Clean Water Act §319(h)

Project Final Report

Dry Run Watershed Land Use BMP Education Project

Workplan #04-07

Memorandum of Agreement #M-04517172

Cooperative Agreement #C9994861-04

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Completion of the *Dry Run Watershed Land Use BMP Education Project*, including all of the tasks and activities defined in the work program and summarized in this Final Project Report were made possible through the participation of all of the following individuals:

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Executive Summary

The *Dry Run Watershed Land Use BMP Education Project* was approved by the Commonwealth of Kentucky—Division of Water, the U.S. EPA, and the Georgetown-Scott County Planning Commission (GSCPC) in fiscal year 2003-2004 and annually reauthorized as a multi-year effort to be completed in 2010. The grant for the Dry Run Watershed, in part, is funded by resources made available under the Clean Water Act (CWA) Section 319(h), and by both the City of Georgetown and Scott County, under the auspices of the GSCPC, which is the local agency administering the grant. The goals and objectives for the Dry Run Study are:

1. To reduce or prevent non-point source (NPS) pollution in the developing watersheds throughout Kentucky; and
2. To reduce or prevent NPS pollution in the developing Dry Run Watershed in Scott County to serve as a case study for Goal 1.

The Dry Run Watershed includes approximately 8,600 acres of mostly agricultural land. It is located in the center of Scott County, Kentucky, just north and partially within the boundaries of the City of Georgetown. It contains a portion of the Toyota Manufacturing Plant, whose large employment base has contributed to high growth in the surrounding area.

While the growth and urbanization as seen in Scott County is generally desired, it is understood that negative impacts will result from nonpoint source pollution due to the increased imperviousness of future urban land uses if efforts are not made to address watershed protection issues prior to the development occurring. What is unique about this project is that these “efforts” are focused at a watershed level and combine both planning and engineering tools to achieve a common goal.

Historically, land use planning and the engineering design for stormwater management and environmental protection are addressed separately through different processes and they both tend to focus on effects immediately adjacent or “downstream” of the project site. It is rare and often cost-prohibitive to try to determine the greater effects a land use change might have at a watershed level. The materials and methods developed through this project to achieve the goals established provide the information needed to predict and mitigate the negative impacts of land use disturbance caused by increased growth and urbanization. These tools developed include:

1. *Watershed Characterization and Assessment* or the gathering of as much information as possible about the current stream and

watershed conditions including physical characteristics and evaluation of the quality and health.

2. *Watershed Protection and Restoration Strategy* is the evaluation of information obtained by the first tool and the beginning of watershed planning. This is where any existing problem areas in the watershed are identified, a plan is proposed to address the problem (and cause of the problem) and measures are planned to prevent the problem in the future.

3. *Water Quality and BMP Modeling* which is best described as a use of the information gathered to develop a hydrologic model of the watershed that can be used to predict how land use changes may affect stream quantity and quality. This project used XP-SWMM which was able to numerically and graphically demonstrate the impacts development has on the stream and to evaluate how the use of different BMP's reduces those impacts.

4. *Watershed Future Land Use Planning* which uses the first three tools along with established planning methods including public input and review of all relative factors to establish the best possible future use of the land to be adopted by government bodies.

5. *Land Use BMP Education* is providing all those who will use the land (now and in the future) with information regarding Best Management Practices (BMP) to protect our water resources.

Through the development and use of these tools for the Dry Run Watershed, many lessons were learned that can be shared and duplicated (with time and money saved) throughout other developing watersheds in Kentucky. Although it will be many years before the true benefits of this project and proactive planning efforts can assuredly be measured, we believe that the goals and objectives established for this project and the time and labor put forth will provide long term future benefits both to the citizens of Scott County and to other similar communities through the protection of our streams and water resources.

1.0 Introduction and Background

In fiscal year 2003-2004, the Commonwealth of Kentucky—Division of Water and the U.S. Environmental Protection Agency (EPA) funded a grant for the Dry Run Watershed using, in part, resources made available under Clean Water Act (CWA) Section 319(h). Matching funds provided by the City of Georgetown and Scott County through the Georgetown-Scott County Planning Commission (GSCPC) complete the circle of public agency sponsors for this grant.

The "Dry Run Watershed Basin" is a distinct geographic area that covers 13.3 square miles in Scott County, or about 8600 acres, including the Dry Run stream and its tributaries as shown in Figure 1.

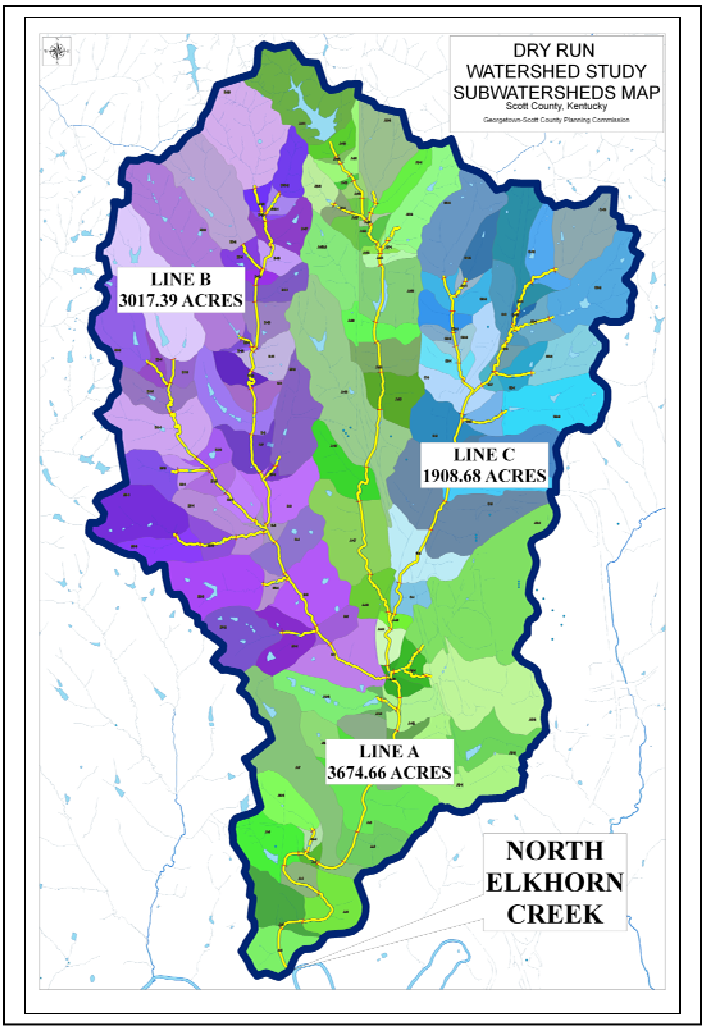


Figure 1: Dry Run Watershed and its major tributaries

The Dry Run Watershed is one of the hundreds of sub-watersheds within the larger Kentucky River Watershed, which itself is 7000 miles in size covering 42 counties in Kentucky.

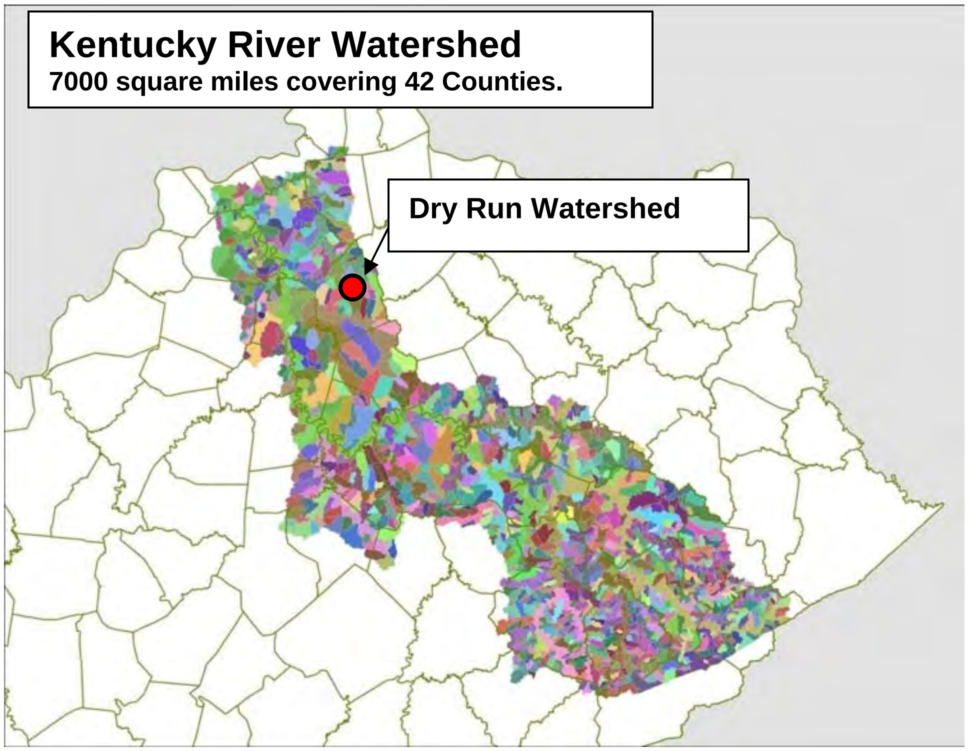


Figure 2: Dry Run Watershed within Kentucky River Basin

The Dry Run Watershed is located north of downtown Georgetown at the confluence of Dry Run Creek and North Elkhorn Creek (i.e., Moss Park and Bi-Water Farm), extending north towards and including approximately one-half of the Toyota Motor Manufacturing of Kentucky (TMMK) property, Anne Mason and Royal Spring Schools, Derby Estates, Scott County Fire Station #1 and Harbor Village. Approximately one-third of the proposed study area is currently located within the current Urban Service Boundary (USB) with the potential to grow to over one-half of the study area within a minimum of ten years according to Comprehensive Plan estimates. (1)

Based on development projections, the Dry Run Basin is the area identified for future growth and urban development within the community. There are several factors that will guide growth into this basin including the existence the major roadways of US 25, Champion Way and I-75; the existence of school facilities and grounds, major sanitary sewer trunk lines and related infrastructure, and construction of the proposed northwest bypass connecting U.S 460 at Western Elementary/Canewood to Cherry Blossom Way/Delaplain Road at I-75 (exit 129). This area was also identified as a growth corridor during the latest Comprehensive Plan review.

The watershed contains over 1,000 separate parcels, including 361 agricultural parcels (6,000 acres), 598 residential parcels (1,100 acres), 55 industry parcels (1,200 acres), and 23 commercial parcels (300 acres). It includes approximately 23 miles of mapped streams and 80 acres of FEMA floodplain. There are over 700 landowners within the watershed. Although the majority of acreage is in large farm operations and farm holdings, the majority of property owners live in residential subdivisions on suburban size lots.

According to the 2006 GSCPC Comprehensive Plan, "All growth indicators show a positive and even accelerating growth rate across Scott County". Growth is expected to occur in most of Scott County, but the growth within the Georgetown Urban Service Boundary (USB) is expected to be more rapid than in the unincorporated areas of the county. The Urban Service Boundary is the delineation of land surrounding the City of Georgetown that remains unincorporated but is within the service area of Georgetown's city services, such as sewer and water. The City of Georgetown and its associated Urban Service Boundary are shown in Figure 3.

The Dry Run watershed was selected for this education grant because of its location proximate to the developing City of Georgetown and for its potential for change, due to anticipated urban development, that could have adverse effects on a watershed if not properly planned and managed.

The City of Georgetown has grown significantly over the past 30 years, and those trends are expected to continue into the future. Scott County was the second fastest growing county in Kentucky in terms of percentage of population growth from 2000-2009 (4). When, where and how development occurs is not known, fully understood nor precisely estimated; however, growth is—in the words of community participants in this Dry Run Study— "inevitable and merits the attention of people who live and work in Georgetown and Scott County."

It is recognized that conversion of the open space and agricultural lands to other land uses could have adverse effects on the environmental qualities of the watershed if not properly planned and managed. In addition, agricultural practices and the management of existing land uses also can have negative repercussions that must be understood to be properly managed.

