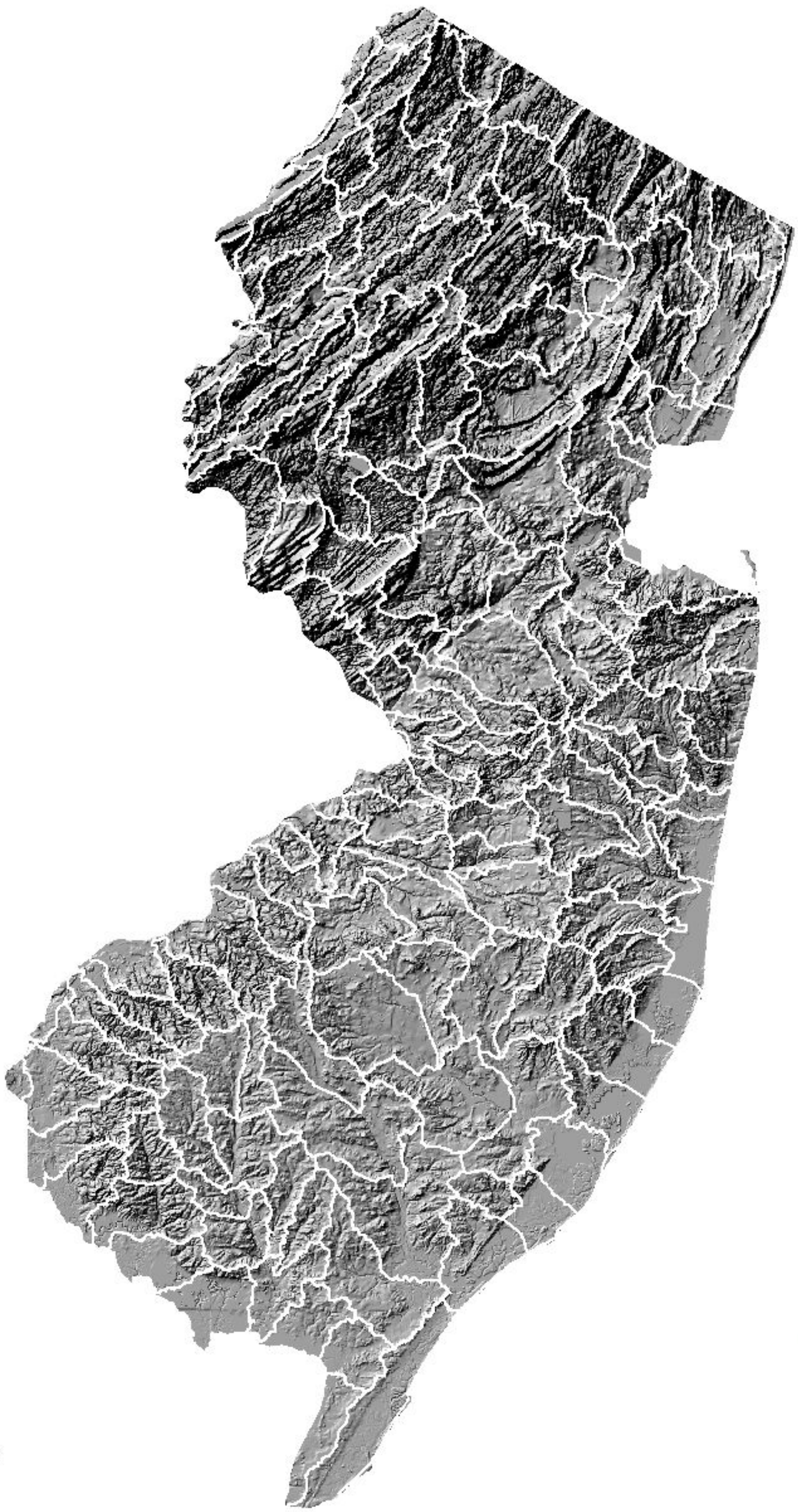
New Jersey Water Withdrawals, Uses, Transfers, and Discharges by HUC11, 1990 to 1999

User's Guide



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NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION

The mission of the New Jersey Department of Environmental Protection (NJDEP) is to assist the residents of New Jersey in preserving, sustaining, protecting and enhancing the environment to ensure the integration of high environmental quality, public health and economic vitality.

NEW JERSEY GEOLOGICAL SURVEY

The mission of the New Jersey Geological Survey is to map, research, interpret and provide scientific information regarding the state's geology and ground-water resources. This information supports the regulatory and planning functions of the NJDEP and other governmental agencies and provides the business community and public with information necessary to address environmental concerns and make economic decisions.

PRINTING SUGGESTIONS

The User's Guide is designed to be printed out in color on 8 ½" by 11" paper in portrait mode. The Appendixes are designed to be printed out in color on 11" x 17" paper in portrait mode. The user may have to modify the printer settings in order to produce legible output on smaller pages for the appendixes.

COVER PAGE

The cover page shows a gray tone hillshade image of the state of New Jersey overlaid by HUC11 boundaries in white.

New Jersey Water Withdrawals, Uses, Transfers, and Discharges by HUC11, 1990 to 1999

User's Guide

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HUC11 Tables, Figures and Maps

New Jersey Water Withdrawals, Uses, Transfers, and Discharges by HUC11, 1990 to 1999
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Abstract

This New Jersey Geological Survey (NJGS) report summarizes data on water withdrawal, use, transfer and discharge in New Jersey from 1990 through 1999 for all of New Jersey's 151 11-Digit Hydrologic Unit Code (HUC11) drainage basins. The HUC11 delineations were developed by the United States Geological Survey (USGS) and modified by the New Jersey Department of Environmental Protection (NJDEP) to meet its Geographic Information Systems (GIS) mapping requirements. The NJDEPs HUC11s range in size from 3 to 349 square miles, and average about 60 square miles. HUC11s are aggregated together to form 20 Watershed Management Areas (WMA) and these are further aggregated to form 5 Water Regions (WR) (Figure 1). Withdrawals are defined as the volume of fresh water withdrawn from ground-water or surface-water sources. Withdrawals include sources regulated under the Water Supply Management Act (N.J.S.A. 58:2-1 et seq.), and estimates of those from private domestic wells and small, public non-community water systems. Use is defined as the volume of water actually used in the HUC11, after accounting for transfers. Use is categorized into one of eight use groups: agricultural, commercial, industrial, non-agricultural irrigation, mining, potable supply, power generation and not classified. Transfers consist of water moved between HUC11s and include fresh water (e.g. bulk transfers of potable water) and sewage (e.g. via sewer collection pipes). Discharge points and reported discharge volumes are also included.

Owing to the large file size of this report, it is divided into a User's Guide and 20 appendixes, one for each Watershed Management Area (WMA). The User's Guide (this document) provides background information on the data source, corrections, definitions and other details relating to the development of this report. Each appendix consists of two pages for each HUC11 located within the WMA of interest. The first page is a cover page. The even numbered page contains tables and figures summarizing volumes and other descriptive statistics for the specific HUC11. The odd numbered page shows a map with withdrawal points, discharge points and base map information for the same HUC11.

This report is intended for a technical audience familiar with water-supply issues in New Jersey. It assumes the reader has a general understanding of water withdrawal, transfer and discharge practices as well as the watersheds of New Jersey.

This report supports the 2006 update of the New Jersey Water Supply Plan. The plan is updated on a periodic basis in order to ensure an adequate and safe supply of water.

Thanks to an ongoing data-accuracy evaluation process this report is more accurate than earlier ones.

