekeeping practices for residential properties. Wherever possible, on-site infiltration or capture and reuse of storm water runoff should be encouraged.

Applicable BMPs and Storm Water Management Practices

- Maximize green space during development and through planning efforts
- Implement design controls for impervious areas: side walks, streets, parking lots, etc. that minimize their impacts
- Promote Low Impact Development (LID) concepts: rain barrels and cisterns, rain gardens, etc.
- Install detention/retention/wetland/bioretention facilities for larger sites (> 5 ac.)
- Avoid flow concentration in curb-and-gutter and pipe drainage systems to the extent practical
- Dry wells and infiltration trenches are generally acceptable for this land use with vegetated/grass pre-filtration
- Use vegetated/grass swales, channels, and filter strips where concentrated flow occurs; level spreaders, check dams, and other similar techniques can be used to disperse flow
- Good Housekeeping Practices
- Parking lot and street sweeping
- Proper fertilizer, pesticide, herbicide application
- Encourage pet waste disposal
- Lawn debris management
- Household hazardous material disposal
- Illicit discharge detection and elimination
- Storm drain inlet stenciling
- Efficient use of road deicing chemicals or use of alternate methods
- General community based stormwater education and outreach

### 4.2.3. Construction Sites

Construction sites refers generally to any disturbed area within the watershed characterized by bare soil materials. This category would include construction sites for commercial, industrial, and residential land uses in addition to disturbed agricultural lands and gravel extraction zoned properties. The primary concern for these sites is erosion and generation of sediment that can make its way to the stream channel. For many construction sites, debris and illicit discharges can also become an issue. Illicit discharges are especially associated

with the maintenance and operation of construction vehicles and the vehicular traffic at the entrance locations to construction sites that often tracks materials offsite. Vehicle wash downs can also become an issue, especially with concrete trucks and agricultural machinery.

Applicable BMPs and Storm Water Management Practices

- Adopt a construction site pollution prevention plan or development manual
- Control construction entrances using constructed rock filter BMPs
- Minimizing clearing and grubbing activities
- Encourage construction phasing
- Stockpile topsoils to promote faster long-term revegetation
- Establish long-term vegetative cover as soon as possible
- Install interim cover (seeding or other vegetation) as soon as possible for disturbed areas
- Use construction erosion controls such as: mulching and erosion control mats, silt fences, straw bales, etc.
- Require pipe slope drains or geogrids for steep slopes if necessary
- Rock check dams
- Channel lining and/or riprap
- Use of temporary sediment basins for large developments (> 5ac.)
- Dust control
- Construction site debris management
- Contractor/supplier education

### 4.2.4. Rural Residential & Low Density Agricultural Land Uses

This land use category relates to those properties zoned as Agricultural Estate, Rural Estate, and Low Density Residential as well as those zoned for Agricultural uses that have well established croplands or are used for managed grazing operations. These land uses typically do not contribute a great deal of pollution to the surface water runoff, but certain practices may be of concern, particularly agricultural chemical application and animal operations. The main pollutants of concern for these properties are phosphorus and nitrogen loading, nutrient enrichment, and pathogens from animal sources. Pathogens can also be a problem associated with leaky or inefficient on-site septic systems. Control mechanisms for these properties often depend on educating the property owners and revolve around daily operational practices.

Applicable BMPs and Storm Water Management Practices

- Encourage use of vegetation, landscaping, and trees adjacent to croplands and other potential pollutant sources to serve as filters
- Minimize and control use of fertilizers, pesticides, and herbicides
- Control of animal and livestock operations including waste control & disposal
- Minimize animal contact with the streams and farm ponds that overflow into streams
- Expand municipal sanitary sewer and water system networks as appropriate
- On-site septic system inspection and maintenance program
- Encourage on-site drainage through overland flow and vegetated channels and swales
- Control nearby land uses to maintain localized wellhead protection zones

#### 4.2.4.1. Undeveloped Land

The last land use category basically encompasses any unused tract of land that isn't characterized as bare soil. This might include unused or seldom used pastures, infrequently used croplands, open spaces covered with vegetation, and wooded areas. These areas are generally an asset to the watershed and protection of the areas from development is the biggest concern. Wooded areas in particular collect rainfall and produce minimal runoff and should be retained whenever possible.

Applicable BMPs and Storm Water Management Practices

- Encourage use of vegetation, landscaping, and trees throughout the watershed
- Land use planning to maintain green space areas and corridors
- Establish stream buffers
- Permanent vegetated filters along edges of cropland areas
- Maximize wooded areas near streams
- Encourage reforestation efforts
- Stream and channel bank stabilization as required
- Consider natural channel design/remediation techniques
- Give preference to vegetation based stream and bank stabilization methods

### 4.3. Specific Property Considerations

In addition to considerations for particular land uses, special provisions should also be made for the unique portions of the watershed such as the areas near the Miller Sink and the area near the intersection of Hamilton-Trenton Road and Wayne-Madison Road.

The Miller Sink area is an important point of infiltration in the watershed and should be maintained as a recharge area. Although this is private property, the BCSWD should encourage Miller Brewing to set aside the area for floodplain management purposes. In fact, the inlet channel could be improved and the area could function more effectively as a storm water detention area as well as local ground water recharge zone. The function of this area as a detention facility also directly affects the flood conditions in the downstream area between Gephart Road and Riverside Drive proceeding downstream towards Hamilton-Trenton Road. This is designated as Area #4 on Figure 1. There are tracts of land adjacent to Gephart Road and Riverside Drive that are currently being proposed for development, but homes and other permanent structures should not be constructed along the reach until long term preservation and establishment of the Miller Sink as an effective detention facility is established.

During the development of this SWMP, FMSM had conversations with the Butler County Transportation Improvement District concerning the proposed connector roadway between State Route 63 and US 127. The new roadway corridor is indicated on the Planning and Protection Map shown in Figure 1 and would pass through the area essentially bisecting the watershed near the location of Hamilton-Trenton Road. It is likely in the future that some type of industry will locate in the area. This would require special planning from a storm water management perspective. It is important that whatever development occurs in the area be properly planned in order to protect storm water runoff, but more importantly the area is in the wellhead protection zones for Miller Brewing, Duke Energy, and to some extent the City of Trenton. Adding large portions of impervious area to this portion of the watershed would not be beneficial to storm water and requires special consideration to assure that a recharge deficit is not created. We recommend that the area have special development restrictions placed on it to minimize this problem and encourage long term groundwater protection. Alternately, rezoning of the area may be an option worth considering.

## 5. Conclusions and Recommendations

Based on the identified problems in the Jackson Ditch watershed and the evaluation of potential mitigation options, FMSM has prepared the following recommendations for the watershed. A meeting was held with the Butler County Engineer's Office on April 12, 2006, to discuss the general concepts, and this document will be not be finalized until after a planned stakeholder meeting for the watershed. The recommendations include specific initiatives geared to the Jackson Ditch watershed, such as capital improvement projects and planning to control land use and zoning, as well as aspects of the Butler County Storm Water District Storm Water Management Plan.

## 5.1. Capital Improvements

Countywide policies and programs are good for long term storm water management, but can make it difficult to yield immediate tangible results on a small watershed scale. Structural mitigation options such as channel improvements, culvert replacement, and regional detention basins can provide more immediate results, but can be costly to construct. Several of these options were discussed in Section 3.1 above and those with the potential to be effective are included below.

### 5.1.1. Regional Detention Basin

Based on the preliminary analyses performed for this study, a regional detention basin near Busenbark Road north of Hamilton-Trenton Road could be a feasible alternative for immediate flood reduction downstream. The results of our modeling predicts the basin would provide flood reduction benefits, but achieving a favorable benefit cost ratio could rely on other factors such as outside funding sources and considerations of community input. It is important to note, the analyses performed for this study by FMSM were strictly conceptual and additional steps are warranted before proceeding with construction of a regional facility of this nature.

A regional facility is going to rely largely on the community's interest and desire to implement the facility, along with the economic constraints. Funding for the basin could be derived from cost sharing programs, grant programs, user fees, developer fees within the watershed, and other sources to be determined. If the decision is made to pursue the regional detention basin, FMSM recommends the first step be a feasibility study. The feasibility study would assess several facets of the proposed project that were beyond the scope and capabilities within the current efforts. A partial list of items addressed by the feasibility study might include:

- Community and stakeholder interest,
- Potential opposition,
- Operational efficiency,
- Constructability,
- Environmental impacts/benefits, and
- Economic considerations (costs/benefits and potential sources of funding)

Based on our experience with basins of this nature and the current conditions in the watershed, particularly the limited number of homes affected and the relatively shallow depth of flooding, FMSM cannot recommend pursuing a regional detention basin at this time. Instead it is recommended that Butler County continue its active participation in the FEMA National Flood Insurance Program and explore pre-disaster mitigation options and buyouts for frequently affected properties in the floodplain. If at some point in the future, a regional detention facility becomes a priority, then the first step should be to perform a more detailed feasibility study to address the issues listed above.

### 5.1.2. Stream Restoration

Another structural mitigation option that could provide flood control and channel improvement benefits for the Jackson Ditch stream corridor is stream restoration using natural channel design techniques. Portions of Jackson Ditch would appear to be strong candidates for reconstruction to more natural conditions. The more natural, nested channel with meanders and an incorporated overbank floodplain is not only better at retaining debris and sediment, but also provides in-stream storage that would help address flooding issues. The scale of channel restoration would need to be determined, but simply removing some of the old tree growth and planting more brush species would improve the strength of the channel banks and decrease limb falls and debris loading to the stream, which would improve the maintenance problems currently recognized at several of the culverts along the reach.

One possible stream restoration scenario would involve reconstruction in the same area as the proposed regional detention facility near Busenbark Road north of Hamilton-Trenton Road proceeding southward onto the Miller Brewing property. The tract of land near Busenbark Road south of S.R. 73 is essentially land-locked between the east and west branches of Jackson Ditch and would require some significant design and construction efforts to be a developable property. A natural stream channel in this area could make this property more usable and provide the storm water benefits mentioned above. On the Miller Brewery property, two debris-jam prone bridges are essentially abandoned and could be removed, which would improve overall flood conditions in the area. In all, restoring the nearly 12,000 feet of stream channel in these two areas could prove beneficial to the immediate area as well as potentially developable areas downstream.

Stream restoration could be a promising feature of the Jackson Ditch watershed for long term conditions, but this approach can be costly to implement. Instead of a County sponsored restoration initiative, FMSM recommends that Butler County seek to incorporate stream restoration in future development along the stream corridor, particularly near the Busenbark Road location and on the Miller Brewing Company properties. If in the future, someone wants to develop those tract of land near the stream, Butler County should advocate that a natural channel design be included in the development plans. The natural channel design would improve conditions in Jackson Ditch and make the property more usable from a floodplain management perspective. Again, a feasibility study similar to the one described for the regional detention facility would be recommended before proceeding with a stream restoration initiative of this nature.

## 5.2. Land Use Control and Management

The fundamental basis for many of the recommendations in this SWMP is that land use has a direct correlation to pollution potential. Several BMPs and management practices for the various land use categories in the watershed were presented in Section 4.2 above to reduce the pollution potential. Specific items for the five major land use categories follow.

An example of how and where different types of BMPs might be applied for different land uses is illustrated in Figure 2. The intent of Figure 2 is to demonstrate the variety of land uses that can occur within a watershed and how storm water BMPs can be applied selectively to help address potential storm water pollution issues and excess runoff. Figure 2 only demonstrates the types of storm water control techniques to consider for different land uses and it should not be misconstrued as all encompassing prescription for a given land use or as a planning recommendation for the type of development patterns that should occur in

the watershed. Furthermore, the tracts of land shown Figure 2 were selected at random due to their geometry and the typical representation of the watershed. The land uses and controls shown should not be considered as a recommendation for the specific activities that would be appropriate for this particular portion of the watershed.