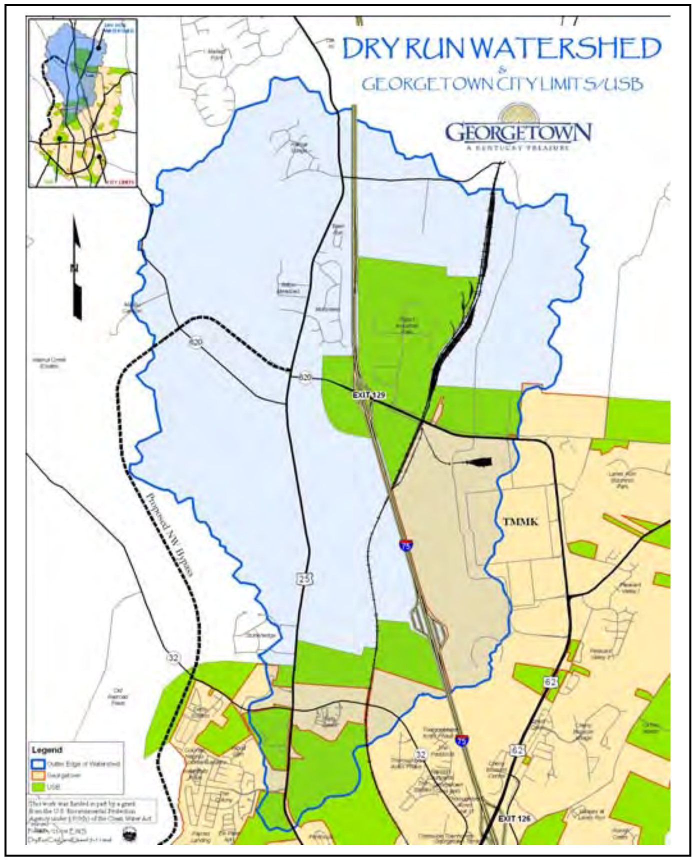


Figure 3: Dry Run Watershed, Georgetown City Limits and USB

Therefore a central purpose of this study has been to establish a baseline of the existing condition of the Dry Run watershed. This was done by documenting the physical and environmental condition of the waterways within the watershed at the start of the project, along with the existing land uses in place. By developing a future land use plan with a consideration for its effect on the environmental quality of the watershed, the success of this growth management tool can be measured over time and the incremental findings will have an educational benefit for other communities facing similar issues.

Earlier Watershed Planning Efforts:

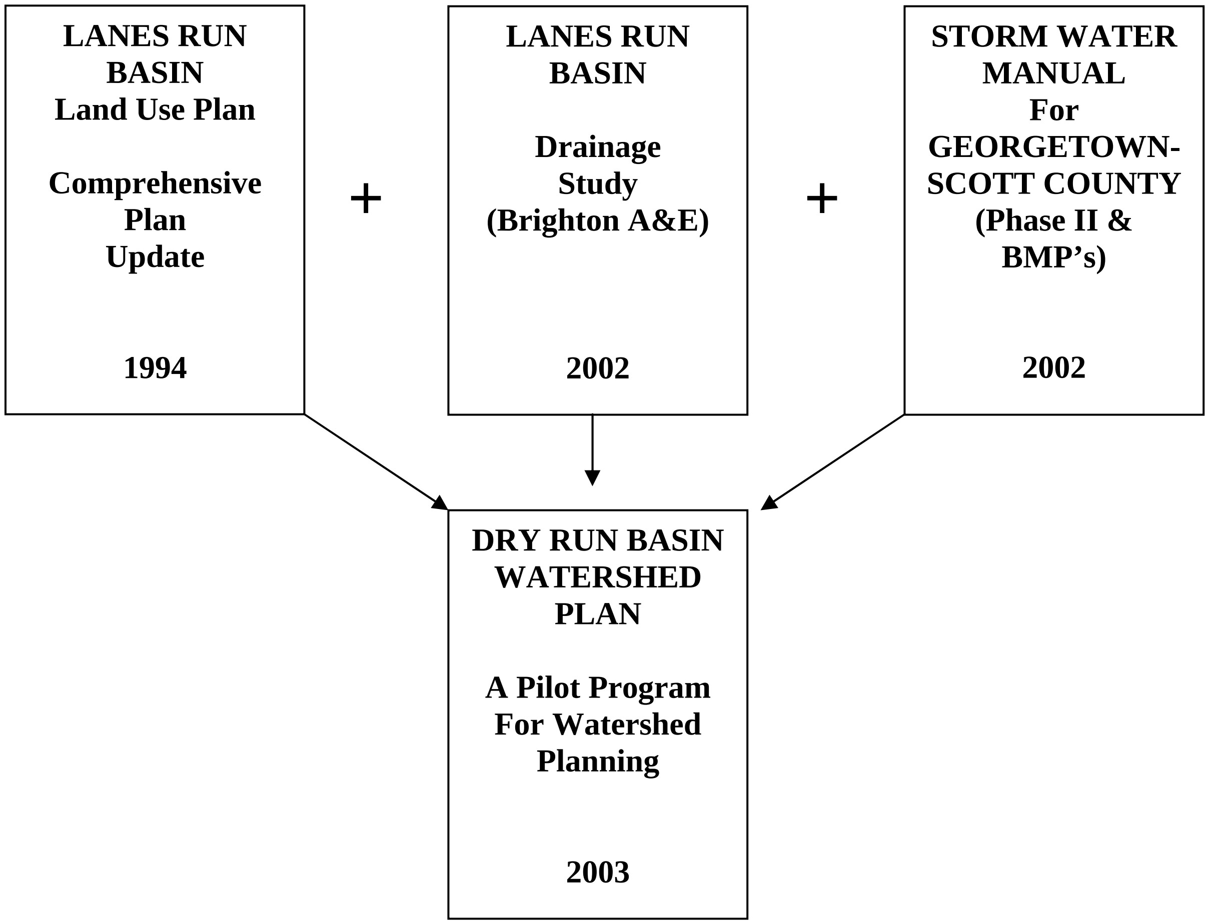
Prior work in an adjacent watershed (Lanes Run) in the late 1990s informed GSCPC of the benefits of a watershed-based computer model. At that time, "a hydrologic study was performed on Lanes Run (stream) to demonstrate that the proposed Georgetown Business Park would not increase the peak flow rate of Lanes Run." The overall conclusions of the study, based on a series of proposed land use plans for the Business Park and subsequent developments including a golf community, single-family residential subdivision and a multi-family unit apartment complex, were that flow rates would be reduced by constructing a series of retention and detention basins, including water quality features.

The ultimate goal of that study and future updates was to minimize or reduce the severity of flood damage to downstream properties by reducing the flow rates for major storm events. Planning for development within the watershed on a comprehensive basis taking into consideration the impact of a development to the whole watershed led to the realization by GSCPC that watershed planning should be an important component of the agency's planning and development review efforts.

The earlier work prompted previous Planning Commission staff, specifically Brad Frazier, Planning Commission Engineer, with the input and support of the City, County and design community, to develop a new Storm Water Manual that was adopted by Georgetown and Scott County. This manual details water quality and quantity designs, and requirements for new developments. These earlier efforts motivated the creation of the Dry Run Watershed BMP Education Project to build on and continue the momentum of previous work.

The following studies and/or ordinances have been adopted that would be the equivalent of the proposed Dry Run Basin Watershed Plan. The three (3) elements that would create a similar document in the Lanes Run Drainage Basin include: The Lanes Run Basin Land Use Plan (component of the 1994 and 1996 Comprehensive Plan), Lanes Run Basin Drainage Study, and Storm Water Manual for Georgetown & Scott County. Please contact the Development Services office of the Georgetown-Scott County Planning Commission for more information on the Lanes Run Project or documents described above.

ADOPTED COMPONENTS FOR LANES RUN DRAINAGE BASIN



One proposed product of the Dry Run study, which will be discussed in greater detail later in this report, is the Dry Run Small Area Plan. The Small Area Plan is a proactive effort to guide development within the watershed. The Dry Run Small Area Plan is being incorporated into an ongoing effort to develop and adopt a future land use map for the unincorporated areas of the county. The future land use recommendations for the Dry Run Watershed will be the basis for the county future land use map designations for that geographic area.

The current Comprehensive Plan was adopted in 2006. The Dry Run Small Area Plan will serve as a specific chapter in an update to the Comprehensive Plan to be completed in 2011. Both the Dry Run Small Area Plan and the ongoing Comprehensive Plan update will be coordinated to reflect the same direction for the Dry Run Watershed study area. Goals and objectives in the Comprehensive Plan, as they relate to the Dry Run Watershed area, will come directly from this Small Area Plan. In addition, findings of this study will serve as a basis for the Environmental Goals & Objectives of the future Comprehensive Plan update.

2.0 Materials and Methods

The following Goals and Objectives of the Dry Run Watershed BMP Educational Project were established in the grant application.

Dry Run Watershed BMP Educational Project Goals, Objectives, and Activities:

1) **Goal: Reduce or Prevent NPS Pollution in the Developing Watersheds throughout Kentucky.**
   a) *Objective: Educate City and County Land Use Decision Makers, as well as the General Public, throughout Kentucky on Land Use BMP decision processes to reduce or (NPS) Pollution.*
      i) Present Land Use BMP methodologies and results at conferences and meetings attended by Land Use Decision Makers.
      ii) Submit articles on Land Use BMP methodologies to journals, magazines and newsletters that have an audience of Land Use Decision Makers.
      iii) Educate the General Public through newspaper articles, printed materials, and presentations.

2) **Goal: Reduce or Prevent Nonpoint Source (NPS) Pollution in the Developing Dry Run Watershed in Scott County to serve as a Case Study for Goal 1.**

   a) *Objective: Prevent Stream Bank Erosion and Channel Enlargement in the Dry Run due to Urbanization.*
      i) Catalog and survey all blue line streams in watershed and enter into existing city/county Geographic Information System (GIS) to be evaluated with computer model.
      ii) Develop computer model of stream hydrology to model "channel protection" and "channel forming" runoff events so that stream is not degraded by urbanization in watershed.

   b) *Objective: Improve and Prevent Degradation of Stream Water Quality in Dry Run due to Urbanization by Using the Land Use Decision Process as a NPS BMP.*
      i) Evaluate Water Quality Impacts with computer model to determine effects of different Future Land Uses.
      ii) Determine most appropriate Future Land Uses in watershed.
      iii) Present appropriate Land Use results to Georgetown/Scott County leaders.

The work plan that was developed included the following milestones.

Project Milestones:

1. Submit all draft materials to the Cabinet for review and approval
2. Gather Land Use, Meteorological, and Stream Data
3. Field Survey of Stream & Watershed Features
4. Develop Water Quality Goals for Hydrologic Modeling
5. Submit Draft Water Quality Goals to NPS Staff
6. Develop Hydrologic Computer Model
7. QA/QC Model and Validate Results with Historic Flows
8. Develop Preliminary Land Uses
9. Evaluate Water Quality Impact of Preliminary Land Uses
10. Adjust Land Uses to Meet Water Quality Goals
11. Present Appropriate Land Uses to Georgetown/Scott County Leaders
12. Prepare Presentation(s) for Land Use BMP Education
13. Submit Draft Presentation(s) to NPS Staff for Review
14. Prepare Articles to Submit to Journals, Magazines, and Newsletters
15. Submit Articles to NPS Staff for Review
16. Conduct Presentations at Conferences and Meetings (minimum 30 presentations)
17. Submit Articles (minimum 12 articles to be submitted)
18. Submit advanced written notice of all presentations
19. Upon request of the Division of Water, submit Annual Report and/or participate in the Cabinet sponsored biennial NPS Conference.

20. Write Final Report

21. Submit three copies of the Final Report and submit three copies of all products produced by this project

The project was designed such that there were to be four phases of work that needed to be completed for the project to be considered a success. Those phases were:

- Watershed Assessment
- Watershed Modeling
- Future Land Use Analysis
- Education of Findings for Local Decision Makers

The watershed characterization and assessment and watershed protection and restoration strategy were the initial items on the work plan. The physical features of the stream and watershed were surveyed to establish their existing condition and to use as the physical structure of a hydrologic model. The methodology for these two components can be found later in this report and the full reports are located in Appendix C and D.

After this phase was complete, we next determined the Water Quality Goals for the project. The Project Oversight Committee (POC) and the personnel working on the technical and land use aspects of the projects set these goals. Examples of Water Quality Goals identified included requiring post-developed hydrology to match pre-developed hydrology, provision for groundwater recharge and treatment of all impervious runoff from new development. The goals established can be met by requiring BMPs such as extended detention basins, porous pavement, green/vegetated rooftops, infiltration basins, vegetated swales, bio-retention filters, and others.

Once the goals were established, the work began on the hydrologic model. Existing data for stream conditions, rainfall, land uses and ground cover, soils, geology, were necessary for developing the model and were gathered and catalogued along with the existing Geographic Information System (GIS) data that Georgetown/Scott County has developed. The hydrologic model was developed by utilizing the XP-SWMM software program. Once the model was developed for the existing watershed hydrology, it was reviewed through a QA/QC process to ensure that its output was accurate and its results became the baseline to compare future hydrologic impacts due to land use changes. More information on the specific methodology and results of the modeling are discussed in Section 2.3 of this report and can be found in Appendix E.

After the Hydrologic Model and existing baseline results were established, a Preliminary Future Land Use overlay for the watershed was developed in order to plug future land uses into the model to determine their impact on water quality and stream conditions. The Future Land Use Analysis will be addressed in more detail later in this report, but the approach taken is summarized below.

