# TENNESSEE
# SOURCE WATER ASSESSMENT PROGRAM
# SUBMITTAL

## Introduction

Congress, the Environmental Protection Agency and the States are increasing their emphasis on the prevention of pollution, particularly in the protection of the raw water sources for public water systems. The initial step toward prevention of contamination of public water supplies came with the Federal Safe Drinking Water Act Amendments of 1986. At that time, each state was required to develop a wellhead protection program to protect the water source of public water systems relying on ground water (wells or springs). The new Source Water Assessment provisions of the Federal Safe Drinking Water Act 1996 Amendments expanded the scope of protection beyond ground water systems to include protection of the waters supplying surface water systems.

Section 1453 of the 1996 Safe Drinking Water Act (SDWA) Amendments (see Appendix A) requires that all states establish Source Water Assessment Programs (SWAP), and submit a plan to the Environmental Protection Agency (EPA) by February 6, 1999 detailing how they will:

- Delineate source water protection areas.
- Inventory significant contaminants in these areas.
- Determine the susceptibility of each public water supply to contamination.

Source Water Assessment Programs are required to include public water systems using surface water or ground water. EPA-approved Wellhead Protection Programs are acceptable for the ground water systems under the new Source Water Assessment/Protection Program. States may need to perform supplemental work for wellhead protection if the susceptibility analysis was not done or the public involvement requirements were not met. Tennessee's Wellhead Protection Program was approved by EPA in July of 1994. A susceptibility analysis has been developed for Tennessee's ground water systems to meet the Source Water Assessment requirements. These susceptibility determinations will serve to enhance Tennessee's existing Wellhead Protection Program and prioritize resources.

EPA published the State Source Water Assessment and Protection Programs Guidance in August of 1997 to help states develop SWAP submittals. The SWAP program submittal is due to EPA by February 6, 1999. EPA has nine months to approve the program or it will be approved by default. The state has up to two years after EPA program approval to complete the source water assessments or, with an approved time extension, up to no more than three and one half years (i.e., November 6, 2001 or May 6, 2003).

States are permitted to tailor the delineations, source inventories and susceptibility analyses by the type of water system. Tennessee has done this for ground water systems but has not chosen to do so for surface water systems. Public water systems include community water systems as well as various types of noncommunity systems such as hotels, campgrounds, churches, schools and industries.

Source water/wellhead protection areas for public water systems using ground water are generally based on hydrogeologic considerations and/or modeling. In some instances a fixed radius around the well or spring or a some other set shape ("cookie cutter" approach) using calculated withdrawal amounts has been used.

Source water protection areas for public water systems using surface water are generally based on the portion of the watershed area upstream of the water intake. Other factors that are considered in defining the protection area include setbacks/buffer zones; and/or time-of-travel (the time it takes for water to travel a given distance). The states are given considerable flexibility in defining the size of these areas to allow for practical considerations for the individual states.

States are also required to have considerable public involvement in developing the assessments and to have the completed assessments easily accessible to the public. Each state must convene a statewide citizen and technical advisory committee to receive public input when developing the state SWAP (see Appendix B for SDWA requirements and EPA guidance) as well as hold public meetings across the state prior to the submittal of the program to EPA. An approvable state SWAP submittal is required to address how the state has ensured broad representation and wide public involvement, as well as how the state will make the results of the assessments available to the public in an understandable manner.

SWAPs are not intended to replace existing programs addressing pollution sources. Congress did not require states to go beyond the Source Water Assessment phase and create a radically new "protection program." The assessments are intended to enhance the protection of drinking water supplies within existing programs at the federal, state and local levels. ***The new amendments do not confer any new regulatory or enforcement authorities for drinking water source protection upon the states.*** Tennessee's Source Water Assessment Program efforts will be used to improve the existing Source Water Protection efforts within Tennessee's Wellhead Protection Program and Watershed Management Program.

## Tennessee's Source Water Assessment Approach

Congress has given the states considerable flexibility in the implementation of their Source Water Assessment Programs based on state-specific needs/concerns. Tennessee Department of Environment and Conservation (TDEC) will be working within the existing framework of its Watershed Management Program, using the Source Water Assessment Program to enhance its effectiveness. By the nature of the Source Water Assessment Program and its linkage with the Watershed Management Program, the SWAP will be a dynamic, iterative process.

Linking the Source Water Assessment Program with the Watershed Management Program brings the issue of public water supplies to the forefront. The Ground Water Management Section within the Division of Water Supply is responsible for the Underground Injection Control Program (discharges to ground water) in Tennessee and

as such has regulatory authority under Tennessee's Water Quality Control Act. Protection/management efforts within the Division of Water Supply will concentrate on Wellhead Protection Program where long-term contamination is a demonstrated problem. Protection/management efforts for surface water will lie with the Division of Water Pollution Control and its Watershed Management Program, where they have regulatory control over discharges to surface water (NPDES permitting, etc.) under the Tennessee Water Quality Control Act. The Division of Water Supply will assist/coordinate these efforts through its Source Water Assessment Program.

For ground water systems, Tennessee will continue to rely on its EPA-approved Wellhead Protection Program with improved prioritization from the addition of the susceptibility analysis and improved information for public access through GIS. The emphasis for protection/management for ground water systems will be from within the continuing wellhead protection program, but will still involve the Watershed Management Program as well. Tennessee intends to provide assistance for local source water protection programs as resources allow statewide, but concentration will be on source water/wellhead protection areas with the worst problems or potential problems.

## Tennessee's Watershed Management Approach

Source Water Protection has been incorporated into the Watershed Management Program goals, objectives and management strategies. Watershed Management looks at the health of the watershed as a whole in areas of discharge permitting, monitoring and protection. Both ground water and surface water systems will be addressed in the individual watershed plans. In areas with karst {limestone characterized by solution features such as caves and sinkholes as well as disappearing streams and spring}, Watershed Management is particularly important because the differentiation between ground water and surface water is sometimes nearly impossible. What is surface water can become ground water in the distance of a few feet and vice versa.

Tennessee's Watershed Management Program approach uses the 54 U. S. Geological Survey 8 digit Hydrologic Unit Code (HUC) watersheds (Figure 1) that make up Tennessee. These 54 watersheds have been arranged into five groups across the state (Figure 2) to be looked at in a five year cycle (Figure 3 ). Each watershed will have a plan issued at the wrapup phase of the five year cycle for that watershed (Figure 4). Source water assessments will be an integral part of the plan for both surface water and ground water.

The water systems (both surface and ground water) will be addressed in the order of these same watershed groupings so as to be synchronized with the watershed management cycle. Division of Water Supply staff will be accompanying Division of Water Pollution Control staff to the public meetings for the watersheds. Since the Watershed Management work got its start a few years ahead of SWAP, the Group 1 watershed source water assessments will have to be completed by December of this year. Thereafter, one group per year will be completed and an additional group initiated (group 2 and part of 3 in calendar year 2000; group 3 & part of 4 in calendar year 2001; group 4 and part of group 5 in calendar year 2002; and completion of group 5 in 2003).

The Division of Water Pollution Control began its watershed management cycles in 1996. In order for the Source Water assessments to become synchronized with this cycle, assessments will concentrate on the Group 1 and Group 2 watersheds to have them completed for the watershed plans due in the years 2000 and 2001, respectively.

Source Water Assessment/Protection will play a role under the majority of the chapter headings for the individual plans as follows:

- **Goals**
  – Assure source water protection

- **Objectives**
  – Incorporate source water protection activities

- **General Watershed Description**

- **Water Quality Criteria and Use Classification**
  - Source water assessment/delineated protection areas

- **Use Support Assessment**
  - Vulnerability of the water supply systems

- **Water Quality Concerns & Issues**

- **Management Strategies**
  - Source water protection

The Water Quality Criteria and Use Classification will specifically address the source water assessment/delineated protection areas for drinking water use. Standard setting will also be addressed where necessary. Tennessee also has a new Ground Water Classification that should become effective before the end of the calendar year, which in theory could allow wellhead protection areas to have a higher level of protection in remediation situations. The criteria for protective designation are unfortunately considerably more stringent than downgrading an aquifer to a lesser classification that requires less remediation.

INSERT FIGURE 1

MAP WITH 54 HUC UNITS

INSERT FIGURE 2

MAP WITH GROUP 5 WATERSHEDS

# *Watershed Management*
# Cycle

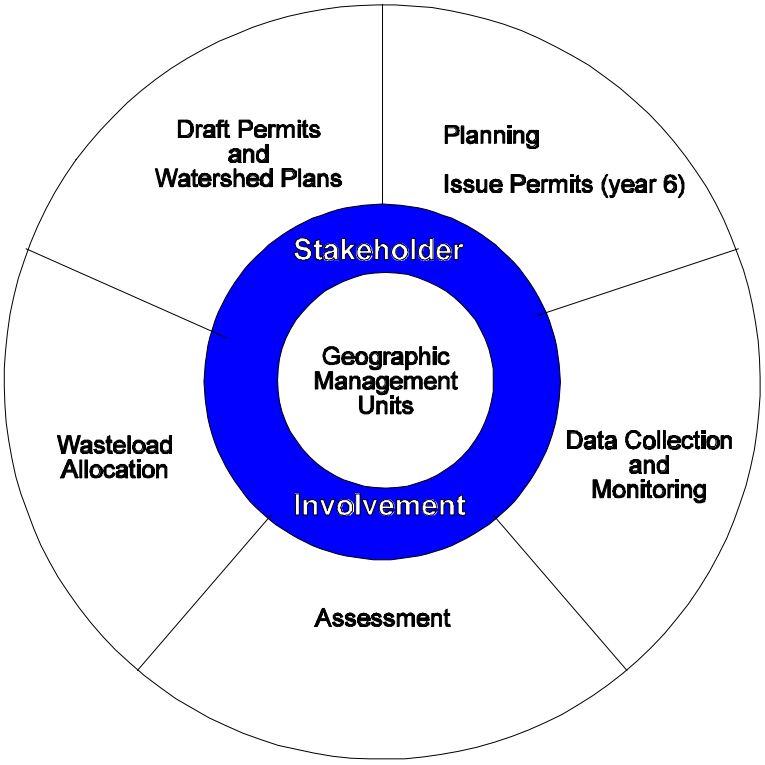



**Figure 3**

*Watershed Management*

# Timeline

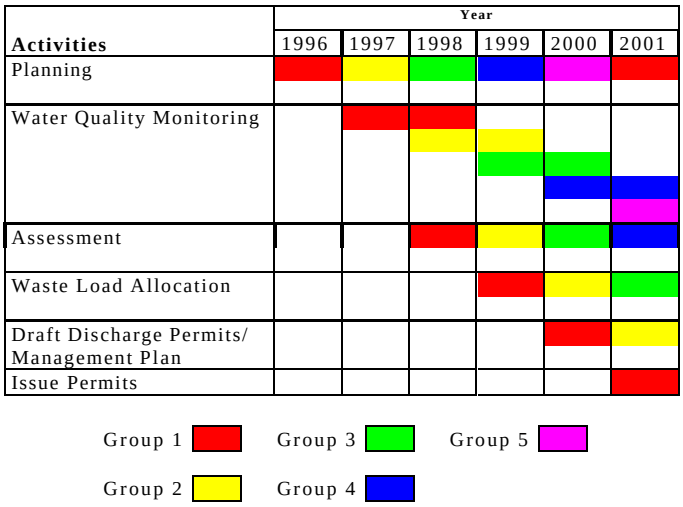



**Figure 4**

## Additional Protection - Related Elements

In addition to the implementation of the Watershed Management Program within the Division of Water Pollution Control, Tennessee has other protection measures in place which provide a framework for Source Water Protection:

1) T.C.A. 68-221-706 requires the Department of Environment and Conservation to exercise general supervision over the construction of a public water system. Public Water System Regulation 1200-5-1-.05(8) prohibits any person from operating a public water system without prior approval of the Department. In order for a potential water supplier to obtain approval of a new raw water source, the quality of the raw water must be determined and assured:

   a) Rule 1200-5-1-.05(12) specifically requires all chemical, biological and radiological analyses to be completed prior to using the source.

   b) Tennessee's engineering design criteria for public water systems require that an engineering report be produced that describes the project in detail. The design criteria also cover chronic and emergency events that may affect the quality of the water.

   c) In addition, Environmental Assistance Center personnel from the Division of Water Supply are required to investigate potential raw water source sites and determine if anything is present that might create a drinking water hazard.

2) An early warning system headed by the Tennessee Emergency Management Agency (TEMA) as well as mandatory spill reporting are already in place to provide notification to water suppliers on the release of contaminants. The Division of Water Supply hopes to improve the information available with the Source Water Assessment Program to allow for more informed decisions.

3) Rule 1200-5-1-.31(4) requires all surface water systems as well as ground water systems impacted by surface water ("under the influence") to employ filtration and disinfection. The filtration drastically reduces any concerns over microbiological contamination such as the protozoa cryptosporidium (see Appendix C regarding cryptosporidium and immune deficient populations). Cryptosporidium is not killed by disinfection and must be filtered out to remove it from the raw water. Not all states require filtration. Much of the concern driving the Source Water Protection requirements stems from the use of unfiltered surface water in other states.

4) Rule 1200-5-1-.34 requires all public ground water systems to develop wellhead protection plans. This Rule took effect in January of 1994 and Tennessee's Wellhead Protection Program was approved by EPA in July of 1994. Tennessee is well into the implementation phase of its Wellhead Protection Program. As an EPA-approved Wellhead Protection Program, Tennessee's Program meets or exceeds the requirement for the ground water source component under the new Source Water Assessment Program, with the exception of the susceptibility analysis which has been added as a part of SWAP development.