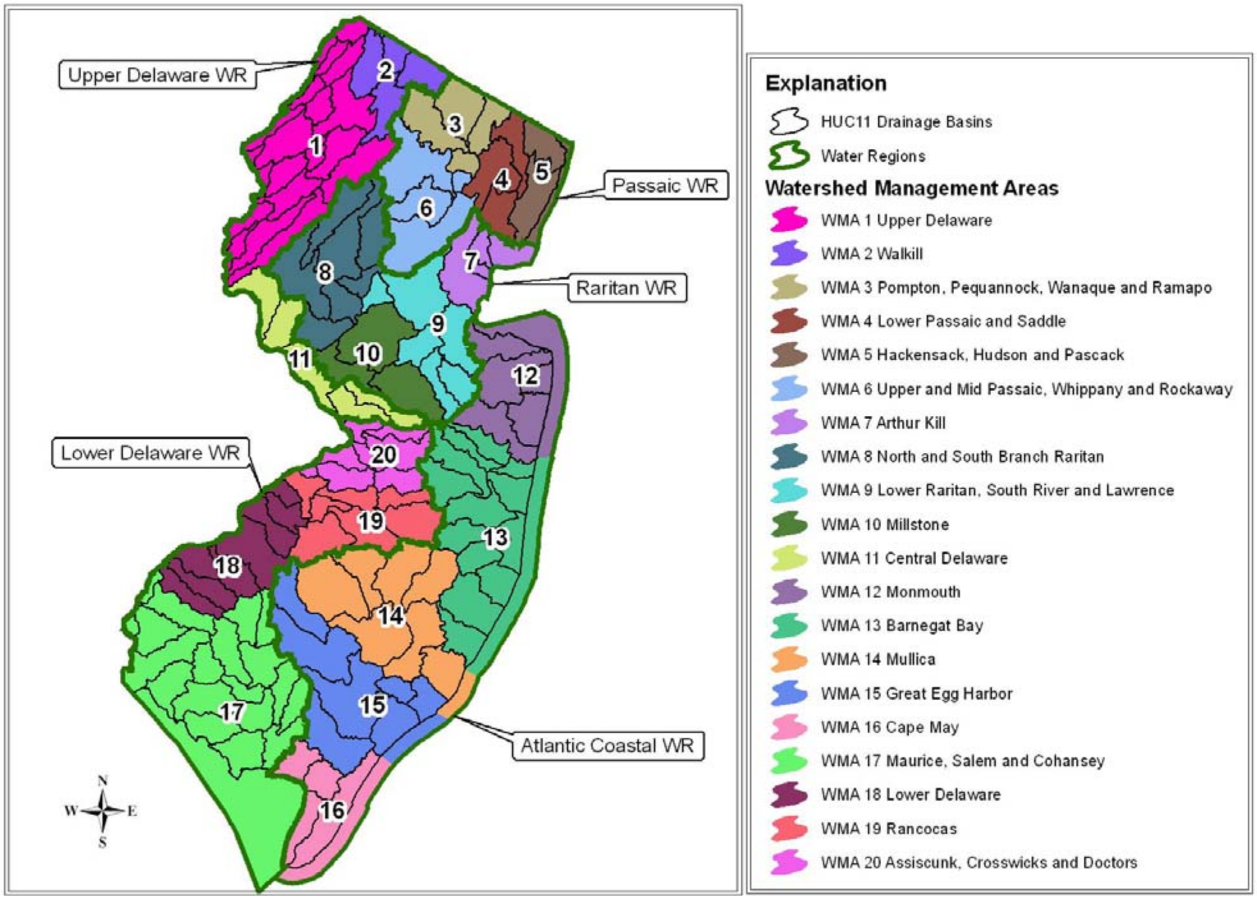

Figure 1. Map of New Jersey showing Water Regions, Watershed Management Areas and HUC11 boundaries.

1.0 Overview of Data Tables and Figures

The even numbered page of each appendix, for each WMA, contains data tables and figures describing withdrawal, transfer, use, and discharge volumes from 1990 through 1999 as well as other descriptive statistics for each of New Jersey's 151 HUC11 drainage basins. The data are intended to provide the user with an overview of water use in that particular basin and aid the NJDEP in developing an effective water resource management strategy specific to the basin. The information is not intended to be used to regulate specific withdrawals.

The tables and charts summarizing data for each HUC11 were created in a Microsoft® Excel 97 spreadsheet and converted to an Adobe® PDF document for this report. The spreadsheet was designed to update the tables and figures based on the selected WMA and HUC11. As a result the page layout is the same, but the data are unique to the selected HUC11. The data are stored on a monthly basis by the smaller HUC14 drainage basin in the underlying database for the same ten-year period. In order to minimize locational errors the data are summarized here on an annual and monthly basis by HUC11.

Withdrawal and use data are presented for agricultural, commercial, industrial, mining, non-agricultural irrigation, potable supply and power-generation uses equal to, exceeding or with the capability of exceeding 100,000 gallons of water a day. This is the regulatory criteria used by the NJDEP Division of Water Supply (DWS) Bureau of Water Allocation (BWA). Not classified uses are not included in these data since they are only a small percentage of total use. Withdrawals are described by the source (surface water or ground water), where the water is withdrawn (point, municipality and watershed), and where the water is transferred to for end use. In addition, an estimate of fresh-water withdrawals from domestic wells and small, public non-community water systems are included in the analysis.

After withdrawal, the water is tracked to its place of use and ultimately its place of discharge. For all uses except potable supply, water is assumed to be used and discharged at the place of withdrawal. For potable supply, a series of NJDEP databases and GIS coverages were used to track the transfer of water from withdrawal, to place of use, to collection area and ultimately to place of discharge. The accuracy of the results depends on the accuracy of withdrawal locations and on the GIS coverages of water-purveyor service areas and sewer-service areas. The best available coverages were used, but inaccuracies still remain. It is hoped that by summarizing on a HUC11 scale, errors arising from inaccuracies in service area coverages will diminish in comparison to other components of the water budget.

All use groups except potable supply are assigned a month specific consumptive-use percentage. Potable supply uses are assigned a water system month and year specific consumptive-use percentage. This estimates the percentage of water that is lost to the atmosphere by evaporation resulting from that water use in that month. This enables one to estimate total consumptive water use in each HUC11, by use type.

Water use is reported in each HUC11. This is not always equivalent to water withdrawal in the same HUC11 because of exports and imports.

This report supports the 2006 update of the New Jersey Water Supply Plan. The plan is updated on a periodic basis in order to ensure an adequate and safe supply of water.

An earlier report (Domber and Hoffman, 2004) summarized withdrawals and transfers on a Watershed Management Area (WMA) basis. This earlier report presented a similar analysis but on a larger areal scale.

1.1 Data Creation and Quality Information

1.1.1 Withdrawals

<u>Data Source</u>

The withdrawal data are based on reports submitted to the BWA. Under NJDEP regulations N.J.A.C. 7:19 et seq. all non-agricultural fresh-water users capable of withdrawing more than 100,000 gallons per day must-obtain a water allocation permit. As a condition of the permit, the users must submit reports of monthly withdrawals on an annual or quarterly basis, depending on the type of allocation permit. Under NJDEP regulations N.J.A.C. 7:20A-1 et seq. all agricultural users capable of withdrawing more than 100,000 gallons per day must obtain a water usage certification from the BWA. These permits are subject to less rigorous reporting requirements, but are still required to submit monthly withdrawal volumes on an annual basis. The withdrawal data, along with information on limits on withdrawal volumes and withdrawal locations, are maintained by the BWA in computer databases. Generally, only fresh-water withdrawals are regulated. Withdrawals of saline water are not regulated by BWA unless the withdrawal could impact fresh-water resources.

Throughout the 1990 to 1999 period BWA maintained three databases using the database software Knowledgeman®. The databases are WATERA, WSOURCE and USAGE. WATERA contains information about each water allocation permit or water usage certification. Each permit has one entry in WATERA. WSOURCE contains information on each withdrawal point. A user may withdraw water from one or more points and may withdraw a mixture of surface and ground water. An allocation permit or usage certification has as many entries in WSOURCE as it has physical water-withdrawal points. USAGE contains the actual withdrawal data. Each entry in it contains data for one specific year for one specific water-withdrawal source. Thus, each water allocation permit or certification may have as many entries in USAGE as the number of withdrawal points multiplied by the number of available years of data.

NJGS migrated these three databases into a Microsoft® Access database. Records for 1990 through 1999 were corrected for duplicate entries. The records were also examined to identify data gaps. If gaps were found, the paper records were searched for the missing entries. If additional searching did not uncover the missing data, the data gap was preserved. Additional research more accurately defined the location, watershed and physiographic province of each withdrawal point. Earlier reports (Hoffman and Lieberman, 2000; and Hoffman, 2000a and 2001) were based on this Access database.

In 2002 the data contained in the Access database were transferred into the New Jersey Water Tracking Data Model (NJWaTr) (Tessler, 2004). NJWaTr is designed to contain not only fresh water-withdrawal information but also information on the location and rates of fresh-water transfers, sewage transfers, and wastewater discharges. When the data were transferred into NJWaTr they underwent an additional round of quality control resulting in the correction of some volumes withdrawn and the locations of some withdrawals. Since NJWaTr data is used in this report, the results here do not match exactly the results of the earlier reports. This report supersedes those earlier reports.

