

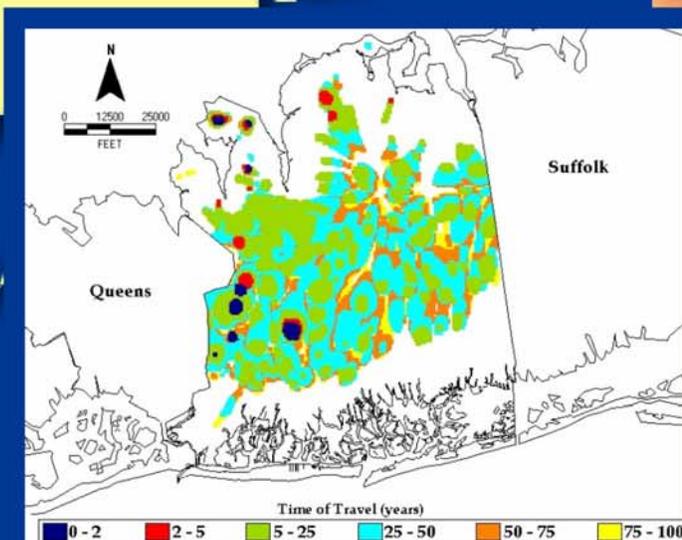


Long Island Source Water Assessment Summary Report

New York State
Department of Health

in cooperation with
Nassau County Dept. of Health
Nassau County Dept. of Public Works
Suffolk County Dept. of Health Services

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1.0 Introduction

The federal Safe Drinking Water Act (SDWA) Amendments of 1996 created a Source Water Assessment Program (SWAP) to evaluate existing and potential threats to the quality of public drinking water supplies throughout the U.S. To carry out this program in New York, the Bureau of Water Supply Protection of the New York State Department of Health (NYSDOH) developed the New York State SWAP Plan, with input from a variety of interested parties. Public participation efforts initiated in 1997 included focus group meetings, a satellite broadcast, work with the New York State Department of Environmental Conservation (NYSDEC) and the New York State Soil Conservation Committee to provide funding for County Water Quality Coordinating Committees to hold public meetings, and establishment of a citizens' advisory

committee known as the Source Water Protection Coordinating Committee (SWPCC). A subcommittee of the SWPCC, the Long Island SWAP Steering Committee, developed the general work plan for completing source water assessments on Long Island.

Continuing public participation during implementation of the Long Island SWAP is described in Appendix A.

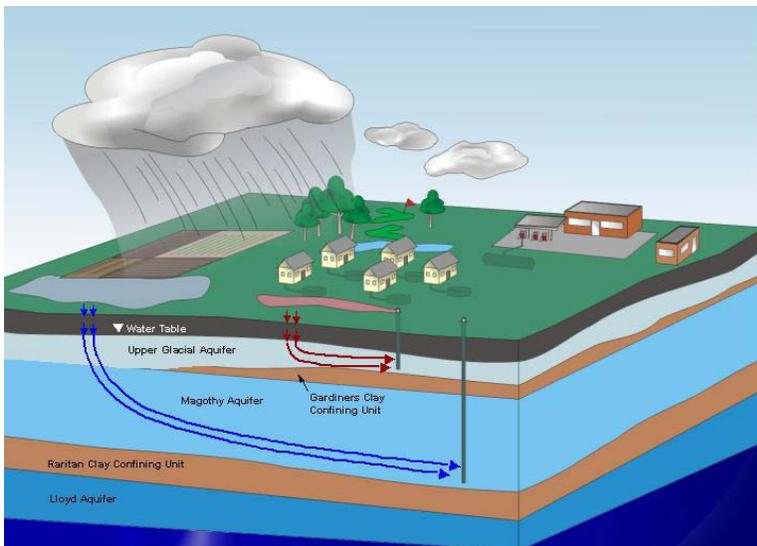


Figure 1-1 The source water assessment studies summarized in this report considered aquifer and geologic characteristics, individual well characteristics, land use, and known point sources to estimate the susceptibility of each well to any future contamination.

1.1 The Long Island SWAP

Source water assessments were performed for all public water supplies in Nassau and Suffolk Counties, in accordance with the final New York State SWAP Plan prepared by the NYSDOH and

approved by the U.S. Environmental Protection Agency (EPA) in November 1999, and with the more detailed work plan developed by the Long Island SWAP Steering Committee. The Long Island source water assessments, performed by an engineering firm (CDM) under contract to NYSDOH, utilized computer modeling and geographic information system (GIS) tools to build upon earlier resource management initiatives at the state and county levels. Groundwater, pumped from numerous wells, is the only source of potable water in Nassau and Suffolk Counties. This document is a summary of the results of individual assessments for the 938 community and 418 non-community wells serving public water supplies on Long Island. (Community wells are those that serve multiple residences; non-community wells serve businesses, schools, and other nonresidential public places.) The individual assessments of each

well will be available from the water suppliers, county health departments, and the NYSDOH upon request, and subject to protocols to assure the appropriateness of the request. Project documentation is described in more detail in Appendix B to this Summary Report. As described in the SWAP Plan, the source water assessment for each well has three components:

- Delineating the source water recharge area for the well;
- Determining the prevalence of contaminants within the source water area; and
- Analyzing the susceptibility of the well to potential contamination.

These components are described in the following pages. While reading this report it will be useful to keep in mind that terms like *prevalence*, *sensitivity* and *susceptibility* are used with specific technical meanings, which fit into the sequence of sections into which this summary report is organized.

Section 2 of this document describes how computer models were used to determine the land surface area that contributes recharge to each well. Section 3 discusses the assignment of *contaminant prevalence* ratings, based upon the potential presence of contaminants within the contributing area, as a result of both the land use types that are present and the point sources that exist. Well sensitivity, based upon the time of travel to each well, and the factors affecting the likelihood that any contaminants existing in the recharge area will travel to the well, is described in Section 4. Section 5 discusses how the contaminant prevalence and sensitivity ratings are combined to assess the *susceptibility* of each well to contamination. Section 6 summarizes the study conclusions. As mentioned above, Appendix A and Appendix B describe the public participation and project documentation, respectively. Appendix C summarizes the approach to develop source water assessments for the non-community wells.

It is important to remember that the source water assessments only indicate the *potential* for contamination of a supply well, based upon the likelihood of the presence of contaminants above ground in the source water recharge area and upon the possibility that any contaminants present can migrate down through the aquifer to the depth at which water enters the well screen. In most cases, the susceptibility, or potential, for contamination has not resulted in *actual* source water contamination. If contamination of a well source is identified, water suppliers either provide treatment or withdraw the well from service, so that all potable water distributed to residents of Nassau and Suffolk Counties meets all applicable drinking water standards. County health departments oversee delivery of safe water and address any violations. Violations have been minimal and are reported to consumers. Violations by public water systems can be reviewed on the Web at <http://www.health.state.ny.us/nysdoh/water/main.htm>.

1.2 Background

The Long Island SWAP builds upon the existing oversight of public water systems by Nassau and Suffolk Counties and their understanding and protection of the groundwater resource. Potable water supplied by community water systems in Nassau and Suffolk Counties, with rare exceptions, meets all drinking water quality standards. Over the past several decades, localized groundwater contamination has been addressed by treatment of the well water or by discontinuing use of the affected well. Water resource managers have long recognized that precipitation recharging into the ground can carry dissolved contaminants down to the aquifer system and have implemented regional groundwater protection programs that treat all of Nassau and Suffolk Counties as a potential recharge area. Regulatory programs have been developed to address potential sources of groundwater contamination and to prevent pollutants from being introduced to the aquifers.

The sanitary sewerage program that was implemented throughout most of Nassau County and in densely developed parts of Suffolk County was very effective in reducing groundwater contamination from sanitary, commercial, and industrial wastewaters. Sanitary sewers continue to prevent nitrates, detergents, and other contaminants associated with wastewater from reaching the groundwater. Regulatory bans on products of concern such as phosphate detergents and certain pesticides have also been effective in reducing the amount of contaminants introduced to the aquifer. Discharges from industrial and commercial facilities are regulated, and monitoring and enforcement activities have significantly reduced the impacts of volatile organic chemicals (VOCs) on groundwater supplies. Implementation of land use restrictions and the purchase of large tracts of open space for preservation and groundwater protection have also helped to protect groundwater quality in specific areas of Long Island.

An extensive network of monitoring wells has been installed and is routinely monitored to assess groundwater quality. Over time, as more and more data describing the groundwater resource was compiled, Nassau and Suffolk Counties developed computer models to synthesize the information into a comprehensive framework incorporating all of the significant factors affecting groundwater flow. Calibrated groundwater flow models were used as tools to help estimate the direction and rate of groundwater flow throughout the system, as well as how the aquifer responds to changing conditions such as water supply pumping. Over the past 20 years, source water assessments in Nassau and Suffolk Counties have integrated the Counties' extensive databases with sophisticated geographic information systems (GIS) and computer modeling tools. The SWAP builds upon these existing groundwater models and databases, and uses GIS tools to combine model-generated source water delineations with land use and point source data.

2.0 Source Water Assessment Area Delineation

The first step in conducting the SWAP was to identify all active community and non-community supply wells, using databases provided by NYSDOH, NYSDEC, the Nassau County Department of Public Works (NCDPW), the Nassau County Department of Health (NCDH), and the Suffolk County Department of Health Services (SCDHS). Computer models of groundwater flow and contaminant transport were then used to delineate the area contributing recharge (the source water area) to each supply well in Nassau and Suffolk Counties. It is important to note that the source water area for a particular well is not necessarily adjacent to that well: as shown schematically in Figure 1-1 above, the recharge area (especially for a deep well) might be some distance “upgradient” of the well, and may include a large and irregularly shaped area. Computer models are used to determine the land surface area that provides recharge to the well.

2.1 Background

Over 1,350 public supply wells provide potable water to the residents of Nassau and Suffolk Counties, as shown on Figure 2-1. In Nassau County, water is supplied by 50 community water suppliers operating 365 wells and by four non-community suppliers operating seven wells. In Suffolk County, 573 wells operated by 39

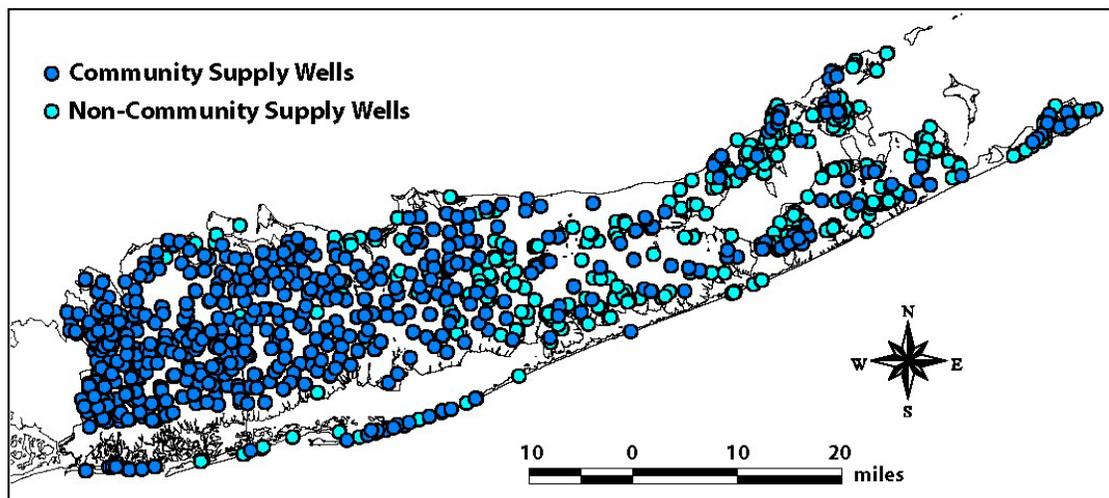


Figure 2-1 The SWAP located and delineated recharge areas for over 1,350 community and non-community public water supply wells.

community water suppliers, as well as 411 non-community supply wells, provide potable water to residents.

From the databases, well locations, depths, screened intervals, and recent pumping rates were assembled for each well. The information was compiled into well files used by the groundwater models to simulate groundwater flow and to estimate source water areas. In addition to the physical and operational data collected to

describe each supply well, water quality data was also organized and reviewed to characterize the raw or untreated water quality at each well, and to provide some insight into factors affecting groundwater quality.

Existing groundwater flow models developed by the engineering consultant CDM together with NCDPW, SCDHS, and the Suffolk County Water Authority (SCWA), were used as the basis for delineating the contributing source water areas for each public supply well. The set of models included the Nassau County Regional model and Suffolk County's Main Body flow model (two freshwater flow models), and the North Fork model, South Fork model, and Shelter Island model (three dual-density or salt water intrusion models). All five models were based upon three-dimensional finite-element codes developed at CDM. The two freshwater flow models used the Dynflow (DYNamic groundwater Flow) code, and the three dual-density models used the Dynswim (DYNamic Salt Water Intrusion Model) code.

All models used for the source water assessments had previously been calibrated during earlier studies. Each model's ability to represent aquifer conditions was tested by comparing model simulated water levels and stream baseflows to water levels measured at monitoring wells and to observed stream baseflows under various conditions of precipitation, recharge and water supply pumping. The models' success in reproducing observed conditions provides confidence that they are capable of reliably depicting aquifer conditions. As part of the SWAP, the Nassau County model was refined using additional data collected over the past 15 years, and re-calibrated to recently observed conditions. The calibrated models were then used to simulate aquifer conditions resulting from long-term average conditions of precipitation, recharge, and stormwater management for the SWAP delineations.

2.2 Significant Assumptions for Supply Well Assessments

Models are simplified representations of the real world that necessarily incorporate many simplifying assumptions. The source water areas delineated using the groundwater models are sensitive to assumed rates of recharge and water supply pumping. Several key assumptions have been incorporated into this modeling evaluation:

- Long-term average annual rates of precipitation and recharge remain constant for 100 years;
- The locations of all supply wells remain constant for 100 years; and
- Water supply pumping rates will remain constant for 100 years.

These assumptions are appropriate for planning purposes for areas of stable development, population, and land use. In areas where new wells are sited or where pumping rates change in response to changing development patterns, population, and demand for public water supply, the contributing area delineations may change

significantly. Furthermore, the time-of-travel evaluations (how long it takes precipitation—and any associated contaminants—to migrate through the aquifer to the well) consider potential contaminant migration by advective flow only (the effects of dispersion are not included).

Because in reality precipitation, recharge, and water supply pumping rates are always changing, the boundaries of the source water area contributing recharge to any particular well will also change over time. The source water area delineations developed as part of the SWAP demonstrate that most of Nassau County, and large parts of Suffolk County, do serve as source water areas for the public water supply. This affirms water managers' historical approach of treating the entire land surface as a potential source water area that is worthy of protection.

