CHAPTER 1. PHASE I & II STRATEGY

1.1 INTRODUCTION

This report summarizes Phase I and II of a 5-year Water Quality Management Strategy for the Christina River Basin. The first two phases of work were conducted during 1995, 1996 and 1997 and include a watershed inventory, preliminary water quality assessment, and public education/outreach effort crafted to identify and understand the sources of pollutant loads entering drinking water streams. This strategy is designed as a watershed-based, multi-agency, interstate approach toward improving the water quality of Christina Basin streams which provide drinking water for over a half-million people in Pennsylvania, Maryland and Delaware. The 5-year water quality strategy is expected to culminate in the year 2000 with the adoption of Total Maximum Daily Loads (TMDL) for the major streams of the Christina River Basin and completion of a watershed management plan.

The Christina Basin Water Quality Management Strategy is especially important given the recent national "Clean Water Action Plan" announced by the President of the United States. The President's "Clean Water Action Plan - Restoring and Protecting America's Waters" dated February 1998, reports that 40% of U.S. waters assessed do not meet water quality goals. Half of the nation's 2000 major watersheds have serious or moderate water quality problems. Fortunately, watershed management, such as the strategy underway in the Christina River Basin, is available to address water quality problems.

1.2 DESIGNATED STREAM USES

Clean water in the streams of the Christina River Basin is required to sustain the diverse human, ecological, aesthetic, and recreational resources of the watershed. The quality of life, health, and vitality of citizens and businesses of New Castle County, Delaware; Chester County, Pennsylvania; and small portions of Cecil County, Maryland are also dependant upon these waters. The four major streams in the 565-square mile Christina Basin include the Brandywine Creek, White Clay Creek, Red Clay Creek and the Christina River. The headwaters of these streams form in Pennsylvania and Maryland and flow through the Piedmont hills of northern New Castle County in Delaware to the Delaware River at Wilmington (Figure 1-1).

Preservation of the quality of ground and surface waters is important, as they provide 75 percent of the public water supply for residents in New Castle County, Delaware and much of the water supply withdrawals in Chester County, Pennsylvania (CCPC, 1996 and WRANCC, 1997). Waters of the Christina Basin provide close to 100 million gallons per day in public water supplies to more than a half-million people in the three States. The following public water suppliers withdraw surface and/or ground water from the Christina River Basin for domestic, commercial and industrial use.

Delaware

- Artesian Water Company (ground water)

- City of Newark (surface and ground water)
- United Water Delaware (surface water)
- City of Wilmington (surface water).

Pennsylvania

- West Grove Borough (ground water)
- Avondale Borough (ground water)
- Kennett Square Borough (ground water)
- Downingtown Municipal Water Authority (surface water)
- City of Coatesville Authority (surface water)
- Philadelphia Suburban Water Company (surface and ground water)
- Lukens Steel (surface water)
- Embreeville Hospital (surface water).

