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THE STATE OF DELAWARE

SOURCE WATER
ASSESSMENT PLAN

Delaware's approach to protecting
its sources of public drinking water

Delaware Department of Natural
Resources & Environmental Control

DELAWARE SOURCE WATER ASSESSMENT PLAN (SWAP)

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ACRONYMS

BMP :	Best Management Practices
CERCLA:	Comprehensive Environmental Response, Compensation, and Liability Act
CPWS :	Community Public Water System
CTAC :	Citizens and Technical Advisory Committee
DGS :	Delaware Geological Survey
DHSS :	Department of Health and Social Services
DNREC :	Department of Natural Resources and Environmental Control
DPH :	Division of Public Health
DRWA:	Delaware Rural Water Association
DWR :	Division of Water Resources
DWSRF:	Drinking Water State Revolving Fund
GIS:	Geographic Information System
GPM :	Gallons Per Minute
GPS:	Global Positioning System
GWUDI :	Ground Water Under the Direct Influence of Surface Water
LUST :	Leaking Underground Storage Tank
MCL :	Maximum Contaminant Level
MGD :	Million Gallons per Day
NPDES :	National Pollutant Discharge Elimination System
NTNCPWS :	Non-Transient Non-Community Public Water System
PCB:	Polychlorinated Biphenyls
PMCL:	Primary Maximum Contaminant Level
PWS:	Public Water System
PWSS:	Public Water Supply Supervision Program
SARA:	Superfund Amendments Reauthorization Act
SDWA:	Safe Drinking Water Act
SIRB:	Site Investigation and Restoration Branch
SMCL :	Secondary Maximum Contaminant Level
SWAP :	Source Water Assessment Plan

SWAPP : Source Water Assessment and Protection Program
TMDL: Total Maximum Daily Load
TNCPWS : Transient Non-Community Public Water System
USEPA : United States Environmental Protection Agency
USGS : United States Geological Survey
UST : Underground Storage Tank
WHPP: Wellhead Protection Program
WRA : Water Resources Agency at the University of Delaware
WRPA : Water Resource Protection Area

DEFINITIONS

AQUIFER : a water-bearing geological formation that will yield water to a well or spring. Aquifers can be classified as confined, semi-confined or unconfined.

BASIN : the surface area that drains into a surface water system.

BACKGROUND LEVEL : Generally, the amount of a substance that occurs naturally in the environment.

BEST MANAGEMENT PRACTICES : Structural, nonstructural and managerial techniques that are recognized to be the most effective and practical means to control nonpoint source pollutants yet are compatible with the productive use of the resource to which they are applied. These are used in both urban and agricultural areas.

CHLORINATION : A method of disinfecting water using chlorine gas or chlorine-based chemicals (either drinking water or wastewater).

COMBINED SEWER OVERFLOW : Flow of wastewater and runoff in a combined sewer in excess of the sewer capacity. It represents the flow that cannot be treated immediately and is frequently discharged directly to a receiving stream without treatment, or to a holding basin for subsequent treatment and disposal.

COMMUNITY PUBLIC WATER SUPPLY : A public water supply which serves at least fifteen (15) service connections used by year round residents or regularly serves at least twenty-five (25) year round residents.

CONFINED AQUIFER : An aquifer bounded above and below by impermeable beds (such as silt or clay) or beds of distinctly lower permeability than that of the aquifer itself and containing ground water which is everywhere at a pressure greater than atmospheric and from which water in a well will rise to a level above the top of the aquifer.

CONTAMINANT : Any substance, either man-made or natural which is concentrated enough to degrade water quality to a degree that renders such water harmful to public health and safety, or to the environment.

CONTAMINANT SOURCE INVENTORY : A list of possible contaminant sources within the delineated source water assessment areas. The inventory process includes: reviewing existing data on the locations of potential contaminant sources, identifying likely sources for further information, and verifying the accuracy and reliability of data sets.

DELINEATION : The process of defining and/or mapping a boundary that approximates the areas that contribute water to a particular water source used as a public water supply.

DOMESTIC WELL : A well primarily used for potable non-public water supply purposes which serves 3 or fewer dwelling units.

EFFECTIVE POROSITY: The volume of void spaces through which water or other fluids can travel in a rock or sediment divided by the total volume of the rock or sediment.

EROSION : Wearing away of soil by running water, wind, or ice; erosion is the process by which the earth's surface is shaped and occurs even in remote, uninhabited areas at a slow rate (geologic erosion); of more concern is accelerated erosion caused by people's activities.

EROSION-PRONE SLOPE : These are areas consisting of lands with soils that are easily eroded.

GROUND WATER : Any water naturally found under the surface of the earth.

GROUND WATER UNDER THE DIRECT INFLUENCE AT SURFACE WATER (GWUDI) : Any water beneath the surface of the ground with (i) significant occurrence of insects or other macroorganisms, algae, or large diameter pathogens such as Giardia lamblia or (ii) significant and relatively rapid shifts in water characteristics such as turbidity, temperature, conductivity, or pH which closely correlates to climatological or surface water conditions.

HAZARDOUS WASTE : Any waste material that is potentially dangerous, including explosives, radioactive materials, and chemicals.

HYDRAULIC GRADIENT: The gravity or pressure gradient which controls the lateral flow of ground water through an aquifer..

INFILTRATION : The entry of water (from precipitation, irrigation, and snowmelt) into the soil profile.

INFILTRATION RATE : The rate at which water applied to the surface of the ground can enter the soil.

NON-TRANSIENT NON-COMMUNITY WATER SYSTEM : A public water system that is not a community water system and that regularly serves at least twenty-five (25) of the same persons over six (6) months per year.

NON-COMMUNITY PUBLIC WATER SUPPLY: A public water supply which has at least fifteen (15) service connections or regularly serves an average of at least twenty-five (25) individuals daily at least sixty (60) days out of the year. Also referred to as a Transient Non-Community Public Water Supply.

NONPOINT SOURCE POLLUTION: Pollution of surface or ground water supplies originating from landuse activities and/or the atmosphere, having no well-defined point of entry.

PERCOLATION: Downward movement of water through the unsaturated soil profile or rock units to the water table.

PERCOLATION RATE: The rate at which water moves through unsaturated granular material or rock toward the water table.

POINT SOURCE POLLUTION: Pollution of surface or ground water supplies at well-defined, usually manufactured “points” or locations; discharges of treated wastewater from municipal and industrial treatment plants are common point sources of pollution.

PUBLIC DRINKING WATER SYSTEM: A community, non-community, or non-transient non-community water system, which provides piped water to the public for human consumption. The system must have at least 5 service connections or regularly serve at least 25 individuals daily for at least 60 days.

RECHARGE AREA: Land area over which precipitation infiltrates into the soil and percolates downward to replenish an aquifer

SALINITY: The quality of water based on its salt content; salinity is usually expressed in parts per thousand [seawater is typically 18 parts per thousand].

SATURATED THICKNESS: The thickness of an aquifer that is fully filled with water.

SEMI-CONFINED AQUIFER: An aquifer which is overlain by a layer of sufficiently less permeability (such as very fine sand) than the aquifer itself but through which significant amounts of water can pass into the aquifer.

SEPTIC SYSTEM: An onsite system designed to treat and dispose of domestic sewage; a typical sewage system consists of a tank that receives wastes from a residence or business and a system of tile lines or a pit for disposal of the liquid effluent remains after decomposition of the solids by bacteria in the tank.

SITE INDEX DATABASE: The DNREC database developed for whole basin assessments that is used to characterize the relative environmental release potential of a discrete potential source of contamination.

SOURCE WATER: Any aquifer or surface water body from which water is taken either periodically or continuously by a public water system for drinking or food processing purposes.

SOURCE WATER ASSESSMENT AREA: The delineated area which contributes water to a public water supply system. This is called a wellhead protection area for a well and a watershed or basin for a surface water intake.

SUSCEPTIBILITY: The relative likelihood that a public water supply might draw water contaminated at concentrations at levels of concern to public health.

SUSCEPTIBILITY DETERMINATION: An evaluation of conditions in the source water assessment area to determine the potential for contaminants to impact public drinking water quality.

SURFACE WATER: Lakes, ponds, streams, rivers, and other water bodies, which lie on the land surface.

TRANSMISSIVITY: The rate at which water is transmitted through a unit width of an aquifer under a unit hydraulic gradient.

UNCONFINED AQUIFER: An aquifer in which no relatively impermeable layer exists between the water table and the ground surface and an aquifer in which the water surface is at atmospheric pressure.

UNSATURATED ZONE: Partially saturated soil and rock units above the water table.

VULNERABILITY: The relative ease with which contaminants, if released into a source water area, could move and enter a public water supply well or intake at concentrations of concern. Vulnerability includes consideration of such factors as aquifer characteristics, well or surface water intake integrity, and well screen depth.

WATERSHED: An area of land bounded by drainage divides which contributes runoff to one specific delivery point in a stream network; large watersheds may be composed of several smaller “subwatersheds”, each of which contributes runoff to different locations that ultimately combine at a common delivery point.

WATER TABLE: The upper boundary of the saturated zone of an unconfined aquifer.

WELLHEAD PROTECTION AREA: the surface and subsurface area surrounding a water well or wellfield supplying a public water system through which contaminants are likely to move toward a reach such well or wellfield.

PUBLIC SUMMARY

DELAWARE SOURCE WATER ASSESSMENT PLAN

In 1996, the U.S. Congress amended the Safe Drinking Water Act (SDWA) and added a new program called the Source Water Assessment and Protection Program (SWAPP). The amendments require each state to identify and evaluate the sources of water within the state that are used by public drinking water systems. The goal of this program is to assess the susceptibility of public water sources to contamination and to promote and facilitate the protection of these public water system sources to complement traditional water treatment activities. To assist in accomplishing this work, Congress has also provided funding support to each state to conduct these assessments.

The Delaware Department of Natural Resources and Environmental Control (DNREC) has the lead role in the development and implementation of the Delaware SWAPP. Its work is closely supported by the Delaware Department of Health and Social Services - Division of Public Health (DPH) and the Water Resources Agency/ University of Delaware. The first major task of this federally mandated program is to develop the State's approach to conducting source water assessments and submit this plan to the USEPA by February 6, 1999. After receiving EPA's approval of the program, Delaware will have about three years to complete the assessment work.

The USEPA provided guidance to the states on the content and process to follow in developing the Source Water Assessment Plan (SWAP). Congress wanted to ensure that the public was involved in this program, therefore, each state was required to assemble a SWAP committee to shape the content of the program. In Delaware, the Citizen and Technical Advisory Committee consisted of representatives from a wide range of groups including private citizens, agricultural organizations, environmental organizations, civic organizations, industry, water suppliers, and other interested parties. The committee met regularly and guided the development of the Delaware SWAP.

The SWAP outlines how source water assessments will be conducted for all of the public water systems in Delaware. These assessments will consist of three major components as required by the SDWA and guidance developed by the U.S. Environmental Protection Agency (EPA). Each of the 582 public water systems in Delaware will have assessments of their susceptibility to contamination as follows:

- First, a determination will be made of where the source(s) of the water used by each system originates. In Delaware, the majority of the 582 public water systems utilize wells to extract ground water to serve their customers. For these systems, the source water areas are the boundaries of the land surrounding the well that are important for the water quality of that well. Called wellhead protection areas, these areas will be delineated using methods established in the State's EPA approved Wellhead Protection Plan (1990). In addition to ground water sources, several of the larger public water systems utilize surface water resources to supply their customers. The

delineated source water areas for these systems are the watersheds upstream of the systems' intakes. Those areas of the watersheds closest to these streams will receive more stringent attention.

- Second, the State will develop an inventory of significant existing and potential sources of contaminants located within the source water assessment areas. All known existing and potential point (i.e. leaking underground storage tanks, landfills, etc.) and non-point (i.e. residential lawns, agricultural fields, etc.) contaminant sources will be cataloged and organized in a Geographic Information System (GIS), a computer program that organizes this information and displays it on maps.
- Third, these two components (source water assessment areas and potential contaminant sources) will then be used to determine the susceptibility of each public water supply source to contamination. A susceptibility determination will provide a description of the potential for that source of water to become contaminated using the following methodology:

Initially, a vulnerability determination will be made examining physical features of the well or surface water intake. Vulnerability is defined as "the relative ease with which contaminants, if released into a source water area, could enter a public supply well or surface water intake." For ground water sources, vulnerability involves a review of the physical construction of the well and the depth and type of aquifer from which the well draws water. It is assumed that surface water sources are highly vulnerable because they are open to the air, contaminants can move quickly, and there are less mechanisms for attenuation of contaminants.

Next, the "presence of existing and potential contaminant sources" determined by the contaminant inventory will be combined with the vulnerability determination to give an indication of the susceptibility of the source water for that public water system. Susceptibility is defined as "the potential for a public water system to draw water contaminated by inventoried sources at concentrations of concern." Additionally, chemical-monitoring results for these systems will be reviewed for the presence of any contaminants of concern within the source water. Each source will then be assigned a susceptibility ranking ranging from "least susceptible" to "most susceptible" for the following nine contaminant categories: nutrients, pathogens, petroleum hydrocarbons, pesticides, polychlorinated biphenyls (PCB's), metals, other inorganics, other organics, and turbidity.

When the source water assessments are completed, they will be made available to the public. Notice of their availability will be advertised on the Internet through the DNREC webpage (<http://www.dnrec.state.de.us/>) and the Water Resources Agency webpage (<http://www.wr.udel.edu/>). The extent to which the assessments are made available will depend on the level of public interest, but at a minimum they will be at the DNREC offices. For larger public water systems, the assessments will also be available at the water suppliers' offices.

Additional information on the Source Water Assessment and Protection Program and on the Source Water Assessment Plan can be obtained from the DNREC Water Supply Section at 302-739-4793 and the DNREC Web Site at www.dnrec.state.de.us.

CHAPTER 1: OVERVIEW OF THE PROGRAM

1.1 Introduction and Background of Source Water Assessment and Protection Program

In 1996 the U.S. Congress amended the Safe Drinking Water Act (SDWA) establishing a Source Water Assessment and Protection Program (SWAPP). This new program requires the states to evaluate the sources of water used to supply public drinking water systems (wells, streams, reservoirs, etc.). The goal of the SWAPP is to promote and facilitate the assessment and protection of these public drinking water sources to complement the traditional water treatment approach. Both approaches aim to ensure safe public drinking water. It should be recognized that for many years the primary mechanism for ensuring that our public drinking water supplies were safe was to construct water treatment systems that could remove materials that were harmful to our health. To this end, water suppliers have invested millions of dollars in treatment and distribution facilities that ensure that the water delivered to your tap is clean and healthy.

The Source Water Assessment and Protection Program will add another layer of protection to our public drinking water supplies. Instead of completely relying on treatment to deliver a safe product, the SWAPP offers an approach to manage, control, and/or eliminate some of the potential contaminants before they reach the treatment system. To assist the states in implementing their SWAPP and provide some direction to this nationwide effort, the U.S. Environmental Protection Agency (USEPA) published the document "State Source Water Assessment and Protection Programs Guidance" (August 1997). This guidance requires states to develop an assessment plan – termed the Source Water Assessment Plan (SWAP) – which explains how states will assess the susceptibility of public water systems to existing or potential contamination. The preparation of Delaware's SWAP relies on both the EPA's guidance and on the unique programs already in place in Delaware.

1.2 Statutory Requirements

The SDWA Amendments of 1996 (Public Law 104-182) established a national requirement for the states to place a greater emphasis on ensuring the quality of public drinking water supplies through the "prevention" of contamination. According to the guidelines provided by the USEPA, this prevention approach has two key components:

- A clear state lead, with flexibility and resources to achieve results:
- A strong ethic of public information and involvement within the states' decision-making processes.

The USEPA wanted the states to have flexibility in developing their individual program because prevention activities often involve decisions about land use which are generally controlled at the local or state level. Additionally, Congress has provided resources (funding) to the states to develop and implement this federally mandated program. The 1996 Amendments also placed a great deal of emphasis on involving the public in both the design of the state SWAP and in having ready access to the individual system assessments. The USEPA's intention is that by

involving the public in the entire process the public will be able to make more informed decisions regarding the protection of its drinking water sources.

As required by the USEPA guidance, state SWAPs must include the following elements:

- Methodology and approach to delineate the boundaries of source water assessment areas from which each public water system draws water;
- Methodology for the inventory of significant potential sources of contamination;
- Approach to determining the susceptibility of these source waters to contamination; and
- Adequate public involvement in developing the state's source water assessment plan.

All states have until February 6, 1999 to submit their SWAP to the USEPA. Delaware has been informed that its SWAP will be initially reviewed by the USEPA Region 3 Office for completeness of the basic requirements. It will then undergo a more extensive review that could take up to nine months to complete. After nine months, the SWAP is automatically approved unless the EPA disapproves the program. The state will have 2 years after EPA's program approval to complete all Public Water System (PWS) assessments. The USEPA may extend this up to 18 additional months if requested by the state.