2.3 Modeling Approach

The *discretization*, or spacing of nodes used in the regional groundwater flow models (see Figure 2-2) ranged from approximately 1000 to 3000 feet, which is appropriate for

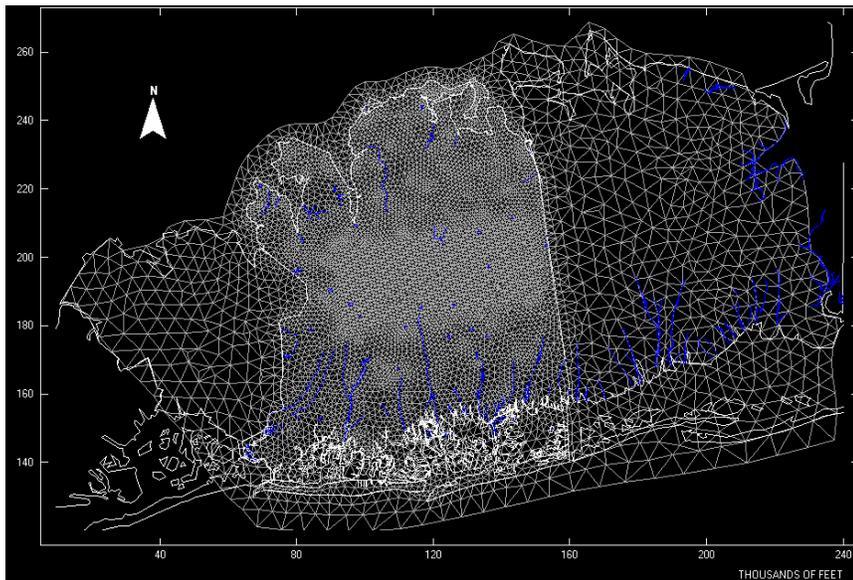


Figure 2-2 Finite-element grid for the Nassau County Groundwater Model

regional water management studies but is not discrete enough to reliably simulate a representative source water area for a single well. To estimate the source water areas, additional discretization was added to the models throughout all of Nassau and Suffolk Counties.

While the computational power of computers has increased significantly in recent years, using a single highly discretized grid to simultaneously simulate all of Nassau and Suffolk Counties was not possible, given computer processing limitations. It was necessary to divide Nassau and Suffolk Counties into sub-regional model grids to allow incorporation of the desired discretization, a node spacing of no more than 200 feet. A series of sensitivity simulations was conducted to develop an approach that provided the desired node spacing and minimized the number of sub-grids required. In all, 16 subregional grids were utilized for the source water area simulations. Sufficient overlap between the adjacent sub-grids was included to ensure that all of the 100-year contributing area associated with each well/wellfield could be included

within a single sub-grid. In addition to the additional horizontal discretization included in the Nassau and Suffolk Main Body models, an additional model level was added to the Magothy aquifer, to improve the vertical representation of public supply well screened intervals.

The hydrogeologic framework, hydrogeologic properties, boundary conditions, and recharge rates were interpolated directly from the existing regional flow models into the sub-regional flow models. Long-term average rates of precipitation were used to specify long-term average rates of recharge, based upon existing methods of storm-water management. In unsewered areas, 85 percent of the water withdrawn from the community supply wells was returned to the aquifer as recharge, to simulate the effectiveness of on-site septic or wastewater disposal systems.

Water supply pumping rates for each well were assigned based upon documented patterns of pumping and upon the ready availability of pumping data. Seven low-capacity community wells in Nassau County and 37 low-capacity community wells in Suffolk County with no historical reported pumpage data were simulated using the same assumptions as those developed for the non-community wells.

The water supply pumping rates defined for each supply well were incorporated into the regional models, which were then used to generate the boundary conditions, recharge rates, and pumping rates for the sub-regional models. The flow fields generated by each sub-regional grid were checked against the results of the regional models. The flow fields generated from each sub-grid were then used by the Dyntrack (DYNamic contaminant TRACKing model) code to estimate the area contributing recharge to each well, assuming that recharge rates and water supply pumping rates were constant for a period of 100 years, as discussed above. If more than one well was screened at the same elevation within a particular wellfield, the pumping rates were combined, and the same contributing area was assigned to each well. This approach helped to address the fact that while pumping from an individual well may vary considerably from day to day, pumping from the wellfield is more consistent. If two or more wells within the same wellfield were screened at different depths, individual contributing areas were defined for each well.

The model was also used to estimate the minimum time of travel from the water table to each well.

2.4 Community Supply Well Results

Well-specific reports, including depictions of each supply well's contributing area, were prepared for each community supply well. Each report included a series of tables, and two figures illustrating the well's source water or contributing area and the characteristics of the source water area. The data characterizing each well, including the NYSDEC identification number, the supplier, well depth, the screened interval, and the assigned water supply pumping rate, were summarized in each well report, along with the model sub-grid that was used to simulate the well, and the

minimum model-estimated time of travel from the water table to the well, under the average annual conditions considered.

The source water area contributing recharge to each well was divided into a series of travel-time intervals, including the area with travel times from the water table to the well screen of: less than 2 years, between 2 and 5 years, between 5 and 25 years, between 25 and 50 years, between 50 and 75 years, and between 75 and 100 years. Using the GIS program ArcInfo, the model-estimated source water areas were superimposed upon base maps of land uses and potential point sources of contamination, as shown in Figures 2-3 and 2-4.

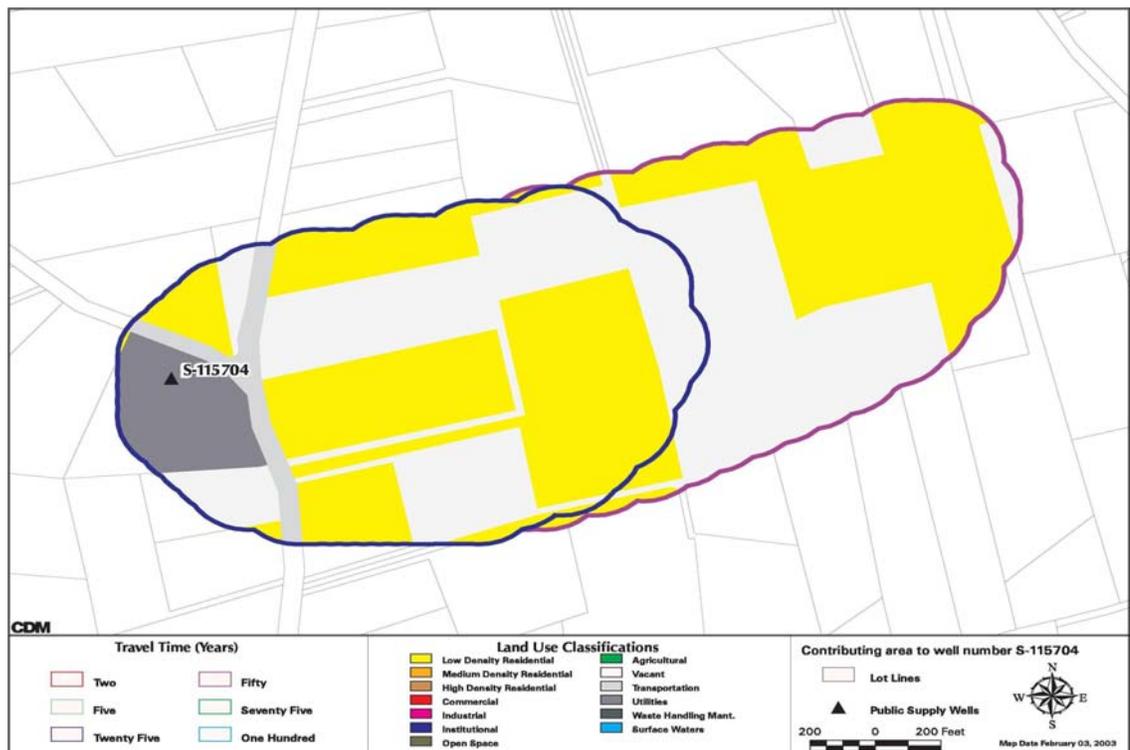


Figure 2-3 Computer-modeled source water recharge area for a Suffolk County well showing areas of groundwater travel times of 25 and 50 years (smaller and larger colored outlines) superimposed upon mostly low-density residential land use (yellow)

To account for the uncertainty associated with modeling assumptions such as constant rates of water supply pumping and recharge, ArcInfo was used to extend the boundaries of the contributing areas by up to 200 feet. The buffer was incorporated as a conservative measure to help to account for variability in recharge and water supply pumping rates. As a result of these buffers, adjacent simulated contributing areas to nearby wells are sometimes depicted as overlapping, rather than as adjacent to each other.

The first figure included in each well report (e.g., Figure 2-3) illustrates the model-estimated area contributing recharge to a supply well within each of the specified travel-time intervals, superimposed upon land use information and lot lines provided by the counties. Figure 2-4 depicts the model-estimated area contributing recharge to a supply well within each specified travel time interval, superimposed upon point source information. The potential point sources of contamination identified within

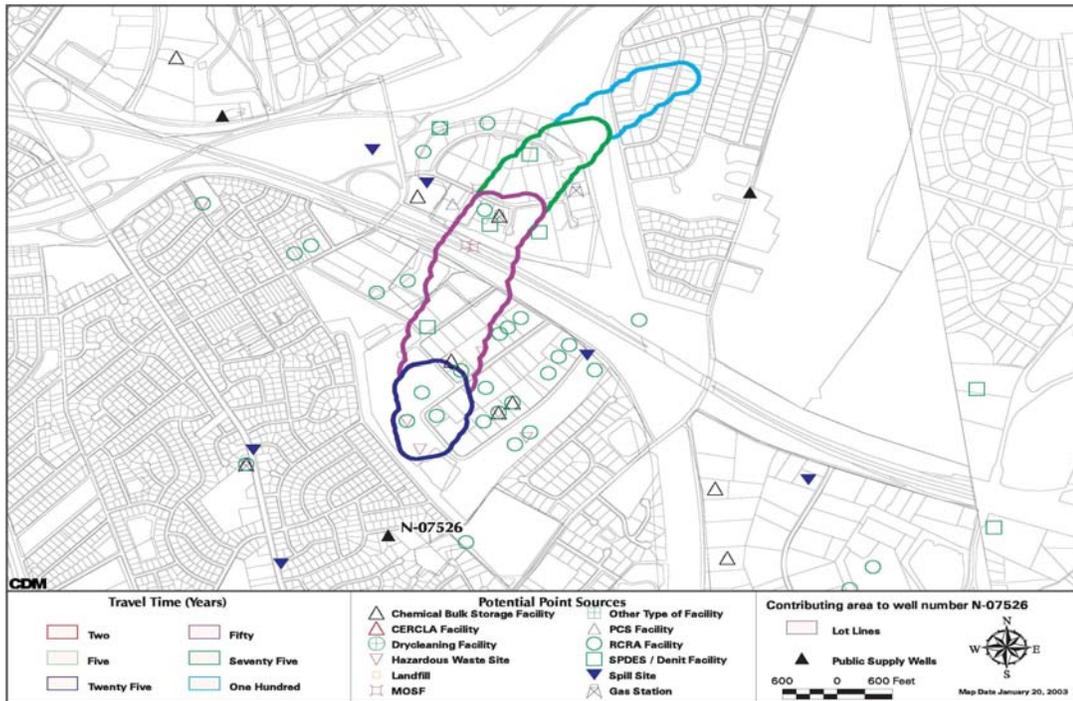


Figure 2-4 Source water area for a Nassau County well superimposed upon potential contaminant point sources

each travel-time interval within the well's contributing area are listed in each well report.

For many of the deeper wells, the time of travel from the water table to the well exceeds 100 years. For 79 of these deep wells, no source water areas can be identified by these 100-year simulations.

2.5 Non-Community Well Characterization

The majority of the 418 non-community wells in Nassau and Suffolk Counties are shallow wells pumping at relatively low rates. The SWAP plan recommended application of EPA's Wellhead Protection Area (WHPA) code to estimate the contributing area for each of these wells. Because the WHPA assumes that wells fully penetrate the entire thickness of the aquifer, which is not the case for most Long Island non-community wells, an alternative semi-analytical approach was developed

in cooperation with SCDHS. Implementation of this approach is described in more detail in Appendix C.

3.0 Contaminant Inventory

Contaminant prevalence within a supply well's contributing or source water area is one significant factor in determining whether the well is susceptible to contamination. New York State's SWAP plan provides a framework for identifying the possibility that different types of contaminants may be associated with a variety of land covers and potential point sources that could be found within a well's contributing area. This framework was modified and refined to better utilize the data available to characterize Nassau and Suffolk Counties, and to be more applicable to Long Island conditions.

3.1 Contaminant Categories

The New York State SWAP plan identifies 14 different categories of potential groundwater contaminants. After reviewing existing water quality data, and identifying the need to make the well-specific reports as focused and useful as possible, those contaminants of concern to Long Island groundwater managers were aggregated into four categories, for purposes of the contaminant prevalence rating classifications:

- VOCs
- Pesticides
- Microbials
- Nitrates

While significant for surface water supplies, *sediments/turbidity* (identified as one of the 14 categories in the New York State SWAP Plan) were not considered to be significant potential sources of contamination for the groundwater supply found in Nassau and Suffolk Counties. *Disinfection by-products precursors* were similarly not believed to be water quality concerns in Nassau and Suffolk Counties, as the organic materials that may react with disinfectants to form disinfection by-products are more typically observed in surface water, rather than groundwater sources.

Halogenated solvents, petroleum products, and other industrial organics were aggregated into a single contaminant category, **VOCs**. There is considerable overlap between the types of land use and potential point sources that could introduce these types of contaminants to the groundwater supply.

The **pesticides** contaminant category identified in the SWAP plan was retained as a separate contaminant category for this analysis.

Protozoa, enteric bacteria, and enteric viruses were aggregated into the **microbials** category for purposes of this study. All public water system wells have been assessed for the direct influence of surface water and none of the wells are considered susceptible to protozoa. No water quality or monitoring data exist that have identified the

presence of coliforms in community water supply wells; monitoring is not currently conducted to identify the potential presence of viruses. Potential point sources of all of these microbials are similar. Viruses are known to remain infective for a longer period of time than the other microbials in groundwater. Hence, all three indicators of fecal contamination have been aggregated into a single microbial category (based on the sensitivity characteristics of viruses) for purposes of analysis.

Nitrates were selected to replace the inorganics *phosphorus* and *cations/anions*. Increased levels of nitrates associated with overlying land uses have been documented as a water quality concern in Nassau and Suffolk Counties for many years. Nitrate has long been the inorganic parameter causing the most widespread concern.

