

# Maintaining Redundancy In An Aging Infrastructure

Presented to the New York City  
Department of Environmental Protection  
October 20, 2005

J. Christopher Nielson, P.E., Commissioner  
Cleveland Division of Water





# History

- 1856 First Lake Erie Pumping Station
- 1910 Typhoid Outbreak
- Chlorine Added, Sand Filtration, And Intakes Moved Farther Out Into The Lake
- 1917 Garrett Morgan, Gas Mask Inventor, Rescued Trapped Workers In Collapsed Intake Tunnel
- 1920's Division & Baldwin Filtration & Treatment Plants Constructed
- 1950's Nottingham And Crown Intakes And Treatment Plants Constructed



# Cleveland Water System Today

- 4 treatment plants and connecting infrastructure serve 1.5 million people, > 500 mgd capacity
- 9 interconnected service areas
- Total service area is 640 square miles in five counties
- 414,300 metered accounts
- Over 5000 miles of pipes



# Four Treatment Plants

Cleveland Distribution System



0 1.25 2.5 5 Miles

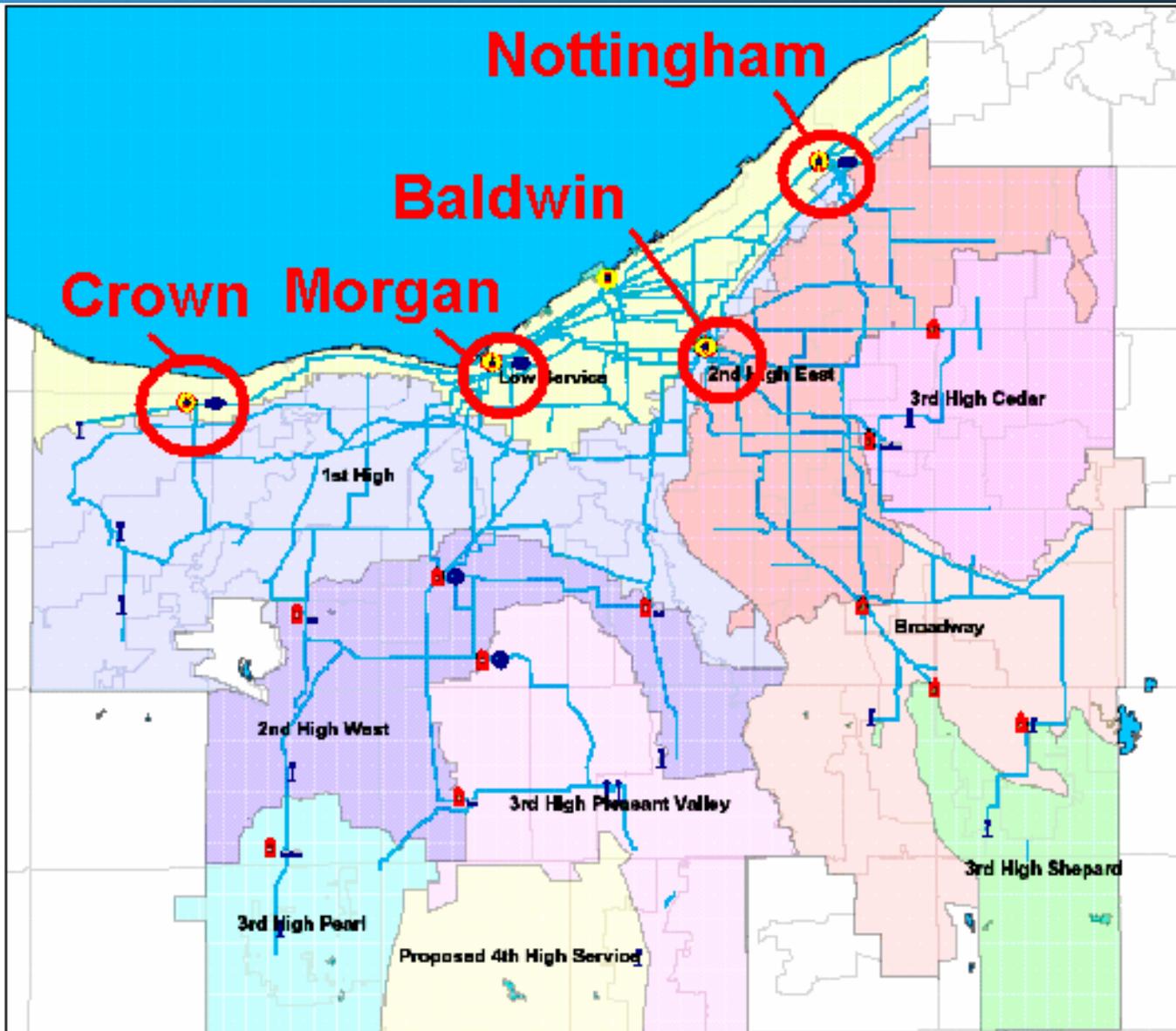
Legend

FACILITY\_TYPE

- Waterworks
- PS
- Secondary PS
- Tower
- Reservoir + PS
- PS + Stor. Unit
- PS + Reservoir
- Two Towers
- PS + 2 Stor. Units
- PS + 1 Stor. Unit

NAME

- 1st High
- 2nd High East
- 2nd High West
- 3rd High Cedar
- 3rd High Pearl
- 3rd High Pleasant Valley
- 3rd High Shepard
- Broadway
- Low Service
- Proposed 4th High Service
- All other valves
- SDE, Ohio\_Lakes