Some permittees did not report enough information to allow a water source to be assigned to the withdrawal. These include water purveyors that have gone out of business as well as some agricultural withdrawals. These withdrawals were assigned a source according to the statewide average, in which 75 percent are surface water and 25 percent are ground water.

Water withdrawals from domestic wells are based on data contained in the 1996 New Jersey Statewide Water Supply Plan (NJDEP, 1996a). The 1996 Plan reported the volume of water withdrawn from domestic wells by county. The 1990 county volume was distributed throughout the municipalities in that county proportional to the number of domestic wells in each municipality. The number of domestic wells in each municipality was derived from 1990 census data. Increases in withdrawals were then calculated by adding the number of new domestic wells permitted in each municipality, as reported to the BWA, and assuming that each well served 3 people at an annual average rate of 75 gallons per person per day. This was done for each year for the period 1991 to 1999.

Withdrawals from multiple small, public non-community systems (potable supply) that serve approximately 25 or more people for part of the year, that are not required to report withdrawal volumes to BWA, were estimated from system-capacity information on file with the Bureau of Safe Drinking Water (BSDW).

Data Reliability and Qualifications

Withdrawal data are self-reported and BWA periodically reviews the sources, meters and reporting requirements. All water allocation permittees are required to recalibrate flow meters to within five percent accuracy every five years. As a whole, potable supply diversions are considered the most accurate (Diane Zalaskus, BWA, oral communication, 1998). Similar analysis by the United States Geological Survey (USGS) considers the data from potable supply users to be 'highly reliable' (Nawyn and Clawges, 1995). The reported withdrawals for industrial and commercial uses are considered to be slightly less accurate than potable supply. The estimates of irrigation, mining and power generation use volumes are the least accurate. However, the specific accuracies vary with the individual measuring and reporting the data.

The records of agricultural withdrawals are generally the least accurate and some may be significantly in error because reported water withdrawal is estimated, not metered. The BWA cannot estimate percentage of error in these records. In some counties agricultural withdrawals are a significant percentage of total withdrawals. However, on a statewide average, agricultural use is less than 10 percent of total withdrawals.

Five important qualifications apply to the withdrawal data:

(1) This report attempts to quantify, on a monthly basis, the amount of water consumed or transferred to the atmosphere (and not available to the basin) by each type of water use. The percentages used were gleaned from the literature and from water-supply professionals.

(2) Only fresh-water withdrawals are summarized here. Saline-water users are not required to obtain a water allocation permit unless the diversion impacts freshwater. Thus, the saline-water withdrawals for cooling at the Oyster Creek and Salem nuclear power plants are omitted from this report.

(3) All nondomestic-well data are from data submitted to the NJDEP. The data here repeat any inaccuracies in these reports.

(4) Water released from an on-stream reservoir that flows downstream to an intake is not considered a withdrawal or release at the reservoir site. It is counted as a withdrawal from the stream at the surface-water intake-pipe location. If there is an intake pipe on the reservoir then the withdrawal is considered to take place at that reservoir location.

(5) All potable water supplied by water purveyors must be treated to drinking-water standards. The total volume supplied by these purveyors is included in the 'potable supply' use category. However, the end user may not use all of this water strictly for potable purposes. For example, a potable-supply water main may convey water to commercial or industrial facilities that use the water for non-potable purposes. However, since the water comes from a potable-water supplier, all the volume is considered to be for potable supply. A more detailed breakdown would require examination of the reported users for all potable-water suppliers with an estimate of volumes delivered to each. The available resources did not allow for such a detailed analysis on a statewide basis.

More information on the compilation and interpretation of withdrawal data is available in the N.J. Geological Survey Report OFR 00-1 'New Jersey Water Withdrawals 1990-1996' (Hoffman and Lieberman, 2000).

Withdrawals by Aquifer

Ground-water withdrawals are assigned to a source aquifer, where possible, using several databases. For potable-supply wells this determination is based on aquifer picks made by the NJDEP Well Head Protection Program. For other wells the aquifer is determined by the well driller and/or by a BWA staff person. The specific aquifers assigned to each aquifer group are given in Hoffman and Lieberman (2000). Each ground-water withdrawal is also characterized as coming from a confined aquifer or an unconfined aquifer. All wells located in the Highlands, Valley and Ridge, Piedmont physiographic provinces are considered to be unconfined.

Since domestic well withdrawals were estimated by municipality, they can not be assigned to a specific aquifer. Instead domestic wells were grouped into their own unconfined aquifer group.

Data Organizers

In 1997, NJGS checked and corrected withdrawal data for the 1990 through 1996 period. These data were entered into a Microsoft® Access database and used to produce a summary report (Hoffman and Lieberman, 2000), and were simplified and made available on the Internet (Hoffman, 2000a).

In 2001, NJGS added volumes and locations for withdrawals from 1997 through 1999 to the same Access database. This led to the release of a series of data tables that can be used in a GIS for a graphical analysis of withdrawals in New Jersey (Hoffman, 2001).

In 2001, the USGS began work on a data model for watershed water-budget analysis, partially funded by the NJDEP. This work lead to the development of the NJWaTr that tracks fresh-water use, fresh-water transfers, sewage transfers, and waste-water discharges (Tessler, 2004). NJGS is responsible for loading NJWaTr with accurate data as well as presenting the data in a meaningful manner. The withdrawal data in this product are from NJWaTr and reflect an additional round of error checking.

A previous Microsoft® Excel workbook summarized withdrawals, transfers and discharges on a WMA basis (Domber and Hoffman, 2004).

1.1.2 Fresh-water Transfers

Data Source

All withdrawals of water are assigned to a use area. For all non-potable supply users this was assumed to be at the location of the water withdrawal. All potable supply diversions are assigned to a use area referred to as a Drinking Water Service Area (DWSA). The DWSA is equivalent to the area that the purveyor delivers water to and may cover more than one HUC11. Use is assumed to be distributed evenly across the DWSA. Domestic well withdrawals are assigned to a use area equivalent to the municipal boundary. Similarly, use is assumed to be distributed evenly throughout the area and may cover more than one HUC11.

For potable-water purveyors who did not purchase or sell water from other purveyors, the total withdrawals are assumed to be transferred to and distributed equally throughout its DWSA. These withdrawals were then distributed, on an areal basis, to the HUC14s and corresponding HUC11s that intersected the DWSA.

For purveyors who bought or sold water from other purveyors (referred to as bulk transfers) the use was reduced by the volume of water sold and increased by the volume of water purchased. The resultant volume was evenly distributed, on an areal basis, to the HUC14s that intersected the DWSA.

Data Reliability and Qualifications

Bulk water transfers are reported twice, once by the seller and once by the buyer. A review of records supplied to BWA shows the sellers and buyers seldom report the same volumes of water. In most cases NJGS used sellers information on volume of water sold. The largest transfers are in New Jersey's urbanized northeast and north coastal regions. Owing to the work required, NJGS only contacted the largest water purveyors in these two regions for their bulk transfer information. The bulk transfer data included in NJWaTr and this report represent approximately 75 percent of the state-wide transfers.

The delineations of DWSA GIS coverage is of unknown quality. Purveyors were supplied with draft maps of service areas based on a set of 1970 DEP maps. Each was asked to correct the map. Some replied with corrections showing the distribution of pipes in the ground. Others indicated total franchise area, including areas where distribution infrastructure was planned but not currently built (Gail Carter, oral communication, 2002). Tracking down these discrepancies is beyond the scope of this report. However, these discrepancies become less important at large spatial scales.

Data Organizers

The NJDEP Division of Science, Research and Technology (DSRT) provided the purveyor service areas in GIS format. All bulk water transfers were collected and assigned to HUC14s by NJGS staff.

1.1.3 Sewage Imports and Exports

Data Source

The volume of sewage imported or exported from an area is derived from an analysis of volumes of waste water (also referred to as treated wastewater) discharged from a wastewater treatment plant and the sewer service areas which feed that plant. The waste water discharged from a wastewater treatment plant was assumed to have originated as sewage in the plant's service areas and to be proportional to the size of each service area. This sewage volume was then evenly assigned to all HUC14 drainage basins that overlapped the service area, again on an areally-proportional basis. The sewage volume discharged was then summed up by HUC11. Where the source and discharge point were in different HUC11s, it was counted as an export from the source HUC11 and import to the receiving HUC11.