Three additional potential contaminants of concern, **chlorides**, **metals**, and **radionuclides**, represent localized, rather than regional, water quality issues; they are addressed in a site-specific manner. Nassau County identified **chlorides** as an inorganic of particular concern. Since chloride contamination is primarily associated with salt water intrusion in coastal areas, the SWAP contaminant prevalence/sensitivity/susceptibility process was not designed to identify this potential localized issue. Instead, the well-specific reports developed for those supplies that are vulnerable to salt water intrusion identify their vulnerability to chloride contamination. Similarly, **metals** are of concern in localized areas downgradient of specific hazardous waste sites. The potential impact of these sites is also addressed as a separate issue in well-specific reports. The presence of industrial **radionuclides** is a documented concern downgradient of a single facility on Long Island; hence this category can also best be addressed as a special case.

3.2 Contaminant Prevalence Resulting from Land Use

The New York State SWAP Plan includes a table identifying the potential for groundwater contamination based upon land cover. This table was used as the framework for development of a similar table describing the potential for groundwater contamination by each of the four contaminant categories chosen for the Long Island SWAP – VOCs, pesticides, microbials, and nitrates – based upon actual land use mapped by Nassau and Suffolk Counties.

A variety of land use types are present within the source water areas of most of the supply wells on Long Island. Each of these land use types is associated with varying potentials to introduce different types of contaminants to the underlying aquifer. In order to identify the different land uses present within each well's source water area, base maps were developed that depict land uses throughout the Counties. The basemaps were developed using ArcInfo, based upon existing data provided in electronic format by the Nassau and Suffolk County Planning Departments. The maps were consistent with the land use categories and color assignments used by the Suffolk County Planning Department.

In general, the land use designations were the most complete for Suffolk County's five eastern towns. These five towns are less densely developed than the western part of Long Island, with land uses that were predominantly low to medium density residential, agricultural, open space, and/or vacant in nature. Land use mappings for the two cities and three towns in Nassau County, and the five western towns in Suffolk County are not as reliable, given the number of parcels with undesignated land uses. While it was beyond the scope of the SWAP to generate complete and verified land use base maps for Nassau County and western Suffolk County, every reasonable effort was made to assign the correct land use categories to all undesignated parcels. In general, the Nassau County communities and western Suffolk County towns are more highly developed than the five east end towns, with large percentages of the western part of the study area designated as high density and medium density residential, along with open space.

Areas served by sanitary sewage systems discharging off-shore were also delineated using ArcInfo, to consider the relative potential impacts of sewered and unsewered land areas upon underlying groundwater quality. Each of the developed land use categories was further subdivided into sewered and unsewered categories. The potential for each of the land use types found in Nassau and Suffolk Counties to introduce each of the four contaminant categories to underlying groundwater was rated as high (H), medium (M), low (L), or N (negligible). These potentials, developed in conjunction with NYSDOH, NCDH, NCDPW, and SCDHS, are presented in Table 3-1.

The groundwater model output files delineating each community supply well's source water area were used by ArcInfo to summarize the number of acres of each land use type that falls within each supply well's total source water area, and also the number of acres of each land use type that falls within travel time intervals of 2, 5, 25, 50, 75, and 100 years.

Using these acreages of land use within the well source-water areas and the contaminant potentials for each land use defined in Table 3-1, *contaminant prevalence ratings* resulting from land use were calculated for each well. *Contaminant prevalence* was rated using the logic developed as part of the New York State SWAP Plan, as modified for the Long Island assessment approach. Contaminant prevalence for each of the four contaminant categories was evaluated independently as follows.

**Table 3-1
Potential for Groundwater Contamination Based upon Land Use***

Land Use Types	VOCs (solvents / petroleum products)	Pesticides	Nitrates	Microbials
Low Density Residential Sewered Unsewered	L L	L L	L L	L M
Medium Density Residential Sewered Unsewered	L L	L L	M M	L H
High Density Residential Sewered Unsewered	L L	L L	M H	L H
Commercial Sewered Unsewered	M H	L L	L M	L M
Industrial Sewered Unsewered	M H	L L	L M	L M
Institutional Sewered Unsewered	L L	L L	L M	L M
Open Space	L	L	L	L
Agricultural	L	H	H	L
Vacant	L	L	N	L
Transportation	M	M	M	L
Utilities	M	M	L	L
Waste Handling & Maintenance	H	M	M	M
Surface Waters	N	N	L	L
Unverified	M	M	M	M

***Definitions:**

Negligible (N): Land use type results in minimal, if any, presence of the contaminant category.

Low (L): Land use type results in detections that are expected to be rare and, if detected, contaminant concentrations are expected to be below levels of concern for drinking water.

Medium (M): Land use type results in detections that are expected to be uncommon but, if detected, contaminant concentrations could be expected to be at or above levels of concern for drinking water.

High (H): Land use type results in detections that may occur frequently at levels of concern for drinking water.

Land uses with the same contaminant prevalence rating within the contributing area of a well (according to Table 3-1) were aggregated for the evaluation of contaminant prevalence. (For example, for VOCs, the acreages of commercial unsewered, industrial unsewered, and waste handling & maintenance land uses were aggregated to get the total acreage with “high” potential for VOCs within that well’s source water area.) For nitrates and VOCs, the entire source water area was considered; for the microbial and pesticide contaminant categories, the analysis was refined with calculations of land use percentages within specific time-of-travel intervals as described in more detail below. Microbial contaminant prevalence assessments do

not include any land use or point sources located in the contributory area greater than 25 years' travel time, because that greatly exceeds the time required to inactivate even the most persistent viruses in groundwater.

The assessments of contaminant prevalence resulting from land use, which are summarized in each well report, were made as follows. For each of the four contaminant categories, a contaminant prevalence rating—high, medium, or low—was assigned to each well. This prevalence assignment was based on the aggregate percent acreage of the highest contaminant potential found within the contributing area for that contaminant category, in a manner illustrated by Figure 3-1.

For example, when evaluating the VOCs category for a specific well, the highest VOC potential (from Table 3-1) that exists in the well's source area—high, medium, low, or negligible must be determined. If land uses with high VOC potential exist, the percentage acreage of high uses will define the prevalence. If more than 50 percent of the land within the well's source water area has high potential for VOCs, the first bar of Figure 3-1 applies and the land-use-related VOC contaminant prevalence rating assigned would be **High** for that well. If, instead, between 5 percent and 50 percent of the land within the source water area for that well is high for VOCs, the second bar in the figure applies and the assigned contaminant prevalence rating would be reduced to **Medium**. If land with a high VOC potential is less than 5 percent of the well's area, or if no such land exists, land with medium VOC potential would then be the important factor, and would be compared with the third bar in Figure 3-1. As shown, if more than 50 percent of such a well's contributing area has a medium contaminant potential for VOCs, the assigned contaminant prevalence rating would again be **Medium**. However, if less than 50 percent of the area is comprised of land uses with a medium VOC contaminant potential (again, assuming less than 5 percent *high* VOC potential, if any), the assigned contaminant prevalence rating would be reduced to **Low** as in the fourth bar of the figure. Thus, the percentage of the land uses having the highest contaminant potential (from Table 3-1) is considered first. If more than 50 percent of the contributing area is comprised of land with high contaminant potential, that governs the prevalence assignment for the well, and the proportions of the lower-potential land uses that make up the rest of the area are disregarded. Prevalence ratings for nitrates were assigned in the same way as for VOCs.

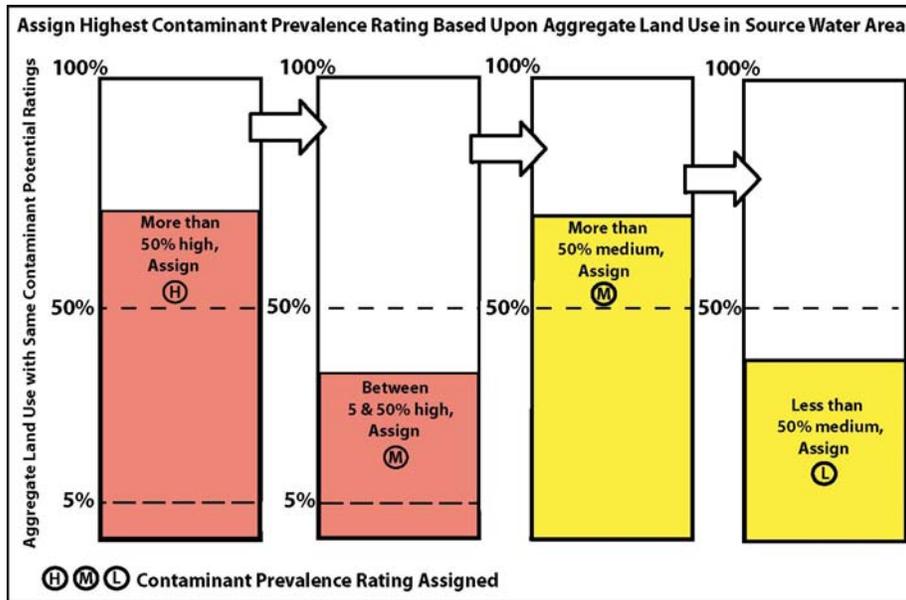


Figure 3-1 Contaminant prevalence ratings based upon land use. A land-use-related prevalence rating was assigned to each well for each of the four contaminant categories.

For microbials and pesticides, land-use-related contaminant prevalence ratings for three separate travel-time intervals were developed. Land uses in the contributing area within a 2-year time of travel from the water table to the well, land uses within a 2- to 5-year time of travel to the well, and land uses with a

time of travel between 5 and 25 years were each aggregated to provide three possible contaminant prevalence ratings for microbials. For pesticides, land uses within the 25-year time of travel to the well are combined to generate one contaminant prevalence rating, the second contaminant prevalence rating is assigned based upon land uses in the area with a time of travel between 25 and 75 years, and the third contaminant prevalence rating is based upon the land use in the contributing area with a time of travel between 75 and 100 years.

3.3 Contaminant Prevalence Resulting from Point Sources

Based upon the framework in the New York State SWAP Plan, Table 3-2 was developed to define the potential for various types of contaminant point sources identified in federal, state, and county databases to introduce contaminants from each of the four contaminant categories into the groundwater.

A variety of databases was collected and synthesized into an extensive listing of facilities and activities that could, if not properly managed or operated, affect groundwater quality. Data were obtained from EPA's Envirofacts database, and from NYSDOH, NYSDEC, NCDH, NCDPW, and SCDHS, and organized as a Microsoft Access 2000 file. The database included an identification number assigned by the agency that supplied the data, a facility name, address, SIC code (if available), and location coordinates, when available. Geocoding was used to define the location of those facilities that specified addresses rather than location coordinates in the databases. Locations could not be defined, however, for hundreds of facilities where mailing addresses or P.O. boxes were identified as the facility location.

Most of the facilities included in the database are not currently sources of groundwater contamination, and will probably never release contaminants to the aquifer. While the point source database does include documented releases of contaminants to the environment, some of these releases have been mitigated before they reached the groundwater table, and others that have reached the aquifer system are being contained, remediated, and/or monitored. All of the sites included are, however, potential sources of groundwater contamination should an unanticipated leak, spill, or other release occur.

**Table 3-2
Potential for Groundwater Contamination from Discrete (Point) Sources**

Discrete Sources	Contaminant Category			
	VOCs	Pesticides	Nitrates	Microbials
CERCLIS	P/H	P/L	P/M	NP
Hazardous Waste Facilities	P/H	P/L	P/M	NP
Landfills	P/H	P/L	P/M	P/L
Chemical Bulk Storage	P/H	P/L	P/M	NP
Major Oil Storage Facilities (MOSF)	P/H	NP	NP	NP
RCRA Facilities	P/H	P/L	P/M	P/L
SPDES / Denitrification Facilities	P/H	P/L	P/H	P/H
Spills	P/H	P/L	P/L	NP
Dry Cleaners	P/M	NP	NP	NP
PCS Facilities	P/H	P/L	P/M	P/L
Gas Stations	P/M	NP	NP	NP

Definitions

Possible (P): Potential contamination source is considered a possible source of the contaminant category, irrespective of aquifer or watershed characteristics. The “P” is combined with H, M, L, and N as defined in Table 3-1).

Not Probable (NP): Potential contamination source is not considered a probable source of the contaminant category, irrespective of aquifer or watershed characteristics.

Potential point sources located within each well’s contributing area are identified in each well report. The potential for each of these potential point source types to introduce each of the four contaminant categories to underlying groundwater was identified as possible (P) or not probable (NP). Point sources identified as possibly causing contamination from a particular category were assigned a high (H), medium (M), low (L), or negligible (N) rating, as with the land-use-based contamination sources. These potentials (shown in Table 3-2) were developed in conjunction with NYSDOH, NCDH, NCDPW, and SCDHS and were modified by group consensus, following a review of the first draft of community well reports.

Contaminant prevalence ratings based upon the presence of potential point sources within each well’s contributing area are summarized in each public supply well report. Again, the highest potential contaminant prevalence rating based upon the point sources within a contributing area was assigned. For example, the presence of any single point source with a high rating for VOCs would result in an H rating for VOCs, regardless of the other facilities located within the well’s contributing area.

3.4 Final Contaminant Prevalence Rating

As described above, for each of the four contaminant categories – VOCs, pesticides, nitrates, and microbials – , a contaminant prevalence rating was developed for both land use and point sources within the source water area of each well. In each case, the higher of the two contaminant prevalence ratings (land use or point source) was assigned as the final prevalence rating. The final contaminant prevalence rating for each of the four contaminant categories is summarized in each public supply well report.

The contaminant prevalence ratings indicate that facilities or activities within the contributing area have the potential to contaminate the recharged ground water, according to the following relative scale:

Low (L): contaminant detections are expected to be rare and, if detected, are expected to be below levels of concern for drinking water.

Medium (M): contaminant detections are expected to be uncommon but, if detected, could be at, or above, levels of concern for drinking water.

High (H): contaminant detections may occur frequently at levels of concern for drinking water.

As discussed, the contaminant prevalence ratings are based on *general* assessments of the *potential* for facilities and various land uses to cause contamination. The ratings do not include specific assessments for each facility and land use in a particular contributing area. The assessments do not consider compliance with applicable regulations to prevent contaminant releases or other site-specific management practices to prevent contamination, and are therefore likely to over-estimate the potential for contamination.

Contaminant prevalence ratings for community public supply wells in Nassau and Suffolk Counties are summarized by Figures 3-2 and 3-3.