The Planning Analysis involved two main components, detailed GSCPC staff evaluation of potential land uses and the public input process. GSCPC staff initially used a gravity model concept composed of the major features of the watershed in application with planning principles to evaluate possible future land use. This initial planning and GIS effort was further adjusted based on community needs and existing comprehensive plan goals to produce the first Dry Run Future Land Use Map.

Next, several GSCPC staff in consultation with the Project Oversight Committee made a determination that the participation of Dry Run Watershed property owners and local community leaders was needed in order to strengthen the process of planning for future growth within the watershed. Therefore, a Design Charette was organized to gather community input. Out of the Design Charette and after some refinement by GSCPC staff, a final Future Land Use Map (Appendix G) was developed.

The proposed land uses shown on this map were added into the model to determine future impacts on water quality and physical changes in watershed characteristics. The results of these changes were then evaluated and BMP's were iteratively developed and introduced into the model to meet the Water Quality Goals. After evaluation of the specific BMP properties necessary to meet the goals, the determination was made that certain BMP's will be necessary as a requirement for each determined land use. In short, a hydrologic computer model was used to aid in the land use decision-making process to meet water quality goals.

As mentioned previously, water quality impacts are almost always evaluated after the land use decision process is over, if evaluated at all. Urbanization increases peak runoff flows and duration of flows, even with post-developed hydrologic controls. If degraded areas of stream are restored by developers, but the stream hydrology is impacted negatively by urbanization, then the restored stream areas, as well as the rest of the stream that was originally stable, will undergo increased bank and bed erosion. This can cause stream bank failures, increased sedimentation, decreased aquatic habitat quality and basically undo any restoration work that was performed.

It was determined that the proposed land uses, with BMP's in place, would improve water quality in the watershed. The land uses and BMPs necessary to meet the goals were finally presented to the Georgetown-Scott County Planning Commission. This action in combination with continued hydrologic modeling will enable growth to occur in the watershed through the proposed land uses while maintaining or improving the level of water quality and improving the quality of life for all of the residents.

The overreaching purpose of this project was to educate Land Use Decision Makers on the tools and processes available during the Land Use Decision process to prevent or reduce NPS pollution caused by urbanization. As such, Land Use BMP presentations were given to the public through various conferences, seminars, literature, and meetings attended. A project oversight committee (POC) composed of representatives from the public and private sector was organized at the start of the project to guide the progress of the grant work. The POC met a minimum of four times a year for the 5-year length of the project. Additional information regarding the Land Use BMP Education component is discussed in Section 2.5 of this report.

2.1 Watershed Characterization and Assessment

The "Watershed Characterization and Assessment Report" (WCAR) prepared by CDP Engineers for the Dry Run Watershed Land Use BMP Education Project is included in its entirety as Appendix C. In that report CDP observes that if stream water quality is addressed in the development/design process, it is often much too late to adequately protect the watershed from degradation. Through the progress of this project, a primary goal has been to address the water quality issues of the watershed's streams well before the development of the Dry Run watershed. In order to do so, a current survey and assessment of the streams were performed to establish baseline condition.

2.1.1 Survey Methodology

The exact methodology used to obtain the data is found in the WCAR in the Appendix. In summary, the surveying was performed over the course of four weeks by a survey crew and supervising engineer. Throughout the field data collection phase, the same engineer was present to ensure consistent and appropriate data collection. For a reach to be surveyed, the engineer went ahead to investigate the reach and select the appropriate positions along the stream to collect cross sectional data and any other pertinent data for the study. The survey crew would then collect the cross sectional, structural, thalweg, or other data needed and/or requested by the engineer. Pictures were taken of each cross section, any structures, and special sites, along with any general pictures that would aid in the assessment process. As the conventional survey of the stream reach was conducted, the Engineer conducted a visual survey, taking pictures, filling out data sheets for each reach and taking notes regarding special sites of concern in the surrounding area.

Once the data was collected, the analytical and computational phase of the project began. The survey data was compiled into an AutoCAD drawing with the streams and cross sections labeled. The cross sectional data was then transferred into actual cross sections to be used for stream analysis and modeling. Two major classifications or assessments were made for each stream reach. The stream assessment sheets provided a means for a general "health and stability" classification, while the plan view and cross sectional data were used to complete a major stream type classification using Rosgen methodology and computations. The stream assessment sheets were converted into electronic files for easy reproduction and addition.

The scoring of the stream reaches according to the assessment sheets reflects the general "health and stability" of the streams. A universal classification system was developed to facilitate data interpretation and provide local awareness of the watershed health. The classification was developed from the scoring of the data sheets; the score can range between 0 and 200. The general “health and stability” classifications are as follows:

0-70	Severely Degraded
71-90	Moderately Degraded
91-119	Lightly Degraded (Marginal Stream)
120-160	Healthy
161-200	Moderate to Very Healthy

Since the watershed is still largely undeveloped, most of the surveyed streams were of natural material with a score of 50 or above. Common characteristics of stream reaches within the severely degraded range were 60% or more of the stream banks eroded from heavy grazing, very little to no riparian vegetation, very high sediment deposition from trampled banks with backwater or poor flow velocities, very high nutrient loads, and/or dump sites within the stream channel. Some moderately degraded streams had established riparian vegetation, but suffered from the stream down-cutting and siltation, while other moderately degraded streams had mowed or grazed banks with less vertical banks but poor natural stream form, high nutrient loads, and poor habitat availability. Lightly degraded streams were marginal streams that were often in a transitional state between degraded and somewhat healthy streams. Such streams often scored poorly in one or two of the areas of habitat, sedimentation, natural channel form, bank stability, and riparian vegetation. Characteristics of the healthy streams scored around the suboptimal range where most conditions were relatively good, but could improve. The five stream reaches labeled as moderate-very healthy held suboptimal-optimal scores in all areas with healthy riparian vegetation and minimal land use impacts.

From the cross sections and the plan view data of the streams, more detailed quantities were obtained including the width, maximum depth, mean depth, estimated reach length, flood prone width, sinuosity, and slope of the local stream reach. Using those values, the entrenchment ratio and the width/depth ratio were obtained for each representative reach or cross section. The entrenchment ratio, width/depth ratio, sinuosity, and slope were all used to classify the streams according to Rosgen’s major stream types and forms, which range from A-G with numbers from 1-6 for dominant bed material.

Refer to “A Classification of Natural Rivers by David Rosgen” (available through internet download) for more detailed information regarding this classification methodology. The stream type classification was entered into the data sheets for easy access.

2.1.2 Survey Results

The overall health of the streams in the Dry Run watershed is lightly degraded to healthy. About 40% of the streams that were surveyed were considered healthy, while 31% of the streams were lightly degraded (marginal). The highest score that any one reach of stream received was 185 out of 200 (very healthy); this stream was a small intermittent stream with very stable banks, a healthy riparian area, tortuous meanders, a wide floodplain, and stable habitat. The lowest scoring stream reach had been heavily grazed with large areas of erosion and mud from trampled banks, and was also affected by backwater from a pond just below; its score was 50 (severely degraded). Table 1 displays the "health and stability" results.

Table 1: Summary of Stream Health Assessment Sheets

Score	Health Status	% of Total Streams
0 - 70	Severely Degraded	8.9
71 - 90	Moderately Degraded	12.7
91 - 119	Lightly Degraded/Marginal	31.6
120 - 160	Healthy	40.5
161 - 200	Moderate—Very Healthy	6.3

As reflected above, there were some severely degraded streams and areas of concern within the Dry Run watershed. Such problematic areas included a stream reach below a truck stop where numerous oil spills and major littering problems have reached the stream through various drainage points.

While visual surveying and assessment sheets enabled one to draw many conclusions regarding the current status of the streams, the Rosgen classification aided in the realization of what processes the stream is going through or what it may go through, in addition to its current status. Because classifying the streams was the last step in the data analysis process, the previous findings from the assessment sheets were reinforced and a greater understanding of the stresses and stability of the streams was achieved. Most all the stream reaches with low health and stability scores had multiple letter classifications, indicating that the stream was in a transitional phase from one stream type to another. Due to physical stresses imposed upon them, these once healthy E or C stream types have now transitioned or began the transition to F or G stream types. In contrast, most of the healthy streams had single letter classifications of E or C, indicating the stability of the stream with proper access to its floodplain. Refer to the stream assessment sheets, provided in Appendix A, to view the classifications of each stream reach.

Finally, all of the surveyed and collected data has been compiled into a GIS file. This user friendly program will allow others to view the watershed and all of the data that has been collected in regards to this project. Users will be able to view the streams' current conditions by reading a list of characteristics for each cross section or structure and selecting the pictures or drawing from that list for visualization.

2.1.3 Survey Conclusions

The analysis of the stream data revealed that the Dry Run Watershed had no major concentrations or entire branches of degradation. The areas of concern within the watershed were at specified locations where immediate land use heavily affected the stream's health and stability. The most common causes of degradation were from heavy grazing of livestock and large pollutant loads from truck stops. Given the proper attention, many of the sites of known deterioration could be remedied by a clean up or by implementing Best Management Practices such as a riparian buffer or water quality units.

The most important recommendation for this component was gained only through hindsight during the completion of the modeling and iterative BMP selection and testing exercise. The recommendation is to plan well ahead of the surveying for the type of modeling to be used and to have a to fairly accurate knowledge of the watershed layout and a preliminary plan for delineation of subwatersheds. It is also important to try to guage the general accuracy needed for the goals established. While it is almost always a desire to get the most information as possible during initial planning, the amount of work associated with the data is multiplied through the later components and can amount to an unreasonable amount of data processing.   For example, this project obtained data for over 120 different cross sections which later became individual subwatersheds used in the modeling. While all this information is wonderful to document existing conditions and for model accuracy, we ideally could have achieved similar results in the end with much less data and considerable less time modeling.

2.2 Watershed Protection and Restoration Strategy

After the Watershed Characterization and Assessment Report (WCAR) was developed and revealed that the Dry Run Watershed had no major concentrations or entire branches of degradation, it was determined that the areas of concern that were identified within the watershed should be analyzed in more detail to determine the cause of the problems and possible solutions. This information was necessary to help plan for later grant components. The Watershed Protection and Restoration Strategy Report (WPRS) prepared by CDP Engineers for the Dry Run Watershed Land Use BMP Education Project is included in its entirety as Appendix D.

2.2.1 WPRS Methodology

This WPRS Report was prepared in the fall of 2005, to follow up on the results of the WCAR and to set the stage for the modeling and land use planning components of the project. The methodology used to develop the WPRS was to evaluate the sources and locations of stream degradation from the Stream Assessment survey forms, notes and photos described previously. Based on the findings, the sources of pollution are described below and best methods of remediation are explored based on current understanding of best management practices.

2.2.2 WPRS Results

As a rapidly growing community, Georgetown has many surrounding watersheds that are presently under development. The Dry Run Watershed, currently a rural watershed, is projected to undergo relatively rapid urbanization in the future as well. The Watershed Protection and Restoration Strategy was developed to provide information about the health of the watershed and a means to protect specific areas within the watershed while enhancing or restoring other areas. Prior to development, a plan incorporating many of the principles described below will help protect the Dry Run watershed from degradation and encourage restoration of the waterways.

There are many stream reaches and areas within the watershed that are in good condition and performing most or all of their intended physical and biological functions. To protect the water quality and general health of the watershed, land use decision makers and the general public must understand stream systems and be informed of appropriate positive watershed decisions and practices. Steps should also be taken in project planning to incorporate "protective" measures to prevent any further damage to the watershed. Land use decision makers should be aware of potential sources of impairment to the waterways and alternative solutions that may be implemented to prevent or remediate the impairment. Through prudent watershed decisions, landowners can protect and often improve the waterways.

IMPAIRMENTS OF THE DRY RUN WATERSHED

As mentioned previously, there were no entirely degraded stream branches or major concentrations of degradation. Impairments of the Dry Run Watershed were identified at various points and in different forms throughout the watershed. Many of the impairments were located along the streams while some were found at localized points, such as construction sites and dump sites. In order to address the negative impacts within the Dry Run Watershed, they must be understood. This section will provide a summary (see the full WPRS found in the Appendix for more details) of the causes and significance of the impairments identified.

Sediment - is the leading pollutant in Kentucky waterways and likewise in the Dry Run Watershed. Sediment is harmful to aquatic life and can also destroy habitat by accumulating on natural streambeds or other areas and smothering the plants and creatures that live there. The causes for sediment can be linked to stream bank erosion, construction site runoff and certain agricultural practices.

Increased Stream Temperature - Another pollutant of Dry Run streams is increased stream temperature. Increased temperatures may be caused by a many things, including tree and vegetation removal and paved surfaces and can change and destroy habitats.

Chemical Contamination - Chemicals, nutrients and other pollutants such as oil and grease can be detrimental for stream health as well as hazardous for people and other animals that may come in contact with the contaminated waters. Visual indicators and pollutant sources were used to identify the likely areas of pollution. Sources of hazardous materials and black seepage were noted in the Dry Run Watershed as well as excess algae, which is typical indicator for high nutrient loads.