In reference to Figure 2, several types of land uses are illustrated. Specific features of the major land use categories have been highlighted as follows:

### 5.2.1. Industry/Heavy Commercial Land Use

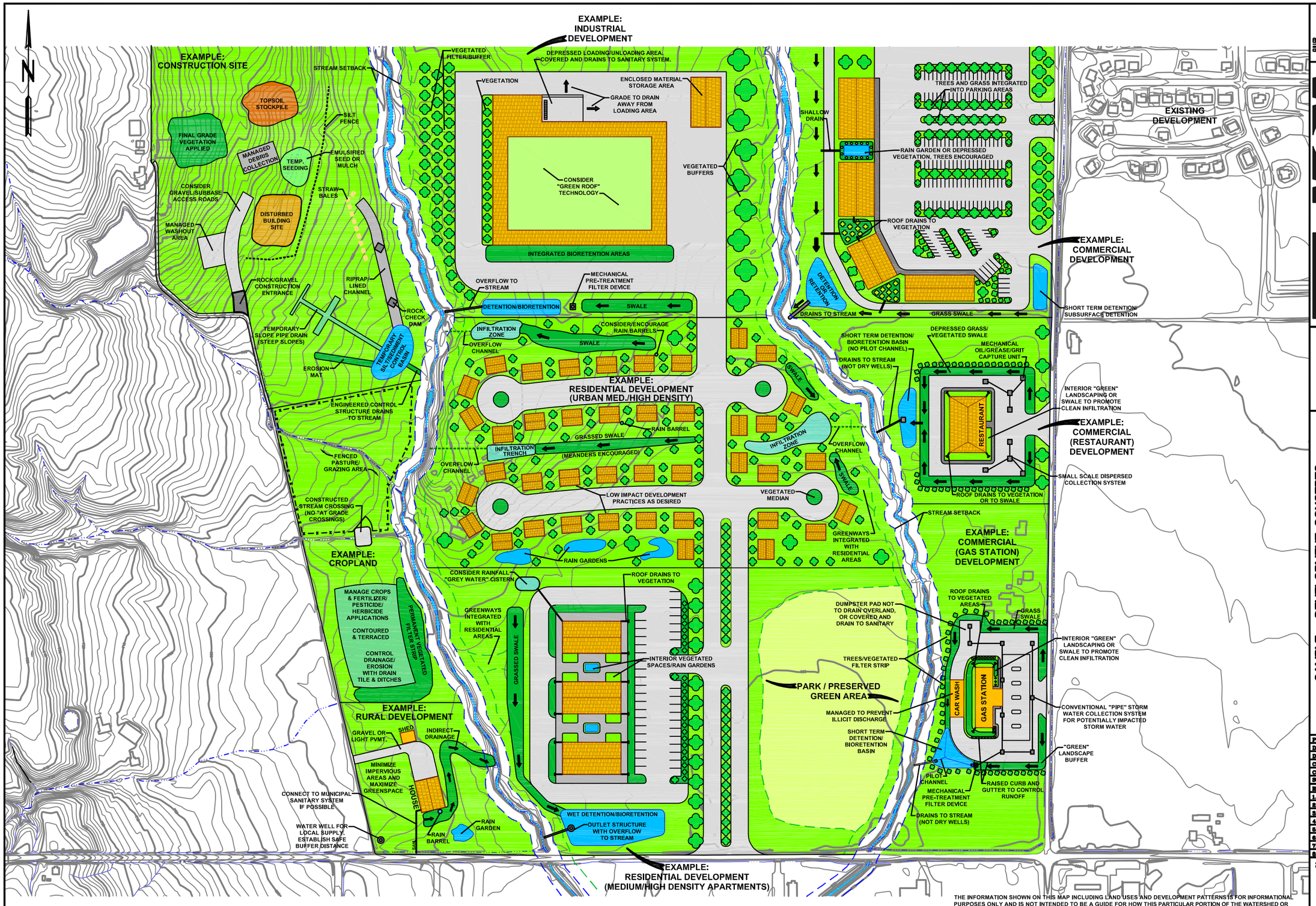
Green space and green technology should be used as much as possible to minimize impervious area and the connection of impervious areas directly to the storm network. Roof drains should be connected to vegetation, instead of being allowed to flow directly onto pavement. Loading dock areas, material storage areas, grease pits, runoff from gas stations, and other higher risk areas should be stringently controlled to prevent storm water pollution. Mechanical pre-treatment devices, such as oil and grit separators and hydrocarbon capture devices, should be used where applicable. Site development plans should incorporate grass swales that drain to bioretention facilities or detention facilities for sites larger than five (5) acres. These detention and bioretention facilities should have overflow channels that are connected to the stream network for high flow events. Extensive vegetative landscaping including grassed filter strips, trees, shrubs, rain gardens, and bioretention facilities should be encouraged throughout the watershed. Placement of vegetation next to stream corridors can create a vegetative buffer that benefits water quality and acts as a screen to adjacent properties.

### 5.2.2. Urbanized Medium to High Density Residential and Light Commercial Land Use

Again, green space and green technology should be used as much as possible. With residential developments, a few additional options such as greenways, parks, trails, and the like adjacent to the stream can be incorporated into the planning efforts to create more desirable community interaction with the stream network. Low impact development techniques also fit particularly well for residential areas and should be encouraged. Other design aspects such as grassed swales, infiltration trenches, rain gardens, and the like should be incorporated into landscaping plan for neighborhoods. For developments larger than five (5) acres, detention facilities may be appropriate, but these facilities should not be centralized if avoidable. It is more desirable to have several smaller infiltration areas than a large deep detention area if possible. After neighborhoods are established, the focus on these areas should shift towards household hazardous waste disposal programs, education and outreach to promote proper lawn maintenance and chemical application.

### 5.2.3. Construction Sites

The main focus for construction sites is and should continue to be sediment and erosion control. Several techniques are used to address these issues including BMPs, but construction site management should also be addressed. Practices like phasing of construction, topsoil stockpiling, seeding and temporary cover management, debris collection, and vehicular pollution prevention, including control of construction entrances, are all effective ways to prevent unnecessary pollution from entering the stream. Ongoing education and outreach that involves contractors and suppliers in the storm water control and protection process is a necessity.




THE INFORMATION SHOWN ON THIS MAP INCLUDING LAND USES AND DEVELOPMENT PATTERNS IS FOR INFORMATIONAL PURPOSES ONLY AND IS NOT INTENDED TO BE A GUIDE FOR HOW THIS PARTICULAR PORTION OF THE WATERSHED OR ANY OTHER PORTION OF THE WATERSHED SHOULD DEVELOP. THE INTENT OF THIS MAP IS TO DEMONSTRATE VARIOUS TYPES OF CONCEPTUAL STORM WATER MANAGEMENT TECHNIQUES ASSOCIATED WITH GIVEN LAND USE TYPES THAT TYPICALLY MIGHT OCCUR WITHIN THIS WATERSHED AND ANY USE OF THIS MAP BEYOND THAT PURPOSE IS NOT RECOMMENDED AND OUTSIDE THE CONTEXT OF THE FMSM SCOPE OF SERVICES FOR THIS PROJECT.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Fuller Mossbarger Scott & May


# SAMPLE - DEVELOPMENT CONCEPTS

## WATERSHED STUDY AND STORM WATER MANAGEMENT PLAN
## JACKSON DITCH WATERSHED
## BUTLER COUNTY STORM WATER DISTRICT
## CITY OF TRENTON, BUTLER COUNTY, OHIO

| | |
|---|---|
| PROJECT NO. | CN2004074 |
| DATE | APRIL 2006 |
| DRAWN BY | BFS |
| CHECKED BY | EC |
| CHECKED BY | |
| SCALE | NO SCALE |
| REVISED | |
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SHEET

**Figure 2**

### 5.2.4. Rural Residential and Low Density Agricultural Land Use

These properties generally do not pose significant threats to the watershed, but there are a few specific items of concern and practices that can help prevent pollution. With agricultural areas, the focus should be on preventing excess nitrogen, phosphorus, and nutrients associated with farm practices. Pathogens from animal waste is also of concern and can be addressed by controlling pasture areas and keeping animals away from stream corridors. Rural residential properties also benefit from the same household hazardous waste disposal programs and lawn care programs being applied in higher density neighborhoods. Education initiatives should focus on proper land management for these larger tracts of land.

### 5.2.5. Undeveloped Land

The goal for undeveloped land is relatively simple, preserve as much of it as possible as green space and promote the use of vegetation and trees. Development in the watershed is inevitable, to promote the good characteristics of undeveloped land from a storm water perspective, green space should be incorporated throughout the design and where possible areas should be preserved in their natural state. A good example of this practice would be to maintain tree buffers at the edges of properties and promote vegetation for new developments.

## 5.3. BCSWMP and Program Elements

Many of the items in the BCSWMP will play a role in improving the Jackson Ditch watershed and protecting it for years to come. Perhaps the best solution in this watershed, which is also a major focus of the BCSWMP, is an effective public education, outreach, and involvement program. Butler County should continue to do effective storm water related outreach and strive to expand the program to meet the needs of the local communities. In the Jackson Ditch watershed, education and outreach programs should be driven by the importance of wellhead protection areas and be catered to specific threats to the aquifer associated with pollutants and practices. Outreach should first be directed towards contractors and members of the development community, industries, and local municipalities to garner support and assistance; then the program can be branched out to focus on individuals to promote good ongoing watershed maintenance. Individual support can lead to a variety of programs such as volunteer clean up efforts and adopt-a-watershed. The goal is to make everyone who lives and works in the watershed aware of the issues and give them a sense of watershed pride that will promote a self-sustaining healthy condition.

Outreach and participation aimed at the local municipalities also will provide benefits in terms of increased cooperation and a team approach to addressing watershed issues. Jurisdictional lines should not be a preventative factor for promoting sound watershed management and Butler County should strive to minimize jurisdictional differences through continued coordination with local communities and municipalities. The local groups should particularly focus on enforcement and compliance for construction sites and high risk facilities. Where applicable, common design parameters between Butler County and local communities should be required. Countywide adoption of development manuals such as the ODNR "Rainwater Manual" and/or the ODOT "Location and Design Manual" will promote effective design practices.

Lastly, Butler County should include more storm water aspects in their community planning process, to encourage proactive storm water management using green space, riparian corridors, stream buffers, and protected areas.

### 5.4. Specific Land Use Recommendations

The Miller Sink is an important feature of the Jackson Ditch watershed and should be maintained as an infiltration area. It is safe to assume that some degree of modifications could occur to the area and it would still function adequately, but in no scenario should it be eliminated as that could have substantial negative effects on the watershed. There are options where areas could be used as a detention facility to help conditions in downstream areas, but at present, the infiltration portion of the tract is better left undisturbed. Butler County should encourage Miller Brewing to set aside the property for long term use and improve its hydraulic efficiency during their routine property maintenance and operations to prevent excess overflows toward Gephart Road.

In addition to the Sink located on Miller's property, the northeastern portion of the property near Wayne-Madison road is important for long term wellhead protection programs at Miller, Duke Energy, the Southwest Regional Water District, and even the City of Trenton. The proposed SR63 connector access road makes the area likely to be developed at some point in the future. This area and those surrounding it are currently zoned for industrial uses, but should be considered developmentally sensitive for design purposes. Any development that is allowed on these tracts should be stringently controlled to assure no negative pollutant or runoff effects are caused.

## 6. Next Steps

FMSM has provided the recommendations in this SWMP as general guidance for the types of activities that should occur in the Jackson Ditch watershed to promote sound storm water management. Implementation of these activities will be a lengthy process and require cooperation from other local and state authorities, stakeholders in the watershed, private property owners, and the citizens of the area in general. FMSM looks forward to participating in the implementation process to the extent applicable to the scope of this project and can provide future assistance as needed.

During the previous phases of this project FMSM facilitated a meeting with area stakeholders to keep them apprised of the study goals, methodology, and findings. FMSM will continue the process by conducting a stakeholder meeting to discuss the content of the storm water management plan described in this report to and solicit feedback on the plan. Once the plan is finalized, FMSM will prepare a project newsletter that can be mailed to stakeholders and other interested parties that describes the efforts performed for the project, the findings of those efforts, and our recommendations for storm water management and planning initiatives.

# Appendix A

# Butler County Storm Water Management Plan

# Butler County
# Storm Water District

Butler County, Ohio

## *Storm Water Management Plan*

*February 25, 2003*

BUTLER COUNTY ENGINEER'S OFFICE

BCEO

GREGORY J. WILKENS, PE., PS. BUTLER COUNTY ENGINEER

# I. Executive Summary

Butler County is required to submit a Storm Water Management Plan (SWMP) in accordance with 40 CFR Part 122.32 and Ohio Law. This document outlines the Butler County Storm Sewer District's plan to develop, implement, and enforce a storm water management program designed to reduce the discharge of pollutants to the "maximum extent practicable", to protect water quality, and to satisfy the appropriate requirements of the Clean Water Act (CWA) in accordance with the Ohio EPA NPDES Phase II program. The SWMP addresses the six minimum control measures (MCM's) as required by state regulations. The Plan also identifies the County's legal authority to implement the general permit.

# II. Legal Authority

Butler County has established the Butler County Storm Sewer District under Ohio Revised Code (ORC) Section 6117 with authority to control the quality of separate storm water discharge to its storm sewer system. Its authority addresses municipal discharges. Butler County has both the fiscal authority and legal resources to fully implement its SWMP, with the exception of the requirement to enforce erosion and sediment control regulations on development of parcels, which have a size ranging from one acre up to, but not including five acres. Section 307.79 of the ORC specifically limits the authority of the Board of County Commissioners (BOCC) to regulate erosion and sediment control plans to five contiguous acres or more. The County Commissioners Association of Ohio is actively pursuing changes in current law to revise this restriction to one acre or more in compliance with proposed Ohio EPA rules and regulations.