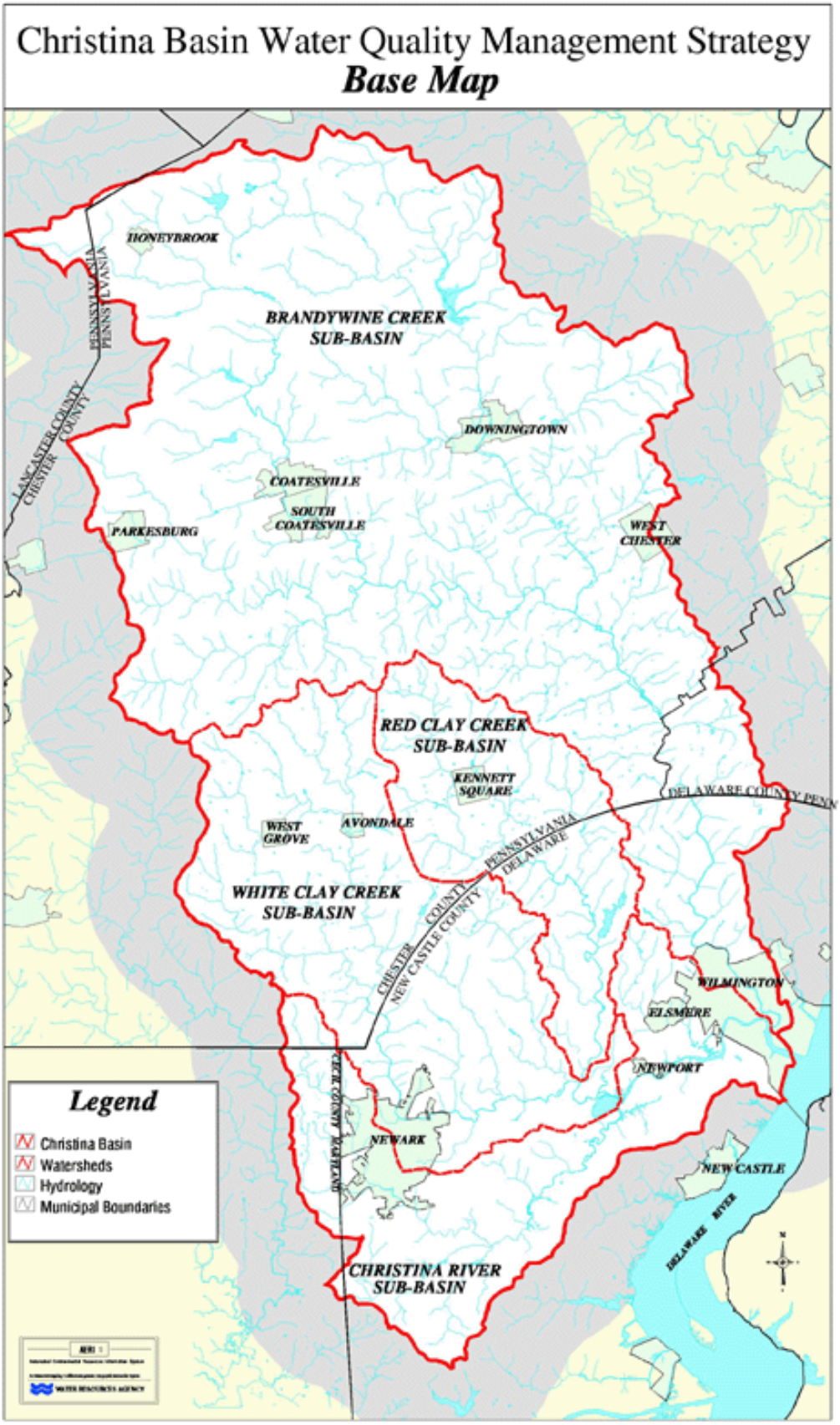
In addition to water supply, the streams of the Christina Basin provide many recreational and ecological opportunities as well as important habitats for wildlife, aquatic life, and plant life. The stream corridors provide valuable recreation such as fishing, canoeing, and hiking for residents of the watershed. The cool waters support an abundant fishery for species such as rainbow/brown trout, smallmouth bass, and white perch. Nature lovers can enjoy the natural beauty which includes an abundance of wildlife from wood ducks to bog turtles to the graceful Great Blue Heron. In Delaware, 30,000 legal-sized trout are stocked annually in Christina Basin waters. Over 2700 trout stamps are sold to Delaware anglers to fish these waters. Canoe liveries report many canoeists ply their craft over Brandywine rapids. In Delaware, approximately 8,400 registered boats are owned by Christina Basin mariners. And the Parks and Recreation Department of both States report many visitors enjoy the open space in the Christina Basin for recreation pursuits (DNREC, 1997).

According to the "State of Delaware Surface Water Quality Standards (as amended February 26, 1993)", the streams in the Christina Basin provide the following designated uses:

- Public, Agricultural and Industrial Water Supply
- Primary and Secondary Contact Recreation
- Fish, Aquatic Life and Wildlife
- Cold Water Fish (Put and Take)
- Waters of Exceptional Recreational or Ecological Significance (ERES).

According to Chapter 93 of the "Pennsylvania Water Quality Standards," the designated uses for streams in the Christina Basin include:

- Potable, Industrial, and Livestock Water Supply
- Irrigation
- Water Contact Sports and Aesthetics
- Boating and Fishing
- Wildlife Water Supply
- Trout Stocking and Warmwater Fishes
- Cold Water and Migratory Fishes
- High Quality (HQ) and Exceptional Value (EV) Waters.