5) Tennessee Code Annotated (T.C.A.) 68-221-704 {Tennessee Safe Drinking Water Act} authorizes the Water Quality Control Board to establish standards and procedures to assure an adequate supply of safe drinking water which dependably complies with maximum contaminant levels. These procedures provide for requiring a minimum quality of water that may be taken into a public water system. Existing monitoring for community water systems includes the following list of chemicals (there are monitoring waivers available where chemicals are not used in a particular area):

Table 1 – Required Chemical Analyses

| | |
|---|---|
| 1,1 Dichloroethylene | Ethylene dibromide |
| 1,1,1-Trichloroethane | Fluoride |
| 1,1,2-Trichloroethane | Glyphosate |
| 1,2,4-Trichlorobenzene | Heptachlor |
| 1,2-Dichloroethane | Heptachlor epoxide |
| 1,2-Dichloropropane | Hexachlorobenzene |
| 2,3,7,8-TCDD (Dioxin) | Hexachlorocyclopentadiene |
| 2,4 Dichlorophenoxyacetic acid | Lindane |
| 2,4,5 Trichlorophenoxyproprionic acid | Mercury |
| Alachlor | Methoxychlor |
| Antimony | Monochlorobenzene |
| Arsenic | Nickel |
| Asbestos | Nitrate |
| Atrazine | Nitrite |
| Barium | ortho-Dichlorobenzene |
| Benzene | Oxamyl (Vydate) |
| Cadmium | para-Dichlorobenzene |
| Carbofuran | Pentachlorophenol |
| Carbon tetrachloride | Picloram |
| Chlordane | Polychlorinated biphenyls |
| Chromium | Selenium |
| cis 1,2-Dichloroethylene | Simazine |
| Cyanide | Styrene |
| Dalapon | Sulfate |
| Di(2-ethylhexyl) adipate | Tetrachloroethylene |
| Di(2-ethylhexyl)phthalate | Thallium |
| Dibromo chloropropane | Toluene |

| | |
|---|---|
| (DBCP) | |
| Dichloromethane | Total nitrate and nitrite |
| Dinoseb | Toxaphene |
| Diquat | trans 1,2-Dichloroethylene |
| Endothall | Trichloroethylene |
| Endrin | Vinyl chloride |
| Ethyl benzene | Xylenes (total) |

Tennessee will be using as its contaminants of concern those contaminants regulated under Section 1412 of the Federal Safe Drinking Water Act, the major portion of which are listed as the contaminants in Table 1 above. Also included are the contaminants regulated under the Surface Water Treatment Rule which include Cryptosporidium, Giardia (both are microbiological pathogens which are protozoa), turbidity, Legionella and viruses.

6) TDEC's Division of Water Supply is assisting the Department of Agriculture's Division of Regulatory Services in the routine monitoring of streams in the vicinity of selected surface water intakes, with the exception of the majority of the West Tennessee samples (there are few intakes in West Tennessee). There have been atrazine detections on several rivers in Tennessee, which are given in the accompanying table. These samples were taken immediately after rainfall events during the growing season. *These samples were intentionally taken as worst case scenario, collecting any oil slicks across the top of the water. These samples should not be considered representative of the river's overall waters or the water being drawn in at the intake, since that withdrawal is near the bottom of the water column*. This work is critical for both agencies as it is used in the monitoring waiver program for the Division of Water Supply and is a key component of the Pesticide Management Plan for the Department of Agriculture. The Regulatory Services Division is also taking ground water samples across the State to monitor for pesticides with periodic assistance from the Division of Water Supply.

Table 2
Atrazine "Hits" During Growing Season
(April – August; 1996-1998)

| County | River |
|---|---|
| Bedford | Duck River |
| Bedford | Duck River |
| Greene | Lick Creek |
| Franklin | Elk River |
| Dyer | North Forked Deer |
| Dyer | Obion |
| Decatur | Beech |
| Henry | Big Sandy |
| Haywood | South Forked Deer |
| Haywood | Hatchie |
| Hardin | Tennessee |

| | |
|---|---|
| Hardin | Tennessee |
| Lincoln | Elk River |
| McMinn | Oostenaula Creek |
| Obion | Obion |
| Robertson | Red River |
| Warren | Barren Fork |
| Warren | Barren Fork |
| Williamson | Harpeth |

Tennessee already has a monitoring waiver program which is susceptibility-based. Any additional information turned up in the assessments will be incorporated into the existing monitoring waiver program.

## Ground Water Approach

Tennessee's Wellhead Protection regulations took effect in 1994 (Appendix D). Tennessee's approach relies on a mandatory wellhead protection program for all public water systems using ground water sources. Since Tennessee's Wellhead Protection Program relies on mandatory regulations, public hearings were held across the state in the process of promulgating the regulations and public comments were addressed at that time. The Source Water Assessment Technical and Citizens Advisory Committee has been briefed on the Wellhead Protection Program and offered no suggestions for changes. The susceptibility analysis determination for ground water systems is being added to the Program to meet the Source Water Assessment requirements, but is not being promulgated into the Wellhead Protection Regulations.

The "clock" for the required submittals started September 1, 1994, with the water systems having up to three and a half years (depending on system size) to develop their individual wellhead protection plans. The push in late 1995 and 1996 for the medium and large water systems was to define the area to protect. In 1996 and 1997, the push has been inventorying the potential contamination sources within that area for each water system and 1997/1998 will be the time to develop a management plan to protect the wellhead protection area. Small water systems (less than 100 connections) and noncommunity systems have an abbreviated version of the above, with the wellhead protection areas defined as a set radius and less involved management plans.

The wellhead protection program is linked to the sanitary surveys done for each water system. The status of the system's wellhead protection plan is determined at the sanitary survey and points are taken off if the submittals are not up to date. Drinking Water NOV's also address wellhead protection submittals.

Division of Water Supply staff wrote a 101 page Wellhead Protection Guidance Document (Appendix E) that accompanied the Wellhead Protection Regulations to assist water systems in developing their wellhead protection plans. The lengthy guidance document was in large part due to the variety of geologic conditions across the state.

A brief description of Tennessee's Wellhead Protection Program is given below. There are three basic steps involved: defining the wellhead protection area, inventorying the potential contaminant sources within that area and developing a wellhead protection plan.

**Defining the wellhead protection area:**

A "wellhead" is the source area for the water which is withdrawn through a well or spring, similar to the concept of the head of a river. To protect the water supply, it is important to know where the water flowing to that well or spring is coming from. There are more complicated hydrogeological considerations, but the basic concept is that ground water flows downhill (downgradient) and the area of protection will be uphill (upgradient) from the well or spring.

There are two wellhead protection zones established for each well or spring -- an inner zone (Zone 1) around the well or spring to protect the immediate area from spills, etc., and a larger management zone (Zone 2) which takes into account the wide variety of geologic conditions across Tennessee to provide for long-term management for the well, wellfield or spring. For the sand aquifers of West Tennessee, the wellhead management zones are modeled using USGS MODFLOW, EPA WHPA or other models acceptable to the Department. The geology of Middle and East Tennessee does not lend itself to modeling and a combination of potentiometric surface (water table mapping) and watershed/topographic boundaries is used.

**Inventorying the potential contamination sources within the defined wellhead protection area:**

Once the wellhead protection area has been designated, an inventory of potential contaminant sources within the designated zones is required. This involves identifying those facilities and operations within the wellhead protection area which have the potential to impact the ground water flowing to the public supply well or spring. Once the potential contaminant source inventory is completed, the system is required to develop a plan. For the noncommunity (churches, schools, etc.) and small community systems this plan is simple. For larger systems more is required.

**Developing wellhead protection management strategies:**

Public water systems have limited tools at their disposal in protecting their water supply. For this reason, the Wellhead Protection Regulations require the solicitation of local government and local planning/zoning commission support as well as public education. This solicitation may not always be successful; however, in most cases, the local government entities are seeing the benefits of cooperation. Local government support can come in the form of local ordinances and local zoning considerations (similar to that for floodplains). State agencies with ground water regulatory roles are also involved to focus attention on regulatory activities in the wellhead protection areas.

The public education requirements within the regulations also help in fostering voluntary cooperation within industry and the general public in the use of best management practices within the wellhead protection areas. Each medium to large water system (categories 2, 3 and 4) is required to publish a notice in the local newspaper describing wellhead protection, the system's wellhead protection area and soliciting the public's help in protecting the water supply. Water systems will shortly have the option of addressing their public education requirements under the annual Consumer Confidence Reports.

**Size categories:**

For the purpose of developing the wellhead protection program, public water systems using ground water have been broken down into the following categories:

CATEGORY 1:
(a) Community PWS with less than 100 connections and less than 20,000 gallons per day (gpd) average daily production
(b) All Noncommunity PWS

CATEGORY 2:
(a) Community PWS with 100 to 999 connections and less than 315,000 gpd average daily production.
(b) Community PWS with less than 100 connections and 20,000 to 314,999 gpd average daily production.

CATEGORY 3:
(a) Community PWS with 1000 to 2999 connections and less than 1,000,000 gpd average daily production.
(b) Community PWS with less than 1000 connections and 315,000 to 999,999 gpd average daily production.

CATEGORY 4:
(a) Community PWS with 3,000 or more connections.
(b) Community PWS with less than 3,000 connections and 1,000,000 gpd or greater average daily production.

*Size categories are based on connections and average production rates for the entire system and not a particular well or wellfield. For community systems using both surface water and ground water, the size category is based on ground water production capacity.*

**Zone 1:**

The inner "wellhead protection zone," also known as Zone 1, is a fixed radius set by size category, although the system has the option of using modeling at 8 weeks time of travel for West Tennessee.

ZONE 1 RADII BY CATEGORY

(i) Category 1: 250 feet*

(ii) Category 2: 500 feet

(iii) Category 3: 750 feet

(iv) Category 4: 750 feet

*Category 1 for Zone 2 is also fixed at 750 ft.

The 750 foot radius using reasonable aquifer characteristics in the WHPA model translates into roughly 6 - 8 weeks time-of-travel in unconfined sands. This was explained during the approval process for Tennessee's Wellhead Protection Program and is also in the guidance document. The 250 foot radius translates into 1 - 2 weeks. **Time-of-travel is irrelevant in this context for karst areas.** Dye traces have shown as much as **6 miles of travel in less than 24 hours** in Middle Tennessee after a major rain event.

The reasoning used here was a more practical consideration rather than a geologic one. Category 1 systems (trailer parks, very small communities, etc.) exist in rural areas where no other public supplies available. These same rural areas have very little in the way of potential contaminant sources -- except for the system (read trailer park/ small community) itself. From practical experience, they are typically their own worst enemy. Zone 1 for these systems is aimed at "well bore" protection (i.e., don't stack drums around the well, dump waste around the well, etc.) to protect from contamination running down the side of the casing and from contamination within the well's cone of depression.

Tennessee has in its wellhead protection regulations a provision for modifying wellhead protection areas where the Division feels that the existing delineated wellhead protection areas are inadequate. It has always been the intent of the Division to modify the Category 1 systems to geologically defined areas as resources permit. Were it not for the new Source Water Assessment/Protection requirements this would probably already be underway.

**Zone 2:**

For Zone 2, Tennessee has specified in regulation which hydrogeologic delineation methods are acceptable with the exception of Category 1 systems, which are fixed radii. The delineated wellhead protection areas must be submitted for approval by the Division of Water Supply.

For the West Tennessee unconsolidated sand aquifers, either EPA's WHPA model or USGS's MODFLOW are acceptable to model the wellhead protection area. The minimum Time of Travel (TOT) acceptable within Tennessee's regulations is 10 years. A few water systems in Shelby County near Memphis have opted to designate a 40 year TOT wellhead protection area due to rapid growth in the area. Note that the 10 year TOT only applies to West Tennessee sand aquifers - 10 year TOT would be irrelevant in karst. For karst, the ground water basin/watershed is being defined for the wellhead protection area using the potentiometric surface ("water table") created from ground water elevations from wells and springs and dye trace information where available and basic topographic/watershed information. The minimum wellhead/recharge area for water systems in Middle and East Tennessee is calculated from the Aquifer Recharge Area &

Withdrawal Balance (ARAWB) formula (page 27 of the Wellhead Protection Guidance Document).

Where practical, all wellhead areas are composited into one larger area to minimize confusion for the general public and for continuity/ease of management. In addition, the approved modeling method under the WHPA modeling program used for West Tennessee (which is the area where wells are typically more closely spaced) takes into account the impact withdrawal from adjacent wells has in the flow pattern, which in a great many cases results in a composite area.

### Conjunctive delineation:

Conjunctive delineation is "the integrated delineation of the zone of ground water contribution and the area of surface water contribution to a public water supply" (Appendix D, EPA Source Water Protection Guidance Document). Tennessee has always taken conjunctive delineations into account in karst areas as a part of its wellhead protection program. **There is not a clear cut distinction between ground water and surface water in karst** - it is impossible to consider one without the other. Conjunctive delineation is nothing new in karst areas -- Tennessee does not feel it is necessary to create a separate "conjunctive delineation" process which would merely generate confusion.

The ground water basin/watershed is being defined for the wellhead protection area with much of the wellhead protection area delineation as a topographically defined watershed. Note that the ground water under the direct influence (GWUDI) determination also addresses the most severely impacted ground waters and this is taken into account in the susceptibility analysis.

### Tennessee's Wellhead Protection Program:

Tennessee has one of the most comprehensive Wellhead Protection programs in the Southeast, covering all community and noncommunity ground water systems. The intent for the ground water portion of Source Water Assessment/Protection is to rely on the existing Wellhead Protection Program which is well into the implementation phase. A susceptibility analysis to determine a relative risk for each water system is being a added to comply with Source Water Assessment requirements. Considerable work is being undertaken to get wellhead protection data into an electronic database format for incorporation into GIS (Geographic Information System). The Division of Water Supply is contracting with the Ground Water Institute at the University of Memphis for this work, making use of the Wellhead Protection setaside from the Drinking Water State Revolving Fund.