1.3 Availability of Source Water Assessments to the Public

The Delaware Department of Natural Resources and Environmental Control is the lead agency in conducting source water assessments. At this time, there are approximately 582 PWSs in Delaware, as summarized by county in Table 1-1:

Table 1-1 Summary of Public Water Supply Systems in Delaware (January 1999)

	CPWS		NTNCPWS		TPWS		TOTAL	
	Systems	Wells / Surface Intakes						
Kent County	54	126 / 0	28	40 / 0	42	47 / 0	124	213 / 0
New Castle County	44	140 / 6	26	54 / 0	41	46 / 0	111	240 / 6
Sussex County	139	315 / 0	44	77 / 0	164	206 / 0	347	598 / 0
Total	237	581 / 6	98	171 / 0	247	299 / 0	582	1051 / 6

When the source water assessments are completed, they will be made available to the public. DNREC has established a web site where information on source water assessment can be found (www.wr.udel.edu/swpp1.html). This site also contains information on the Source Water Assessment and Protection Program (SWAPP). The DNREC web site will be continually updated to provide the public with current information on the status and availability of these assessments. Also, the public water suppliers will notify their customers of the availability of these assessments.

The extent to which individual assessments are made available will depend on the level of public interest. At a minimum, the assessments will be available at the DNREC offices and with the public water supplier. For the larger systems that may attract more public interest, the assessments can be made available through the public libraries in each county, the libraries of colleges and universities, and at city and county offices. Phone numbers for people to contact to explain the assessments will also be publicized.

1.4 Components of Delaware's Source Water Assessment Plan

The following chapters describe the components of Delaware's SWAP which consists of the following five major elements:

- **Public Participation:** A Citizen and Technical Advisory Committee (CTAC) was assembled to facilitate input to the program from both the general public and those with technical expertise. Meetings were held at least monthly from September 1998 until January 1999 to discuss each draft component of the proposed source water assessment plan and receive comments on improving the work. The CTAC will also meet following SWAP submittal to EPA in order to consider EPA's comments. A web site was established to provide greater public access to the SWAP.
- **Delineation of Source Water Assessment Areas:** The areas contributing source water to each of the public water systems will be determined and mapped.
- **Existing or Potential Contaminant Source Inventory:** All known existing or potential point and non-point sources of contamination will be inventoried within the source water assessment area. Field inspections will be conducted as necessary.
- **Susceptibility Determination:** Using information about the ground water or surface water system and the contaminant inventory, a determination will be made as to the potential for the source water system to become contaminated (even though it may be able to remove these contaminants through treatment).
- **Source Water Assessment Implementation:** The work of conducting assessments for all of the public water systems in Delaware will be accomplished over an approximate 3-4 year period beginning in 1999. The priority of conducting

assessments considers factors such as population, water quality, vulnerability, and public requests.

1.5 Existing Programs Related to Source Water Assessment and Protection Program

There are a number of existing programs and activities that will be a part of implementing Delaware's Source Water Assessment and Protection Program. A key program is the Delaware Wellhead Protection Program (WHPP) approved by EPA in 1990. The WHPP will serve as the basis for delineation of ground water based public water supply systems in Delaware. Details related to the modeling of wellhead areas and the assumptions to be used as well as some of the basic well inventory data has been assembled for this program and will be essential for the timely completion of the source water assessment work.

Other programs that will be very useful for the SWAP include:

- Delaware Whole Basin Management Program: This project will assist in the development of a computerized, Geographic Information System based contaminant inventory for most of the state.
- Wellhead Protection Program: The Delaware Wellhead Protection Program (WHPP) was approved by the EPA in 1990. The WHPP includes seven (7) key elements
 - 1) Duties and responsibilities,
 - 2) Delineation of wellhead protection areas,
 - 3) Identification of contaminant sources,
 - 4) Management approaches,
 - 5) Protection of new wells,
 - 6) Contingency planning, and
 - 7) Public participation
- Christina River Basin Water Quality Management Strategy: This program will provide the delineated watersheds and an inventory of existing and potential sources of contamination in northern New Castle County and Pennsylvania. It is a jointly coordinated Delaware-Pennsylvania work program the goal of which is to assess point and non-point sources of pollution to the streams in the Christina River Basin and recommend actions to improve these waters.
- Comprehensive State Ground-Water Protection Program – The Delaware Comprehensive State Ground Water Protection Plan (CSGWPP) was endorsed by the USEPA in January 1999. The CSGWPP identifies wellhead protection areas and recharge potential areas as key priority areas for all programs that involve ground water protection.

- Total Maximum Daily Loads (TMDLs): The SWAP for surface water supplies will also incorporate work being developed for the TMDLs. This work will model the ability of the Christina River Basin waters to assimilate a variety of contaminants, and establish specific limits on both point and non-point sources contributing to these waters.
- Pesticide Program: The DDA Pesticide Program oversees important components to the source water program including Pesticide Enforcement, the Delaware State Pesticide Management Plan, a Pesticide Monitoring Network, and Pesticide Storage and Mixing facilities.
- Water Resource Protection Area Program for New Castle County: This is a program adopted by New Castle County government that was designed to improve the protection of public water supply sources in New Castle County. It consists of a series of maps and regulations that manages land use activities within areas important to public water supplies.
- Piedmont Basin Riparian Inventory Project: This is a Whole Basin Management project in which trained personnel will walk or boat all of the major streams and tributaries of the Piedmont Basin (about 300 miles). During this scientist will record data important to assessing the condition of these waterways, most of which are used as a source for public drinking water.
- Public Water Supply Supervision Program: The DHSS Public Water Supply Supervision Program (PWSS) oversees all public water systems in Delaware. The SWAPP will require close coordination with the PWSS for SWAPP grant coordination, annual intended use plan for the Drinking Water State Revolving Fund (DWSRF), DHSS/DNREC memorandum of agreement for the DWSRF, raw and treated monitoring results, SDWA regulatory requirements relevant to SWAPP, and susceptibility determinations

1.6 Funding for the Source Water Assessment and Protection Program

Financial support for the development of the Delaware SWAPP comes from setasides in the State's Drinking Water State Revolving Fund (DWSRF). Delaware is utilizing funding from the Fiscal Year 1997 DWSRF to develop its SWAPP and to conduct assessments. The full 15% allowable for source water assessments was set aside to assure that all assessments could be completed over the allowable time frame. Delaware can utilize these funds over a 4-year period for delineation and assessment activities. In addition, the wellhead protection program will also be partly funded for the duration of the DWSRF. In addition to the DWSRF setaside funds, staff resources supporting the Delaware SWAPP include those from the Clean Water Act Section 106 grant, and from state general funded positions.

There are resources available to complete the source water assessment for existing public water supplies. However, DNREC will likely request the 18-month extension allowed under the SDWA Amendments of 1996.

CHAPTER 2: PUBLIC PARTICIPATION

2.1 Citizen and Technical Advisory Committee

The SDWA Amendments and USEPA guidance required that states form advisory committees to review and provide comment on their SWAPs. To facilitate public participation, USEPA recommends that the state form a citizens advisory committee to protect the general public's interests and a technical advisory committee to offer technical advice on the SWAP.

The USEPA guidance stated "one committee is possible if a state demonstrates in its submittal that the structure, membership, and process of the committee provided for viewpoints for both technical and citizens' considerations." The Delaware committee members elected to combine both interests in its Citizen and Technical Advisory Committee (CTAC) for several reasons:

- Delaware is a small state both in terms of geography and population and, thus, both interests could be well represented with a single committee;
- Other states found that the two committees ended up working together and eventually combined into one committee;
- The timeline for developing Delaware's SWAP submittal required the efficiency realized by a single committee.

Committee membership was selected using USEPA guidance on what general interests should be represented and on membership on the previous Wellhead Protection Advisory Committee. Specific groups were targeted based on these recommendations, including existing watershed committees, public interest groups, government agencies, farm organizations, developers, technical experts, and vulnerable population groups. Invitations were sent to representatives from these and other groups to attend the first workshop in June 1998. In addition, advertisements were published in the local newspapers inviting the interested public to attend the June workshop. A target size for the committee was set at between 30 and 40 members, with a limit of 1 vote per organization. However, no one who expressed interest or attended the June workshop was denied membership on the committee. The CTAC consists of 36 members, or approximately 1 person for every 20,000 Delaware residents. A list of the committee members is included in Table 2-1. The committee contained representative from all interest groups recommended by USEPA, including concerned citizens and technical experts. Although not all members were able to attend each meeting, each expressed their concerns either verbally or in writing.

It was agreed that the committee would meet one day each month beginning in September 1998. Monthly meetings would be considerate of the time that the volunteers were giving to the committee yet would allow adequate time between meetings to prepare the next chapter of the SWAP for the committee to review. One chapter of the SWAP was presented at each meeting for the committee to review. Members were encouraged to review the chapters, ask questions, and provide comments. The comments were then incorporated into the chapter following the general concerns of the CTAC. Also at each meeting, committee members were

given a list of questions designed to solicit responses that could be incorporated into the SWAP. The questions were based on USEPA guidance and were helpful in gaining the committee's participation.

Appendix A includes the questions that were put to committee members. Responses are available at the DNREC offices. Appendix B includes agendas and summaries from each committee meeting. The meeting summaries are extremely detailed, including questions asked by committee members, and the responses that were given. Also at the end of each monthly meeting summary in Appendix B, the committee member's verbal responses to the specific DNREC questions are provided. All written comments by committee members, including written answers to the questions posed at each meeting, are included in Appendix C.

Table 2-1 Members of the Delaware Citizen And Technical Advisory Committee

American Association of Retired Persons	Frank Desrosier/ Joseph Demul	Citizen
Artesian Water Company	Joseph Dinunzio	Technical
Christina Conservancy	Lorraine Fleming	Citizen
City of Dover	Anthony Gersitz	Technical
Civic League for New Castle County	Marion Stewart	Citizen
Committee of 100	Jeff Bross (Duffield Associates) Tim Ruga (Duffield Associates) Tad Yancheski (Tetra Tech)	Citizen/ Technical
Common Cause	John Flaherty	Citizen
Council of Farm Organizations	Jane Mitchell	Citizen
Culligan Water Conditioning	Ken Bacon	Technical

Table 2-1 Members of the Delaware Citizen And Technical Advisory Committee (Cont'd)

Delaware Department of Agriculture	Scott Blaier	Technical
Delaware Department of Health and Social Services	Anita Beckel	Technical
Delaware Department of Natural Resources and Environmental Control	John Barndt (Water Supply Section) Hassan Mirsajadi (Watershed Assessment) Steve Smailer (Water Supply Section) Stephen Williams (Whole Basin Management)	Technical
Delaware Farm Bureau	Pam Thornburg	Citizen
Delaware Geological Survey	John Talley	Technical
Delaware Nature Society	Chris Brown	Citizen/ Technical
Delaware Public Health Association	Eugene Campbell, MD	Citizen
Delaware Rural Water Association	Jigar Patel	Technical
League of Women Voters	Til Purnell	Citizen
Town of Lewes, Board of Public Works	Gilbert Holt	Technical
US Environmental Protection Agency Region III	Ashley Toy	Technical

Table 2-1 Members of the Delaware Citizen And Technical Advisory Committee (Cont'd)

US Geological Survey (USGS)	Dan Soeder	Technical
United Water Delaware	Sheila Dolan	Technical
Water Resources Agency/University of Delaware	Jerry Kauffman Martin Wollaston	Technical

2.2 Existing State Committee's Relevant to the Source Water Assessment and Protection Program

Many programs relevant to the SWAPP were represented on the CTAC. Others will be involved as Delaware implements its SWAPP. These include the following:

- DNREC Whole Basin Assessment Teams (all DNREC programs)
- Christina Basin Water Quality Strategy Committee (interstate coordination)
- Pesticide Advisory Committee
- Resource Protection Area Technical Advisory Committee for New Castle County

2.3 Public Information/Participation Outreach Activities

SWAP public workshops were held in June 1998 and January 1999. The June 1998 workshop was an organizational meeting to set up the committee, to hand out questionnaires to solicit the attendees' opinions on various source water issues, and to provide information to the public. The January public workshops were held at the Bear Public Library in New Castle County and at the Milford High School in Kent County, and were designed to enable the public to review the draft SWAP and to provide verbal and written comments. (See Appendix J) Comments received at the workshops are included in the meeting summary reports. In addition, public comments were also received following submittal of the draft SWAP (February 1999). Those comments are included in Appendix C.

Several education activities were conducted to ensure the public's understanding of the complex issues surrounding the SWAP. Three public workshops already mentioned were held to discuss and review the plan. A CTAC meeting was held each month where each chapter was explained in detail. Public information dissemination included newspaper advertisements and the Delaware SWAPP webpage (<http://www.wr.udel.edu/swpp1.html>). Public outreach programs included presentations given, when requested, at seminars and to groups such as the Delaware Rural Water Association, Citizens Coalition, League of Women Voters, Council of Farm Organizations, Chemical Industry Council and public ceremonies such as the signing of

Delaware's DWSRF grant. In addition, over 500 letters were mailed to all public water system owners appraising them of the SWAP and seeking their input.

CHAPTER 3: SOURCE WATER ASSESSMENT AREA DELINEATION

The USEPA has provided the states with guidance (EPA, August 1997) on the items that must be included in a state's SWAP submittal. The guidance, however, allowed for a large degree of flexibility between the states. The initial step in developing the program is the delineation of areas that contributes to and could impact public drinking water surface intakes, raw water storage facilities, and wells. These source water assessment areas are the geographic extent for conducting the contaminant inventory and lastly, determining the susceptibility of each public water source. For some source water assessment areas, the delineations will utilize existing information maintained in the geographic information systems of the State of Delaware and the Water Resources Agency/University of Delaware (WRA). For others, particularly the ground water systems, the modeling and delineation of the boundaries of these areas will need to be accomplished through the source water assessment activities. The remainder of this chapter will describe the methodology that Delaware will utilize to delineate source water assessment areas for both surface water and ground water public water supplies.

3.1 Surface Water Supply Sources in Delaware

There are only three public water suppliers in the State of Delaware that have surface water intakes for their source of drinking water, all located in New Castle County. These are the City of Wilmington, the City of Newark, and United Water Delaware. The surface waters used by these three suppliers are Brandywine Creek, White Clay Creek, Red Clay Creek, and the Christina River. Although these streams vary in size, they all share a common trait - the headwaters of these waterways are in another state, Pennsylvania. In addition, much of the drainage basin for three of the four waterways are also within Pennsylvania. A small portion of the Christina River watershed is in the State of Maryland. This major drainage basin, called the Christina River Basin, ultimately flows into the Delaware River.

Additionally, there is one large surface water storage facility in Delaware, the Hoopes Reservoir, which is owned and operated by the City of Wilmington. It is a two billion gallon off-stream pumped storage facility located on a tributary of the Red Clay Creek, although the water stored in Hoopes is pumped from the Brandywine Creek. The entire 2 square mile watershed for Hoopes Reservoir is within Delaware. Hoopes Reservoir is principally an emergency storage facility utilized by Wilmington when conditions on the Brandywine Creek are impaired by quality or quantity. Hoopes Reservoir is also used by United Water Delaware, the Artesian Water Company, and the City of Newark through an agreement with Wilmington to release raw water from the reservoir into the Red Clay Creek to be withdrawn, treated, and distributed by United Water when needed.

One other surface water source that is used daily in Delaware is the Octoraro Creek in the Susquehanna River Basin of Pennsylvania. Water from this out-of-state source enters Delaware as finished water through pipelines from the Chester Water Authority in Pennsylvania. One of the pipelines connects the Chester Water Authority to the Artesian Water Company and another pipeline connects the Chester Water Authority to United Water Delaware. The following table

summarizes the public water suppliers that utilize surface water for public supplies in Delaware and shows the percentage of each watershed that is within Delaware's state boundaries.

Table 3-1 Summary of Watersheds Used for Public Drinking Water in Delaware

Water Supplier	Source Water/ Watershed	Maximum Withdrawal	Total Watershed Area	% of Watershed in Delaware
City of Wilmington	Brandywine Creek	44 MGD	320 Sq. Miles	10%
City of Wilmington	Hoopes Reservoir	24 MGD	2 Sq. Miles	100%
City of Newark	White Clay Creek (above Newark)	3 MGD	70 Sq. Miles	14%
United Water Delaware	Red Clay/ White Clay Creek	30 MGD	155 Sq. Miles	40%
United Water Delaware	Christina River at Smalley's Pond	6 MGD	56 Sq. Miles	81%
Chester Water Authority, Pennsylvania	Octorora Creek	8 MGD	140 Sq. Miles	0%

3.2 Delineation of Source Water Assessment Areas for Surface Water Systems

According to US EPA's document "State Methods for Delineating Source Water Protection Areas for Surface Water Supplied Sources of Drinking Water" (August 1997) there are three main methods states utilize to delineate surface water assessment areas upstream of a public supply intake:

- Topographic boundary delineation,
- Setback/buffer zone delineation,
- Time-of-travel calculation.

Topographic boundaries are determined by the contour of the land. These boundaries are commonly referred to as the watershed or drainage basin for the stream. A setback/buffer zone is an area along the banks of a stream established by a policy decision considering such factors as the slope of the land adjoining a stream, size of stream, and local land uses along the stream. According to US EPA, a typical buffer zone is a strip of land up to about 200 feet wide. The third method for delineating a surface water assessment area is by developing time-of-travel calculations. This approach is used to determine how long it would take for a contaminant moving at the same speed of the stream water to reach the supply intake(s). This method is very useful for emergency response activities and most important for places where there are sources of contamination located directly adjacent to the stream with little overland flow needed to enter the watercourse.

Figure 3.1: Public Surface Water Supplies

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Please contact the Source Water Assessment and Protection

Program at Phone: (302) 739-4793 or Fax: (302) 739-2296

to request more information regarding this map.

Figure 3.2: Christina Basin Watershed Delineation

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Program at Phone: (302) 739-4793 or Fax: (302) 739-2296

to request more information regarding this map.