# III. Development of the SWMP

Following a selection process, Butler County retained the services of Fuller, Mossbarger, Scott and May Engineers, Inc. (FMSM) and Environmental Rate Consultants (ERC) to facilitate the formation of a countywide Storm Sewer District and the preparation of an NPDES Phase II Storm Water Permit. In June, 2002, representatives from local governments in the County along with other interested parties such as local development organizations, watershed groups, Chamber of Commerce, environmental and conservation groups and others were invited to a "Kick-off" meeting to discuss the NPDES Phase II Permit Program and the formation of a Steering Committee to assist the County in evaluating alternatives to address the Phase II requirements and prepare the SWMP. A diagram of the process is illustrated in Figure 1.

The Steering Committee has met monthly since the Kick-off meeting, with an average of 25 attendees, and addressed the following issues:

1. NPDES Phase II permit requirements;
2. Legal Organization Options;
3. Alternative Management Strategies and Structures;
4. Level of Service and Cost of Service;
5. Financing Programs;
6. Formation of an ORC 6117 Storm Sewer District;
7. Six Minimum Control Measures (MCM's) and associated Best Management Practices (BMP's)

8. Location of 303(d) Impaired Waters and causes of impairment;
9. Selection of BMP's that fit community needs and address impairments;
10. Storm Water Management Plan.

A list of participating organizations that attended these meetings is shown in Figure 2.

A Workshop for elected officials was held on January 15, 2003. Over 50 officials representing 20 local governments in the County attended this meeting. The Phase II program requirements were summarized along with information on the proposed Butler County Storm Sewer District. Resolutions were received from 12 local governments petitioning the County Commissioners to establish a County Storm Sewer District to administer the NPDES Phase II program. The Board of County Commissioners on February 20, 2003 established the Butler County Storm Sewer District chartered under Section 6117 of the Ohio Revised Code.

This NOI and SWMP is the direct result of the Steering Committee meetings and public officials workshop and participation and input by those attending.

## IV. Permit Coverage Area

The SWMP includes all of the unincorporated areas in the townships listed in Appendix 6 (not included herein), of U.S. EPA Phase II Storm Water Rules update based on the 2000 Census along with those municipalities that by resolution or ordinance have agreed to participate in the County-wide District, including:

| | | |
|---|---|---|
| Butler County | Fairfield Township | Hanover Township |
| Lemon Township | Liberty Township | Madison Township |
| Ross Township | St. Clair Township | West Chester Township |
| Wayne Township | Village of New Miami | Village of Seven Mile |
| City of Trenton | | |

This area is shown on Figure 3 and has a population of 132,000 residents and represents 45 percent of the total land area in Butler County.

## V. Rationale for Program BMP Selection

The Best Management Practices (BMP's) proposed in this SWMP have been developed to specifically address the list of "Impaired Waters" included in the OEPA 303(d) Report. The Storm Water Steering Committee intends to utilize the BMP's and the process shown in Figure 4 – the "Implementation Matrix" to mitigate the sources of impairment in the "Impaired Waters" noted above.

Since June 2002 Butler County has actively solicited input from local governments and other interest groups in the development of this Storm Water Management Plan and in establishing a County Storm Sewer District under ORC 6117. The purpose of this District is to provide sufficient funding, organization structure and staff for implementation of the permit requirements, the Six Minimum Control Measures (MCM's) and this Storm Water Management Plan. The Plan addresses each of the Six MCM's and provides a framework of BMP's to improve the quality of runoff to the area streams and rivers.

## VI. Reporting Requirements

The Butler County Storm Sewer District will submit its required report annually during the first term of the permit cycle. The report will include the status of compliance with the permit conditions, an assessment of the appropriateness of the best management practices (BMP's) and progress towards achieving the measurable goals for each of the six MCM's. Also included will be a summary of the activities the Butler County Storm Sewer District will undertake during the reporting cycle and any changes to BMP's or measurable goals and all relevant data (monitoring) obtained during the reporting period.

## VII. Storm Water Management Program

This Plan outlines the six Minimum Control Measures (MCM's), which are expected to result in reductions in pollutants discharged within Butler County. The identified water quality problems include, but are not limited to, organic enrichment, habitat and flow alteration, nutrients, and siltation. The six MCM's will address the identified water quality pollutants.

This Storm Water Management Program defines the requirements and the proposed actions for the Butler County Storm Sewer District to address each requirement with BMP's or other means of compliance. The SWMP is intended to reduce pollutant levels to the maximum extent practicable under current state law, to protect water quality, and to comply with the Ohio Revised Code and the Clean Water Act. The SWMP includes management practices, control techniques, system design, and engineering methods. Each MCM includes BMP's, measurable goals, person(s) or departments responsible, and rationale and decision process documentation. The measurable goals and time frame for each BMP can be viewed in the Implementation Matrix of the SWMP (Figure 4).

The Six Minimum Control Measures are addressed separately below. This plan outlines the six MCM's, which are expected to result in reductions in pollutants discharged by Butler County. The six MCM's will address the identified water quality pollutants.

### Introduction

This Storm Water Management Program defines the requirements, in blue, and the methods for the Butler County Storm Sewer District to address each requirement with BMP's or other means of compliance, in green. The SWMP should reduce pollutant levels to the maximum extent practicable, to protect water quality, and to comply with the Ohio Revised Code and the Clean Water Act. The SWMP includes management practices, control techniques, system design, and engineering methods. Each MCM includes BMP's, measurable goals, person(s) or departments responsible, and rationale and decision process documentation. The measurable goals and time frame for each BMP can be viewed in the Implementation Matrix of the SWMP (Appendix A).

The Six Minimum Control Measures are addressed separately below:

## 1. Public Education and Outreach on Storm Water Impacts

1.1. The Butler County Storm Sewer District will implement a public education program to distribute educational materials to the community or conduct equivalent outreach activities about the impacts of storm water discharges on water bodies and the steps that the public can take to reduce pollutants in storm water runoff.

1.1.1 To distribute educational materials to the community, the Butler County Storm Sewer District will annually develop and distribute a media awareness packet to local media outlets (TV, Radio, Regional and Neighborhood Newspapers).

1.1.2 To distribute educational materials and inform the public through an outreach program, the Butler County Storm Sewer District will coordinate an education and curriculum program with local school districts, provide and distribute educational materials, train educators about the program, and establish a Butler County Storm Sewer District website.

1.1.3 To inform the public on the impacts pollutants can have on water bodies and to reduce pollutants in storm water runoff, the Butler County Storm Sewer District will implement a storm drain stenciling program including purchasing and coordinating installation of 300 stencils per year, until all storm water facilities are labeled, utilizing local governments, watershed groups, and civic groups. Labeling practices shall also be included in all future storm water facility construction, both public and private.

1.1 The District will document the decision process for the development of a storm water public education and outreach program. The decision process documentation shall include the overall public education program, individual BMP's, measurable goals, and persons responsible for the program.

1.2.1 The Storm Water Coordinator will be responsible for the overall management and implementation of the Public Education and Outreach program. The Storm Water Coordinator will create and document requirements by implementing the BMP's listed above. The Public Information Specialist will identify target audiences and develop an outreach strategy, to reach them. The Storm Water Coordinator will determine target pollutant sources to address. The Storm Water Coordinator will evaluate the success of the Public Education MCM and BMP's and document the achievement of the measurable goals.

## 2. Public Involvement / Participation

2.1 The District will comply with State and local public notice requirements when Implementing the public involvement/participation program.

2.1.1 To comply with State and local public notice requirements, the Butler County Storm Sewer District will hold public meetings and/or citizen discussion panels until the plan is fully implemented, throughout the county, targeting diverse groups.

2.2 The District will document the decision process for the development of a storm water public involvement / participation program. The decision process documentation will include the overall public involvement/participation program, individual BMP's, measurable goals, and persons responsible for the program. The District will:

2.2a Identify how they have involved the public in the development and submittal of the Notice of Intent (NOI) and SWMP description.

2.2b Actively involve the public in the development and implementation program.

2.2c Identify the target audiences for the public involvement program, including the types of ethnic and economic groups engaged and actively involve potentially affected stakeholder groups, including commercial and industrial businesses, trade associations, environmental groups, homeowners associations, and educational groups, among others.

2.2d Identify the types of public involvement activities included in the program. Where appropriate, consider the following types of public involvement activities:

- Citizen representatives on a storm water management panel
- Public hearings
- Working with citizen volunteers willing to educate others about the program
- Volunteer monitoring or stream clean-up activities

2.2e Identify the person or department that is responsible for overall management and implementation of the storm water public involvement/participation program and individual BMP's.

2.2f Identify how to evaluate the success of the minimum control measure, including the BMP's and measurable goals.

2.2.1 The Storm Water Coordinator will be responsible for the overall management and implementation of the Public Involvement/Participation program. Requirements will be addressed by the Coordinator through creating, implementing, and documenting the BMP process. The Coordinator will evaluate the success of the Public Education MCM and BMP's and document achievement of the measurable goals. To get the community actively involved in the program, the Butler County Storm Sewer District will implement the following BMP's:

2.2.2 Facilitate and oversee volunteer stream clean-up and monitoring programs.

2.2.3 Establish and maintain a community storm water hotline. The hotline will be used to develop a database of complaints, as an investigation tool for the complaints, and as a means of enforcement.

## 3. Illicit Discharge Detection and Elimination

3.1 The District will develop, implement, and enforce a program to detect and eliminate illicit discharges into the MS4.

3.1.1 The Butler County Storm Sewer District will develop an Illicit Discharge Plan and coordinate approval by member local governments:

3.1.1.1 As part of the Plan, the District will develop a database of potential problems areas.

3.2 The District will develop a storm sewer system map, showing the location of all outfalls and the names and location of all surface waters of the State that receive discharges from those outfalls.

3.2.1 The Butler County Storm Sewer District will work within the existing County GIS to create a storm sewer map.

3.3. Within five (5) years of when coverage under the general permit was granted, the District will submit the following to the Ohio EPA:

3.3.a A list of on-site sewage disposal systems (Home Sewage Treatment Systems, HSTS's) connected to discharge to the MS4, with addresses;

3.3b A storm sewer map showing the location of HSTS's connected to the MS4. The map shall include details on the type and size of conduits/ditches in the MS4 that receive discharges from the HSTS's, as well as water bodies receiving the discharges from the MS4.

3.3.1 The Butler County Storm Sewer District, in conjunction with County Agencies and an Executive Committee will develop a list of on-site sewage disposal systems. The District will be charged with collecting the data, establishing a database, and creating a map.

3.4 To the extent allowable under State or local law, the District will effectively prohibit, through ordinance, or other regulatory mechanism, illicit discharges into its storm sewer system and implement appropriate enforcement procedures and actions.

3.4.1 The District will draft the illicit discharge detection and elimination ordinance, including enforcement procedures and will meet with participating local governments to coordinate enactment and implementation of the ordinance.

3.5 The District will develop and implement a plan to detect and eliminate non-storm water discharges, including illegal dumping into the storm system.

3.5.1 The District will develop the draft Plan to detect and eliminate non-storm water discharges including illegal dumping by:

3.5.1.1 Performing Dry weather screening

3.5.1.2 Conducting Chemical field tests (see 3.9d) and

3.5.1.3 Meeting with each participating local government to coordinate adoption of the Illicit Discharge Plan.

3.6 The District will inform public employees, businesses, and the general public of hazards associated with illegal discharges and improper disposal of waste.

3.6.1 The District and Storm Water Coordinator will meet with local government employees, business groups, and the public to inform them of the hazards by preparing brochures and a news release about the hazards. This requirement will also be addressed through the Public Education MCM as well as in the Pollution Prevention/Good Housekeeping MCM.

3.7 The District will address the following categories of illicit discharges only if they are identified as significant contributors of pollutants: water line flushing, landscape irrigation, diverted stream flows, rising ground waters, uncontaminated ground water infiltrations, uncontaminated pumped ground water, discharges from potable water sources, foundation drains, air conditioning condensation, irrigation water, springs, water from crawl space pumps, footing drains, lawn watering, residential car washing, flows from riparian habitats and wetlands, dechlorinated swimming pool discharges, street wash water, and discharges from fire fighting activities.

3.7.1 The Storm Water Coordinator will monitor the effectiveness of BMP's and address adverse affects of the above stated potential illicit discharges.

3.8. The District will create a list of other similar occasional incidental non-storm water discharges that will not be addressed. They will document any local controls or conditions on the discharges. They will include a provision prohibiting any individual non-storm water discharge that is determined to be contributing significant amounts of pollutants to the MS4.

3.8.1. The Storm Water Coordinator will create a list of non-storm water discharges and include provisions for restrictions in the Illicit Discharge Ordinance.