Christina Basin Water Quality Management Strategy
Base Map
HONEYBROOK
PENNSYLVANIA
PENNSYLVANIA
BRANDYWINE CREEK
SUB-BASIN
LANCASTER COUNTY
CHESTER COUNTY
DOWNINGTOWN
COATESVILLE
SOUTH
COATESVILLE
PARKESBURG
WEST
CHESTER
RED CLAY CREEK
SUB-BASIN
KENNETT
SQUARE
DELAWARE COUNTY PENN
WEST
GROVE
AVONDALE
PENNSYLVANIA
DELAWARE
WHITE CLAY CREEK
SUB-BASIN
CHESTER
COUNTY
NEW CASTLE COUNTY
WILMINGTON
ELSMERE
NEWPORT
NEWARK
NEW CASTLE
DELAWARE RIVER
CHRISTINA RIVER
SUB-BASIN
Legend
Christina Basin
Watersheds
Hydrology
Municipal Boundaries

1.3 WATER QUALITY PROBLEMS

Water quality and the biological health of the Christina Basin streams are becoming stressed due to rapid growth and increased utilization of the streams for water supply and wastewater discharges. Currently, some streams in the Christina Basin exhibit impaired water quality and habitat primarily due to impacts from human-related activities (DNREC, 1994). The major water quality problems in the lower reaches of the Brandywine Creek are due to elevated levels of suspended sediment, bacteria, nitrogen and phosphorus. Surface water in the main stem of the Red Clay Creek is impaired due to high levels of bacteria, nutrients, metals, and organics. Impaired water quality in the lower reaches of the White Clay Creek primarily in Delaware is due to elevated nutrients, bacteria, temperature and suspended solids. According to the "Habitat Quality of Delaware Nontidal Streams" published in 1994, 39 percent of the nontidal streams in the Piedmont of Delaware have "poor" habitat (DNREC, 1994). Both states have posted fish consumption advisories along the Brandywine Creek, Red Clay Creek, and tidal Christina River due to unacceptable levels of PCB's, chlordane, and dioxin found in fish tissue and sediment (DNREC and PADEP, 1997).

Impaired surface water quality and habitat is attributed to point and nonpoint sources of pollutants which enter the streams of the Christina Basin. Point (end-of-pipe) sources of pollutants include combined sewer overflows (CSO's) and municipal/industrial wastewater discharges. Non-point sources of pollutants include stormwater runoff from land development, active construction, unmitigated contaminated sites, commercial/industrial sites, roads/highways, turf, recreation, golf course facilities, agriculture activities, and eroding stream banks. In addition, non-point sources include diffuse contributions of pollutant loads carried to the streams by ground water, such as septic disposal systems, subsurface contamination from hazardous waste sites, old landfills, and agricultural chemicals. The identification and inventory of the point and non-point sources of water pollution is one of the objectives of this Christina Basin Water Quality Management Strategy.

1.4 PRIORITY WATERSHED STATUS

The Federal Clean Water Act's Section 319 Nonpoint Source Pollution Management Programs of Delaware and Pennsylvania have identified priority watersheds for water quality assessment in the Christina Basin. The Delaware DNREC Division of Soil and Water Conservation has identified the White Clay Creek and Christina River as priority watersheds for funding and implementation in New Castle County (DNREC, 1995). The Pennsylvania Department of Environmental Protection, Bureau of Watershed Conservation has identified the White Clay Creek and Red Clay Creek as high priority watersheds based on a list of 104 watersheds in the Commonwealth (PADEP, 1994). The Delaware Estuary Program has identified the Christina Basin as a priority watershed for non-point source pollutant reduction (DELEP, 1997).

1.5 INTER-STATE WATER QUALITY STRATEGY

In recent history, Delaware and Pennsylvania had disagreements regarding disparate water quality standards in the Christina Basin. In 1993, the U.S. Environmental Protection Agency mediated and recommended that the Delaware River Basin Commission bring the two States together and create the Christina Basin Water Quality Management Committee to resolve water quality problems involving the Christina Basin streams in Delaware and Pennsylvania. The fundamental purpose of this watershed-based effort is to coordinate the surface water quality

management policies of Pennsylvania, Delaware and the Federal government within the Basin. The Christina Basin Water Quality Management Committee developed a unified 5-year strategy toward improving the quality of these streams which supply drinking water to residents on both sides of the Pennsylvania and Delaware state line. Agencies and stakeholders represented on this multi-State Committee include the:

- Brandywine Valley Association (BVA)/Red Clay Valley Association (RCVA)
- Chester County Conservation District (CCCD)
- Chester County Health Department (CCHD)
- Chester County Planning Commission (CCPC)
- Chester County Water Resources Authority (CCWRA)
- Delaware Dept. of Natural Resources and Environmental Control (DNREC)
- Delaware Nature Society (DNS)
- Delaware River Basin Commission (DRBC)
- New Castle Conservation District (NCCD)
- Pennsylvania Department of Environmental Protection (PADEP)
- U. S. Environmental Protection Agency (Region III) (USEPA)
- U. S. Geological Survey (USGS)
- U. S. Natural Resources Conservation Service (USDA-NRCS)
- Water Resources Agency for New Castle County (WRANCC)