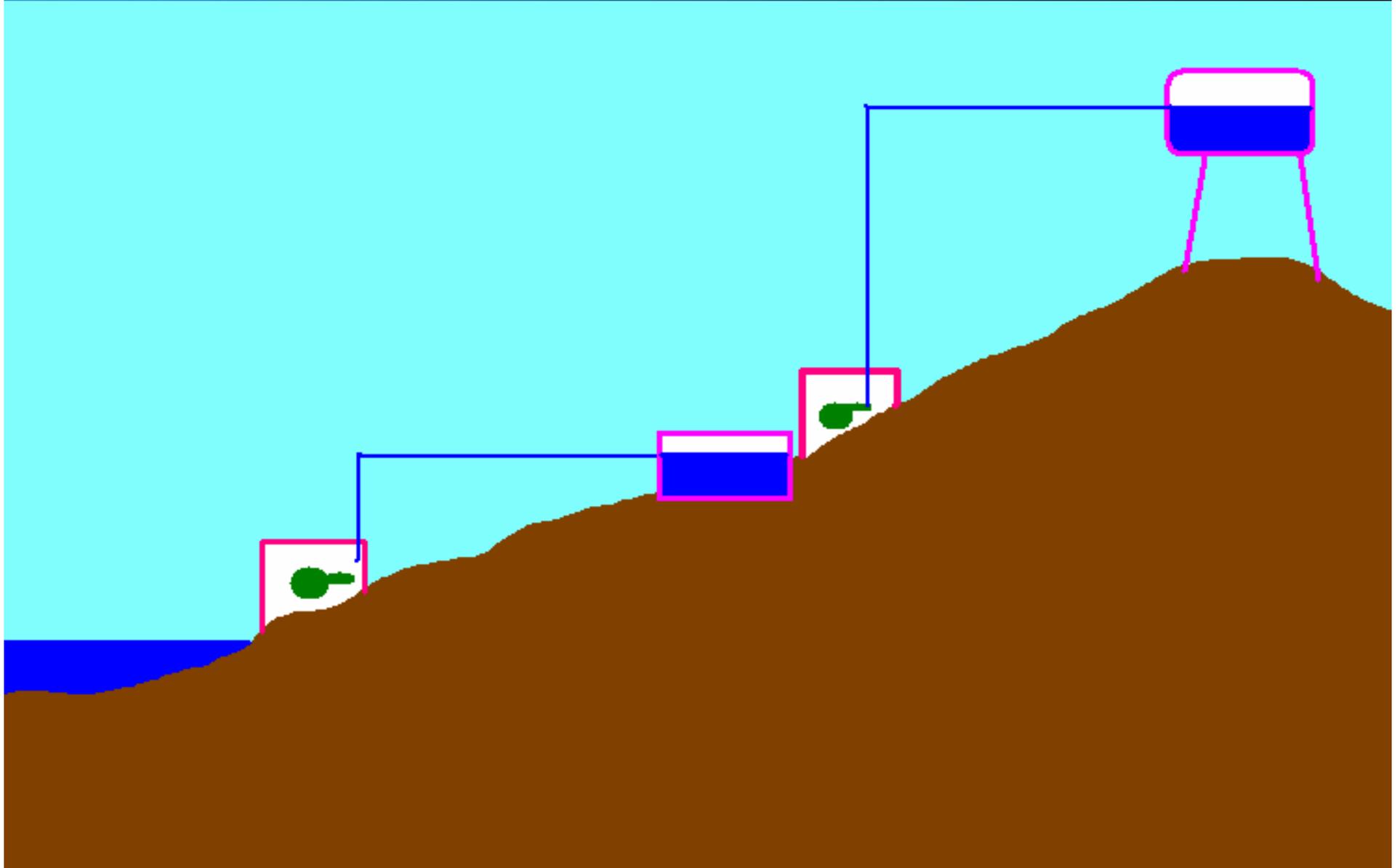


# Waterworks Facilities

- 4 Raw Water Intake Tunnels And Crips
- 5 Raw Water Pump Stations
- 4 Water Treatment Plants
- 20 Potable Water Pump Stations
- 4 Surge Tanks
- 400 Miles Trunk Mains
- 5200 Miles Distribution Mains
- 22 Storage Reservoirs And Tanks

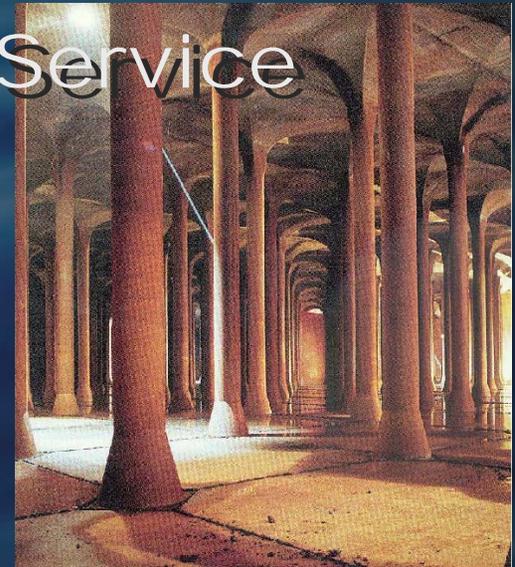


# How CWD Delivers Water



# Overall Redundancy Philosophy

- Provide Modal Day Capacity (250-300 mgd) At All Times
- Provide Complete Primary Service Redundancy
  - Intakes
  - Raw Water Pumping
  - Treatment
  - Finished Water Pumping
  - Clearwells