Tennessee has 248 community ground water systems and over 600 noncommunity ground water systems. The locations of the community water supply wells and springs are shown in Figure 5. The list of community ground water systems is given in Appendix F. The vast majority of the wellhead protection area delineations have been done. Most of the management plans have been done for the medium and large systems as well. The

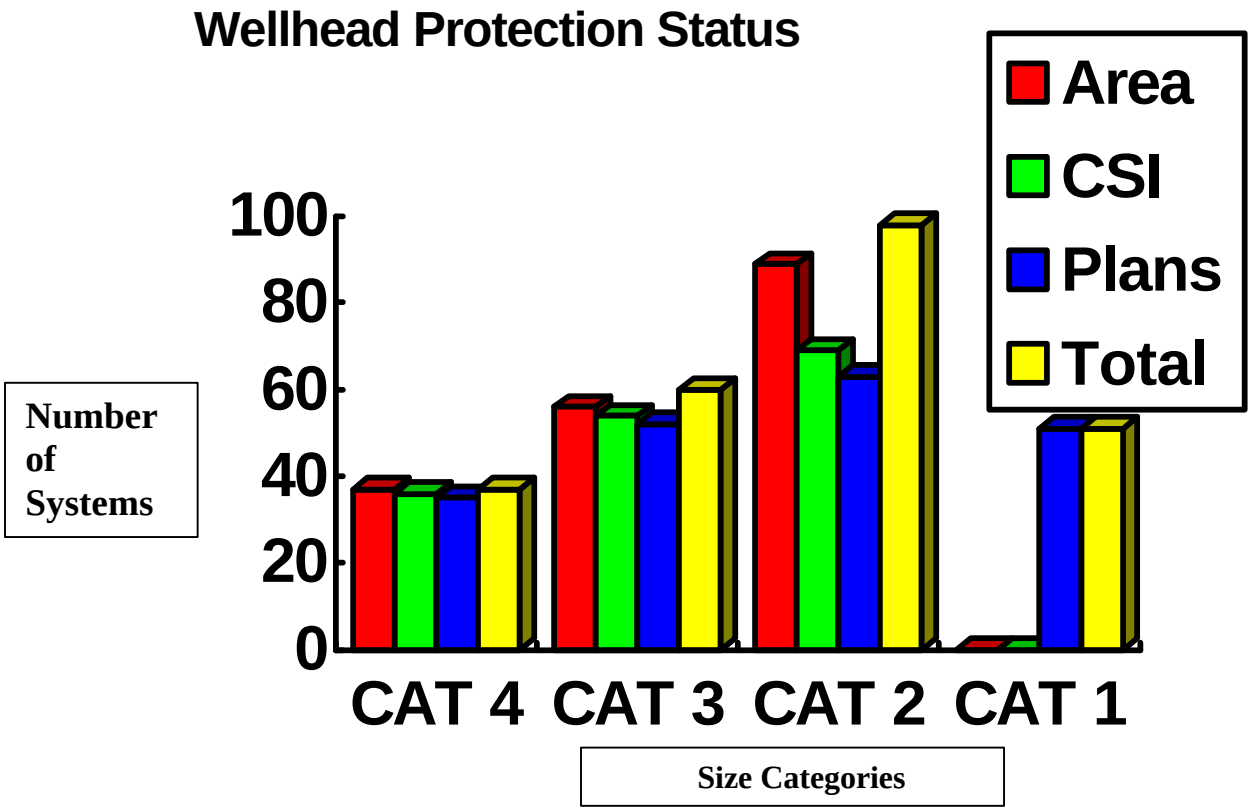
status of the Wellhead Protection Program for the various size categories is given in Figure 6. There are several additional plans as well as a small number of contaminant source inventories and area delineations ready for review that are not shown in Figure 6. The Division of Water Supply and the Tennessee Association of Utility Districts (representative of the National Rural Water Association) have assisted many of the water systems in developing their individual wellhead protection plans.

Tennessee has already been issuing notices of violation (NOVs) and penalizing points on sanitary surveys for delinquent wellhead submittals. The susceptibility analyses will be done by Division of Water Supply staff using existing potential contaminant source inventories and other available databases such as TRI, hazardous waste generators, etc. (field followup will occur on a case-by-case basis).

The timeframe for assessment completions is linked with the watershed management cycle. Those within the Group 1 will be completed by end of December 1999 to synchronize with the watershed cycle. Thereafter, one group per year will be completed and an additional group initiated (group 2 and part of 3 in calendar year 2000; group 3 & part of 4 in calendar year 2001; group 4 and part of group 5 in calendar year 2002; and completion of group 5 in 2003).

Figure 5

Map of Community Public Ground Water Systems




September, 1999

Figure 6

## Surface Water Approach

The SWAP for surface water systems will be closely linked to Tennessee's existing Watershed Management Program and integrated into that program. Tennessee has 148 community public water systems relying on 167 intakes and an additional 13 noncommunity water systems/intakes in 73 counties across the state (Figure 7). Three of the community systems are in West Tennessee with the remainder in Middle and East Tennessee. A list of these systems is given as Appendix G. There will be no distinction of system type in the Source Water Assessment Program for surface water intakes.

As an initial step in developing the Source Water Assessment Program, public water systems with surface water intakes were sent questionnaires in November of 1997. One hundred sixty six systems were asked:

1) If they had ever had to shut down their intakes,
2) if they had any concerns upstream of their intakes and
3) if they were willing to serve on the Source Water Assessment Committee.

Seventy-five systems responded back. In response to question 1), eight have had to shut down:

1) Four of these from barge traffic or other transportation related (highway or railroad) spills.
2) Two were industrial related.
3) One was a sewer line rupture and
4) One was not identified.

The concerns listed upstream of the intakes (only 28 of respondents listed concerns, some more than one) could be characterized as follows:

**Table 3 – Water Systems Survey**

| Number of Responses | Facility/Activity Type |
|---|---|
| 12 | industrial/ commercial facilities |
| 9 | transportation related (barge, hwy/railroad, hwy/railroad bridges) |
| 6 | municipal wastewater treatment plants |
| 4 | agricultural activities |
| 1 | maintenance garage |
| 1 | correctional facility |
| 1 | landfill |
| 1 | marina |

Figure 7 – Surface Water Systems

There is a need to improve emergency response, enhanced communications and public/industry awareness for surface water systems. Much of this could also be said for ground water systems. The Source Water Assessment Program and Watershed Management Program add additional layers of protection for public water supplies. It is of note that:

1) There have been no violations for chemical drinking water standards for Tennessee's surface water systems, which is not the case for ground water systems (see Figure 8).

2) Siting of new public water system raw water sources already requires a water quality/hazard assessment prior to construction.

3) Surface water systems have been required to have filtration for over 20 years in Tennessee. This drastically reduces any concerns over microbiological contamination that exists in other states such as New York that do not require filtration of their surface water sources. *

4) The velocity of water in streams is such that contaminant plumes are short lived, allowing intakes to be shut off for several hours while a plume passes downstream. Surface water systems are already required to have 24-hour emergency storage capacity or other equivalent contingency planning measures.

*Microbiological contamination concerns were a major driving force for the Source Water Protection additions to the 1996 Amendments of the Safe Drinking Water Act. *Proper filtration and chlorination provide excellent protection for the general population; but it does need to be understood that for people with immune deficiencies (cancer patients undergoing chemotherapy, persons with AIDS, etc.), these measures are not enough. See the discussion regarding immune deficient populations in Appendix C.*

Contam public water supplies
Figure 8

## Source Water Assessment Zones for Surface Water Systems

Tennessee is using a simplified time-of-travel for the designation source water assessment/protection zones. It is based on using a flow velocity of 1 ft/sec, which is a high rate of flow just below or nearing flood conditions much higher than average. For eight hours time of travel, this roughly corresponds to 5 miles upstream (see Figure 9 below). For 24 hours time of travel this roughly corresponds to 15 miles upstream (see Figure 10). Water systems in Tennessee are already required to have 24 hour storage capacity or other alternative measures for water supply, which effectively gives 48 hours lead time.

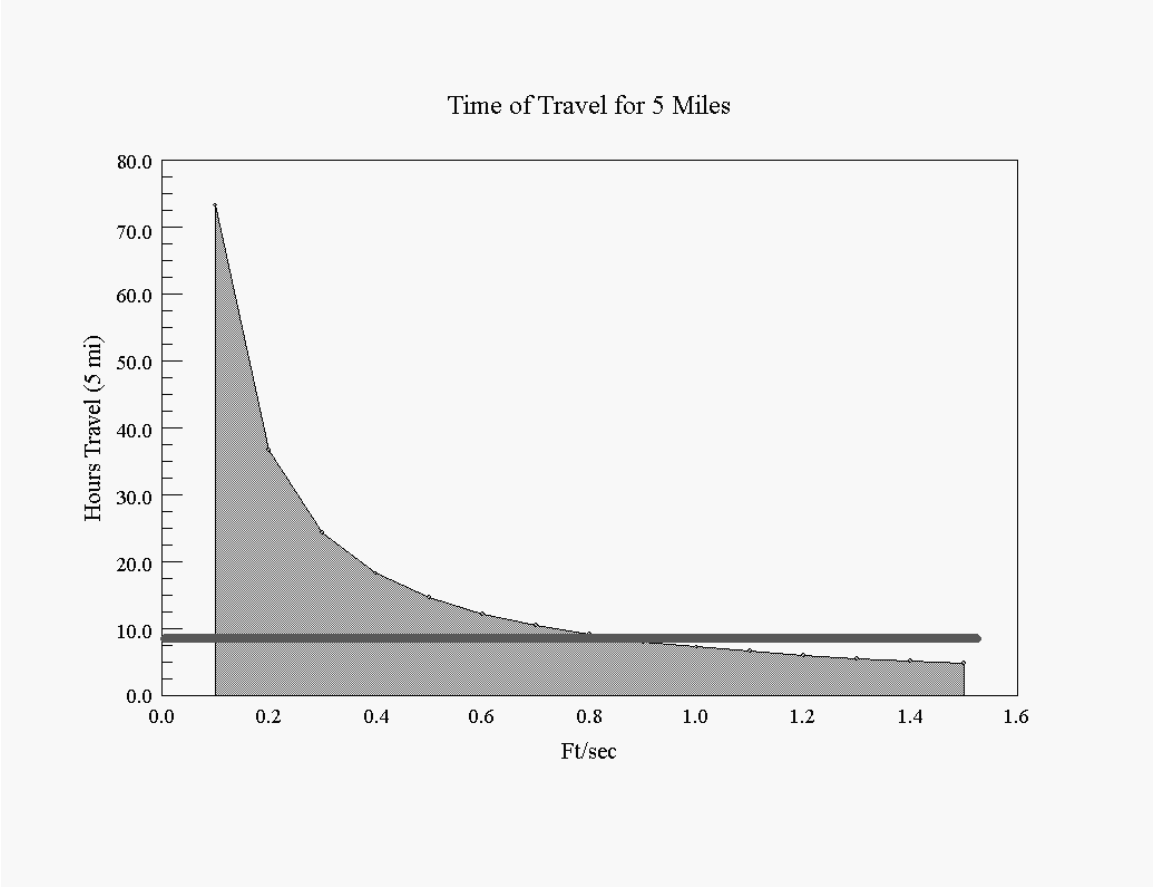



Figure 9

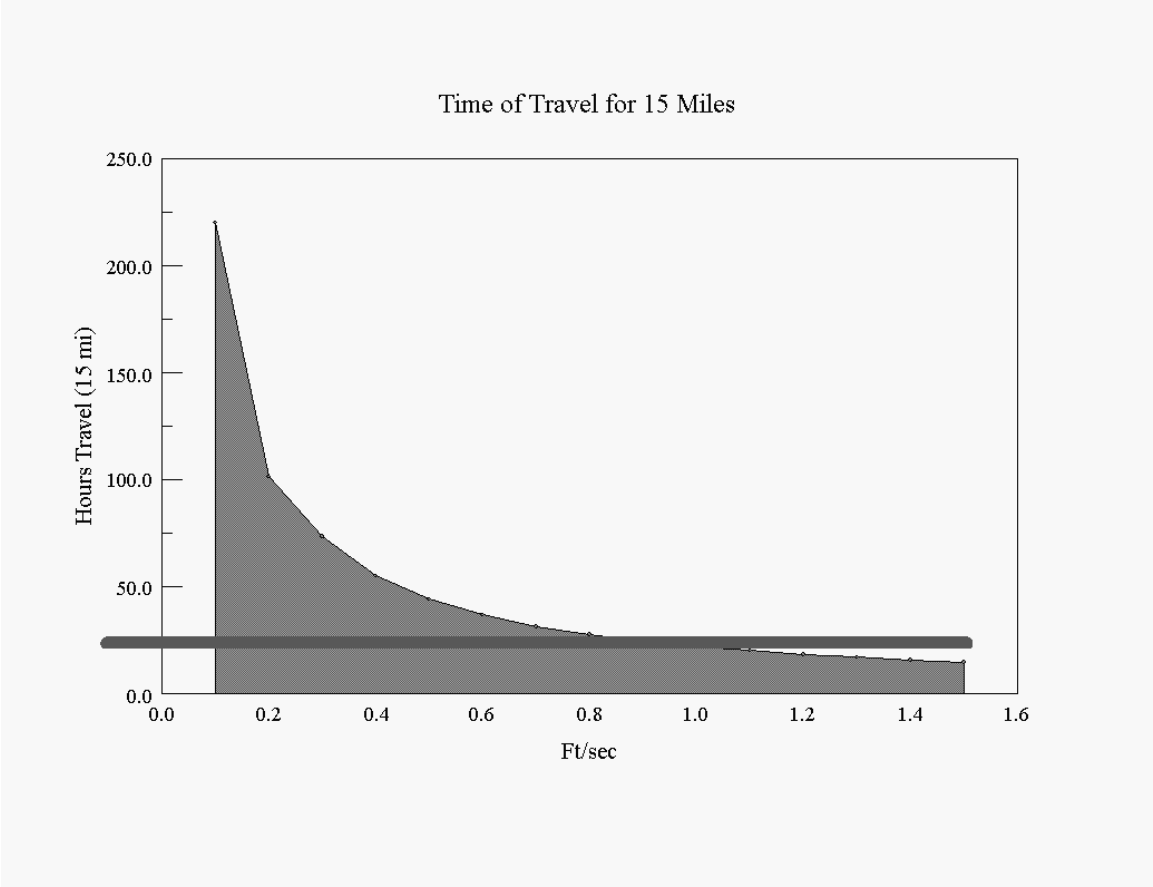



Figure 10

This method of delineation is less complex than using modeling for individual rivers and lakes, but and is actually more protective under most conditions. Normal flow conditions typically range from 0.2 to 0.4 ft/sec. At low flow conditions, where the waterbody is at its lowest levels and there is little benefit of dilution, fifteen miles actually translates into several days upstream (greater than 200 hours). The same 5 and 15 miles upstream is also being used for lakes since their variable nature (including raising and lowering of water levels artificially via dam releases) would require complex and unreliable modeling. Here again 5 and 15 miles upstream is considerably more conservative and protective, since flow would generally be expected to be lower in lakes than rivers. In the case of city reservoirs/very small watershed reservoirs, the feeding stream may not continue back up for 5 miles, in which case the entire watershed will be assessed.

As a part of the individual assessments there will be a "survey corridor" of 1000 feet to either side of the stream within which potential contaminant sources will be inventoried. This corridor will more than encompass the 100 year flood zone, which is typically 200 - 500 feet off of the stream (TVA personal communication). Inventories will also include to within 1/2 mile downstream of the intake to account for the possibility of backflow conditions. All tributaries to the stream where the intake is located which are "blue line"

streams {perennial streams which register as solid blue lines on USGS 7 ½ topographic maps} will also be included in the survey up to the appropriate distance from the intake.