In 1994, the Pennsylvania DEP, Delaware DNREC, and USEPA identified the Chester County Conservation District, Chester County Water Resources Authority and Water Resources Agency for New Castle County as local coordinators for the Christina River Basin. In March 1995, the CCCD and WRANCC prepared a work plan and proposal for Phase I of the Christina Basin Water Quality Management Strategy for consideration by the Committee. On May 15, 1995 the Committee approved the first phase of the program to include a watershed inventory, design of a stormwater monitoring program, and a public education/outreach program. Watershed data collected during the initial phases of work will be used as input for the Christina Basin TMDL model. In September 1995, the Delaware DNREC with funding assistance from USEPA and Pennsylvania DEP authorized $166,000 in Section 319 funds to the Committee to commence Phase I of the 5-year program. In September 1996, the Pennsylvania DEP awarded $82,000 in Section 319 funds for Phase II of the strategy.

1.6 TMDL APPROACH

The Christina Basin Water Quality Management Committee plans to address point and non-point source water quality problems through two approaches: (1) voluntary watershed/water quality planning and management and (2) a Total Maximum Daily Load (TMDL) approach. Section 303(d) of the 1972 Federal Clean Water Act (CWA), as amended, requires the development of TMDL's for all stream segments not meeting water quality standards after the implementation of technology based effluent controls. In 1996, The Widener School of Law, on behalf of the American Littoral Society and the Sierra Club, filed a federal complaint with EPA asking the Court to order Pennsylvania and Delaware to establish TMDL's for water quality limited segments. In 1996, the DNREC and PADEP published a Section 303(d) list which set a deadline for completion of a TMDL in main stem segments of the Christina Basin by the year 2000. In 1997, the DNREC and USEPA signed an interagency Memorandum of Understanding which established deadlines for completion

of the TMDL's. The Christina Basin TMDL will be the second completed in the State of Delaware. The first TMDL in Delaware was completed in the Appoquinimink River watershed in 1997.

The Total Maximum Daily Loads (TMDL) for the Christina Basin will include three components - a waste load allocation (WLA), a load allocation (LA), and a margin of safety (MOS). The waste load allocation is the portion of the TMDL that is allocated to point sources such as end-of-pipe wastewater discharges. The WLA is being developed by collecting stream water quality data at 33 in-stream monitoring stations in the Christina Basin. The stream water quality data will be combined with NPDES wastewater discharge data using a Low-Flow, Point Source WASP receiving water model. The Load Allocation is the portion of the TMDL that is allocated to non-point sources and natural background conditions. Load allocations will be developed by collecting land use, soils, and stormwater monitoring data and inputting them into an HSPF nonpoint source model. The third component of the TMDL is the margin of safety which is set aside to account for uncertainty in the allocation process. The complex TMDL will consist of the following components in the Christina River Basin.

TMDL = WLA + LA + MOS

Where:

TMDL = The Total Maximum Daily Load which is the maximum amount of a pollutant that can be put into the water body without violating water quality standards.

WLA = Waste Load Allocation which is allocated to point sources through a low flow, WASP receiving water model.

LA = Load Allocation allocated to nonpoint sources through a high flow, HSPF hydrodynamic and water quality model.

MOS =The Margin of Safety set aside to account for uncertainty in the allocation process.

By the year 2000, the completed TMDL may recommend reductions in point and nonpoint source loads to meet water quality standards in the Christina River Basin. Point-source reduction programs may include modified effluent limits and/or improvements to NPDES wastewater treatment plants. Non-point source reductions may be achieved through structural, nonstructural, and institutional best management practices (BMP's) such as detention ponds, reforestation, agricultural conservation and riparian stream buffers to control stormwater runoff and reduce water quality impacts to the receiving streams in the Christina Basin. A major emphasis will be placed on public involvement to facilitate BMP implementation.