The State of Delaware's approach to delineating surface source water assessment areas will utilize topographic boundaries, physical land characteristics (soils), and setback/buffer zones in an hierarchical arrangement. Initially, all lands upstream of the public surface water supply intakes will be divided into watersheds based on the topography of the land. The US EPA's Final Guidance document requires states to delineate the source water assessment area for surface water sources based on the watershed upstream of the suppliers' intakes up to the state's borders. For Delaware, the watersheds of the four streams used for water supply - the Brandywine Creek, the White Clay Creek, the Red Clay Creek, and the Christina River, have been delineated (Figure 3-1). However, since such a large portion of the watersheds for these surface water sources for Delaware are in Pennsylvania, the watershed delineations have been extended into Pennsylvania (Figure 3-2). It is the intention of Delaware to work closely through existing interstate relationships with the Commonwealth of Pennsylvania and Chester County, Pennsylvania personnel to implement elements involved in Delaware's source water assessment activities, including the delineation, potential contaminant inventory, and susceptibility determinations.

Fortunately, Delaware has been working with Pennsylvania agencies on a project initiated several years ago called the Christina Basin Water Quality Management Program. A regional management committee has been established consisting of representatives from Pennsylvania, Delaware, USEPA, and the Delaware River Basin Commission. The goal of this program is to address water quality problems through a regional, watershed approach. Ultimately, TMDLs, as required by Section 303 (d) of the Clean Water Act, will be established for these four streams in the Christina River Basin through the development of a watershed water quality model. The TMDLs will be limits established on discharges that will result in improving the quality of these surface water sources including those used for public drinking water. Through this program and the DNREC Whole Basin Team, the basic delineation of the entire watershed and the sub-basins for each of these streams has been completed and is maintained in a Geographic Information System (GIS) database at the WRA and at DNREC. A base map has been developed that shows the hydrology, road network, major/minor watersheds, and the state/county/municipal boundaries of the 565 square mile Christina River Basin. The data used to create the base map is from the following sources:

Roadway and Stream Network

Delaware Department of Transportation (DELDOT) (1995)
Pennsylvania Department of Transportation (PENNDOT) (1995)
Maryland Department of Transportation (MDOT) (1995)

State/County/Municipal Boundaries

DELDOT (1995)
PENNDOT (1995)
MDOT (1995)

Watershed Boundaries

Delaware - Water Resources Agency (1995)

Pennsylvania - Digitized from Chester County Planning Commission watershed maps by WRA (1995)

Maryland - Digitized from the USGS Newark West Quadrangle by WRA (1995)

Additionally, a variety of GIS data layers have been developed to characterize the watershed and provide a foundation for assessing these source waters. This data includes impervious cover, land use, zoning, topography, and soil classifications. This program and information will be utilized for surface water delineation in the Delaware SWAP and to coordinate interstate source water assessment and protection efforts within the Christina River Basin area.

Although the entire watershed area is important, and will be considered, for source water assessment, different land areas have varying impacts to surface water quality, usually related to relative distance from the stream. To delineate the areas of most value to surface water quality, the State will use an approach based on natural land characteristics and a buffer area of 200 feet. The methodology using floodplains, adjacent steep slopes, and soil characteristics used by the Water Resources Agency in developing the Water Resource Protection Area (WRPA) Program in New Castle County will be employed. The WRPAs are areas that were determined by the Delaware Geologic Survey, DNREC, and WRA to be most important to maintaining the quality and quantity of the sources of public drinking water - both ground and surface water supplies. These areas were delineated, mapped and adopted into the land development code for New Castle County in 1991 and were subsequently updated.

Delaware's surface water assessment areas are lands upstream of public water supply intakes that are in the 100-year floodplain, erosion prone slopes contiguous to and draining towards a floodplain, and areas that drain directly to public water supply reservoirs (Figure 3-3). The erosion prone slope areas consist of lands with soils that easily erode as mapped in the United States Department Agriculture Soil Survey for New Castle County. These areas, used for the WRPA program in New Castle County, will be utilized for delineating surface water source water assessment areas. In areas along tributaries where there are no delineated erosion-prone slope areas or 100 year floodplain on the New Castle County WRPA maps, a fixed distance of 200 feet from both edges of the stream will be established.

It should also be noted that the CTAC expressed concern that these surface water supply sources are also the receiving streams for hundreds of stormwater pipes. This maze of pipes provide a direct pathway for materials from roads and parking lots often miles away to get transported to the stream. The time, effort, and resources (personnel and money) needed to perform this mapping would be extensive but are not needed due to on-going work associated with the Piedmont Whole Basin Assessment. In particular, the Riparian Corridor Inventory project will be mapping every outfall (including stormwater discharge pipes) in the 300 miles of stream that are being walked. Therefore, the actual mapping of these structures will not be included in the delineation but will be considered as part of the identification of existing or potential sources of contamination.

Figure 3.3: Surface Water Source Delineation

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Please contact the Source Water Assessment and Protection

Program at Phone: (302) 739-4793 or Fax: (302) 739-2296

to request more information regarding this map.

Lastly, consideration will be given to some of the area downstream of the surface water intake for United Water Delaware at Stanton in the delineated assessment area. The stream used for source water, the White Clay Creek, is influenced by tidal action up to the intake. The contaminant inventory and vulnerability analysis may need to consider some portion of this

Figure 3-3 Surface Water Source Delineation

downstream area since contaminants could migrate upstream by tidal movement under certain flow conditions. A likely point downstream is the tidal control structure.

It is recommended that a similar stream buffer approach be used in Pennsylvania to target areas of higher importance to surface water quality. It should be noted that there will be gaps between the last downstream intake in Pennsylvania and the Delaware state line for the Brandywine Creek. Also, there are no public water system intakes in Pennsylvania on the Red Clay, White Clay, and the Christina River. Data from the Christina River Basin Management Program will be used for these assessments.

3.3 Surface Water Delineation Classification Hierarchy

A two-zone delineation classification approach will be used for source water assessment areas for all surface supply sources in Delaware. Each delineation level (1A, 1B, 2) will have an impact on the contaminant source inventory and the susceptibility determination to be described in the remaining chapters.

<u>CATEGORY</u>	<u>DELINEATED AREA</u>
Level 1A	100-year floodplains, and/or erosion-prone slopes;
Level 1B	Buffer areas 200 feet from each side of streams;
Level 2	All watershed areas above public drinking water supply intakes

See Appendix I, page I-3 for an example of this approach

3.4 Ground Water Supply Sources in Delaware

With the exception of the six (6) surface water intakes and the associated three systems, all of the rest of Delaware’s public water systems rely on ground water as the only source of public drinking water. Table 3-2 summarizes the approximately 1050 public supply wells in Delaware by county and by system type.

These public water supply wells have been drilled to a wide range of depths and draw water from various aquifers. For source water assessment purposes, a key factor need to delineate the source water area is whether a well is screened in an unconfined, semi-confined, or confined aquifer. Semi-confined and confined aquifers are generally, but not always, deeper than the unconfined aquifer and are separated from the overlying geologic formation by a layer of clay-like materials. These materials, termed confining layers, impede the vertical movement of water making confined aquifers less susceptible to contamination than unconfined aquifers. A listing of all current public water supply systems is provided in Appendix D. Additionally, the wells currently within the DNREC database for Kent, Sussex, and New Castle Counties are illustrated in Figures 3-4, 3-5, and 3-6, respectively. DNREC began locating all public supply wells using global positioning units (GPS). The Delaware SWAP will delineate the source waters of the following ground water-based public water supply systems:

- Community Public Water Systems (all GPS locations)
 - Publicly-owned purveyors
 - Investor-owned purveyors
 - Privately-owned purveyors

- Non-Transient Non-Community Public Water Systems (all GPS locations)
 - Schools/Day Care Centers
 - Offices/Factories

- Transient Non-Community Public Water Systems (GPS work began January 1999)
 - Restaurants and Stores
 - Hotels/Recreation Areas

Table 3-2 Summary of Public Water Supply Wells in Delaware (August 1999)

	CPWS Wells	NTNCPWS Wells	TPWS Wells	TOTAL Wells
Kent County	158	47	34	239
New Castle County	123	59	11	193
Sussex County	337	76	74	487
Total	618	182	119	919

3.5 Delineation of Source Water Assessment Areas for Ground Water Systems

As with surface water sources, the delineation of areas critical to protecting the quality and quantity of ground water sources has been underway for several years. In 1990, Delaware's Wellhead Protection Program was approved by the USEPA. This program established the methodology used in Delaware for delineating wellhead protection areas in the SWAP. The areas that will be delineated are divided into two categories: wellhead protection areas (the surface or sub-surface area surrounding a water well or wellfield through which contaminants are likely to move toward and reach such well or wellfield) and recharge-potential areas (areas where the soil and rock characteristics are favorable for water on the land surface to pass into an aquifer). A July 1994 draft report written by the Delaware DNREC entitled "*Wellhead Protection Area Delineation Manual*" provides additional detail on the following explanation of the State's approach to wellhead protection area delineation.

The DNREC policy for delineating wellhead protection areas provides the guidance for delineating the source water assessment areas around public water supply wells. This policy applies to all of the categories of wells listed previously. All public supply wells pumping at or less than 50,000 gallons per day (gpd) are assigned a circular wellhead area of 150 feet radius centered on the well. For most low pumping-rate wells the 150-foot radius would include the 5-year time of travel. Also more detailed wellhead protection area (WHPA) delineations at low pumpage are not credible due to their sensitivity to ground water flow direction. On the other hand, all public water system wells withdrawing more than 50,000 gpd would have a wellhead protection area delineated using various modeling techniques such as USEPA's WHPA Code and the United States Geological Survey's Modflow computer models.

Another important factor in delineating the wellhead protection area is the determination of whether the well is drawing water from a confined, unconfined, or semi-confined aquifer. Many aquifers in Delaware are considered semi-confined or confined - the aquifer has an impermeable layer over the top of it that significantly reduces the lateral flow of water from above. In most cases, a well screened in one of these aquifers may be considered confined by DNREC and the wellhead area would be a 150 foot radius circle centered to the well. The exception to this is where these otherwise confined aquifers subcrop (i.e. are in limited, but direct hydraulic connection with) beneath the unconfined aquifer. The aquifers that have subcrop areas include the Rancocas, Magothy, Potomac, Pocomoke, Ocean City, Manokin, Cheswold, and Frederica aquifer units of the Chesapeake Group

The unconfined aquifer covers the surface of much of Delaware and consists mainly of a sand layer of varied depth that generally thickens from 0 to 130 feet as you move from north to south. This aquifer is usually referred to as the Columbia or water table aquifer. Wells screened in an unconfined or semi-confined aquifer are treated the same when considering wellhead protection delineation. If the pumping rate is at or less than 50,000 gpd, the wellhead is again the 150-foot radius circle centered on the well. If the pumping rate exceeds 50,000gpd,

hydrogeologic modeling is required to determine the wellhead protection area. Water use reports required by the DNREC Allocation Program are used to determine the pumping rate for existing wells.

The Delaware DNREC is using ground water models to delineate wellhead protection areas for wells pumping greater than 50,000 gpd. As described in Delaware's Wellhead Protection Plan, DNREC uses a 5-year time of travel in the modeling, meaning that it would take 5 years for a drop of water to travel from the outer boundary of the resulting wellhead protection area boundary to the well. These models vary in complexity, detail, and cost and the one selected for a well will depend on the individual conditions. Factors necessary as inputs to the models include transmissivity, saturated thickness, effective porosity, ground water flow direction, and hydraulic gradient.

DNREC will also be using the ground water recharge-potential mapping project to provide additional information needed to better define the local conditions for input into the wellhead models. This project characterizes the ease with which recharging water (or other liquids) can move through the subsurface and into the unconfined aquifer. The Delaware Geological Survey (DGS) utilizes a "stack-unit" methodology to rank areas as either poor, fair, good, or excellent (Andres, 1991). This method is basically a detailed lithologic characterization of the top 25 feet of soils and sediments from which an inference can be made about the intrinsic permeability of the material. The recharge-potential mapping has been completed for all of New Castle County with most of Kent County and Sussex County completed as well (Figure 3-7). The remainder of the State will be completed during the year 2001.

In New Castle County, the wellhead protection areas to be used for the SWAP include delineations from a decade ago through work by the Delaware Geological Survey, DNREC, the Water Resources Agency, and New Castle County Council. Wellhead protection areas were delineated and adopted into law by New Castle County Council as part of the New Castle County WRPA program. The State DNREC included the wellhead protection program provisions of the NCC WRPA Program in its USEPA approved Wellhead Protection Program. The areas (Figure 3-6) are defined as:

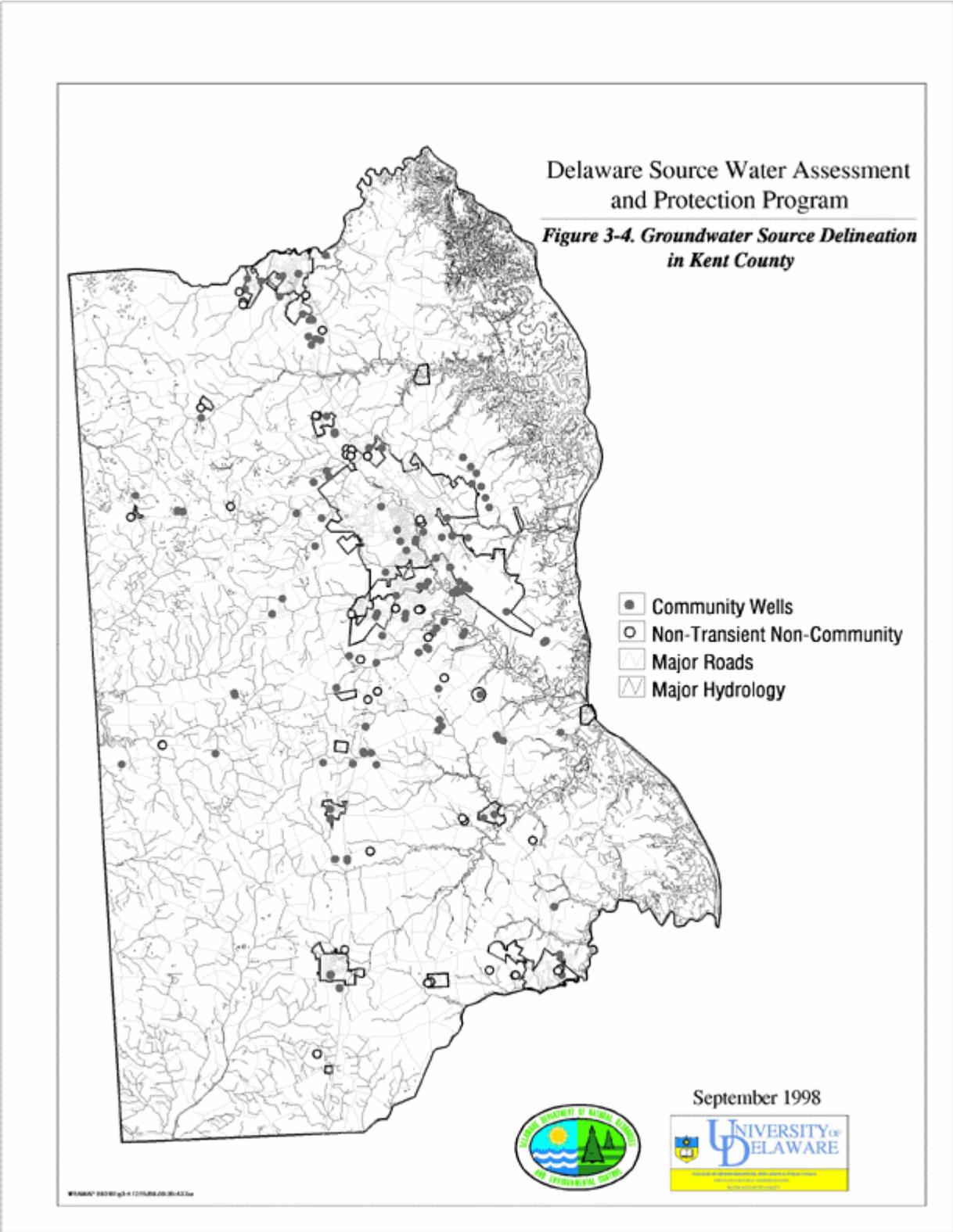


Figure 3-4 Ground-Water Source Delineation in Kent County

Delaware Source Water Assessment
and Protection Program

*Figure 3-5. Groundwater Source Delineation
in Sussex County*

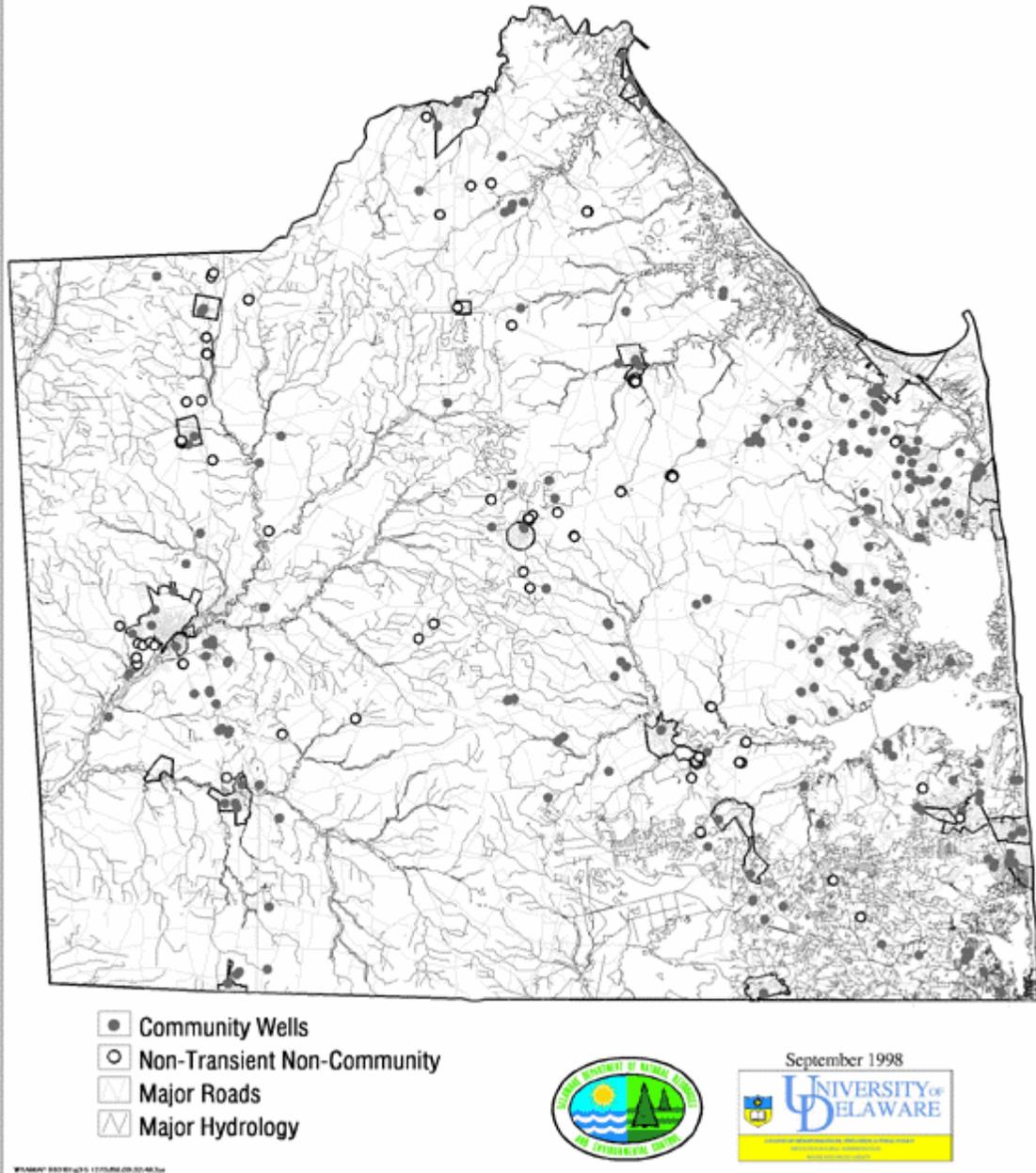


Figure 3-5 Ground-Water Source Delineation in Sussex County

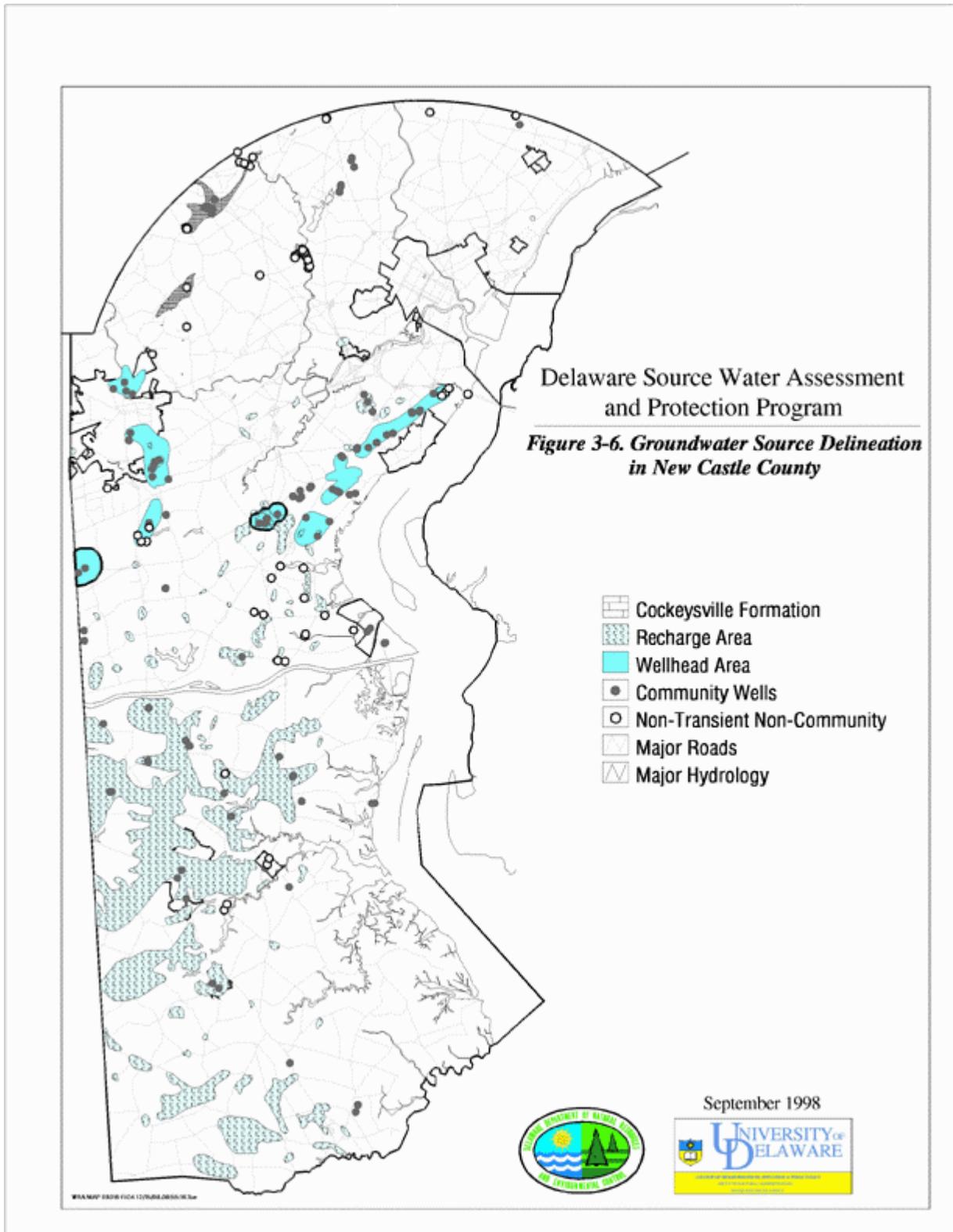


Figure 3-6 Ground-Water Source Delineation in New Castle County

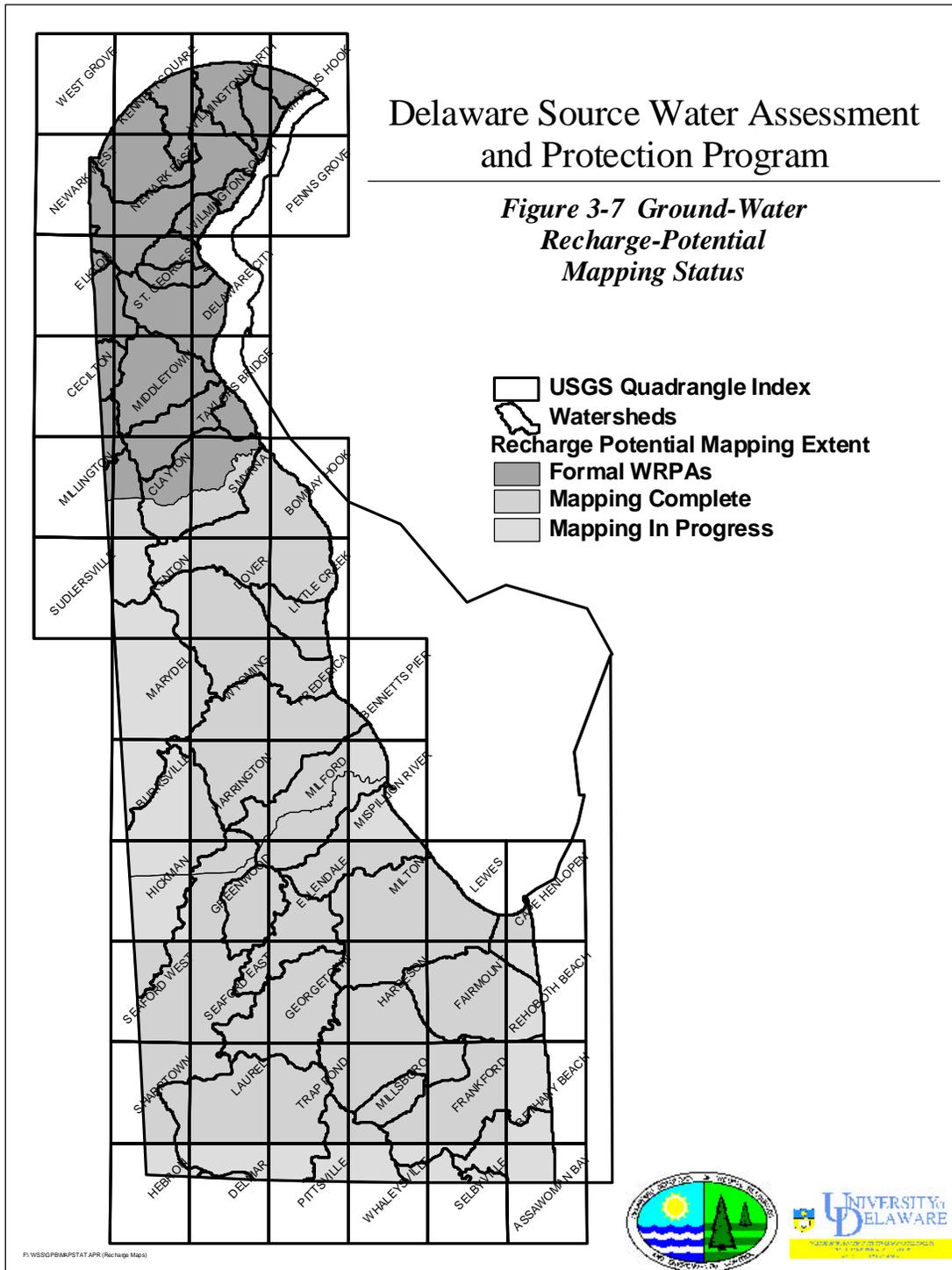


Figure 3-7 Ground-Water Recharge-Potential Mapping Status

- Class A Wellhead Areas - the area within a 300-foot radius circle around the community public supply well; this area can be reduced to a 150-foot radius when the well is located within a confined aquifer;
- Class B Wellhead Areas - the areas around the Glendale and Eastern States Wellfields community public water supplies which were delineated through the use of hydrogeologic mapping, analytical methods, and application of the USEPA modular semi-analytical models using a five year time of travel;
- Class C Wellhead Areas - the areas around community public water supply wellfields delineated by interpretation of geologic and hydrologic reports and maps, water-table maps, and professional judgement;
- Cockeysville Formation Areas - two relatively small environmentally sensitive areas in northern New Castle County comprised of fractured calcitic and dolomitic rock which support rapid ground water recharge and contain a number of important community public water supply wells.

These areas will be included in the Delaware SWAP for the delineation of community public water supply wells in New Castle County. They are consistent with the DNREC approach for the State with the exception of the wellhead area surrounding a well, which can be up to a 300 foot radius in New Castle County. Additionally, the Class C wellhead areas may be included in the State wellhead delineation work using ground water models. The State will also add the NTNC PWS wells and the TNCPWS wells to the mapped wellhead areas in New Castle County for inclusion in the SWAPP. A 150-foot radius wellhead area will be assigned to them unless the pumpage exceeds 50,000 gpd.

3.6 Conjunctive Delineations

USEPA has described the need to consider situations where surface water is closely tied to ground water. Delineations that consider this situation have been termed “conjunctive delineations.” This concept is particularly useful in instances where ground water is under the direct influence of surface water (GWUDI). At this time, no GWUDI conditions have been recognized in Delaware for any public water supply systems; hence, no conjunctive delineations are warranted. However, DNREC will take steps as part of its susceptibility determination to include surface water drainage areas as part of wellhead delineation areas and contaminant source identification.

CHAPTER 4: CONTAMINANT SOURCE INVENTORY

Once the source water assessment areas of ground and surface water supplies are delineated, the USEPA source water guidance manual requires each State to conduct an inventory of potential contaminant sources. The following chapter outlines the State of Delaware approach to identify the contaminants of concern and its plan to inventory contaminants and "significant" sources of contamination.

During the upcoming implementation phase of the Delaware SWAPP, the contaminant source inventory will identify the potential point and non-point sources of contamination within the source water areas of close to 1000 public wells and the 6 public surface water intakes in Delaware. Point source contaminants include site specific or discrete sources such as NPDES wastewater discharges, landfills, underground storage tanks, and hazardous waste storage facilities. Non-point source contaminants include diffuse sources such as stormwater runoff from agriculture, construction, industrial/commercial sites, and septic systems.

The State of Delaware proposes to inventory and map potential contaminant sources utilizing geographic information system (GIS) technology. The contaminant inventory will utilize the GIS developed by both DNREC and WRA. Staff at DNREC and WRA have already compiled some of this data through existing Delaware watershed and wellhead protection programs. The locations of existing or potential point sources of contamination will be mapped by latitude and longitude utilizing GPS technology whenever feasible. The non-point sources are identified by land use classification such as residential, industrial, commercial, and agricultural. Land uses will be identified using polygonal GIS mapping (Anderson et al., 1976). After the locations of the existing potential sources of contamination are entered into the GIS, attribute data will be developed which will allow easy access to parameters such as permit number and contaminant type in a "point and click" format.

4.1 Contaminants of Concern

The State of Delaware identifies "contaminants of concern" as regulated substances with primary and secondary maximum contaminant levels (MCLs) and unregulated substances as listed in the *State of Delaware Regulations Governing Public Drinking Water Systems* revised March 31, 1991, and parameters which will be regulated in the future such as *Cryptosporidium*, *Giardia lamblia*, Radon, and five haloacetic acids. Table 4-1 summarizes the Delaware contaminants of concern along with the MCLs (if assigned), 50% of the MCL for natural substances, and detection levels for synthetic substances. It should be noted that any change in MCL designation by either EPA or the Delaware DPH would be incorporated into the Delaware SWAPP and source water assessments.

Table 4-1 Contaminants of Concern

Substance (1)	Maximum Contaminant Level (MCL), mg/l	Natural or Synthetic Substance	Contaminant Category
<u>Primary MCL's</u>			
Arsenic (As)	0.05	Natural	Metals
Barium (Ba)	1	Natural	Metals
Cadmium (Cd)	0.01	Natural	Metals
Chromium (Cr)	0.05	Natural	Metals
Fluoride (F)	See regulations (1)	Natural	Other Inorganic
Lead (Pb)	0.05	Natural	Metals
Mercury (Hg)	0.002	Natural	Metals
Nitrate Nitrogen (NO3-N)	10	Natural	Nutrient
Selenium (Se)	0.01	Natural	Metals
Silver (Ag)	0.05	Natural	Metals
Turbidity	See regulations (1)	-	Other Inorganic
<u>Secondary MCL's</u>			
Chloride (Cl)	250	Natural	Other Inorganic
Color	15 color units	-	Other Inorganic
Copper (Cu)	1	Natural	Metals
Corrosivity	See regulations (1)	-	Other Inorganics
Foaming Agents	0.5	Synthetic	Other Organic
Iron (Fe)	0.3	Natural	Metals
Manganese (Mn)	0.05	Natural	Metals
Odor	3 odor number	-	-
pH	6.5 - 8.5	Natural	Other Inorganic
Sulfate (SO4)	250	Natural	Other Inorganic
Total Dissolved Solids (TDS)	500	Natural	Other Inorganic
Zinc (Zinc)	5	Natural	Metals
Sodium (Na)	See regulations (1)	Natural	Metals
<u>Microbiological Contaminants</u>			
Total Coliform Bacteria	See regulations (1)	-	Pathogen
Fecal Coliforms/E.coli	Free of bacteria	-	Pathogen
Cryptosporidium	EPA regulations pending	-	Pathogen
Giardia lamblia	See regulations (1)	-	Pathogen
<u>Radionuclides</u>			
Radium 226 and 228	5 pci/l	-	Other Inorganic
Gross Particle Activity	15 pci/l	-	Other Inorganic
Tritium	20,000 pci/l	-	Other Inorganic
Strontium	8 pci/l	-	Other Inorganic
Iodine 131	See regulations (1)	-	Other Inorganic
Cesium 134	See regulations (1)	-	Other Inorganic
Radon	EPA regulations pending	-	Other Inorganic
1) Substance regulated by the Delaware Division of Public Health in the State of Delaware Regulations Governing Public Drinking Water Systems, Revised March 31, 1991			
			- Denotes Combined Sources

Table 4-1 Contaminants of Concern (Continued)