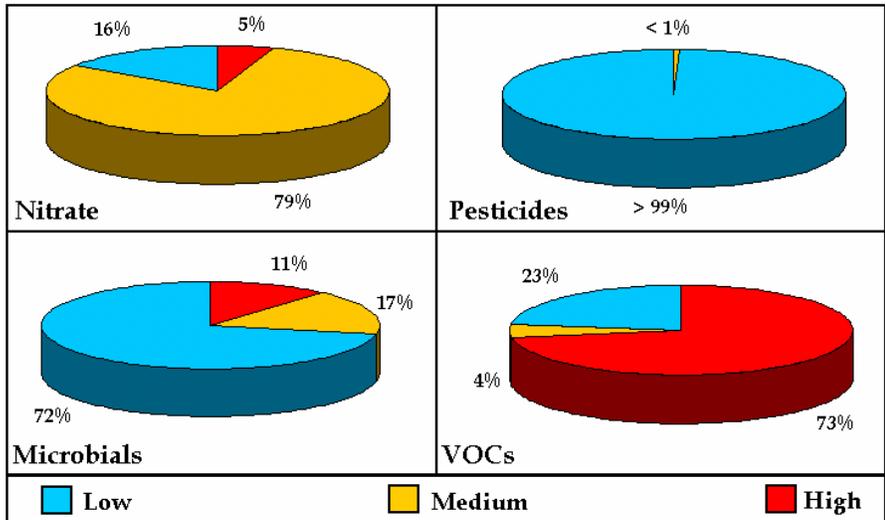


Figure 3-2 Final contaminant prevalence ratings for community supply wells in Nassau County show the majority of wells having medium prevalence for nitrates, low prevalence for pesticides and microbials, and high prevalence for VOCs.

supply wells were rated low with respect to pesticide prevalence, based upon the limited identification of potential pesticide sources within the County. Because most of the County is served by sanitary sewers, the contaminant prevalence rating for microbials is low for the majority of wells. Due to a combination of overlying land uses and point sources, a high contaminant prevalence rating for VOCs was assigned to over 70 percent of Nassau’s community supply wells.

The overwhelming majority of community supply wells in Nassau County were rated medium with respect to nitrate prevalence, based upon the overlying densely developed residential character of the area. Nearly all of the community

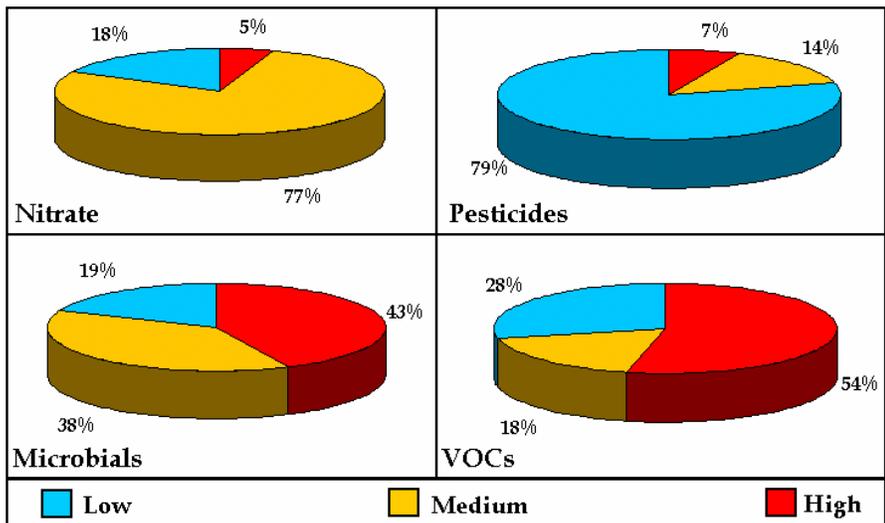


Figure 3-3 Final contaminant prevalence ratings for Suffolk County community supply wells show many similarities to those in Nassau County but also some differences, most notably for microbials.

for pesticides, although 7 percent were assigned a high rating, as they are

In Suffolk County, nearly 80 percent of wells were rated medium with respect to nitrate prevalence, again as a result of overlying residential land uses. Almost 80 percent of community supply wells in Suffolk County were assigned a low contaminant prevalence rating

downgradient of agricultural areas. Because a large part of Suffolk County is not served by sanitary sewers, almost 40 percent of the community supply wells were assigned a high contaminant prevalence rating for microbials. While over 50 percent of community supply wells were rated high for VOC prevalence, resulting from the combination of overlying land uses and point sources, a significant portion of the community supply wells, nearly 30 percent, were rated low for VOC contaminant prevalence.

Due to the less highly developed nature of the east end of Suffolk County where the majority of the non-community wells are located, contaminant prevalence ratings, particularly for VOCs, tended to be lower for the non-community wells.

4.0 Sensitivity

The likelihood that a contaminant that is released within a well's source water area will then travel through the aquifer system to have an impact on water quality at the well is referred to as "sensitivity." The sensitivity of a well to contamination by a particular contaminant is dependent upon both:

- The hydrogeologic setting of the well, and
- The characteristics of the contaminant that is being considered.

New York State's SWAP Plan assigns a sensitivity rating of "high" to all wells that withdraw water from unconfined aquifers with high hydraulic conductivities. NYSDOH recognized that most of the public supply wells on Long Island are screened in aquifers that have high hydraulic conductivities and that the majority of the wells are screened in unconfined (or semi-confined) zones of the upper glacial and Magothy aquifers, and hence would be assigned a "high" sensitivity rating.

To provide additional insight into the susceptibility of supply wells to contamination by various types of contaminants, NYSDOH and the counties initiated an effort to refine the sensitivity assessments, by combining both what is known about the fate and transport characteristics of each category of contaminants and the model-estimated times of travel from the water table to each well. If, for example, the minimum travel time from the water table to a well is estimated to be 50 years, the well would not be sensitive to contamination by microbials, which are not known to persist in the groundwater environment for more than several months. That same well could, however, be sensitive to contamination by a mobile, conservative contaminant such as nitrates.

4.1 Well Sensitivity Classification

To implement this refined sensitivity approach, the groundwater models were used to estimate the minimum time of travel from the source water area to each supply well. The minimum time of travel was then compared to the timeframes indicated in Table

4-1 to define the sensitivity of each well as either low, medium, or high with respect to contamination within each category.

Table 4-1
Well Sensitivity Classification by Contaminant Category and Travel Time

Contaminant Category	Low	Medium	High
Microbials	> 5 Years	2 to 5 Years	< 2 Years
Nitrates	> 100 Years	50 to 100 Years	< 50 Years
VOCs	> 100 Years	50 to 100 Years	< 50 Years
Pesticides	> 75 Years	25 to 75 Years	< 25 Years

NYSDOH further refined this framework for microbials and pesticides such that the sensitivities are specific to the contaminant prevalence ratings resulting from land uses and potential point sources aggregated within specific travel time intervals. For microbials, a sensitivity classification of low was associated with the contaminant prevalence rating for the source water area with a travel time of between 5 and 25 years, a sensitivity classification of medium was associated with the contaminant prevalence rating for the source water area with a travel time between 2 and 5 years, and a sensitivity rating of high was associated with the contaminant prevalence rating for the source water area with a travel time of less than 2 years. The highest of the three susceptibility ratings was then used as the well's susceptibility to contamination by microbials. The microbial contaminant prevalence assessments do not include any land use or point sources located in the contributing area with more than 25 years' travel time to the well. The travel time intervals used for microbial sensitivity ratings include increasing uncertainty factors to account for under-estimation in the assumed pumping and/or recharge rates and hydraulic conductivities.

For pesticides, a sensitivity rating of low was associated with the contaminant prevalence rating for the source water area with a travel time of more than 75 years, a medium sensitivity was associated with the contaminant prevalence rating for the source water area with a travel time between 75 and 25 years, and a high sensitivity rating was associated with the contaminant prevalence rating for the source water area with a travel time of less than 25 years. Again, the highest of the three susceptibility ratings was used as the well's susceptibility to contamination by pesticides.

Travel times to community supply wells in Nassau and Suffolk Counties are illustrated by Figures 4-1, 4-2, and 4-3.

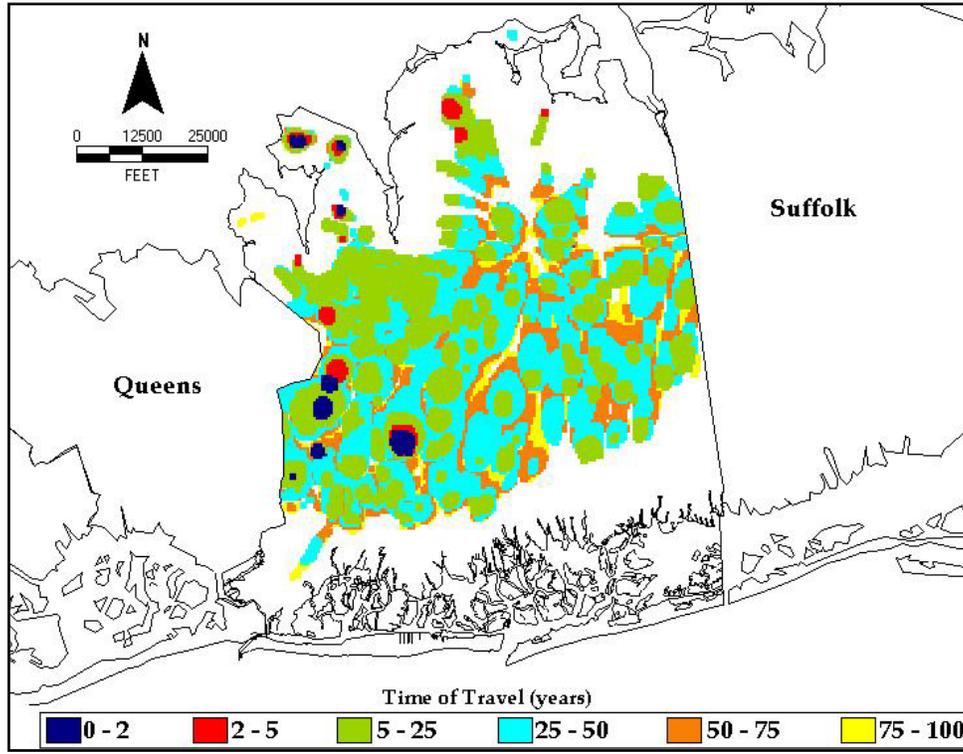


Figure 4-1 Time of Travel to Nassau County Community Supply Wells

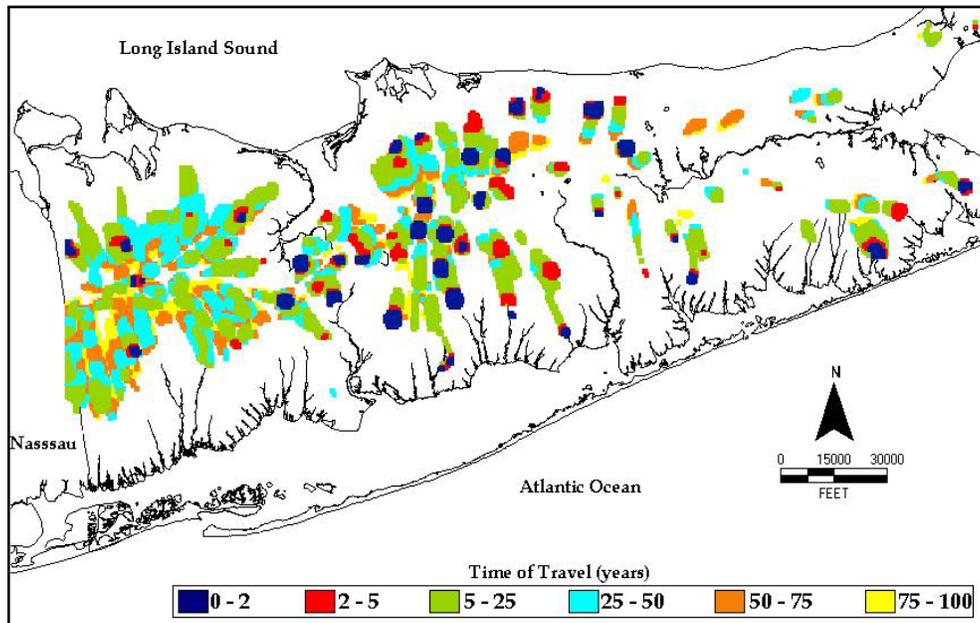


Figure 4-2 Time of Travel to Community Supply Wells in Western Suffolk County

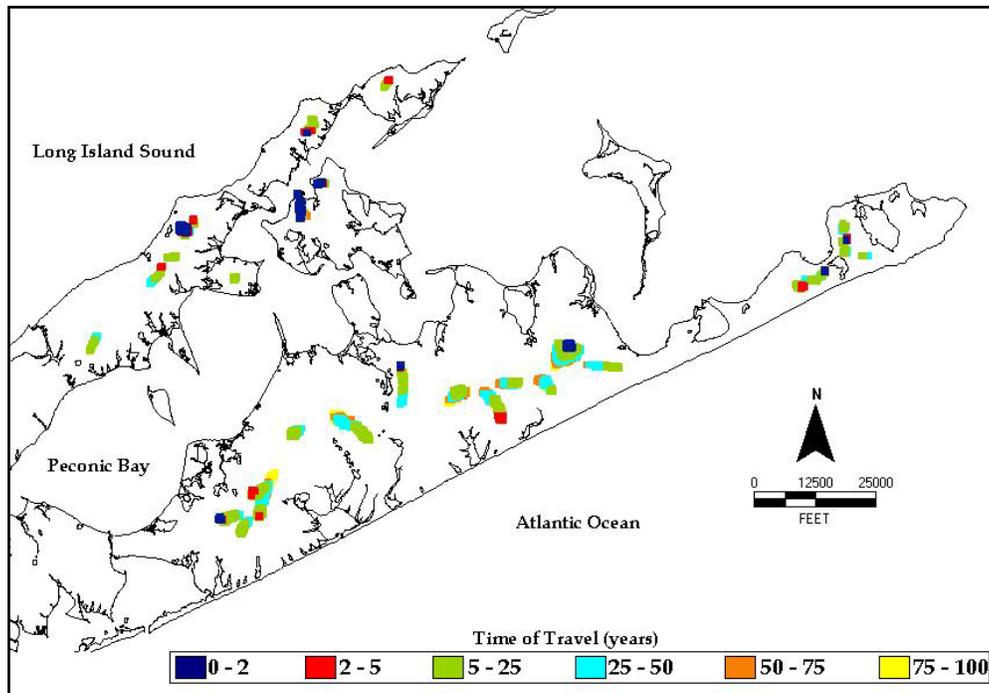


Figure 4-3 Time of Travel to Community Supply Wells in Eastern Suffolk County

The sensitivity of each supply well to each of the four contaminant categories is summarized in each individual well report.

