

Use of a ground-water flow model to assess the effects of future pumpage in the New Jersey Coastal Plain

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Objectives of Presentation

- **Overview of a regional ground-water flow model and the efforts to revise it for current applications**
- **Use of this model to support the NJ Dept. Environmental Protection (NJDEP) revision of the State's Water Supply Plan**

RASA Model Overview

**Originally developed in early
1980s**

**Simulates ground-water flow
in 10 Coastal Plain aquifers**

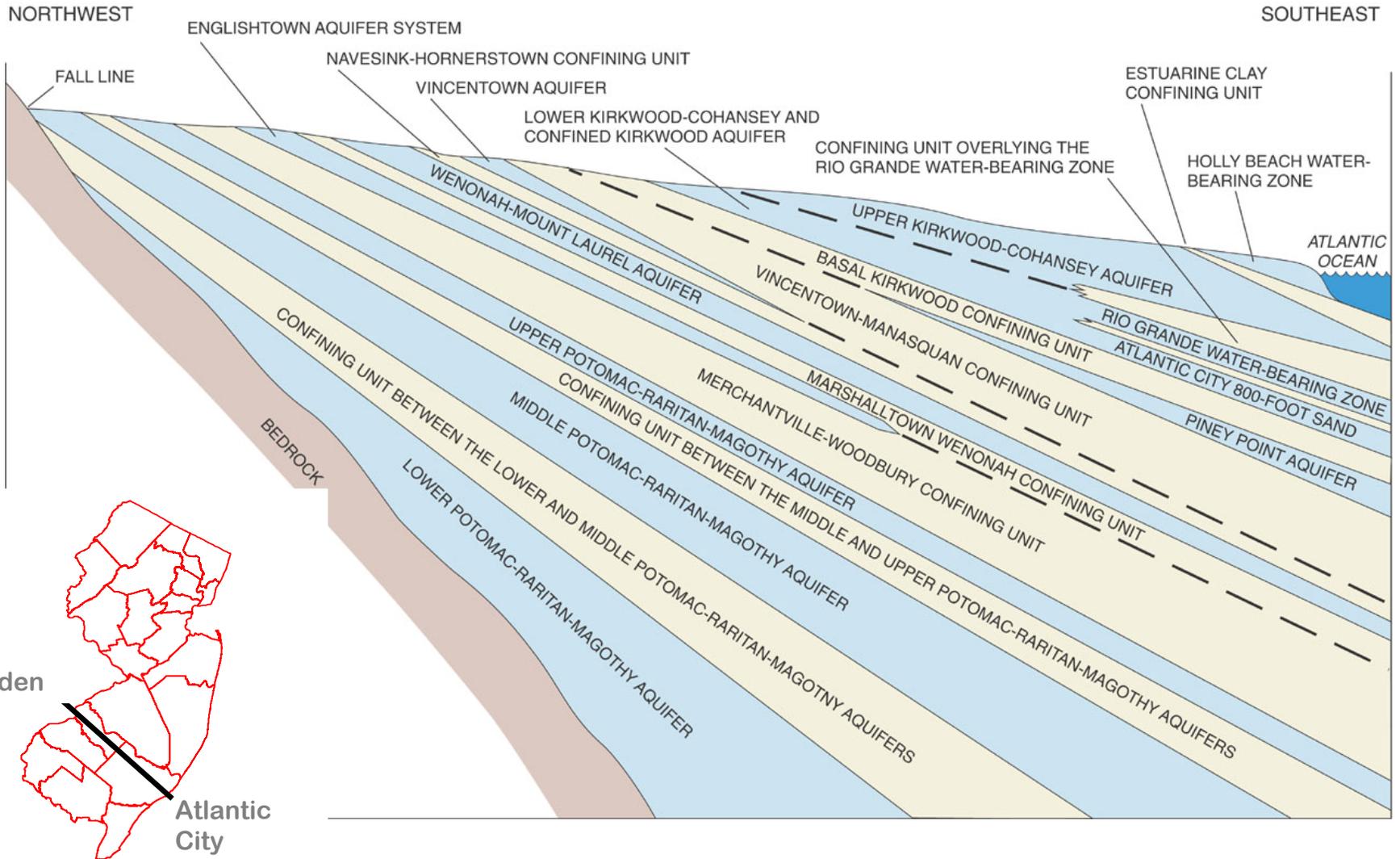
Transient Model

**Average annual ground-water
withdrawals**

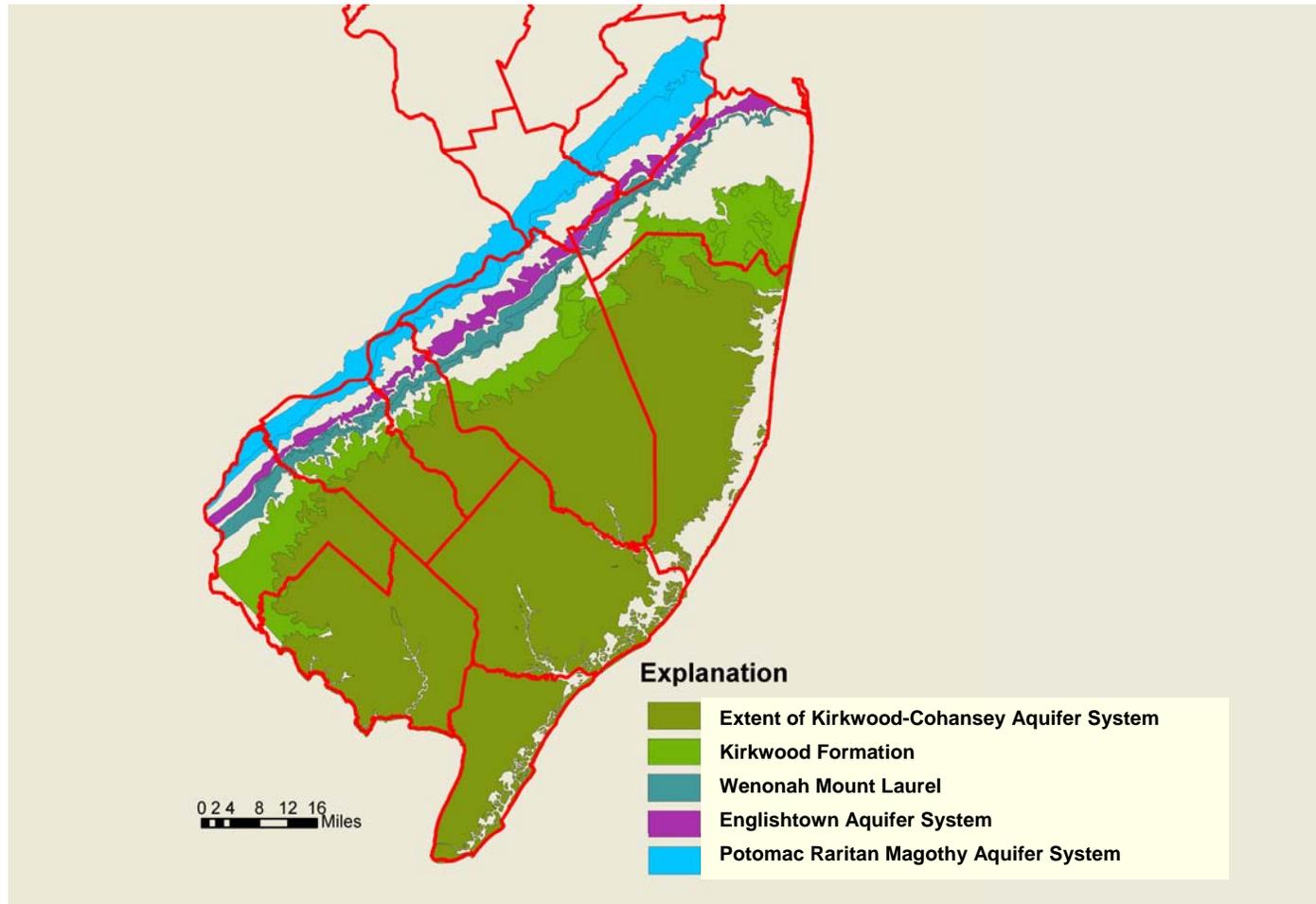


Modified from Martin, 1998

Cross-Section of NJ Coastal Plain



Recharge in Areas of Aquifer Outcrop



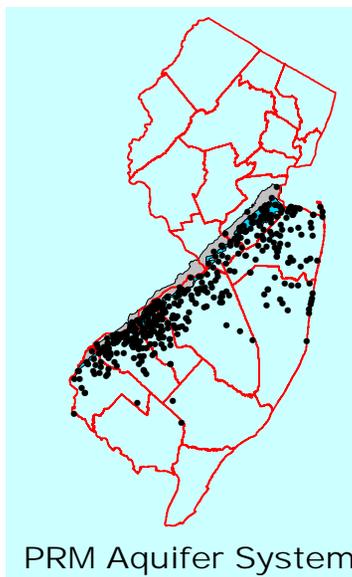
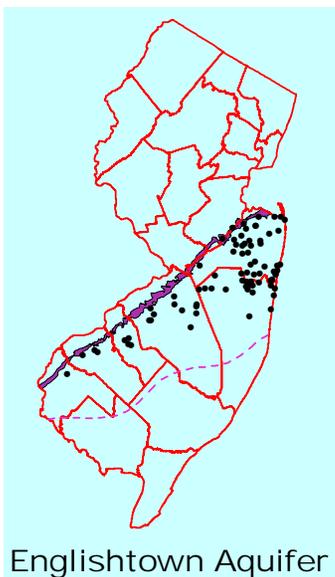
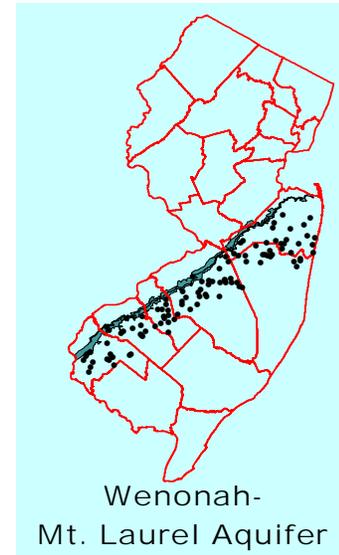
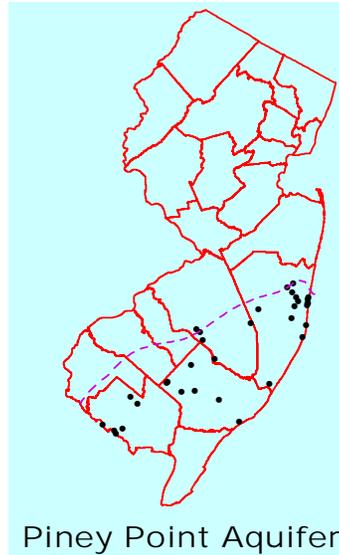
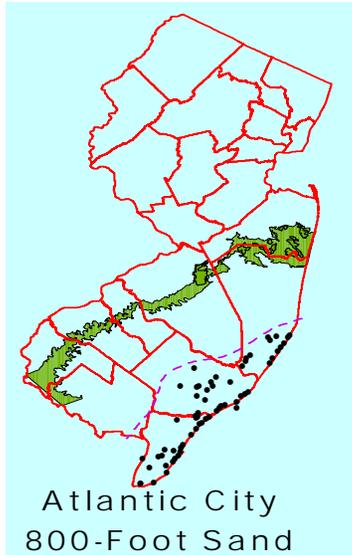
Revisions to RASA Model