3.9. The District will document the decision process for the development of a storm water illicit discharge detection and elimination program. The decision process documentation will include the overall illicit discharge detection and elimination program, individual BMP's, measurable goals, and persons responsible for the program. The District will:

3.9.1 The Storm Water Coordinator will be responsible for the overall management and implementation of the Illicit Discharge Detection and Elimination Program. To meet permit requirements, the Coordinator will thoroughly document the processes of creating and implementing the relevant plans or actions. The Storm Water Coordinator will evaluate the success of the Illicit Discharge Detection and Elimination MCM and BMP's and document achievement of the measurable goals.

## 4. Construction Site Storm Water Runoff Control

4.1 The District will develop, implement, and enforce a program to reduce pollutants in storm water runoff to the MS4 from construction activities that result in or create a land disturbance of greater than or equal to one acre, to the maximum extent practicable under current state law. The plan will include the development and implementation of:

4.1a An ordinance to require erosion and sediment controls, as well as sanctions to ensure compliance;

4.1b Requirements for construction site operators to implement appropriate erosion and sediment control BMP's.

4.1c Requirements for construction site operators to control waste such as discarded building materials, concrete truck washout, chemicals, litter, and sanitary waste at the construction site that may cause adverse impacts to water quality.

4.1d Procedures for site plan review, which incorporate consideration of potential water quality impacts.

4.1e Procedures for receipt and consideration of information submitted by the public.

4.1f Procedures for site inspection and enforcement of control measures.

4.1.1 The District will draft an ordinance establishing:

4.1.1.1 Runoff control BMP's,

4.1.1.2 Erosion control BMP's, and

4.1.1.3 Sediment control BMP's

To reduce pollutants in storm water runoff and will coordinate enactment by participating local governments. Fees for new development or re-development will be charged to defray the cost to the general public.

4.1.2 The District will draft and coordinate implementation procedures for site plan review and site inspection and enforcement measures. The ordinance will incorporate cooperation with building and construction management departments that have jurisdiction within the District.

4.2 The District will document the decision process for the development of a construction site storm water control program. The decision process documentation will include the overall construction site storm water control program, individual BMP's, measurable goals, and persons responsible for the program. The District will provide documentation on:

4.2.1 The Storm Water Coordinator will be responsible for the overall management and implementation of the Construction Site Storm Water Runoff Control program. Requirements will be addressed by thoroughly documenting the creation of BMP's, The Storm Water Coordinator will evaluate the success of the Construction Site Storm Water Runoff Control program and BMP's and document achievement of the measurable goals.

## 5. Post-Construction Storm Water Management

5.1 The District will develop, implement, and enforce a program to address storm water runoff from new development and redevelopment projects that disturb greater than or equal to one acre, to the maximum extent practicable under current state law, The program will ensure that controls are in place that would prevent or minimize water quality impacts by;

5.1a Implementing strategies, which include a combination of structural and/or non-structural BMP's, appropriate for the community;

5.1b Adopting an ordinance to address post-construction runoff from new development and redevelopment projects;

5.1c Ensuring adequate long-term inspection and maintenance of BMP's.

5.1.1 The Butler County Storm Sewer District will develop:

- A riparian corridor and buffer zone plan, and
- Post Construction ordinance for the community.

New riparian corridors and buffers will be established in developing areas and a plan to restore riparian corridors buffers in redeveloping areas will be prepared and implemented.

5.1.1.1 The Butler County Storm Sewer District, along with other local governments will address the long term O&M of the riparian corridor and buffer zone.

5.1.2 The Butler County Storm Sewer District will coordinate with the County Department of Development and local governments to draft new language to update platting requirements to implement Post-Construction Storm Water management.

5.1.2.1 The Butler County Storm Sewer District will develop a plan to provide for long term O&M of the BMP's.

5.2 The District will document the decision process for the development of the post-construction storm water management program (SWMP). The decision process documentation will include the overall post-construction storm water management program, individual BMP's, measurable goals, and persons responsible for the program.

5.2.1 The Storm Water Coordinator will be responsible for the overall management and implementation of the Post-Construction Storm Water Management program. Requirements will be addressed by thoroughly documenting the creation of BMP's. The Storm Water Coordinator will evaluate the success of the Post-Construction Storm Water Management program and BMP's and document the achievement of the measurable goals.

## 6. Pollution Prevention/Good Housekeeping for Municipal Operations

6.1 The District will develop and implement an O&M program that includes a training component and has the ultimate goal of preventing or reducing pollutant runoff from governmental operations.

6.1a They will include employee training to prevent and reduce storm water pollution from activities such as park and open space maintenance, fleet and building maintenance, new construction and land disturbance, and storm water system maintenance.

6.1.1 The District will develop and implement a plan for government employee training to reduce pollutant runoff and provide one joint training class per year.

6.1.1.1 The District will provide a recommended Maintenance Schedule to local participating governments, and

6.1.1.2 Establish an Inspection Plan for County owned storm water facilities and inspect half of the facilities each year.

6.1.2 The District will develop and coordinate implementation of an illegal dumping and control plan.

6.2 The District will document the decision process for the pollution prevention / good housekeeping program. The decision process documentation will include the overall pollution prevention/good housekeeping program, individual BMP's, measurable goals, and persons responsible for the program.

6.2.1 The Storm Water Coordinator will be responsible for the overall management and implementation of the Pollution Prevention / Good Housekeeping program. Requirements will be addressed by thoroughly documenting the creation of BMP's. The Storm Water Coordinator will evaluate the success of the Pollution Prevention/Good Housekeeping program and BMP's and document the achievement of the measurable goals.

# VIII. Financial Capability

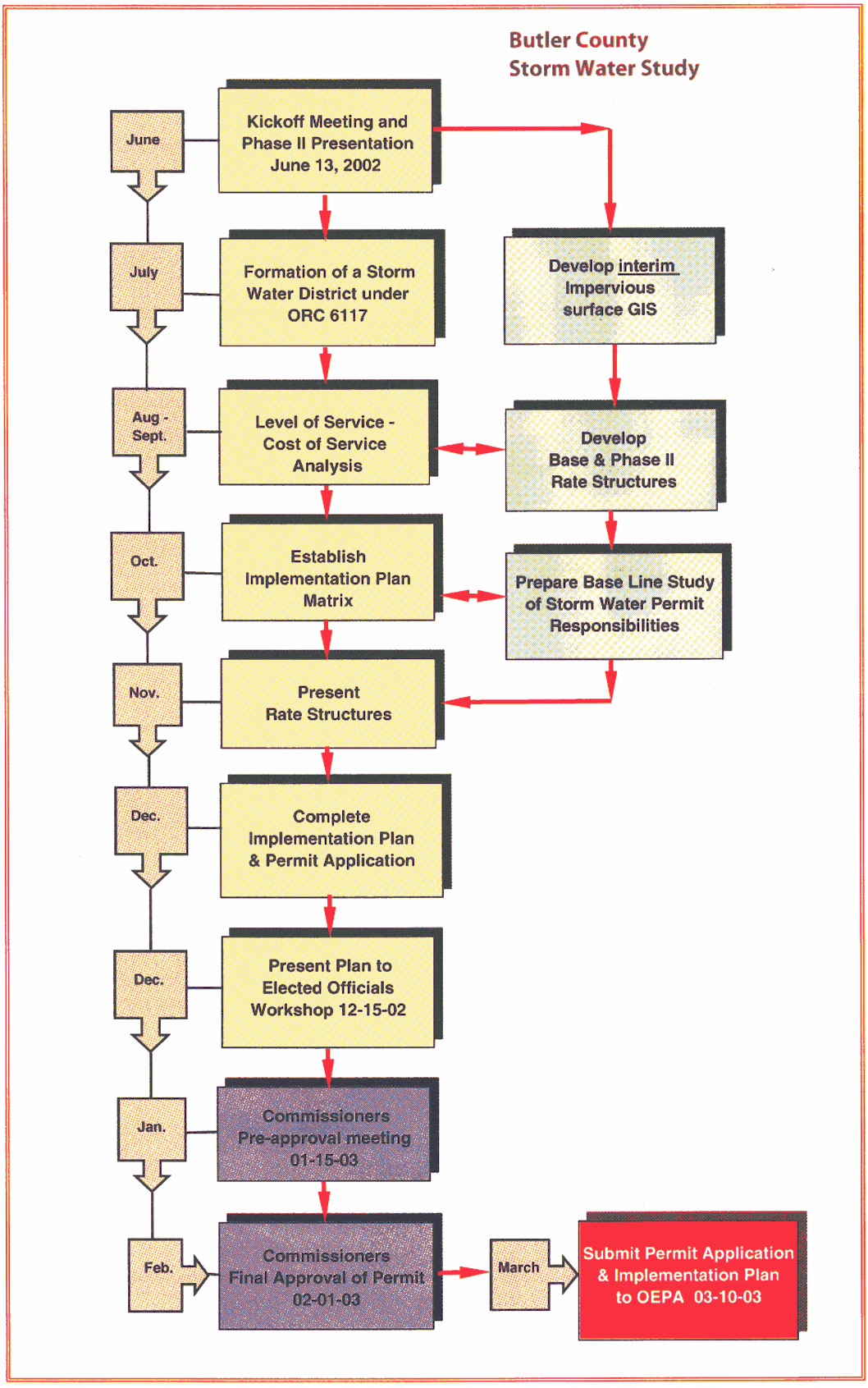
With the formation of the ORC 6117 Butler County Storm Sewer District, the County now has the capability of establishing "rates and charges" for storm water programs. The County will establish a storm water permit for new construction which will finance a portion of the Phase II program costs. The remainder of the funding for this program will result from the establishment of a storm water charge to be levied against all parcels of property within the Phase II area.

# IX. Summary

Since June 2002, Butler County has actively solicited input from local governments and other interest groups in the development of this Storm Water Management Plan and in establishing a County Storm Sewer District under ORC 6117 to administer the District and provide sufficient funding for implementation of the permit requirements, the Six

Minimum Control Measures and this Storm Water Management Plan. The SWMP addresses each of the Six Minimum Control Measures and provides a framework of Best Management Practices to improve the quality of runoff to the area's rivers and streams. The BMP's have been developed to specifically address the list of "Impaired Waters" included in the OEPA 303(d) Report.

**Figure 1 – Storm Water Study Program Development**



| Figure 2 - Butler County Steering Committee Attendance | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Organization** | **Name** | **June** | **July** | **Aug.** | **Sept.** | **Oct.** | **Nov.** | **Dec.** | **Jan.** |
| **Butler County Townships** | | | | | | | | | |
| Township of Fairfield | Randolph, Ron | X | X | X | | X | X | | X |
| Township of Fairfield | Sutton, Mark | | X | | | | | | X |
| Township of Hanover | Cropenbaker, Bill | X | X | X | X | X | X | X | X |
| Township of Lemon | Snook, Robert | X | X | X | X | X | X | X | X |
| Township of Lemon | Croucher, Elsa | | | | | | | | X |
| Township of Liberty | Kern, David | X | X | | X | | | X | |
| Township of Liberty | King, Tim | | | | | | | X | |
| Township of Madison | Kramer, Ben | | | | | | | | X |
| Township of Madison | McGuire, Bill | | | | | | X | X | X |
| Township of Milford | Gillespie, Paul | X | | | | | X | X | |
| Township of Ross | Willsey, Thomas | | | X | | | X | | X |
| Township of St. Clair | Berry, Don | | | | | | | | X |
| Township of St. Clair | Collins, Jewel | X | X | | | X | X | X | X |
| Township of Wayne | McIntire, Bill | | | | | X | X | X | |
| Township of West Chester | Fitzgerald, Mark | X | X | X | | X | | | X |
| West Chester Township | Brewer, Marie | | | | | | X | | |
| West Chester Township | Stoker, C | | | | | | X | | X |
| West Chester Township | Tacosic, Dave | | | | | | | | X |
| West Chester Township | Alvarez, Jose | | | | | | | | X |
| West Chester Parks | Zerkle, Bill | | | | | | | | |
| West Chester Planning & Zoning | Elliff, Brian | | | | | | | | |
| **Butler County Municipalities** | | | | | | | | | |
| City of Fairfield | Turner, Jim | X | X | X | X | X | | | |
| City of Hamilton | Arthur, Dan | | | | | | X | X | X |
| City of Hamilton | Crum, Darla | | | | | | | X | |
| City of Hamilton | Haskins, Alison | X | X | | X | X | X | X | X |
| City of Hamilton | Hinchberger, Jim | | | X | X | X | X | | |
| City of Hamilton | Reigelsperger, Ralph | X | X | | | | | | |
| City of Middletown | Duritsch, Dave | | X | | | | | | |
| City of Oxford | Orth, Andy | | | | X | X | | X | X |
| City of Oxford | Popescu, Victor | | X | X | X | X | X | X | X |
| City of Trenton | Leichman, Rob | X | X | X | X | X | | X | X |
| City of Trenton | Mobley, James | | | | | | | | X |
| Village of Millville | Settles, Robert | | | | | | | | X |
| Village of New Miami | Fox, Donald L., Sr. | X | | | | | | | |
| | | | | | | | | | |