The 1000 foot inventory corridor to either side of the stream is illustrated in Figure 11 below. Also indicated in the Figure 11 are the five miles and fifteen miles upstream points on the main stream and its tributaries as well as the HUC 11 boundaries. In actuality, in simplistic cases such as the one illustrated in Figure 11 where the area of concern fall essentially within one HUC11 unit, the entire unit is being inventoried rather than restricting the inventory to the 1000 foot corridor. This has proven to be a more convenient and less time consuming method in these small subwatersheds.

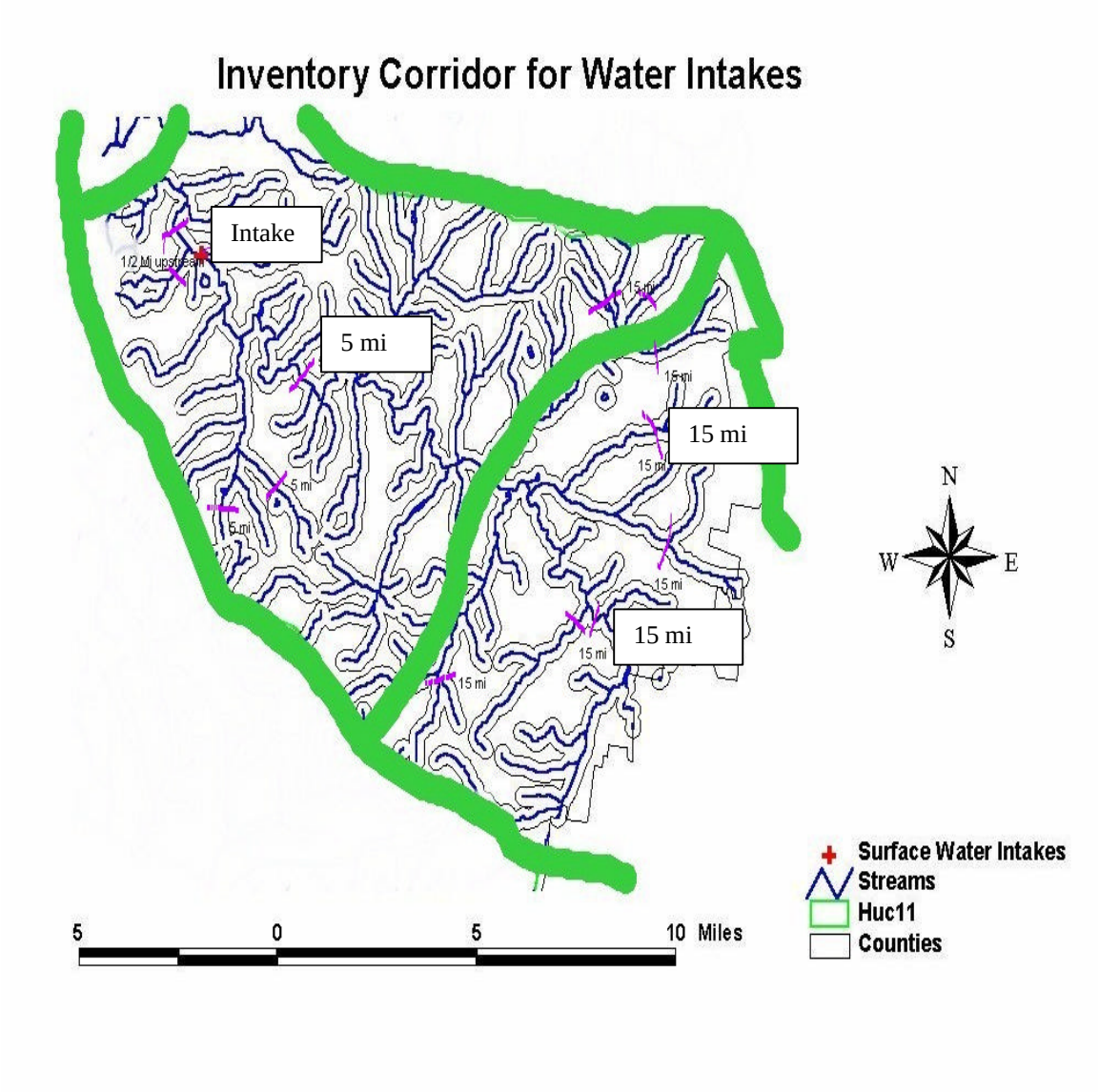



**Figure 11**

For purposes of the assessments, there will be two zones of protection for each surface water intake (unless there is a consolidation of multiple intakes along a stream reach):

1) Critical Source Water Protection Zone - five miles upstream of the intake and along any major tributaries with a 1000 ft corridor.

2) Source Water Management Zone (SWMZ) - encompasses the remainder of the appropriate watershed within that HUC unit.

   Zone A (Inner SWMZ) 5 - 15 miles upstream of the intake and major tributaries with a 1000 foot corridor.

   Zone B (Outer SWMZ) from 15 miles to the upper end of the watershed

**Critical Source Water Protection Zone**

Within the proposed critical source water protection zone, significant potential contaminant sources will be located in the field by the Division of Water Supply's contractor to provide accurate locational information for existing databases. Activities within the critical source water protection zone will include:

1) Confirming intake location
2) Interviewing water system staff
3) Confirming permitted stream discharge (NPDES) locations
4) Confirming permitted storm water discharge locations
5) Inventorying agricultural use
   a) Row crop
   b) Pasture
   d) Animal feeding operations/waste lagoons*
6) Performing a "windshield survey" for other potential nonpoint source activities
7) Confirming locations of other significant industrial activities {using business phone database and narrowing the search using Standard Industrial Classification (SIC) codes}
8) Confirming locations for landfills, Superfund sites, hazardous waste handlers/generators, TRI (Toxic Release Inventory) release sites
9) Performing a "windshield survey" of facilities and activities for best management practices (good versus poor "housekeeping")

*For purposes of the source water assessments, animal feeding operations will be inventoried that have above the threshold number of animals given below and (1) stable, confine and feed or maintain animals for a total of 45 days or more in any

12 month period and that (2) do not sustain crops, vegetative forage growth or post harvest residues in the normal season over any portion of the facility.

1) 9,000 or more chickens (one commercial chicken house typically holds 24,000 birds) {meets the State's Class II CAFO definition}
2) 100 or more swine (greater than 55 pounds)
3) 50 or more cattle

These threshold numbers are for inventory purposes only to simplify the inventory process and are below those given for concentrated animal feeding operations (CAFO) defined in Tennessee's Strategy for Animal Feeding Operations (with the exception of chickens) developed jointly by the Department of Agriculture and the Department of Environment and Conservation. The State's Strategy is included as Appendix H.

There will be considerable emphasis placed on facilities with storm water discharge permits within the appropriate watersheds upstream of the intakes. This is the most complete database relating to surface water discharges and potential contaminant sources in the vicinity of streams. Unfortunately, the locational information is poor at best and improving that data will be a part of the inventorying process. These facilities are required by regulation to develop Pollution Prevention Plans (Appendix I) that take a comprehensive look at facility operations and address the same environmental concerns that need to be addressed for the source water assessments.

The concerns that will be the focus of the nonpoint source portion of the inventory are given in the table below. Owing to the variety and potential number of nonpoint source problems and nature of the source water assessments, this will obviously be a cursory look and not a complete detailed assessment of nonpoint source problems. A more complete field identification listing of Nonpoint Source problems has been provided by the Nonpoint Source Program in the Department of Agriculture and is given as Appendix J.

Table 4

| | Nonpoint | Source | Concerns | | |
|---|---|---|---|---|---|
| **Row cropping** | grassy buffer strips near streams and rivers | grassed waterways in fields | riparian zones along streams | stabilized streambanks | contour farming on steeper slopes |
| **Livestock** | fenced streams | riparian zones along streams | proper disposal of animal waste | improperly located or maintained animal waste lagoons (near waterbody or sinkhole) | proper disposal of dead animals |
| **Construction** | proper erosion control/gradients, terraces; vegetative growth | proper sediment retention/silt fences and bales; ponds | | | |
| **Riparian Zone Removal** | clearing of stream banks | unfenced stretches of streams, lakes to significant numbers of livestock | | | |
| **Urban Runoff: roads, golf courses, parking lots, etc.** | untreated runoff from large impermeable surfaces | uncontrolled flow of storm event runoff from impermeable surfaces to streams and sinkholes | excessive Pesticide/fertilizer applications to lawns, golf courses | | |
| **Forestry** | improper placement/maintenance of haul roads | insufficient riparian zones along waterbodies | improper use of pesticides along waterbodies | | |
| **Illegal Dump Sites** | usage of any land as a dumping ground | discarding objects into waterbodies or sinkholes | | | |
| **Abandoned/unreclaimed Mineral Extraction (quarries, mines, oil & gas)** | contaminated surface waters from mining operations reaching neighboring waterbodies | seepage of ground water from spoil piles to waterbodies | abandoned/poorly maintained oil & gas wells | poorly maintained tank batteries (storage tanks from oil & gas operations) | abandoned/unreclaimed gravel, phosphate and limestone quarries |
| **Failing septic tanks** | seeping of septage to the surface | straight pipes into waterbodies or sinkholes | | | |
| **Well vicinity protection** | placement of septic fields too close to well | pesticide/fertilizer mixing too close to well | livestock too close to well | Animal waste lagoons too close to well | |
| **Pesticide Mixing & Storage** | mixing of pesticides/fertilizer on bare ground | mixing of pesticides/fertilizer too close to waterbodies/sinkholes/wells | storage of pesticides/fertilizer too close to sinkholes/waterbodies/wells | improper storage of pesticides/fertilizer w/ exposure to the elements | Improper disposal of pesticides & fertilizer |

## Source Water Management Zone

Within the proposed Source Water Management Zone, Tennessee Department of Environment and Conservation (TDEC) will rely more on electronic media/TDEC files and databases to provide the information in a somewhat less accurate but less manpower-intensive manner. For the Inner Zone (Zone A) of the Source Water Management Zone, higher risk contaminant sources will still be located in the field such as:

1) TRI release sites
2) Permitted discharge (NPDES) sites

3) Permitted storm water discharge locations
4) Targeted high risk SIC code list from phone database
5) Animal feeding operations/waste lagoons

The inventory for the Outer Zone (Zone B) of the Source Water Management Zone will rely on electronic databases only and focus on known contaminant sources which have affected the water intake or caused the intake to be shut down as a precautionary measure.

Sanitary surveys will not play a role in source water assessments for surface water systems. The restricted timeframe to complete source water assessments makes it unrealistic to tie them in with the schedule for the sanitary surveys for surface water systems. In addition, the source water assessments for surface water systems are being contracted out and there are no regulatory requirements for these assessments. This would also make it difficult to provide a viable link. As surveys are being conducted, Water Supply staff will be directed to ask if there are SWA concerns and whether or not they have their particular assessment on file once they are completed.

The schedule for surface water systems is linked to the Watershed Management cycle. Those within the Group 1 will be completed by end of December 1999 to synchronize with the watershed cycle. Thereafter, one group per year will be completed and an additional group initiated (group 2 and part of 3 in calendar year 2000; group 3 & part of 4 in calendar year 2001; group 4 and part of group 5 in calendar year 2002; and completion of group 5 in 2003). The source water assessments for surface water systems are being done by contract, with the last assessment submittals due several months prior to the required deadline. There is a sizeable final payment that will be forfeited if the submittals from the contractor are not completed on time.

## Susceptibility Analysis

Tennessee is blessed with an abundance of high quality ground water and surface water. Prevention of contamination is a critical element in the protection of these waters if Tennesseans are to continue to benefit from these high quality waters. There are certain natural and man-made factors which make certain water sources more susceptible to contamination. All water sources should be considered to have some susceptibility to contamination since no water source is completely immune. There are specific geologic and hydrologic settings that make the water source more vulnerable due to natural conditions. There are also certain man-made processes and activities that put the water sources more susceptible to contamination due to the proximity of these potential contaminant sources.

For the purposes of Tennessee's Source Water Protection Program, susceptibility is defined as : the potential for contamination of a public water system's raw water source at levels above drinking water standards or other health-based concerns; based on the likelihood and character of releases from potential contaminant sources and human activities within the areas hydrologically upgradient of the raw water source

Determining the relative potential risk of contamination for each water system intake and well or spring allows EPA and the states to prioritize resources in the protection of water sources and also gives the water system information to better manage the water supply. Tennessee has developed a susceptibility analysis based on a series of yes/no potential contamination factors to keep the susceptibility evaluation as objective as possible. These factors are then incorporated into a pie chart, with each factor as a separate "slice." The size of the slice has been assigned a percentage according to concern (e.g., contamination detected at an intake is a high concern and a larger slice) based the experiences on senior level technical staff within the Division of Water Supply and will not change from evaluation to evaluation. The key to Tennessee's Susceptibility Analysis Method is whether the slice is a yes (shaded dark) or no (unshaded).

It is very difficult with current resources to inventory urban nonpoint source problems. These tend to be pervasive in the urban environment - parking lots, runoff from yards with fertilizer and herbicides, etc. Unless the Division has information to indicate otherwise, this "slice" will score as a yes in urban settings (e.g., indicated by urban coverage on topographic map) by default. If there are serious nonpoint source problems, the "multiplicity" factor will also score.

To address multiple sources under a specific category, a separate "multiplicity factor" has been added. Where there are multiple sources under a particular category, the "multiplicity" slice will also be scored.

Intakes, wells/wellfields or springs that have a larger percentage of the pie chart shaded in on their susceptibility diagram will be considered more susceptible to contamination. There are separate sets of factors for surface water and ground water. Example susceptibility diagrams for a hypothetical surface water intake and ground water withdrawal point are given below.

For purposes of Tennessee's Source Water Assessment Program, high susceptibility is greater than 40% of the susceptibility diagram (pie chart) filled in from a summation of the susceptibility factors; medium susceptibility is 20% - 40% filled in and low susceptibility is less than 20% filled in.