Stream Bank Erosion - often results in sedimentation of a stream as well as the altering of a stream’s shape and stability. The areas of stream bank erosion that were observed in the Dry Run Watershed were predominantly due to diminished riparian buffers and channel manipulation possibly due to heavy livestock grazing, which not only depletes healthy vegetation along a stream’s corridor, but also exposes stream banks to additional damage by livestock.

The following two sections provide a short description of some of the methods identified in the WPRS report to protect and restore areas that were identified as impaired.

Protection/Prevention Strategies:

To battle many of the impairments of streams we must protect the general stream corridors of a watershed which is composed of the active channel and the closely related floodplains. One way this can be achieved is through the protection of healthy riparian buffers and vegetation along the streams and around other waterways, including sinkholes and ponds. Another way is through the adoption of land use controls including banning of certain land use practices near sensitive areas and requiring water quality and quantity protection measures as needed for a particular land use and location. Most importantly, landowners should be educated about positive watershed practices and land management decisions that provide for the protection of the riparian areas while allowing production practices to continue.

Restoration Strategies:

Although the majority of the Dry Run Watershed currently exists in a relatively stable and healthy condition, there are isolated locations where land use practices are impacting stream health or will become a threat to water quality and stream stability if left unchecked. These specific locations were identified in the WPRS report and map located in Appendix D.

One measure identified in the plan to provide restoration for these identified areas is to require that proposed development provide a plan for action be taken to improve and protect the stream as a condition of development approval. Another method suggested for restoration is the planting and establishment of riparian buffers where needed and requiring an easement prior to development to protect the stream and riparian buffer area. Once again, probably the most important method suggested to achieve restoration is education. The community and landowners need to receive the information necessary to understand watershed and stream issues and how to protect and restore.

2.2.3 WPRS Conclusions

Through the review of the WPRS and evaluation of the impaired stream areas for cause and a proposed solution, many ideas were developed and discussed that contributed to the development of the additional grant components.

This exercise was also instrumental in the recruitment of local community support for the Dry Run Watershed Project. It was similar to an emotional call for help for the streams. It provided hope that in carrying out this project and implementing the small area plan, the stream would be afforded the protection and restoration necessary to return it to a more stable and healthy condition. Also, by understanding the existing conditions of the streams, the causes of their degradation, and suitable remedial actions, the community was empowered to improve the watershed.

Another conclusion reached through this component was that most landowners were completely unaware of the causes of impairment and would willingly participate to modify their actions if they were provided the education and/or some incentive to participate.

Unfortunately, the support and “positive feelings” that were created through this component were relatively short-lived. This leads to the following lesson learned and recommendation. This project was managed by a government agency and consultant, whom were both prone to employee turn-over and divided focus through the duration of the project. Thus, many of the community contacts were not maintained and interest was lost.

It is recommended that to ensure a positive outcome, a strong community leader or local watershed group be established and given the responsibility to oversee the stream restoration and protection component and also to establish specific timelines and goals for continued stream assessment and progress toward completion of restoration efforts.

2.3 Watershed Quality and BMP Modeling

The selection of appropriate land uses to minimize water quality impacts is a primary objective of the grant. The strategy used to accomplish this objective was the development of a hydrologic model to analyze different land uses and their impacts on water quality.

Land use decisions were not entirely based on the results of the hydrologic model but were tested with the model to determine their future impact on water quality and quantity of the runoff. Water quality and Best Management Practice (BMP) modeling is the third phase of the Dry Run Project, building off the results of watershed survey and characterization efforts. The overall design efforts can be broadly classified into three components:

1. Hydrologic model development,
2. Water Quality Assessment,
3. BMP modeling.

A Hydrologic and Hydraulic model was built using XP SWMM which reflected the existing scenario. Based on the modeling results, water quality assessment was later performed using selected pollutants and different land uses. The model was then evaluated based on the impacts of preliminary future land uses in regard to water quality and hydrologic response.

Application of Best Management Practices (BMPs) was later incorporated in order to meet the water quality goals in consideration of the project goal of matching the post-developed hydrology with pre-developed hydrology. Various BMPs such as extended detention basins, porous pavement, infiltration basins, vegetated swales and bio-retention filters were incorporated into the XP SWMM Model and BMP modeling was performed in order to meet the water quality goals. The final stage in modeling was to evaluate the model to finalize the land uses and BMP's for future development.

This chapter is a summary discussion of the modeling effort that covers the methodology, available data collection and integration, results, and conclusions. There is an abundance of supporting data in the form of input/output files, tables, and graphs included in Appendix E, which includes a detailed index of how this information is organized.

2.3.1 Modeling Methodology

The XP SWMM ver. 10.6, a comprehensive software package for dynamic modeling of storm water, sanitary and river systems, was chosen as the computer modeling package for this study. The methodology adopted can be characterized into three phases of modeling:

- Hydrologic and Hydraulic Analysis
- Water quality Assessment
- BMP Modeling

The discussion below summarizes the data collection, input and model development methodologies. Detailed tabular data used is included in Appendix E, Sections A and B.

1. Hydrology and Hydraulic Analysis

XP SWMM version 10.6.3 was used to perform the stormwater and water quality analysis. This software is a comprehensive package which has the capability to simulate flow and pollutant transport in engineered and natural systems including ponds, rivers, lakes, floodplains and the interaction with groundwater.

The updated version of XP SWMM gives the modeler flexibility to model BMP's in the Runoff and Hydraulics mode. The storage/treatment capabilities that were previously found only in the Sanitary mode are now accessible in the Runoff node and sub-catchment and also the Hydraulics mode. For the present study, the BMP option in a Runoff sub-catchment was used to simulate the quantity and quality benefits of certain BMP's such as detention basins, bio-retention, infiltration basins and wetland basins. The resulting nodal hydrograph has the outflow from the BMP which is then combined with the downstream flows.

XP-SWMM was used to compute runoff hydrographs and associated peak discharge values for both existing and future conditions. In XP-SWMM, a variety of methodologies can be used to perform hydrologic computations. The methodologies and data sources specifically used for this project are outlined in the following sections. Input for the hydrologic model includes precipitation data and sub-basin data (area, NRCS runoff curve number, time of concentration and initial abstraction). Table 1 (App. E, Section A) provides a summary of the hydrologic data used for modeling. The data used for the Hydraulic analysis include cross-sections, bridge/Culvert summary and Manning's n values, which were obtained through field assessments/survey, and office analyses (soils, topography, land use, GIS). Another time saving feature is the ability to globally modify input parameters, which saves time and reduces opportunity for error resulting from missing structures needing editing.

- **Sub Basin Delineation**

The Dry Run Watershed, which is comprised of nearly 13.3 square miles, was delineated into smaller sub-basins for hydrograph computations. In XP SWMM, each node represents a sub-basin, hence a total of 180 nodes were introduced into the model. The watershed has three main branches, which were labeled as branches A, B, and C for simplicity. Sub-branches were defined by simply adding a number to the branch it belonged to (A-2, C-3, for example). 120 of the sub-basins represent the drainage areas for each of the surveyed stream cross sections. Additional nodes were added as needed to complete and stabilize (reduce fluctuations during model runs) the model. The sub-basins were smaller or larger depending on the hydrologic and hydraulic modeling characteristics at particular locations. The watersheds and delineated sub-basins are shown in Figure 1 (App. E, Section A).

- **Land Use**

The Existing land use was delineated based on the prevailing land use conditions and Future land use was delineated based on projected future developments and changes in land use patterns. The Existing and Future condition land uses are displayed in Figures 4 and 5 (App. E, Section A). The Soil Conservation Service (SCS) - Curve Number (CN) and Time of Concentration (Tc) are two key model input parameters which are based on the hydrologic soil type and land use condition. Existing CN and Tc parameters were determined for each sub-watershed through site visits and reviewing a detailed map book (Appendix I) produced by the GSCPC-GIS Department showing the sub-watersheds, soil survey mapping and contours overlain on newly acquired aerial photos. These values were determined based on USDA-NRCS TR-55 methodology (USDA-NRCS, 1986). Table 2 (App. E, Section A) provides the curve numbers used in the modeling for future land use types.

- **Precipitation**

Storm events for several return periods were analyzed in this study. A 24-hr Natural Resource Conservation Service (NRCS) type II storm was used to simulate the design rainfall, the rainfall depths were taken from the NOAA’s National Weather Services (NWS) website and are tabulated in Table 6 (App. E, Section A) (App. E, Section A). For the purpose of applying this model to future development as a tool for Georgetown and Scott County, it was determined that the 2-yr event was best suited for water quality and the 100-yr event best for flood control and evaluation. Continuous rainfall simulation was also performed using an 11-month historical data series. The historical data series was used as input to XP SWMM through a text file that specified the data, time & rainfall. And then a rainfall interface file was created by XP SWMM from the input file. The rainfall data input process is accessed in a utility function or global database of XP SWMM. However, since the historic records were for precipitation only, and no stream gauge data was available to model against, this data was of marginal use for model development and evaluation.

- **Channel Routing**

The NRCS hydrology technique was used in channel routing. The required channel information (Cross-section, channel slope, channel length, time of concentration, and Manning's n) was obtained from detailed survey data and field visits. In XP SWMM, there are six major types of hydrograph generation techniques and for the present project the SCS Unit Hydrograph Method was used. The Inputs needed for this method are pervious area, curve number, time of concentration (Tc) and Initial Abstraction. These values were calculated using TR-55 methods set up in *MS Excel* from land characteristics provided by GIS (Figure 2 (App. E, Section A)).

- **Scenario Manager**

XP SWMM has the capability to develop a base condition model and then evaluate adjusted model conditions within that main model utilizing the 'scenarios' tool. This feature was utilized to streamline the evaluation process by having multiple models available at the click of the mouse as opposed to running a file and then having to save and close to check another file. The XP SWMM software gives the flexibility to compare model results graphically and in tables for various scenarios within a given base file. Hence in the Dry Run Project, the Future condition model was divided into two scenarios; **1. Model without BMP**, and **2. Model with BMP** (Figure 3 (App. E, Section A)). The results generated from these scenarios helped to review and evaluate the performance of the BMP's.

2. Water Quality Assessment

In order to perform water quality assessment in XP SWMM, the input data required are event mean concentration (EMC) of pollutants and percentage land uses. EMC's were selected since there was no local historic data regarding pollutant loading, buildup, or wash off so there was no way to effectively build and calibrate a model without existing data to validate the model. The corresponding outputs are pollutant loads and concentrations. The results were generated in XP SWMM in the form of hydrographs and pollutographs that shows flow levels and pollutant concentrations and the output file that gives summary and a time series of flow and pollutant concentrations and also total volume and loads.

- **Event mean concentrations**

The event mean concentrations of the targeted pollutants for different and uses are compiled from many field studies done by the US Geological

Survey and published data from other organizations (Urban Subwatershed Restoration Manual No.1, 2005; Quenzer, Hellweger and Maidment, 1998; Urban Sub watershed Restoration Manual Series, 2007). The data has been summarized in Tables 3 and 4 (App. E, Section A). The water quality data, which includes land use type, pollutant type and EMC, have been associated to the model through the Global Databases. First the global data was populated with the aforementioned water quality inputs and then it was linked to the nodes containing sub-basin data.

- **Percentage Land Use at each sub catchments**

The final step performed in water quality modeling was to divide each sub-basin into land uses. To accomplish this, existing percentages associated with different land uses for each node were added to the model in order to reflect existing scenario. The program generates composite results for each pollutant based on land use assignment.

For the Future scenario, a different approach in modeling was adopted. XP SWMM has flexibility in characterizing sub-catchments within a sub-basin. For the future conditions analysis, each sub-catchment represented one particular land use area. This approach for the future condition model was utilized to allow for application of different treatment unit assignment for a given land use.

3. BMP Modeling

The BMP treatment in XP SWMM was used to simulate the quantity and quality benefits of selected BMPs adopted in the project. BMP treatment process can be modeled in SWMM either in the runoff mode, hydraulic mode or in the sanitary mode. For this project, the BMPs were incorporated into the future conditions model by activating the storage treatment module in the runoff mode for all catchments. Each sub-catchment had its own BMP unit with associated removal efficiency. The main goal of the study is to evaluate the current BMPs, consider new BMPs, and to educate the public regarding the same.

- **Treatment Process**

The BMP modeling in XP SWMM can be performed either as Storage unit or Screening unit. For the project model, infiltration, grass swales, and pervious or modular pavement were modeled as screening units, and detention, bio-retention, and wetland basins were modeled as storage units. Pollutants may be characterized by their concentration alone or by concentration and their particle size/specific gravity distribution. The pollutant removal was done by using the percentage removal efficiencies. The model was developed in such a way that each sub-catchment has its own BMP unit.