- **Finer grid size (0.25 – 3.16 sq. mi.)**
- **More accurate representation of streams**
- **Variable recharge rate**
- **Ground-water withdrawals updated to 2001**
- **Model recalibrated**

NJ Data incorporated into the RASA Model

- **Synoptics – water levels measurements**
- **Water Use – withdrawals by aquifer**
- **Surficial Aquifer Studies - recharge**

New Jersey Coastal Plain Aquifers Synoptic Water-Level Measurements



- Cooperative NJDEP/USGS project
- Every 5 years since 1978
- ~750 wells measured in 6 wks
- Major confined aquifers
- Fall season (medium to low water)
- Water levels used in model calibration

Water Use

(Withdrawal Data obtained from NJDEP)

- **Pumpage input into model by well location and by aquifer**
- **NJDEP issues permits to users w/ withdrawals $\geq 100,000$ gal/day**
- **Users report withdrawals quarterly or annually to NJDEP**
- **Pumpage collected for various water- use categories:**
 - Public Supply**
 - Commercial self-supplied
 - Industrial self-supplied
 - Mining
 - Irrigation
 - Non-cranberry
 - Cranberry
 - Thermoelectric

2001 Ground-Water Withdrawals

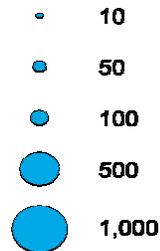
Coastal Plain Aquifers = 300 Mgal/d

Unconfined Aquifers = 70 Mgal/d

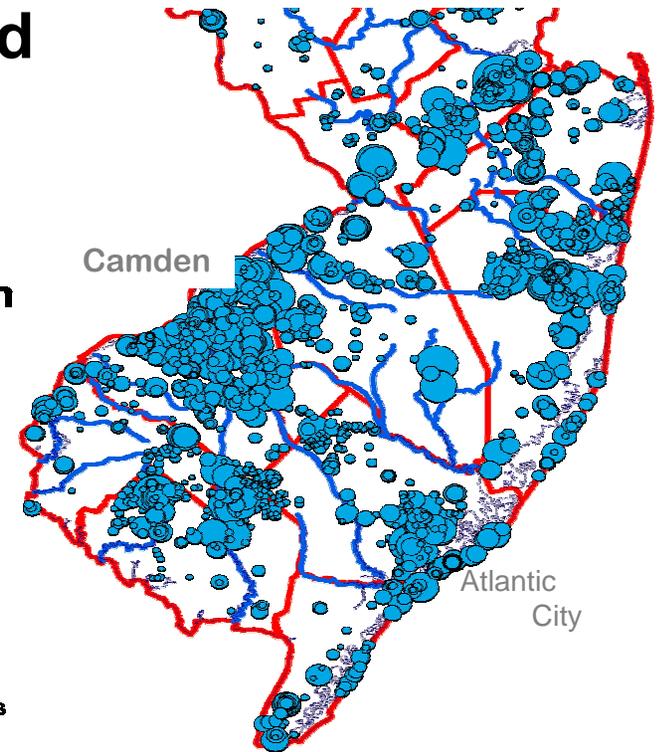
Confined Aquifers = 230 Mgal/d

Explanation

in mgal/yr



0 5 10 20 Miles

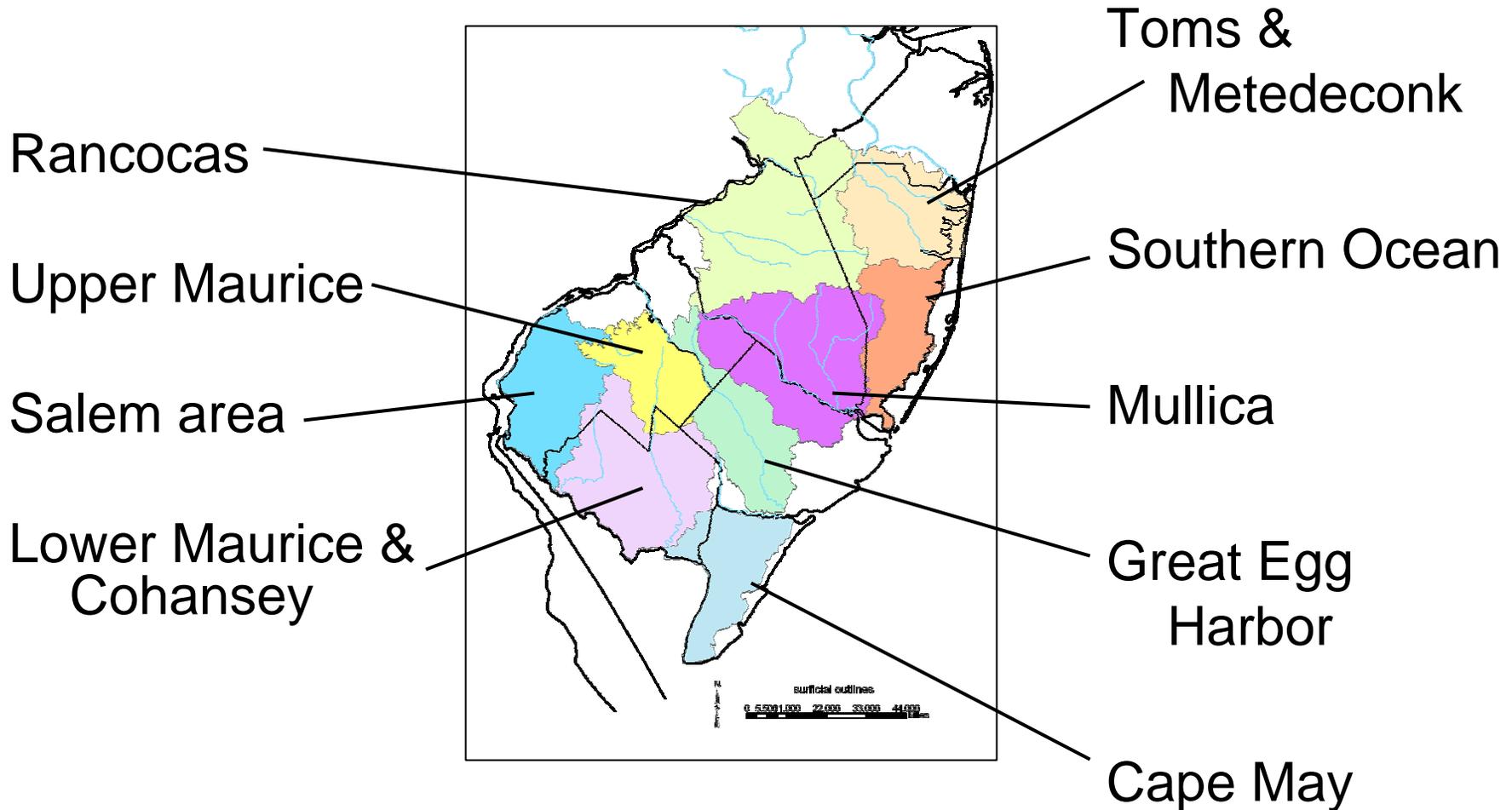


(from GWSIPUMP database for wells > 10 mgy)

Studies Used to Determine Recharge

Produced water-table maps

Water-budget of study area- recharge rates 12-19 in/yr



Application of RASA Model

- USGS technical support for revision to the New Jersey Water Supply Plan
- Project in cooperation w/ NJDEP and NJGS

NJ Statewide Water Supply Plan

- **Mandated by the 1981 Water-Supply Management Act**
- **Addresses need for water-supply management strategy**
- **Delineates water-supply planning areas**
- **Evaluates water resources in the planning areas**
- **Last updated 1996 & currently being revised**

Project Approach using RASA Model

- **Delineate water-supply planning areas**
 - unconfined aquifers- HUC11 scale
 - confined aquifers- 41 budget areas delineated
- **Quantify current (1998) availability** of ground water by flow-budget analysis in planning areas using model results
- Incorporate **projected ground-water demand** to 2010 and 2020 at existing wells
- **Flow-budget analysis** with **projected pumpage**
- **Compare results** with current budget and water levels