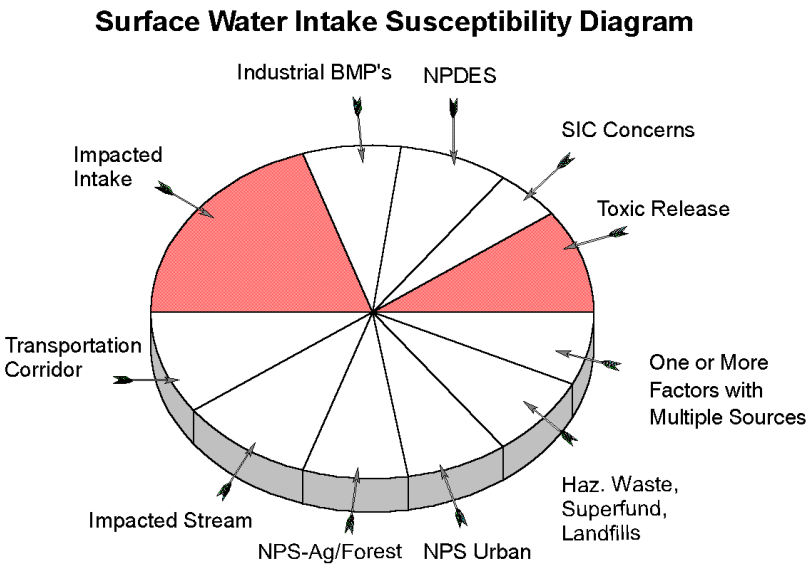



**Figure 12**

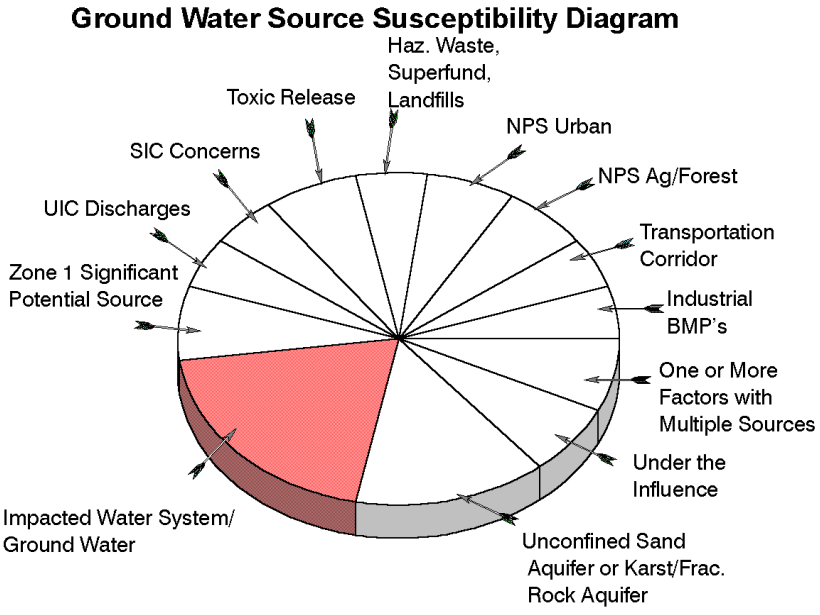



**Figure 13**

In addition to the information collected to make the susceptibility determination, lists of significant potential sources of contamination within the source water protection area will also be compiled with locational and tabular data for GIS use as was discussed under Critical Protection Zone and Source Water Protection Zone. A significant potential source of contamination is defined as: a facility or activity that stores, uses, or produces chemicals or elements, and that has the potential to release contaminants identified in state program {contaminants with health based drinking water standards plus any others a state considers a health threat} within a source water protection area in an amount which could significantly to the concentration of contaminants in the source waters of the public water supply.

The Division of Water Supply is working with the Division of Water Pollution Control to get an inventory of sewer bypasses and overflows which would be considered areas of higher concern - frequently controlled by the same municipality, etc. as the one operating the water system. There is no inventory of sewer locations across the state and locating all of them for the contaminant source inventory would be beyond the resources currently available. Pipelines (excluding water lines) are already included in the susceptibility analyses and will include those concentrated sewers and problem areas that are identified.

## Surface Water Intake Susceptibility

All surface water systems are vulnerable to contamination – any contaminant released upstream of the intake could impact the intake. The susceptibility will be determined based on the density, proximity and types of significant sources of contamination present in the protection area. The following factors will be considered in determining the susceptibility of a specific water intake, with each factor as the "slice" of a pie chart. The size of each slice was determined by weighting the factors as to level of concern. If more than 20% of the pie chart is filled in, the intake will be considered moderately susceptible and if more than 40% of the pie chart is filled in, the intake will be considered highly susceptible. An example susceptibility diagram has been included as Figure 13. The percentages assigned to each factor are given within the slices in the figure.

To address multiple sources under a specific category, a separate "multiplicity factor" has been added. Where there are multiple sources under a particular category, the "multiplicity" slice will also be scored. This will be true for nonpoint source, toxic release, Hazardous Waste/Superfund, NPDES and SIC concerns.

## Surface Water Intake Susceptibility Determination

**TRIS Releases to Water**

■ Yes ☐ No

High toxicity release (Hazard Ranking of 2 or 3 in Sax; Hazardous Properties of Industrial Materials) upstream of the intake within the watershed or ½ mile downstream.

Large quantity release of lower toxicity (greater than 50 gallons or 100 kg) less than 15 miles upstream or ½ mile downstream.

The "multiplicity factor" will also be scored where there are multiple TRI releases reported upstream of the intake.

**Facilities/Activities of Concern within a Watershed based on SIC Codes ****

■ Yes ☐ No

Facilities of concern (based on priority SIC Codes identified below) less than 5 miles upstream or ½ mile downstream of the intake which are within the 1000 ft corridor of the stream or tributary.

The "multiplicity factor" will also be scored where there are multiple facilities with SIC code concerns upstream of the intake.

**The Standard Industrial Classification (SIC) Codes of concern were based on the top 100 Toxic Release Inventory releases to water in Tennessee reported from 1993 – 1996 (see table below). Additional facility/activity types are listed which may be a potential problem as a result of the types of materials and/or waste handled or which have resulted in previous Departmental investigations/action.

**Table 5**
**Top 100 TRI Releases to Water in Tennessee**

| SIC Code (Major) | Category | Number of Facilities |
|---|---|---|
| 20 | Food & Kindred Products | 3 |
| 22 | Textile Mill Products | 2 |
| 24 | Lumber & Wood Products | 2 |
| 26 | Paper & Allied Products | 6 |
| 27 | Printing & Publishing | 2 |
| 28 | Chemicals & Allied Products | 22 |
| 29 | Petroleum & Coal Products | 1 |
| 30 | Rubber & Miscellaneous Plastics | 9 |
| 31 | Leather & Leather Products | 1 |
| 32 | Stone, Clay & Glass Products | 2 |
| 33 | Primary Metal Industries | 15 |
| 34 | Fabricated Metal Products | 9 |

| | | |
|---|---|---|
| 35 | Industrial Machinery & Equipment | 5 |
| 36 | Electronic & Other Electrical Equipment | 7 |
| 37 | Transportation Equipment | 6 |
| 39 | Miscellaneous Manufacturing Industries | 3 |
| 49 | Electric, Gas & Sanitary Services (Includes Landfills) | 1 |
| 87 | Engineering & Management Services | 1 |
| 97 | National Security/Airplane Production | 1 |

Additional Facilities of Concern

25 Furniture Manufacture
42 Trucking/Storage Services
44 Water Transportation & Marinas
47 Freight Transportation Services
5015 Used Motor Vehicle Parts (Salvage Yards)
5093 Scrap and Waste Materials (Metal Recycling)
5171, 5172 Petroleum Bulk Storage
5191 Farm Supplies, Agricultural Chemicals
5541 Gasoline Service Stations
5989 Fuel Dealers Retail
5999O Feed & Farm Supply Dealers Retail
7342 Disinfecting & Pest Control Services
75 Automobile Related Services
7389 Commercial Part B Hazardous Waste Treat, Store, Disposal

**National Pollutant Discharge Elimination System (NPDES) Discharges**

■ Yes ☐ No

Municipal/Industrial NPDES discharges within 15 miles upstream or ½ mile downstream of the intake within the 1000 ft corridor of the stream or tributary.

The "multiplicity factor" will also be scored where there are multiple facilities with NPDES discharges upstream of the intake.

**Known Impact to Water System**

■ Yes ☐ No

Water system has had to temporarily shut down intake due to contamination or as a precautionary measure.

Water system has had to increase treatment due to contamination threat or problems.

Contaminants for which there are primary Drinking Water Standards have been detected at or in the vicinity of the intake.

**Major Transportation Corridor**

■ Yes ☐ No

Within fifteen miles upstream of the intake or ½ mile downstream of the intake there are railways or major highways (two lanes or more) within the 1000 ft corridor or bridges or pipelines (excluding water lines).

The stream upon which the intake occurs is subject to barge traffic.

**Impacted Stream**

■ Yes ☐ No

Within 15 miles upstream of the intake, the stream upon which the intake is located or a tributary of that stream has been designated as a 303d listed stream under the Clean Water Act.

**NonPoint Source Impacts – Agriculture and Forestry**

■ Yes ☐ No

Nonpoint Source concerns related to agricultural or forestry practices have been identified within 15 miles upstream of the intake.

The "multiplicity factor" will also be scored where there are multiple agricultural and forestry nonpoint source concerns upstream of the intake.

**NonPoint Source Impacts - Urban**

■ Yes ☐ No

Nonpoint Source concerns related to urban runoff have been identified within 15 miles upstream of the intake.

Unless the Division of Water Supply has information to indicate otherwise, this "slice" will score as a yes in urban settings (e.g., indicated by urban coverage on topographic map) by default.

The "multiplicity factor" will also be scored where there are multiple urban nonpoint source concerns upstream of the intake.

**Facilities Handling Hazardous Waste; Landfills and Superfund Sites**

■ Yes ☐ No

Permitted RCRA facility (hazardous waste treatment, storage or disposal facility), hazardous waste generator, municipal or industrial landfill or Superfund site within 15 miles upstream or ½ mile downstream of the intake within the 1000 ft corridor of the stream or tributary.

The "multiplicity factor" will also be scored where there are concerns from multiple facilities upstream of the intake.

**Industrial Best Management Practices**

■ Yes ☐ No

Spills, diking problems, polluted runoff, etc. identified in the Pollution Prevention Plan required for Storm Water General NPDES Storm Water Discharges as described in Rule 1200-4-10-.04 (5) within 15 miles upstream or ½ mile downstream of the intake within the 1000 ft corridor of the stream or tributary.

Identified "poor housekeeping" practices (leaks and spills; improper drum storage; waste disposal or material storage) from field assessment activities within 15 miles upstream or ½ mile downstream of the intake within the 1000 ft corridor of the stream or tributary.

Identified problems from mining or oil and gas production activities within 15 miles upstream or ½ mile downstream of the intake within the 1000 foot corridor of the stream or tributary.

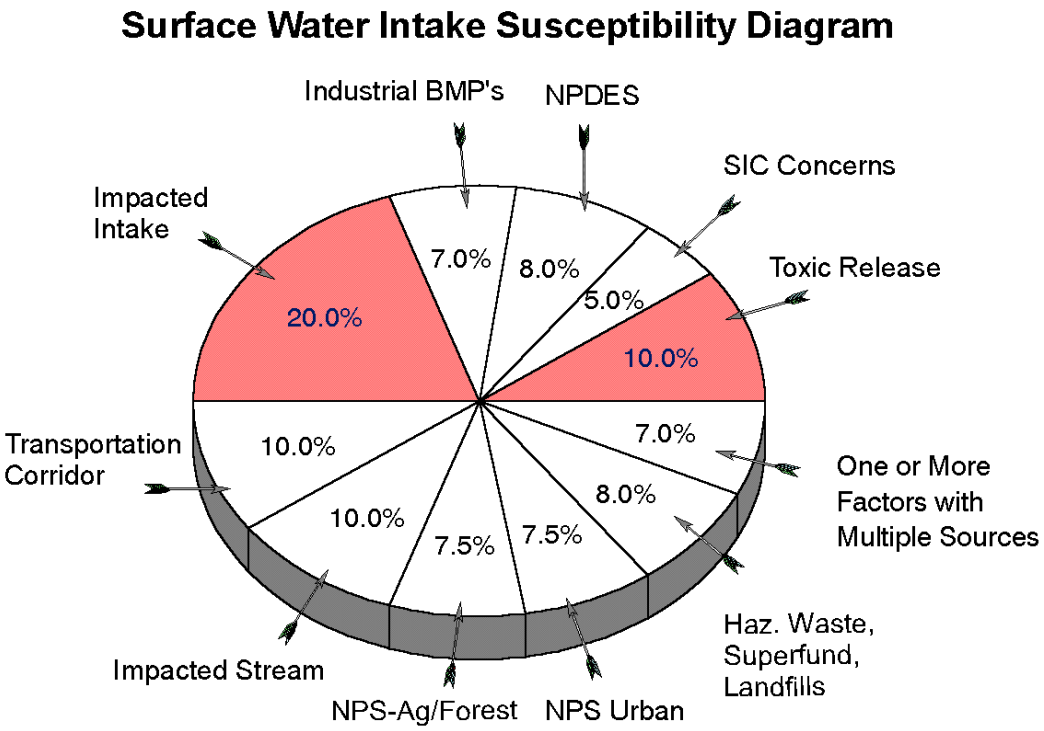

Surface Water Intake Susceptibility Diagram
Industrial BMP's
NPDES
SIC Concerns
Impacted Intake
Toxic Release
7.0%
8.0%
5.0%
20.0%
10.0%
Transportation Corridor
10.0%
7.0%
One or More Factors with Multiple Sources
8.0%
10.0%
7.5%
7.5%
Haz. Waste, Superfund, Landfills
Impacted Stream
NPS-Ag/Forest
NPS Urban

**Figure 14**

## Ground Water (Well & Spring) Susceptibility

Tennessee's Wellhead Protection Program for public ground water systems began in 1994. The only significant modification necessary to comply with the Source Water Assessment requirements is the addition of the susceptibility analysis for the water source (well/wellfield or spring).

There are two wellhead protection zones established for each well or spring -- an inner zone (Zone 1) around the well or spring to protect the immediate area from spills, etc., and a larger management zone (Zone 2) which takes into account the wide variety of geologic conditions across Tennessee to provide for long-term management for the well, wellfield or spring.

The varying geology across the state makes some areas more vulnerable than others. All ground water in Tennessee should be considered somewhat vulnerable to contamination.

### Hydrogeology of Tennessee

The geology of Tennessee makes certain aquifers more vulnerable to contamination where there is no confining layer or naturally filtering layer to deter contamination from reaching the ground water (Figure 8). The unconfined sand aquifers of West Tennessee (particularly the Memphis Sand Aquifer) are vulnerable to contamination (see Figure 15) as are the karst limestone aquifers of Middle and East Tennessee. The hydrogeologic makeup of Tennessee is given in Table 6 below.