Substance (1)	Maximum Contaminant Level (MCL), mg/l	Natural or Synthetic Substance	Contaminant Category
<u>Total Trihalomethanes (TTHM)</u>	0.1	Synthetic	Other Organic
<u>Volatile Organic Chemicals (VOCs)</u>			
benzene	0.005	Synthetic	Pet. Hydrocarbons
Carbon tetrachloride	0.005	Synthetic	Other Organic
Ortho-dichlorobenzene	0.6	Synthetic	Other Organic
Para-dichlorobenzene	0.075	Synthetic	Other Organic
1,2-dichloroethane	0.005	Synthetic	Other Organic
1,1-dichloroethene	0.007	Synthetic	Other Organic
Cis-1,2-dichloroethene	0.07	Synthetic	Other Organic
Trans-1,2-dichloroethene	0.1	Synthetic	Other Organic
dichloromethane	0.005	Synthetic	Other Organic
1,2-dichloropropane	0.005	Synthetic	Other Organic
ethylbenzene	0.7	Synthetic	Pet. Hydrocarbons
Monochlorobenzene	0.1	Synthetic	Other Organic
styrene	0.1	Synthetic	Other Organic
Tetrachloroethene	0.005	Synthetic	Other Organic
toluene	1	Synthetic	Pet. Hydrocarbons
1,2,4-trichlorobenzene	0.07	Synthetic	Other Organic
1,1,1-trichloroethane	0.2	Synthetic	Other Organic
1,1,2-trichloroethane	0.005	Synthetic	Other Organic
trichloroethene	0.005	Synthetic	Other Organic
vinyl chloride	0.002	Synthetic	Other Organic
total xylene	10	Synthetic	Pet. Hydrocarbons
<u>Unregulated Contaminants</u>			
bromobenzene		Synthetic	Other Organic
Bromochloromethane		Synthetic	Other Organic
Bromodichloromethane		Synthetic	Other Organic
bromoform		Synthetic	Other Organic
bromomethane		Synthetic	Other Organic
n-butylbenzene		Synthetic	Other Organic
sec-butylbenzene		Synthetic	Other Organic
Tert-butylbenzene		Synthetic	Other Organic
chloroethane		Synthetic	Other Organic
chloroform		Synthetic	Other Organic
chloromethane		Synthetic	Other Organic
2-chlorotoluene		Synthetic	Other Organic
4-chlorotoluene		Synthetic	Other Organic
Dibromochloromethane		Synthetic	Other Organic
1,2-dibromo-3-chloropropane		Synthetic	Other Organic
1) Substance regulated by the Delaware Division of Public Health in the State of Delaware Regulations Governing Public Drinking Water Systems, Revised March 31, 1991			

Table 4-1 Contaminants of Concern (Continued)

Substance (1)	Maximum Contaminant Level (MCL), mg/l	Natural or Synthetic Substance	Contaminant Category
<u>Unregulated Contaminants (con't.)</u>			
1,2-dibromoethane		Synthetic	Other Organic
Dibromomethane		Synthetic	Other Organic
1,3-dichlorobenzene		Synthetic	Other Organic
Dichlorodifluoromethane		Synthetic	Other Organic
1,1-dichloroethane		Synthetic	Other Organic
1,2-dichloropropane		Synthetic	Other Organic
2,2-dichloropropane		Synthetic	Other Organic
1,1-dichloropropene		Synthetic	Other Organic
Cis-1,3-dichloropropene		Synthetic	Other Organic
Trans-1,3dichloropropene		Synthetic	Other Organic
Hexachlorobutadiene		Synthetic	Other Organic
Isopropylbenzene		Synthetic	Other Organic
4-isopropyltolulene		Synthetic	Other Organic
naphthalene		Synthetic	Other Organic
Propylbenzene		Synthetic	Other Organic
1,1,1,2-tetrachloroethane		Synthetic	Other Organic
1,1,1,2-tetrachloroethane		Synthetic	Other Organic
1,2,3-trichlorobenzene		Synthetic	Other Organic
Trichloropropane		Synthetic	Other Organic
1,2,4-trimethylbenzene		Synthetic	Other Organic
1,3,5-trimethylbenzene		Synthetic	Other Organic
o-xylene		Synthetic	Pet. Hydrocarbons
m-xylene		Synthetic	Pet. Hydrocarbons
p-xylene		Synthetic	Pet. Hydrocarbons
<u>Pesticides, PCBs and Other Organics</u>			
Alachlor	0.002	Synthetic	Pesticide
Aldicarb	0.003	Synthetic	Pesticide
Aldicarb Sulfone	0.003	Synthetic	Pesticide
Aldicarb Sulfoxide	0.003	Synthetic	Pesticide
Atrazine	0.003	Synthetic	Pesticide
Benzo(a)pyrene	0.0002	Synthetic	Other Organic
Carbofuran	0.04	Synthetic	Pesticide
Chlorodane	0.002	Synthetic	Pesticide
Dalapon	0.2	Synthetic	Pesticide
Di(2-ethylhexyl) adipate	0.4	Synthetic	Other Organic
Di(2-ethylhexyl)phthalate	0.006	Synthetic	Other Organic
Dibromochloropropane	0.0002	Synthetic	Pesticide
Dinoseb	0.007	Synthetic	Pesticide
Diquat	0.02	Synthetic	Pesticide
2,4-D	0.07	Synthetic	Pesticide
1) Substance regulated by the Delaware Division of Public Health in the State of Delaware Regulations Governing Public Drinking Water Systems, Revised March 31, 1991			

Table 4-1 Contaminants of Concern (Continued)

Substance (1)	Maximum Contaminant Level (MCL), mg/l	Natural or Synthetic Substance	Contaminant Category
<u>Pesticides, PCBs and Other Organics</u>			
Endothall	0.1	Synthetic	Pesticide
Endrin	0.002	Synthetic	Pesticide
Ethylenedibromide (EDB)	0.00005	Synthetic	Pesticide
Glyphosphate	0.7	Synthetic	Pesticide
Heptachlor	0.0004	Synthetic	Pesticide
Hepachlor epoxide	0.0002	Synthetic	Pesticide
Hexachlorobenzene	0.001	Synthetic	Pesticide
Hexachlorocyclopentadiene	0.05	Synthetic	Pesticide
Lindane	0.0002	Synthetic	Pesticide
Methoxychlor	0.04	Synthetic	Pesticide
Oxamyl (Vydate)	0.2	Synthetic	Pesticide
Pentachlorophenol	0.001	Synthetic	Pesticide
Picloram	0.5	Synthetic	Pesticide
Polychlorinated biphenyls (PCBs)	0.0005	Synthetic	PCB
Simazine	0.004	Synthetic	Pesticide
2,3,7,8-TCDD (Dioxin)	3x10 ⁻⁸	Synthetic	Pesticide
Toxaphene	0.003	Synthetic	Pesticide
2,4,5-TP (Silvex)	0.05	Synthetic	Pesticide
1) Substance regulated by the Delaware Division of Public Health in the State of Delaware Regulations Governing Public Drinking Water Systems, Revised March 31, 1991			

The contaminants of concern and their possible presence in the source waters of surface and ground water supplies will be used to conduct the source water susceptibility analysis outlined in Chapter 5. The Delaware Whole Basin Program has classified the contaminants of concern into the following major categories:

- Nutrients (such as Nitrogen and Phosphorus)
- Pathogens (such as Bacteria, Cryptosporidium and Giardia)
- Petroleum Hydrocarbons (such as gasoline and heating oil)
- Pesticides (such as Endrin and Lindane)
- Polychlorinated biphenyls (PCBs)
- Other Organics (such as benzene and chloroform)
- Metals (such as Lead, Copper, Zinc)
- Other Inorganics (such as Chlorides and Sodium)
- Turbidity (such as Total Suspended Sediment and Total Dissolved Solids)

4.2 Existing Data

The State of Delaware proposes to inventory and map the potential sources of contaminants utilizing a GIS. Delaware DNREC and WRA staff are currently developing GIS

contaminant source inventory databases for the Delaware Whole Basin Program, the New Castle County Water Resource Protection Area Program, and the interstate Christina Basin Water Quality Management Strategy. The SWAP contaminant source inventory will utilize data compiled from the following existing programs in Delaware:

- Whole Basin Program (Piedmont, Delaware Bay and Estuary, Chesapeake, and Inland Bays/Atlantic Ocean Basins)
- Christina Basin Water Quality Management Strategy (DE, PA, MD)
- New Castle County Water Resource Protection Area Program
- Wastewater Spray Irrigation Program
- Sludge Application Program
- On-site Septic Program
- Underground Injection Control Program
- Solid Waste Management Program
- Hazardous Waste Management Program
- Superfund and Hazardous Substance Control Program
- Underground Storage Tank Program
- Non-point Source Program
- Wellhead Protection Program
- Pesticide Program

4.3 Contaminant Sources Affecting Surface Water Supplies

The contaminant source inventory for surface water supplies will utilize GIS data compiled primarily from the Piedmont Whole Basin Program and the Christina River Basin Water Quality Management Strategy. The only public surface water intakes in Delaware are in the Christina River Basin, which is an interstate watershed. Delaware, Pennsylvania, and Maryland are situated in the source waters (watershed) upstream from these intakes. Many of the potential contaminant sources in the Delaware and Pennsylvania portions of the Christina River Basin have been delineated by the Whole Basin Program and the Christina River Basin Water Quality Management Strategy. This data was compiled as input to the receiving stream and watershed models of the Christina River Basin that will be used for TMDL analysis which is due by the year 2000. Interstate coordination between the states of Delaware and Pennsylvania will occur through the existing interstate Christina River Basin Water Quality Management Committee. Figure 4-1 contains an example of a proposed GIS base map for the contaminant source inventory for surface water supplies in the Christina River Basin of Delaware, Pennsylvania, and Maryland.

Delaware Source Water Assessment and Protection Program

Figure 4.1 Contaminant Source Inventory in the Christina River Basin

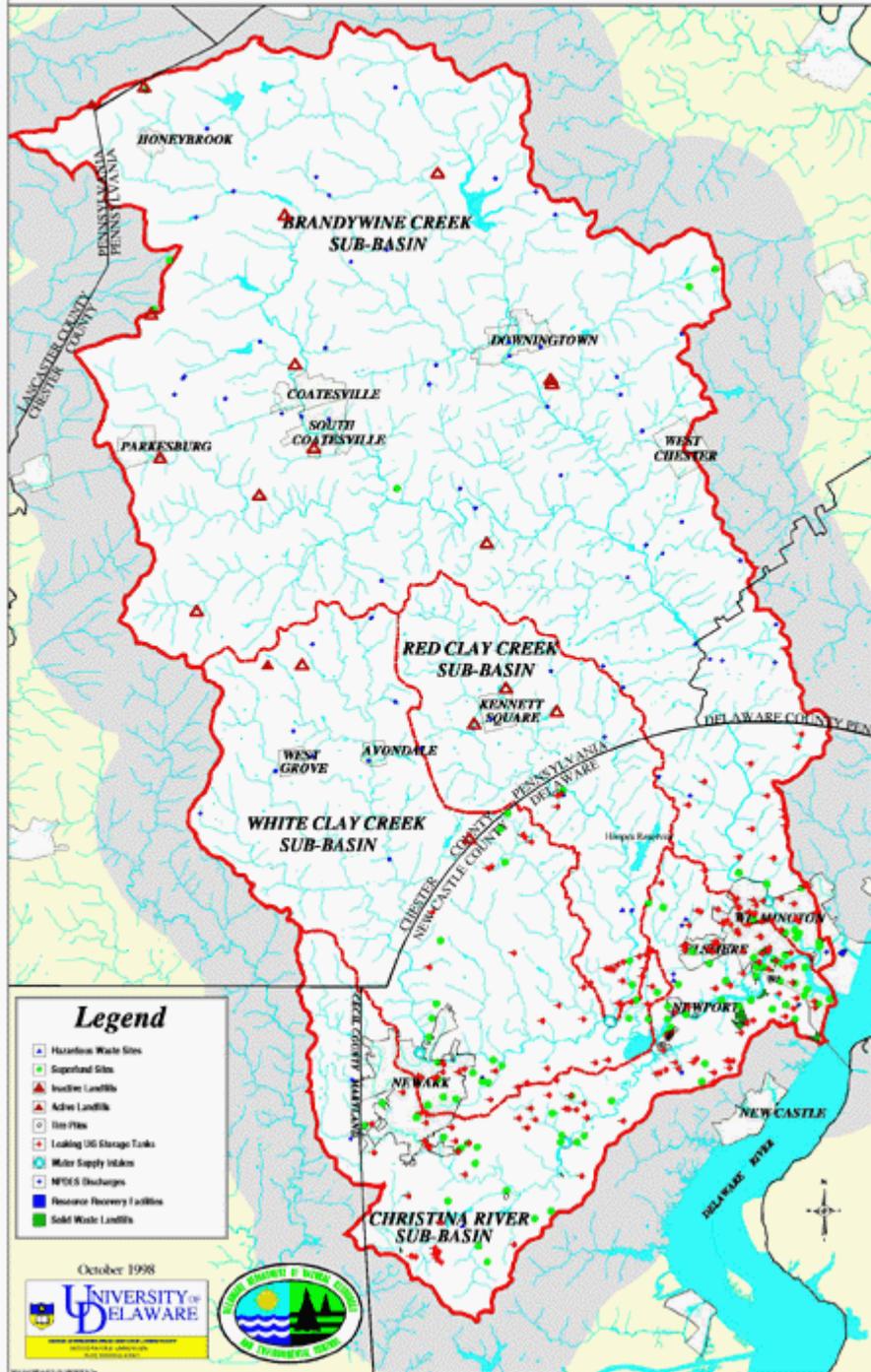


Figure 4-1 Contaminant Source Inventory in the Christina River Basin

The State of Delaware plans to conduct the contaminant source inventory for surface water supplies in accordance with the following plan:

1. *Base Map* - Prepare a GIS base map delineating the five surface water intakes in Delaware along with the source water boundaries of the Brandywine Creek, Red Clay Creek, White Clay Creek, and Christina River watersheds which are upstream from the intakes. The contaminant source inventory should also consider the tidal areas of the White Clay Creek watershed downstream from the United Water Delaware Stanton intake, since this intake is influenced by tidal activity.
2. *Potential Point Sources of Contamination* - Compile a database of the potential point source contaminants within the source water of the Christina Basin. Appendices E and F provide examples of existing point source contaminant inventories that were compiled by the WRA for the Christina River Basin Water Quality Management Strategy. The database will include the following parameters:
 - Permit No.
 - Owner
 - Watershed
 - State, County
 - Latitude/Longitude
 - Reissue Date
 - Flow Limit (mgd)
 - Description/Parameters

Point source data compiled for the Piedmont Basin under the Delaware Whole Basin Management Program will also be included in the inventory.

3. *Potential Nonpoint Sources of Contamination* - Compile a database and map the nonpoint sources of contaminants within the surface water source area of the Christina River Basin. The nonpoint source contaminant inventory will include polygonal GIS land use mapping. Appendix G contains a land use classification table for the Christina River Basin, which is the source water area for the public surface water intakes in Delaware.

4.4 Contaminant Sources Affecting Ground Water Supplies

Data collected for the Delaware Whole Basin Program will form the primary basis for the contaminant source inventory in the ground water source areas. This information is stored in a “site index database” developed by the basin teams to allow for GIS presentation of point sources of contamination. (The site index database is further described in Section 5.2). Scientists from the Whole Basin teams are developing a data base that identifies the locations of potential contaminant sources. This data will also be supplemented with information collected by the WRA in the Newark and Hockessin water resource protection areas. The data base will include

information from the USEPA Retired Senior Volunteer Program (RSVP) for the New Castle wellfield. The Delaware SWAP proposes to inventory the sources of contaminants in ground water areas according to the following methodology:

1. *Base Map* - Compile a series of 4 GIS base maps, one for each Whole Basin, which will include the whole basin boundaries, public community wells, transient and non-transient non community wells, wellhead areas, and recharge areas. These four maps will provide the foundation for an inventory of contaminant sources applicable to ground water supplies. Figure 4-2 delineates the drainage basins within Delaware, which include the Piedmont, Delaware Bay, Chesapeake Bay, and Estuary and Inland Bays/Atlantic Ocean. This Whole Basin map will provide a framework for the contaminant inventory in ground-water areas.
2. *Potential Point Sources of Contamination* - Inventory the point sources and overlay this information over the source water areas. Contaminants within the source waters of public ground-water supplies will be considered for the contaminant source susceptibility determination outlined in Chapter 5.
3. *Potential Non-point Sources of Contamination* - Inventory and map the potential non-point sources of contaminants within the source waters of ground-water supplies. Figure 4-3 contains a typical draft potential contaminant source inventory for the City of Seaford in Sussex County, Delaware. Figure 4-4 portrays a typical draft potential contaminant source inventory for the source water areas of the Newark Laird Tract and South wellfields. The Delaware SWAP will prepare similar GIS maps for the other CPWS's, the TNCPWS's, and the NTNCPWS's in New Castle, Kent, and Sussex Counties.

