

**SCOPE OF WORK**  
**APPOQUINIMINK RIVER WATERSHED**  
**MANAGEMENT PLAN**  
September 22, 2006

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## **I. APPOQUINIMINK RIVER WATERSHED CHARACTERISTICS**

The Appoquinimink watershed is part of the major Delaware Estuary basin, and drains approximately 47.25 square miles to the Appoquinimink River. The 16 mile long Appoquinimink River flows through agricultural lands in the headwaters to wetlands and tidal marshes that extend from its banks to the confluence with the Delaware River. The Appoquinimink River is tidal in nature, which means that an estuarine environment is prevalent in the lower portion of the watershed and that the hydrologic and hydraulic characteristics are unique in the sense that the flows in the River are dependent on tidal flows. Three major populated areas, Middletown, Odessa, and Townsend, are located in the watershed, and development in and around these areas is rapidly increasing and therefore having an effect on the hydrologic characteristics of the watershed. Decreased water quality is evidenced by algal growth in the four major ponds and lakes, Wiggins Mill Pond, Noxontown Lake, Silver Lake, and Shallcross Lake, which is directly related to increased nutrient loadings (phosphorus and nitrogen) in stormwater runoff stemming from agricultural activity.

Just as development can have an affect on watershed characteristics, traffic routes can also greatly influence the nature of stormwater runoff. There are several major traffic routes that run through the Appoquinimink watershed. U.S. Route 13 runs from north to south and is the major traffic route that basically bisects the watershed from west to east. Other major routes are State Route 1 which connects Odessa to Middletown, and State Route 896 which runs north/south from Middletown in the northwestern portion of the watershed.

## **II. PLAN PREPARATION STRATEGY**

Due to the nature of the Appoquinimink watershed being tidal and relatively flat, the approach to the assessment of the watershed will take into great consideration regional geographic characteristics for more comprehensive planning. A logical geographic breakdown would be that of the subwatersheds contributing to each lake, and the Consultant will evaluate the potential for regional planning based on this approach.

A volume based approach will be employed to determine stormwater management districts, which will be guided by a defined release rate most likely determined by the capacity of the streams and infrastructure within the watershed.

The Appoquinimink watershed experiences heavy pollutant loadings from agricultural and land development activities. While the main goal is to control stormwater runoff volume (quantity), the stormwater management planning approach will also focus on stormwater best management practices (BMPs) that have a positive contribution to the overall health of the watershed by efficiently removing pollutants (quality).

Meetings will occur throughout the planning process. Some of these will be progress update meetings with the watershed stakeholders and some of the meetings will be public. To efficiently prepare progress report meetings, it is determined that up to six (6) watershed stakeholders meetings and three (3) public meetings will take place at key stages throughout the planning process.

The plan will contain, at a minimum, the following items:

- (1) a survey of existing runoff characteristics in small as well as large storms, including the impact of soils, slopes, vegetation, and existing development;

- (2) a survey of existing significant obstructions and their capacities;
- (3) an assessment of projected and alternative land development patterns in the watershed and the potential impact of runoff quantity, velocity, infiltration, and quality;
- (4) an analysis of present and projected development in flood hazard areas and its sensitivity to damages from future flooding or increased runoff;
- (5) a survey of existing drainage problems and proposed solutions;
- (6) a review of existing and proposed stormwater collection systems and their impacts;
- (7) an assessment of alternative runoff control techniques and their efficiency in the particular watershed;
  - a. an assessment of alternative stormwater quality and infiltration techniques and their efficiency in the particular watershed;
  - b. an assessment of the existing stormwater management control sites that could be retrofitted to enhance stormwater runoff quality and quantity control, specifically the Greenlawn development which is under the old code that designated a 24-hour detention of the first inch of runoff (first flush) only;
- (8) an identification of existing and proposed federal, state, and local flood control projects located in the watershed and their design capacities;
- (9) a designation of those areas to be served by stormwater collection and control facilities within a ten-year period, an estimate of the design capacity and costs of such facilities, a schedule and proposed methods of financing the development, construction, and operation of such facilities, and an identification of the existing or proposed institutional arrangements to implement and operate the facilities;
- (10) an identification of floodplains within the watershed, and the tidal effect on vulnerable areas located in the more estuarine regions of the watershed;
- (11) criteria and standards for the control of stormwater runoff from existing and new development which are necessary to minimize dangers to property and life;
- (12) priorities for implementation of action within each plan;
- (13) provisions for periodically reviewing, revising, and updating the plan;
- (14) provisions as are reasonably necessary to manage stormwater such that development or activities in each municipality within the watershed do not adversely affect health, safety, and property in other municipalities within the watershed and in basins to which the watershed is tributary; and
- (15) consideration of consistency with other existing municipal, county, regional, and state environmental and land use plans.