1.7 COMPATIBILITY

The Water Quality Management Strategy is designed for compatibility and to avoid redundancy with existing water-quality programs in the Christina River Basin. The Strategy is especially designed to coordinate the initiatives of the Delaware DNREC Piedmont Whole Basin Program and the Chester County Water Resources Management Plan. The Strategy is also designed to support watershed management efforts of volunteer and non-profit organizations that are consistent

with the goals and objectives of this strategy. The Christina Basin Strategy will be integrated with the following initiatives:

- Delaware DNREC Piedmont Whole Basin Program
- USGS/Chester County Cooperative Monitoring Programs and Studies
- Water Resources Management Plan for Chester County, Pennsylvania
- Delaware Estuary Program Comprehensive Management Program
- Pennsylvania Act 167 Stormwater Management Requirements
- Section 319 Non-Point Source Program for the States of Delaware and Pennsylvania
- U. S. EPA NPDES Part 2 Stormwater Permit Application for New Castle County, Delaware and Delaware DOT
- Red Clay/White Clay Creeks, PL 83-566 Project
- White Clay Creek Wild and Scenic River Study, Watershed Management Plan
- Combined Sewer Overflow Study for Wilmington, Delaware
- Governor's Task Force on the Future of the Brandywine and Christina Rivers, A Vision for the Rivers, Delaware
- WATER 2000/2020 Plan for New Castle County, Delaware
- Volunteer stream watch and monitoring programs such as the Brandywine Valley Association, White Clay Watershed Association, Red Clay Valley Association, Christina Conservancy, Delaware Nature Society, Brandywine Conservancy, and Stroud Water Research Laboratory
- Local municipal watershed/water quality initiatives.

1.8 MISSION STATEMENT/OBJECTIVES

The mission of the Christina Basin Water Quality Management Strategy is to complete a five-year program to: (1) identify point and nonpoint source pollutants in the watershed, (2) establish achievable water quality goals for the watershed, and (3) develop and implement a water quality management plan to achieve and maintain water quality utilizing public outreach and consensus building among the public and all stakeholders.

The purpose of the Christina Basin Strategy has evolved into 4 distinct objectives:

1. Develop Water Quality Goals for the Watershed (i.e. Complex TMDL's)
   a. Point source modeling and water quality goals
   b. Nonpoint source stormwater modeling and water quality goals
   c. Integrate the point and nonpoint source TMDL's to create the complex TMDL's for the watershed

2. Provide Effective Demonstration Best Management Practices (BMP's)
   a. Riparian buffers
   b. Reforestation
   c. Agriculture conservation
   d. Stream reforestation
   e. Stormwater/wetland management
   f. Institutional tools for municipal ordinances, zoning and planning

3. Stakeholder Involvement (Public/Local Government Water Suppliers/Discharges/Land Owners)
   a. Introduce stakeholders to the Christina Basin Initiative
   b. Educate stakeholders regarding their individual responsibility to water quality management
   c. Involve stakeholders in process of finalizing water quality goals and development of a watershed management plan

4. Develop and Implement a Christina Basin Watershed Management Plan
   a. Utilize the regulatory TMDL Plan
   b. Stress a voluntary, consensus driven approach
   c. Emphasize responsibilities of all stakeholders

1.9 5-YEAR WATER QUALITY MANAGEMENT STRATEGY

The Christina Basin Water Quality Management Committee plans to accomplish the Strategy during several phases over a 5-year period. The duration of each phase will be approximately one year. The 5-year program began in September 1995 and is expected to extend through 2000:

Phase I - Water Resource Inventory/Public Education/Demonstration BMP's (1996)

- Inventory and map watershed resources such as land use, soils and other data.
- Collect stream water quality data at over 33 monitoring stations for the point source effort.
- Assess existing surface water quality on a stream by stream basis.
- Evaluate adequacy of existing local stormwater management ordinances to control runoff quality.
- Estimate stormwater pollutant loads and percent impervious cover and existing land uses for the subwatersheds utilizing the Schueler "Simple Method."
- Select subwatersheds for implementation of demonstration BMP's in the Delaware and Pennsylvania portions of the Basin.
- Design a stormwater monitoring program to characterize representative stormwater quality in priority subwatersheds.
- Develop public outreach and education initiatives.
- Prepare a Phase I Watershed Report.

Phase II - Stormwater Monitoring/TMDL Watershed Model/Public Education (1997)

- Input the watershed inventory into a GIS format and disseminate the mapping and data to agencies and the public.
- Implement the stormwater monitoring program to characterize representative stormwater pollutant loads from various land uses.
- Initiate development and calibration of the TMDL Models to include a point source, low flow WASP receiving water model and a nonpoint source high flow HSPF model.
- Develop guidance and sample language for use in stormwater, soil erosion, sediment control, and subdivision/zoning codes and ordinances.