# Overall Redundancy Philosophy (Cont'd)

- Provide Secondary Service Area Redundancy
- Secure Power Supply
  - Two Power Feeds Per Facility
  - Utilize Separate Substations for Feeds
  - Install Generators Where Dual Feeds Not Feasible



# Service District Redundancy

- Pumping
  - 2 or more stations per District
  - Modal Day Capacity Within Each Station
- Storage
  - 2 or more Tanks/Towers Per District
  - Major East/West Side Reservoirs
  - (> 20mg each)

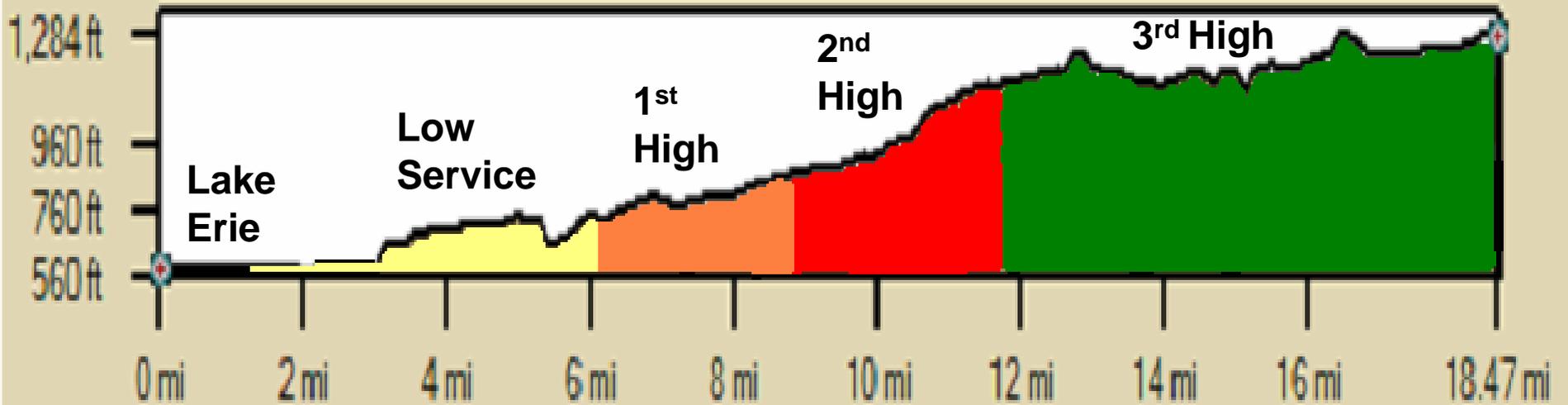


# Service District Redundancy (cont'd)

- Transmission
  - 2 Or More Mains To Each Service District
  - Totally Interconnected
  - Ability To "Bleed" From Higher To Lower Districts
- Power Supply Redundancy
- SCADA
  - Redundant Radio And Phone Systems At 90% Of Facilities