DEP maintains a draft GIS coverage of sewer service areas. This tends to indicate primarily the sewer franchise areas, not where pipes are actually in the ground. This results in an overestimation of the areas actually served by sewers.

Data Reliability and Qualifications

This method assumes that sewage is generated evenly across a sewer service area. It is back calculated from the total volume of waste water discharged by a plant and the relative areas in each HUC11 of all sewer service areas feeding that plant.

Data Organizers

NJGS, using the capacities of NJWaTr, estimated the volume of sewage imported to or exported from each HUC11.

1.1.4 Volumes of Generated Sewage

Data Source

The volume of sewage generated on a HUC11 basis was derived from estimates of sewage generated in each HUC14. The amount of sewage generated in each HUC14 is back calculated, based on a redistribution of wastewater discharged.

Sewer volumes are based on a redistribution of wastewater and a comparison of the sewer service areas which feed a particular treatment plant. The volume of waste water reported discharged from that plant is assumed to have been generated on an equal areal basis from all sewer service areas. A GIS coverage of the sewer service areas was intersected with a HUC14 GIS coverage. This allowed an estimation of sewage generated in each HUC14 and HUC11. Where the sewage was generated outside the HUC11 or was exported to a different HUC11 then it is accounted for in section 1.1.3 Sewage Exports and Imports.

Data Reliability and Qualifications

Estimates of the volume of sewage generated based on volume of waste-water discharge assume that the volume of water delivered to the treatment plant is identical to the volume of sewage generated. However, the volume delivered to the plant is the sum of sewage generated, infiltration into the pipes, discharge from any users that may have their own water allocations (and thus don't receive potable water) but are connected to the sewer, and inputs from combined sewer inflows. Additionally this assumes that sewage is generated uniformly throughout the entire sewer service area. For sewer service areas which extend over two different HUC11s this may introduce an error if the sewage generation is not generated uniformly throughout the service area. Better estimates of sewage generated in each HUC11 would require accurate metering at the point of generation.

Data Organizers
NJGS, using the capacities of NJWaTr, estimated the volume of sewage generated in each HUC14 and HUC11.

1.1.5 Waste-Water Discharges

Data Source
Sewage treatment plants report monthly volumes of discharged waste water (also referred to as treated wastewater) under a New Jersey Pollution Elimination System (NJPDES) Permit. Discharge points have been accurately located using a Global Positioning System (GPS). The volumes and locations were supplied by the NJDEP Division of Water Quality (DWQ). These data are available through DWQ's web site: http://www.state.nj.us/dep/dwq/.

Only surface-water waste-water discharges are included in NJWaTr and this report. Ground-water waste-water discharges appear to be less than 20 percent of surface water discharges and are not typically transferred over long distances. Ground-water discharges will be included in future versions of NJWaTr.

Data Reliability and Qualifications
NJGS considers the volumes of discharged wate water to be of good accuracy. The locations of discharge points are very accurate due to the use of GPS data.

As a practical matter, the volume of water discharged in a HUC11 in a year is equal to the volume of sewage generated in that HUC11, estimated from discharge data, plus the volume imported, minus the volume exported.

Data Organizers
The basic data are generated by DWQ staff. They were added to NJWaTr by NJGS staff.

1.1.6 Destination of Waste-Water Discharges

Each waste-water discharge point was plotted using GIS, and classified as discharging to freshwater, brackish water or salt water. This was then used to quantify the total annual volumes of waste-water being discharged to each destination type in each HUC11.

For the purposes of this analysis, all discharge points beyond the coast of New Jersey (into the Atlantic Ocean, Delaware Bay, Newark Bay or Hudson River) were classified as a salt-water discharge. Any discharge to a stream or river below the head of tide but upstream of the coast along the Atlantic or Delaware Bay coastline was classified as being a brackish-water discharge.

Discharges above the head of tide were classified as freshwater. The major exception to this approach is with the Delaware River. Brackish water extends from Delaware Bay upstream in the Delaware River, normally to within a few miles of the Delaware Memorial Bridge. However, the head of tide in the Delaware River is about 50 miles upstream at Trenton. All discharges to the Delaware River downstream from the head of tide at Trenton but upstream from the Delaware Memorial Bridge were classified as discharging to freshwater. Discharges to the Delaware River downstream of the Delaware Memorial Bridge and to Delaware Bay, were considered as discharges to salt water.

Data Source
The location of discharge points was provided by DWQ staff. The coastline was based on a GIS coverage (NJDEP, 1996). The head of tide also comes from a GIS coverage (Coast Survey Ltd, 1986).

Data Reliability and Qualifications
The locations of waste-water discharges are very accurate. It is clear which ones are salt-water discharges and which ones are far inland. Defining brackish-water discharges is much more difficult. Preferably a delineation of the maximum extent of the salt water in each stream would be available. In lieu of this, the head of tide coverage was used. However, this is not entirely correct because at the head of tide all water in the stream is fresh. The effect of the tides extends farther upstream than the actual salt water. Thus some of the discharges classified as being into brackish water may actually be to a tidally-influenced reach of a stream that is fresh. However, the majority of the brackish water discharges are all very close to the coastline, so the brackish water label is essentially correct.

Data Organizers
Assigning each discharge point to freshwater, brackish water or salt water was done by NJGS staff.

1.1.7 Watershed and Drainage Basin Definitions

Hydrologic Unit Codes (HUCS)
The USGS divides the United States into 21 regional hydrologic units (Seaber and others, 1987). Each regional hydrologic unit is given a 2-digit hydrologic unit code (HUC2). Each regional hydrologic unit is then subdivided into sub-regional hydrologic units. Each sub-regional hydrologic unit is coded by adding, as a suffix an additional 2-digit code to the original 2-digits, resulting in a 4-digit code. This is explained in more detail on the USGS's web site: http://water.usgs.gov/GIS/huc.html.

Each sub-region is in turn subdivided into smaller areas generally based on natural drainage divides. This leads to accounting units and cataloging units. At each subdivision additional numbers are tacked onto the end of the code, leading to 6 digits (for accounting units), 8 digits (for cataloging units). New Jersey has additionally mapped two smaller hydrologic units using an 11-digit and 14-digits code to identify them. The various levels of nested hydrologic units are commonly referred to as HUC2, HUC4, HUC6, HUC8, HUC11 and HUC14 drainage basins.

The HUC2, HUC4, HUC6 and HUC8 hydrologic units are defined on a national basis (Seaber and others, 1987). The HUC11 and HUC14 hydrologic units are defined on a local basis and have been done so for New Jersey by Ellis and Price (1995). The HUC11s and HUC14s were reevaluated in 2000 and some slight modifications made (Robert Schopp, USGS, oral communication, 2002).

It is important to note that the hydrologic unit boundaries are based on surface water drainage divides, but do not necessary equate to watersheds, particularly at smaller scales. In other words, a hydrologic unit may have another hydrologic unit upstream of itself. Together the two could comprise a true watershed. Individually, the upstream one is a watershed while the downstream one is not.

Digital coverages of HUC2, HUC4, HUC6 and HUC8 watersheds in the United States are available from the USGS's National Atlas web site: http://www-atlas.usgs.gov/atlasftp.html.

Digital coverages of HUC11 and HUC14 watersheds in New Jersey are available from the NJDEP GIS web site: http://www.nj.gov/dep/gis/.

Drainage Basin Reporting Basis

All water withdrawal and transfer data are initially calculated on a HUC14 basis in the NJWaTr database. However, there are concerns about the accuracy of the GIS coverages (particularly DWSAs and sewer service areas) on this scale. For this reason, withdrawals and transfers are aggregated up to the HUC11 scale. NJGS believes that any errors in the underlying coverages become less significant as the hydrologic unit size becomes larger.

HUC11 Modifications For This Analysis

In the Passaic River watershed the Whippany River flows into the Rockaway River about a mile upstream from where the Rockaway River enters the Passaic River. The Whippany River is tributary to the Rockaway River and is so indicated in the NJDEP watershed coverage. However, there are no surface-water intakes downstream from the confluence of the Whippany River with the Rockaway River and no major ground-water withdrawals in the Rockaway River's watershed downstream from this point. Thus the Whippany River watershed is not a factor in determining the water resources of the Rockaway River watershed. Therefore, for this analysis, the Whippany River is assumed to be upstream from the Passaic River but not upstream from the Rockaway River.