4.5 Significant Sources of Contamination

The USEPA source water guidance requires each State to define "significant" sources of contamination. The Delaware SWAP submittal defines "significant" existing and potential sources of contamination to include those sites identified within the source water areas of ground and surface water supplies. The State of Delaware Whole Basin Program has defined an approach for determining significant sources of contamination based on several factors such as toxicity, population, location, hydrogeologic sensitivity, and number and /or sites of contaminated sources. Contaminant sources will be characterized as chronic or acute. For example, a leaking underground storage tank is likely to be a chronic (long-term) source of contamination, whereas, a chemical spill may be an acute (short-term) source of contamination. The definition of "significant" also takes into account the various classes of contaminants such as bacteria, organics, inorganics, and metals. The potential sources of contaminants, which will be considered "significant" in Delaware, include:

Delaware Source Water Assessment and Protection Program

Figure 4-2. Whole Basins within the State of Delaware

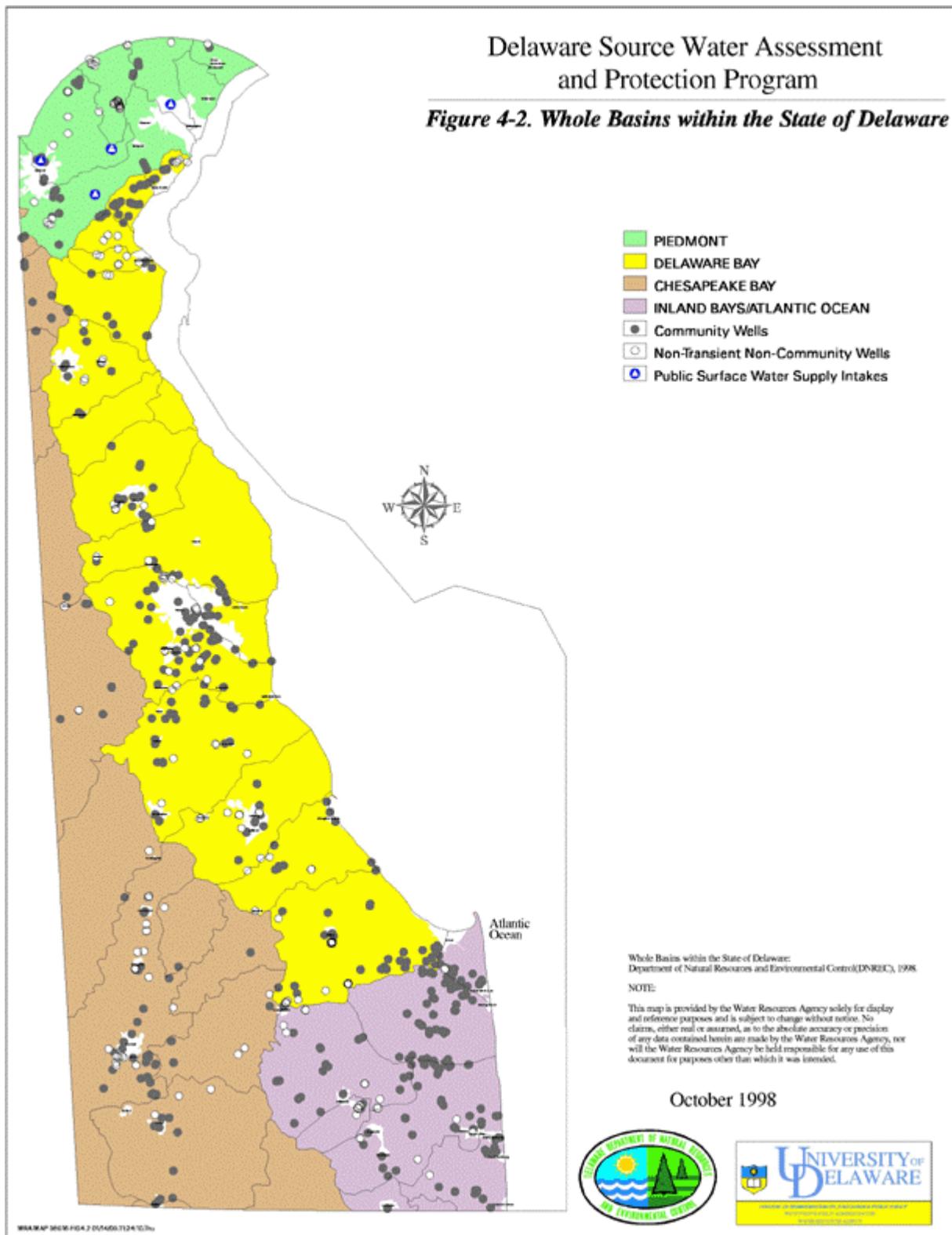


Figure 4-2 Whole Basins within the State of Delaware

Delaware Source Water Assessment and Protection Program

Figure 4-4. Contaminant Source Inventory in the City of Newark

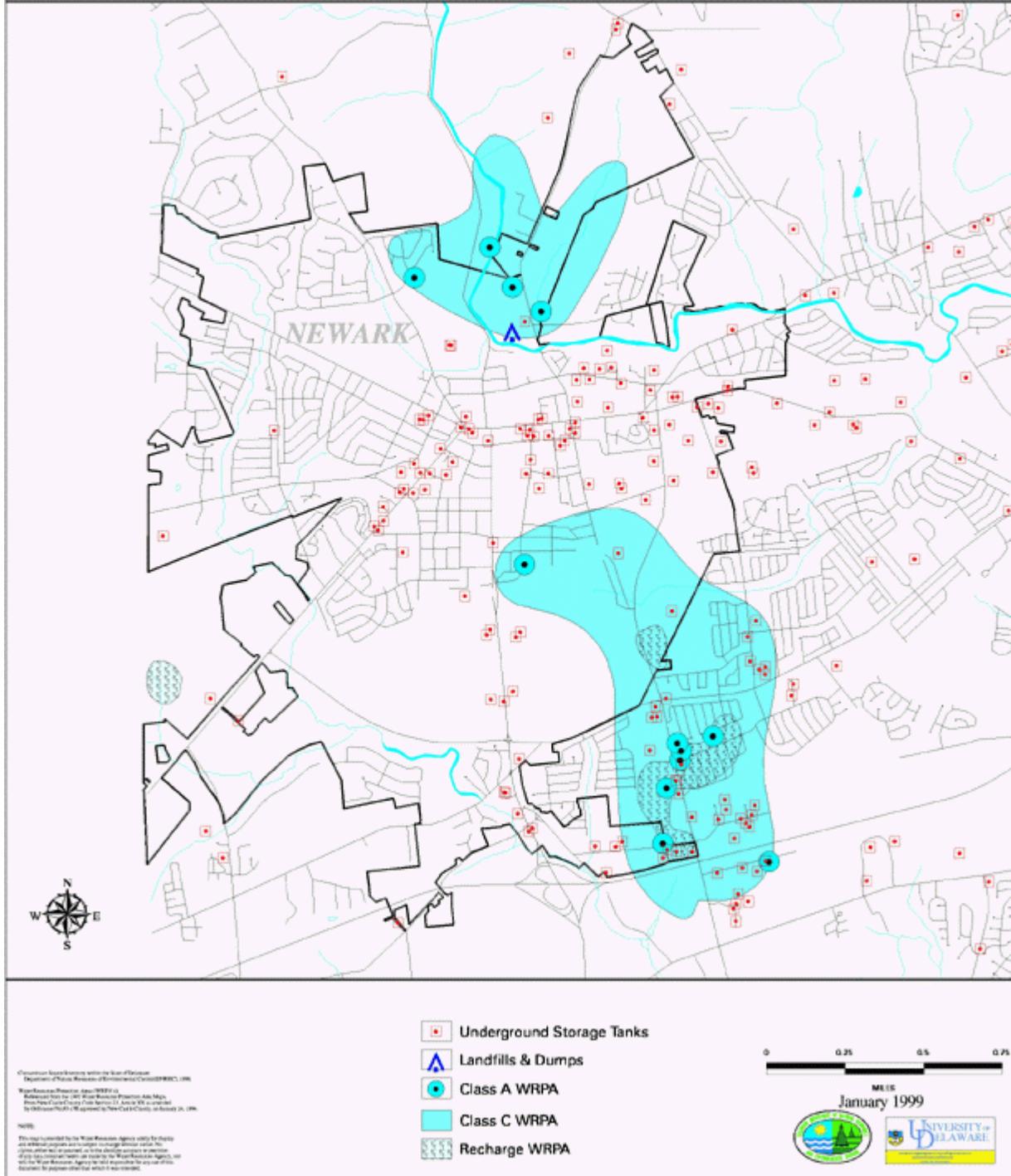


Figure 4-4 Contaminant Source Inventory in the City of Newark

Point (Discrete) Sources

- Hazardous Substance Sites (Superfund and SIRB)
- Underground Storage Tanks/Leaking Underground Storage Tanks
- Landfills/Dumps
- NPDES Wastewater Discharges
- Tire Piles
- Hazardous Waste Generators
- Toxic Release Inventory (TRI) Sites
- Salvage Yards
- Pesticides Loading and Mixing Areas
- Large On-Site Septic Systems
- Waste Water Spray Irrigation
- Waste Sludge Application
- Confined Animal Feed Operations (CAFOs)
- Combined Sewer Overflows
- Dredge Spoils
- Domestic Septic Systems
- SARA Title III Sites

Non-point (Land Use) Sources

- Residential
- Commercial
- Vehicle Operations
- Junk/Salvage Yards
- Industrial
- Transportation
- Highways/Parking Lots
- Railroads
- Airports
- Sewer Lines
- Utilities
- Combined Urban
- Recreation
- Cropland
- Confined Animal Feed Operations (CAFOs)
- Farmsteads

These “significant “ potential sources of contamination will be used to determine the susceptibility of source water areas in the approach outlined in Chapter 5 of this document.

4.6 Naturally Occurring Contaminants

There are several naturally occurring contaminants which will be identified as part of the assessments of public water supplies. These include iron, chloride, sodium, radon, radium, manganese, sulfate, and others. These will be identified as part of the susceptibility determination. However, these naturally occurring contaminants would be identified as naturally occurring and referred to the system or other appropriate program. As an example, a well may be deemed susceptible to salt-water intrusion (sodium and chloride contamination potential) because of its construction and proximity to a salt-water body, and actual water quality data.. There are currently both active monitoring in critical areas and are active allocation program to address problems.

CHAPTER 5: SUSCEPTIBILITY DETERMINATION

The key part of a source water assessment is the determination of the likelihood that a particular public water supply system will capture contaminants at concentrations of concern. This analysis – termed susceptibility determination - combines information obtained from - the delineation of source water protection areas (chapter 3), the contaminant source inventory (chapter 4), and the vulnerability determination (chapter 5).

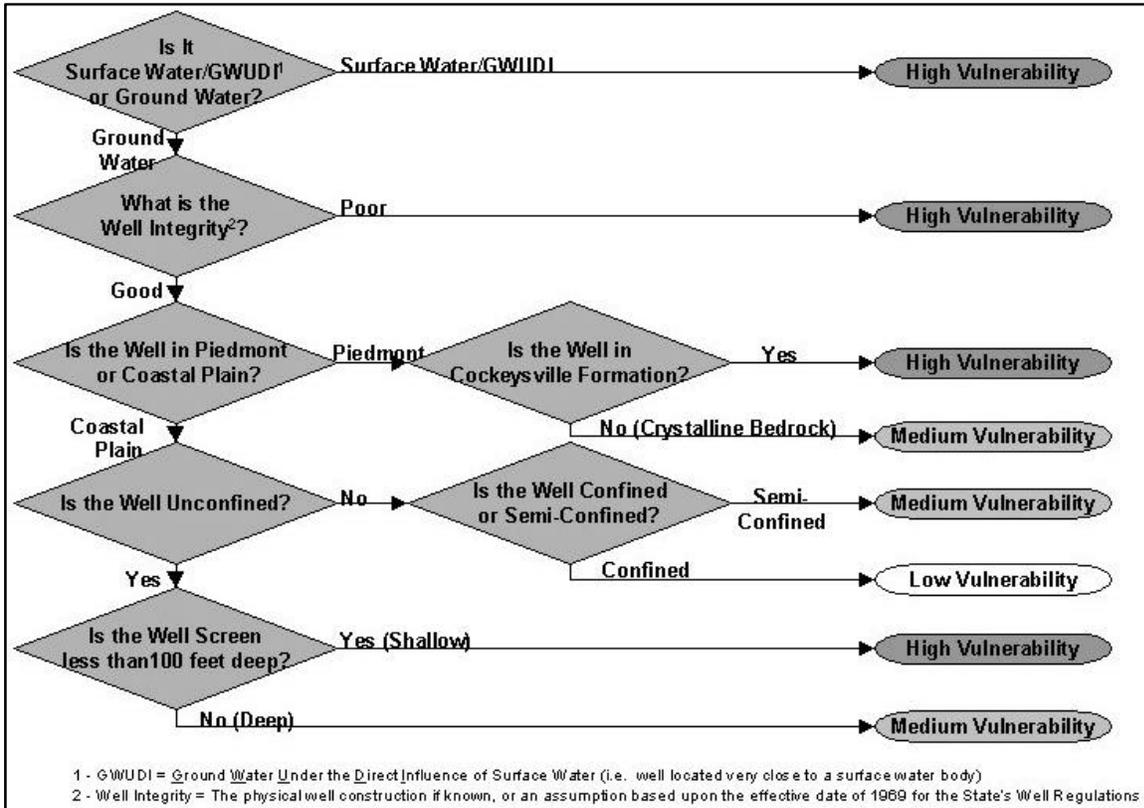
Delaware’s approach to conducting susceptibility determinations is a stepwise process which first defines the “vulnerability” of a public water system and second describes the potential sources of contamination (discrete or point sources, non-point or land use sources) found within the source water assessment area. It is important that the terms “susceptibility” and “vulnerability” as used in the Delaware SWAP be understood. Vulnerability is an intrinsic property of a well or intake and the source water assessment area. Vulnerability is defined as *“the relative ease with which contaminants, if released into a source water area, could move and enter into a public water supply well or intake at concentrations of concerns.”* The susceptibility determination combines the vulnerability of the system with the potential for a well or intake to be impacted by the both point and non-point contaminant sources found within the source water assessment area. Susceptibility is defined as *“the potential for a public water system to draw water contaminated by inventoried sources at concentrations of concern.”*

The susceptibility determination is intended to specifically address the source water assessment areas of public drinking water – both surface and ground water. However, treatment of public water is also very important in presenting the public with the full picture of the safety of their drinking water after it has entered the water distribution system. Appendix D includes a listing of all public water systems including those that have treatment and the type of treatment used. Although treatment is not a factor in the susceptibility determination, it will nonetheless be included as part of source water assessment package provided to the public such as in the consumer confidence reports.

5.1 Vulnerability Determination

The vulnerability of a system is the relative ease with which contaminants, if released into a source water area, could move and enter a public water supply well or surface water intake at concentrations of concern. Systems are ranked as having high, medium, or low vulnerability according to the process described in this section. The determination of system vulnerability is conducted through a series of questions about the type of system (surface or ground water) intake (well or surface), hydrogeologic setting, and well depth. Figure 5-1 provides a schematic for the vulnerability determination process described below:

Figure 5-1 Vulnerability Determination Process



Does the system derive water from surface water, ground water, or ground water under the direct influence of surface water (GWUDI)?

If the system derives water from surface water or is a well which has been determined to be “ground water under the direct influence of surface water” then the system is regarded as having high vulnerability. This is because surface water systems are open to surface contamination, have relatively fast travel time, and offer fewer mechanisms to naturally attenuate contaminants.

If the water supply system derives water from ground water, then additional analysis is needed (next step).

- Is the well integrity good or poor?

Well integrity refers to the condition of the upper terminus of the well that can be visually inspected. Indications of poor integrity would be caving around the wellhead, breaches in the well housing, or any defect that would allow contaminants very near the wellhead to enter the well annulus.

If the well is determined to have poor integrity, i.e. the construction of the well could allow

contaminants to enter the well directly, then the well is regarded as having high vulnerability. Well integrity will primarily be determined from visual inspection of the well or wells installed prior to July 14, 1969 (the date that Delaware initially adopted its water well regulations). Wells constructed before July 14, 1969 will be regarded as having good integrity if visual inspection has confirmed that indicators of poor well integrity, such as improper grouting, are not evident. Wells that have been installed since July 14, 1969 are regarded as having good integrity (unless visual inspection indicates otherwise). DNREC will coordinate visual inspections of the wells with other agencies. In particular, the DPH and the Delaware Rural Water Association (DRWA) during their routine visits to the water supply facilities.

If the well is determined to have good integrity, then additional analysis is needed (next step).

- Is the well located in the Piedmont or Coastal Plain Physiographic Province?

If the well is located within the Piedmont Physiographic Province of Delaware and is completed in the Cocksylville Formation as mapped by the DGS. (Bulletin 19) and delineated on the New Castle County Water Resources Protection Area maps (WRPA, 1993) then the well has high vulnerability. This is because the Cocksylville Formation's karst geology allows water to flow through sinkholes and dissolution channels, and fractures quickly. If the well is located within the Piedmont Physiographic Province, and is completed in a formation other than the Cocksylville Formation, then it has medium vulnerability.

Wells in the Coastal Plain Physiographic Province require additional analysis (next step).

- Is the well screen in an unconfined (water table) aquifer?

If the supply well is not screened in an unconfined aquifer, then it is either in a confined aquifer or a semi – confined aquifer. If a well is determined to be screened in a confined aquifer then it is regarded as having low vulnerability. This is because the well screen is deeper and protected by overlying confining layers (such as silt or clay) which restrict the vertical flow of water and possible contaminants. If the well is screened in a semi-confined aquifer, then it has medium vulnerability. This is because the well screen is partially protected, but water flow through or around the confining layer may still be significant.

As part of the delineation process DNREC will determine the status of individual wells (i.e. unconfined, semi-confined, confined). These determinations will utilize resources including the Delaware Geological Survey, driller logs, and best professional judgment.

If the well is determined to be in an unconfined (water table) aquifer, then this final additional analysis is necessary (last step).

- Is the top of the well screen 100 feet or greater below the ground surface in an unconfined aquifer?