# Table 6
## TENNESSEE'S HYDROGEOLOGICAL CHARACTERISTICS

**WESTERN TENNESSEE**

**Alluvial Aquifer.** The Alluvial Aquifer in western Tennessee underlies the flood plain of the Mississippi River and its tributaries and the southern end of the Western Valley of the Tennessee River. This aquifer, which consists of sand and gravel with interbeds of clay, is used primarily for rural domestic supplies and for some irrigation. This aquifer is capable of yielding more than 1,500 gallons per minute to wells in the Mississippi River area. In some areas iron concentrations which exceed 1.0 milligram per liter are a problem.

**Memphis Sand.** In western Tennessee, the Memphis Sand ("500 Foot Sand") is the primary aquifer of use. The Memphis Sand underlies approximately 7,400 $mi^2$ in western Tennessee. It primarily consists of a thick body of sand that contains subordinate lenses or beds of clay or silt at various horizons. The sand ranges from very fine to very coarse, but commonly it is locally fine, fine to medium, or medium to coarse. The Memphis Sand ranges from 0 to about 900 feet in thickness but, where the original thickness is preserved, it is about 400 to 900 feet thick. The base of the Memphis Sand dips westward at rates of about 20 to 50 ft/mi, but it is faulted at many places. The Memphis Sand yields water to wells in most of the area of occurrence and, where saturated, makes up the Memphis aquifer.

Recharge to the Memphis aquifer is from precipitation on the outcrop, which is a broad belt across western Tennessee, or by downward infiltration of water from the overlying fluvial deposits and alluvium. In the outcrop-recharge belt, the Memphis aquifer is under water-table conditions (unconfined), and the configuration of the potentiometric surface is complex and generally conforms to the topography. In the subsurface to the west of the outcrop-recharge belt where the Memphis aquifer is confined (artesian), the potentiometric surface generally gently slopes westward, and water moves slowly in that direction.

**Fort Pillow Sand.** The Fort Pillow Sand ("1400 Foot Sand") underlies the Memphis Sand and the Flour Island Formation in the western portion of West Tennessee. The Flour Island Formation acts as an upper confining layer to the Fort Pillow and a lower confining layer for the Memphis Sand. The sand is fine to medium; thickest in the southwest portion of the Memphis area; thinnest in the northern and northeastern parts. Once the second principal aquifer supplying the city of Memphis; still used by industry. Principal aquifer providing water for municipal and industrial supplies west of the Mississippi River.

**Cretaceous Sand.** The Cretaceous Sand aquifer is composed of the McNairy and Coffee Sands, and the Tuscaloosa Formation. The formations crop out in the eastern part of the Coastal Plain and underlie the Tertiary Sand to the west. The Cretaceous Sand aquifer (recently renamed the Western Valley aquifer) is used primarily in and near the outcrop area where it supplies water for municipal, industrial, and rural use. Water in the aquifer is unconfined in the outcrop area and confined in the subsurface farther west. The Cretaceous Sand aquifer is underlain by the Ordovician Carbonate aquifer and the Cambrian-Ordovician Carbonate aquifer (Knox).

**MIDDLE TENNESSEE**

**Mississippian Carbonate (*KARST*).** The Mississippian Carbonate aquifer (recently renamed the Highland Rim aquifer) consists of flat-lying carbonate rocks of Mississippian age and underlies the Highland Rim physiographic province. Land in the eastern, northern, and southern parts of the province is predominantly undulating, whereas the western part is more dissected and hilly to steep. Altitude of land surface averages about 1,000 feet above sea level. The bedrock formations weather of form a deep (up to 100 feet thick) chert regolith, which stores ground water and releases it to openings in the bedrock. Fractures in the bedrock have been widened selectively by solution, permitting rapid transmission of water, as well as providing some storage. Well yields commonly range from 5 to 50 gal/min.

**Ordovician Carbonate (*KARST*).** The Ordovician Carbonate aquifer (recently renamed the Central Basin aquifer) consists of generally flat-lying carbonate rocks of Ordovician age and underlies the Central Basin physiographic province. The outer part of the Central Basin is predominantly hilly and steep; average altitude of land surface is about 750 feet above sea level. Regolith in the outer part of the Central Basin ranges form less than 2 to more than 10 feet thick. Land in the inner part of the province is predominantly rolling and undulating with an average altitude of about 600 feet above sea level. Regolith cover in the inner part of the province is thin (less than a foot) to absent. Water is stored in and moves through solution-enlarged vertical joints and horizontal bedding planes. Wells commonly yield from 5 to 20 gal/min. At depth (>1000 ft) the Central Basin is underlain by the Knox Aquifer, whose upper formations can provide substantial quantities of water.

**Pennsylvanian Sandstone (*PREDOMINANTLY FRACTURED ROCK AQUIFER*).** The Pennsylvanian Sandstone aquifer (recently renamed the Cumberland Plateau aquifer) consists of generally flat-lying sandstone, shale, and conglomerate of Pennsylvanian age and underlies the Cumberland Plateau physiographic province. Land surface in this province is gently rolling to hilly, bordered by a prominent escarpment of both sides. Altitude of the plateau surface is generally between 1,700 and 1,900 feet above sea level; the height of the escarpments averages 900 feet. Regolith is generally less than 4 feet thick. Water is stored in and moves through fractures, faults, and bedding plane openings in the bedrock. Wells commonly yield from 5 to 50 gal/min.

**EASTERN TENNESSEE**

**Cambrian-Ordovician Carbonate (*KARST*).** The Cambrian-Ordovician Carbonate aquifer (recently renamed the Valley and Ridge aquifer) consists of extensively folded and faulted carbonate, sandstone, and shale of Cambrian and Ordovician age underlying the Valley and Ridge physiographic province. The rock formations crop out alternately in long, narrow belts, so that aquifer characteristics show marked areal variability. The ridges range in altitude from about 1,500 to over 7,000 feet above sea level; valleys

generally range between 750 and 1,000 feet above sea level. Generally regolith is thin over the shales and sandstones and thick over the limestone. The sandstone and shale units are poor aquifers; nearly all the high producing wells and springs are in the dolomitic limestone formations, particularly the upper formations of the Knox Group (Mascot and Kingsport). The Knox aquifer is frequently singled out as a separate aquifer. Water moves through solution-enlarged fractures, which in areas may form extensive networks. The folding and faulting has produced regional anisotropy in aquifer hydraulic properties, and ground water may move preferentially in strike-parallel or strike-normal directions. Well yields commonly range from 5 to 200 gal/min.

**Crystalline Rock Aquifer (*FRACTURED ROCK AQUIFER*).** The Crystalline Rock aquifer (recently renamed the Blue Ridge Aquifer) consists of crystalline rock of Cambrian and Precambrian age underlying the Blue Ridge physiographic province. The province is characterized by extremely rugged terrain, with several mountain peaks higher than 6,000 feet above sea level, and valleys ranging from 1,000 to 1,500 feet above sea level. The aquifer consists of dense, fractured bedrock covered on the lower parts of the slopes with a thick mantle (as much as 100 feet) of regolith, alluvium, and colluvium. The regolith stores ground water, releasing it to fractures in the bedrock. The essentially unmodified fracture openings contribute very little to storage, functioning mainly to transmit water stored in the regolith. Wells yield from 5 to 50 gal/min.

***INFORMATION FOR THIS TABLE WAS DERIVED FROM THE FOLLOWING SOURCES:**


1. Tennessee Dept. of Health and Environment; Ground Water Management Strategy, 1988.
2. Bradley, M. W., and Hollyday, E. F., 1985. Tennessee ground-water resources, *in* National Water Summary 1984: Hydrologic Events, Selected Water Quality trends, and Ground Water Resources: U. S. Geological Survey Water Supply Paper 2275, p. 391-396.
3. U. S. Geological Survey. 1986. Potential for Leakage among Principal Aquifers in the Memphis Area, Tennessee. Water-Resources Investigation Report 85-4295.

Figure 15
Vulnerable Aquifers

Tennessee has an abundance of karst (Figure 16) which is highly susceptible to contamination. Karst is characterized by sinkholes, springs, disappearing streams and caves; as well as by rapid, highly directional ground water flow in discrete channels or conduits. The term karst refers to limestones and dolomites (magnesium-rich limestones) where ground water flows through solution-enlarged channels, bedding planes and microfractures within the rock. Karst systems are quite easily contaminated since the waters can travel long distances through conduits with no chance for natural filtering processes of soil or bacterial action to diminish the contamination. Transport times across entire karst flow systems may be as short as hours or weeks, orders of magnitude faster than that in sand aquifers.

Water in karst areas is not distinctly surface water or ground water. In unconfined or poorly confined conditions, karst aquifers have very high flow and contaminant transport rates under rapid recharge conditions such as storm events. This is a particular concern for public water systems using wells or springs in karst areas where pathogenic organisms that would not be present in true ground water can survive in ground water under the influence of surface water.

The most vulnerable wells and springs in Tennessee would have to be those that have been determined to be under the direct influence of surface water. Required testing of community public water systems using ground water has shown numerous instances of individual sources under the direct influence of surface water across Middle and East Tennessee (Figure 17). These systems have to have their sources filtered as if they were surface water intakes or undertake other protective measures. Approximately 2/3 of the community public water systems using ground water in Middle and East Tennessee have had at least one source determined under the direct influence of surface water.

The following factors will be considered in determining the susceptibility of a well, spring or wellfield, with each factor as the “slice” of a pie chart. The size of each slice was determined by weighting the factors as to level of concern. If more than 20% of the pie chart is filled in, the source will be considered moderately susceptible and if more than 40% of the pie chart is filled in, the source will be considered highly susceptible. An example susceptibility diagram has been included as Figure 18. The percentages assigned to each factor are given within the slices in the figure. Note that for ground water susceptibility determinations, there is a hybridization of vulnerability (geologic) and susceptibility factors.

To address multiple sources under a specific category, a separate “multiplicity factor” has been added. Where there are multiple sources under a particular category, the “multiplicity” slice will also be scored. This will be true for nonpoint source, toxic release, Hazardous Waste/Superfund, UIC and SIC concerns.

Figure 16
Sinkhole Distribution in Tennessee

Figure 17
Ground Water Under the Direct Influence

## Ground Water Source Susceptibility Determination

### Vulnerability Factors

**Ground Water Under the Influence of Surface Water**

■ Yes ☐ No

Well or spring has tested and determined to be under the influence of surface water. A wellfield would be considered under the direct influence if one or more wells within it test positive for influence.

For susceptibility, generic karst and GWUDI have separate scores. There is karst and there is **KARST**. Systems under the direct influence are in rapid flow, mature conduit karst, which is of considerably more concern than those systems in karst that are not under the direct influence. Wells/springs scored for GWUDI will automatically also be scored for karst.

**Karst/Fractured Rock Aquifer or Unconfined Sand Aquifer**

■ Yes ☐ No

Well or spring is within karst/fractured rock area of the state or well is in unconfined sand aquifer in West Tennessee.

### Susceptibility Factors

**Zone 1 Wellhead Protection Area**

■ Yes ☐ No

Significant potential source of contamination within Zone 1 of the Wellhead Protection Area. Well integrity problems also score under the Zone 1 factor as do abandoned wells within Zone 1.

The "multiplicity factor" will also be scored where there are multiple potential sources within Zone 1 of the Wellhead Protection Area.

**TRIS Releases**

■ Yes ☐ No

TRIS Release to water or land within Zone 2 of wellhead protection area.

The "multiplicity factor" will also be scored where there are multiple TRIS releases within Zone 2 of the Wellhead Protection Area.

**Facilities/Activities of Concern within the Wellhead Protection Area based on SIC Codes**

■ Yes ☐ No

Facilities/Activities of Concern within the Zone 2 Wellhead Protection Area based on SIC Codes (same SIC Codes as for surface water intakes).

The "multiplicity factor" will also be scored where there are multiple facilities of concern within Zone 2 of the Wellhead Protection Area.

**Underground Injection Control (UIC) Discharges**

■ Yes ☐ No

Class V injection wells (shallow nonhazardous) within Zone 2 of the Wellhead Protection Area. Class V wells include vertical waste disposal wells and commercial/industrial septic tanks, floor drains and large capacity (serving more than 20 persons) septic tanks.

The "multiplicity factor" will also be scored where there are multiple UIC discharges within Zone 2 of the Wellhead Protection Area.

**Impacted Water System/Ground Water**

■ Yes ☐ No

Contaminants for which there are primary Drinking Water Standards have been detected in the well or spring.

Water system has had to increase treatment due to contamination threat or problems.

Ground water contamination has been detected within Zone 2 of the Wellhead Protection Area or the presence of monitoring wells within Zone 2.

**Major Transportation Corridor**

■ Yes ☐ No

Within Zone 2 of the Wellhead Protection Area there are railways or major highways (two lanes or more) within the 1000 ft corridor or bridges or pipelines (excluding water lines).

**NonPoint Source Impacts – Agriculture and Forestry**

■ Yes ☐ No

Nonpoint Source concerns related to agricultural or forestry practices have been identified within Zone 2 of the Wellhead Protection Area.

The "multiplicity factor" will also be scored where there are multiple agricultural and forestry nonpoint source concerns within Zone 2 of the Wellhead Protection Area.

**NonPoint Source Impacts - Urban**

■ Yes ☐ No

Nonpoint Source concerns related to urban runoff have been identified within Zone 2 of the Wellhead Protection Area.

Unless the Division of Water Supply has information to indicate otherwise, this "slice" will score as a yes in urban settings (e.g., indicated by urban coverage on topographic map) by default.

The "multiplicity factor" will also be scored where there are multiple urban nonpoint source concerns within Zone 2 of the Wellhead Protection Area.

**Facilities Handling Hazardous Waste; Landfills and Superfund Sites**

■ Yes ☐ No

Permitted RCRA facility (hazardous waste treatment, storage or disposal facility), hazardous waste generator, municipal or industrial landfill or Superfund site within Zone 2 of the Wellhead Protection Area.

The "multiplicity factor" will also be scored where there are concerns from multiple facilities within Zone 2 of the Wellhead Protection Area.

**Industrial Best Management Practices**

■ Yes ☐ No

Spills, diking problems, polluted runoff, etc. identified in the Pollution Prevention Plan required for Storm Water General NPDES Storm Water Discharges as described in Rule 1200-4-10-.04 (5) within Zone 2 of the Wellhead Protection Area.
Identified "poor housekeeping" practices (leaks and spills; improper drum storage; waste disposal or material storage) from field assessment activities within Zone 2 of the Wellhead Protection Area.