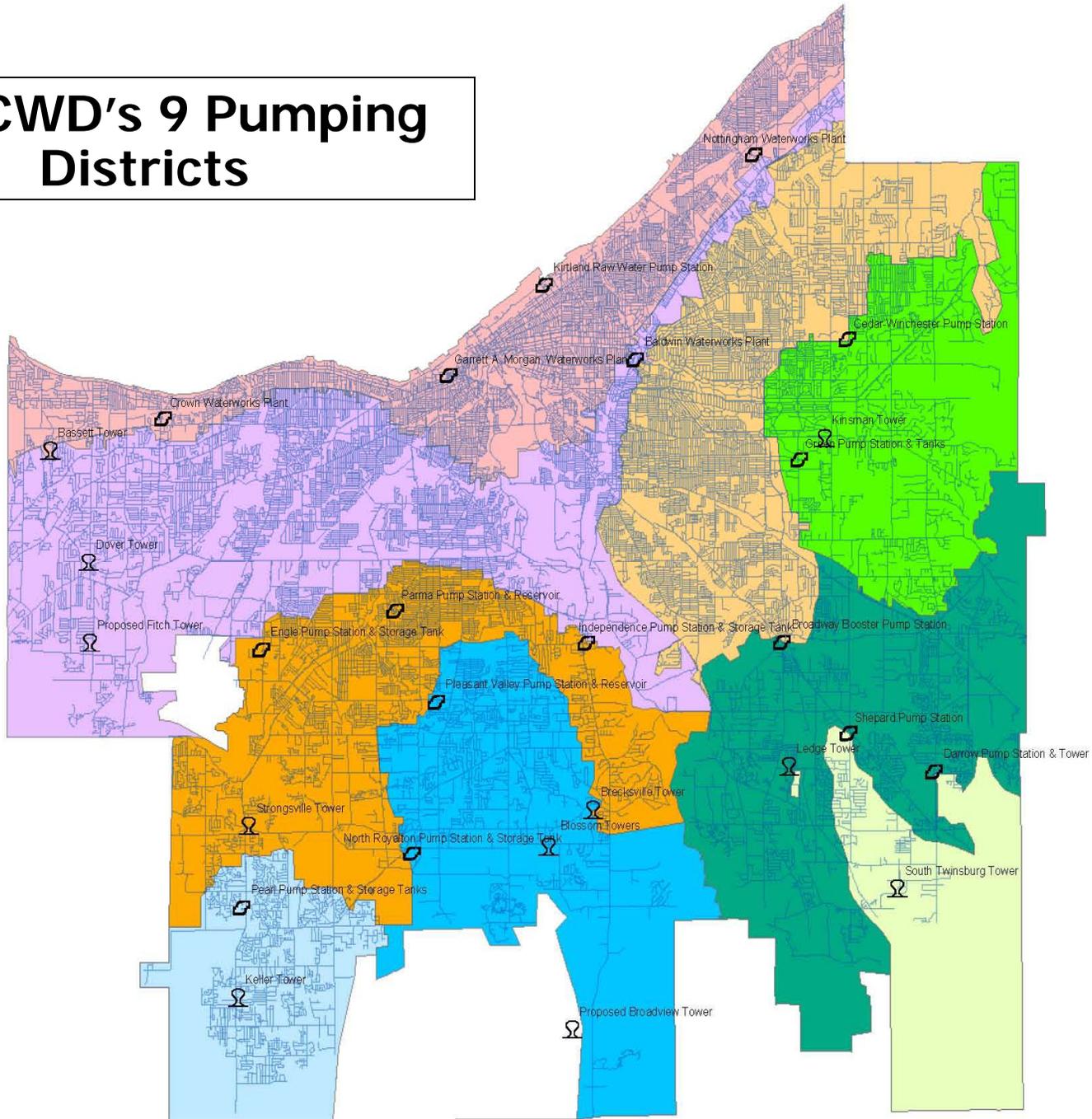
# Pump-Centric System



# CWD Pumping Districts



## CWD's 9 Pumping Districts



- Legend**
- Pumping District**
- 1st High West
  - 2nd High Service
  - 2nd High West
  - 2nd/3rd High Broadway
  - 3rd High Cedar
  - 3rd High Pearl
  - 3rd High Pleasant Valley
  - 3rd High Shepard
  - Low Service West
  - Proposed 4th High Service

1 Miles

# Transmission System

## Cleveland Distribution System



0 1.25 2.5 5 Miles

### Legend

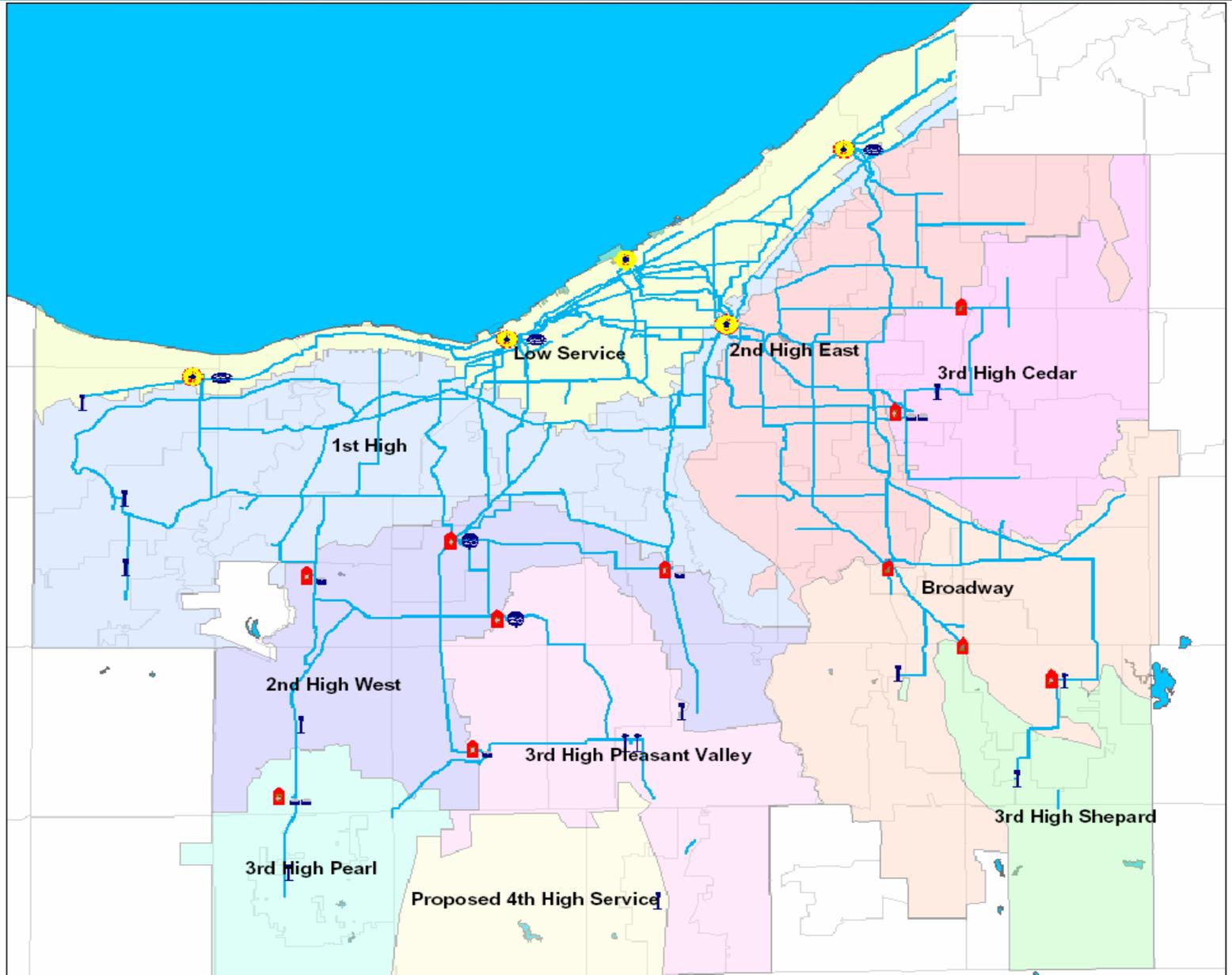
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TrunMain