- **Pollutant Removal Efficiencies**

The pollutant removal efficiencies of selected BMP's for the targeted pollutants have been gathered from US EPA Stormwater Best Management Practice Design Guide Volume 1, Sep, 2004. The data was incorporated into the model to simulate the water quality reductions. Table 5 (App. E, Section A) gives the list of BMPs used in the study with associated pollutant removal efficiencies.

- **Regional BMPs**

The ongoing modeling effort can be considered innovative since it incorporates a regional or watershed vision into BMPs modeling. BMPs have been assigned to the model relative to the land use and target pollutants, hence creating flexibility in selection of only those that are required at that site, while allowing for evaluation of the impact to the watershed as a whole.

2.3.2 Modeling Results

The models developed were complex and development time was extensive. After the base network was developed (nodes and links to represent the three main branches of Dry Run), there was an extended period of model debugging and fine tuning to stabilize the model and have it produce dynamic outputs that would be reasonable for what could be seen in a natural condition. This effort often included adjusting the time-step or frequency of iterations of a model run, adding intermediate nodes to balance the model (upstream and downstream structure outputs are continually compared in a run and the higher the difference in values between them, the more unstable the model), and extending the cross section extents to fully incorporate the flood prone area (flow is lost from the system if flow elevations exceed the elevations of a cross section so additional contours were identified and included).

Hydrology and Hydraulic Results

Multiple rainfall events were modeled to test model error, stability, and continuity. Historic time-series rainfall data was imported and run in the model as well, despite the fact that there was no corresponding stream gauge data to use to calibrate the model. However, it was shown that this historic data can be imported and used within the model. Should a community have or begin collecting gauge data, the model could be used to simulate real time conditions.

With the model developed and refined to produce reasonable results (expected variations in flows, elevations, excellent continuity and stability) for a range of rainfall events (2, 10, 50, and 100 yr, 24 hr), the next step was to determine what rainfall events would be best utilized for this project and for future use of the model for Georgetown/Scott County planning and evaluation. For evaluation of floodplains and impacts to the floodplain from development, it was logical to select the 100-yr, 24-hr event since that is the basis for FEMA regulatory floodplains and the National Flood Insurance Program (NFIP), of which Georgetown and Scott County are participants. For water quality, the 2-yr event was selected because it represents a relatively high frequency, low magnitude event that also:

- ► Closely approximates the bank-full or channel forming rainfall event for streams
- ► Is the standard event for sediment control on construction sites
- ► Ties in with current Georgetown/Scott County design regulations requiring provisions for Water Quality Volume and Recharge controls.

Model input and output files generated from XP SWMM for each event are included in Appendix E, Sections C and D.   Appendix E, Section C contains output files from the XP SWMM model runs for the four rainfall events used to develop the model. The data presented includes Water Surface Elevations (peaks), Flow results (cfs), and Water Quality Results. Appendix E, Section D contains a series of longitudinal profiles or horizontal views of stream segments showing graphically the peak water levels in the channel for a given event. For this section only the 2-yr and 100-yr events are represented.

Water Quality and BMP Modeling Results

Pollutants and BMPs were added to the model after the hydrology and hydraulics were configured and the model was performing satisfactorily. Pollutants modeled included Total Settleable Solids (TSS), Nitrogen, Phosphorus, Metals, Oil/Grease, and Fecal Coliforms. BMPs, while not identified as specific BMPs like rain gardens, permeable pavements etc., were modeled based on their mode of treatment such as detention, infiltration, and screening, which are modes of treatment typical of low impact or green type BMPs like bio-retention and infiltration basins.

Water quality results were based on the 2-yr event model for existing conditions. Three scenarios were evaluated; existing conditions, future conditions without BMPs, and future conditions with BMPs. Existing conditions provides the base from which the evaluation of future development impacts can be compared and the subsequent protective measures the BMPs provide to meet the project goal of preserving the existing water quality of the streams. In general, the results were indicative of what would be expected.

The future conditions model with no BMPs typically showed elevated pollutant levels (both concentration and total load). Applying the BMP, which applies both infiltration to reduce flow volumes and pollutant removal based on a fixed percent from the national data collected, brought the pollutant concentrations and load down equal to or below existing conditions.

There were some exceptions for some sub-basins and even fluctuations for different pollutants within a sub-basin, but the general trend was that the BMPs were producing the desired effect of preserving or improving the water quality. Oil/Grease and Metals were the pollutants that most often resulted in aberrant results, which are likely due to poor removal effectiveness of the BMP. With infiltration and recharge factored into this rainfall event (the scenario with the BMP), the results indicate a reduction in flows and elevations in the future conditions model equal to or below the existing conditions. This is demonstrated in Figure 6 (Appendix E, Section A), which shows the dashed line hydrograph representing the future with BMP condition. Comparative tabular results summaries for the 2-yr models are included in Appendix E, Section A.

Water Quantity and BMP Modeling Results

Water quantity results, looking at the 100-yr event and impacts to the floodplain in the future land use condition do not show a significant change from the existing condition. The future conditions model, not factoring in infiltration and recharge BMPs, generally resulted in around a 3% increase in flows and a corresponding slight increase in elevation. This relatively small increase is not surprising since it is expected there will be some inevitable increase in impervious surfaces due to roadway improvements and development, but the proposed future land use map still maintained a large percentage of land as agricultural (based on the recommendations of the design charrette and GSCPC Comprehensive Plan).

If infiltration and recharge were factored into this rainfall event, the results may well have indicated a reduction in flows and elevations in the future conditions model. An attempt was made to demonstrate this and is shown in Figure 7 (Appendix E, Section A) with the dashed line hydrograph representing the future with BMP condition. However, after review it was realized that the factors used to simulate recharge for the 2-yr event (Residual Flow fraction in XP SWMM) could not be carried over directly into larger (or smaller) events since there were conversion factors that would simulate a fixed percent capture and infiltration for a fixed event size. Applying the same factors to other events would result in higher (or lower) than required water quality management than the community requires. Since this large magnitude event was being evaluated for quantity and not quality, the decision was made not to pursue developing the modified factors for required recharge. Tabular results summaries for the 100-yr models are included in Appendix E, Section A.

2.3.3 Modeling Conclusions

Through the detailed modeling efforts and subsequent review and compilation of results, it became clear that the SWMM model provides several tools that the community can use for future planning in the Dry Run watershed and across all of Scott County.

As an **Evaluation Tool**, the resultant model can be used during development plan review to analyze drainage and water quality impacts that may result from proposed development. This evaluation using the watershed vs site approach, will allow the user to review the impacts not only to the site, but also at any point in the watershed upstream and downstream of the proposed development, providing the big picture review so often lacking in current design and planning processes. It has been shown that the model can mimic the application of current regulations for things such as groundwater recharge, water quantity and quality volume control, and channel protection.

Lastly, the model can be a predictive tool to evaluate the application of BMPs to mitigate the impacts of development. For instance, if the model predicts that a proposed design cannot meet existing condition hydrology and water quality, the designer can explore options such as modifying the type or extents of a proposed land use or change the BMP to something that could be more appropriate and effective in meeting water quality goals.

As a **Watershed Tool**, as was previously mentioned, a community can now assess development and land use planning on a watershed scale. This does not necessitate the developer/engineer creating an entire watershed model, but rather plugging the proposed development into the existing model and evaluating the impacts to the watershed. The same goes for application of BMPs, whether local or regional (should that need or opportunity arise).

Often the best approach or best option for a sub-basin would be a regional detention or water quality BMP system. With the model developed for the watershed, these regional solutions can be evaluated by the community in advance of development such that it proactively facilitates or guides the direction development may occur in that area. On the watershed scale, the model can serve as means to assess the effectiveness of a riparian buffer (possibly for consideration as an added regulatory requirement). Lastly, this Watershed Tool can be used to evaluate stream habitat and designated use protection as a community looks ahead to matching pre-development water quality in the post-developed condition.

The model can also be used as a **Planning Tool**. The model predicts land use impacts for quantity and quality as development is proposed. These growth impacts can be evaluated in advance of development, i.e. proactive planning. Planners can use this tool to quickly assess and determine design and BMP needs and, as mentioned previously, the impacts can be evaluated throughout the watershed. In review and modification of community policy and regulations, suggested changes can be worked into the model to evaluate the benefits, constraints, feasibility, and impacts that may result from such changes. This allows the community to make sound decisions on the direction of their policies. Lastly, as a Planning Tool, the model allows for review and evaluation of the pre-development hydrograph (not just peak flow) in the post-developed condition, which is beyond most current regulatory requirements but is the direction of the future…volume control.

The modeling effort and model itself was not without fault and difficulty, however, and a few of the shortfalls or wish list items will be touched on here.

First, the modeling could have benefitted significantly from more detailed stream and watershed information such as gauging data, pollutant data, additional cross sections and definition of structures crossing the stream (culverts, bridges). However, with the available budget and lack of historic data, the model still proved to be useful. The model provides a means to compare apples to apples, even if we are not sure what type of apples they are (i.e. We don't know the pollutant concentrations or a wide array of BMP performance effectiveness, but we can apply a consistent value across all models and get good relative comparisons for different scenarios).

Second, XP SWMM is a costly piece of proprietary software that many communities, and development engineers working in those communities, may not be able to afford. It also has a fairly steep learning curve. An alternative free-ware version, EPA SWMM5, could be an ideal solution but it does not integrate seamlessly with XP SWMM, and it does not have water quality modeling capabilities. The XP SWMM has the compatibility to export data to EPA SWMM5. During the analysis, it was found that certain features used in XP SWMM are not supported by SWMM5.

Third, through no fault of the model or data, the project suffered through numerous staff changes on the modeling side, so it was very difficult to carry a consistent train of thought throughout the project.

The final result is a good, accurate and useful model and the best product that could have been put forward for the project. But, a significant amount of time was lost stepping back and then regaining momentum through the staff transitions.

2.4 Watershed Future Land Use Planning

Once the environmental component of the study was complete, i.e. the watershed assessment and the stream restoration report complete, and the modeling was underway, the final phase of the work plan began. The final phase for the Dry Run Watershed BMP Education Project was to explore a means to integrate land use planning principles with the environmental assessment of the watershed and by using a public participation process formulate a guide for future land use at the watershed level. This effort would also provide reasonable future land use conditions needed to input and test the modeling and BMP introduction efforts.

The methodology will be discussed in more detail in the coming pages; however, the goal of the future land use planning effort was to gather the participation of a broad base of local citizens in order to develop a future land use strategy for the watershed that would be proactive, i.e. that would be in place prior to development occurring, and would place emphasis on protecting the environmental health of the watershed.

2.4.1 Future Land Use Planning Methodology

GSCPC wanted to understand not only the impacts that existing land uses were currently having on the health of the Dry Run watershed, but also the effects future land use changes in one sub-watershed might have throughout the watershed. We therefore needed land use assumptions to test through the computer model. This meant that we needed data on what the future land uses would be planned and anticipated in the watershed. The trouble was that the local comprehensive plan did not include a countywide future land use plan map. We had to create a generalized future land use map for the county, which led to another key issue about how to produce one in a short period of time. Our modeling process could not wait 12 or 18 months for a full-fledged, participatory process of developing a citizen-driven future land use plan. The answer lie in the choice of a one-day Design Charette to not only produce a citizen-driven future land use plan, but also to develop a core group of citizen advocates who would take ownership of the future land use plan developed and promote it to other groups and the political bodies.

The methodology developed for the future land use planning portion of the study was multi-pronged. Its main public component was the use of this community-based Design Charette to gather and condense community feeling, which along with existing watershed conditions and planning data was used to compose a physical plan that could be supported by the local citizenry and political bodies. It also included an initial phase of more objective study using GIS technology to study Future Land Use suitability of land within the watershed. This early work was meant to gather more objective background data to inform later work.

The Dry Run Watershed, as previously noted, lies partially within the City of Georgetown and partially within the Unincorporated area of Scott County. Any Future Land Use Plan and watershed protection strategy has to be generally accepted by the majority of land owners to be valid, but it also must be politically beneficial to the Georgetown City Council and the County Magistrates to be implemented.

Prior to the Design Charette, which was planned for July of 2008, the GIS and Planning staff within GSCPC undertook an innovative GIS gravity modeling exercise to increase the knowledge of factors that influence the suitability of land for development within the watershed. The exercise involved identifying a number of factors that impact land development such as percentage slope, major road frontage, proximity to school and park facilities, availability and proximity of sewer, etc. Some factors were common while others impacted only certain land uses. Setting sliding scale measurements for each factor, a gravity model representing the area of influence was then created for each factor representing high to low suitability for development. Different gravity models were then combined to create “high-low” impact maps.

For example, one factor influencing the development of commercial land was proximity to major intersections. Land was evaluated and given a weighting based on its proximity to a major intersection. A uniform color scale was used that indicated worst (dark blue) to best suitability for development.

This exercise established a baseline rational for future land use development within the watershed. These gravity models were presented to the Charette participants in the early educational and background phase of the Charette gathering. All the maps created in the GIS Gravity modeling exercise can be found in Appendix I.