4.2 Community Supply Well Sensitivity Results

Table 4-2 summarizes the sensitivity ratings for Nassau and Suffolk County community wells. For microbials and pesticides, the highest sensitivity rating for a particular well is included in the summary. To evaluate the effectiveness of the well sensitivity ratings, water quality data for wells with travel times within each of the sensitivity classification categories was also compiled and evaluated statistically and is presented in the table. No microbial data is presented, because no microbial detections have been reported in community wells. The sensitivity ratings for each well are not indicative of the presence of contamination within the source water area. They are based upon the minimum time of travel from the water table to a supply well. They are, therefore, indicative of the potential for a contaminant that is introduced at the water table to reach the supply well. Consequently, a high sensitivity rating for a well may not be incompatible with a non-detection of contamination in the well, because there may not be any sources of contamination in the well's contributing area.

Due to well depths and minimum travel times, only 18 community supply wells in Nassau County with a high sensitivity to microbials were identified. Moving further east in Suffolk County, where more supply wells are shallower and have shorter travel times from the water table to the well screens, 124 supply wells were identified

with high sensitivities to microbial contamination. No detections of microbial contamination believed to have resulted from aquifer contamination have been reported at community public supply wells in either Nassau or Suffolk Counties, including those wells with high sensitivities based upon low travel times.

Table 4-2

Well Sensitivity Rating Summary for Community Supply Wells for Each Contaminant Category

Contaminant Category	Sensitivity	Nassau County			Suffolk County		
		Number of Wells	Average Concentration	% Non-Detects	Number of Wells	Average Concentration	% Non-Detects
Microbials	High	18	-	-	124	-	-
	Medium	16	-	-	69	-	-
	Low	331	-	-	380	-	-
Nitrates (mg/l)	High	316	2.26	6	468	3.13	15
	Medium	18	0.86	11	57	0.63	74
	Low	31	0.60	15	48	0.25	85
Pesticides (µg/l)	High	243	0.53	96	376	0.155	96
	Medium	88	-	100	136	0.010	99
	Low	34	-	100	61	0.001 (only 1 detection)	>99
VOCs (µg/l)	High	316	19.06	69	468	1.95	77
	Medium	18	0.77	91	57	0.23	96
	Low	31	1.04	95	48	0.15	98

As a result of the persistence and mobility of nitrates in the aquifer, most wells in Nassau and Suffolk Counties were rated as highly sensitive to contamination by nitrates, if a source of nitrates was present within the source water area. In Nassau County, the mean nitrate concentration for raw water samples from wells with high sensitivity was 2.26 milligrams per liter (mg/l). The mean nitrate value for raw water samples from wells with medium sensitivity was 0.86 mg/l, and the mean nitrate value for raw water samples from wells with low sensitivity was 0.60 mg/l. In Suffolk County, the mean nitrate value for raw water samples from wells with high sensitivity was 3.13 mg/l; the mean nitrate value for raw water samples from wells with medium sensitivity was 0.63 mg/l, and the mean nitrate value for raw water samples from wells with low sensitivity was 0.25 mg/l.

Many public supply wells have minimum times of travel of less than 25 years from the water table to the well screen, thus, most wells were rated as highly sensitive to pesticide contamination and the sensitivity ratings appear to be consistent with monitoring results. The well sensitivity results in Nassau County are consistent with the results of water quality monitoring by the community water systems, where all 8 wells with detections had a high sensitivity rating. In addition, a pesticide degradate, TCPA, was detected in three additional wells using the more comprehensive and sensitive analysis conducted in conjunction with Suffolk County in samples from 166

of 365 community supply wells in Nassau County. Overall, pesticides were detected in less than 4 percent of the community wells, and all of the wells with detections in Nassau County were rated with high sensitivity. The sensitivity analysis in Suffolk County, where more complete data was available, appears to be consistent with the ratings. Pesticides were detected in less than 4 percent of raw samples from Suffolk County community wells with high sensitivity ratings; the average concentration of pesticides from highly sensitive wells was 0.155 micrograms per liter ($\mu\text{g}/\text{l}$). Pesticides were detected in 1 percent of the raw water samples from Suffolk County wells with medium sensitivity, the average concentration in wells with a medium sensitivity being 0.01 $\mu\text{g}/\text{l}$. Pesticides were only detected in one of the samples taken from the wells with a low sensitivity to pesticides, at a concentration of 0.32 $\mu\text{g}/\text{l}$; the average concentration for wells with low sensitivities was 0.001 $\mu\text{g}/\text{l}$.

In Nassau County, VOCs were detected in 31 percent of the wells with high sensitivity ratings and the average concentration of raw water samples from these wells was 19.06 $\mu\text{g}/\text{l}$. VOCs were detected in 9 percent of the wells with medium sensitivity ratings, at an average concentration of 0.77 $\mu\text{g}/\text{l}$, and in only 5 percent of wells with low sensitivity, at an average of 1.04 $\mu\text{g}/\text{l}$. In Suffolk County, VOCs were detected in 23 percent of the samples from wells with high sensitivity ratings, with an average concentration of 1.95 $\mu\text{g}/\text{l}$. VOCs were detected in 4 percent of the samples from wells with medium sensitivity ratings, at an average concentration of 0.23 $\mu\text{g}/\text{l}$, and in only 1 percent of samples from wells with low sensitivity ratings, at a concentration of 0.15 $\mu\text{g}/\text{l}$. Those wells with low sensitivity to VOCs have travel times in excess of 100 years, and tend to be deep wells located along the coasts.

To further evaluate whether the well sensitivity classification is indeed a good predictor of water quality, Nassau and Suffolk Counties identified 27 public supply wells that were closed as a result of nitrate, VOC, and/or pesticide contamination. Using the existing regional groundwater models and historical water supply pumping rates to estimate the time of travel from the water table to the well, the sensitivity of each of the closed supply wells to contamination from each of the four contaminant categories was evaluated according to Table 4-1. The study demonstrated that the sensitivity of each of the closed wells to contamination by the parameter of concern would have been rated as “high” based on the SWAP analyses.

All Nassau County non-community supply wells except one have travel times exceeding 100 years; therefore they were not considered sensitive to contamination from any of the four categories. By contrast, nearly all of the non-community supply wells in Suffolk County are shallow, with less than 2 years of travel from the water table to the well screen. Almost all of the Suffolk County non-community wells are assigned a high sensitivity rating for all four contaminant categories based upon the short time of travel from the water table to the well screen.

5.0 Susceptibility

The *susceptibility* of a water supply well to contamination is dependent upon both the presence of potential sources of contamination within the well’s contributing area (contaminant *prevalence*), and the likelihood that the contaminant can travel through the environment to reach the well (*sensitivity*). Contaminant prevalence and sensitivity are combined to estimate the susceptibility of each well to contamination as described below.

5.1 Susceptibility Rating Assignment

The susceptibility of each public supply well to contamination was evaluated by considering both contaminant prevalence and sensitivity, which were related according to the matrix presented as Figure 5-1. For example, a low contaminant prevalence combined with a high sensitivity (for a particular contaminant category at a particular well) results in a susceptibility ranking of “medium” for that well, as shown in the matrix. The multiple combinations of prevalence and sensitivity rankings made it useful to introduce two additional rankings for susceptibility – Very High and Medium-High. The well susceptibility matrix shown was based upon the matrix included in the New York State SWAP Plan, and was modified by NYSDOH for the Long Island SWAP with input from Nassau and Suffolk Counties. Each well’s susceptibility to each of the four contaminant categories is evaluated separately. The susceptibility ratings are included in each community supply well report.

Figure 5-1
Well Susceptibility Matrix

	Negligible Contaminant Prevalence	Low Contaminant Prevalence	Medium Contaminant Prevalence	High Contaminant Prevalence
High Sensitivity	Low	Medium	High	Very High
Medium Sensitivity	Low	Low	Medium	Medium- High
Low Sensitivity	Low	Low	Low	Medium

5.2 Susceptibility Rating Results

The susceptibility ratings for community supply wells in Nassau and Suffolk Counties are summarized by Figures 5-2 and 5-3.

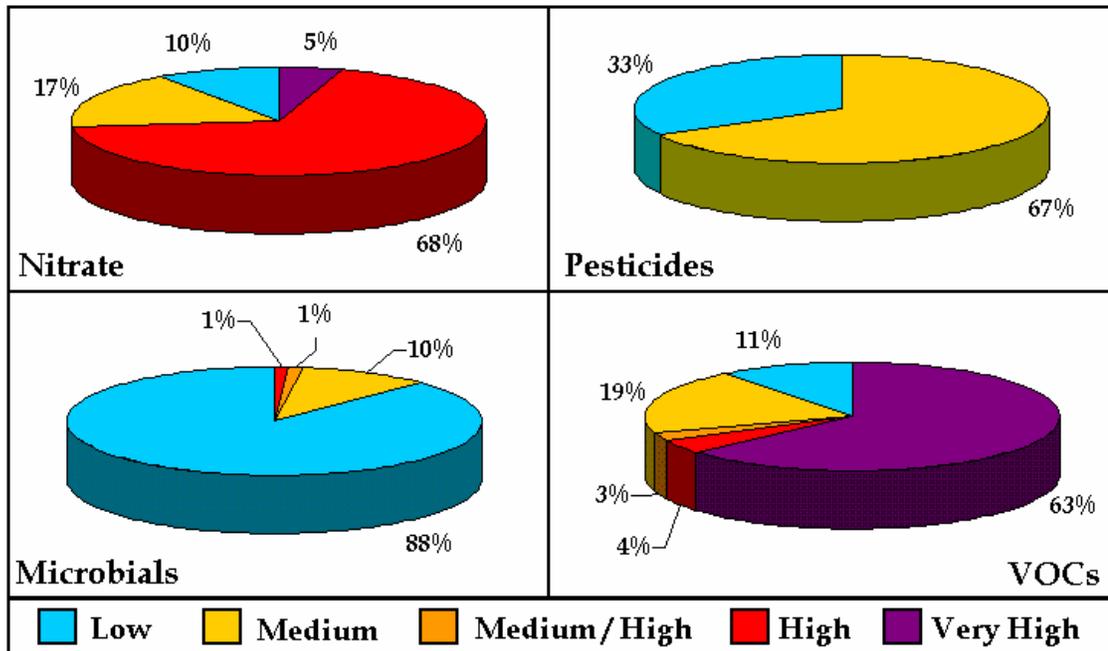


Figure 5-2 Summary of susceptibility ratings for Nassau County community supply wells show the majority of wells having high susceptibility for nitrates, medium susceptibility for pesticides, low susceptibility for microbials and very high susceptibility for VOCs.

Almost 90 percent of community supply wells in Nassau County have a low susceptibility to microbial contamination, due to both the sanitary sewerage program that has reduced the potential for microbials to be introduced to the subsurface environment (prevalence), as well as to the low sensitivity to microbial contamination based upon travel times to supply wells in excess of 5 years. Only 1 percent each of Nassau County community supply wells were rated either medium-high or high for microbials.

Over 70 percent of Nassau County wells were rated high, or very high for nitrate susceptibility, due to the high sensitivity of most wells to this conservative contaminant, and to its assumed prevalence, resulting from overlying land uses in Nassau County. Pesticide susceptibility ratings were generally medium, because of the very limited agricultural land that remains in the County. Due to the extensive distribution of potential sources of VOCs in the highly developed areas of Nassau County, 70 percent of community supply wells have susceptibility ratings of medium high, high or very high for VOCs, while 30 percent have low or medium susceptibilities.

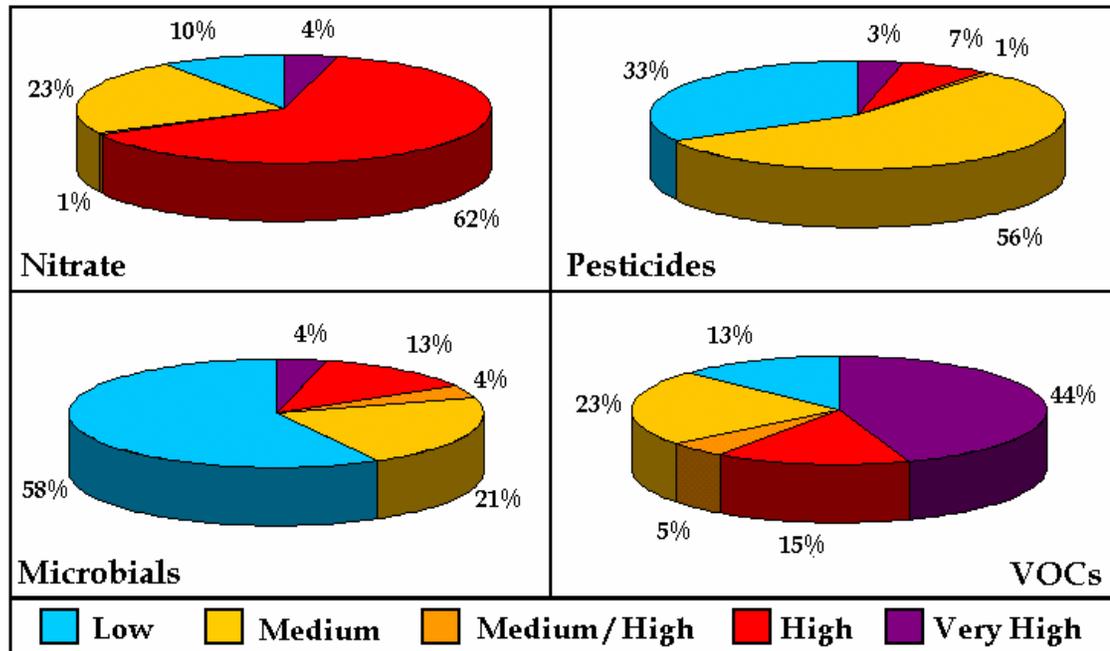


Figure 5-3 Summary of susceptibility ratings for Suffolk County community supply wells show the majority of wells having high susceptibility for nitrates, medium susceptibility for pesticides, low susceptibility for microbials and very high susceptibility for VOCs.

Almost 60 percent of community supply wells in Suffolk County have a low susceptibility to contamination by microbials. Over 20 percent of the community supply wells were rated medium-high, high, or very high for microbials, as a result of the presence of microbial sources in unsewered areas and the relatively short travel times from the water table to shallow well screens, particularly in the central and eastern parts of the County.

Almost 70 percent of Suffolk County community supply wells were rated as high, or very high for nitrates; with the lower population density accounting for reduced contaminant prevalence ratings in the central and eastern parts of the County. The susceptibility of only about 10 percent of community supply wells was rated medium-high, high, or very high for pesticides, largely where significant tracts of agricultural land exist in eastern Suffolk County.