Identified problems from quarrying, mining or oil and gas production activities within Zone 2 of the Wellhead Protection Area.

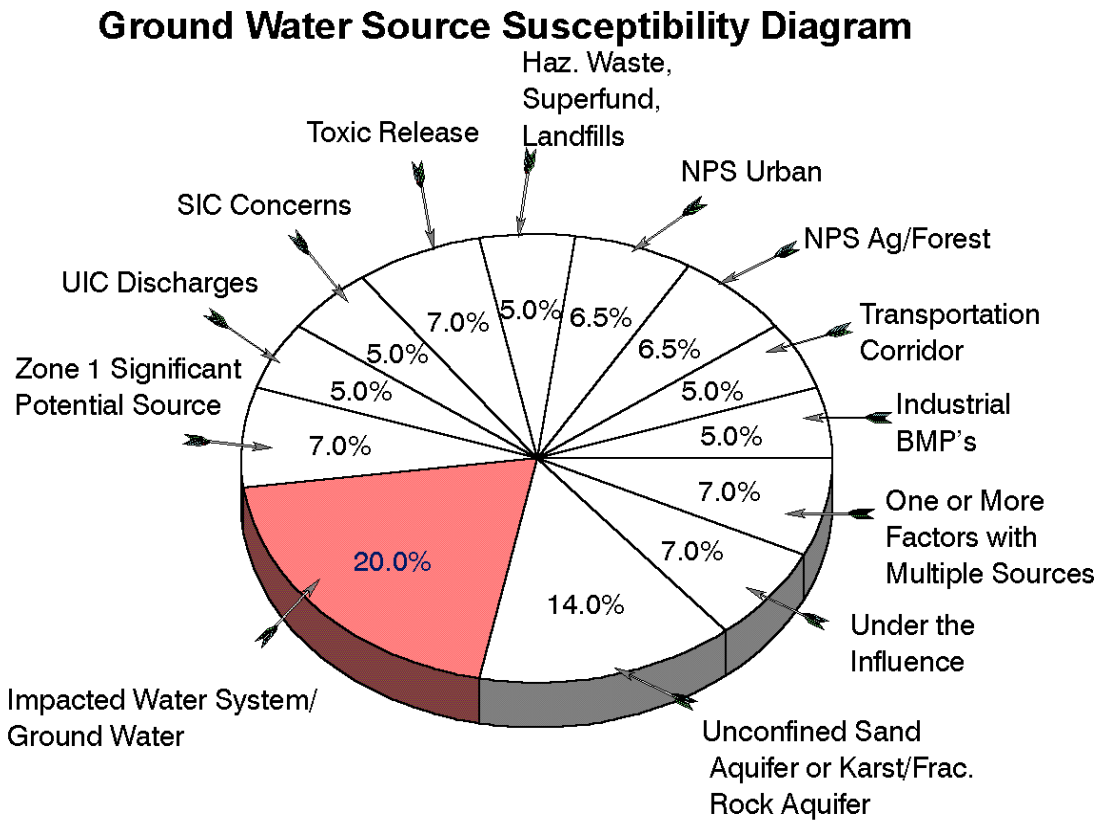

Ground Water Source Susceptibility Diagram
Haz. Waste, Superfund, Landfills
Toxic Release
NPS Urban
SIC Concerns
NPS Ag/Forest
UIC Discharges
Transportation Corridor
Zone 1 Significant Potential Source
Industrial BMP's
One or More Factors with Multiple Sources
Under the Influence
Unconfined Sand Aquifer or Karst/Frac. Rock Aquifer
Impacted Water System/ Ground Water
7.0%
5.0%
6.5%
6.5%
5.0%
5.0%
7.0%
5.0%
5.0%
7.0%
7.0%
20.0%
14.0%

**Figure 18**

## Interstate Issues

There was no requirement by Congress to look outside of state borders. There is no formal agreement process planned at this time, but Tennessee will be open to this if it becomes necessary and expects EPA to assist in this.

The real states of concern bordering Tennessee are all within EPA Region IV which considerably simplifies interaction among the states. As was pointed out, there are concerns in Northern Mississippi about Memphis' withdrawals affecting the aquifer in Mississippi and concerns along the Tennessee River in Tennessee and Alabama. Contract negotiations are about to begin on a US Geological Survey proposal for the Ground Water Institute at the University of Memphis and the USGS to further study the Memphis/Mississippi issue. Tennessee will be using wellhead SRF monies to assist in this study.

There may also shortly be a triple state issue (Tennessee, Georgia and Alabama) in the withdrawal of water from the Tennessee River in Chattanooga to supply Atlanta. Lincoln Memorial University in Claiborne County, Tennessee receives its water from Cudjo Caverns in Virginia. This cave is protected as a part of Cumberland Gap National Park and is not expected to need significant further protection. Lafayette in Macon County Tennessee has as a backup source an intake on the Barren River in Kentucky approximately five miles into Kentucky. This intake would be a problem for state personnel to even assess, but the contractor should be able to cover this (possibly enlisting the aid of Kentucky's affiliate of the National Rural Water Association). Tennessee has already been working with Alabama with the Ardmore wellfield which straddles the state line (the Tennessee well shows contamination, the two Alabama wells do not).

## Funding

Tennessee will be making use of funding available for source water assessments from the capitalization grant for the new Drinking Water State Revolving Fund. Approximately 1.27 million dollars (a 10% setaside) are available for Tennessee's Source Water Assessment activities under the Drinking Water State Revolving Fund. Due to the size of the task and staffing constraints, TDEC's Division of Water Supply will be contracting out the inventory portion the Source Water Assessment work. This money will have to be used prudently to accomplish a task of this magnitude.

Tennessee is fortunate that the implementation of its mandatory Wellhead Protection Program is nearing completion, which is well ahead of most other states. Tennessee's Wellhead Protection Program was implemented with very little in the way of federal funding. The level of funding now available for Source Water Protection would have made it difficult to establish the ground water (Wellhead Protection) and surface water components of Source Water Assessment within the given timeframe.

The Division of Water Supply is making use of the Wellhead Protection setaside (4% of a possible 5%) from the Drinking Water State Revolving Fund to contract with the Ground

Water Institute at the University of Memphis for GIS related work and the U. S. Geological Survey for a Memphis recharge study (over interstate withdrawal issues with Mississippi). This will bring Tennessee's Wellhead Protection Program information to the level needed for Source Water Assessment.

The following workplan was submitted to EPA for the SWAP DRSF setaside in August of 1998:

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## Workplan Submitted to EPA for SWAP DWSRF Setaside

**GENERAL**

The majority of this workplan concentrates on the assessment phase of the Source Water Assessment Program (SWAP) and the contracting out of that assessment work. This workplan will be a dynamic document and will be subject to change as the SWAP evolves.

The SWAP will be developed and implemented by the Tennessee Division of Water Supply. Assistance from an outside contractor will be obtained by TDWS to develop and implement the SWAP. As a result, some components of this workplan will be contingent upon the approval of the contract.

Tennessee anticipates that the entire 10% setaside of $1,227,620 will be required for Source Water Assessment to completion as shown in the Intended Use Plan for the FFY 1997 capitalization grant.

The workplan schedule contemplates completion of the SWAP by May 2003, which is the final date of completion allowable with the 18 month extension. Therefore, Tennessee requests that the EPA extend the 2 year primary period to complete the assessments for an additional 18 months so that the delineation and assessment work can be completed.

**PURPOSE**

The purposes of the SWAP are to:

- Institute a collaborative and comprehensive program to delineate ground and surface water sources serving public water systems;

- Assess the threat or potential threat of contamination to those sources;

- Provide information to managers of public water systems and to local, state and federal government officials having jurisdiction over land use decisions that enhances their abilities to incorporate the protection of drinking water supplies in their respective decision-making processes.

- Provide information on source waters of public water systems to customers of those systems and to the general public; and

- Develop comprehensive and collaborative efforts between the public, and local, state and federal governments to eliminate threats to water sources for public water supplies.

Tennessee's Wellhead Protection Program was approved in July of 1994 and its implementation is nearly complete. The funding for the SWAP setaside will be used to develop and perform the assessments for public water systems relying on surface water sources.

The process of developing and implementing the SWAP will involve a public participation and information process that will give the general public an opportunity for comment and input and access to final results. The results of the SWAP will be publicly disseminated through consumer confidence reports and local libraries and will be available through an Internet Web Site maintained by the Tennessee Department of Environment and Conservation (TDEC).

**OBJECTIVES OF WORKPLAN**

The objectives of this workplan are generally to:

- Develop and implement the strategic approach and plan for conducting source water assessments;

- Solicit and incorporate public participation through a technical and citizens advisory committees for development of the source water assessment plan (SWAP);

- Delineate the boundaries of the hydro-geographic and topographic areas, which provide source water for public water systems using surface water intakes;

- Develop the plan to inventory potential contaminant sources in the delineated areas

- Determine the susceptibility of the water systems;

- Describe how a SWAP will link with existing protection programs; and

- Describe how and through what means or media source water assessments will be made available to the public.

**Implementation of the Source Water Assessment Program**

The focus of implementing the SWAP will be on the following areas:

  - Identify source waters and delineate source water boundaries;

  - Inventory existing and potential contaminant sources;

  - Determine potential impact of contaminant sources;

- Prepare assessment reports which include maps and information about each assessment; and

- Disseminate assessment reports to interested persons, through Internet Web Site and other appropriate means of public communication.

The inventory and assessment will be done by contract. The intended activities within the delineated areas above the individual surface water intakes is as follows:

First 5 miles Upstream of Intake (including tributaries) and 1000 ft off the stream bank:

Interview Water System personnel
Confirm intake location
Confirm permitted discharge (NPDES) locations
Confirm permitted storm water discharge locations
Inventory agricultural use
    Row crop
    Pasture
    Concentrated animal feed lots/waste lagoons
Other industrial activities (using SIC codes and phone CD to create target list)
Confirm locations for landfills, Superfund sites, hazardous waste handlers/generators, TRI (Toxic Release Inventory) release sites
Evaluate sites against vulnerability index (checklist)

5 - 15 miles Upstream of Intake (including tributaries) and 1500 ft off the stream bank:

Confirm selected higher risk activity locations
    TRI release sites
    Permitted discharge sites
    Permitted storm water discharge locations
    Targeted high risk SIC code list from phone CD
    Concentrated animal feedlots/waste lagoons

15 miles - End of Watershed

Electronic database only (no field verifications)

BUDGET JUSTIFICATION

The budgets for the activities of the SWAP were developed in accord with the following general guidelines. As the program develops, the tasks, activities and estimates may change. The table accompanying this section gives a cost breakdown for Division of Water Supply purchases and activities.

*Salaries/Benefits*

TDWS does not anticipate hiring any additional staff for SWAP activities or paying salaries for existing TDWS staff. The required assessments will be done by contract. It is presently anticipated that the Tennessee Association of Utility Districts (member of the National Rural Water Association) will be performing the assessments under a sole source contract.

*Indirect Costs*

There will be no indirect costs as there will be no salary/benefit charges.

*Out-of-state Travel*

Out-of-state travel will be required for TDWS staff to attend meetings at Region IV in Atlanta and/or applicable meetings or conferences at other locations.

*In-state Travel*

In-state travel is required for TDWS staff to attend meetings, conferences, and conduct evaluations on contractor work. Some funding of travel for the technical and citizens advisory committee to meet will also be required for those with minimal resources to travel.

*Operating*

Office Supplies - Standard office supplies are necessary to ensure that employees have adequate resources. Printing and copying costs are included.

*Equipment*

Computer equipment (workstations, software, plotters, digitizer) purchases will be necessary for GIS (Geographic Information System) activities to enable the TDWS to provide assessments to the public using GIS as required for SWAP. The contractor will be providing completed assessments for each surface water system, but TDWS will be doing the work for the ground water systems and will also need the capacity to produce additional copies for the public for all water systems.

*Training*

Training monies are required to keep staff updated with respect to developing SWAP information, training on hardware and software systems, new or changing information management technologies and EPA requirements.

***Expenditures for TDWS ($127,620 total):***

| | FY99 | FY00 | FY01 | FY02 |
|---|---|---|---|---|
| Computer Purchases (includes software purchases) | $50,000 | 2,810 | 2,810 | |
| Office Supplies | 3,500 | 3,500 | 5,000 | 10,000 |
| Out of State Travel | 5,000 | 5,000 | | |
| In State Travel | 10,000 | 10,000 | 5,000 | 5,000 |
| Training | 5,000 | 5,000 | | |

**Contracts**

Contractors' expenses for travel, lodging and per diem will be included as part of the costs agreed to in the contract. Although a significant part of the contract assistance has yet to be determined, TDWS has initially estimated its contract to be $1,100,000. As the program develops and other resource needs are identified, this estimate may change. The contract will be submitted to EPA prior to initiation of contract. TDWS will be attempting to contract with Tennessee Association of Utility Districts for this work.

Tennessee has 180 surface water intakes for public water systems, with 147 community systems and 14 noncommunity systems. The anticipated milestones are based on number of intakes assessed.

## Implementation Schedule for Individual Source Water Assessments

Tennessee fully expects to require the 18 month extension provided for by Congress to complete the assessments. There are 180 surface water intakes for public water systems in Tennessee. The contractor will be paid per assessment completed. In addition, there is a sizeable final assessments report completion payment to the contractor conditional upon all deliverables being submitted to the Division of Water Supply by March 31, 2003. The target date for the State's submittal of a summary report to EPA will be May 1, 2003. There will be annual status submittals to EPA as well.