Delineate Planning Areas in Confined Aquifers for Budget Analysis

Delineation based on—

Hydrologic Boundaries

Ground-water divides

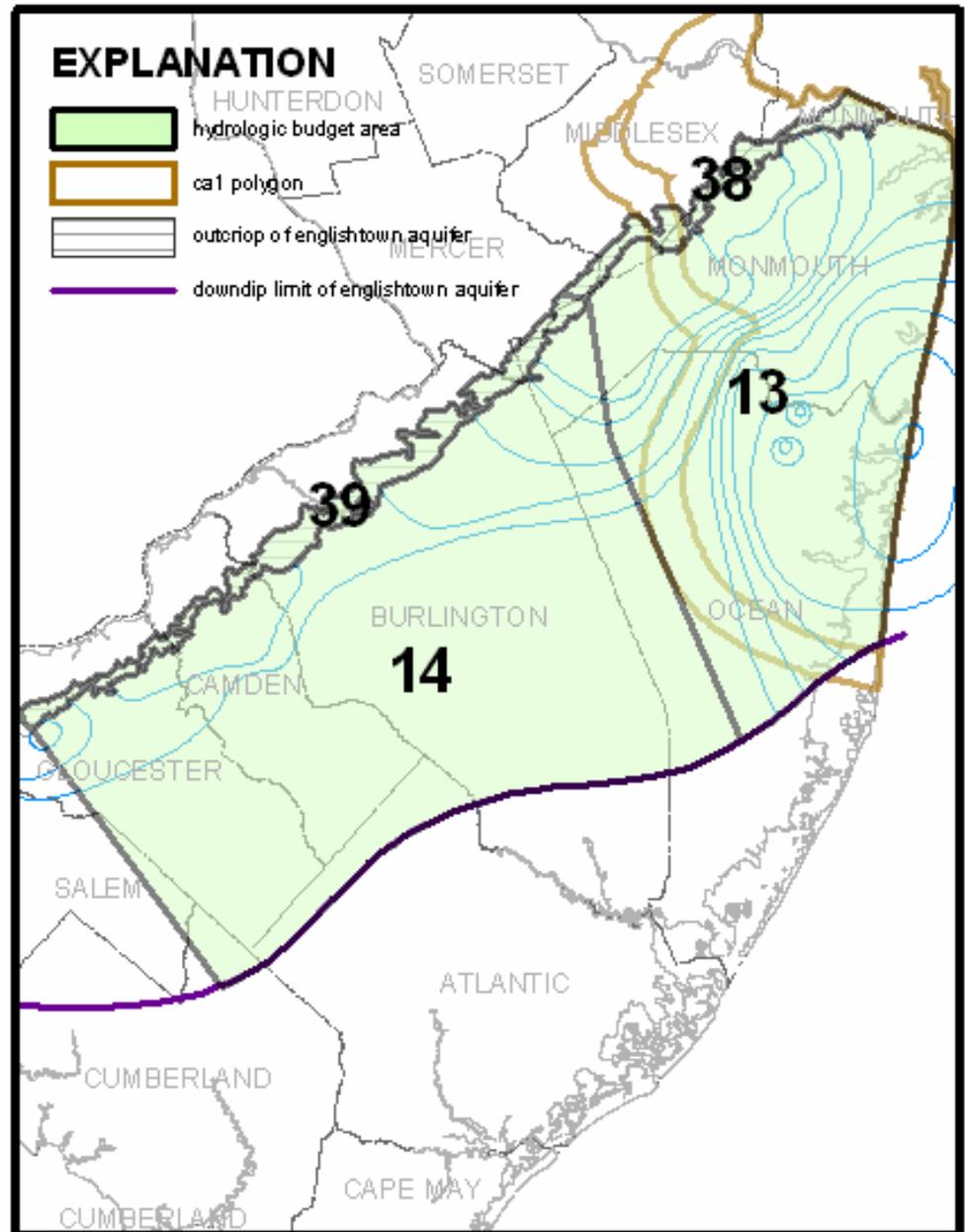
Aquifer limits

Outcrop areas

Regulated conditions

Location of 250-mg/L isochlor

Critical areas (areas of regulated withdrawals)



Projected Ground-Water Demand and Growth Simulations