| Butler County | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Butler County Engineer | Greg Wilkens | X | X | X | X | X | X | X | X |
| Butler County Engineer | Dennis Krall | X | X | X | X | X | X | X | X |
| Butler County Engineer | Scott Harris | X | X | X | X | X | X | X | X |
| Butler County Engineer | Eric Pottenger | X | X | X | X | X | X | X | X |
| Butler County Health Department | Agrew, Jeff | X | | | X | | | X | |
| Butler County Farm Bureau | Hoelscher, Pat | | X | X | X | X | X | X | |
| Butler County Metro Parks | Muska, Michael | X | | X | X | | X | X | |
| Butler County Prosecutor | Davidson, Betsy | X | X | | | X | X | X | X |
| Butler County Health Department | Krinov, Bob | | | X | | X | X | | |
| Department of Development | Juengling, Michael F. | | | X | X | X | | X | X |
| Department of Environmental Services | Lodor, Mary Lynn | | X | X | X | X | X | X | X |
| Department of Environmental Services | Moore, Mary | X | X | X | X | | X | X | X |
| Soil & Water Conservation District | Carter, David | | | | | | X | | |
| Soil & Water Conservation District | Deaton, Jennifer | X | X | X | X | X | X | X | X |
| Soil & Water Conservation District | Prunty, Brian | | | | | | X | | |
| **Special Interest Groups** | | | | | | | | | |
| Developers | Wunnenberg, Chris | X | X | X | | X | X | X | X |
| Home Builders' Association | Kleingers, Jim | | | | | X | | | |
| Home Owners' Associations | Betscher, Keith | | X | X | | X | X | | |
| Home Owners' Associations | Healey, Pat | X | | | X | | | X | |
| Izaak Walton League | Zehler, Raymond C. | | X | | X | | | X | |
| Kleingers & Associates | Painter, Rob | | | | X | | | | |
| Kleingers & Associates | Wolfe, Randy | | | | X | | | | |
| Miami Conservancy District | Rinehart, Kurt | X | X | X | | | X | | X |
| Mill Creek Watershed Council | Ellwood, Nancy | X | X | X | X | X | X | X | |
| Ohio Contractors Association | Smith, Dan | | X | X | | | | | |
| Ohio State University Extension | Remley, Dan | | | | | | X | X | |
| Ohio Valley Development Council | Reed, Etta | | X | | X | X | X | X | |
| Three Valley Conservation Trust | Frimerman, Larry A. | X | X | | | | X | | |
| Three Valley Conservation Trust | Renwick, Bill | | X | X | X | X | X | X | X |