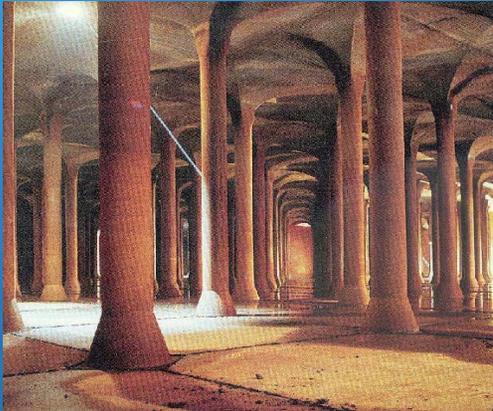
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- <all other values>
- SDE.Ohio\_Lakes



# Secondary Facilities

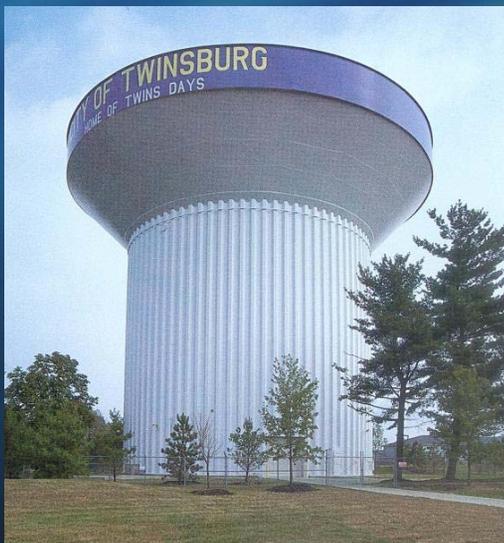
## Reservoirs



## Tanks



## Elevated Towers



## Pump Stations



# CWD Philosophies on Power Redundancy

Reliability of grid considered in Y2K. Failure deemed unlikely.

Utilize CPP backup peaking generators, just in case.

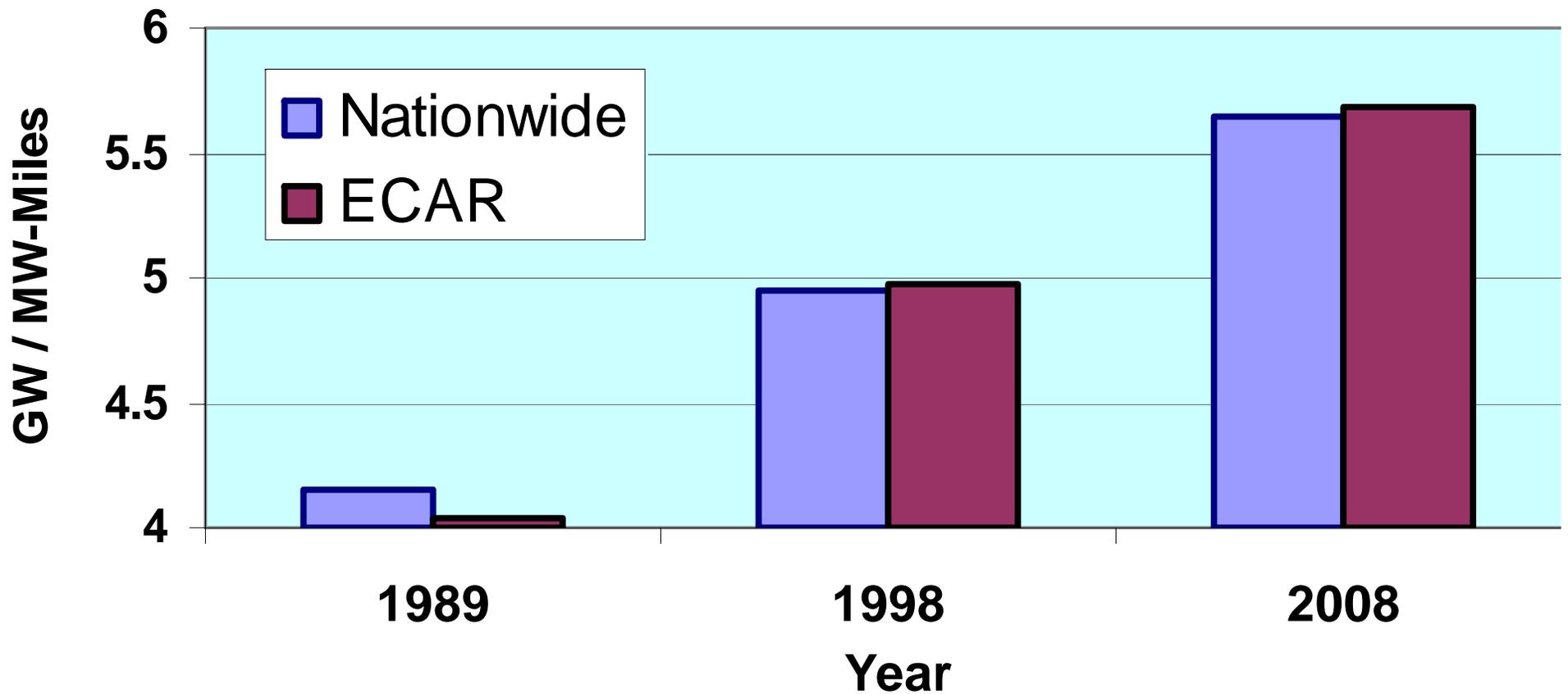


*CPP's two 16 MW Turbine Generators @ W. 41<sup>st</sup>*



# Is The Grid Vulnerable ?

## Overloading the Grid



# What Went Wrong?

- Trees Caused Arcing Of Power Lines
- Inadequately Monitored Grid
- Total Grid Failure
- Cleveland Water Lost All Power
- Very Limited Generator Capacity
- Supply Disruption To 600,000 People
- Boil Alert For 80% Of System