**Projected increases for 2010 and 2020 determined by
NJGS by 3 methods:**

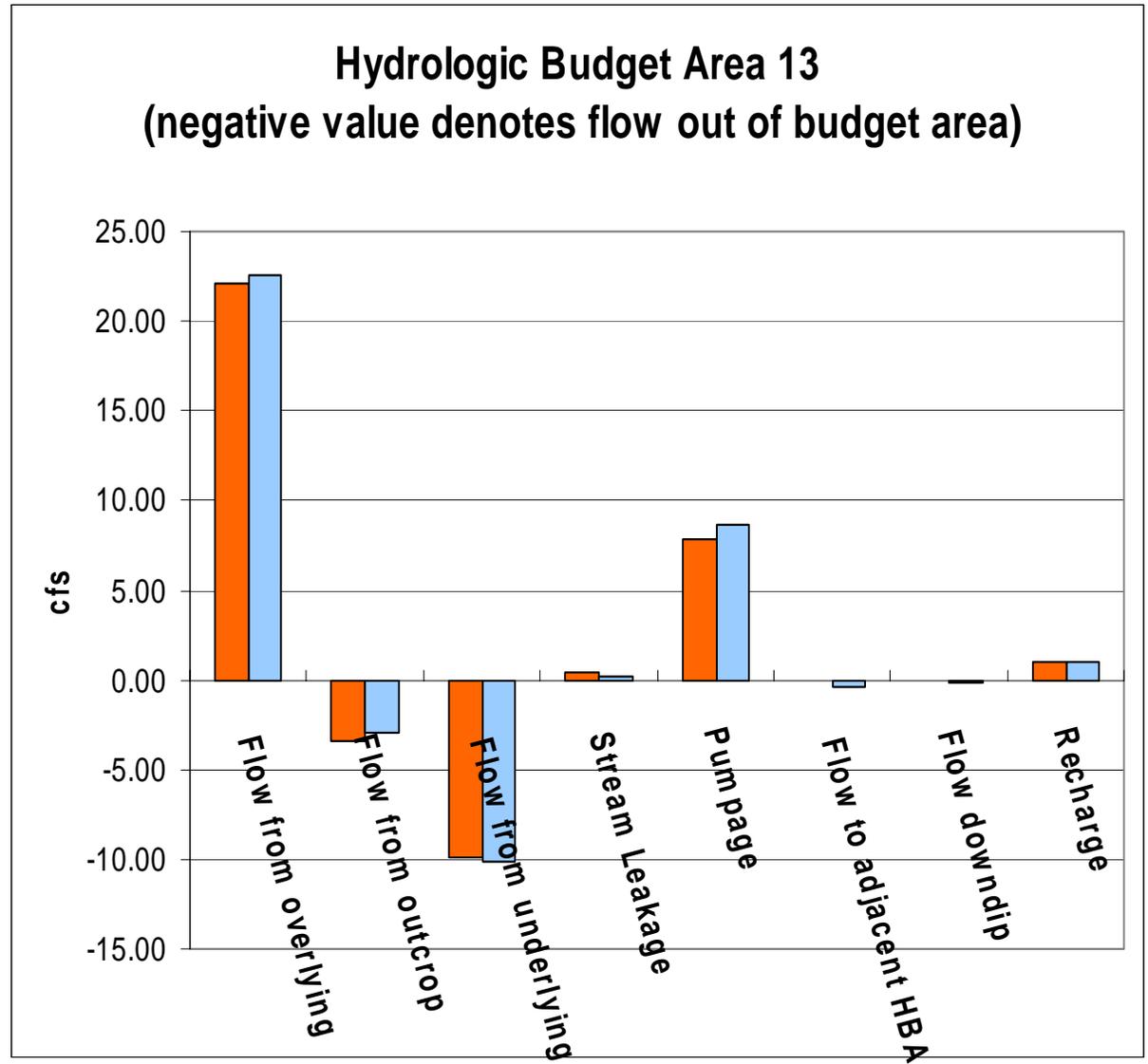
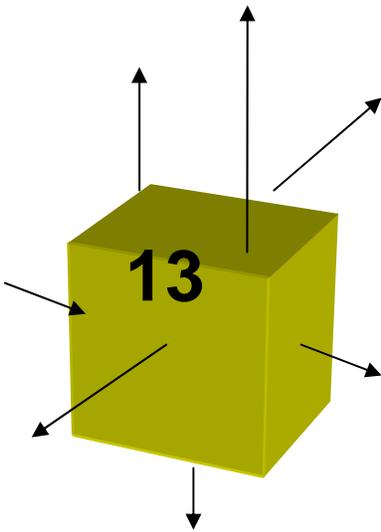
- 1. US Census data-- county population growth**
- 2. Trend Analysis-- 1990-99 ground-water withdrawals**
- 3. NJ State Planning Office-- areas of growth**