The concept and approach presented in the previous discussions have been organized into stages that include the above indicated 15 elements of the plan.

## **Stage A - Data Collection and Analysis**

### **A.1 - Data Collection/Review/Analysis**

This task will involve the necessary efforts to gather, review, and analyze the required data to complete the technical and institutional planning steps for the Appoquinimink River Watershed Stormwater Management Plan. The Consultant will work to collect data from New Castle County and the municipalities, and local, state, and federal agencies that will aid in preparation of the plan. The data will consist of information concerning existing and future conditions in the watershed. All data collection activities will be accomplished by gathering available information from either the agencies that will be contacted or from the data collection questionnaire that will be provided to the municipalities. A special effort will be made to obtain any usable information that the municipalities may have acquired or developed as part of its watershed planning effort.

Data to be collected will include, but may not be limited to (and will be based on available information and/or questionnaire results). Information will be collected and compiled regarding:

- Comprehensive land use plans and current zoning maps to develop a build-out scenario for the future land use data layer for modeling purposes
- Existing municipal ordinances
- Stormwater-related problems and proposed solutions

To better pinpoint areas of concern throughout the watershed, problem areas will be identified through citizen input in the compilation of problem area survey forms. The identification of the problem areas will help in assessing the stormwater management controls needed in the future for the watershed. Those problem areas identified as “significant” will be field evaluated, and the model will utilize these sites as points-of-interest to develop design storm flows. A collection of past studies/investigations will be compiled and reviewed for proposed solutions and reasons why progress has not been made. The plan will summarize these problem areas, provide much of the hydrology that will be required in design of proposed solutions, provide schematic potential solutions to correct these problems, and specify possible sources of funding to pursue. The plan will make suggestions for other programs/activities to deal with the issues raised during the planning process. Information will be collected and compiled regarding:

- Existing and proposed flood control projects
- Existing and proposed stormwater control facilities
- Existing and proposed stormwater infrastructures collection and control facilities, including a designation of those areas to be served by stormwater collection and control facilities within a 10-year period, a schedule and the proposed methods of financing the development, construction, and operation of such facilities, and an identification of the existing or proposed institutional arrangements to implement and operate the facilities, where this information is readily available.
- Soils
- Geology
- Flow obstructions

- Topographic mapping
  - Because the watershed is considerably flat, a 10 meter resolution Digital Elevation Model (DEM) may not be sufficient for modeling purposes, and the availability of LIDAR data will be investigated for use in the topographic development
- Aerial photographs
- Engineering and planning studies
- Streamflow data

Currently there are 3 stream gauges in the watershed as follows:

<b>GAUGE NO.</b>	<b>LOCATION</b>	<b>From</b>	<b>To</b>
01483153	Noxontown Lake Outlet Near Middletown, DE	1992-12-11	2003-06-20
01483155	Silver Lake Tributary At Middletown, DE	2005-09-15	2005-09-15
01483170	Dove Nest Branch Near Odessa, DE	1979-02-26	2004-07-12

This data will be collected and put in a format to be used in the calibration process.

- Rainfall data – rainfall data required for use in calibration and to develop design storm amounts will be collected.
- Floodplain information

#### **A.2 - Review of Existing Plans/Studies/Reports/Programs**

A comprehensive review of related documents and/or programs will be performed, and a coordinated list of the goals and objectives from each of the project documents will be developed. Existing documents to be reviewed shall consist of, but not be limited to:

- Water Supply and Wellhead Protection Plans
- Flood Mitigation Plans
- Municipal Wastewater Management Plans (various)
- Municipal Flood Insurance Studies (various), Federal Emergency Management Agency
- Municipal Ordinances
- University of Delaware Mosquito Breeding in Basins Study
- Any other studies discovered during the planning process

This task also involves the review and preliminary analysis of the technical data that has been obtained for consistency and usability. It also includes the review of the institutional data

collected through the municipal data questionnaire process for consistency and usability in the final implementation plan.

#### Anticipated Product

The product will include the information listed above, gathered and organized in such a way as to be usable for both short- and long-term watershed planning (including updates). A final data summary will be prepared that will identify and/or catalogue the collected data.