Almost 65 percent of the community supply wells in Suffolk County have susceptibility ratings of medium high, high, or very high for VOCs, while over 35 percent of the wells are rated medium or low. The distribution of community supply well susceptibility ratings for microbials is shown on Figure 5-4. Each colored dot represents the susceptibility at a single community supply well. The figure shows that microbial susceptibility tends to increase in unsewered areas in the central and eastern areas of Long Island.

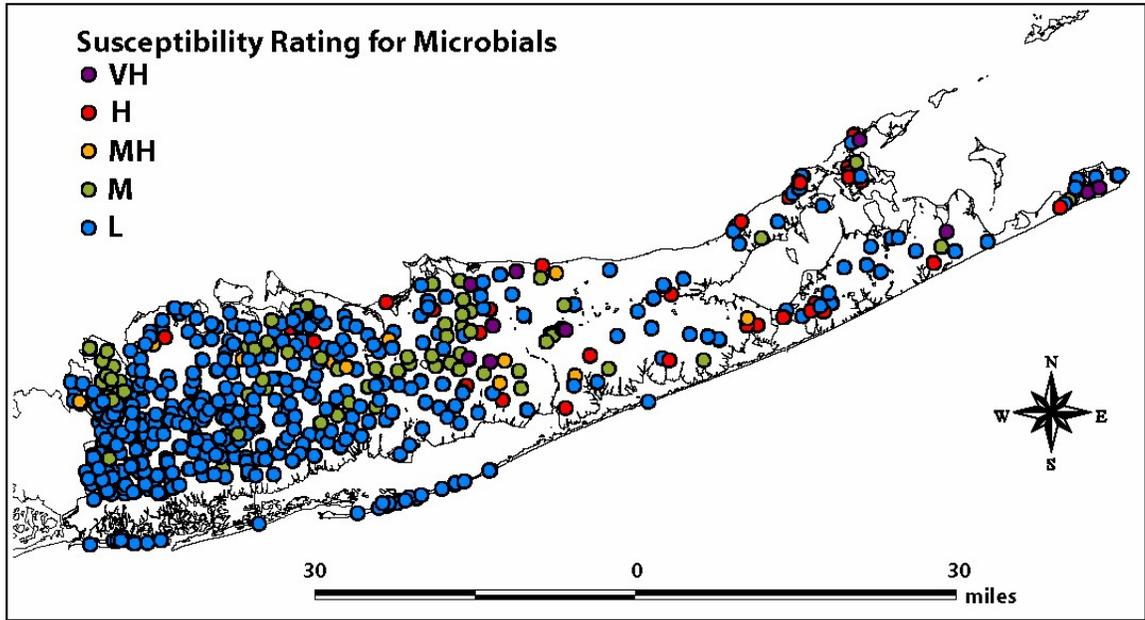


Figure 5-4 Community Supply Well Susceptibility Ratings for Microbials

Figure 5-5 illustrates the distribution of community supply well susceptibility ratings for nitrates. A comparison of available water quality data to susceptibility ratings tends to support the SWAP results, as shown in Figure 5-6.

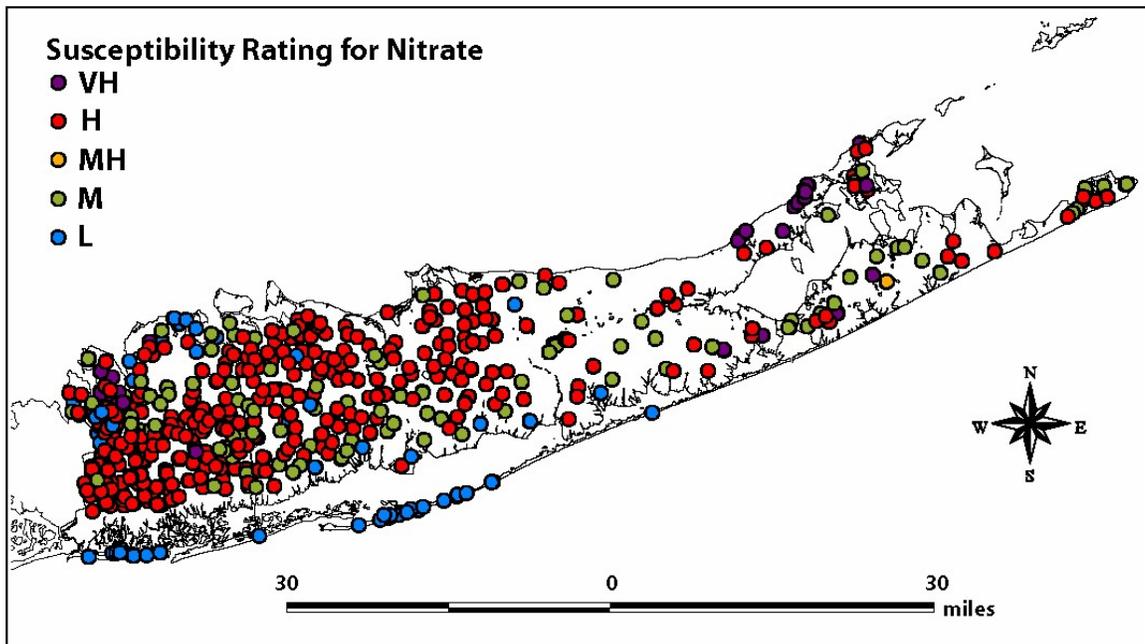


Figure 5-5 Community Supply Well Susceptibility Ratings for Nitrates

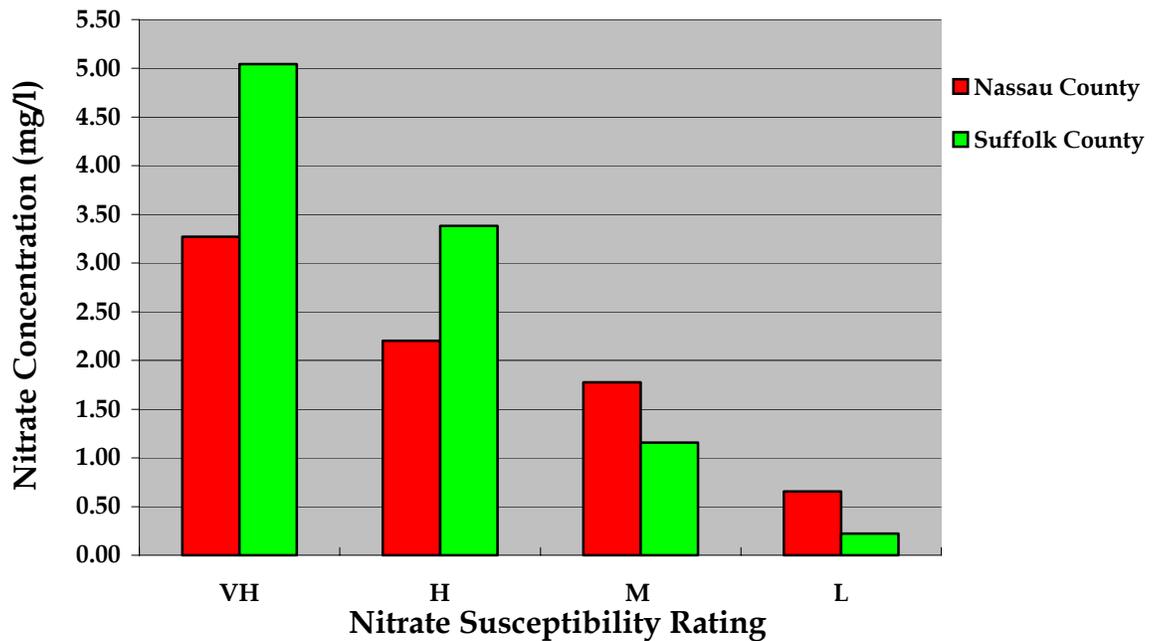


Figure 5-6 Relationship between Susceptibility Ratings and Mean Nitrate Concentrations

In Nassau County, nitrate concentrations in samples from wells with a very high susceptibility to nitrates averaged 3.27 mg/l. Nitrate was detected in 92 percent of the samples from wells with a high susceptibility, at an average concentration of 2.20 mg/l. Nitrate was detected in 96 percent of the samples from wells with a medium susceptibility rating, at an average of 1.77 mg/l. Nitrate levels in samples from the wells with a low susceptibility rating averaged 0.65 mg/l. In Suffolk County, samples from wells with a very high susceptibility to nitrates had an average concentration of 5.05 mg/l and samples from wells with a high susceptibility to nitrates averaged 3.38 mg/l. Samples from wells with a medium susceptibility averaged 1.16 mg/l, and samples from wells with a low susceptibility rating averaged 0.22 mg/l.

Figure 5-7 shows that most of the wells with high susceptibility to pesticide contamination are located in agricultural areas in central Suffolk County, or on the North Fork.

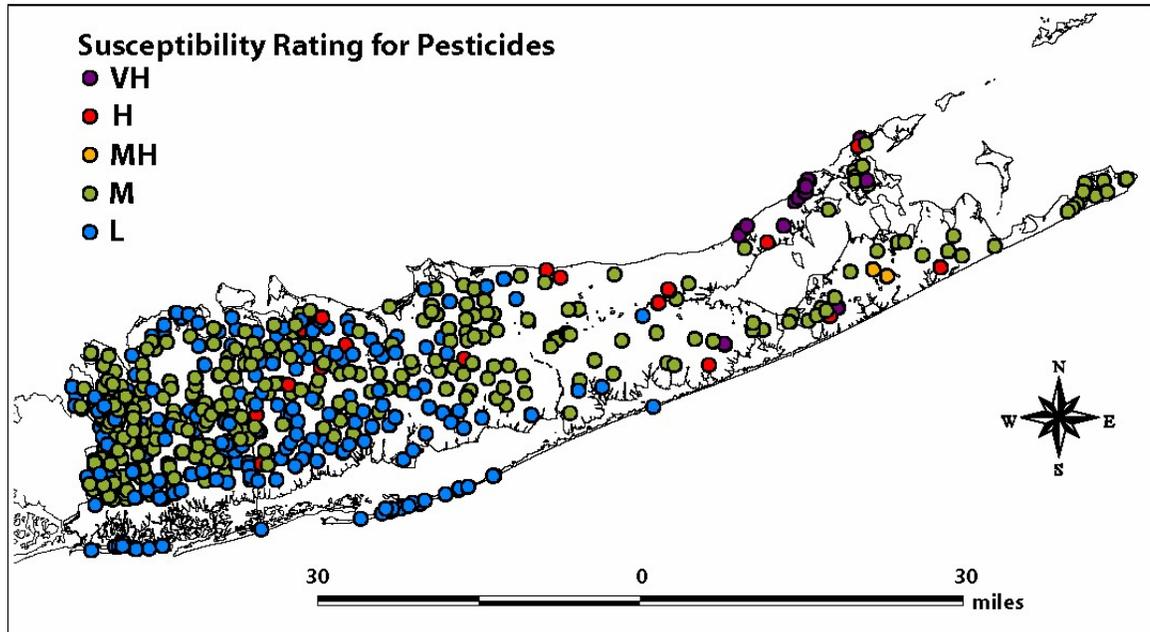


Figure 5-7 Community Supply Well Susceptibility Ratings for Pesticides

Available pesticide data from recent years identified pesticides in untreated water from only 11 Nassau County wells, or less than four percent of the wells. These wells had medium susceptibility ratings for pesticides. One well had contamination above the MCL, which required treatment. The assessment for this well contains the notation “*The medium susceptibility rating for pesticides assigned based upon available information is superseded by water quality data indicating that the well is highly susceptible to pesticide contamination.*” Pesticides were detected in 58 percent of the samples taken from Suffolk County wells with a very high susceptibility rating at an average concentration of 2.8 µg/l; in 7 percent of the samples from wells with a high susceptibility rating at an average concentration of 0.35 µg/l, in less than 1 percent of the samples from wells with a medium susceptibility rating at an average concentration of 0.019 µg/l, and in less than 1 percent of the samples from wells with a low susceptibility rating, at an average concentration of 0.005 µg/l.

Figure 5-8 illustrates the distribution of VOC susceptibility ratings for community supply wells. VOCs were detected in 33 percent of the samples taken from Nassau County wells with a very high susceptibility rating at an average concentration of 23.0 µg/l, in 35 percent of samples from wells with a high susceptibility rating at an average concentration of 7.51 µg/l, in 3 percent of samples from those wells rated medium-high at an average concentration of 0.12 µg/l, in 21 percent of the samples from wells rated medium at an average concentration of 3.07 µg/l, and in 8 percent of samples from those wells rated low, at an average concentration of 1.13 µg/l.

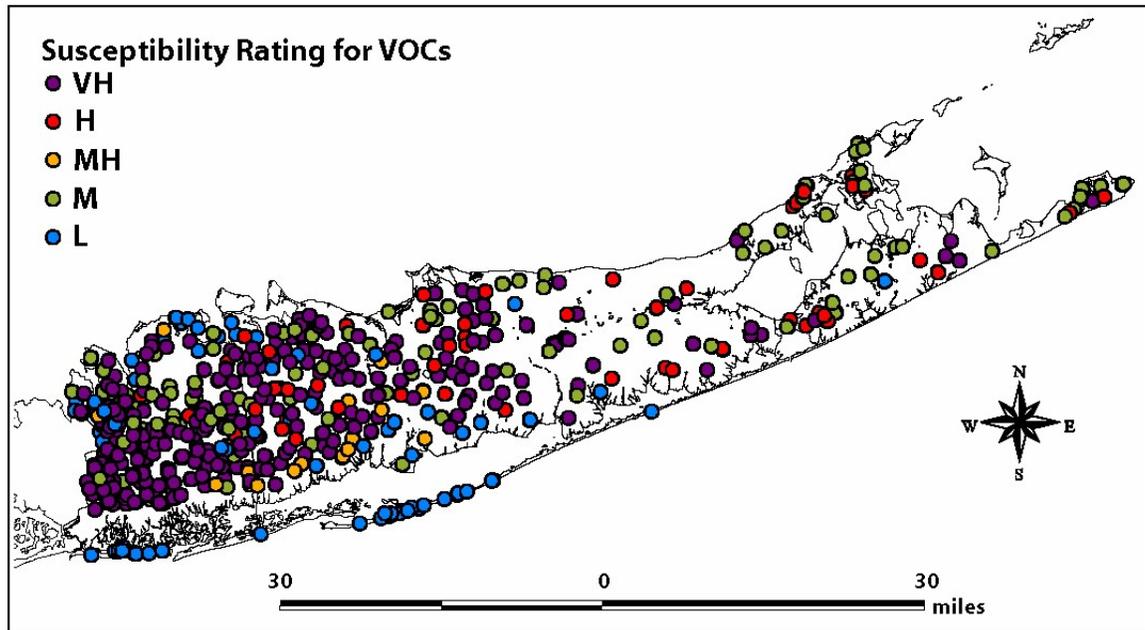


Figure 5-8 Community Supply Well Susceptibility Ratings for VOCs

In Suffolk County, VOCs were detected in 25 percent of the wells with a very high susceptibility rating at an average concentration of 2.42 $\mu\text{g}/\text{l}$, in 23 percent of the samples from wells with a high susceptibility rating at an average concentration of 0.79 $\mu\text{g}/\text{l}$, in 3 percent of those rated medium-high, at an average concentration of 0.11 $\mu\text{g}/\text{l}$, in 16 percent of those with a medium susceptibility rating, at an average concentration of 1.55 $\mu\text{g}/\text{l}$, and in 3 percent of those rated low, with an average concentration of 0.24 $\mu\text{g}/\text{l}$.