Simulate each method separately

**Compare results of each method to the baseline (1998)
simulation for each budget area**

Flow-Budget using Trend Analysis

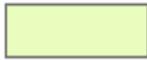
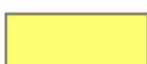
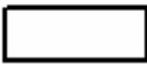
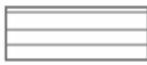
2010
1998

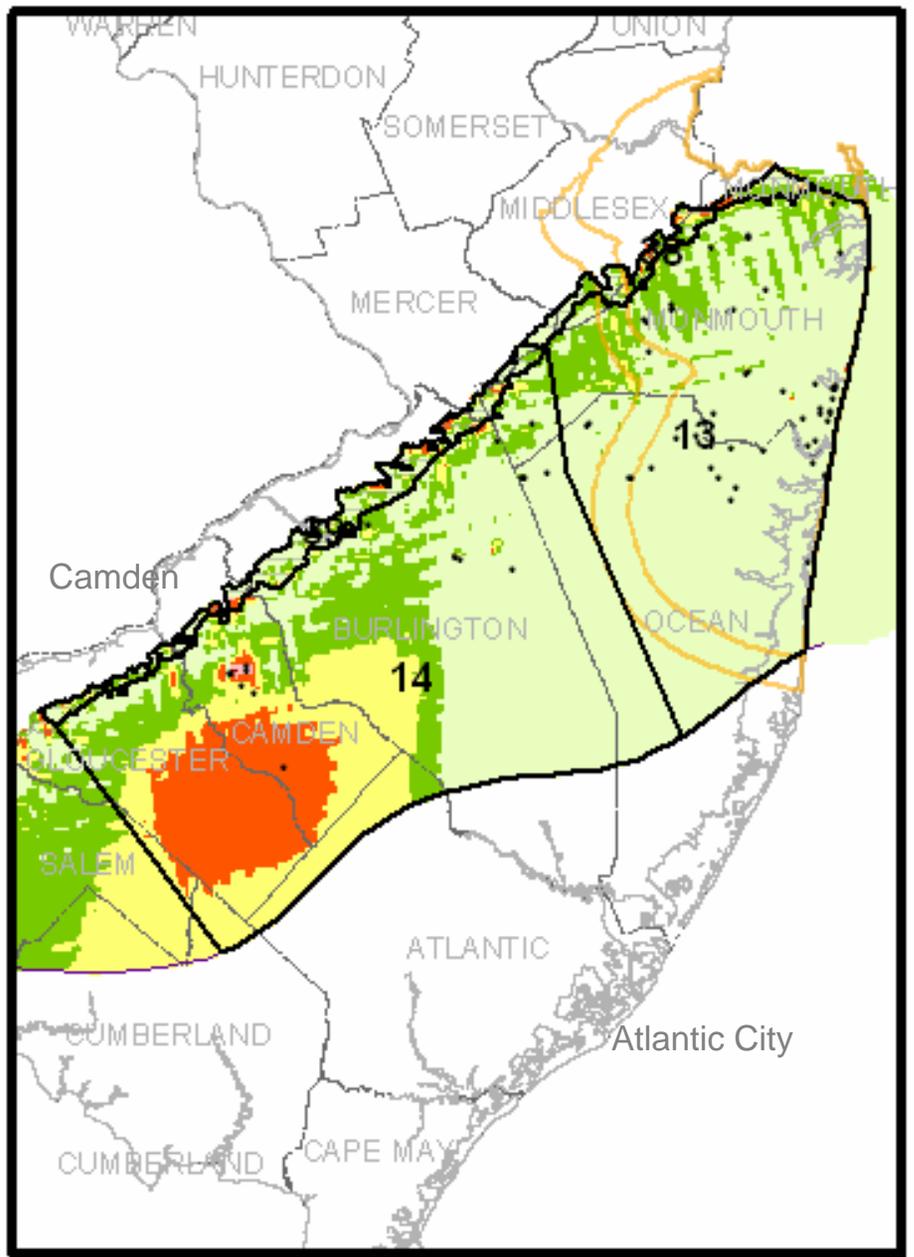


Difference in Simulated Water Levels (1998–2010) using Trend Analysis

EXPLANATION

Water-level difference, in feet

-  -28 - 0
-  ≥0 - 2
-  ≥2 - 5
-  ≥5 - 10
-  ≥10 - 20
-  ≥20 - 37
-  hydrologic budget area
-  ca1 polygon
-  outcrop of english town aquifer
-  downdip limit of english town aquifer
-  water-supply well



RASA Model is used to assess other Water-Supply Concerns in NJ Coastal Plain

- Simulate **Declining Water Levels**- new permits
- **Water Availability**- effects of new wells
- Quantify **Streamflow Depletion**- limited by model discretization
- Determine flow directions and fluxes in existing areas of **Saltwater Intrusion**

Questions?