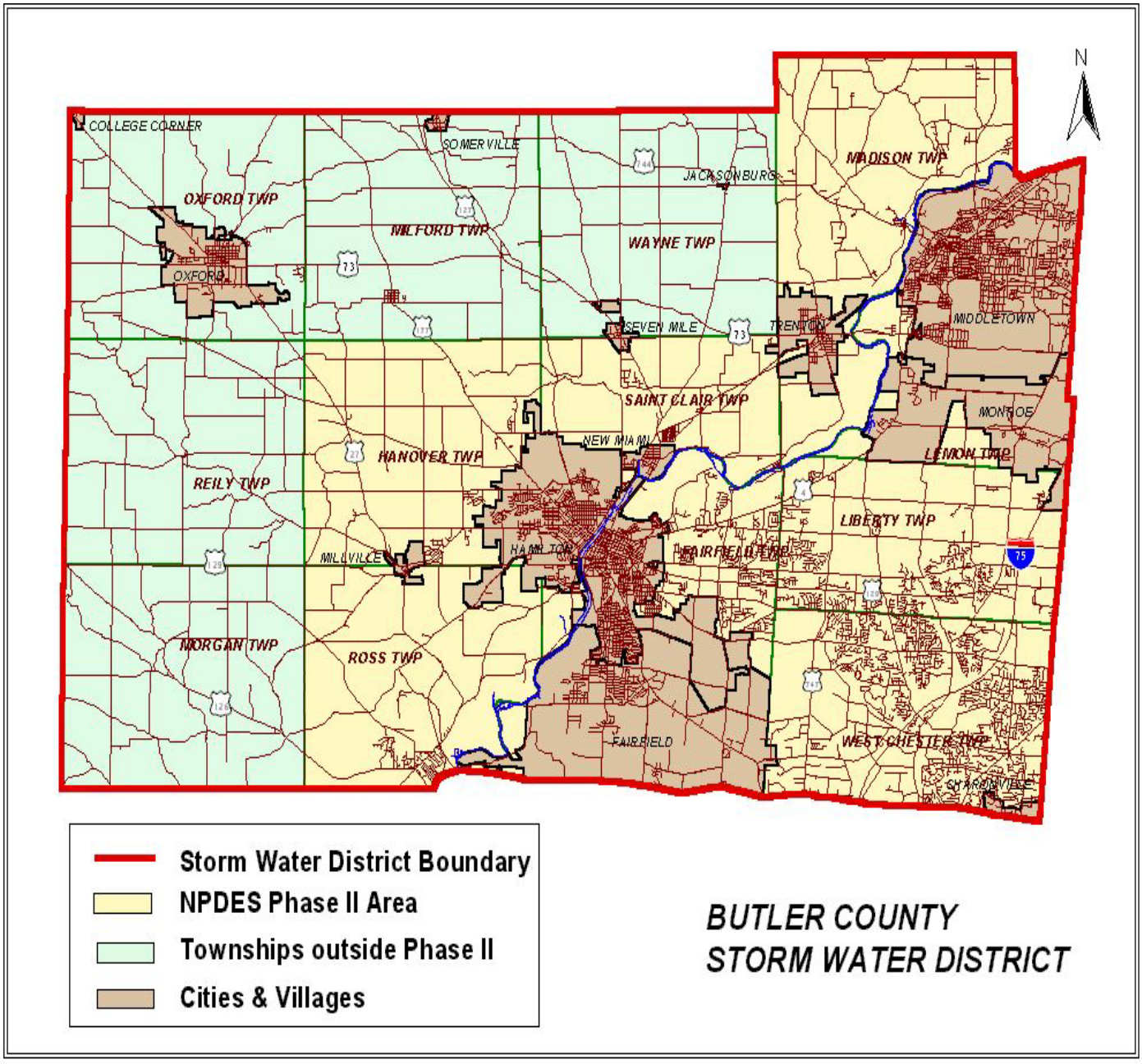



Figure 4 Implementation Matrix

| MCM No. | Minimum Control Measure | BMP No. | BMP's | Measurable Goals | Year 1 (2003) | Responsibility | Year 2 (2004) | Responsibility | Year 3 (2005) | Responsibility | Year 4 (2006) | Responsibility | Year 5 (2007) | Responsibility |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Public Education and Outreach | *1.1.1 | Media Awareness Packet | Annually prepare at least one Press Release Packet and distribute to Local Media | Prepare Press Release Packet and distribute to local media | District | Revise Press Release and redistribute to local media | District | Revise Press Release and redistribute to local media | District | Revise Press Release and redistribute to local media | District | Revise Press Release and redistribute to local media | District |
| | | *1.1.2 | Education Program for Local Schools | Adopt and distribute K-12 Water Curricula Program within 5 years | Draft a Water Curricula Program for children ages 10-12 | District | Implement 10-12 program by distributing materials to schools and training educators. Draft grades 7-9 program | District | Implement 7-9 program by distributing materials to schools and training educators. Draft grades 4-6 program | District | Implement 4-6 program by distributing materials to schools and training educators. Draft grades k-3 program | District | Implement k-3 program by distributing materials to schools and training educators. | District |
| | | *1.1.3 | Storm Drain Labeling | Purchase and coordinate installation of 300 labels per year until all basins in District are marked, beginning year 2 | Defer to Year 2 | | Plan and coordinate Labeling Program, choose locations, purchase labels and install 300 labels | District | Coordinate program, choose locations, purchase labels, and oversee instillation of 300 labels | District | Coordinate program, choose locations, purchase labels, and oversee instillation of 300 labels | District | Coordinate program, choose locations, purchase labels, and oversee instillation of 300 labels | District |
| | | 1.2.1 | Document Decision Process | Document Decision Process | Prepare documentation guidelines | District | Yearly documentation | District | Yearly documentation | District | Yearly documentation | District | Yearly documentation | District |
| 2 | Public Involvement / Participation | *2.1.1 | Public Meetings and Citizen Discussion Panels | Hold two (2) Public Meetings and One (1) Citizen Discussion Panel per year until Program is implemented | Develop and organize meeting materials, set and facilitate meetings and discussion panel, and attend | District | Set and facilitate 2 meetings and 1 discussion panel and attend | District | Set and facilitate 2 meetings and 1 discussion panel and attend | District | Set and facilitate 2 meetings and 1 discussion panel and attend | District | Set and facilitate 2 meetings and 1 discussion panel and attend | District |
| | | *2.2.2 | Stream Clean-up & Monitoring | Facilitate and oversee one Stream Clean-Up and Monitoring Program each year beginning year 2 | Defer to Year 2 | | Organize Program, build volunteer base, facilitate and oversee Clean-Up and Monitoring activities | District | Build volunteer base, facilitate and oversee Clean-Up and Monitoring activities | District | Build volunteer base, facilitate and oversee Clean-Up and Monitoring activities | District | Build volunteer base, facilitate and oversee Clean-Up and Monitoring activities | District |
| | | *2.2.3 | Storm Water Hotline, Database, and Response Program | Document complaints received and follow up with response in a timely manner | Answer calls, build database, perform field re-con and/or interviews in a timely manner | District | Answer calls, build database, perform field re-con and/or interviews in a timely manner | District | Answer calls, build database, perform field re-con and/or interviews in a timely manner | District | Answer calls, build database, perform field re-con and/or interviews in a timely manner | District | Answer calls, build database, perform field re-con and/or interviews in a timely manner | District |
| | | 1.2.1 | Document Decision Process | Document Decision Process | Prepare documentation guidelines | District | Yearly documentation | District | Yearly documentation | District | Yearly documentation | District | Yearly documentation | District |
| 3 | Illicit Discharge Detection and Elimination | 3.1.1 | Illicit Discharge Plan | Develop Illicit Discharge Plan and coordinate approval by member local governments | Defer to Year 2 | | Develop Illicit Discharge Plan | District Local | Implement Illicit Discharge Plan and coordinate approval with local governments | District Local | | | | |
| | | *3.1.1.1 | Locate Problem Areas | Develop Problem Area Database beginning year 3 | Defer to Year 3 | | Defer to Year 3 | | Develop Location Plan, interview complainants, research site history, and build database | District | Interview complainants, research site history, and build database | District | Interview complainants, research site history, and build database | District |
| | | 3.2.1 | Storm Sewer System Map with Outfalls | Field locate outfalls and map 20% of District area each year | Initiate mapping plan, GIS mapping, field work, and surveying for 20% of area | District | Perform GIS mapping, field work, and surveying for 40% of area | District | Perform GIS mapping, field work, and surveying for 60% of area | District | Perform GIS mapping, field work, and surveying for 80% of area | District | Perform GIS mapping, field work, and surveying for 100% of area | District |
| | | 3.3.1 | HSTS List and Map | Field locate HSTS and map 20% of the area each year | Develop Location Plan, perform records search, GIS mapping, field work, and surveying for 20% of area | District County | Perform GIS mapping, field work, and surveying for 40% of area | District | Perform GIS mapping, field work, and surveying for 60% of area | District | Perform GIS mapping, field work, and surveying for 80% of area | District | Perform GIS mapping, field work, and surveying for 100% of area | District |
| | | 3.4.1 | Illicit Discharge Ordinance | Establish Illicit Discharge Ordinance for District and fully implement and enforce within five years | Develop draft of Illicit Discharge Ordinance with sanctions | District Local | Solicit comments and coordinate community adoption | District Local | Implement Illicit Discharge Ordinance | District Local | Enforce Illicit Discharge Ordinance | District Local | Enforce Illicit Discharge Ordinance | District Local |
| | | 3.5.1 | Non-Storm Water Discharge Plan | Establish non-storm water discharge plan and fully implement within five years | Defer to Year 4 | | Defer to Year 4 | | Defer to Year 4 | | Develop draft of non-storm water discharge plan to detect and monitor discharges | District | Implement non-storm water discharge plan to detect and monitor discharges | District |
| | | 3.5.1.1 | Dry Weather Screening | Prepare Dry Weather Screening Plan and visually inspect 400 mapped outfalls and sample when necessary, beginning year 4 | Defer to Year 3 | | Defer to Year 3 | | Organize Dry Weather Screening Plan coordinating with BMP 3.2.1 | District | Monitor and sample outfalls while mapping and documenting findings for 400 outfalls | District | Monitor and sample outfalls while mapping and documenting findings for 400 outfalls | District |
| | | 3.5.1.2 | Chemical Field Tests | Develop field testing protocol, purchase equipment and take 200 samples of various stream miles in District each year, beginning year 3 | Defer to Year 3 | | Defer to Year 3 | | Organize Chemical Field Testing Plan and protocol, conduct field tests, and monitor results of 200 samples in various stream miles | District | Conduct field tests, and monitor results of 200 samples in various stream miles | District | Conduct field tests, and monitor results of 200 samples in various stream miles | District |
| | | 3.5.1.3 | Coordinate screening & testing plan with Local Governments | Organize Cooperative Screening and Testing Plan | Defer to year 3 | | Defer to Year 3 | | Draft and organize Plan with Local Governments | District Local | Organize Plan with Local Governments | District Local | Organize Plan with Local Governments | District Local |
| | | 3.6.1 | Provide information about Hazards of Illicit Discharges | Make at least two (2) presentations per year to local groups on Illicit Discharge | Defer to year 2 | District | Prepare and make 2 presentations to the public, government employees, and business groups | District | Prepare and make 2 presentations to the public, government employees, and business groups | District | Prepare and make 2 presentations to the public, government employees, and business groups | District | Prepare and make 2 presentations to the public, government employees, and business groups | District |
| | | *3.6.1.1 | Illicit Discharge Brochure | Draft, print and distribute 200 brochures on Illicit Discharges per year | Prepare, print, and distribute 200 brochures on Illicit Discharges | District | Prepare, print, and distribute 200 brochures on Illicit Discharges | District | Prepare, print, and distribute 200 brochures on Illicit Discharges | District | Prepare, print, and distribute 200 brochures on Illicit Discharges | District | Prepare, print, and distribute 200 brochures on Illicit Discharges | District |
| | | *3.6.1.2 | News Releases on Illicit Discharges | Prepare and distribute one (1) news release per year, beginning year 2, on Illicit Discharges to local media | Defer to year 2 | | Prepare and distribute a News Release on Illicit Discharges | District | Prepare and distribute a News Release on Illicit Discharges | District | Prepare and distribute a News Release on Illicit Discharges | District | Prepare and distribute a News Release on Illicit Discharges | District |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 3.7.1 | Monitor BMP's | Monitor each installed BMP at least every other year | Review BMP's and prepare effectiveness reports | District | Review BMP's and prepare effectiveness reports | District | Review BMP's and prepare effectiveness reports | District | Review BMP's and prepare effectiveness reports | District | Review BMP's and prepare effectiveness reports | District |
| | | 3.8.1 | List and Restrict Non-Storm Water Discharges | Prepare Plan to Restrict Non-Storm Water Discharges and implement within three years | Prepare Plan and list of Non-Storm Water Discharges | District | Review and update Plan and list of Non-Storm Water Discharges | District | Review and update Plan and list of Non-Storm Water Discharges | District | Review and update Plan and list of Non-Storm Water Discharges | District | Review and update Plan and list of Non-Storm Water Discharges | District |
| | | 3.9.1 | Document the Decision Process | Document Decision Process | Prepare documentation guidelines | District | Yearly documentation | District | Yearly documentation | District | Yearly documentation | District | Yearly documentation | District |
| MCM No. | Minimum Control Measure | BMP No. | BMP's | Measurable Goals | Year 1 (2003) | Responsibility | Year 2 (2004) | Responsibility | Year 3 (2005) | Responsibility | Year 4 (2006) | Responsibility | Year 5 (2007) | Responsibility |
| 4 | Construction Site Storm Water Runoff Control | 4.1.1 | Construction Control Ordinance | Enact Construction Control Ordinance, including runoff, erosion, and sediment control plans, and implement within five years. | Develop Draft Construction Control Ordinance with sanctions | District | Meet with local jurisdictions and implement Ordinance | District Local | Implement Ordinance | District Local | Enforce Ordinance | District Local | Enforce Ordinance and review program | District Local |
| | | *4.1.1.1 | Runoff Control BMP's | Implement Runoff Control BMP Plan and enforce within 3 years | Defer to year 2 | | Draft BMP Plan | District | Implement and enforce BMP Plan | District | Enforce BMP Plan | District | Enforce BMP Plan | District |
| | | *4.1.1.2 | Erosion Control BMP's | Implement Erosion Control BMP Plan and enforce within 4 years | Defer to year 3 | | Defer to year 3 | District | Draft BMP Plan | District | Implement and enforce BMP Plan | District | Enforce BMP Plan | District |
| | | *4.1.1.3 | Sediment Control BMP's | Implement Sediment Control BMP Plan and enforce within 4 years | Defer to year 3 | | Defer to year 3 | District | Draft BMP Plan | District | Implement and enforce BMP Plan | District | Enforce BMP Plan | District |
| | | 4.1.2 | Site Plan Review and Inspection Process | Develop Site Plan Review and Inspection Process and enforce within three years | Develop Site Plan Review and Inspection Process Plan | District | Develop Site Plan Review and Inspection checklist and manual | District | Enforce Site Plan Review and Inspection Plan | District | Enforce Site Plan Review and Inspection Plan | District | Enforce Site Plan Review and Inspection Plan and review program | District |
| | | 4.2.1 | Document the Decision Process | Document Decision Process | Prepare documentation guidelines | District | Yearly documentation | District | Yearly documentation | District | Yearly documentation | District | Yearly documentation | District |
| 5 | Post Construction Storm Water Management | *5.1.1 | Post construction Ordinance with Riparian Corridor (RC) and Buffer Zone (BZ) | Enact Post Construction Ordinance with Riparian Corridor (RC) and Buffer Zone (BZ) within five years | Develop Draft Post Construction Ordinance with Riparian Corridor (RC) and Buffer Zone (BZ) | District County | Solicit comments from public and communities adopt ordinance | District | Implement and enforce RC and BZ ordinance | District County | Enforce RC and BZ ordinance | District County | Enforce RC and BZ ordinance and review program | District County |
| | | 5.1.1.1 | Long Term RC and BZ Stability Plan | Develop a Plan to ensure long term RC and BZ stability | Develop Draft of Long Term Stability Plan of RC and BZ | District County | Solicit comments from public and communities adopt Plan | District Local | Implement Long Term Stability Plan | District County | Implement Long Term Stability Plan | District County | Implement Long Term Stability Plan | District County |
| | | *5.1.2 | Update Zoning Ordinances | Develop Draft of Updated Zoning Ordinances within five years | Defer to year 3 | | Defer to year 3 | | Obtain copies of existing Zoning Ordinances | District | Draft an update of Zoning Regulations | District County | Implement new Zoning Ordinances | District County |
| | | 5.1.2.1 | Long Term Stability of Zoning Ordinances | Develop a Plan for Long Term Stability of Zoning Ordinances within five years | Defer to year 4 | | Defer to year 4 | | Defer to year 4 | District County | Develop a Draft Plan for Long Term Stability of Zoning Ordinances | District County | Implement Long Term Stability Plan | District County |
| | | 5.2.1 | Document the Decision Process | Document Decision Process | Prepare documentation guidelines | District | Yearly documentation | District | Yearly documentation | District | Yearly documentation | District | Yearly documentation | District |
| 6 | Pollution Prevention / Good Housekeeping | 6.1.1 | Train Government Employees | Establish Plan for training Government Employees and train 25% of them beginning year 2 | Develop Training materials and Plan | District County Local | Produce training materials and hold training sessions for 25% of government maintenance employees | District County Local | Produce training materials and hold training sessions for 50% of government maintenance employees | District County Local | Produce training materials and hold training sessions for 75% of government maintenance employees | District County Local | Produce training materials and hold training sessions for 100% of government maintenance employees | District County Local |
| | | *6.1.1.1 | Maintenance Schedule | Develop Maintenance Plan and Schedule within 4 years | Defer to year 2 | | Develop Maintenance Plan | District County | Coordinate with local entities to develop schedule | District County | Implement Maintenance Plan and Schedule | District County | Implement Maintenance Plan and Schedule | District County |
| | | 6.1.1.2 | Inspection Plan for BMP's | Develop Inspection Plan for BMP's and inspect half of BMP's each year, beginning year 2 | Develop Inspection Plan and schedule | District County | Coordinate with local entities to develop Plan and schedule inspection of 50% of BMP's | District County | Coordinate with local entities to develop Plan and schedule inspection of 50% of BMP's | District County | Coordinate with local entities to develop Plan and schedule inspection of 50% of BMP's | District County | Coordinate with local entities to develop Plan and schedule inspection of 50% of BMP's | District County |
| | | 6.1.2 | Illegal Dumping and Control Program | Develop Plan for Illegal Dumping and Control Program within five years | Defer to year 3 | | Defer to year 3 | | Develop draft of Illegal Dumping and Control Program | District County | Implement Illegal Dumping and Control Program and incorporate Butler County Hazardous waste collection | District County | Continue Illegal Dumping and Control Program and incorporate Butler County Hazardous waste collection | District County |
| | | 6.2.1 | Document the Decision Process | Document Decision Process | Prepare documentation guidelines | District | Yearly documentation | District | Yearly documentation | District | Yearly documentation | District | Yearly documentation | District |

# Appendix B

# Regional Detention Basin Support Data

# Regional Detention Basin Data Sheet

**Basin Facts**

| | | | |
|---|---|---|---|
| Minimum Elevation | 642 | feet | |
| Maximum Elevation | 652 | feet | (Matches topography) |
| Embankment Height | 10 | feet | |
| Crest Width | 20 | feet | |
| Footprint Area | 48.5 | acres | |
| Maximum Storage | 195 | ac-ft | |
| Outlet Structure | 48" + 60" RCP | | (Optimized for Existing 100yr) |

**Stage-Storage-Discharge Curve**

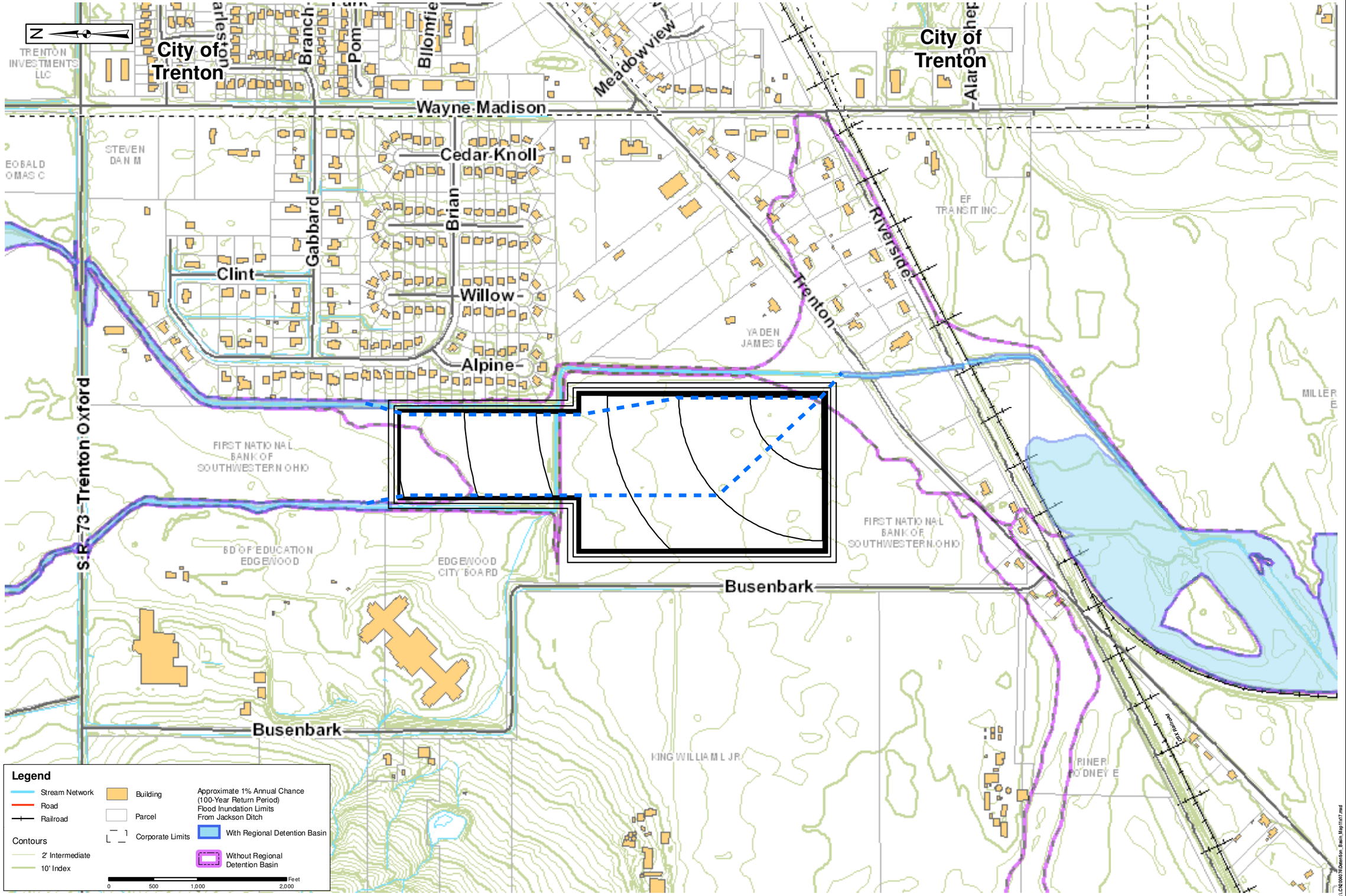
| Elevation (feet) | Depth (feet) | Cumulative Storage (ac-ft) | Discharge (cfs) | Notes |
|---|---|---|---|---|
| 641 | 0 | 0.000 | 0 | |
| 642 | 1 | 1.400 | 16 | |
| 643 | 2 | 8.700 | 52 | |
| 644 | 3 | 25.300 | 106 | |
| 645 | 4 | 50.500 | 164 | |
| 646 | 5 | 81.800 | 221 | |
| 647 | 6 | 117.700 | 273 | |
| 648 | 7 | 156.100 | 320 | |
| 649 | 8 | 194.900 | 2000 | Assumed in case of overtopping. |
| 650 | 9 | --- | | |
| 651 | 10 | --- | | |
| 652 | 11 | --- | | Top of Dam |