Susceptibility to Contamination by Metals and Radionuclides Groundwater contamination by metals and radionuclides is a localized – rather than regional – water quality concern on Long Island. For that reason, the potential for a community supply well to be affected by metals or radionuclides was ascertained on a site-specific basis. Nassau and Suffolk Counties identified four facilities (three CERCLA facilities and one hazardous waste facility) where metals contamination of groundwater has been documented within a contributing area to a public supply well and a single CERCLA facility with documented radionuclide contamination.

Those community supply wells whose source water area included any of the facilities known to introduce metals to the groundwater were identified as susceptible to metals contamination. In Nassau County, four wells located in two water districts were identified as susceptible to metals contamination. In Suffolk County, two wells at a single wellfield were identified as susceptible to metals contamination.

Source water areas for two wellfields in Suffolk County included part of the facility property where historical groundwater contamination by radionuclides has been documented. In all, ten community supply wells were identified as susceptible to radionuclide contamination.

Susceptibility to Chloride Contamination Because chloride contamination generally results from the proximity of a supply well to Long Island's coast, rather than from overlying land use, wells susceptible to chloride contamination were identified based upon their locations with respect to documented positions of nearby salt water interfaces and upon the results of earlier field and modeling evaluations. Six community supply wells in northwestern Nassau County and seven supply wells in southwestern Nassau County were identified as having a high susceptibility to chloride contamination. Nine community supply wells located on the north and south forks in Suffolk County, as well as several community supply wells on Shelter Island were identified as having a high susceptibility to chloride contamination. In

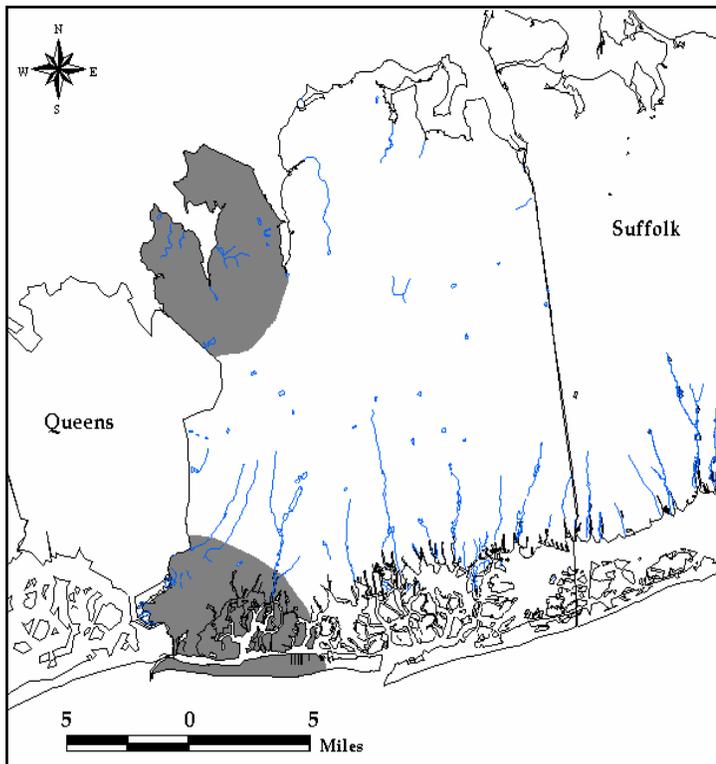


Figure 5-9 Nassau County Areas Vulnerable to Salt Water Intrusion

eventually become contaminated. An extensive variety of resource management and pollution prevention programs have been implemented on the federal, state, county, and local levels to minimize the release of contaminants to groundwater. The fact that VOCs are not detected in almost 70 percent of the Nassau County and Suffolk County samples with a very high susceptibility rating demonstrates the effectiveness of existing programs.

A high susceptibility rating does imply, however, that the contaminant in question is likely to be present above ground within the source water area, and that if released to the ground, it does have the potential to travel down through the aquifer to reach the well. Continued vigilance in compliance with water quality protection and pollution

most cases, this susceptibility can be managed by monitoring and moderating water supply pumping rates. Nassau County wells susceptible to chloride contamination are, in general, located in the shaded areas shown on figure 5-9. Wells that are vulnerable to salt water intrusion in Suffolk County are located in coastal areas on the north and south forks, and on Shelter Island.

5.3 Significance of Results

It must be emphasized that a high susceptibility rating for a particular contaminant does not imply that the water from that well will

prevention programs as well as continued monitoring and enforcement will help to continue to protect groundwater quality.

6.0 Results and Conclusions

Source water assessments have been developed for each community and non-community supply well in Nassau and Suffolk Counties. Three-dimensional groundwater models were used to estimate the land surface area contributing recharge to each well under long-term average conditions of recharge and water supply pumping, and to estimate the minimum time of travel from the water table to the well screen under these conditions. The potential for existing land uses and regulated activities located within each well's source water area to introduce contaminants to the aquifer was evaluated using GIS tools; existing land use mappings; and federal, state, and county databases of regulated facilities. Finally, the potential for various contaminants to be present within each well's source water area, the ability of the contaminants considered to persist in the environment and travel through the aquifer, and the time of travel from the water table to the well were all considered in determining the susceptibility of each well to possible contamination.

The susceptibility of each public supply well to contamination by microbials, nitrates, pesticides, and VOCs was assessed, based upon current land uses and water supply pumping patterns. In general, based upon the existing patterns of water supply pumping and development, the majority of wells had high susceptibility ratings for nitrates and VOCs, but were not highly susceptible to contamination by microbials or pesticides. It must be noted that a high susceptibility rating for a particular contaminant does not imply that the water at that well will eventually become contaminated. Comprehensive resource management and pollution prevention programs have been implemented at the federal, state, county, and local levels to minimize the release of contaminants to groundwater. The fact that VOCs are not detected in almost 70 percent of the samples taken from Nassau and Suffolk County wells with a very high susceptibility rating for this contaminant category underscores that susceptibility to contamination does not mean the source water will inevitably become contaminated. A high susceptibility rating does indicate, however, that the contaminant in question is likely to be present above ground within the source water area, and that if released to the ground, it has the potential to travel down through the aquifer to reach the well. In general, raw water quality data from the community supply wells was consistent with the susceptibility ratings for each contaminant. With one exception, average concentrations of detected contaminants were highest in wells with very high susceptibility ratings, and the average concentrations decreased consecutively for wells with susceptibility ratings of high, medium-high, medium and low. Continued vigilance in compliance with water quality protection and pollution prevention programs as well as continued monitoring and enforcement will continue to protect groundwater quality.

The modeling and assessments performed during this study are based on several clearly stated assumptions, such as consistency of precipitation and of pumping rates.

Because the source water area for each well does change in response to changing recharge rates and water supply pumping rates at the well and at surrounding wells, the results for an individual well may change. Particularly in the western parts of the study area, source water areas for supply wells are immediately adjacent to source water areas for other wells, fitting together like pieces in a complex puzzle. As water supply pumping rates change at individual wells, the exact boundaries of the source water area for any particular well and its neighbors change. It is clear that most of the land surface of Long Island serves as a potential recharge area for water supply, and that activities on the land surface can affect drinking water quality.

The source water assessments provide a reminder that the activities of Nassau and Suffolk residents living above their water supply have the potential to impact source water quality. The susceptibility results also provide additional information for water resource managers to set priorities and to target water quality protection and management programs, including planning, enforcement, and monitoring programs.

Finally, the distinction between source water withdrawn at the well, and the potable water delivered by water suppliers to consumers, must be emphasized. Raw, untreated water withdrawn from the aquifer by water suppliers is monitored for the presence of hundreds of potential contaminants. If any contaminants are present at levels above drinking water standards, the water is either treated to remove the contamination, or the well is removed from service. Water suppliers, NYSDOH, NCDH, and SCDHS continue to work closely together to assure that water delivered to Long Island residents meets all applicable drinking water standards.

List of Acronyms

EPA – Environmental Protection Agency

GIS – geographic information system

NCDPW – Nassau County Department of Public Works

NCDH – Nassau County Department of Health

NYSDEC – New York State Department of Environmental Conservation

NYSDOH – New York State Department of Health

SCDHS – Suffolk County Department of Health Services

SCWA – Suffolk County Water Authority

SDWA – Safe Drinking Water Act

SWAP – Source Water Assessment Program

SWPCC – Source Water Protection Coordinating Committee

VOCs – volatile organic chemicals

WHPA – Wellhead Protection Area

Appendix A

This Appendix summarizes the documentation of the Long Island SWAP Program, describes the public participation program that was implemented, and includes the response to public comments on the source water assessment reports.

A.1 Public Participation

During development of the New York State SWAP Plan, NYSDOH initiated a variety of public participation activities, as noted in Section 1.0. During implementation of the SWAP, several public participation initiatives were continued. Long Island SWAP Steering Committee meetings were held to report on progress and results, and to solicit guidance on interpretation and presentation of the SWAP results. Long Island SWAP Steering Committee meetings were held on January 24, 2002; June 25, 2002; October 22, 2002; and February 13, 2003.

The approach to implementing the SWAP Plan on Long Island was presented to the public at meetings held on March 19, 2002 at the Old Bethpage Village Restoration facility in Nassau County, and on March 20, 2002 at the Cornell Cooperative Extension Building in eastern Suffolk County and the H. Lee Dennison Building in western Suffolk County. NCDH and SCDHS invited interested water suppliers to attend informational meetings to explain and review the SWAP process and draft source water assessments in February 2003. Public meetings to review the draft Long Island SWAP summary report were held on March 3, 2003 at the Suffolk County Legislative Building in eastern Suffolk County and on March 4 at the H. Lee Dennison Building in western Suffolk County and at the Old Bethpage Village Restoration facility in Nassau County.

The individual assessments and the summary of assessment results were reviewed, evaluated, and refined, in cooperation with NYSDEC, County agencies, and the water suppliers. Well-specific assessments will be summarized by the health departments for each community water systems and incorporated by each supplier into their Annual Water Quality Report in 2004.

A.2 Response to Public Comments

A variety of comments on the individual source water assessment reports were provided by 26 suppliers and/or their consultants in Nassau County, and by six suppliers and/or their consultants in Suffolk County.

Most of the comments pertained to the data used to characterize specific wells, although there were several general comments. The response to each type of comment provided is summarized below.

Wells Selected for Assessment

Several suppliers noted that they did not receive reports for all of their active wells, or that they received reports for wells that are not in service.

Draft Source Water Assessment reports were prepared for all wells identified as “active” in New York State Department of Health (NYSDOH), Nassau County Department of Health (NCDH), Nassau County Department of Public Works (NCDPW), or Suffolk County Department of Health Services (SCDHS) databases.

Source Water Assessment reports have been produced for all wells that were identified as active on or prior to January 1, 2002. Reports had been distributed for nine (two Nassau County, seven Suffolk County) wells that were not properly identified by the N- or S- number or by supplier in the existing databases; with the help of the County health departments, reports were forwarded for those wells. Assessments have not been performed as part of this study for wells that came on-line during 2002. The wells on one supplier’s common suction system were simulated appropriately as a single well; duplicate reports were generated for the four other wells on the system.

Nassau County Department of Health confirmed that five additional community supply wells were abandoned. The wells have been removed from the models, and the areas in which they were relocated were re-simulated. No source water assessments will be provided for those wells. Assessments have been completed for all inactive wells that have not been formally abandoned, as they may be utilized again in the future.

Data Used in Well Assessments

Comments were received from suppliers in both Nassau and Suffolk Counties that well screens, well depths and well locations were inaccurate.

All well screen elevations, well depths, and well locations that were shown in the draft well reports were obtained from the existing state and County databases. All revised well screen elevations, revised well depths and revised location information identified in the comments have been corrected, and a new well database has been developed. Wells with significant changes in well screen elevation (e.g.; redrilled wells) and/or location were re-simulated, resulting in revised minimum travel times and source water areas.

Operational pumping patterns were not incorporated into the evaluation. It is far beyond current computational processing capabilities to consider the temporal variations in pumping patterns at each well. Although it is recognized that water supply pumping rates vary considerably between growing and non-growing seasons, and between years of high precipitation and low precipitation, the SWAP evaluation

is based upon average annual pumping rates for an average year of precipitation/recharge. Incorporating the 200 foot buffers onto the source water area depictions helps to account for the intermittent pumping at higher rates.

Source Water Area Simulation Approach

Several comments were received on the approach that was used to represent wells within a wellfield, and upon the appearance of the simulation results.

Two water districts in Nassau County were concerned that wells screened within the same location should have been simulated together. For one water district, the new well screen information provided by the supplier was incorporated into the model for the well of concern. Although the two other wells of concern were located on the same site and screened at similar depths, they are separated by more than 200 feet. Since the node spacing in the model is 200 feet, the wells were assigned at two different nodes and were therefore simulated individually. The minimum time of travel for both wells is exactly the same, the susceptibility ratings for each contaminant category are the same for both wells.

One source water assessment result was reportedly inconsistent with the known natural groundwater flow field. That well had already been re-simulated and the results were resubmitted to the supplier.

Several suppliers commented upon the unexpected or strange shapes of the source water assessment. It is agreed that many of the source water areas appear to be unusual when viewed individually. However, considered in the context of the source water areas for adjacent and nearby wellfields, it can be demonstrated that adjoining source water areas fit together like the “pieces in a puzzle” and appear to be appropriate representations of the contributing areas, as shown by figure A-1.