Along New Jersey's coastline are a several HUC11s which include the eastern half (or ocean side) of the barrier islands and a portion of the Atlantic Ocean to the east. Just to the west of these HUC11s are another set of HUC11s which include the western (or inland) half of the barrier islands and the bay areas. The HUC11 codes specify that the eastern HUC11s are downstream from the western HUC11s. From a water-supply viewpoint, however, these ocean HUC11s are not significantly affected by the 'upstream', inland HUC11s. For this reason, the HUC11's that include the Raritan Bay, the eastern sections of the Barrier Islands and Delaware Bay are not considered to have upstream HUC11s.

1.1.8 Population Estimates

Municipal population estimates for 1940 through 2000 are based on reported Census data. The population in each municipality was distributed evenly (on an areal basis) to every HUC14 which overlaps that municipality. Population was then summed up for each HUC14 and then again for each HUC11.

The population projections for 2010, 2020 and 2030 are based on New Jersey Metropolitan Planning Organization (MPO) municipal population projection data. The population projections for each municipality were distributed evenly (on an areal basis) to every HUC14 which overlaps that municipality. Population was then summed up for each HUC14 and then again for each HUC11.

1.1.9 Land Use

The NJDEP analyzed aerial photos taken in 1986 and 1995 to classify land use in several different ways. One classification system divided land use into the categories of agricultural, barren, forest, urban, water and wetlands. More detail of this process is available in the metadata associated with the GIS data that provide this information. The metadata are available at: http://www.nj.gov/dep/gis/lulc95shp.html.

1.1.10 Pinelands and Highlands

The NJDEP has GIS data that correspond to the legal definition of the New Jersey Pinelands and New Jersey Highlands regions available at http://www.nj.gov/dep/gis/stateshp.html#PINELAND and http://www.nj.gov/dep/gis/stateshp.html#HIGHLANDS, respectively. The data were intersected with the HUC11 coverage to determine the total area of each HUC11 shapefile data in these two regions.

1.2 Description of Tables and Figures

The following sections provide a description for each of the Tables and Figures included on the even numbered page of the 20 appendixes. The first page of each appendix is the title page.

1.2.1 Table 1. Freshwater Withdrawals in the HUC11

This table shows annual fresh-water withdrawals in the HUC11 of interest by water source - surface water (Delaware River or other) or ground water (broken out as to confined and unconfined aquifers). These data contribute to Figures 1 and 2, sections 1.2.11 and 1.2.12 respectively.

1.2.2 Table 2. Freshwater Imports To and Exports From the HUC11

This table shows the volume of fresh-water imports and exports with the net volume (defined as imports minus exports). For HUC11s that have more exports than imports (resulting in a negative net volume) the net volume is shown in red. These data contribute to Figures 1 and 2, sections 1.2.11 and 1.2.12 respectively.

1.2.3 Table 3. Nonconsumptive and Consumptive Water Use in the HUC11, by Use Type

Table 3 shows annual nonconsumptive and consumptive use of freshwater in the HUC11 broken out by type of water use. The use groups described in section 1.3.3 of this user's guide have been further consolidated in this table because of space limitations. The consolidation is based on similar consumptive use percentages. The total volume of freshwater used in a HUC11 should be equal to withdrawals in the HUC11 plus imports and minus exports. Consumptive water is defined in section 1.3.2 of this user's guide.

The data are stored as monthly volumes for each detailed use in the underlying NJWaTr database. For all non-potable uses the consumed (or consumptive) volume is calculated by multiplying the monthly-use volume by the consumptive percentage and then summing for each year. Annual consumed volume is then divided by annual use volume to give an annual consumed percent. For potable uses, a separate consumptive use volume was calculated for each drinking water service area for each year and month. These data are summarized in Figure 3, section 1.2.13.

1.2.4 Table 4. Average Seasonal Use - Nonconsumptive and Consumptive

Table 4 shows the average volumes of unconsumed (nonconsumptive) and consumed (consumptive) water in the HUC11 on a seasonal basis by water use. The use groups described in section 1.3.3 of this user's guide have been further consolidated in this table because of space limitations. The consolidation is based on similar consumptive use percentages. These data contribute to Figure 4, section 1.2.14.

1.2.5 Table 5. Sewage Generation and Transfers in the HUC11

Table 5 shows annual volumes of sewage generated in, imported into and exported from a HUC11. The volume discharged in the HUC11 is the base data. The other volumes are estimates based on extent of sewer-service areas in a HUC11. A more detailed description is given in section 1.1.4 of this user's guide. These data are summarized in Figure 5, section 1.2.15.

1.2.6 Table 6. Destination of Treated Effluent Discharges in the HUC11

Table 6 is a detailed breakout of the destination of waste-water discharges in the HUC11. Refer to section 1.1.6 of this user's guide for details. The sum of the three destinations is the total volume of waste-water discharged in the HUC11. These data are summarized in Figure 6, section 1.2.16.

1.2.7 Table 7. 1999 Water Allocation in HUC11 by Water Source

Large water withdrawers must obtain a permit from the NJDEP (see section 1.1.1 of this user's guide). This table shows, for 1999, the maximum volume that could be withdrawn under the effective water allocation permits, as broken out by surface water and ground water.

1.2.8 Table 8. Water Allocation in HUC11 by Water Use Group

This table shows, for 1999, the maximum volume that could be withdrawn under the water allocation permits, as broken out by the use of water as designated in the permit.

1.2.9 Table 9. Descriptive Statistics for the HUC11

This table shows a variety of descriptive statistics for the HUC11.

The first section shows the area of the HUC11 in square miles. It also shows the area (if any) upstream of the HUC11. It also presents the total watershed area that contributes flow to the downstream-most part of the HUC11.

The second section shows estimated population of the HUC11, based on US Census Bureau data, for the years 1940, 1950, 1960, 1970, 1980, 1990 and 2000. Population projections for 2010, 2020 and 2030 are also included. This is described in more detail in section 1.1.8 of this user's guide.

The third section shows the percentage of the HUC11 in each of 6 land-use categories for the years 1986 and 1995. More detailed description on the land-use classification is in section 1.1.9 of this user's guide. The table also shows the change, in percent area of the HUC11, from 1986 to 1995.

The fourth section shows the percentage of the HUC11 in the New Jersey Pinelands and New Jersey Highlands. More information on how this was established is in section 1.1.10 of this user's guide.

1.2.10 Table 10. Upstream and downstream HUC11s

Table 10 indicates the HUC11 immediately downstream of the HUC11 of interest, as well as the upstream HUC11s, if any.

1.2.11 Figure 1. Average Source of Freshwater

This figure shows for the period 1990 through 1999 the average annual source of freshwater withdrawals- groundwater, surface water or imports. Data from Tables 1 and 2 contribute to this graph, sections 1.2.1 and 1.2.2 respectively.

1.2.12 Figure 2. Average Destination of Fresh Water

Freshwater from the HUC11 is used in one of three ways. It may be used consumptively, which means it is evaporated. It may be used in a nonconsumptive manner, which results in discharge of the water to the surface or ground water, or it may be exported from the HUC11 for use in a different HUC11. This figure shows, for the period 1990 through 1999, the average annual destination of the freshwater. Data from Tables 1 and 2 contribute to this graph, sections 1.2.1 and 1.2.2 respectively.

1.2.13 Figure 3. Consumptive and Nonconsumptive Use

This figure shows for the period 1990 through 1999 the average annual consumptive and nonconsumptive use of water in the HUC11, by type of water use. Use groups are further grouped in this figure based on similar consumptive use percentages. This graph is generated from data in Table 3, section 1.2.3.

1.2.14 Figure 4. Average Seasonal Consumptive Water Loss, by Use Group

Figure 4 shows the average volume of water consumed in the HUC11 by season. Use groups are further grouped in this figure based on similar consumptive use percentages. This graph is generated from data in Table 4, section 1.2.4.

1.2.15 Figure 5. Average Sewage Generation and Transfers

Figure 5 shows the average annual volume of sewage generated in the HUC11, along with average annual volumes of sewage imported and exported, based on data from 1990 through 1999. This graph is generated from data in Table 5, section 1.2.5.

1.2.16 Figure 6. Average Treated-Effluent Discharge by Location

This figure shows the average annual volume of treated effluent (waste water) discharged to freshwater, brackish water and salt water in the HUC11 based on data from 1990 through 1999. This graph is generated from data in Table 6, section 1.2.6.