### **A.3 - Municipal Ordinance Reviews/Evaluations**

This task will involve the detailed evaluation of the municipal ordinances in order to prepare a municipal ordinance comparison matrix. This matrix is intended to display, for both the actual preparation of the implementation plan and also for the municipal education process, the current stormwater management provisions in the various municipal ordinances for all watershed municipalities. The objective of the preparation of the matrix is to easily and effectively see the similarities and differences, as well as the consistency/inconsistency, between the various municipal ordinances in the watershed. The matrix will be used to develop ordinance provision recommendations for the various municipalities that are based on the standards and criteria.

#### Anticipated Product

The product of this task will be a completed matrix of stormwater management ordinance provisions for the watershed municipalities which identifies the current status of ordinance provisions as they relate to stormwater management.

### **A.4 - Streambank Erosion Inventory**

A.D. Marble & Company will conduct an inventory of severe streambank erosion to confirm previously identified reaches and to identify newly developing erosion problems. It is assumed that all of the severely eroded areas will be in the higher gradient, non-tidal reaches of the watershed. A.D. Marble & Company, through Borton-Lawson, will work with DNREC, New Castle County, the New Castle Conservation District, and other groups as appropriate to identify potential erosion problems. The purpose of this initial coordination will be to reduce the effort required to complete the field reconnaissance.

Based on the findings of the coordination, A.D. Marble & Company will identify stream reaches with a high potential for severe erosion problems. These areas will be inventoried and eroded reaches will be identified and located using a Global Positioning System (GPS). The severity of the erosion can be assessed using Rosgen's Bank Erosion Hazard Index (BEHI)/Near-Bank Stress (NBS) protocol. In coordination with DNREC, we can use the BEHI/NBS to set a threshold for identifying and quantifying streambank erosion.

While conducting the inventory, A.D. Marble & Company will make observations of other potential in-stream problems including evidence of upstream erosion (such as mid channel sediment bars). Upon coordination with and approval from DNREC, these areas can be inventoried for streambank erosion as well.

The streambank erosion inventory will be based on selected sites previously evaluated by the Center for Watershed Protection to determine whether there has been any significant change in conditions since that study was done. Also, in order to avoid an "apples and oranges" situation, the inventory will be performed using the same methodology that was used in the original study.

Assumptions:

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- Fifteen pre-identified reaches will be evaluated
- The coordinates of each site will be provided by DNREC
- The stream reaches will be close to a public road and reasonably accessible with no private property issues
- The previous Center for Watershed Protection (CPW) findings will be provided by DNREC
- A qualitative assessment will be made using the CWP Unified Stream Assessment (USA)

### **A.5 - Tidal Marsh Impairment Assessment**

A.D. Marble & Company, through Borton-Lawson will work with DNREC to identify four tidal marsh areas/tidal stream reaches to assess the feasibility of developing an impairment index. Two sites will be identified based on the presence of a known disturbance or impairment. The other two sites will be in an undisturbed area and will serve as a benchmark from which to compare the health of the sites downstream of the disturbed areas. The undisturbed sites may be upstream of the disturbed areas chosen. A biologic and habitat assessment of the tidal marsh and/or tidal stream will be made at the disturbed and undisturbed areas to determine if there is a difference in the assessment results. If the difference is discernable, this may be useful elsewhere as an index of impairment.

It is anticipated that the EPA's *Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers* (1999) will be used to assess the stream environments. The habitat assessment and benthic macroinvertebrate protocols will likely be used in this assessment. A.D. Marble & Company will work with Borton-Lawson and DNREC to identify an appropriate tidal marsh assessment technique. Potential methods include the "*Delaware Rapid Assessment Method*" (in development by DNREC) and the *Method for the Evaluation and Inventory of Vegetated Tidal Marshes in New Hampshire* (Cook, et al 1993). If this assessment shows promise in identifying an impairment index, additional sites can be studied at the direction of DNREC.

Assumptions:

- DNREC will identify the assessment sites in coordination with Borton-Lawson and A.D. Marble & Company
- Each paired stream and marsh assessment areas will be adjacent to each other
- The assessment areas will be close to a public road and reasonably accessible with no private property issues
- One marsh assessment methodology will be approved by DNREC
- The marsh assessment methodology will be based on qualitative measures of function and will not require detailed quantitative assessment

### **A.6 - Data Preparation for Technical Analysis**

This task involves the engineering work necessary to transform the information collected under Task A.1 into a geographic information system (GIS) that can be used for the later technical tasks. Included will be the preparation of "land characteristics" GIS data layers for modeling and display purposes.

The GIS data layers will include:

- **Base Mapping** – Existing base map information (roads, streams, municipal boundaries, text, etc.) will be collected from New Castle County, the municipalities within, and DelDOT, and the most accurate data will be utilized to develop the watershed base map.

All data will be projected into the coordinate system utilized by the County. All data from the various municipalities will be merged into a seamless base map.