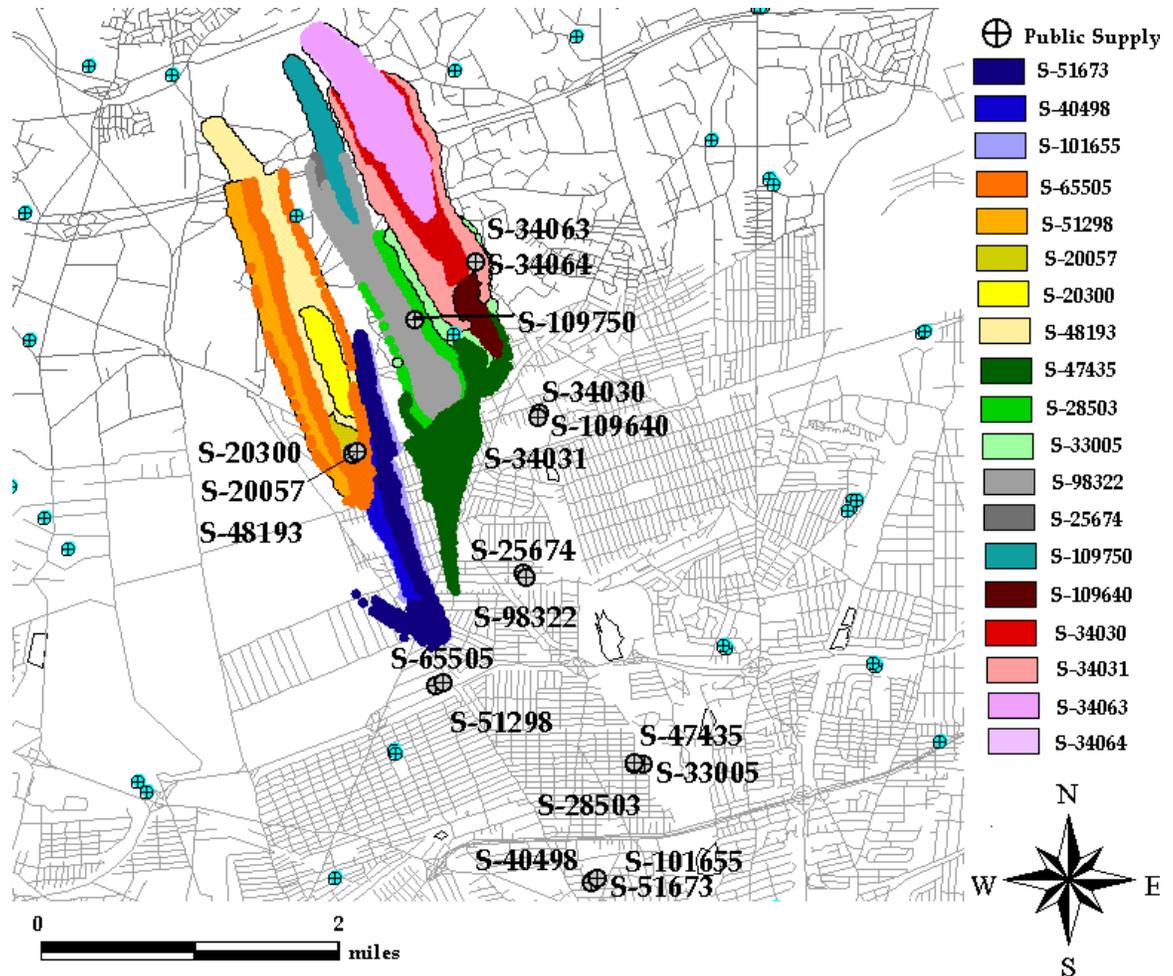


Figure A-1 Source Water or Contributing Areas for Nearby Supply Wells Fit Together Like the “Pieces of a Puzzle”

Contaminant Inventory within Assessment Area

Sixteen Nassau County suppliers reported that the locations of potential point sources included in the contaminant inventory were erroneous. One supplier in Nassau County and one supplier in Suffolk County reported that sewered area was incorrectly incorporated as unsewered area in the contaminant prevalence assessments.

The locations of all facilities incorporated into the contaminant prevalence assessment had been obtained from existing federal, state and county databases. Those facilities that the suppliers reported were not actually present within their well’s source water area have been removed where they affect the contaminant prevalence assessments in the SWAP reports. Some reports may still list erroneously located facilities where they do not affect the assessment outcome, because there are correctly located facilities of a similar type in the source water area. The potential point sources have

not been removed from the master point source database provided to NYSDOH, in case the correct locations are identified at some later date.

The sanitary sewerage coverage provided by Nassau County depicts the questioned area in question in Nassau County as unsewered. This information was double-checked with Nassau County Department of Public Works. The private sanitary sewer system identified by the Suffolk County supplier was incorporated into the contaminant prevalence assessment for the affected wells.

Assessment Result Did Not Reflect Contamination

Two Nassau County suppliers reported that the assessment did not include a known plume, and one Suffolk County supplier identified a facility identified as a Superfund site. Two Nassau County suppliers reported that their susceptibility ratings were too low, as the wells had already experience contamination.

A note was added to the SWAP reports (directly beneath Table 5B, Well Susceptibility Summary) for those suppliers who have identified plumes within their contributing areas. The note states:

This well is susceptible to VOC contamination based upon the identification of a VOC plume within the source water area.

The susceptibilities for VOCs are largely driven by the contaminant prevalence ratings. Because most of Nassau County is served by sanitary sewers, the contaminant prevalence ratings depend largely on identification of the presence of potential point sources within the source water area. If more accurate and comprehensive coordinate information were available, it is possible that one (or more) potential point sources would be identified in a source water area that would increase the susceptibility rating. However, the long travel times for recharge to reach most wells in Nassau County means that the contamination resulted from activities decades ago, which may not be reflected in the analysis of current land uses and facilities. Furthermore, the contamination may have resulted from undocumented spills or disposal that occurred prior to the implementation of current regulatory and management programs.

The SWAP reports for wells with low susceptibility ratings and observed VOC or pesticide contamination will include a note, indicating that water quality data indicating contamination supersedes the low susceptibility rating obtained using the SWAP evaluation process. Furthermore, reports for wells with medium susceptibilities and VOC or pesticide detections exceeding the applicable standard will include a similar note.

Inadequate Time to Review Draft Well Assessments

Suppliers expressed concerns that there was inadequate time to review the draft individual well assessment reports and provide corrections.

The NYSDOH and county health departments appreciate the conscientious and expeditious review provided by many suppliers and their consultants. The correction of the underlying information for the assessment, as noted above, improved the accuracy of the assessment results and their usefulness in source water management. Unfortunately, the 15-month contract schedule allowed only one month for public water system review, in order provide time for the contractor to incorporate the comments and in some cases re-simulate the assessment areas.

Assessment Information Provided to the Public

Suppliers expressed concerns that the public may misinterpret assessment results included in the Annual Water Quality Reports (AWQR) as indicative of actual water quality delivered to consumers.

State regulations require that, if the State has completed a source water assessment, public water system include in their AWQR notice that this information is available and the means to obtain it. The AWQR must include a brief summary of the system's susceptibility to potential sources of contamination, using language provided by the State or county health departments. The federal Consumer Confidence Report Rule has similar requirements.

NYSDOH will work with county health departments to integrate the source water assessment summary into the context on the AWQR information about the source(s), treatment and water quality. The assessment summaries will distinguish assessment ratings from drinking water quality reported elsewhere in the AWQR. The assessment summaries will note where the source water assessments only indicate the *potential* for contamination of a supply well, and that the *potential* has not resulted in *actual* contamination of the source water. Inclusion of assessment results in the AWQR emphasizes the important public education message that in many cases, the *potential* for contamination can be mitigated by existing or expanded management programs. The assessment summary will also note where contaminants are detected in the source water, but the water supplier has provided treatment or withdrawn the well from service, so that all potable water distributed to customers meets applicable drinking water standards.

Public water suppliers may add supplementary information on their management programs to their AWQR, in order to put the assessment summaries into the context of the overall water quality protection effort.

Suppliers questioned whether systems with Low susceptibility ratings for microbials could be relieved of the requirement to present educational information on *Cryptosporidium* in their Annual Water Quality Report.

New York State Public Health Law and the State Sanitary Code require that all Annual Water Quality Reports include educational language about *Cryptosporidium*.

Suppliers expressed concerns that public availability of assessment information and maps is inconsistent with their security policies and attempts to safeguard sensitive information.

The assessments will include a Source Water Assessment (SWA) map that displays the general location of specific water sources as well as potential sources of contamination. Coordinate data will not be included; however, identifying information, such as street locations, is on the maps. NYSDOH does not, however, believe that the data included on the SWA maps is inherently sensitive. Such data is readily available from existing public information sources. Thus, while the county health departments should release coordinate data only in accordance with the Bureau of Water Supply Protection's data release policy, source water assessment reports and public summary reports prepared based on these assessments can be released to the public and other interested parties as originally intended in the SWAP plan. NYSDOH asks, however, that county health departments and public water suppliers release these reports only upon request and develop protocols for reviewing requests, to assure the appropriateness of the request, and log all requests (e.g. name of requester, date, reason for request). Requests that are deemed by the county health departments or suppliers to be inappropriate, such as requests from non-credentialed requestors, requests without a justifiable public or private benefit, or requests without a specific use or purpose, and which do not require disclosure under the Freedom of Information Law (Article 6 of the Public Officers Law) should be denied.

Appendix B

Project Documentation

This Appendix summarizes the documentation of the Long Island SWAP Program.

Several types of documentation were prepared to describe the implementation and results of New York State's Source Water Assessment Program for Nassau and Suffolk Counties.

Community and Non-community Supply Well Reports - Well-specific reports delineating each well's source water area based upon long term average recharge and pumping, the contaminant prevalence ratings associated with land use and point sources located within the well's source water area, and well sensitivity and susceptibility ratings for each of the four contaminant categories were developed for each of the 938 community supply wells and 418 non-community supply wells in Nassau and Suffolk Counties. These well-specific reports, developed using available data and tools, provide water suppliers and water resource managers with an overview of the susceptibility of their wells to contamination caused by human activities within each well's source water area.

Task Reports - Task reports were prepared to document progress on each phase of the project as follows:

Task 1A	Regional Management Plans and Programs
Task 1B	Prior and Ongoing Source Water Assessments
Task 1C	Groundwater Quality and Monitoring Programs
Task 1D	Emerging Issues
Task 2A	Public Water Supply Data
Task 2B	Land Use Data
Task 2C	Potential Point Source Data
Task 3A.1	Nassau County Groundwater Model
Task 5	Sensitivity Evaluation

The deliverables for Tasks 3, 4, and 6 were comprised of the individual well reports prepared for the 365 community supply wells in Nassau County and 573 community supply wells in Suffolk County, the 7 non-community supply wells in Nassau County, and the 411 non-community supply wells in Suffolk County, along with supporting backup materials.

Summary Report - This document provides an overview of the source water area delineation, contaminant inventory, and susceptibility evaluations, as well as a summary of the source water assessment results for the groundwater supply in Nassau and Suffolk Counties.

Appendix C

Non-Community Well Assessment Approach

C.1 Source Water Delineation Approach

The majority of the 418 non-community wells in Nassau and Suffolk Counties are shallow wells pumping at relatively low rates. Initially, the SWAP scope of work recommended application of EPA's Wellhead Protection Area (WHPA) code to estimate the contributing area for each of these wells. Because the WHPA assumes that wells are fully penetrating, which is not the case for most Long Island non-community wells), an alternative semi-analytical approach was developed in cooperation with SCDHS.

Data to characterize withdrawal rates was not available for most of the non-community wells. In addition, supply wells withdrawing less than 45 gallons per minute (gpm) do not require NYSDEC well permits. Consequently, documentation of well construction details is not available for many of the low-capacity non-community supply wells. After consultation with SCDHS, it was determined that for the majority of those non-community wells for which no screen depth or water supply pumping data is available, the following assumptions were appropriate:

- Non-community wells for which no data are available are screened a minimum of 40 feet into the water table (as per SCDHS requirement);
- Non-community wells for which no data are available pump at a rate of 1,000 gallons per day (gpd);
- Non-community wells located along the coast are screened 20 feet into the water;
- Seasonal non-community wells pump at a rate of 500 gpd.

Reported pumpage and screened intervals were used for those wells with available data.

The five existing calibrated groundwater flow models used for the community well assessment were also used as the basis for developing the contributing or source water areas for the non-community supply wells in Nassau and Suffolk Counties. The 200-foot discretization used for the community supply well simulations was not adequate to estimate the contributing area for a series of the low capacity non-community wells. Therefore, a set of very highly discretized sub-grids (e.g., node spacing 10 feet) was used to develop representative source water areas for the non-community supply wells pumping at 1000 gallons per day (500 gallons per day for seasonal wells). The resulting contributing areas were reviewed and refined, to

develop a representative non-community well contributing area template. Utilizing the sub-regional model contoured water levels to define the direction of flow with respect to each non-community well, the contributing area was defined assuming that recharge rates and water supply pumping rates were constant for a period of 100 years. Use of the data and information incorporated into the existing calibrated groundwater flow models provided more representative depictions of the areas contributing water to the non-community supply wells.

The width of the largest estimated source water area produced using this approach was doubled and used as the template for the non-community wells. This conservative approach is being employed to help to address the transient nature of actual supply pumping at these wells, many of which have much higher short-term pumping rates during the summer months.

Land use for the entire source water area for each non-community well was aggregated for the purposes of contaminant prevalence assessment.

The minimum time of travel from the water table to 401 of the non-community wells was less than two years. These wells were all identified as sensitive with respect to contamination by microbials, nitrates, pesticides and VOCs. For the remaining 17 deeper non-community wells, screened deep within the Magothy aquifer or the Lloyd aquifer on the south shore barrier islands, the time of travel from the water table to the well exceeds 100 years. For those wells, no source water areas can be identified by the 100 year simulations. These wells have a low sensitivity rating for each of the four contaminant categories.

C.2 Significant Assumptions for Non-community Well Assessments

The model-simulated source water areas are sensitive to assumed rates of recharge and water supply pumping. Several key assumptions have been incorporated into this modeling evaluation:

- Long term average annual rates of precipitation and recharge are constant for 100 years.
- Water supply pumping rates will remain constant for 100 years.
- The locations of supply wells will remain constant for 100 years.

These assumptions are appropriate for planning purposes for areas of stable development, population and land use. In areas where new wells are sited or where pumping rates change in response to changing development patterns, population and demand for public water supply the contributing area delineations may change significantly. Furthermore, the time of travel evaluations consider potential contaminant migration by advective flow only (the effects of dispersion are not included).

Because in reality, precipitation, recharge, and water supply pumping rates are always changing, the boundaries of the source water area contributing recharge to any particular well will also change over time. The source water area delineations developed during this SWAP demonstrate that most of Nassau County, and large parts of Suffolk County do serve as source water areas for the public water supply. This affirms water managers' historical approach to treat the entire land surface as a potential source water area that is worthy of protection.