**Detention Basin Flow Characteristics**

| Storm Event | Inflow (cfs) | Outflow (cfs) | Peak Elevation (feet) | Available Freeboard (feet) | Peak Storage (ac-ft) |
|---|---|---|---|---|---|
| 2-Year Flood Event | 191 | 96 | 643.8 | 8.2 | 22.3 |
| 5-Year Flood Event | 327 | 147 | 644.7 | 7.3 | 43.1 |
| 10-Year Flood Event | 443 | 187 | 645.4 | 6.6 | 62.9 |
| 25-Year Flood Event | 614 | 240 | 646.4 | 5.6 | 94.8 |
| 50-Year Flood Event | 755 | 280 | 647.1 | 4.9 | 123.1 |
| 100-Year Flood Event | 907 | 318 | 648.0 | 4.0 | 154.9 |

# Conceptual Project Cost Opinion Summary

| | Alternate #1 Buy-Out | Alternate #2 Regional Basin |
|---|---|---|
| **1.0 Property Acquisition** | | |
| 1.1 Approximate Number of Properties | 21 | 1 |
| 1.2 Approximate Property Value | $ 1,934,000 | $ 350,000 |
| 1.3 Approximate Number of Structures | 42 | - |
| 1.4 Estimated Area Disturbed | 25 | 95 |
| Subtotal Property Acquisition | $ 2,059,000 | $ 350,000 |
| Property Value Contingency ( 10% ) | $ 206,000 | $ 35,000 |
| Acquisition Contingency ( 25% ) | $ 515,000 | $ 88,000 |
| **Total Property Acquisition** | **$ 2,780,000** | **$ 473,000** |
| **2.0 Consulting Services** | | |
| 2.1 Surveying Services | $ 25,000 | $ 5,000 |
| 2.2 Legal Fees | $ 25,000 | |
| 2.3 Permitting | $ 5,000 | $ 15,000 |
| 2.4 Engineering / Design | $ 47,000 | $ 558,000 |
| 2.5 Construction Administration | $ 117,000 | $ 1,394,000 |
| Subtotal Consulting Services | $ 219,000 | $ 1,972,000 |
| Consulting Services Contingency ( 20% ) | $ 44,000 | $ 395,000 |
| **Total Consulting Services** | **$ 263,000** | **$ 2,367,000** |
| **3.0 Construction Costs** | | |
| 3.1 Mobilization and Demobilization | $ 5,000 | $ 30,000 |
| 3.2 Site Preparation | | $ 95,000 |
| 3.3 Structure Demolition & Disposal | $ 125,000 | $ - |
| 3.4 Utility Relocation | $ - | $ 50,000 |
| 3.5 Sediment and Erosion Control | $ 3,000 | $ 15,000 |
| 3.6 Seeding and Mulching | $ 63,000 | $ 238,000 |
| 3.7 Mass Earthwork | $ - | $ 1,850,000 |
| 3.8 Basin Outlet Structures | $ - | $ 45,000 |
| Subtotal Construction Costs | $ 196,000 | $ 2,323,000 |
| Construction Contingency ( 20 % ) | $ 39,000 | $ 465,000 |
| **Total Construction Costs** | $ 235,000 | $ 2,788,000 |
| **Total Property Acquisition** | $ 2,780,000 | $ 473,000 |
| **Total Consulting Services** | $ 263,000 | $ 2,367,000 |
| **Total Construction Activities** | $ 235,000 | $ 2,788,000 |
| **Total Project Costs** | **$ 3,278,000** | **$ 5,628,000** |

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# Conceptual Detention Basin

Jackson Ditch Watershed Study
and Storm Water Management Plan
Butler County Storm Water District
Butler County, Ohio

| | |
|---|---|
| PROJECT NO. | CN2004074 |
| DATE | May, 2006 |
| DRAWN BY | MAE/ELC |
| CHECKED BY | JR |
| CHECKED BY | |
| SCALE | 1" = 500' |
| REVISED | |
| 1. | |
| 2. | |
| 3. | |
| 4. | |

**SHEET**

**1 OF 1**

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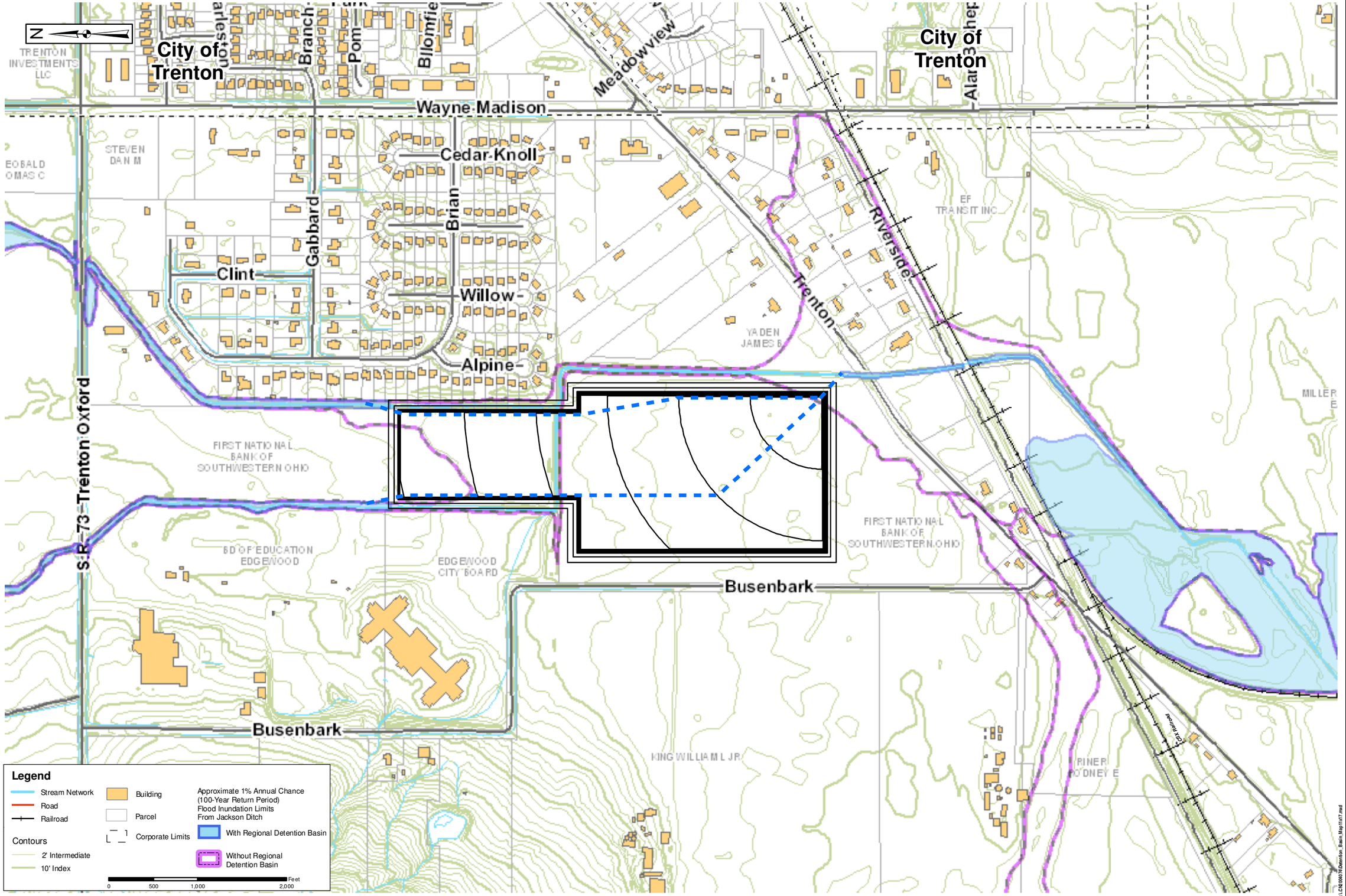


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**SHEET**

**1 OF 1**

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# Appendix C

# References and Websites

## Appendix C - BMP References

| | Citation | Synopsis |
|---|---|---|
| **Stormwater Manuals** | | |
| 1 | "Rain Water and Land Development Manual Draft", May 2005,Ohio Department of Natural Resources ftp://ftp.dnr.state.oh.us/Soil_&_Water_Conservation/rainwater/ | A draft stormwater management manual with descriptions and photos of storm water management techniques and BMPs |
| 2 | "Location and Design Manual", Ohio Department of Transportation, http://www.dot.state.oh.us/se/hy/LD2/entireL&Dbookmarked.pdf | Roadway drainage design manual with considerations of stormwater BMP practices. |
| 3 | "Ohio Department of Transportation Storm Water Management Plan", Ohio Department of Transportation, URS, March 10, 2003 http://www.dot.state.oh.us/se/hy/post%20construction.htm | 38 Best Management practices were provided to meet the six Minimum Control Measures (MCM) required by the Ohio EPA. |
| 4 | "Guidebook of Best Management Practices for Michigan Watersheds", 1998, Michigan Department of Quality Control, Surface Water Quality Devision. | Guideline using stormwater BMPs approaches in site planning and design for developers and contractors. |
| 5 | "Regional Best Management Practices", Draft Manual, Northern Kentucky Sanitation District 1, Louisville MSD, and Clermont County Office of Environment Quality http://www.sd1.org/stormwater/BMP_Manual_Final_Draft.pdf | A comprehensive Stormwater Best Management Practices manual that provides fact sheets and schematics of conventional structural BMPs. |
| 6 | "Stormwater Best Management Practices for Bowling Green, KY", December 2004, FMSM Engineers Inc. http://www.bgky.org/publicworks/planningdesign/bmpindex.php | BMP manual for construction sites with fact sheets for site planning and designing, sediment management practices and BMP decision Matrix. |
| 7 | "Protecting Water Quality in Urban Areas - Best Management Practices for Dealing with Storm Water Runoff from Urban, Suburban and Developing Areas of Minnesota", March,2001, Minnesota Pollution Control Agency. http://www.pca.state.mn.us/water/pubs/sw-bmpmanual.html | Stormwater BMP manual for Suburban and Developing Areas of Minnesota with description, schematics, applications and design guidelines. |
| 8 | "Stormwater Best Management Practice (BMP) Handbooks", 2003,California Stormwater Quality Associatio. http://www.cabmphandbooks.com/ | A comprehensive Stormwater Best Management Practices manual that provides fact sheets of more than one hundread structural BMPs with photos, applciations and design guidelines . |
| 9 | "Determining Urban Stormwater Best Management Practice (BMP) Removal Efficiencies", 2000, Wright Water Engineers, Inc. | Description of performance and design consideration of several structural BMPs such as grass filter strip, grassed swale, infiltration basins and hydrodynamic devices. |
| 10 | "Catalog of Stormwater BMPs for Cities and Counties", Idaho Department of Environmental Quality http://www.deq.state.id.us/water/permits_forms/permitting/catalog_bmps.cfm | A BMP manual with fact sheets that provide a general overall, applications and brief design guidlines of structural BMPs. |
| 11 | "Northern Virginia BMP Handbook",1992,Northern Virginia Planning District Commission&Engineers an Surverys Institute http://www.novaregion.org/pdf/NVBMP-Handbook.pdf | Guideline for design of Best Management Practices in Northern Virginia with fact sheets of BMPs that provide designers with general overview of how to size, select and locate a BMP practice. |
| 12 | "Knoxville BMP Manual", May 2003, City of Knoxville, Tennesse, Stormwater Engineering Devision http://www.ci.knoxville.tn.us/engineering/bmp_manual/ | A comprehensive Stormwater Best Management Practices manual including separate sections on appropriate best management practices for construction activities, erosion control, industrial land-uses, and wastewater treatment with detailed design standards, drawings and BMP decision Matrix. |
| 13 | "Blackberry Creek Alternative Futures Analysis Project. ", 2003, Conservation Design Forum, Inc.and Kane Co, IL, Department of Environemental Management, IL http://www.co.kane.il.us/kcstorm/blackberry/ | Description of alternative site design approaches to minimize the impact of development to environment. Fact sheets for severl Stormwater Best Management Practices with applciation scale, demonstation photos, limits and design considerations were provided. Example site design for residential, commercial/industrial and rurual development were given. |
| 14 | "Revised Manual for New Jersey: Best Management Practices for Control of Nonpoint Source Pollution from Stormwater", 2000, NJDEP Division of Watershed Management, http://www.state.nj.us/dep/watershedmgt/bmpmanual.htm | BMP Manual to provide effective and economical alternatives for control of nonpoint source pollution resulting from land development with decision making tables and design considerations of severl structural BMPs. |
| 15 | "Green technology: the delaware urban runoff management approach", January 2004, Integrated Land Management, Inc. http://www.dnrec.state.de.us/DNREC2000/Divisions/Soil/Stormwater/New/DURMM_TechnicalManual_01-04.pdf | A Technical manual prepared for desiging BMPs to minimize stormwater impacts from land development. Performance and pollutant remove efficiency of several structural BMPs such as Infiltration, filter stip, biofiltration and bioretention were studied. |