- **Aerial Photographs** – The most recent aerial photographs will be incorporated into the GIS for analyses purposes.
- **Land Use/Land Cover Information** – Existing 2002 Existing Land Use files will be collected from the County and overlaid with parcel data collected by the County. Current aerials (photographic and/or digital images if available) will be collected and utilized to update the land cover maps into the format required for hydrologic modeling (TR-55 land use classifications). Land development projects completed subsequent to existing data will be added as necessary. Prepared GIS layers will be field checked for accuracy.
- **Future Land Use Conditions** – Existing zoning information and the County comprehensive plans will be utilized to convert the existing land development conditions mapping to the future land use scenario for development for ultimate build-out conditions.
- **Predevelopment Conditions Analysis** – A no development scenario will be developed to compare existing and future condition flow to flows that occurred prior to any development.
- **Soils Information** – Digital County soils data will be collected where available. The data collection effort will be coordinated with NRCS to obtain “official soils data where available.” If digital data will not be available in time for this study, the County Soils Survey maps will be digitized and attributes attached to illustrate NRCS hydrologic soils groups, permeability for potential recharge areas, and erodibility. Overlay mapping will be necessary to prepare the hydrologic soils group map necessary for modeling.
- **Digital Elevation Models** – Digital elevation models (DEMs) will be utilized to delineate the subareas for which detailed modeling will be completed. The DEMs will be merged to form a seamless watershed map and projected to the appropriate coordinate system.
- **Digital Raster Graphics (DRGs)** – Digital USGS topographic maps will be compiled and utilized for watershed and subwatershed delineation cross referencing and location of obstructions and problem areas.
- **Wetlands** – Wetlands will be identified in the watershed through the utilization of maps compiled for the State Wetlands Mapping Project (SWMP). It is recommended that the State Wetlands Mapping Project (SWMP) maps be used to identify the wetlands in the watershed rather than the NWI maps.
- **Geology** – Digital geologic maps will be developed for the watershed from existing USGS and DNREC sources. Geologic features pertinent to the features of the watershed, i.e., limestone, sandstone, etc., will be extracted and displayed to portray the goals of the plan.
- **Obstructions** – Obstructions will be located on the appropriate base map and data or attributes attached or linked to the locations.

- **Problem Areas, Flood Control Structures, Stormwater Management Facilities, etc.** – These will be located on the appropriate base map and data or attributes attached or linked to the locations. All DelDOT inlets will be inspected and mapped in the GIS database. Since no GIS information is available regarding stormwater facilities, the stormwater best management practices (BMP) facilities inventory will be collected from Middletown for their respective detention basins and from New Castle County for the remainder, and data will be added to the GIS database. Data regarding Dams will be obtained from the DNREC or other governing bodies that have access to dam data.
- **Floodplains** – Floodplain data will be transposed to the appropriate base map and displayed with the development in the watershed. Proposed land developments will be projected in the GIS to display their relationship to the floodplains.
- **Environmental Characteristics** – Environmental characteristics such as open space, buffers, streambank erosion problems and tidal results from Tasks A.4 and A.5., etc. will be displayed on the appropriate base map where appropriate.

A summary of data sources will be supplied (simplified Metadata) and will include data type (coverage, shapefile, image) source, projection, and year.

### **Delineation of Subwatersheds**

The watershed and subwatersheds will be delineated by the Consultant on a base map at the scale of 1 inch equal to 2,000 feet staying consistent with previous studies and HSGS HEC-12 delineations if possible. Subwatersheds will be established based on the office data and results of the field reconnaissance task. This breakdown of the watershed by major tributary drainage courses and points of interest will be the basis for the hydrologic and hydraulic analyses. Field verification will be performed, if required.

The subwatersheds will be further delineated to subareas based on the following:

- the location of existing problems, as identified by local officials in the municipal survey during the field reconnaissance or from data previously compiled in any previous studies,
- the location of major obstructions (primarily bridges), highway culverts, or stormwater control facilities,
- confluence points of tributaries, as deemed appropriate based on engineering judgment and good modeling practice,
- first order streams, and
- other points of interest, such as stream gauging or water quality monitoring stations, locations of water quality concerns, or outfall sections downstream of existing developments or where development is anticipated to occur.

This task will also include mapping of relevant watershed planning information onto GIS data layers. This mapped information will include:

- floodplain areas - the approximate floodplain limits plotted over the watershed base map or the highlighting of those stream segments for which detailed flood insurance studies are available.