1.2.17 Figure 7. Net Transfers

Figure 7 presents a visual comparison of average annual net water gains and losses to the HUC11. The left bar in the graph summarizes water imported to the HUC11, either freshwater or sewage. The right bar summarizes water lost from the HUC11, either by exports of freshwater or sewage, or by evaporation associated with consumptive water use. This does not account for water withdrawn in the HUC11, used in a non-consumptive manner, and returned to the HUC11 by some sort of discharge facility.

If the left bar is taller than the right bar, the HUC11 imports more water than it exports. If the right bar is taller, it exports more than it imports. The difference is a rough indicator of the net impact on the HUC11's water budget.

Note that this analysis does not consider the impacts of changes to water quality. Nor does it consider impacts that withdrawals may have on smaller areas within the HUC11.

1.3 Selected Data Definitions

1.3.1 Source of Withdrawals

Fresh-water withdrawals are identified as being either from surface water or ground water. Surface water is defined as water in a river, canal, stream, creek, lake or pond with a surface-water inflow and outflow. Ground water is defined as water in a well, spring, or pond with no surface-water inflow or outflow. Ground-water withdrawals are assigned to either a confined or unconfined aquifer.

Withdrawals of saline water (primarily for the cooling of nuclear power plants) are not included in these figures.

1.3.2 Consumptive Water Use

Consumptive water use is defined as water that is evaporated to the atmosphere after use. It is a function of the use to which the water is put and of the time of year. Domber and Hoffman (2004) present monthly estimates of consumptive water loss by type of use. For this analysis of all non-potable water uses, reported monthly withdrawals were multiplied by the estimated monthly consumptive percentage to estimate the volume of water used consumptively. For potable-water supply uses, a separate consumptive use was calculated for each DWSA for each month and year. Potable supply consumptive use was assumed to be any use from May through October that exceeded the winter baseline use. The winter baseline use was calculated as the average use for January, February, March, April, November and December of each year. Use during the baseline period is assumed to be primarily indoor water use and therefore nonconsumptive. The monthly volumes consumed were summed over a year to give a total annual volume of consumed water. The annual consumed water volume was divided by the annual total water use volume to get the annual consumed percentage reported here. Thus the annual consumptive percentage reported for a watershed management area, water region or HUC11 watershed is not the average of each monthly consumptive use percentages.

1.3.3 Use of Withdrawals

The following use groups are used to characterize data in this report. The use is based on information contained in BWA data.

<u>Agricultural Water Use</u>
Agricultural use is water withdrawn in support of agricultural activities. It is subdivided in NJWaTr into these subcategories based on information in BWA's permit file:

- general agriculture	- greenhouse	- vegetables, leaf crops
- blueberries	- agricultural irrigation	- Christmas trees
- cranberries	- sod	- aquaculture
- field crops	- tree fruit	

<u>Commercial Water Use</u>
This category is defined as water withdrawn by a specific user in support of commercial activities. It is subdivided in NJWaTr into these subcategories based on information in BWA's permit file:

- commercial	- fire	- recreation

Industrial Water Use
This category is defined as water withdrawn by a specific user in support of industrial activities. It is subdivided in NJWaTr into these subcategories based on information in BWA's permit file:

- air conditioning	- cooling (industrial)	- injection
- dewatering	- industrial	- pollution control

Irrigation Water Use
This category is defined as all nonagricultural use of water for irrigation. It is subdivided in NJWaTr into these subcategories based on information in BWA's permit file:

- golf course turf	- irrigation for non-agricultural purposes

Mining Water Use
This category accounts for water reportedly withdrawn to assist in mining operations. It is not subdivided in NJWaTr into any subcategories.

Potable Supply Water Use
This category accounts for water delivered by public-water suppliers to all users (private, commercial and industrial). It is subdivided in NJWaTr into these subcategories based on information in BWA's permit file:

- bottling	- public supply	- other
- domestic	- institutional	- industrial, food processing
- medicinal value	- unused	
- public non-community	- desalination	

Domestic well withdrawals are used in a manner very similar to the way a residential user of a public supply system would use water. However, the geographic location of domestic wells versus public supply systems, the regulatory requirements and the resource management strategies are different for the two. As a result, a distinction between domestic well use and potable purveyor use is made in this report.

Power Generation Water Use
This is defined as freshwater used to assist in the generation of power. It is subdivided in NJWaTr into these subcategories based on information in BWA's permit file:

- power generation	- hydropower generation	- thermal power generation
- geothermal/heat pump		

Not Classified
This category is used if the actual use of the withdrawal can not be identified.

2.0 Overview of HUC11 Map

The summary maps for each of New Jersey's 151 HUC11 drainage basins were developed using ESRI® ARCMap 9.1 software and NJDEP GIS data. Each HUC11 map was exported from ARCMap as a jpeg image and converted to an Adobe® PDF document for this report. The maps are intended to provide an overview of water withdrawal locations, the source and use of the withdrawal, the 1999 total withdrawal volume, discharge points, and 1999 total treated effluent discharge volume. All volumes are in millions of gallons per year (MGY). Transfer information is not included because the data is not available in a GIS mapping format. Underlying base maps are included to provide a general overview of land use, hydrography and topography.

2.1 Base Map and Background Data

The maps were developed by overlaying a series of GIS datasets in ESRI® ArcMap 9.1 software. The USGS 1:100,000-scale topographic maps are the underlying base maps in all of the maps. Fourteen 1:100,000-scale base maps cover all of NJ. They include the Scranton, Middletown, Bridgeport, Allentown, Newark, Long Island West, Reading, Trenton, Long Branch, Wilmington, Hammonton, Dover, Atlantic City, and Cape May maps. These base maps contain numerous bits of information including hydrography, elevation contours, roads, place names and political boundaries. Transparent black-and-white hillshade grids placed over the base map create the quasi-three-dimensional appearance of the figures. The hillshade grids are based on 10-meter DEMs. The red polygons designate the HUC11 drainage-basin boundaries. All HUC11s except for the HUC11 of interest are partially shaded white to focus the user's attention on the HUC11 of interest.

2.2 Water Withdrawal, Use and Discharge Data

The water data were developed by NJGS using data contained in its New Jersey Water-Transfer Data Model (NJWaTr). NJWaTr contains information from multiple NJDEP water-related programs. Different symbols, colors and sizes represent the source, use and 1999 volume, in millions of gallons, respectively, for each known withdrawal point. See Table 1 below. The color for each of the withdrawal points represents the use of the water. See Table 2 below. Potable-supply withdrawals may include water-purveyor-supplied industrial, commercial and irrigation uses. Domestic wells are not included. The size of the symbol is proportional to the total 1999 withdrawal in millions of gallons per year (MGY). The larger the symbol the larger the withdrawal and the smallest symbol represents no reported withdrawal during 1999.

Symbol	**Source of Water**
□ (square)	confined groundwater
○ (circle)	unconfined groundwater
△ (triangle)	surface water

Table 1. Symbol and source of water for HUC11 Maps.

Color and Symbol	Use Category
▲■● (green)	Agricultural
▲■● (red)	Commercial
▲■● (pink)	Industrial
▲■● (orange)	Irrigation (non-agricultural)
▲■● (dark green)	Mining
▲■● (grey)	Not classified
▲■● (blue)	Potable supply
▲■● (yellow)	Power generation

Table 2. Symbol color and corresponding water use category for HUC11 Maps.

NJWaTr permitted discharge points are shown as purple symbols in the maps. The 1999 treated-effluent surface-water discharge volumes are shown as purple diamonds in the maps, with the larger symbols representing larger discharges. Permitted non-sanitary-sewer discharge points are shown as purple pentagons in the maps, but no volumes are indicated.

2.3 Map Scale and Key

The map scale, both the scale bar and scale text, are adjusted for each HUC11 map in order to maximize the image on the page. If the document is viewed on screen or printed out on paper other than 11” by 17” portrait mode, the scale text is incorrect. The scale bar remains correct.

The state overview map box, located in the lower right hand corner of the page, shows the location of the HUC11 (in green) and the area of the map (in red) in New Jersey. New Jersey county boundaries (in black) and HUC11 boundaries (in grey) are also shown.

The key is fixed for all figures. Figure 2 below is a separate image of the key that can be referred to if the user zooms in to a smaller area on the computer screen.