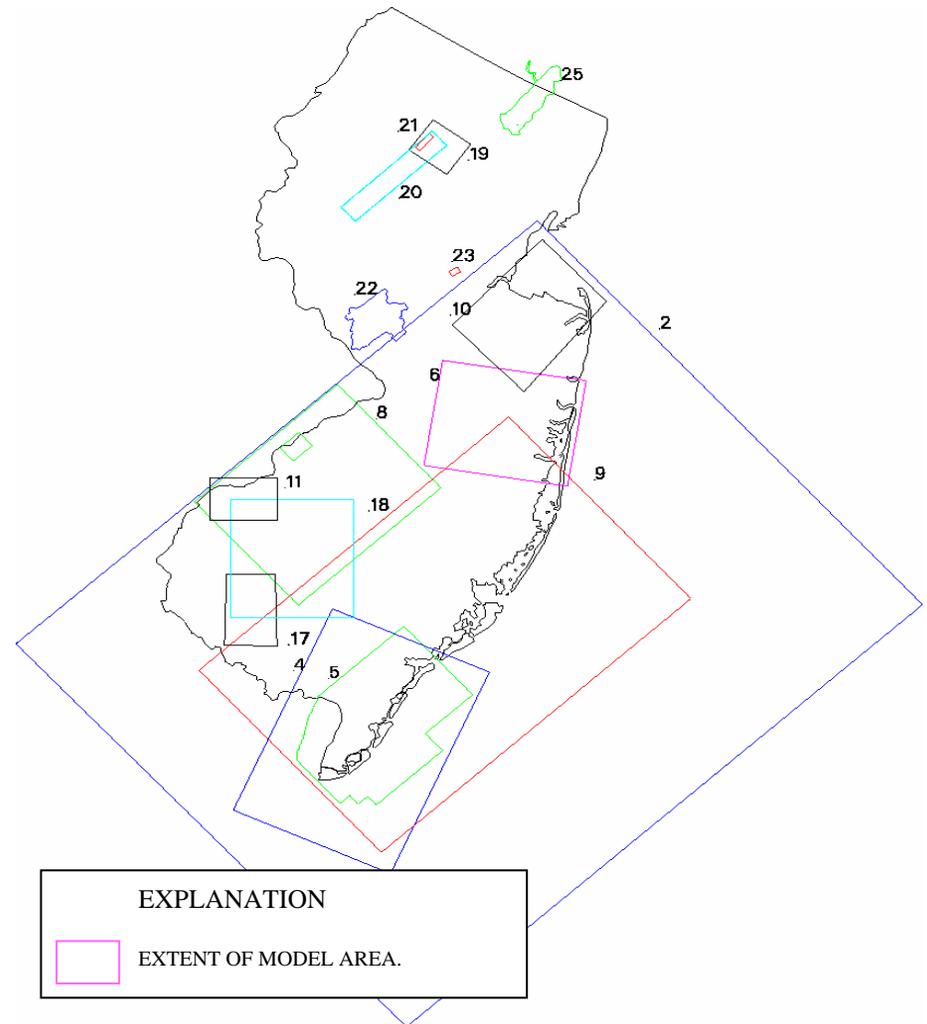
Thank you!

Model Maintenance Project (in cooperation w/ NJ Dept. of Environmental Protection)

Numerical models have
been used as tools to
address water-supply
issues

Archive NJ Ground-water
flow models

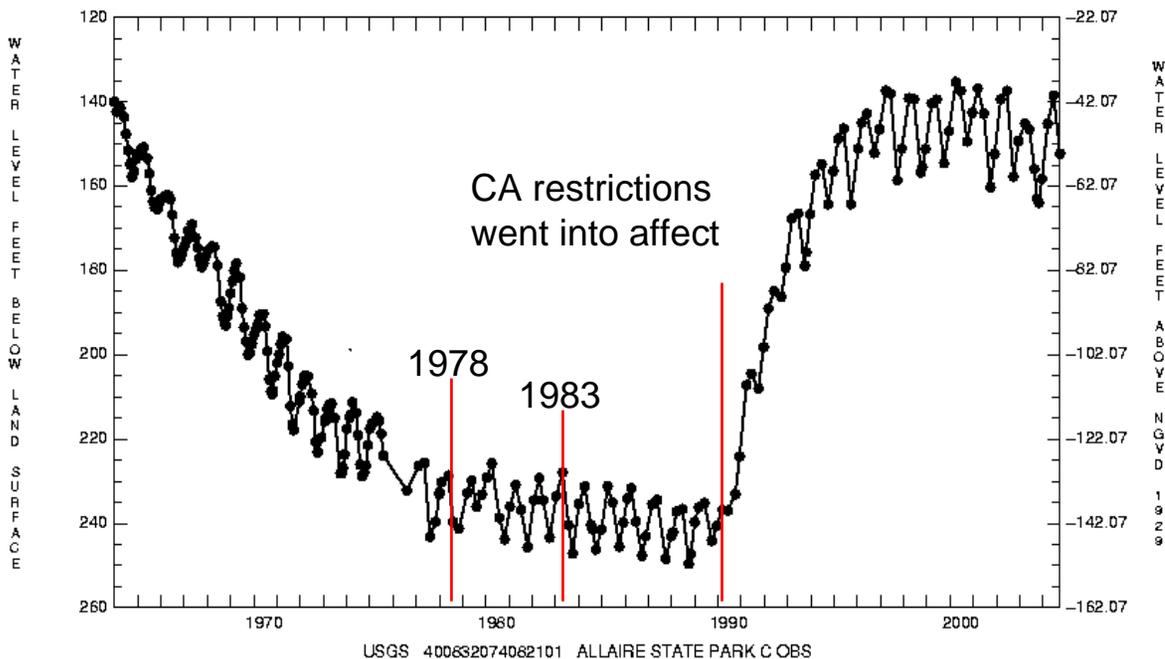
Models can be updated
to address increasing
ground-water use in an
more efficient and cost-
effective manner