## Appendix C - BMP References

| | Citation | Synopsis |
|---|---|---|
| **Erosion and Sediment Control** | | |
| 16 | "RUSLE Erosion Prediction Spreadsheet",Ohio Department of Natural Resouce, Devision of Soil and Water Conservation, http://www.ohiodnr.com/soilandwater/docs/loadreduction/RUSLE_Erosion_Prediction.pdf | Manual of RUSLE to predict erosion and sediment load |
| 17 | "Estimating TMDL background sediment loading from existing data – FINAL REPORT to the Great Lakes Commission",Peter J. Whiting Department of Geological Sciences, Case Western Reserve University. | Sediment Loading Estimation for Great Lake watershed using statistical models. |
| 18 | "Estimation of Pollutant Loads in Rivers and Streams: A Guidance Document for NPS Programs ",R. Peter Richards, Water Quality Laboratory, Heidelberg College,Ohio | Estimation of Pollutant Loads in Rivers and Streams from non-point pollution source. |
| 19 | "Reports from the Ohio Tributary Monitoring Program Annual Loads of Sediment, Nutrients, and Chloride", Water Quality Lab, Heidelberg College,Ohio | Estimation of total amount of water and five water quality constituents transported annually in seven of the largest rivers within the state of Ohio,. |
| 20 | USGS Surface Water Quality Gages http://waterdata.usgs.gov/nwis | USGS surface water quality gages. |
| 21 | "Butler Soil & Water Conservation District Storm water Pollution prevention Plan (SWPPP) Checklist for Construction Site.", Butler Soil & Water Conservation District, http://www.butlercountyohio.org/conservation/Urban/SWPPPchecklist.pdf | Provides a checklist for construction site. |
| 22 | "Butler County Stormwater District: Stormwater Management Plan", Butler County Stormwater District, Februray, 2003 http://www.stormwaterdistrict.org/StormWaterMgtPlan.pdf | Outlined the Butler County Storm Sewer District's plan to develop, implement, and enforce a storm water management program designed to reduce the discharge of pollutants to the "maximum extent practicable", to protect water quality, |
| **Low Impact Development** | | |
| 23 | "Low Impact Development", US Environment Protection Agency, October, 2000. http://www.epa.gov/owow/nps/lid/lid.pdf | Literature Review of EPA Low Impact Development program. |
| 24 | "Preliminary Data Summary of Urban Stormwater Best Management Practices: Part C",EPA-821-R-99-012, US Environment Protection Agency, Augest, 1999. http://www.epa.gov/OST/stormwater/ | Description and performance of stormwater Best Management Practices. |
| 25 | "Preliminary Data Summary of Urban Stormwater Best Management Practices: Part D",EPA-821-R-99-012, US Environment Protection Agency, Augest, 1999. http://www.epa.gov/OST/stormwater/ | Costs and benifits of stromwater BMP structure. |
| **Aquifer Protection** | | |
| 26 | "Development of Appropriate Stormwater Infiltration BMPs: Part I Potential Water Quality Impacts, Monitoring and Efficacy Evaluation1", G. Fred Lee, Proceedings of Ground Water Protection Council 98 Annual Forum,September, 1998 | Guidance on the appropriate use of urban area and highway stormwater infiltration as a best management practice for stormwater runoff water quality management. |
| 27 | "Optional enhanced measures for the protection of water quality in the Edwards aquifer", February, 2005, Texas commission on environmental quality | Technical Guidance on Best Management Practices for Aquifers. |

## Appendix C - BMP References

| | Citation | Synopsis |
|---|---|---|
| **Individual BMP Fact Sheets** | | |
| 28 | "Storm Water Management Fact Sheet Minimizing Effects from Highway Deicing", EPA 832-F-99-016.US Environment Protection Agency, September 1999. http://www.epa.gov/owm/mtb/mtbfact.htm | Fact Sheet of Deicing product application. |
| 29 | "Storm Water O&M Fact Sheet Handling and Disposal of Residuals",EPA 832-F-99-015 US Environment Protection Agency, September 1999. http://www.epa.gov/owow/nps/lid/lidlit.html | Fact sheet for handling and disposal of residue. |
| 30 | "Storm Water O&M Fact Sheet: Catch Basin Clean ",EPA 832-F-99-011 US Environment Protection Agency, September 1999. http://www.epa.gov/owow/nps/lid/lidlit.html | Fact sheet for maintenance of catch basin. |
| 31 | "Storm Water Technology Fact Sheet :Stormwater Wetland",EPA 832-F-99-025 US Environment Protection Agency, September 1999. http://www.epa.gov/owm/mtb/mtbfact.htm | Fact sheet for design and implementation of stormwater wetland. |
| 32 | "Storm Water Technology Fact Sheet Bioretention", EPA 832-F-99-012 US Environment Protection Agency, September 1999. http://www.epa.gov/owow/nps/lid/lidlit.html | Fact Sheet of Bioretention Basins for designers to size, select and design a Bioretention Basin. |
| 33 | "Storm Water Technology Fact Sheet Hydrodynamic Separators", EPA 832-F-99-017 US Environment Protection Agency, September 1999. http://www.epa.gov/owm/mtb/mtbfact.htm | Several Hydrodynamic Separator widely used in storm water treatment were discussed and the pollutant removal efficiency of each seperator was studied. |
| 34 | "Storm Water Technology Fact Sheet Infiltration Trench",EPA 832-F-99-015 US Environment Protection Agency, September 1999. http://www.epa.gov/owm/mtb/mtbfact.htm | Fact sheet for design and implementation of Infiltration Trench. |
| 35 | "Storm Water Technology Fact Sheet Vegetative Cover",EPA 832-F-99-025 US Environment Protection Agency, September 1999. http://www.epa.gov/owm/mtb/mtbfact.htm | Fact sheet for design and implementation of Vegetative Cover. |
| 36 | "Storm Water Technology Fact Sheet Sand Filters", EPA 832-F-99-007 US Environment Protection Agency, September 1999. http://www.epa.gov/owow/nps/lid/lidlit.html | Fact Sheet of Sand Filters for designers to size, select and design a sand filter. |
| 37 | "Storm Water Technology Fact Sheet:Wet Detention Ponds",EPA 832-F-99-048 US Environment Protection Agency, September 1999. http://www.epa.gov/owm/mtb/mtbfact.htm | Fact sheet for design and implementation of wet detention pond. |
| 38 | "Stormwater Demonstration Project",http://www.portlandonline.com/bes/index.cfm?c=31870 | Fact sheets with photos for developers to incorporate Landscape swale, green street design in site planning and development. |
| 39 | "Vegetated Roof Cover:EPA Fact Sheet", EPA-841-B-00-005D.US Environment Protection Agency, September 1999. http://www.epa.gov/owow/nps/lid/lidlit.html | Vegetated Roof Cover:Case study in Philadelphia, Pennsylvania on vegetated roofs. The study demonstrates the use of a vegetated roof to reduce runoff, conserve energy and improve community aesthetics. Includes design information and monitoring data. |
| 40 | Fact Sheet http://www.deq.state.id.us/water/data_reports/storm_water/stormwater_catalog_bmp38b.pdf | Fact Sheet for designers to size, select and design a bio-infiltration swale. |
| 41 | BMP Desin Criteria http://www.chulavistaca.gov/City_Services/Development_Services/Engineering/PDF%20Files/StormWaterManual/B-5.pdf | Fact Sheet for designers to size, select and design a Dry Well. |
| 42 | Fact Sheet http://www.lowimpactdevelopment.org/ffxcty/2-2_drywells_draft.pdf | Fact Sheet for designers to size, select and design a Dry Well. |
| 43 | http://www.webdesignpros.net/consult/pdffiles/Frenchdrains.pdf | Fact Sheet for designers to size, select and design a Dry Well. |
| 44 | http://www.state.nj.us/dep/watershedmgt/DOCS/BMP_DOCS/chapter3.pdf | Fact Sheet for designers to size, select and design a Dry Well. |

## Appendix C - BMP References

| | Citation | Synopsis |
|---|---|---|
| **Websites** | | |
| 45 | California Construction Site BMP Fact Sheets http://www.dot.ca.gov/hq/construc/stormwater/factsheets.htm | Fact sheets and drawings for construction site BMPs including sediment control and erosion protection practices. |
| 46 | Center for Wateshed Protection http://www.cwp.org/stormwater_mgt.htm | Website providing watershed managers with links to helpful manuals and other web sites. |
| 47 | DEQ Storm Water Management Guidelines http://www.deq.state.or.us/wq/groundwa/swmgmtguide.htm | Outline of different methods available to remove pollutants from stormwater, prior to discharging to groundwater resources as alternatives to the use of dry wells. |
| 48 | EPA Municipal Technologies: http://www.epa.gov/owm/mtb/mtbfact.htm | Fact sheets and drawings of combined sewer and stormwater management. |
| 49 | EPA Stormwater Website www.epa.gov/npdes/storm water | Website containing technical and regulatory information about the NPDES stormwater program. |
| 50 | Low Impact center http://lowimpactdevelopment.org/ffxcty/ | Low Impact Development program that provides factor sheet of several widely used stormwater structural BMPs. |
| 51 | Low Impact center http://www.lid-stormwater.net/intro/sitemap.htm | Schematics and drawings demonstrating LID site planning strategy for how/high density residential development and commercial development. |
| 52 | Low Impact Development (LID) Literature Review and Fact Sheets, US Environment Protection Agency, http://www.epa.gov/owow/nps/lid/lidlit.html | General overview of Low Impact Development Strategy in site planning and design. |
| 53 | Low Impact Development Design Tools http://www.lid-stormwater.net/ | Demonstration of Low Impact Development concepts used in site planning and design. |
| 54 | Low Impact Development, http://www.epa.gov/nps/lid/ | General Information website of Low Impact Development Strategy including fact sheets, design strategy, other non-EPA wetsite links. |
| 55 | Natural Resources Defense Council http://www.nrdc.org/water/pollution/storm/stoinx.asp | Documents of some of the most effective strategies being employed by communities around the country to control urban runoff pollution. |
| 56 | Portland Bureau of Environmental Servies http://www.portlandonline.com/bes/index.cfm?c=31870 | Website with projects, homeowner handbooks, fact sheets of stormwater BMP practices. |
| 57 | Smart Growth http://www.epa.gov/livability/ | Information website on various smart growth topics and EPA funding sources, and links to other helpful web sites. |
| 58 | Stormwater Manager's Resource Center http://www.stormwatercenter.net/ | Resources including guidance documents, slide shows, model ordinances, and fact sheets for stormwater managers. |
| **Other Topics related to Stormwater BMPs** | | |
| 59 | "Analysis of Treatment System Performance", International Stormwater Best Management Practices (BMP) Database, Februray, 2006,GeoSyntec Consultants, Wright Water Engineers Inc. | Analyzed available monitoring data drawn from the International Stormwater Best Management Practices (BMP) Database to determine the treatment performance for widely used BMP structures. |
| 60 | "Stormwater plant materials - a resource guide",2000, City of Boise, Public Works Department. | Detailed information on appropriate plant material for stormwater BMP practices. |
| 61 | "UST Systems: Inspecting And Maintaining Sumps And Spill Buckets", US Environment Protection Agency, http://www.epa.gov/OUST/pubs/sumpmanl.htm | Guidance of management of underground gas tank. |
| 62 | http://www.chesapeakebay.net/pubs/subcommittee/nsc/uswg/BMP_Definitions.PDF | BMP categories and definitions |