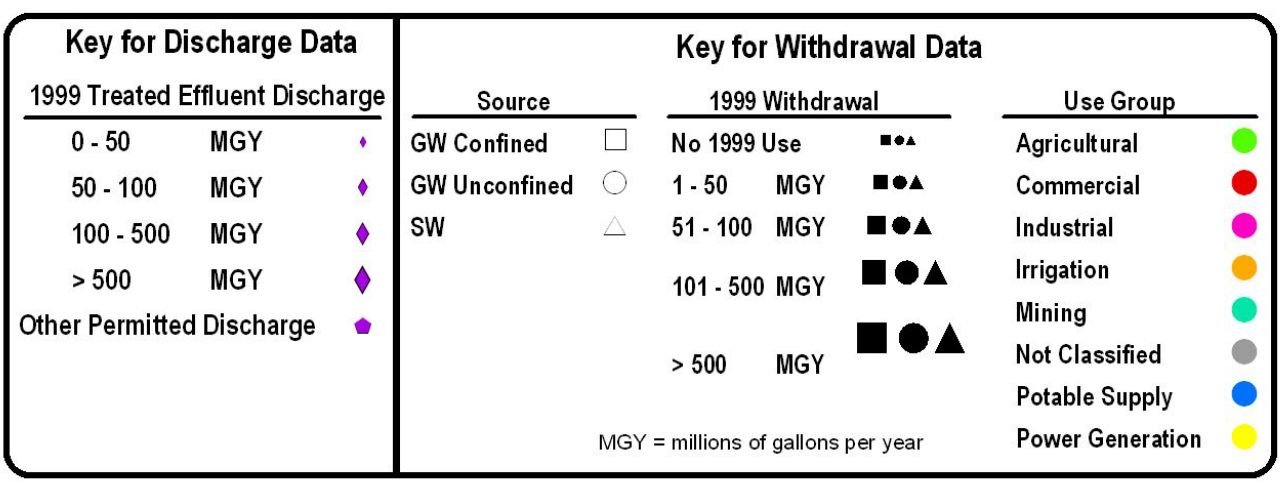

Figure 2. Key for HUC11 Maps.

3.0 Table of WMA and HUC11s

Table 3 below contains the WMA number, WMA name, HUC11 code, and HUC11 name for all of New Jersey's 151 HUC11 drainage basins.

WMA#	WMA Name	HUC11	HUC11Name
1	Upper Delaware	02040104090	Shimers Brook / Clove Brook
1	Upper Delaware	02040104110	Walpack Bend / Montague Riverfront
1	Upper Delaware	02040104130	Little Flat Brook
1	Upper Delaware	02040104140	Big Flat Brook
1	Upper Delaware	02040104150	Flat Brook
1	Upper Delaware	02040104240	Van Campens Brook / Dunnfield Creek
1	Upper Delaware	02040105030	Trout Brook / Swartswood Lake
1	Upper Delaware	02040105040	Paulins Kill (above Stillwater Village)
1	Upper Delaware	02040105050	Paulins Kill (below Stillwater Village)
1	Upper Delaware	02040105060	Stony Brook / Delawanna Creek
1	Upper Delaware	02040105070	Pequest River (above/incl Bear Swamp)
1	Upper Delaware	02040105080	Bear Creek
1	Upper Delaware	02040105090	Pequest River (below Bear Swamp)
1	Upper Delaware	02040105100	Beaver Brook
1	Upper Delaware	02040105110	Pophandusing Brook / Buckhorn Creek
1	Upper Delaware	02040105120	Lopatcong Creek
1	Upper Delaware	02040105140	Pohatcong Creek
1	Upper Delaware	02040105150	Musconetcong River (above Trout Brook)
1	Upper Delaware	02040105160	Musconetcong River (below incl Trout Bk)
2	Wallkill	02020007000	Rutgers Creek tribs
2	Wallkill	02020007010	Wallkill River (above road to Martins)
2	Wallkill	02020007020	Papakating Creek
2	Wallkill	02020007030	Wallkill River (below road to Martins)
2	Wallkill	02020007040	Pochuck Creek
3	Pomp., Peq., Wan. and Ramapo	02030103050	Pequannock River
3	Pomp., Peq., Wan. and Ramapo	02030103070	Wanaque River
3	Pomp., Peq., Wan. and Ramapo	02030103100	Ramapo River
3	Pomp., Peq., Wan. and Ramapo	02030103110	Pompton River
4	Lower Passaic and Saddle	02030103120	Passaic River Lower (Saddle to Pompton)
4	Lower Passaic and Saddle	02030103140	Saddle River
4	Lower Passaic and Saddle	02030103150	Passaic River Lower (Nwk Bay to Saddle)
5	Hackensack, Hudson and Pascack	02030101170	Hudson River
5	Hackensack, Hudson and Pascack	02030103170	Hackensack R (above Hirshfeld Brook)
5	Hackensack, Hudson and Pascack	02030103180	Hackensack R (below/incl Hirshfeld Bk)
6	Up. and Mid Pas., Whip. and Rock.	02030103010	Passaic River Upr (above Pine Bk br)
6	Up. and Mid Pas., Whip. and Rock.	02030103020	Whippany River
6	Up. and Mid Pas., Whip. and Rock.	02030103030	Rockaway River
6	Up. and Mid Pas., Whip. and Rock.	02030103040	Passaic River Upr (Pompton to Pine Bk)

WMA#	WMA Name	HUC11	HUC11Name
7	Arthur Kill	02030104010	Newark Bay / Kill Van Kull / Upr NY Bay
7	Arthur Kill	02030104020	Elizabeth River
7	Arthur Kill	02030104030	Morses Creek / Piles Creek
7	Arthur Kill	02030104050	Rahway River / Woodbridge Creek
8	North and South Branch Raritan	02030105010	Raritan River SB (above Spruce Run)
8	North and South Branch Raritan	02030105020	Raritan River SB (3 Brdgs to Spruce Run)
8	North and South Branch Raritan	02030105030	Neshanic River
8	North and South Branch Raritan	02030105040	Raritan River SB (NB to Three Bridges)
8	North and South Branch Raritan	02030105050	Lamington River
8	North and South Branch Raritan	02030105060	Raritan River NB (above Lamington)
8	North and South Branch Raritan	02030105070	Raritan River NB (SB to Lamington)
9	Low. Rar., South and Lawrence	02030105080	Raritan River Lower (Millstone to NB/SB)
9	Low. Rar., South and Lawrence	02030105120	Raritan R Lower (Lawrence to Millstone)
9	Low. Rar., South and Lawrence	02030105130	Lawrence Brook
9	Low. Rar., South and Lawrence	02030105140	Manalapan Brook
9	Low. Rar., South and Lawrence	02030105150	Matchaponix Brook
9	Low. Rar., South and Lawrence	02030105160	Raritan R Lower (below Lawrence)
10	Millstone	02030105090	Stony Brook
10	Millstone	02030105100	Millstone River (above Carnegie Lake)
10	Millstone	02030105110	Millstone River (below/incl Carnegie Lk)
11	Central Delaware	02040105170	Hakihokake/Harihokake/Nishisakawick Ck
11	Central Delaware	02040105200	Lockatong Creek / Wickecheoke Creek
11	Central Delaware	02040105210	Alexauken Ck / Moore Ck / Jacobs Ck
11	Central Delaware	02040105230	Assunpink Creek (above Shipetaukin Ck)
11	Central Delaware	02040105240	Assunpink Creek (below Shipetaukin Ck)
12	Monmouth	02030104060	Raritan / Sandy Hook Bay tributaries
12	Monmouth	02030104070	Navesink River / Lower Shrewsbury River
12	Monmouth	02030104080	Shrewsbury River (above Navesink River)
12	Monmouth	02030104090	Whale Pond Bk / Shark R / Wreck Pond Bk
12	Monmouth	02030104100	Manasquan River
12	Monmouth	02030104910	Raritan Bay / Sandy Hook Bay
12	Monmouth	02030104920	Atlantic Coast (Sandy Hook to WhalePond)
12	Monmouth	02030104930	Atlantic Coast (Whale Pond to Manasquan)
13	Barnegat Bay	02040301020	Metedeconk River NB
13	Barnegat Bay	02040301030	Metedeconk River SB
13	Barnegat Bay	02040301040	Metedeconk River
13	Barnegat Bay	02040301050	Kettle Creek / Barnegat Bay North
13	Barnegat Bay	02040301060	Toms River (above Oak Ridge Parkway)
13	Barnegat Bay	02040301070	Union/Ridgeway Branch (Toms River)
13	Barnegat Bay	02040301080	Toms River (below Oak Ridge Parkway)
13	Barnegat Bay	02040301090	Cedar Creek
13	Barnegat Bay	02040301100	Barnegat Bay Central & Tribs
13	Barnegat Bay	02040301110	Forked River / Oyster Creek
13	Barnegat Bay	02040301120	Waretown Ck / Barnegat Bay South
13	Barnegat Bay	02040301130	Manahawkin/Upper Little Egg Harbor tribs
13	Barnegat Bay	02040301140	Lower Little Egg Harbor Bay tribs