The Charette timeline and work plan can be found in Appendix F. The Charette was a one day event lasting from 8:30 until 4:30 on the last Friday in July 2008. The purpose of the Design Charette was: 1) to gather the community together to be educated and informed on the project and on existing conditions in the watershed and 2) Through a series of small group brainstorming sessions to develop a proposed future land use map and a series of goals and objectives for future growth in the watershed. The results or findings of the Design Charette were intended to be refined further by Planning Commission staff.

2.4.2 Future Land Use Planning Results

The first portion of the Design Charette was an educational forum. Multiple perspectives were used to educate land owners and community stakeholders on the environmental, physical and social characteristics of the watershed. The second phase was a design exercise where small groups of participants led by a facilitator developed group specific plans for the watershed. The final portion of the Charette involved GSCPC staff consolidating all the group ideas into one plan, later presented to the entire group for their endorsement as the consolidated Future Land Use Plan Map.

Findings from the Charette were discussed with GSCPC staff and the Rural Land Use Committee and a final map was drafted. That map was later modified to fit as a component of the County Future Land Use map. The Future Land Use Map designations for this Small Area Study are the direct result of that public input effort and will be incorporated into the Scott County Future Land Use Map (Appendix G).

There were three general themes that came out of the Charette that will form the goals and objectives for the area in the County's Comprehensive Plan. First, there should be a strong emphasis on the preservation of existing open space and agricultural lands. Second, as development occurs, it should be concentrated near existing developed areas, closer to existing services. Last, all development, regardless of type or location, should minimize impacts on the Dry Run stream.

It was interesting to note that despite the very different backgrounds of the Charette participants and the unique make up of each workgroup, the maps that each group produced had approximately 60% agreement with each other as far as what each group proposed as their future land use designations. This agreement was due in large part because of the presence of the west half of the Toyota Manufacturing Facility in the southeastern part of the watershed. Generally, the groups had the most disagreement on future land uses in the northern half of the watershed, which lies outside of the Urban Service Boundary. The disagreement in the groups' visions centered on how much of this area would remain Agricultural/Open Space and how much Residential development would occur. Staff took the five work groups' maps and created one combined Future Land Use map (Appendix F).

For purposes of the Dry Run project, the watershed Future Land Use Map was reviewed and approved for use in this project by the Planning Commission in December 2008. One physical result of the project is that this map formed the basis for the future land use designations later when our agency began to create the Future Land Use Map for Scott County as part of our five-year Comprehensive Plan update, which should be adopted in the second half of 2011.

2.4.3 Future Land Use Planning Conclusions

It is necessary to stress the importance that the future land use planning component has for this project and to document several of the lessons learned through this process. The single most important reason for this component, even above the significance of proactive planning, is the community involvement that has occurred and its relationship with the comprehensive plan.

Without the future land use planning and the small area plan presented for adoption into the comprehensive plan, this project could be just another "engineering or environmental study" produced by a consultant and condemned to be "filed away" or "shelved" after completion. But, due to the unique cooperation between planning and engineering and the successful community involvement process, this project will be adopted as a part of the guiding document for Scott County and its goals for future growth and development and have the potential to be replicated throughout the remaining undeveloped watersheds in this county.

The Future Land Use Planning process was not without its problems. Staff turn-over resulted in numerous individual goals not being realized or carried over from one staff member to another. Individual staff members have their own set of interests, knowledge and skills. As one member takes over duties from another, the focus of the project may subtly change resulting in a blurring of the final vision for the project. It also resulted in the extension of time taken to complete the project as new staff members came up to speed on the project goals, history, process, etc.

Also, the detailed and time-consuming nature of the modeling effort was realized early on which enforced the need to develop a concentrated planning effort as opposed to multiple scenarios to be "tested" with the model. Another impact on the planning objectives occurred through the "economic downturn" which began mid-way through this project. This caused a significant questioning about the future growth projections and the need for proactive planning, but later led to a reinforcement of the need for planning for sustainable development necessary to avoid the costly problems associated with poorly planned infrastructure.

It is believed by those involved with this project that the "planning efforts" were eventually realized due to the following: Initial planning and establishment of the project milestones as well as the decision to modify the plan as needed based on current conditions. For example, the Design Charette was not an original part of the project milestones but became a very successful tool after realization of the importance of community buy-in and the value of volunteer time.

2.5 Land Use BMP Education

The overreaching purpose of this project was to educate Land Use Decision Makers on the tools and processes available during the Land Use Decision process to prevent or reduce NPS pollution caused by urbanization. As such, Land Use BMP presentations were given to the public through various conferences, seminars, literature, and meetings attended. A project oversight committee (POC) composed of representatives from the public and private sector was organized at the start of the project to guide the progress of the grant work. The POC met a minimum of four times a year for the 5-year length of the project.

2.5.1 Land Use BMP Education Methodology

The POC helped direct the project to ensure both local and statewide community water quality needs and goals were addressed, reviewed project progress, and served to educate others about the Land Use Decision Process as an NPS BMP. The POC enabled the personnel working on this project to network with other public and private agencies to improve the overall effectiveness of this BMP education project in protecting/improving water quality.

The Education Component of the Project is also a primary focus. In order to further this goal, public outreach on the work in the Dry Run Watershed has been ongoing throughout the project. Presentations help to spread our knowledge of local issues related to stream protection and land use planning that may be relevant to other jurisdictions in Kentucky and that may further watershed protection in general.

2.5.2 Land Use BMP Education Results

The grant work plan established the goal of making a minimum of eight presentations at annual conferences and meetings with an average expected audience of 200 Land Use Decision Makers per presentation (1600 people) It also set a goal of a minimum of 22 presentations to local groups such as the Kentucky River Authority, Fiscal Court, Kiwanis, etc. with an average expected audience of 30 Land Use Decision Makers (660 people).

The actual number of statewide or regional conference presentations Georgetown-Scott County Planning Commission employees have given is nine. A list of the presentations made and the audience reached can be found in Appendix H.

The number of statewide or regional presentations exceeded the target over the course of the project. GSCPC personnel and personnel from

CDP Engineers presented at State or regional conferences including the following: Ohio-Kentucky-Indiana Regional Planning Conference, American Planning Association-Kentucky Statewide Annual Conference, the Ohio Stormwater Conference, the Kentucky-Tennessee Water Professionals Conference among others. Topics have ranged from "Best Management Practice Available ***Is*** the Land Use Plan" to "GIS techniques Used in Stormwater Management Planning".

The second benchmark for the Educational portion of the grant for presentations to local groups was not reached, although it is estimated that the number of local people educated in the local outreach process exceeded the projected number to be reached (660). Georgetown-Scott County Planning Commission (GSCPC) personnel regularly give presentations to other land use decision makers throughout the state. In addition, GSCPC personnel have taken some unique approaches to Watershed Education that was positively received. A listing of these presentations can be found in Appendix H, but the following section highlights one of our unique efforts.

In Spring of 2009, we constructed a 3-D physical model of the watershed. This was done by laminating color aerial photos of the watershed to 3 x 5 foot sheets of foam board. The foam boards were then cut at 5-foot contour intervals and stacked to create a 3-D topographic model of the watershed. The resulting 3-D model proved to be a dynamic tool for initiating discussion of watershed issues. We displayed the model at a booth that was rented for the Governor's Conference on the Environment on September 30th and October 1st at the Lexington Convention Center. The booth provided information on the Dry Run Watershed Project including a scrolling slide show of the stream inventory photos. The model was displayed for two days at the conference attended by an estimated 600 individuals.

In addition, the model has been displayed in a specially constructed case in the lobby of the GSCPC building. It continues to attract the attention of walk-in visitors including applicants, developers, and public officials and offers the opportunity to have a tangible discussion of the watershed efforts in the Dry Run Basin with local property owners and land use decision makers. Photographs of the model and additional information can be found in Appendix J.

2.5.3 Land Use BMP Education Conclusions

Although the original Measures of Success established for this project (and described many times as "overly optimistic" by staff) were not fully met, we believe that the Objective to "Educate City and County Land Use Decision Makers, as well as the General Public, throughout Kentucky on

Land Use BMP decision processes to reduce or prevent (NPS) Pollution" was reached. Through the many presentations, exhibits and papers, this project has reached many different groups throughout Kentucky and even to surrounding states. The local education efforts have certainly informed numerous City and County decision makers (and community participants) for the duration of this project through the Land Use Charette, POC meetings, newspaper articles, public meetings, and open house presentations as well as the numerous walk-in visitors we have everyday.

While eduction has always been the main component of this project, as the title suggests, it has also been the toughest part due to the following reasons and the subsequent lessons learned. The most difficult issue and one learned early on involves focus. Focus being the ability to keep the project on track and maintain progression toward the goal of BMP education. Staff transitions and multiple responsibilities as described previously definitely had an effect on project focus, but the main issue of focus was the idea that this project was a case study with BMP education as the main goal. As this was a pilot project in many ways, this reminder was needed many times when the related work seemed to focus only on the second objective of nonpoint source polution prevention instead of how can this be used for education. This issue is problematic as it can lead to frustration and stress when a certain expected outcome is not achieved as planned or it feels like effort is being wasted. The recommendation to deal with this is to constantly remind those involved of the education focus and to deal with failures as lessons learned (and to be shared) instead of losses.

One example that occurred during this project where this lesson can be demonstrated led to the creation of the 3-D model of the watershed and a renewed focus on education. The loss of focus and source of frustration came after a long conversation with a participant at one of the presentations where the need for watershed planning was stressed and how the modeling and potential results would be used. The participant discussion was mostly about specific modeling results for water quality but ended with a very simple description answering "So what exactly is a watershed?" That conversation triggered two different realizations, first that the education provided was not meeting the entire goal as the focus had shifted to the specific work, and second, that we were not relating well to all audiences which leads to the next recommendation.

This recommendation is common knowledge for any type of education but one that is worth repeating. Be considerate of the audience you are trying to reach and be prepared to provide the basics to bring them to the level you are presenting on. This became very clear after the 3-D model was constructed and the renewed interest that was gained through its use as a conversation starter and a beginning point of education about this project.

The final lesson realized through the education component is that it is tough to convince an audience of the importance of future planning without the aid of convincing results or a project conclusion. This was discussed many times by those involved in this project while planning the education component and also witnessed through questions received from presentations. Many of the presentations through this project came at the end of a component and were presented more from the “why do this?” side or a “how to” through our experience and lacked a definite benefit. The only recommendation here is to understand this going forward and to be prepared for that type of question with historic data or information from similar projects.

3.0 Results and Discussion

This Watershed Land Use BMP Education Project established a goal of reducing and preventing the negative impacts of land use disturbance caused by increased growth and urbanization by predicting those negative impacts on a watershed level and using a land use decision process as a NPS BMP. Steps were taken to reach this goal by establishing baseline land use and stream conditions, creating a model to predict future changes in watershed condition and using the model information as a basis for decisions regarding proposed changes in land use and development characteristics.

The baseline condition of the watershed has been established through field work and has been digitally fed into the watershed model. Water Quality Goals were established by GSCPC staff and the Project Oversight Committee. A Future Land Use Plan was created through a public participation process that included a one day Design Charette. The model was tested with BMP's and verified. Outputs of the model have shown us that through our current storm water regulations and BMP requirements in place, development according to the type, density and location proposed on the Future Land Use Map will not decrease water quality within the watershed.

As a result of the Dry Run study, the Planning Commission staff has identified the following new strategies that, if incorporated along with our existing stormwater regulations, will make our stormwater management program more effective. They are:

Stream Riparian Buffering

The need for continuous riparian buffers throughout the watershed became obvious early on during the stream assessment and can be seen just by reviewing the pictures taken at each cross section. Areas with sufficient vegetative buffers received the highest scores while areas lacking had noticeable and severe bank erosion and silted channel bottoms. The primary reason some of the existing stream areas scored so low was eroding banks and silted bottoms, caused in most cases by unfettered access of livestock to the stream. We concluded that if a stream buffering ordinance could be implemented and enforced, that would mitigate this issue.

There are many documented water quality benefits of riparian buffers including pollutant removal, temperature control, providing wildlife habitat and the minimization of flood damage by the restriction of building in the buffer area. The specific recommendation for Riparian Buffer

Establishment is that all areas from the adopted FEMA 100-year floodplain be utilized as riparian buffers and all other stream areas (those documented as part of the Dry Run study) have a buffer of 25' each side from the top of the defined bank. An additional component of this recommendation is that specific requirements be established for what defines a riparian buffer including the density and type of vegetation established.

Develop Land Use-Specific BMPs

Our current regulations allow a developer a virtual free rein when it comes to selecting stormwater mitigation techniques, as long as they can document the overall effectiveness for pollutant removal. We concluded that it would be more effective if a BMP "menu" could be developed that forced developers to pick BMPs based on the type of development being pursued.