The Division of Water Supply has chosen Tennessee Association of Utility Districts (Tennessee representative of the National Rural Water Association) as its sole source contractor owing to its close communication ties with water systems across the state. The contract has not yet been finalized, but is in the final stages. The assessments' completion schedule is as follows:

Milestones

March 30, 1999
Complete assessments for 5 intakes

June 30, 1999
Complete assessments for 10 intakes

September 30, 1999
Complete assessments for 10 intakes

December 31, 1999
Complete assessments for 15 intakes

March 31, 2000
Complete assessments for 10 intakes

June 30, 2000
Complete assessments for 10 intakes

September 30, 2000
Complete assessments for 10 intakes

December 31, 2000
Complete assessments for 15 intakes

March 31, 2001
Complete assessments for 10 intakes

June 30, 2001
Complete assessments for 10 intakes

September 30, 2001
Complete assessments for 10 intakes

December 31, 2001
Complete assessments for 15 intakes

March 31, 2002
Complete assessments for 10 intakes

June 30, 2002
Complete assessments for 10 intakes

September 30, 2002
Complete assessments for 10 intakes

December 31, 2002
Complete assessments for 10 intakes

March 31, 2003
Complete assessments for 10 intakes

## Information Management

***Communication and coordination with a multitude of agencies is the most critical factor in the success of Source Water Protection.*** Agencies from within TDEC and outside of TDEC recognize the value of having readily available, useful information on public water systems and their source water areas in their daily operations. Source Water Assessment/Protection Program and Watershed Management Program efforts rely heavily on Geographic Information Systems (GIS) to provide this information in an effective manner. GIS computer networks allow databases to be linked to points or other geographic information on a map and allow numerous features to be electronically "overlaid" on top of one another such as geology, land use, population, roads, streams, etc. During a GIS session on a computer, any of those points can be linked to its detailed record in a database with the click of a mouse button.

TDEC will also be making considerable use of global positioning system (GPS) units for accurately locating facilities, features, etc. in the field. GPS units are hand-held portable electronic equipment that read off of navigation satellites to determine a reasonably precise location by latitude and longitude. This information can then be readily entered into GIS.

The long range goal of the Source Water Assessment Program is to place the assessments on TDEC's webpage in an interactive GIS format for ready public access.

# INVOLVING THE PUBLIC

## SWAP Advisory Committee

Communication to the general public was emphasized in the 1996 Amendments to the Safe Drinking Water Act regarding Source Water Assessment/Protection. There are a number of provisions for public awareness and involvement as well as a provision for a technical and citizens advisory committee. Congress required each state to create a technical and citizens advisory committee in the development of the SWAP for submittal to EPA.

EPA's Guidance Document stated that the advisory group should "include, but not be limited to, public interest groups (e.g., medical associations), vulnerable population groups (e.g., elderly transplant patients, dialysis patients, chemotherapy patients, people living with HIV/AIDs), groups representing business (e.g., agriculture businesses and chemical manufacturers and small business), local governments, tribes, land conservation groups, and others. A State should provide opportunities for these groups to participate but not be inhibited from program development or implementation should any group decide not to participate."

Tennessee has made a good faith effort at complying with both SDWA requirements and EPA guidance regarding the setup of the Committee and public participation. Tennessee invited the following organizations to be on the Technical and Citizens Advisory Committee:

**Table 7**
**SWAP Committee**

| Association | Active Participation |
|---|---|
| League of Women Voters (two LOWV representatives) | Yes |
| Tennessee Environmental Council* (represents 35 organizations) | Yes |
| Tennessee Medical Association | |
| Tennessee Municipal League | Yes |
| Tennessee Association of Business (representative is also TN Water Quality Board member) | |
| Tennessee Association of Utility Districts | Yes |
| Tennessee Farm Bureau | Yes |
| Natural Resources Conservation Service | Yes |
| U. S. Army Corps of Engineers Water Quality Section | Yes |
| Conservation Education TN Department of Education | Yes |
| University of Tennessee Agricultural Extension Service | Yes |
| Tennessee Conservation League | Yes |
| Murfreesboro Water Department American Water Works Association | Yes |
| U. S. Geological Survey Water Resources Division | Yes |

| | |
|---|---|
| T.V.A.<br>Water Management | Yes |
| Division of Water Pollution Control<br>Watershed Management Section | Yes |
| TN Department of Agriculture<br>Division of Regulatory Services | Yes |
| TN Department of Agriculture<br>Division of Agricultural Resources -<br>NonPoint Source Program | Yes |
| United Church of Christ Network for Environmental and Economic Responsibility (representative is also retired pharmacist & small town mayor) | Yes |
| Citizen Action | |
| Home Builders of Middle Tennessee | |
| American Cancer Society | |
| Pulaski Water System | |
| TN Division of Community Assistance;<br>Pollution Prevention Program | Yes |
| TN Division of Solid Waste Management | Yes |
| TN Division of Water Supply | Yes |
| TDEC Environmental Policy Office | Yes |

*Tennessee Environmental Council has as its members:

Table 8 – TEC Membership

| | |
|---|---|
| American Lung Association of Tennessee | Not 840/840 Citizens' Coalition |
| Cumberland Harpeth Audubon Society | Scenic Tennessee |
| Foothills Land Conservancy | Social Concerns Committee of the First Unitarian Universalist Church |
| Oak Ridge Reservation Local Oversight Committee, Inc. | South Cumberland Land Trust |
| Recycle!Nashville | Southern Environmental Law Center |
| Sierra Club, Tennessee Chapter | Swan Conservation Trust |
| Tennessee Citizens for Wilderness Planning (TCWP) | Tennessee Alternative Growers Association |
| Tennessee Scenic Rivers Association | Tennessee Botanical Gardens at Cheekwood |
| Tennessee Trails Association | Tennessee Environmental Education Association |
| Tennessee Trial Lawyers Association | Tennessee Exotic Pest Plant Council |
| Bring Urban Recycling to Nashville Today (BURNT) | Tennessee Native Plant Society |
| Camp Marymount | Tennessee Recreation and Parks Association |
| Cedar Creek Learning Center | Tennessee River Gorge Trust |
| Hillsboro-West End Neighborhood Association | Tennessee Solar Energy Association |
| Junior League of Nashville | Trust for Public Land |
| Knoxville Recycling Coalition | Warioto Audubon Society, |
| League of Women Voters of Tennessee | Windstar Mid-South Connection |
| Marrowbone Preservation Society | Wolf River Conservancy |

Tennessee's first Technical and Citizens Advisory Committee meeting was on September 3, 1998 and the second on October 20, 1998. Public meetings were then held in Knoxville (December 15), Murfeesboro (December 16) and Jackson (December 17). There was little in the way of comments from the public for the Committee to address. The susceptibility analysis determination was provided to the Committee after having been presented at the public meetings in late December, 1998. It was left up to the Committee as to whether to have an additional meeting after the review of the susceptibility analysis determination. There were no responses from the Committee indicating another meeting was necessary.

Prior to the first Committee meeting, each member was mailed a Source Water Assessment Overview so that they could familiarize themselves with the proposed program. Upon arrival at the meeting, they were each given a notebook containing a number of handouts regarding more detailed background information and available resources (those unable to attend were sent the material as well). Also given to the Committee at that time were the Ohio SWAP Committee Comments (Appendix K) and the specific list of questions for SWAP Committees to address taken EPA's Source Water Guidance Document. The list of questions and responses from the Committee and the Division of Water Supply (including those for susceptibility analysis) are given in Appendix L. There were limited responses from the Committee members, which the division takes to mean the other members were at least minimally satisfied with the program's direction.

Tennessee was fortunate in that the Wellhead Protection Program is well into the implementation phase. Many of the other states required a large number of meetings simply due to the fact that they did not yet have their wellhead protection programs developed yet. This forced them to spend most of their time deciding on wellhead protection are delineation methods, etc. that was not necessary in Tennessee.

Tennessee was also able to make valuable use of the experiences of other states, having reviewed material from sixteen other states outside the southeast as well as considerable discussion with the other seven southeastern states within EPA's Region IV. Ohio put much of their work on their webpage, which was particularly helpful. The SWAP Committee's conclusions for Ohio were excellent, providing valuable insight for the Tennessee Committee to work with (given in Appendix K).

The Advisory Committee will be periodically briefed as to the progress of the source water protection activities, but there are no formal meetings planned at this time. The Division of Water Supply will continue to consult with technical representatives on the committee.

Tennessee found the meetings with its advisory committee to be a resource-intensive endeavor, with the program's severely limited staffing. Unless a specific need arises, Tennessee does not feel that holding superficial committee meetings is an effective use of extremely limited resources. The majority of the committee members have a full schedule as well and it would be inconsiderate of their valuable time.

## Public Meetings/Public Input

Tennessee held its public meetings relatively late in the process to give the SWAP Committee and the Division of Water Supply opportunity to develop a reasonable proposal to present to the public. The Division of Water Supply felt that with the resources it had available, it was prudent to research and develop a basic framework of what could reasonably be carried out for source water assessments within the timeframe available.

The Division's mission on developing the SWAP program has been:

Keep it:
(1) Meaningful,
(2) Practical,
(3) Reasonable,
(4) Implementable, and
(5) Understandable.

Public meetings were then held in Knoxville (December 15), Murfeesboro (December 16) and Jackson (December 17). A copy of the Overview was placed on TDEC's webpage in September of 1998. Notice of the public meetings were posted on the webpage in late October of 1998. The notice for the public meetings was published in newspapers in Memphis, Jackson, Nashville, Chattanooga, Knoxville, Kingsport and Johnson City more than 30 days prior to the meetings.

Questions and comments from the public meetings themselves are given in Appendix M. Written comments provided by the Foundation for Global Sustainability/East Tennessee Headwaters Project and the Division of Water Supply's response is given in Appendix N.

The Division of Water Supply will be giving a presentation on Tennessee's Source Water Assessment Program to the Tennessee Water Quality Control Board at the next available meeting, at the Board's (probably late March of 1999). This was not required by statute since there are no new regulations being promulgated as a part of the Source Water Assessment Program, but this provides a valuable opportunity to publicize the SWAP program and give a presentation to this regulatory Board. This is not the first contact that the Board has had concerning SWAP –the Board was sent the same SWAP Overview as Committee members at the request of one of the Board members who is currently a member of the Committee.

Tennessee's SWAP is closely linked with the Watershed Management Program. Tennessee believes that the structure of the Watershed Management Program more than adequately addresses public participation at the local watershed level (two public meetings within a five year cycle) where it is most needed. The same organizations represented by the committee are typically represented at the local level as well.

## Making the Assessments Available

Summaries of Source Water Assessment reports for individual water systems are required to be made available to the public. Tennessee will be relying on several avenues to fulfill this requirement. A key element in this will be the Consumer Confidence Reports that each community water system is required to send each of its customers annually. The Consumer Confidence Reports (CCR) were also a part of the SDWA Amendments of 1996. In these reports, the systems are required to address the source of their water and the availability of the source water assessments. Water systems will be provided with a brief summary of the susceptibility of their water sources to be included in their Consumer Confidence Reports.

The portion of the CCR regulations currently being promulgated in Tennessee that address source water is given below:

*Rule 1200-5-1-.35*

*(3) Contents of the Report*

*(a) Each community water system must provide to its customers an annual report that contains the information specified in 1200-5-1-.35(3) and 1200-5-1-.35(4).*

*(b) Information on the source of the water delivered:*

*1. Each report must identify the source(s) of the water delivered by the community water system by providing information on:*

*(i) The type of the water: e.g., surface water, ground water; and*

*(ii) The commonly used name (if any) and location of the body (or bodies) of water.*

*2. If a source water assessment has been completed, the report must notify consumers of the availability of this information and the means to obtain it. In addition, systems are encouraged to highlight in the report significant sources of contamination in the source water area if they have readily available information. Where a system has received a source water assessment from the primacy agency, the report must include a brief summary of the system's susceptibility to potential sources of contamination, using language provided by the primacy agency or written by the operator.*

This required source water link in the CCR provides one avenue for increasing public awareness regarding Source Water Assessment/Protection and disseminating summary information from the Source Water Assessment reports. The reports will also be available in paper copy at the local library as well as being available through the Department's webpage {www.state.tn.us/environment}. A generalized map showing each water system (probably by watershed and/or county), potential contaminant sources, the susceptibility diagrams for each water system and a short narrative. The webpage will also be accessible at the local libraries through their internet connections. Each of the Department's Environmental Assistance Centers (formerly known as field offices) will also have copies available for review.

Summaries of the source water assessments will also be included in the individual HUC8 watershed management plans. Source Water Protection will also be addressed at the required public hearings for the Watershed Management Program held in the local watershed area twice within the five year cycle.

Distribution will be based on the Watershed Management cycle so as to include summaries in the individual watershed plans. Source water assessments for the Group 1 watersheds will be available in December of 1999 (they may not yet be on the TDEC webpage), Group 2 on or before December 2000. Group 3 should be available on or before December 2001 and Group 4 and 5 by December 2002. If assessments are proceeding ahead of schedule, the assessments will be released early. Group 1 assessments will likely take the longest since there will be issues of getting the assessment summaries designed for distribution and the webpage information set up. The following ones will hopefully run ahead of schedule.

The summary will include map(s), table(s) of potential contaminant sources and pie chart(s) and a short narrative (executive summary). Please note that there will be multiple pie charts/susceptibility analyses per water system, which will be dependent on the number of withdrawal sources and the relative proximity of these sources to one another. The maps will have the water source location, source water assessment/wellhead area and potential contaminant sources upgradient of the source and basic stream and road locations.

**Source Water Petition Program**

Section 1454 of the SDWA provides for the voluntary establishment of State Source Water Petition Programs. A state can choose to establish a Source Water Quality Protection Partnership Petition Program to help local governments and community water suppliers implement source water protection strategies. Under this authority, States may establish a program to receive, approve and respond to petitions from a public water system operator/owner or local government entity to assist in the development of voluntary local incentive-based partnerships to:

(1) reduce the presence of contaminants,

(2) provide financial or technical assistance requested, and
(3) develop recommendations for voluntary, long-term source water protection strategies.

Under this program, a community water system or a local government may petition the state for assistance in developing a program to guard against contamination from regulated pathogenic organisms, or regulated contaminants detected in source water at levels not reliably or consistently below the drinking water standard.

At this point, TDEC does not intend to develop a voluntary petition program. The Petition Program envisioned by Congress is of extremely limited scope. For a water system/community to be eligible, it must have consistent violations above drinking water standards. The Division of Water Supply does not believe a voluntary petition program goes far enough in that case. TDEC feels that systems with consistent violations need substantially more help than a voluntary partnership has to offer and that expending TDEC's limited resources on voluntary program development is improper. Considering there are even criminal provisions under the Safe Drinking Water Act if a responsible party is not cooperative, it would appear that enforcement is a more viable option.

In addition, there have been no surface water systems with repeated violations in Tennessee and the voluntary Petition process would not lend itself readily to ground water systems. The Department would actually be developing a petition process for a category of systems that do not exist. This is not to say the Divisions of Water Supply and Water Pollution Control will not work with local groups, merely that is not necessary to create a formal petition process for such a limited scope of water systems, particularly when Tennessee does not have systems fitting into that category.