- significant obstructions and their capacities - "significant" obstructions will be those that are identified in the municipal data questionnaires and which are confirmed by the Consultant as being areas where insufficient capacity exists for the necessary storm flows or those that would act as impoundments and affect watershed modeling. A red-light green-light system will be employed to show the magnitude of the obstruction.
- storm sewer systems - for significant system components, areas where storm sewerage exists (service areas) will be indicated generally on the final watershed base map. Storm sewer maps will be collected and included in the Technical Appendix.
- existing federal, state, and local flood protection and stormwater management facilities.
- proposed stormwater facilities within the 10-year planning period - where known and confirmed by the municipalities through the municipal data questionnaire process.
- stormwater related "problems" - those areas indicated in the municipal data questionnaire and where confirmed by technical modeling/analysis (for example, flooding points or areas of streambank erosion).

A.D. Marble & Company will assist Borton-Lawson in documenting the findings of the data collection and analysis. This task will involve conveying data and providing input to the Borton-Lawson prepared report.

#### Anticipated Product

The product will be completed GIS watershed data layers and maps. The maps completed for this task will be preliminary in that they can and/or will be modified and finalized as a part of the final plan preparation efforts.

#### **Stage B - Technical Analysis**

The technical analysis will describe the analytical processes involved with developing a strategy to manage stormwater runoff from new land development. Since stormwater runoff has a direct impact on flooding, water quality, and groundwater recharge, this analysis will consider the following objectives:

- Implement nonpoint source pollution removal methodologies
- Maintain and promote groundwater recharge
- Reduce channel erosion
- Manage overbank flood events
- Manage extreme flood events

These objectives will be accomplished under Subtasks B.1 to B.4.

#### **B.1 Evaluate Water Quality Requirements**

Provide a water quality strategy to encourage nonstructural, low maintenance systems tied to the groundwater recharge/infiltration requirement. The strategy will be tied to the source mechanisms to encourage innovative design practices. Provide water quality volume computational methodology.

## **B.2 Establish Groundwater Recharge/Infiltration Requirements**

Analyze rainfall records in the watershed or region to identify a rainfall depth that produces 90% of an annual runoff volume. Analyze hydrologic soil groups as well as natural and man-made features within the watershed to determine general areas of suitability for infiltration practices. Provide computational methodology for recharge and infiltration.

## **B.3 Establish Streambank Erosion Requirements**

Both Borton-Lawson and A.D. Marble & Company will discuss and provide a streambank erosion standard (for example, detain 1-year, 24-hr storm event and drain over 24-hr period). This work will involve an analysis of the erodibility of soils in and along streams within the watershed.

## **B.4 Establish Overbank and Extreme Event Requirements (release rates)**

This task involves the hydrologic modeling, quantitative computations, and evaluations necessary to analyze runoff characteristics of the watershed under existing and future conditions. It will also establish the need and extent of release rates for the 2-, 5-, 10-, 25-, 50-, and 100-year 24-hour events. High intensity, low duration events such as a few of the most recent hurricane events will be evaluated and criteria possibly incorporated into the standards for management of these storms.

### **Model Selection and Set Up**

This task includes the set-up of the hydrologic model for the analysis of the existing and projected land characteristics of those subareas determined in Stage A. Although a variety of hydrologic modeling programs exist, the most appropriate model available based on the characteristics of the watershed is the United States Army Corps of Engineers Hydrologic Engineering Center – Hydrologic Modeling System (HEC-HMS) 3.0. This model is most adaptable to a mixture of natural and man-made / rural and urban hydrologic regimes that exist in the Appoquinimink Watershed. Input data including rainfall information, drainage network layouts and capacities, travel times within subareas and impoundments, and GIS based data developed under Stage A will be input into the model.

### **Model Calibration**

The model will be run to get preliminary results. It will then be calibrated to obtain a model that can predict the hydrologic response of the watershed with confidence and reliability. Calibration efforts will include the adjustment of model parameters to accurately simulate natural runoff conditions of the watershed. Consideration will be given to all calibration techniques including, but not limited to, use of any available gauging information, comparison with rainfall and runoff information from similar watersheds, comparison with flood insurance study information, regression analyses, and short-term gauging. Calibration will be performed at multiple points within the watersheds to assure the most accurate modeling. Verification of the model will be performed.

### **Design Storm Selection**

Subsequent to calibration of the model, the Consultant will run the model for the 1-, 2-, 5-, 10-, 25-, 50-, and 100-year 24-hour storms. In addition, a high intensity, short duration storm will be analyzed. An analysis of downstream impacts during these storms will be performed to

determine the required design storm(s) based on the watershed hydrologic response of the eight storms. If the rainfall data is available for the June 2006 floods, this storm will also be simulated.