If the top of the well screen is less than 100 feet below ground surface, then the well is regarded

as having high vulnerability. If the top of the well screen is at or greater than 100 feet below ground surface, the well has a medium vulnerability. This is because of indications from studies (Andres, August 1991; Hamilton, et al, 1993) which indicate that the amount of nitrate contamination and pesticide contaminants generally decrease with depth. This step completes the vulnerability determination.

In summary, based on this process the following vulnerability determinations are possible:

High Vulnerability determination would be made for:

1. All surface water systems;
2. All wells with poor well integrity;
3. All wells within the Cockeyville Formation outcrop or drainage areas;
4. All wells in the unconfined aquifer where the top of the well screen is less than 100 feet below ground surface;

Medium Vulnerability determinations would be made for

1. All wells screened in formations other than the Cockeyville Formation but in the Piedmont Physiographic Province;
2. All wells screened in semi-confined aquifers;
3. All wells screened in the unconfined aquifer where the top of the well screen is greater than or equal to 100 feet below ground surface.

Low Vulnerability determinations would be made for

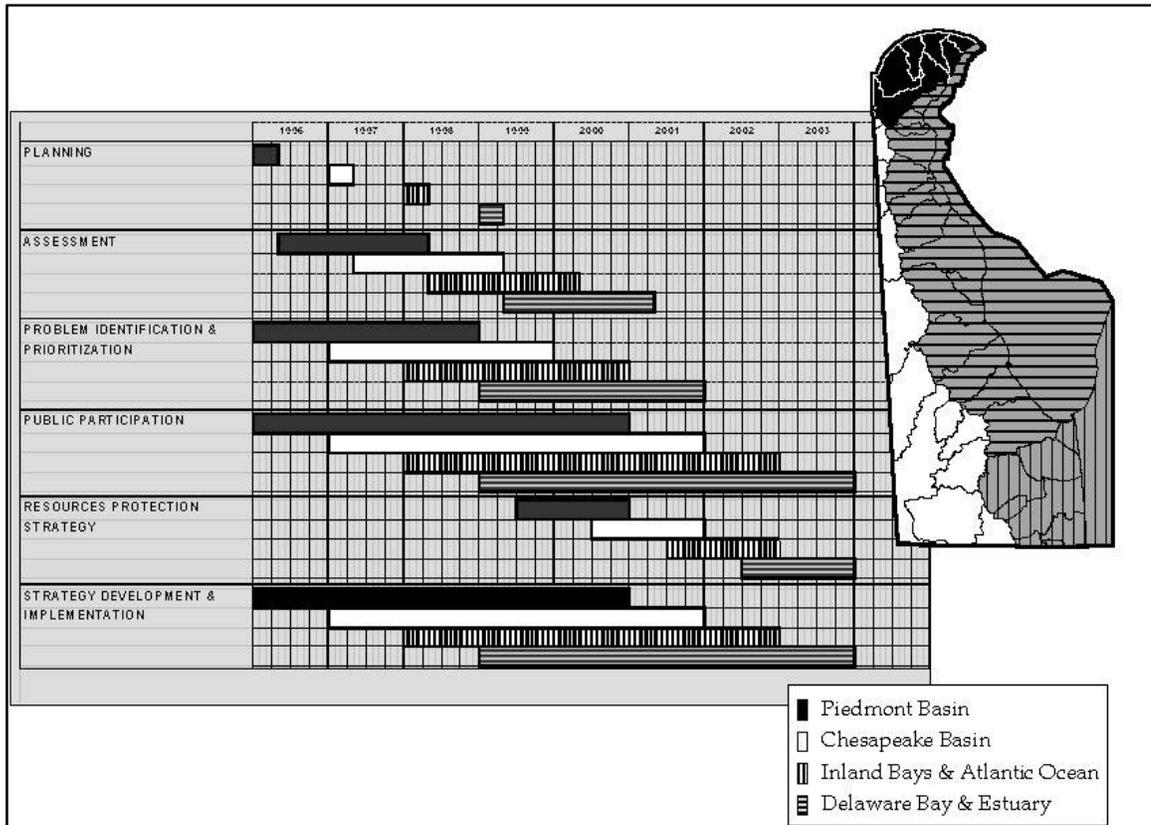
1. All wells screened in confined aquifers.

DNREC and the CTAC recognize that there will be intermediate areas in the prescribed vulnerability determinations approval outlined here. Consequently, there will be an allowance for professional judgement. Further, Section 5.6 notes that the final draft assessments will be reviewed by others such as the system owner, DPH, and DGS prior to being finalized.

5.2 Determining the Potential of Contamination from Discrete Sources

Potential sources of contamination for both surface water and ground water public water systems has been described in Chapter 4. The whole basin assessments for all of the Delaware basins is the source of information for locating discrete potential sources of contaminants. The four basins – Piedmont, Delaware Bay and Estuary, Chesapeake Bay, and Inland Bays/Atlantic Ocean – are being assessed by DNREC. Figure 5-2 summarizes the schedule for completion of each assessment. Discrete or point sources in the Pennsylvania portion of the Christina River Basin will be obtained from the Christina River Basin Water Quality Management Strategy Report (1998) and supplemental work from that effort and in coordination with the Commonwealth of Pennsylvania.

Figure 5-2 Whole Basin Assessment Timeline



The site index database was developed as part of the DNREC Whole Basin assessments. This database was developed to inventory all of the known or potential point sources of contamination within a basin. This approach was developed for the Chesapeake Bay Basin assessment and is being duplicated in each of the other basins. The database includes basic site identification information (name, ID number, latitude and longitude, basin), site type (e.g. leaking underground storage tank, pesticide mixing/loading sites), and program contact. The database includes monitoring activity status and contaminant potential ratings by media (soil, sediment, surface water, ground water, and air) and contaminant class (nutrients, bacteria, petroleum, organics, pesticides, PCBs, metals, and inorganics) for each site. Although this database does not provide all of the detailed information found within program files, it does provide sufficient information to conduct source water assessments. In addition, the site index database is linked with the DNREC-GIS for querying and plotting of information. Figure 5-3 illustrates some of the information available from the site index database as well as the contaminant ranking. Table 5-1 defines the rankings used in the database.

Figure 5-3 Discrete Source Contaminant Potential Rating

SiteType:	Type of Site (e.g. SIRB, LUST, solid waste, etc.)					
Site Name:	Joe's Garage					
SiteID:	N0001795	MapID:	LU15			
Status:	Active					
County:	Sussex	Basin:	Chesapeake	Watershed:	Nanticoke	
Location:	X: 181,840.7	Y: 72,418.7	Location in DE State Plane Coordinates NAD 83 metric			
Comments:	Active Remediation (Pump & Treat Treatment system in place)					
Contaminant Source Potential Rating						
	SW	GW	Soil	Sed	Air	Comment
Nutrients	0	0	0	0	0	
Bacteria	0	0	0	0	0	
Petroleum	0	6	6	0	0	BTEX, GRO, DRO
Organics	0	0	0	0	0	
Pesticides	0	0	0	0	0	
PCBs	0	0	0	0	0	
Metals	0	0	5	0	0	Lead
Inorganics	0	0	0	0	0	
<i>Rating Key: 0-Not Applicable, 1-Present onsite-no releases, 2-Potentially present onsite-no monitoring, 3-Present onsite-no monitoring, 4-Permitted Discharge, 5-Onsite contamination, 6-Offsite contamination</i>						
<i>Media Key: SW-surface water, GW-ground water, Soil-soil, Sed-sediment,</i>						

The relative threat posed by specific point sources (Negligible, Low, Medium, and High) is based on the site index database score as determined by the various program's scientists. DNREC will assign these individual potential contaminant ratings for each of the types of discrete sources found within the source water area.

The source water assessments will include a description of the overall threat based on the number of existing and potential point sources of contamination and their rating. Due to the complexities involving distance, flow rate, contaminant attenuation and dilution processes, some level of professional judgement is necessary to describe the overall level of susceptibility where multiple discrete sources are found within the source water area. Table 5-2 provides a general indication of the types of contaminants that are possible from each of the types of discrete sources.

Table 5-1 Source Water Contaminant-Potential Rating Classification

Site Index Rating	Site Index Rating Definition		Source Water Contaminant Potential	Contaminant Potential Rating Definition
0	Not Applicable	Substance not present in sufficient quantities onsite to cause contamination at a level of concern in this media in the event of a	Negligible (N)	Contaminants not present in sufficient quantities in Source Water Area to cause concern.
1	Present - No or Minimal Releases	Substance present in significant quantities onsite but monitoring data indicates no or minimal releases to this media at levels of concern.	Low (L)	Contaminant(s) present in significant quantities in Source Water Area but monitoring data indicates no or minimal releases
2	Potentially Present - No Monitoring	Substance could be present at levels of concern. No or insufficient monitoring of this media.	Medium (M)	Contaminant(s) could be present at levels of concern. No or insufficient monitoring. Additional information may be required.
3	Present - No Monitoring	Substance present in significant quantities onsite. No monitoring of this media.	Medium (M)	
4	Permitted Discharge	Substance discharged under permit. Monitoring generally required	High (H)	
5	Onsite Contamination	Substance present onsite at levels of concern in this media. Unpermitted discharge.	High (H)	Data indicate that contaminant(s) are present in sufficient quantities in Source Water Area to cause concern. (Permitted Discharge or Non-Permitted Release)
6	Offsite Contamination	Substance present offsite at levels of concern in this media. Unpermitted discharge.	High (H)	

5.3 Determining the Potential of Contamination from Land Use

The type of land use within source water assessment areas is important, particularly regarding potential “non-point source” contamination. There is, however, some overlap between discrete sources of contamination and certain land use categories. For instance, industrial areas may include hazardous waste disposal sites, landfills, etc. whereas agricultural areas may include pesticide mixing sites or animal feedlot operations.

Delaware utilizes a modification of the Anderson et al (1976) land use/ land cover classification system and relies on the most recent GIS interpreted coverages. Delaware will be utilizing 1997 coverages (which are available beginning in 1999) to make assessments. The types of contaminants, which might be derived from different land use types, and the associated contaminant potential ranking are found on Table 5-3. This is, however, not a quantitative determination of contribution, rather it is the potential for some release to occur to source waters.

Actual contaminant loading from land use types to source water areas can be quite variable depending on factors such as recharge-potential and area-specific practices. Consequently, source water assessments will utilize land use depictions to provide a general description of the types of contaminants that are possible. For instance, an area with 50%

Table 5-2 Contaminant Potential from Discrete Sources

	Nutrients		Pathogens		Petroleum Hydrocarbons		Pesticides		PCBs		Other Organics		Metals		Other Inorganics		Turbidity		
	Surface	Ground	Surface	Ground	Surface	Ground	Surface	Ground	Surface	Ground	Surface	Ground	Surface	Ground	Surface	Ground	Surface	Ground	
Discrete Sources																			
SIRB / CERCLA	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	NA
UST / LUST	NP	NP	NP	NP	P	P	NP	NP	NP	NP	P	P	NP	NP	NP	NP	NP	NP	NA
Landfills / Dumps	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	NA
NPDES	P	NP	P	P	P	NP	P	NP	P	NP	P	NP	P	NP	P	NP	P	NP	NA
Tire Piles	NP	NP	NP	NP	P	P	NP	NP	NP	NP	P	P	P	P	NP	NP	P	P	NA
Hazardous Waste Gen. & TSD's	NP	NP	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	NA
TRI	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	NA
Salvage Yards	NP	NP	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	NA
Pesticides L, M, & S	P	P	NP	NP	NP	NP	P	P	NP	NP	P	P	P	P	P	P	P	P	NA
Large On-Site Septic	P	P	P	P	NP	P	NP	NP	NP	NP	NP	P	NP	P	NP	P	NP	P	NA
Waste Water Spray Irrigation	P	P	P	P	NP	NP	NP	P	NP	NP	P	P	P	P	P	P	P	P	NA
Waste Sludge Application	P	P	P	P	NP	NP	P	P	NP	NP	P	P	P	P	P	P	P	P	NA
CAFOs	P	P	P	P	NP	NP	P	P	NP	NP	P	P	P	P	P	P	P	P	NA
Combined Sewer Overflows	P	NP	P	NP	P	NP	P	NP	P	NP	P	NP	P	NP	P	P	P	P	NA
Dredge Spoils	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	NA
Golf Courses	P	P	P	P	NP	NP	NP	P	NP	NP	P	P	P	P	P	P	P	P	NA
Domestic Septic	P*	P*	P*	P*	NP	P	NP	P	NP	NP	NP	P	NP	P	NP	P	NP	NP	NA

- P -** Possible (Contaminant Potential Determined from Site Index Database)
- NP - Not Probable
- NA - Not Applicable
- * - Dependent upon System Density
- 5 - Waiting on comments from the Non-Point Source Program

Table 5-3 Contaminant Potential from Land Use / Land Cover Categories

Land Use	Nutrients		Pathogens		Petroleum Hydrocarbons		Pesticides		PCBs		Other Organics		Metals		Other Inorganics		Turbidity	
	Surface	Ground	Surface	Ground	Surface	Ground	Surface	Ground	Surface	Ground	Surface	Ground	Surface	Ground	Surface	Ground	Surface	Ground
Residential (110-114) ¹	P*	P*	P*	P*	P	P	P	P	NP	NP	P*	P*	NP	NP	P*	P*	P	NA
Commercial (120,121,125,129)	P*	P*	NP	NP	P*	P*	P*	P*	P	P	P*	P*	P*	P*	P*	P*	P	NA
- Vehicle Operations (122)	NP	NP	NP	NP	P*	P*	NP	NP	NP	NP	P*	P*	P*	P*	P*	P*	P	NA
- Junk/Salvage Yards (123)	NP	NP	NP	NP	P*	P*	NP	NP	P*	P*	P*	P*	P*	P*	P*	P*	P	NA
Industrial (130)	NP*	NP*	NP	NP	P*	P*	NP*	NP*	P*	P*	P*	P*	P*	P*	P*	P*	P	NA
Transportation (145,146,149)	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	P	NA
- Highways/Parking Lots (141,142)	NP	NP	NP	NP	P	P	P	NP	NP	NP	P	P	P	P	P	P	P	NA
- Railroads (143)	NP	NP	NP	NP	P	P	P	P	P	P	P	P	P	P	P	P	P	NA
- Airports (144)	NP	NP	NP	NP	P*	P*	NP	NP	NP	NP	P	P	NP	NP	NP	NP	P	NA
Utilities (150)	P	P	P	P	P	P	P	P	P	P	P	P	P	P	NP	NP	P	NA
Combined Urban (160,170,180)	NP	NP	NP	NP	P	P	P	P	P	NP	P	P	NP	NP	P	P	P	NA
Recreation (190)	P	P	NP	NP	NP	NP	P	P	NP	NP	NP	NP	NP	NP	NP	NP	P	NA
Cropland (211,213,214,215,220,290)	P**	P**	NP	NP	NP	NP	P**	P**	NP	NP	P**	P**	P**	P**	P**	P**	P	NA
CAFOs (236)	P*	P*	P*	P*	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	P	NA
Farmsteads (240)	P*	P*	P*	P*	P	P	P*	P*	NP	NP	NP	NP	NP	NP	P	P	P	NA
Rangeland/Pasture (212,310,320,330)	P	P	P	P	NP	NP	P	P	NP	NP	NP	NP	NP	NP	NP	NP	P	NA
Forest Land (410,420,430)	NP	NP	NP	NP	NP	NP	P	P	NP	NP	NP	NP	NP	NP	NP	NP	NP	NA
- Clear-cut Forest (440)	P	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	P	NA
Water (510,520,530,540,590)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Wetlands (600)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Barren/Open (720,730,760)	P	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	P	NA
Extraction (750)	P	P	NP	P	P	P	NP	NP	NP	NP	NP	P	NP	NP	NP	NP	P	NA

P - Possible (May Require Further Analysis to Determine True Potential)

NP - Not Probable

NA - Not Applicable

¹ - (110-114) refers the to Land Use / Land Cover categories as per the Anderson classification scheme (Anderson et al., 1976)

* - Refer to Discrete Source Inventory

** - Potential Evaluated based upon Percentage of Total Area

agriculture row crops and 50% unsewered residential could be subject primarily to nutrients, pesticides, inorganics, and microorganisms.

Since the relative percentages of land use will vary widely between source water areas, judgements will be necessary as to the relative importance of a particular land use. Each source water assessment will include a map of land use within each source water area and a description of the type of contaminants possible along with their contaminant potential ranking of Negligible, Low, Medium, or High.

Two of the land use categories, cropland and residential, will utilize a more refined approach to determining their relative importance within a source water area. For croplands areas, the nutrient rating will be as follows:

<u>Percentage of Source Water Area</u>	<u>Rating</u>
<5%	Negligible
5 to 20%	Low
>20 to 50%	Medium
>50%	High

For unsewered residential which utilize onsite domestic septic systems, the rating for nutrients will be based on the density of domestic septic systems as follows:

<u>(Systems / Acre of Source Water Area)</u>	<u>Rating</u>
1	Low
>1 to <3	Medium
>3	High

It should also be noted that although domestic septic systems are rated based on density, the Residential land use category also considers non-point residential fertilizer application and other potential domestic contaminants.

5.4 Susceptibility Determination

Susceptibility determinations consider the vulnerability of a public water supply to potential or existing sources of contaminants that have been identified within a source water assessment area. Both discrete sources and land use types within the source water area are included in the susceptibility determination. Figure 5-4 illustrates the approach for determining the susceptibility of a particular source of public drinking water. As an example, systems with high vulnerability will be considered most susceptible if sources with a medium or high contaminant potential are found within the source water assessment area.