- Expand and continue the public outreach/education program through the Christina Basin Task Force.
- Implement demonstration BMP's in the watershed.
- Prepare a Phase II Watershed Report.

Phase III - TMDL Model/Demonstration BMP's/Public Education (1998)

- Update the GIS Watershed inventory to include future land uses and biological stream health data.
- Finalize the Point Source WASP receiving water model. Complete calibration of the nonpoint source HSPF model.
- Continue to implement Demonstration BMP's and monitor the status and effectiveness of previous demonstration projects.
- Continue stormwater quality monitoring to characterize pollutants in nonpoint source runoff.
- Expand the public outreach/education program including newsletters and a series of evening outreach meetings.
- Prepare Phase III Watershed Report.
- Develop the scope of a watershed management plan.

Phase IV - TMDL Negotiation (1999)

- Complete the low flow WASP and high flow HSPF models.
- Develop a draft TMDL for the Christina Basin.
- Develop a draft watershed management plan.

Phase V - Comprehensive Watershed Management Plan (2000)

- Hold public information hearings and meetings on the TMDL.
- Finalize adoption of the TMDL incorporating public input.
- Finalize a watershed management plan to manage water quality throughout the Christina Basin based on the adopted TMDL approach and associated point and non-point source load reductions.
- Continue stormwater monitoring to measure effectiveness and implementation of the watershed.
- Continue public involvement program.
- Coordinate the watershed management plan with other State/Federal programs and all private/public stakeholders.
- Prepare final report summarizing Phases I through V.

Implementation

- Continue implementation and update of the watershed management plan and coordinate stakeholder programs and activities.

1.10 PHASE I and II SCOPE OF WORK

Phases I and II of the Christina Basin Water Quality Management Strategy were conducted during 1995, 1996 and 1997 according to the following scope of work:

Task 1 - Project Management

Task 1.1 - The Water Quality Management Committee met bi-monthly to review the progress of work. The Committee was chaired by the Chester County Conservation District (CCCD) and the Water Resources Agency for New Castle County (WRANCC) with overall mediation by the Delaware River Basin Commission (DRBC) and the U.S. Environmental Protection Agency (USEPA).

Task 1.2 - Develop a detailed work plan for Phase I outlining project tasks, budget, milestones, and roles of contracting and subcontracting agencies. The work plan was prepared by the CCCD and the WRANCC incorporating proposals from the various cooperating agencies. Memoranda of Understanding (MOU) by the participating agencies were prepared following approval of the final scope of work.

Task 1.3 - Form a Watershed Inventory Technical Work Group responsible for the collection and organization of data using a Geographic Information System (GIS) in an ARC/INFO format. The work group defined the roles of lead agencies and sources of data as required under Task 2 (Watershed Inventory). The work group included staff from agencies with GIS capability such as the WRANCC, CCWRA, CCPC, NCCD, USGS and others.

Task 2 - Watershed Resource Inventory

Task 2.1 - Prepare a digital base map of the Christina River Basin delineating watershed/subwatershed boundaries, streams/hydrology, reservoirs, roads and state/county/municipal boundaries. The base map and data base were prepared using an ARC/INFO data management system. Thirty eight (38) subwatersheds, each approximately 5 to 30 square miles in area, were delineated on the base mapping for the 565-square mile Christina Basin. The data were organized in a format consistent with the input requirements of the WASP and HSPF watershed models which will be assembled during later phases of the strategy.

Task 2.2 - Inventory watershed resource data on a series of GIS map overlays for the Christina River Basin. Watershed data will be used to identify nonpoint pollutant sources, estimate pollutant loads, and construct a nonpoint source load model during future phases of work. The following series of maps were prepared in a digital format:

- Base Map
- Map 1 - Geology
- Map 2 - Soil Associations
- Map 3 - Outfalls/Intakes
- Map 4 - Topography

- Map 5 - Land Use
- Map 6 - Zoning
- Map 7 - Water Resource Areas
- Map 8 - Parks/Open Space/Protected Lands
- Map 9 - Potential Contaminant Sources
- Map 10 - Best Management Practices
- Map 11 - Stream Water Quality
- Map 12 - Fish Consumption Advisories
- Map 13 - Total Suspended Sediment (TSS) Loads
- Map 14 - % Impervious Cover
- Map 15 - % Agricultural Area
- Map 16 - % Wooded Area
- Map 17 - Watershed Pollution Potential

Task 2.3 - Review the data collected during the Watershed Inventory for consistency with WASP and HSPF format requirements. This included checks of each of the digital coverages and correction of minor errors. The subwatershed delineations conducted during task 2.1 were reviewed and revised to reflect current drainage patterns.