### **Model Runs**

The calibrated model will be run for the selected subareas under the determined design storm(s) for both the existing and future projected land uses.

This will also involve the detailed evaluation of modeling results to perform a problem identification analysis (i.e., a "cause and effect" analysis). This will concentrate on identifying the downstream storm runoff impacts of projected future land development projects. This evaluation will consider both the increase in current downstream storm runoff problems, as well as new downstream runoff problems. In addition, the effect of tidal influences on the lower portions of the watershed will need to be considered.

This work step also consists of performing a technical evaluation of the hydrologic analysis for existing and future land use conditions (ultimate build-out), and recommending standards and criteria to regulate development activity which impacts stormwater runoff. This task also involves performing a release rate (or other similar) analysis and a preliminary distributed storage analysis and developing criteria and standards for proper control of stormwater from new developments. Recommended standards and criteria will accommodate various types of land development activities. The standards and criteria will provide for the application of management practices for the implementation of stormwater control measures.

With the detention basin inventory and mapped stormwater facilities, the calibrated model will then be run to include the effects of selected stormwater control facilities. This will aid in determining if the detention basins are controlling the stormwater runoff to meet the volume based stormwater management criteria.

### **B.5 Compilation of All Technical Standards**

Recommended standards and criteria will accommodate various types of land development activities. The standards and criteria will provide for the application of management practices for the implementation of stormwater control measures.

The standards and criteria will address the following:

- a. Identification of all areas within the watershed where different criteria apply;
- b. Recommended release rate percentages (if applicable) or other levels of control of accelerated runoff from the subareas identified in item a;
- c. Recommended design flood frequencies and computational methodologies for stormwater management measures;
- d. Management measures for infill/redevelopment areas;
- e. A list of recommended alternate stormwater collection and control measures;
- f. Specifications for construction and maintenance of stormwater systems (if applicable);
- g. Safety requirements for stormwater systems during and after construction;

- h. An identification of regional versus localized problems and generalized proposed solutions;
- i. Funding sources for correction of existing problems;
- j. Management measures unique to the tidal portions of the watershed;
- k. Coordinated efforts with concurrent studies. A summary of what tasks will be completed by what programs will be generated so as to avoid duplication of effort;
- l. Feasibility of a stormwater utility or maintenance/management fund;
- m. Identification of repetitive loss structures in the floodplain;
- n. Evaluation of existing floodplain ordinances and their effect in the watershed and recommendations for improvement;
- o. Identification of combined sewer overflow (CSO) problem areas and proposed solutions (if applicable);
- p. A summary of what can and cannot be accomplished under this Stormwater Management Plan;

The recommendations will be presented in layman's language, keeping in mind that they are directed toward the local municipalities, are to address solutions to stormwater management needs, and will be read and interpreted by technical and non-technical people. The technical standards and criteria developed as a part of this task will be watershed-wide in their interpretation and/or application.

Water quality BMP information will be presented, including recommendations for the implementation of water quality “Best Management Practices” or BMPs for new land development activities to minimize impacts of nonpoint source pollution from land development activities.

Non-structural methods of controlling stormwater runoff quantity and quality, such as innovative site planning, impervious area reduction, grading and protection of natural depression areas, buffer zones, temporary ponding on site, and other techniques will be evaluated and recommended for inclusion in the model ordinance.

## **B.6 - Implementation of Technical Standards and Criteria**

This task will involve the identification of the necessary ordinance provisions for each watershed municipality that will be required to be instituted in order to comply effectively with the technical standards and criteria. Included will be the preparation of a single-purpose or “model” ordinance and/or recommendations for updating existing municipal subdivision and land development ordinances to effectively implement the technical standards and criteria for stormwater management in this watershed.

### Anticipated Product

The product will be the charts, tables, and graphs to present the modeling results, the technical interpretation of the modeling results, and the definition of the technical standards and criteria for use in the preparation of the plan. The product will also include the identification of necessary recommended municipal ordinance provisions to implement the technical standards.

**Stage C - Public / Municipal Participation**

Because the Appoquinimink River Association is an active citizen advocacy group that could provide the lead role in many of the items under this section of the scope, much of this portion of the scope of work is based on the Consultant acting in a supporting role.

Coordination efforts and/or activities will continue throughout the duration of the project and will be organized to include the necessary meetings with the County, Consultant, and Department, and up to six (6) stakeholder progress meetings will be held during the project.

The stakeholders meetings will be held to provide education on the planning process to elected municipal officials, the conservation districts, and interest groups, in addition to receiving advice from the municipal officials to assure that the plan fits the needs of the municipalities and to solicit valuable information through the distribution of the questionnaire for technical and institutional data.