Figure 5-4 Source Water Susceptibility Determination Matrix

		CONTAMINANT POTENTIAL				OBSERVED DATA		
		Contaminants not present in sufficient quantities in Source Water Area to cause concern.	Contaminant(s) present in significant quantities in Source Water Area but monitoring data indicates no or minimal releases	Contaminant(s) could be present at levels of concern. No or insufficient monitoring. Additional information may be required.	Data indicate that contaminant(s) are present in sufficient quantities in Source Water Area to cause concern. (Permitted Discharge or Non-Permitted Release)	Naturally occurring contaminant(s) detected in source (raw) water at levels > 50% of the MCL, but ≤ 100% of the MCL. Synthetic contaminant(s) found above Detect Level, but below the MCL. Active treatment may be in place	Contaminant(s) detected in source (raw) water at levels greater than 100% of the MCL. Active treatment may be in place	
		INCREASING CONTAMINANT POTENTIAL				DETECTION	EXCEEDANCE	
VULNERABILITY RATING	Surface Water Intakes	INCREASING VULNERABILITY	3	4	5	6	6	7
	GWUDI Well							
	Poor Integrity Well							
	Cockeysville Well		2	3	4	5	6	7
	Shallow Unconfined Well							
	Crystalline Bedrock Well							
	Semi-Confined Well		1	2	3	4	6	7
	Deep Unconfined Well							
	Confined Well							

SUSCEPTIBILITY SCALE

LEAST	MODERATELY			MOST		
1	2	3	4	5	6	7

The overall number of point sources or the volume of contamination from a particular source will increase the susceptibility of a particular source water area. The source water assessment will include a description of individual discrete sources.

The source water assessment areas differ somewhat between ground water and surface water systems. For wells, the source water assessment area is the wellhead protection area which was modeled using a 5 year time of travel criteria or a 150 foot radius or some other accepted approach. Thus the entire delineated wellhead protection area is treated similarly in the susceptibility determination. Chapter 3 described the delineation approach for surface water systems as including the following zones:

- Zone 1a Flood plains and erosion prone slopes depicted on the WRPA maps
- Zone 1b 200-ft. buffer zone setback along blue line streams (where no flood plain or erosion prone slopes have been defined)
- Zone 2 All remaining areas within the watershed

Both discrete potential contaminant sources and land use which occur within Zone 1a and 1b will be rated using the Susceptibility Determination approach in Figure 5-4 identical to that done for wells. For discrete sources and land use in Zone 2, the contaminant potential rating will be lowered one rating. For example, an individual point source rated as having a High contaminant potential in Zone 1a or 1b would be rated as having Medium contaminant potential if it were found in Zone 2.

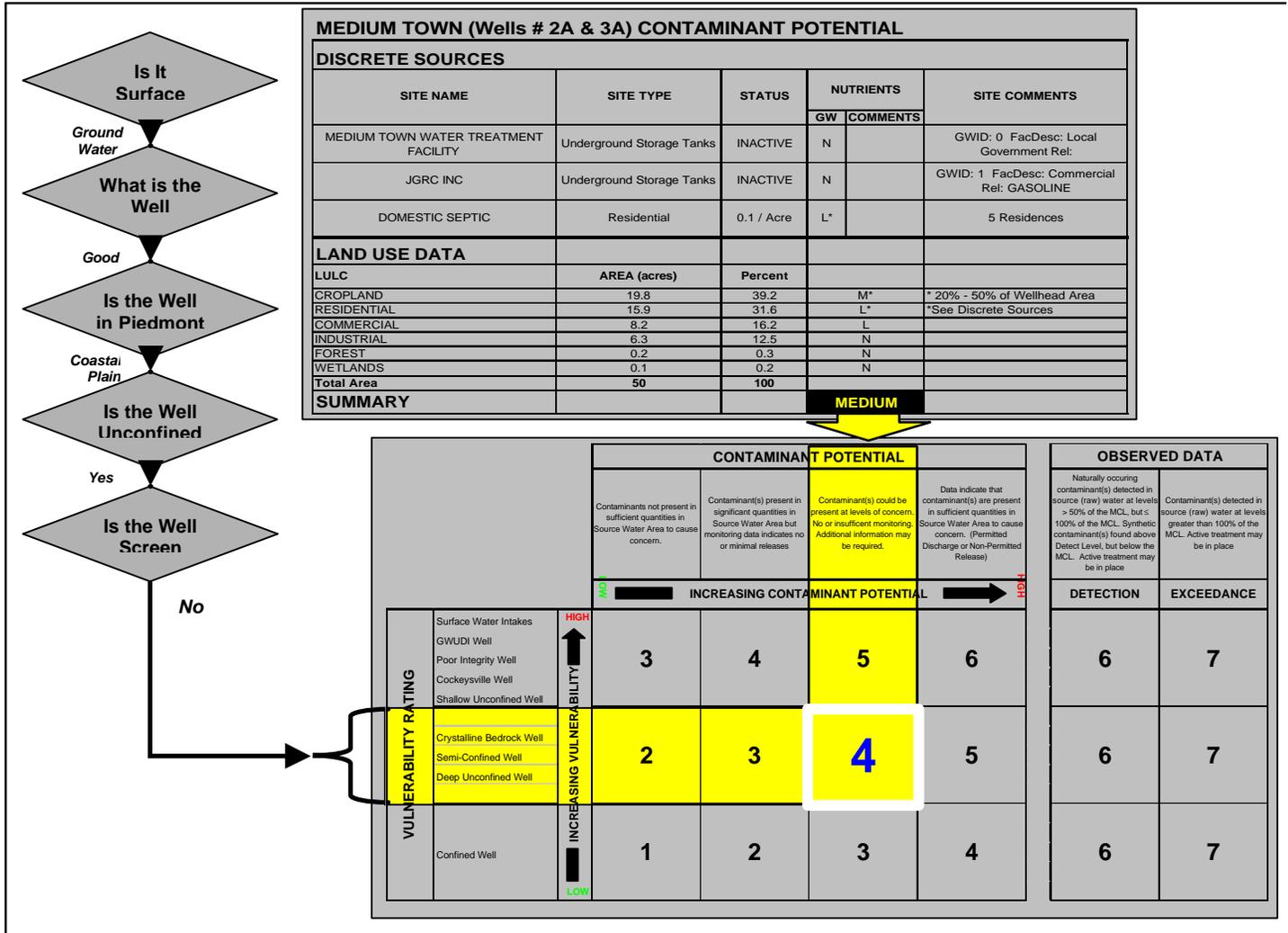
Approaches differ somewhat between surface and ground water systems because of the different impacts that discrete sources and a land use type might have upon the water quality in surface or ground water systems. For instance, leaking underground storage tanks within a wellhead protection area for a public water supply well would make the system highly susceptible to petroleum hydrocarbons. Similar sites within Zone 2 of a drainage basin for a surface water intake would be less of a threat because of attenuation and dilution processes over longer distances within the subsurface.

Both non-point sources (land uses) and point sources may change over time. Consequently, source water assessments and susceptibility determinations would be modified due to these changes. In addition, improvements in data used in the initial assessments may be modified, as new information is included in the assessment (see Section 5.6)

DPH tests water from public water systems for regulated contaminants and certain contaminants that may become regulated under the Safe Drinking Water Act. Certain contaminants may occur naturally (e.g. radionuclides, chloride) while most are anthropogenic in origin. Information on contaminant occurrence in drinking water is obtained from DPH, STORET stream monitoring, DNREC, or water purveyors. Raw water at the well or intake which contains greater than 50% of the MCL up to the MCL for naturally occurring contaminants, or which have detectable concentrations for man-made chemicals, will be regarded as highly susceptible to that contaminant regardless of the vulnerability determination or contaminant source inventory. Contaminants that exceed the MCL in the raw water indicate the most susceptible source waters. The 50% of MCL exceedance or detection of man-made contaminant must be evaluated to assure that it represents a valid value according to DPH protocol. In the case of naturally occurring contaminants, the susceptibility determination will describe the cause of the problem. However, naturally occurring contaminants (such as radon, iron, and chloride) must be handled differently as part of any implementation or protection action which is not part of the assessment.

The highest susceptibility determination (most susceptible) based on contaminant occurrence at the well or intake is found along the right hand column on Figure 5-4. As indicated, high susceptibility ratings are assigned to systems which exhibit the occurrence of specific contaminants. The final susceptibility determination distinguishes between contaminants found above the MCL from those occurring below the MCL. Figure 5-5 is an example of a susceptibility determination for nutrients for a wellhead protection area and includes both non-point and point contaminant sources.

Figure 5-5 Example of Nutrient Contamination Susceptibility Determination



5.5 Source Water Assessment Report Format

Source water assessment reports will be prepared for all public water system wells and surface water intakes. Individual public water systems likely have more than one intake (multiple wells, surface water intakes, etc), so each system will receive assessments for each well and/or surface water intake. Where wells in a particular wellfield are very close, a single assessment may be sufficient.

The assessment report will include the following:

- A brief narrative describing the assessment process used in Delaware;
- Maps of the source water assessment area(s) delineated for each well or surface water intake including the well or intake location;

- Map depicting the land use types within the assessment area including a brief explanation;
- Map depicting the inventory of discrete existing or potential sources of contamination found within the assessment area including a brief description of each discrete source;
- Map showing major transportation routes (highways and railroads) with an indicated mileage of each;
- Description of the susceptibility determination for the types of potential contaminants found within the source water assessment area.

The report will be as clear as possible including both a description of the assessment and applicable maps. Once assessments have been completed and reviewed for accuracy, their availability will be announced and will be available. The assessment will be subject to modification as new information is received or as changes occur within the source water assessment area. In addition, as new wells or intakes are added to new or existing public water systems, assessments will be conducted and added to previous assessments. Appendices H and I are examples for ground water and surface water assessments, respectively.

5.6 Opportunities for Refinement of Source Water Assessment Report

Source water assessments in Delaware will be prepared by DNREC or in cooperation with others (e.g. DPH, WRA, DGS, DDA, and DRWA) and provided to the public water system owner. Modifications may be made if new information is provided to DNREC such as regulatory changes to the SDWA, discrete source regulation, and the like. In addition, periodic changes may be made as significant changes occur in the types of land use, or as significant changes occur with discrete potential contaminant sources, or as significant changes occur in the water system (e.g. increased pumpage, new wells, replacement well, diminished recharge).

5.7 Pro-active Susceptibility Determinations

The information available to conduct susceptibility determinations (source water assessment area delineations, identification of existing or potential sources of contamination) can also be used to assist in planning for new public supply wells or surface water intakes. The DNREC SWAPP will use information from the SWAP and Whole Basin Assessments, for example, to assist public supply owners in evaluating the susceptibility of proposed new wells or intakes to assure that their vulnerability and susceptibility is minimized.

The Well Permitting Program, Water Allocations Program, and the SWAPP will work closely to conduct these “proactive” susceptibility determinations as part of normal well and allocations permitting activities.

CHAPTER 6: SOURCE WATER ASSESSMENT IMPLEMENTATION

6.1 Prioritization of Source Water Assessments

All state SWAPs are due to the USEPA by February 6, 1999. The US EPA then has nine months to review and comment on the document. After USEPA's approval, Delaware will have two years to complete all of the source water assessments for public systems in Delaware. At this time, DPH records indicate that there are 582 water systems in Delaware. Since assessments will be conducted for each well and/or surface water intake utilized as the source of supply for each public water system, this work will involve the examination of over 1000 water supply sources. Parts of Delaware's assessments are dependent upon other statewide efforts, particularly the whole basin assessments. Consequently, Delaware will request from the EPA an additional 18-month extension for completion of all source water assessments.

To accomplish these assessments, DNREC has developed a prioritization approach to organize the work load. Community systems will be assessed first. There are 237 CPWS's in Delaware. The order in which these CPWSs will be assessed will be determined by DNREC by considering the following factors:

- Population served by the system;
- The vulnerability of the source (particularly sources where contaminants of concern have been detected);
- Direct requests from the water suppliers to assess their sources,
- Areas where whole basin assessments or the delineation of wellhead protection areas have been completed.

The Non-Transient Non-Community systems will be assessed next. There are 98 of these water systems in Delaware. The order in which the assessment of the NTNCPWSs will be assessed will also be determined by the factors mentioned for the CPWSs.

The remaining water systems to be assessed are then the Transient Non-Community systems. At this time, DPH records indicate that there are 247 of these systems. The susceptibility assessments of the TNCPWS's will be organized by considering the same factors used for the CPWSs.

It is important to again point out that some of the information necessary for conducting the susceptibility assessments is already being developed through other work programs underway in Delaware. For example, the Whole Basin Assessments have been and continue to collect information on potential sources of contamination and is organizing this data in a Geographic Information System. Also, through the Christina River Basin Water Quality Management Program, information useful for the delineation of the surface water sources in Delaware (extending in Pennsylvania) and potential contaminant sources are being developed. During the time that Delaware is awaiting USEPA approval of its SWAP, many components necessary for the source water assessments will continue to be developed.

6.2 Timeline for Completing Assessments

Delaware will submit its Source Water Assessment Plan to USEPA for approval on or before February 6, 1999. Work already approved under Delaware's USEPA approved Wellhead Protection Program will be ongoing during the 9-month period of USEPA review, which is until November 5, 1999. During the next 2 years, Delaware will proceed with the source water assessments, including the susceptibility determination according to the priority described in Section 6.1.

Parts of Delaware's source water assessment program rely on ongoing work in Delaware's Whole Basin assessment and implementation schedule (See Figure 5-2). Consequently, Delaware will request an extension of 18 months in order to complete all assessment work by April 2003. Delaware also anticipates continuing some level of assessment activity beyond that period under the Wellhead Protection Program. This work would address new public water supply wells or intakes and update assessments based upon significant changes in either the source water assessment area or changes in significant potential sources of contamination.

Table 6-1 outlines the overall timeline for completing source water assessments.

Table 6-1 Timeline for Implementation of the Delaware Source Water Assessment and Protection Program

	1998	1999	2000	2001	2002	2003	2004
SWAP Development							
Development/CTAC		<- February 6, 1999					
Review by USEPA			<- November 5, 1999				
Implementation							
Delineation							
Community Public Water Supply Systems	██	██	██	██	██	██	██
Non-Transient Non-Community Public Water Supply Systems						██	██
Transient Non-Community Public Water Supply Systems						██	██
Contaminant Source Inventory							
Piedmont	██	██	██	██	██	██	██
Chesapeake							
Inland Bays							
Delaware Bay							
Susceptibility Assessments							
Community Public Water Supply Systems						██	██
Non-Transient Non-Community Public Water Supply Systems						██	██
Transient Non-Community Public Water Supply Systems						██	██
Public Availability of Susceptibility Assessments							
Community Public Water Supply Systems						██	██
Non-Transient Non-Community Public Water Supply Systems						██	██
Transient Non-Community Public Water Supply Systems						██	██
SWAPP Funding							
Delineation and Assessment (FY97 Setaside)							
Wellhead Protection							

 = scheduled activity
 = likely extended activity

6.3 Source Water Assessment and Protection Program Progress Reporting

DNREC will report progress to USEPA as part of periodic DWSRF grant reports, WHP Biennial Reporting, Whole Basin Assessment reports, and the biennial Watershed Assessment reports. Additional details will be negotiated with USEPA.

6.4 Application of Source Water Assessment Information to Domestic Well Owners

The Delaware CTAC requested a discussion of the benefits of the SWAP to domestic well owners. This section describes the benefits of the SWAP to Delaware citizens that are not served by a public water system and utilize private domestic wells for their daily water supply.

Domestic well owners can directly benefit from the SWAP by utilizing the extensive amount of information that is either developed through the program or that is being developed statewide as part of the whole basin assessments, geologic investigations, and water quality studies. A large database is being collected and assembled at DNREC, DPH and WRA on information relevant to both public and domestic wells. This information includes hydrogeologic data on aquifers, a statewide potential contaminant source inventory, and water quality information for both ground water and surface water. Personnel from the DNREC, DPH, DGS, and are available to assist domestic well owners and to access additional information when it becomes available. Domestic well owners can also use the methodology developed and employed for the SWAP to assess their own systems.

In addition, DNREC manages a well permit program for the installation of new or replacement wells. Currently, DNREC conducts individual determinations of new domestic wells if they are located near known discrete potential sources of contamination. Special conditions may be applied as the circumstances warrant prior to well installation.

Also, the Division of Public Health provides well water testing kits for domestic wells upon request and for a minimal fee. These kits are available at the following four (4) locations:

- New Castle County Health Unit
Emily Bissell Hospital, Building C
995-8650
- DPH Laboratories
Smyrna
652-2870
- Kent County Health Unit
Williams State Service Center
739-5305
- Sussex County Health Unit
Georgetown
856-5496

There are two domestic well test kits available - one to check for bacteria, and a second to test for nitrates, pH, iron, alkalinity, and sodium. Division of Public Health personnel are available to advise people on how to correct problems when detected.

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Appendix A Citizen And Technical Advisory Committee Questionnaire

Appendix B Delaware Citizen and Technical Advisory
Committee Meeting Summaries

Appendix C Written Comments on the SWAP Document

Appendix D List of All Current Public Water Supply Systems

Appendix E Permitted Wastewater Discharge Point
Sources in the Christina River Basin

Appendix F Hazardous Waste Site Point Sources in the Christina River Basin

Appendix G Land Use Classification Within the Christina River Basin

Appendix H Ground Water Susceptibility Analysis

Appendix I Surface Water Susceptibility Analysis

Appendix J Public Workshop Summaries