Infiltration type BMP's shall be encouraged for all new development, and the selection of water quality BMP's shall be specific to the pollutants expected from the proposed land use type. For example, a proposed land use which has been documented to produce high levels of oils and greases will need to specify a BMP that has been proven to remove a high percentage of this pollutant. BMP maintenance and replacement should be an important factor in selection criteria and all proposed measures must document detailed maintenance requirements. Natural vegetative measures with aesthetic benefits should also play a key role in selection.

Regional Flood Control Facilities

As development occurs, if there was a regional facility that developments could tie into for a fee, it would assist smaller sites in their mitigation. This would also reduce the future cost of maintenance and inspections involved with numerous smaller basins. Larger regional facilities might also serve as passive recreational areas during drier months.

Watershed Educational Outreach Programs

It was clear to the Planning Commission that there is a need for continuous public education on stormwater issues. This is especially true if we implement a stream buffer ordinance and want to address some of the current issues found in the stream related to the agricultural areas and maintenance of BMPs. The following includes a listing of several areas where education outreach is necessary:

Rural Land Use Plan – Currently, we have no Future Land Use Map in the county, leading to the public perception that development in Scott County has been unguided and haphazard. If we can implement a Future

Land Use Map, we can direct less intense land uses to the more sensitive areas of the watershed. Efforts in this direction have begun.

Stream Awareness and Rehabilitation - All proposed applicants for a land use change must be made aware of the Dry Run Study and the existing stream conditions documented in the Dry Run Study corridor assessment for any part of the stream under their area of influence. Also, as part of the application process, current conditions must be evaluated and proposals shall include plans to improve the current stream conditions depending on severity of issues reported. Repairs could include stream cleanup, riparian buffer plantings or establishment, or stream bank or channel rehabilitation, but must be extensive enough to bring conditions up at least one level in stream corridor assessment. Although Dry Run as a whole is not known to be impaired at this time, there were many deficient areas documented as part of the corridor assessment that need specific attention. Many of these repairs could possibly be made through grant funds or other funds set aside annually for this purpose.

Continuing Education and Public Oversight - An education program and public group should be established to continue the work that has been completed to date, including providing education for those in the watershed and other developing watersheds, to monitor/evaluate stream changes to provide a measurement of the effectiveness of this effort, and to be an ongoing resource to evaluate and propose changes to these recommendations as needed. If there was an independent citizen advocacy group overseeing and monitoring the ongoing health of the Dry Run Watershed the chances of incremental deterioration watershed health would be diminished.

This group should be composed of community volunteers as well as some of those who served on the Dry Run Study Project Oversight Committee (POC) and should meet on a regular basis with an annual review of the major stream sections to evaluate and compare to previous conditions. This group could be responsible for making rehabilitation decisions and establishment of riparian buffer criteria. There are many grant opportunities available now for this type of organization and this group would be a good point of contact for these opportunities.

In addition to the above strategies, specific recommendations were proposed in the Dry Run Small Area Study. They included the following zoning and land use regulatory techniques:

1. Density Zoning

Density Zoning is intended to regulate development density by specifying an allowable amount of development per acre, not by specifying minimum lot size. Scott County currently has a cluster development ordinance that is a form of density zoning permitted in the A-1 zone district with a development density allowed overall of one unit per five acres. The Cluster zoning has been an effective tool in protecting environmentally sensitive land, prime farmland in the rural areas of the county. PUD regulations have also been popular and widely used by developers in the county to give design flexibility in the development process.

Density Zoning could be a great tool for watershed protection. But, taking full economic and protective advantage of Density Zoning's layout flexibility requires site analysis, before layout decisions are made, to identify floodplains, stream buffers, steep slopes, valuable trees, and other features to which the layout should be adapted. When density zoning is used to its full advantage, it can result in economies in streets, utilities, and drainage structures. Density Zoning also allows preservation of sensitive areas of a site, whether or not those areas are protected by ordinances. Also, when used together with a stream buffer requirement, Density Zoning assures that stream channels and riparian corridors can be preserved within the constraints of costs, markets, and specific sites.

2. Riparian Buffers

This provision would require the preservation and maintenance of undeveloped areas around streams. This provision would set a limit on either side of perennial streams where no land disturbance could occur during the development process. The purpose of stream buffers is self-evident. Stable vegetation in stream buffers filters inflowing runoff, prevents channel erosion, and creates habitats for functioning ecosystems. Vegetative buffers also provide "right-of-way" for a channel's natural lateral movement, while self-regenerating vegetation slows stream bank erosion.

Riparian buffers can be static or can be allowed to be averaged based on stream bank slopes or other natural features. An example requirement would be: All land disturbances must remain at least 25 feet from stream banks and outside the 100-year floodplain. Exceptions include bike and foot paths of permeable material, utility crossings, road crossings perpendicular to the stream, and wetlands for stormwater treatment.

Requiring riparian buffers also provide opportunities for trails and greenways that would allow for linkages between neighborhood or regional open spaces.

3. Encourage Mixed Use Areas

This provision is intended to mix different types of land use to reduce the need for transportation between them and to reduce the length and area of paved local road infrastructure. Mixed Use areas will also decrease the amount of land required for urban type development as multiple uses could be accommodated on one parcel rather than the current requirement for single use districts. This provision will require an amendment of the Future Land Use Map to identify potential mixed-use nodes and also an amendment of the Zoning Ordinance to develop a mixed-use zoning district or overlay.

4. SWMM Hydrologic Model Update - All new development proposals shall be required to update the SWMM model for any proposed land use changes during the design stage, and model results shall be used to analyze mitigation measures proposed. Development Plan approval and more specifically approval of the required stormwater management plan shall be contingent upon model results for proposed conditions with BMP's meeting pre-development or existing model conditions for the following:

a. All current GSCPC Subdivision Regulation requirements regarding water quantity (peak flow), water quality, groundwater recharge, and channel protection shall be met and demonstrated through model results.
b. Peak flow rates or flood elevations shall not be increased at any point downstream for any of the storm events checked as required by our current regulations (10 year and 100 year as a minimum) and will be verified by checking at least 10 downstream cross sections evenly spaced from the confluence with Elkhorn Creek.
c. Runoff volumes entering the streams shall not be increased at any point downstream for storms up to the 1-year, 24-hour storm event and will be verified by checking the same 10 cross sections mentioned above.
d. Water quality BMP/pollutant screening parameters shall be entered into the model with anticipated pollutants and removal efficiencies based on data provided by current published EPA information such as that used in the Dry Run Study, but the water quality model results shall not be used at this time as a gauge for approval. This exercise shall be used to verify that BMP's have been selected as required in Recommendation #4 and the

resulting data can be used to verify future testing results and further model calibration in the future.

4.0 Conclusions

Planners know through experience that land use planning and development management can have effects on the environmental qualities of watersheds, both positive and negative. Policy makers need to understand how future land uses and development patterns affect water quality and watershed performance. Local decision makers must be educated about the relationship between land use and watershed health. Education in these matters can help achieve better watershed performance. If local elected officials cannot comprehend the importance of development management and land use regulation for watershed management, they won't vote for regulations that enforce land use Best Management Practices (BMPs).

Our local officials have been well informed on the importance of watershed management and the protection of water quality as a result of the long term ongoing work of this study. Additionally, Georgetown is unique in the sense that the water supply for the city comes from Royal Spring. The Royal Spring Aquifer extends from the southern tip of Dry Run Watershed to the center of the City of Lexington in Fayette County. This fact has made the local population sensitive to the topic of water quality and receptive to land use planning for watershed protection.

The challenge we have found in this project has been in educating and engaging the property owners in the watershed and county in general. In the community Design Charette and in the final wrap up presentation of the findings we had attendance of less than a dozen property owners from within the watershed, even though, in the case of the wrap up session, 700 postcards were mailed to all the Dry Run Watershed property owners. Land owners seem to be reluctant to attend and engage in a process unless they feel it will immediately impact their bottom line. We will likely get more engagement from the community when specific protection strategies and land use regulations are proposed.

Historically, planning and land use design for stormwater drainage has looked only at the effects immediately downstream or adjacent to the proposed change and it is rare and often cost-prohibitive to try to determine the greater effects a change might have on surrounding areas. Due to increasing environmental awareness (and subsequent federal and State regulations) we are facing more and more challenges related to future land use planning, particularly in the area of land management related to our water resources. The tools developed through this planning effort will allow us to predict the effects on water quality and quantity that will occur downstream from a land use change in the Dry Run Watershed and provide the information needed to mitigate the effects of that change if used properly and consistently.

Before this study, there was no Future Land Use Map for the entire Dry Run watershed. Through our public outreach efforts, our agency now has achieved a strong start toward the creation of a county land use plan. In fact, the work done in the Dry Run watershed will form a separate element of the upcoming Scott County Future Land Use Plan. The conclusions drawn from this study will be applied countywide in the environmental components of the land use plan.

The Georgetown-Scott County (Kentucky) Planning Commission's Dry Run Land Use BMP Education Project has shown that land use planners, engineers, and GIS specialists can combine their efforts to objectively evaluate water resource management and stream protection for entire watersheds, and that this objective research can help frame the educational message to local policy makers. Understanding the challenges faced and outcomes observed in Georgetown-Scott County can help other local planning departments contribute in more meaningful partnership roles in watershed management.

We have found that this process has allowed us to merge the Engineering and Planning fields to develop a unique perspective on the Dry Run watershed. Through this process, we have a very clear picture of the watershed's hydrologic conditions as related to stormwater and the effect of land uses on those conditions.

One downside of this effort is that it has been time consuming and costly to benchmark the environmental condition of the Dry Run Watershed and to establish and test the model. As a result, this type of study would be difficult to duplicate in other developing watersheds due to the cost and time involved. However, the implementation strategies and the watershed protection strategies, specifically the Land Use specific BMPS are easily justified for use, county-wide, based on this study.

5.0 Literature Cited

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6.0 Appendices

Appendix A: Financial & Administrative Closeout

1. Workplan Outputs
2. Budget Summary
3. Equipment Summary (No special equipment purchased)
4. Special Grant Conditions

Appendix B: Final Project Report Contributors

Appendix C: Watershed Characterization and Assessment Report

Appendix D: Watershed Protection and Restoration Stategy

Appendix E: Water Quality and BMP Modeling

Appendix F: Charette Program Summary Report

Appendix G: Dry Run Small Area Plan

Appendix H: Education Report

Appendix I: GIS Data and Maps

Appendix J: Watershed 3-D Model

Appendix A: Financial & Administrative Closeout

Section A – Workplan Outputs

- Table A-1: Workplan Outputs and Schedule

Section B – Budget Summary

- Table A-2: Original Budget
- Table A-3: Final Expenditures

Section C – Equipment Summary – No equipment was purchased for the project

Section D – Special Grant Conditions – There were no special grant conditions

a. Workplan Outputs

Table A-1 lists the original workplan outputs and schedule from the original Memorandum of Agreement (MOA) #M-04517172 dated 7/1/04. The original grant period was 07/01/04 to 06/30/09. The project end date was revised to 6/1/10 with approval from KDOW.

TABLE A-1. WORKPLAN OUTPUTS & SCHEDULE

		Expected	Expected	Actual	Actual	
	Milestone	**Begin Date**	**End Date**	**Begin Date**	**End Date**	**Comments**
1.	Submit all draft materials to the Cabinet for review and approval.	Duration	N/A	N/A	N/A	
2.	Gather Land Use, Meteorological, and Stream Data	1/05	1/06	11/04	1/06	Desktop research
3.	Field Survey of Stream & Watershed Features	1/05	3/05	2/05	5/05	Field analyses
4.	Develop Water Quality Goals for Hydrologic Modeling	2/05	3/05	3/05	5/05	Developed June 05
5.	Submit Draft Water Quality Goals to NPS Staff	3/05	3/05	6/05	6/05	Submitted June 05
6.	Develop Hydrologic Computer Model	3/05	3/07	6/05	05/07	
7.	QA/QC Model and Validate Results with Historic Flows	2/07	6/07	6/06	01/08	
8.	Develop Preliminary Land Uses	9/05	6/07	9/05	6/07	
9.	Evaluate Water Quality Impact of Preliminary Land Uses	4/07	8/07	6/06	2/09	
10.	Adjust Land Uses to meet Water Quality Goals	6/07	4/09	4/08	1/10	
11.	Present Appropriate Land Uses to Georgetown/Scott County Leaders	4/09	6/09	2/09	3/10	2 exhibiting booths
12.	Prepare and Present design charrette for Land Use consensus building	3/08	8/08	4/08	7/08	2 design charrettes
13.	Prepare and Submit Draft Presentation(s) to NPS Staff for Review a. Watershed Assessment (Mar-Apr 09) b. Modeling Effort (Mar-Apr	4/08	8/09	2/06	4/10	Summary of presentations provided in section 2.5

	09) c. Small Area Planning (Apr-May 09) d. Complete Project/Case Study (Jul-Aug 09)				Submitted	
14.	Prepare Articles to submit to Journals, Magazines, and Newsletters a. Watershed Assessment (Mar-Apr 09) b. Modeling Effort (Apr-May 09) c. Small Area Planning (May-Jun 09) d. Complete Project/Case Study (Aug-Sep 09)	3/09	9/09	3/09a 5/09b 6/09c 8/09d	**Not submitted** **Not submitted** submitted jan 2010 **not submitted**	Summary of written materials provided in Section 2.5
15.	Submit Articles to NPS Staff for Review	4/09	9/09			4 articles, 2 printed
16.	Conduct Presentations at Conferences and Meetings (maximum 23 presentations)	Duration	8/09	9th-11th pres Aug/Sep/Oct 09	N/A	9 presentations, 3 denied
17.	Submit Articles (minimum 5 local media, 9 trade publication articles to be submitted)	Duration	8/09	N/A	American Planner accepted Jun 09	
18.	Submit advanced written notice of all presentations	Duration	8/09	Duration	Submitted Sep 09 - KAPA	
					Sep 09 – Gov Conf on Env	
19.	Upon request of the Division of Water, submit Annual Report and/or participate in the Cabinet sponsored biennial NPS Conference.	As	Requested	N/A	N/A	
20.	Write Final Report	7/09	11/09	9/09	6/10	
21.	Submit three copies of the Final Report and submit three copies of all products produced by this project.	10/09	12/09	5/10	6/10	

b. Budget Summary

Per the Memorandum of Agreement, the original project budget was set at $290,000, with federal funds of $158,500 (54.7%) and a minimum of non-federal match funds from Georgetown/Scott County Planning Commission of $131,500 (45.3%). The original budget is given in Table A-2.