A municipal official’s handbook tailored to the watershed will be developed which will provide guidance to municipalities to implement innovative stormwater management and Best Management Practices. Included in this handbook will be a methodology to implement nonstructural stormwater management measures including conservation planning. Since facility maintenance is always a concern to municipal officials, maintenance provisions for these practices will be included in this handbook.

Table 1 describes the proposed stakeholder meetings and public hearing schedules as well as the purpose of each meeting.

**Table 1. Meeting Topics and Schedule**

<b>Meeting</b>	<b>Purpose of Meeting</b>	<b>Meeting Schedule</b>
Public Meeting 1	Introduction to Stormwater Management – This meeting will introduce the County of New Castle to the ideas and benefits of undertaking the development of a stormwater management plan.	Beginning of the project
Stakeholders Meeting 1	Start-up Meeting – to introduce the stakeholders to the planning process and to establish the degree of critical municipal involvement needed throughout the study. To present the data collection questionnaire and request assistance in gathering the required information.	Beginning of the project
Stakeholders Meeting 2	To review the project status, the data questionnaire results, the prepared maps, and the institutional data (ordinance matrix), to solicit any additional comments or concerns from municipalities with respect to watershed data items, and to provide an overview of runoff problems in the watershed and the “cause and effect” of development on stormwater runoff.	Subsequent to Stage A
Public Meeting 2	To encourage the public about the progress of the plan, to show that public interest and suggestions have been	Part way into Stage B

	taken into consideration, and to discuss general issues concerning the Appoquinimink watershed from a public perspective.	
Stakeholders Meeting 3	To present technical modeling results, to present technical standards and criteria for the watershed, and to discuss water quality issues and preliminary ordinance provisions for the municipalities (general and overall).	After Stage B
Stakeholders Meeting 4	To present the draft plan and review municipal comments. (Initial draft sent to municipalities prior to the meeting.)	Subsequent to draft preparation
Stakeholders Meeting 5	To educate the municipalities on the ordinance adoption and implementation requirements of the plan and to receive comments and direction in the development of the model ordinance.	After Draft Review
Public Meeting 3	To discuss potential education materials and programs such as the website and brochures that show how stormwater management solutions are a community and an ongoing effort.	Prior to Final Stakeholders Meeting
Final Stakeholders Meeting	To review comments from the stakeholders, to present the final draft, and to review implementation.	Following Public Meeting

In addition to the topics covered in Table 5, the Consultant will present one or more of the following implementation techniques at each Stakeholders meeting:

#### **Nonstructural Stormwater Management Techniques**

- Performance Zoning
- Disconnected Impervious Buffers
- Conservation Easements
- Riparian Buffer Zones
- Floodplain Overlay Districts
- Cluster Development
- Tree Planting

#### **Groundwater Recharge/Infiltration**

- Porous Pavement
- Recharge/Infiltration Facilities

#### **Streambank Erosion Protection**

- Streambank Restabilization and Revegetation
- Rechannelization

#### **Water Quality Management**

- Stormwater Treatment Wetlands
- Bioremediation Filters

#### **Innovative Stormwater Management**

#### **Grant/Funding Programs for Specific Problem Areas**

The subject matter may change as a result of issues identified in the meetings. This task will also involve the production and distribution of periodic updates to the stakeholders, municipal officials, interest groups, and the public on the program and issues of the plan. Such updates will be provided in progress report format at least three times during the plan development process.

#### Anticipated Product

The product will include correspondence and meeting notes/minutes from the meetings. In addition, the presentation materials prepared for the meetings will also constitute a defined product of this task for the project.

#### **Stage D - Plan Preparation and Implementation**

##### **D.1 - Plan Report Preparation**

Various components of the plan will be completed. Components of each previous task will be included or at least referred to in the plan. In this way the plan shall contain such provisions as are reasonably necessary to manage stormwater such that storm runoff from development or

activities in each municipality within the watershed shall not adversely affect health, safety, and property in other municipalities within the watershed and in basins to which the watershed is tributary. In addition, the plan shall consider and be consistent with other existing municipal, county, regional, and state environmental and land use plans. The plan shall include the following:

- A description of the hydrologic characteristics of the watershed, the present and future land uses and their impacts on runoff, stormwater collection systems and their impacts on runoff, the available runoff control techniques and their efficiencies in the watershed, a list of significant obstructions, and a justification of their classification and available floodplain information. The available floodplain information will either be included in the plan or their sources referenced;
- Based upon the results of the watershed modeling, the technical evaluation will result in the criteria and standards governing the use of stormwater management controls throughout the watershed. An important aspect of the technical components of the plan will be the delineation of areas which should (and areas that should not) use stormwater detention to reduce peak flows. This determination will be made based upon an evaluation of subarea contributions to peak flows at the identified critical drainage points throughout the entire watershed. Each of the stormwater management alternatives as discussed earlier will be incorporated in the plan as appropriate, based upon the modeling results. Peak discharge tables will be compiled for the critical drainage points from the computer runs involved in the modeling effort;
- The tables for the rainfall depths for various frequency durations which are computed as part of the hydrologic modeling;
- Approximate floodplain limits for areas where detailed Flood Insurance Studies (F.I.S.) are available. Where detailed flood control engineering plans for proposed remedial measures are available from municipal, County, or private agencies, a summary analysis and evaluation of those plans will be included in the stormwater management plan. Where detailed plans are not available, preliminary recommendations relating to such measures will be provided;
- Recommendations for solutions to the existing drainage problems (since the Stormwater Management Plan is not intended to solve existing problems, but to prevent their aggravation and also prevent other future problems, these recommendations for solutions to existing problems that are found to be relevant to the plan will only be conceptual in nature, indicating the type of approach needed and inter-municipal cooperation issues);
- Recommendations for new drainage facilities to prevent future problems due to new development and a discussion regarding inter-municipal arrangements for funding the projects;
- Priorities for implementation. The conclusions and recommendations of the plan will be summarized. Recommended actions will be listed according to agency, municipality, or individual responsible for each action. Priority of recommended actions would be based on chronological order, importance, hydrologic significance, or other factors as may be appropriate.

- As a part of the implementation strategy for the plan, specific steps and/or procedures will be established for pursuing and completing the necessary updates of the plan. Specific circumstances that will "trigger" a decision to update will be identified and described in the plan document. For example, land development circumstances (such as major changes in the type and/or amount of proposed land development and in excess of that which was assumed for the preparation of the original plan) will be identified as reasons for pursuing an update of the plan prior to the Consultant recommended 5-year time frame.
- Any other items mentioned in this Scope of Work.

The preliminary outline for the plan is as follows:

Section I	-	Introduction
Section II	-	Watershed Level Stormwater Management Planning and Implementation
Section III	-	Watershed Characteristics <ul style="list-style-type: none"> <li>• Present Land Use</li> <li>• Projected Land Developments</li> <li>• Significant Obstructions</li> <li>• Floodplain and Drainage Problems</li> <li>• Proposed Solutions to and Funding for Existing Problems</li> <li>• Stormwater and Flood Management Systems</li> </ul>
Section IV	-	Watershed Technical Analysis – Modeling <ul style="list-style-type: none"> <li>• Present/Ulimate Land Development Impacts on Storm Runoff</li> </ul>
Section V	-	Modeling Results Interpretation and Development of Technical Standards and Criteria for Control of Stormwater Runoff
Section VI	-	Runoff Control Techniques and Their Efficiencies
Section VII	-	Existing Municipal Ordinance Information
Section VIII	-	Development of Model Stormwater Ordinance Provisions
Section IX	-	Priorities for Implementation of Technical Standards and Criteria
Section X	-	Plan Review Adoption and Updating Procedures

PLATES/FIGURES:

- a base map showing the watershed delineation and political subdivisions, roadway network, and the location as referenced to the County

- existing land use
- future land use
- hydrologic soil groups
- development and floodplains
- watershed subareas used for hydrologic analysis including information on applicable management strategies
- stream obstructions, flooding, and drainage problem areas
- areas where storm sewer networks exist (if available)

TABLES:

- runoff characteristics of the watershed
- rainfall values for various frequency durations
- peak flow values at points of interest for a high intensity, short duration and mean annual 1-, 2-, 5-, 10-, 25-, 50-, and 100-year storm events for various durations and for present and future conditions
- subareas and corresponding management strategy information

APPENDICES:

- a list (or table) of all obstructions including their locations, sizes, calculated capacities, and any particular information which may seem helpful to the use of the plan
- recommended design storm
- any special information concerning stormwater control facilities, BMPs, and other issues

Anticipated Product

The product will be a draft plan for DNREC and the stakeholders to review and the final Appoquinimink River Watershed Stormwater Management Plan. The final plan will be prepared in three parts, Volume I - Executive Summary and Volume II - a document containing the full text and descriptions of the various plan contents as described above, and Volume III, the Technical Appendices containing data collection, modeling, and technical documentation. The report and data, including GIS files, will be supplied by the Consultant to the County in paper and digital format.

**D.2 – Educational Outreach**