WMA#	WMA Name	HUC11	HUC11Name
13	Barnegat Bay	02040301910	Atlantic Coast (Manasquan to Barnegat)
13	Barnegat Bay	02040301920	Atlantic Coast (Barnegat to Little Egg)
14	Mullica	02040301150	Basto River
14	Mullica	02040301160	Mullica River (above Basto River)
14	Mullica	02040301170	Mullica River (Turtle Ck to Basto River)
14	Mullica	02040301180	Oswego River
14	Mullica	02040301190	West Branch Wading River
14	Mullica	02040301200	Mullica River (GSP bridge to Turtle Ck)
14	Mullica	02040301210	Great Bay / Mullica R (below GSP bridge)
14	Mullica	02040302910	Atlantic Coast (Little Egg to Absecon)
15	Great Egg Harbor	02040302010	Reeds Bay / Absecon Bay & tribs
15	Great Egg Harbor	02040302020	Absecon Creek
15	Great Egg Harbor	02040302030	Great Egg Harbor R (above HospitalityBr)
15	Great Egg Harbor	02040302040	Great Egg Harbor R (Lk Lenape to HospBr)
15	Great Egg Harbor	02040302050	Great Egg Harbor R (below Lake Lenape)
15	Great Egg Harbor	02040302060	Patcong Creek/Great Egg Harbor Bay
15	Great Egg Harbor	02040302070	Tuckahoe River
15	Great Egg Harbor	02040302920	Atlantic Coast (Absecon to Great Egg)
15	Great Egg Harbor	02040302930	Atlantic Coast (Great Egg to 34th St)
16	Cape May	02040206210	West Creek / East Creek / Riggins Ditch
16	Cape May	02040206220	Dennis Creek
16	Cape May	02040206230	Cape May Tribs West
16	Cape May	02040302080	Cape May Bays & Tribs East
16	Cape May	02040302940	Atlantic Coast (34th St to Cape May Pt)
17	Maurice, Salem and Cohansey	02040204910	Delaware Bay (Cape May Pt to Fishing Ck)
17	Maurice, Salem and Cohansey	02040206020	Pennsville / Penns Grove tribs
17	Maurice, Salem and Cohansey	02040206030	Salem R(above 39d40m14s dam)/Salem Canal
17	Maurice, Salem and Cohansey	02040206040	Salem River (below 39d40m14s dam)
17	Maurice, Salem and Cohansey	02040206060	Alloway Creek / Hope Creek
17	Maurice, Salem and Cohansey	02040206070	Stow Creek
17	Maurice, Salem and Cohansey	02040206080	Cohansey River (above Sunset Lake)
17	Maurice, Salem and Cohansey	02040206090	Cohansey River (below Cornwell Run)
17	Maurice, Salem and Cohansey	02040206100	Back / Cedar / Nantuxent Creeks
17	Maurice, Salem and Cohansey	02040206110	Dividing Creek
17	Maurice, Salem and Cohansey	02040206120	Still Run / Little Ease Run
17	Maurice, Salem and Cohansey	02040206130	Scotland Run
17	Maurice, Salem and Cohansey	02040206140	Maurice River (above Sherman Ave Bridge)
17	Maurice, Salem and Cohansey	02040206150	Muddy Run
17	Maurice, Salem and Cohansey	02040206160	Maurice River (Union Lk to Sherman Ave)
17	Maurice, Salem and Cohansey	02040206170	Maurice River (Menantico Ck to Union Lk)
17	Maurice, Salem and Cohansey	02040206180	Menantico Creek
17	Maurice, Salem and Cohansey	02040206190	Manamuskin River
17	Maurice, Salem and Cohansey	02040206200	Maurice River (below Menantico Creek)
18	Lower Delaware	02040202090	Pompeston Creek / Swede Run
18	Lower Delaware	02040202100	Pennsauken Creek
18	Lower Delaware	02040202110	Cooper River

WMA#	WMA Name	HUC11	HUC11Name
18	Lower Delaware	02040202120	Woodbury / Big Timber / Newton Creeks
18	Lower Delaware	02040202130	Mantua Creek
18	Lower Delaware	02040202140	Cedar Swamp / Repaupo Ck / Clonmell Ck
18	Lower Delaware	02040202150	Raccoon Creek / Birch Creek
18	Lower Delaware	02040202160	Oldmans Creek
19	Rancocas	02040202020	Rancocas Creek NB (above New Lisbon dam)
19	Rancocas	02040202030	Greenwood Branch (NB Rancocas Creek)
19	Rancocas	02040202040	Rancocas Creek NB (below New Lisbon dam)
19	Rancocas	02040202050	Rancocas Creek SB (above Bobbys Run)
19	Rancocas	02040202060	Rancocas Creek SB SW Branch
19	Rancocas	02040202070	Rancocas Creek SB (below Bobbys Run)
19	Rancocas	02040202080	Rancocas Creek
20	Assis., Cross. and Doctors	02040201030	Duck Creek and UDRV to Assunpink Ck
20	Assis., Cross. and Doctors	02040201040	Crosswicks Ck (above New Egypt)
20	Assis., Cross. and Doctors	02040201050	Crosswicks Ck (Doctors Ck to New Egypt)
20	Assis., Cross. and Doctors	02040201060	Doctors Creek
20	Assis., Cross. and Doctors	02040201070	Crosswicks Ck (below Doctors Creek)
20	Assis., Cross. and Doctors	02040201080	Blacks Creek
20	Assis., Cross. and Doctors	02040201090	Crafts Creek
20	Assis., Cross. and Doctors	02040201100	Assiscunk Creek
20	Assis., Cross. and Doctors	02040201110	Burlington/Edgewater Park Delaware tribs

4.0 Distribution Information

This report consists of one user’s guide and 20 separate appendixes in PDF format. They may be distributed provided proper attribution to NJGS and NJDEP is made if the information contained herein remains unchanged.

5.0 Publication Information

5.1 Publication Date
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6.0 Author Notes

This report: New Jersey Water Withdrawals, Uses, Transfers, and Discharges by HUC11, 1990 to 1999 is available online from the New Jersey Geological Survey's website: http://www.njgeology.org/.

Please report any errors in this report to the authors.

Check the NJGS web site for possible additional information: http://www.njgeology.org/.

Use of brand, commercial, or trade names is for identification purposes only and does not constitute endorsement by the New Jersey Geological Survey or New Jersey Department of Environmental Protection.

7.0 Abbreviations

Abbreviations used, with reference where appropriate.

- BSDW - Bureau of Safe Drinking Water, NJDEP
- BWA - Bureau of Water Allocation, NJDEP
- DEM – Digital Elevation Maps
- DSRT - Division of Science, Research and Technology, NJDEP
- DWS - Division of Water Supply, NJDEP
- DWM - Division of Watershed Management, NJDEP
- ESRI - Environmental Systems Research Institute, Inc.
- GIS - Geographical Information System
- GPS - Global Positioning System
- HUC - Hydrologic Unit Code (HUC14, HU11) (see Ellis and Price, 1995)
- N.J.A.C. - New Jersey Administrative Code
- NJDEP - New Jersey Department of Environmental Protection
- NJGS - New Jersey Geological Survey, NJDEP
- NJPDES - New Jersey Pollution Discharge Elimination System, NJDEP
- NJWaTr - New Jersey Water-Transfer Data System (see Tessler, 2004)
- USGS - United States Geological Survey
- WMA - Watershed Management Area (see Cohen, 1997)
- WR - Water Region (see Cohen, 1997)

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9.0 References

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10.0 Epigram

Bad water management often occurs when facts are confused with values, when means are confused with ends, and when technical judgments are made by citizens and politicians while value judgements are made by scientists and professionals.
--- Lord, William B, 1984, Institutions and Technology, Keys to Better Water Management: Water Resources Bulletin, 29(5), 653, October, American Water Resource Association.

To treat your facts with imagination is one thing, to imagine your facts is another.
--- John Burroughs