# Emergency Generator And Security Contracts

- Emergency Generators For Every Station
  - Modal Day Capacity For 48 Hours
  - 50 Mw Total/\$25 M Design/Build Contract
- New Security System
  - Card Readers, Cameras/Intrusion Alarms
  - \$23 M Design/Build Contract



# Historical Redundancy Was Not Maintained

GIVE LIGHT AND THE PEOPLE WILL FIND THEIR OWN WAY



## The Cleveland Press

*A Scripps-Howard Newspaper*

THOMAS L. BOARDMAN, Editor

ROBERT H. HARTMANN, Business Manager

OHIO'S LARGEST EVENING NEWSPAPER

Friday, April 26, 1974

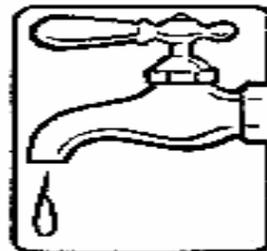
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### Water system in trouble

In a series of carefully detailed articles on Cleveland's water system, Betty Klaric, this newspaper's environmental writer, has made clear a number of important points.

First, there is the assurance that the water coming out of your faucet at home is pure and safe.

Second, there is reason for uneasiness about the Cleveland water system's ability to deliver in the fu-



taken the position that the system belongs to the people of Cleveland who built it, and that they therefore are entitled to lower rates than suburban users.

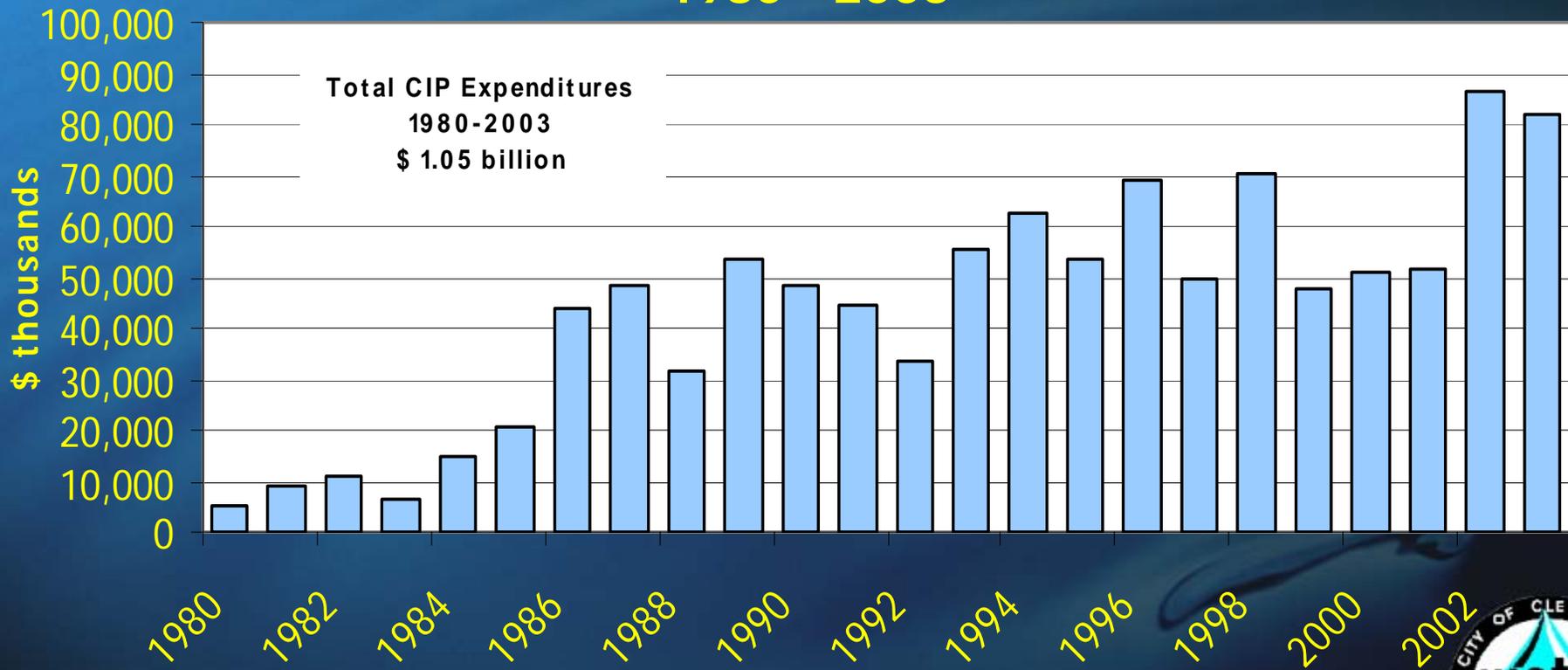
Judge Brown finished hearing testimony in this case last June, but has yet to rule. We believe the judge has had enough time to come to a decision that would allow the managers of the water system to start making concrete plans for improvement.