TABLE A-2. ORIGINAL BUDGET

Budget Categories	Total Budget	319 (h) Grant Funds	Matching Funds
Personnel	$156,500	$75,000	$81,500
Supplies	$17,500	$17,500	$0
Equipment	$0	$0	$0
Travel	$7,000	$7,000	$0
Contractual	$109,000	$59,000	$50,000
TOTALS:	$290,000	$158,500	$131,500
Percentage Match:		54.7%	45.3%

The final expenditures are shown in Table A-3.

TABLE A-3. FINAL EXPENDITURES

Budget Categories	Original Budget	319 (h) Grant Funds Expended	Matching Funds Expended	Revised Expenditures
Personnel	$156,500	$90,000	$72,145	$162,145
Supplies	$17,500	$2,500	$6,355	$8,855
Equipment	$0	$0	$0	$0
Travel	$7,000	$2,000	$3,000	$5,000
Contractual	$109,000	$50,000	$50,000	$114,000
TOTALS:	$290,000	$158,500	$131,500	$290,000
Percentage Match:		54.7%	45.3%	100%

The total grant budget was not modified. Funds were moved between categories as needed to more accurately represent the allocation of funds and distribution of efforts for the grant completion. The revised budget was approved by the KDOW grant administrator and manager.

Georgetown/Scott County Planning Commission was reimbursed $158,500. All dollars were spent; there were no excess project funds to reallocate.

c. Equipment Summary

No equipment was purchased for this grant project.

d. Special Grant Conditions

There were no special grant conditions placed on this project outside of utilizing Geographic Information Systems analyses and mapping. All geospatial data created conforms to the Federal Geographic Data Committee (FGDC) standards..

Appendix B: Final Project Report Contributors

Mr. Sandy Camargo, PE, CFM is the Stormwater Group Manager for CDP Engineers in Lexington, Kentucky and Cincinnati, Ohio. Sandy received a BS and MS in Biosystems and Agricultural Engineering at the University of Kentucky. In his CDP management role, Sandy oversees a wide variety of projects including drainage improvements, flood studies, dam designs, watershed studies, stream restoration, water quality initiatives, stormwater permitting, site development, and erosion control. He serves as the NPDES (National Pollution Discharge Elimination System) Phase II Stormwater consultant for five cities, providing technical guidance, program development, and administration services. Sandy has developed numerous water quality and quantity related plans, ordinances, and grants involving best management practices, groundwater protection, stormwater pollution prevention, watershed protection, construction site and post-construction stormwater management, and low-impact development. He is also serving as Chair of the Lexington (KY) Environmental Commission. Prior to joining CDP, he spent 10 years at the University of Kentucky as a research associate managing stormwater runoff, erosion prevention, and sediment control laboratory and field studies.

Ms. Pavithra Damara, CDP Engineers in Lexington, KY. Received a BE in Civil Engineering at Osmania University, India and MS in Civil Engineering at the University of KY. She is a Stormwater Management Analyst at CDP and has worked on a variety of storm water projects including flood studies, drainage improvements, and water quality initiatives. She has nearly 3 years of experience during which she has gained proficiency in use of several design-support modeling programs. During her professional career she has conducted hydrologic and hydraulic analysis studies for culverts, parking lots, and urban development projects. She has also worked on projects related to, recreational design and planning, streetscape design, site and land use planning, stormwater improvements, GIS and GPS development.

Mr. Benjamin Krebs, PE, CFM was hired by the Georgetown-Scott County Planning Commission as the Commission Engineer in June of 2004. He graduated from the University of Kentucky with a BS degree in Engineering in 1998. He received licensure as a Professional Engineer in 2003 and has over ten years experience in roads, utility design, storm water management and construction. He was appointed floodplain administrator in 2008 after receiving Floodplain Manager Certification. Ben has been a resident of Scott County since 2000.

Mr. Earl Smith graduated from Slippery Rock University of Pennsylvania in June 2002 with a Bachelors of Science Degree in Environmental Studies, and minors in Geography and Geographic Information Technology. In December 2002, Earl moved to Georgetown, Kentucky, where he worked for both the Georgetown-Scott County Planning Commission and the Georgetown Municipal Water & Sewer Service, also helping to build a GIS of its water/sewer system. He has also worked for the County's Property Valuation Assessment office and worked part time for Kriss Lowry &

Associates, a Land Use Planning firm. Earl has served as the Kentucky Association of Mapping Professionals (KAMP) President for the 2005-2006 year and has been a member since 2003. He became GIS Manager for the Georgetown-Scott County Planning Commission in July, 2006 and then Interim Director May 2010.

Brian Shorkey, AICP was hired as a Senior Planner in September, 2008. He graduated from the University of Michigan with a Bachelor of Science degree in Physical Geography in 1997 and earned his Masters of Science degree from Eastern Michigan University in 2001. Brian has over nine years of experience in land planning issues for both public and private agencies.

Joe Kane, AICP, LEED AP was hired in March of 2009. He graduated with a Bachelor of Arts in Archaeology from the University of Florida in May 1989 and earned a Master of Arts degree in Urban and Regional Planning from the University of Florida in 1995. He worked for county planning offices in the St. Louis and Atlanta regions until forming an Historic Property Restoration Company in Lexington, Kentucky in 2000.

Ms. Patricia Flores Shoemaker, AICP, is an urban and environmental planner with over 28 years of professional experience in the public and private sectors, including land use, transportation and infrastructure development projects in California, Nevada and abroad—Armenia, China and Mexico. Pat has an M.S. in Environmental Studies from the California State University, Fullerton, and has been the Assistant Director of Development Services for the Georgetown-Scott County Planning Commission office in Georgetown, Kentucky from October 2007 to August 2008.

Mrs. Bonnie MacIntyre Skinner, was hired by the Georgetown-Scott County Planning Commission as a Planner II in March, 2008. She graduated from the University of Kentucky with a Bachelor of Arts in Geography in 2006. She is pursuing a Masters Degree in Planning with credits from the University of North Carolina at Charlotte. Her prior planning experience was with the City of Versailles, Kentucky and Wesley Chapel, North Carolina.

Appendix C: Water Characterization and Assessment

(The following data is contained on the attached CD)

Watershed C&A Survey Report

- Figure 1: Longitudinal, cross-sectional and plan view of major stream types
- Figure 2: Illustrative guide showing cross-sectional configuration
- Table 1: Summary of Stream Health Assessment sheets

Stream Assessment Data Sheets

Dry Run Parcel Base Map

Appendix D: Watershed Protection and Restoration Stategy

(The following data is contained on the attached CD)

Watershed Protection and Restoration Strategy Report

Watershed Protection and Restoration Strategy Map

Appendix E: Water Quality and BMP Modeling

(The following data is contained on the attached CD)

Watershed Modeling Report

Section A – Raw Data

- Figure 1: Hydraulic Model
- Figure 2: SCS Hydrology Input Parameters in XP SWMM
- Figure 3: Scenario Manager in XP SWMM
- Figure 4: Existing Land use Patterns
- Figure 5: Future Land use Patterns
- Figure 6: Future Scenario: 2 year event – A1 to N8
- Figure 7: Future Scenario: 100 year event – A1 to N8
- Table 1: Hydrologic data used for Existing Model.
- Table 2: Curve Numbers for the Future Land uses.
- Table 3: Event Mean Concentrations of Pollutants for different Land uses
- Table 4: Target Metals associated with particular Land use patterns.
- Table 5: Removal Efficiencies for various BMP's
- Table 6: Precipitation Data

Section B – XP SWMM Inputs

- Existing Watershed Summary Table (*Excel*)
- Future Land Use Watershed Summary Table (*Excel*)
- Future Land Use Sub-watersheds Calculated Map
- XP SWMM Inputs (txt files)
  - Conduit Data
  - Junction Data
  - Cross-Section Data
  - Sub-catchment Data – Existing
  - Sub-catchment Data – Future
  - BMP Inputs – Future with BMP Scenario

Section C – XP SWMM Outputs

- Existing (2, 10, 50 and 100 year)
  - Water Surface Elevation (txt files)
  - Flow Results (txt files)
  - Water Quality Results (txt files)
  - Complete XP SWMM Output Files
- Future without BMP (2, 10, 50 and 100 year)
  - Water Surface Elevation (txt files)
  - Flow Results (txt files)
  - Water Quality Results (txt files)
  - Complete XP SWMM Output Files

Section C – XP SWMM Outputs (cont)

- Future with BMP (2, 10, 50 and 100 year)
    - Water Surface Elevation (txt files)
    - Flow Results (txt files)
    - Water Quality Results (txt files)
    - Complete XP SWMM Output Files

Section D – Longitudinal Flow Profiles

(Each folder contains A, A-C, A-B-C, B, C Branches for entire watershed)

- Existing 2 year
- Existing 100 year
- Future 2 year
- Future 100 year

Section E – Flow Results

- Flow Results - 2 year (*Excel*)
- Flow Results - 100 year (*Excel*)

Section F – Water Quality Results

- Water Quality Results - 2 year (*Excel*)

Appendix F: Charette Program Summary

(The following data is contained on the attached CD)

Charette Summary Report

Charette Program Documentation

- Project Team Bios
- Charette Planning
    - Logistics
    - Presentations
    - Press Release
- Charette Packets
- Charette Outcome
    - Participation List
    - Summary of Ideas
    - Wrap Up Presentation
- Expenses

Charette Land Use Maps

- Charette Land Use Group Maps (Group Trace and GIS Maps)
- Charette Land Use Merged Maps
    - Agricultural Merged
    - Commercial Merged
    - Industrial Merged
    - Quasi-Public Merged
    - Residential Merged
    - Final Composite Trace Map
- Charette Land Use – Final Composite Trace Map

Appendix G: Dry Run Small Area Plan

(The following data is contained on the attached CD)

Dry Run Small Area Study Report

Small Area Plan Maps

- Small Area Plan Map
- GMWSS Wastewater Facility Plan

Appendix H: Education Report

(The following data is contained on the attached CD)

Dry Run Education Summary Table

Dry Run Presentation Information

- 2007 KAPA Fall Conference
- 2008 APA OKI Conference
- 2008 KWRRI Annual Symposium
- 2008 State GIS Conference
- 2008 Charette Program (See Appendix F)
- 2009 Open House Final Wrap-Up
- 2009 Governors Conference on the Environment
- 2009 KAPA Fall Presentation
- 2009 KY-TN WPC
- 2009 Ohio Stormwater Conference
- 2009 StormCon
- 2010 APA Practicing Planner

Appendix I: GIS Data and Maps

(The following data is contained on the attached CD)

Dry Run Watershed Final Map Book

Watershed Spatial Analysis

- Methodology Report
- Variable Worksheet
- Spatial Analysis Maps
    - Spatial Analysis Poster
    - Classifications
    - Commercial Factors
    - Common Factors
    - Industrial Factors
    - Residential Factors

Dry Run Watershed Maps

- Current Future Land Use Map
- Stream and Sub-Basins Map
- City Limits
- Current Land Use
- 100yr WSE

Dry Run Proposed Future Land Use Maps

- Conceptual Future Land Use
- Proposed Future Land Use 12-08
- Proposed Future Land Use 12-08 (aerial)
- Proposed Future Land Use 3-10

Appendix J: Watershed 3-D Model

(The following data is contained on the attached CD)

3-D Model Creation Description

3-D Model Pictures