Task 2.4 - Using the ARC/INFO data management system, derive estimates of population density using census data (persons/square mile) and percent imperviousness for each of the 38 subwatersheds in the Christina Basin. Estimates of percent imperviousness were compiled in a format consistent for input to an HSPF model.

Task 3 - Water Quality Assessment

Task 3.1 - Review and assess existing reports and monitoring data to identify water quality problems on a reach-by-reach basis. The assessment catalogued existing water quality data in a digital format and summarized was data "gaps" which will require further surface water and stormwater monitoring. Existing data will be collected from DNREC, DRBC, PADEP, USGS, CCWRA, USEPA - STORET, Private/Public Water Utilities, and stream watch programs conducted by the nature society and watershed associations.

Task 3.2 - Summarize existing water quality information graphically on a digital map of the Christina Basin. The map delineates stream reaches with poor, fair, and good water quality.

Task 4 - Inventory Stormwater Management Programs

Task 4.1 - Review and evaluate existing State, County, and Municipal stormwater management programs for effectiveness in controlling non-point source runoff within the Christina Basin. This work will be conducted by the Delaware DNREC and the PADEP. The following programs were reviewed within New Castle County, Delaware; Chester County, Pennsylvania; and Cecil County, Maryland:

- Stormwater/Floodplain Ordinances
- Soil Erosion/Sediment Control Regulations
- Zoning/Subdivision Codes.

Task 4.2 - Recommend necessary modifications to existing stormwater management programs to reduce the quantity and improve the quality of runoff.

Task 5 - Estimate Stormwater Pollutant Loads

Task 5.1 - Select representative mean concentrations (mg/l) of total suspended sediment using USEPA, National Urban Runoff Program (NURP), Chesapeake Bay Program, and other literature values.

Task 5.2 - Utilize the GIS to estimate annual pollutant loads from non-point sources from each subwatershed in the Christina Basin using a modification of the following "Simple Method" model by Schueler, 1987:

$$L = (A)(P)(R)(C)(0.226)$$

Where:

L = Annual Pollutant Load (lb.)
A = Subwatershed Area (acres)
P = Annual Precipitation (in.)
R = % Impervious for existing land uses including:
- Protected Lands
- Wooded Areas
- Commercial, Industrial, Office, Manufacturing
- Low, Medium, High Density Residential

C = Mean Pollutant Concentration (mg/l)
0.226 = Conversion Factor

Task 6 - Prioritize and Rank Subwatersheds by Pollutant Potential

Task 6.1 - Using the "screening" model, summarize stormwater pollutant load estimates (lb./acre/yr.) in tabular and graphical form by:

- Subwatershed
- Pollutant
- Land Use.

Task 6.2 - Based on the estimates of total suspended sediment loads and other environmental indicators, estimate the pollutant potential of the subwatersheds to assist in prioritizing demonstration BMP's in future phases of the Christina Basin Water Quality Strategy. Rank the subwatersheds from highest to lowest based on the annual pollutant load estimates.

Task 6.3 - Modify the ranking of subwatersheds based on total loads from the screening model by utilizing:

- Stream Water Quality Monitoring Data

- % Impervious Cover, % Wooded, % Agriculture, and relative TSS loadings
- Watershed Prioritization Report prepared by the CCCD in the Brandywine Creek Watershed
- Best Professional Judgement of Committee Members

Task 7 - Design a Stormwater Monitoring Program

Task 7.1 - Design a stormwater monitoring program to characterize nonpoint source loads from representative land uses in the Pennsylvania and Delaware portions of the Christina Basin. Actual stormwater monitoring was initiated during the Fall of 1997.

The goal of the stormwater monitoring program is to collect representative pollutant load data from sub-watersheds that are mostly homogeneous with respect to land use. The pollutant load data will be used as input data for the HSPF model which will be used for the nonpoint source component of the TMDL model. The design of the stormwater monitoring program includes the following components:

- Monitoring station location in priority subwatersheds
- Monitoring for base flow and storm events
- Siting of monitoring stations based on existing water quality and flow data
- Number of sampling stations
- Station installation/calibration
- Sampling frequency
- Representative storm criteria (mean storm depth/duration)
- Precipitation gage location and design
- Selected pollutants for sampling and lab analysis
- Design of sediment sampling stations
- Method of sampling
    - grab or composite flow weighted
    - manual or automatic sampling
- Laboratory analytical and QA/QC procedures
- Sampling crew responsibilities and roles

Task 7.2 - Compile historical meteorological data for the Christina Basin in an HSPF-compatible format to include precipitation, temperature and evaporation.