There is much to be done. The ancient Division Ave. Plant has deteriorated to a point that threatens its ability to operate. Repairs that should have been made six



# Water's CIP started in earnest in the early 1980's

## CIP Expenditures 1980 - 2003



# CWD's 25 Year Program To Re-Establish and Maintain Capacity

- 1980-1995: Restore Service Capacity
  - Morgan Water Treatment Plant Renovation
  - Suburban Inter-connection Pipes
  - Crown Water Treatment Plant Expansion
  - Parma/Green/Broadway Pump Station Rehab
  - Clean and Line Transmission Mains



# CWD's 25 Year Program To Re-Establish And Maintain Capacity (cont'd)

- 1990-2000 Transmission, Storage and Pumping
  - 50 miles of 24"-48" Mains
  - 16 mg Additional Storage
  - 4 New Pump Stations
  - Rehabilitation of 8 other Pump Stations and Storage Tanks



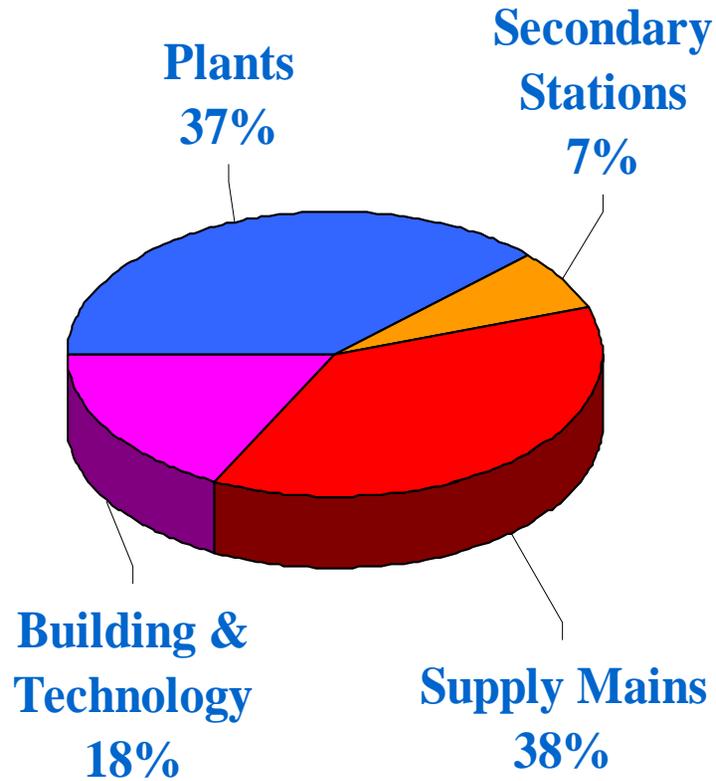
# CWD's 25 Year Program To Re-Establish And Maintain Capacity

- ◆ 1997-2008: Plant Enhancement Program
  - Address All Foreseeable Regulatory Issues
  - Restore Architectural Integrity
  - Replace Process Equipment
  - Establish Internal Plant Redundancy
  - \$700 M Total Program

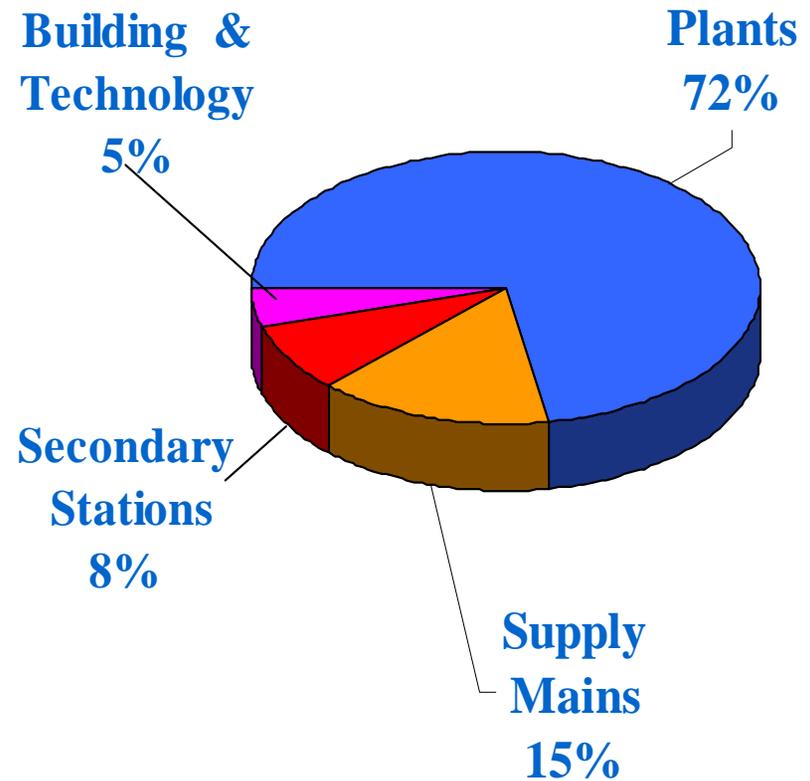


## Division of Water Capital Improvement Program

**1990-1998**



**1999 - 2008**



# Baldwin Water Treatment Plant Filter and Chemical System Restoration

- High Rated 20 Existing Filters
- Rebuilt Other 20 Filters to 200% Capacity
- Replumbed Piping to Allow Maximum Flexibility
- Installed New Chemical Systems in Abandoned Filter Area
- Maintain Full Service During 6 week Outage by Redundancy of Other Plants
- Cleveland Restoration Society Public Building Award – 2004
- Nottingham Followed Identical Approach