CRITICAL AREAS

NJ USGS synoptics in 1978 and 1983 show major declines in 4 aquifers

- **1990 restrictions (40% decrease) went into affect**
- **by 1995 Englishtown aquifers recovered by ~100 ft**

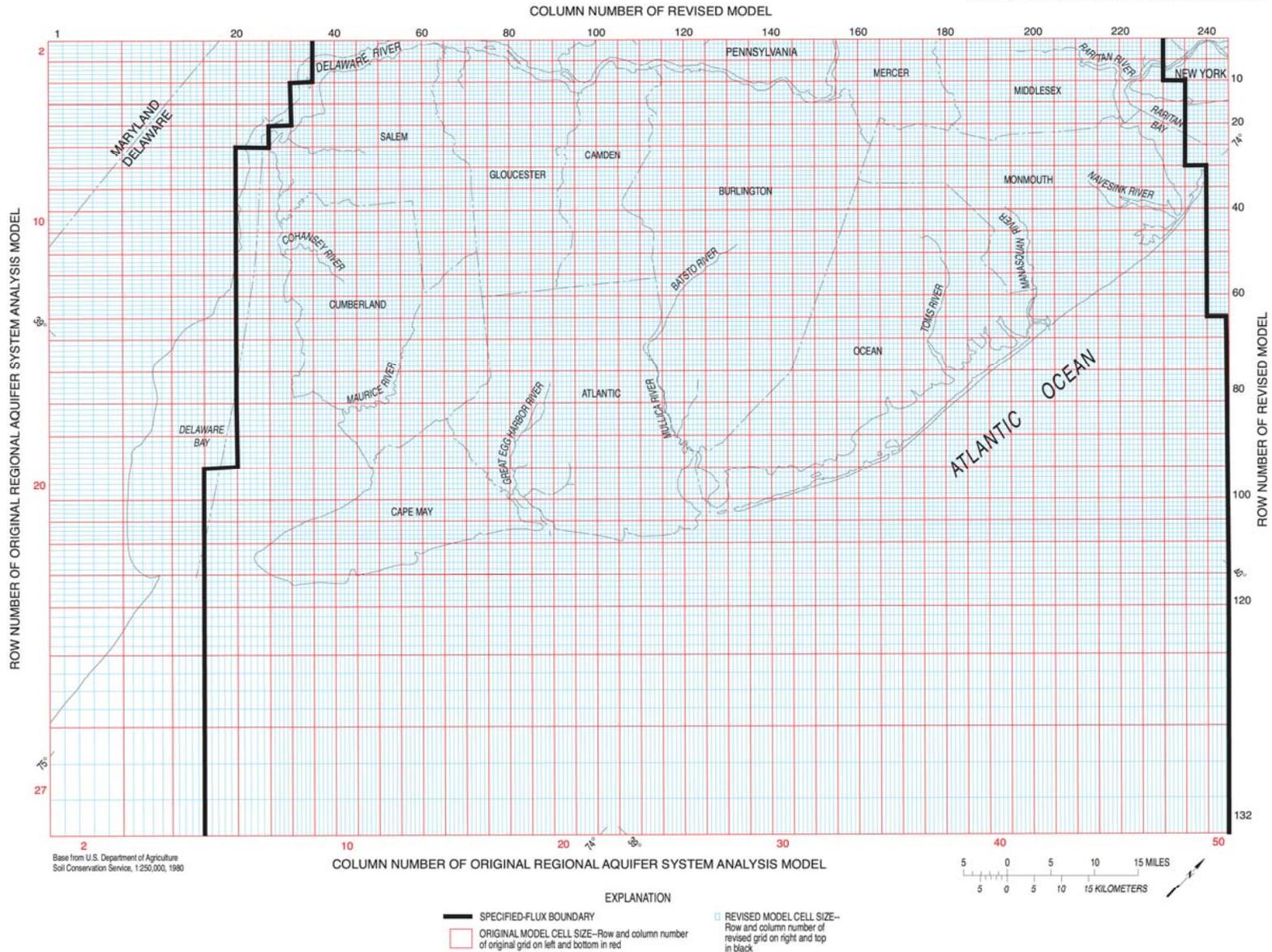


RASA MODEL

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH
NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION

WATER-RESOURCES INVESTIGATIONS REPORT 03-4268
Finite-difference grid and generalized lateral boundaries-PLATE 1
Voronin, L.M., 2004, Documentation of revisions to the regional
aquifer system analysis model of the New Jersey Coastal Plain



FINITE-DIFFERENCE GRID AND GENERALIZED LATERAL BOUNDARIES OF THE ORIGINAL AND REVISED REGIONAL AQUIFER SYSTEM