Task 7.3 - Compile historical and current flow and discharge data in an HSPF-compatible format for the Christina Basin.

Task 7.4 - Compile existing stream channel, slope roughness, and cross-sectional area data for the Christina Basin.

Task 7.5 - Develop a Stormwater Monitoring Procedures Manual summarizing the sampling and analysis program to be conducted during future phases. Excerpts from existing publications will used to develop the manual for the Christina Basin.

Task 8 - Public Outreach/Education Program

Task 8.1 - Conduct a public outreach and education program to inform landowners concerning the need to implement BMP'S. The education program was conducted by the Chester County Conservation District with assistance by the USEPA Regional Administrator's staff and DRBC and include the following components:

- Document progress and success of the Christina Strategy
- Inform citizens about BMP's such as fertilizers/pesticide management, septic systems operation, and riparian buffer protection
- Sustainable Development Planning
- Instill in citizenry a sense of stewardship in the Christina Strategy.

Task 8.2 - Retain a part-time coordinator for the Public Education Component. The Brandywine Valley Association was engaged to conduct the work.

Task 8.3 - Develop and distribute a quarterly Christina Basin Strategy newsletter.

Task 8.4 - Conduct an annual workshop on water quality issues in the Christina Basin.

Task 8.5 - Conduct public meetings to review progress.

Task 8.6 - With assistance by USEPA and DRBC, prepare quarterly press releases describing project progress.

Task 8.7 - Prepare Christina Basin brochures and factsheets.

Task 8.8 - Provide funding for at least one demonstration project utilizing BMP's in each State's portion of the Christina Basin. The CCCD implemented the BMP demonstration projects in the Pennsylvania portion of the Christina Basin. The City of Newark, with assistance by the NCCD and WRANCC, implemented the BMP demonstration project in the Delaware portion of the Basin. The demonstration projects consist of the following:

- Pennsylvania - Riparian Buffer, Reforestation, Agriculture Conservation.

- Delaware - Install and measure the effectiveness of a Natural Stream Restoration Projectutilizing bioengineering, native vegetation, and reforestation techniques along the Upper Christina River in the City of Newark.

<u>Task 9 - Prepare Phase I and II Report</u>

Task 9.1 - Prepare a draft Phase I and II report summarizing:

- Watershed Resource Inventory
- Water Quality Assessment
- Review of Stormwater Management Ordinances
- TSS Load Estimates
- Subwatershed Prioritization

- Stormwater Monitoring Program Design
- Public Outreach/Education Program

Task 9.2 - Circulate the draft report for review and comment by the Christina Basin Water Quality Management Committee and the public.

Task 9.3 - Prepare a final Phase I and II report and submit to USEPA-Region III, Delaware DNREC, and Pennsylvania DEP in accordance with Section 319 program grant procedures.

1.11 FUNDING

The USEPA distributed funds from Section 319 of the Clean Water Act to the States of Delaware and Pennsylvania under a unique arrangement for the first two phases of the Christina Basin Strategy. The Delaware DNREC, Division of Soil and Water Conservation administered the Section 319 funds during Phase I of the project in 1995 and 1996. A local match was required for funds distributed under the DNREC Section 319 program. During Phase II in 1997, the Pennsylvania DEP, Division of Watershed Conservation administered the Section 319 funds. A local match is not required for funds administered by the PADEP. The USEPA provided additional funding support including contract support for watershed training, $30,000 for HSPF training, and $5,000 for consultation to the Christina Basin Committee. Table 1-1 provides a funding summary of the first two phases of the Christina Basin Water Quality Management Strategy.

In addition, Chester County (CCHD, CCWRA, County Commissioners) and the USGS cooperatively funded several stream gage instrumentation sites and monitoring programs that contributed directly to this project (Table 1-2). These data are provided to municipalities, water suppliers, and stakeholders for related water resources management in the Brandywine, Red Clay, and White Clay Creeks watersheds. These programs have been cooperatively funded for over 20 years. In addition, Chester County and the USGS have cooperatively funded numerous other studies and interpretative reports in the Christina Basin, including an updated low flows statistical analysis of stream base flow, radon in ground water, biological data report, and biological trends analyses that will be published in 1998 and 1999.