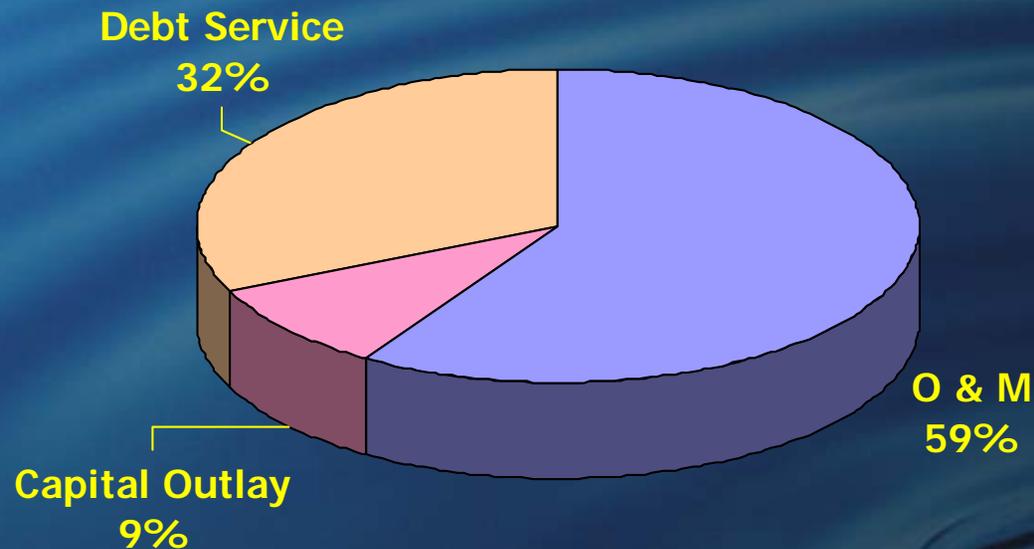
# Morgan Restoration

- Similar Philosophy To Baldwin Approach
- Tight Site Dictated Construction Sequence
  - New Pump Station
  - New Storage On Demolished Pump Station Site
  - Filter Restoration Later To Provide Baldwin/Nottingham Redundancy



Major part of the Division's annual operating budget (~40%) goes toward capital improvements

2004 Operating Budget: \$240 m



(1220 employees)



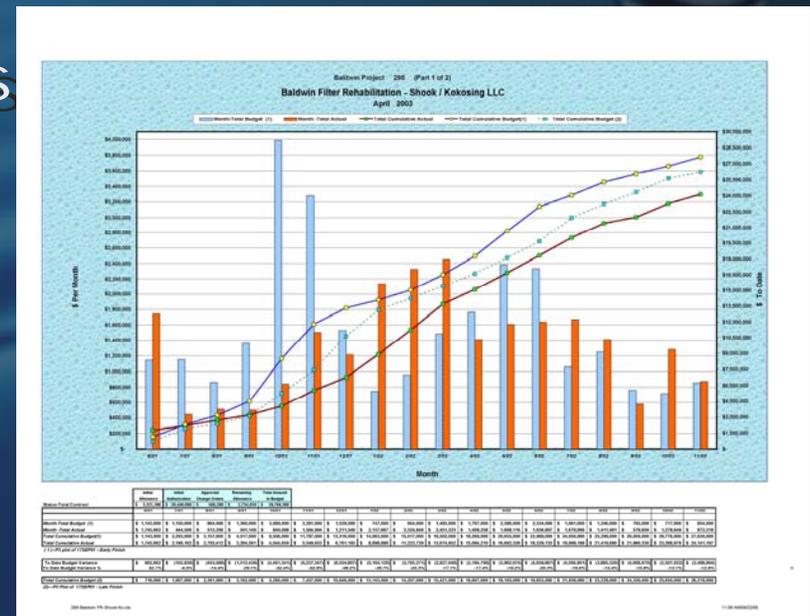
# Why Is Program Management Successful For The City Of Cleveland?

- Pre-Planning is Thorough
- Focus On Project Definition & Scope
- Coordinated Schedules
- Address The Weak Links
- Consistent Communications, Tracking & Reporting
- Shared Responsibility For Risk, QA/QC, Costs
- Defined Decision-making Roles



# Why Pre-Planning?

- Identify Range Of Problems and Needs
- Develop Sound Objectives
- Develop Alternatives
- Establish Priority Setting Mechanisms
- Select Projects And Define Scope
- Coordinate Project Work And Milestones
- Culminate In Project Definition Reports



# How To Better Define Project?

- Facility Plan
- Project Definition Reports
- Detailed Design Memorandum
- Extensive QA/QC
- Value Engineering
- Constructability Reviews



# Cleveland Water Faces Significant Future Challenges

## • Aging Infrastructure

- Trunk Mains

- Ongoing Treatment Plant Needs

- Pump Stations

- Storage Tanks

- Distribution System



# Cleveland Water Faces Significant Future Challenges Beyond Redundancy

- Employee Demographics
  - 35% Of Managers Eligible To Retire In Next 5 years
  - Knowledge And Experience Gap
  - Management Of X And Y Generation Staff
- Financial Conditions
  - Rising Costs
  - Decreasing Consumption
  - Growing Energy Prices
  - Stagnant Local Economy
- Customer Expectations
  - Quick Knowledgeable Response
  - Full Regulatory Compliance
  - Rate Equity
  - Distribution System Control



