Greater London Authority
August 27, 2015

Water in Philadelphia
What can we manage?

CDM Smith
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CDM Smith Water • Environment • Transportation • Energy • Facilities

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Acknowledgments

Many of these slides were developed by the many PWD and CDM Smith team working on this project. They are too numerous to name, but the program and this presentation is a true team effort.

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IWRM

- **Integrated water resources management** (IWRM) has been defined by the Global Water Partnership (GWP) as:

- "a process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems".

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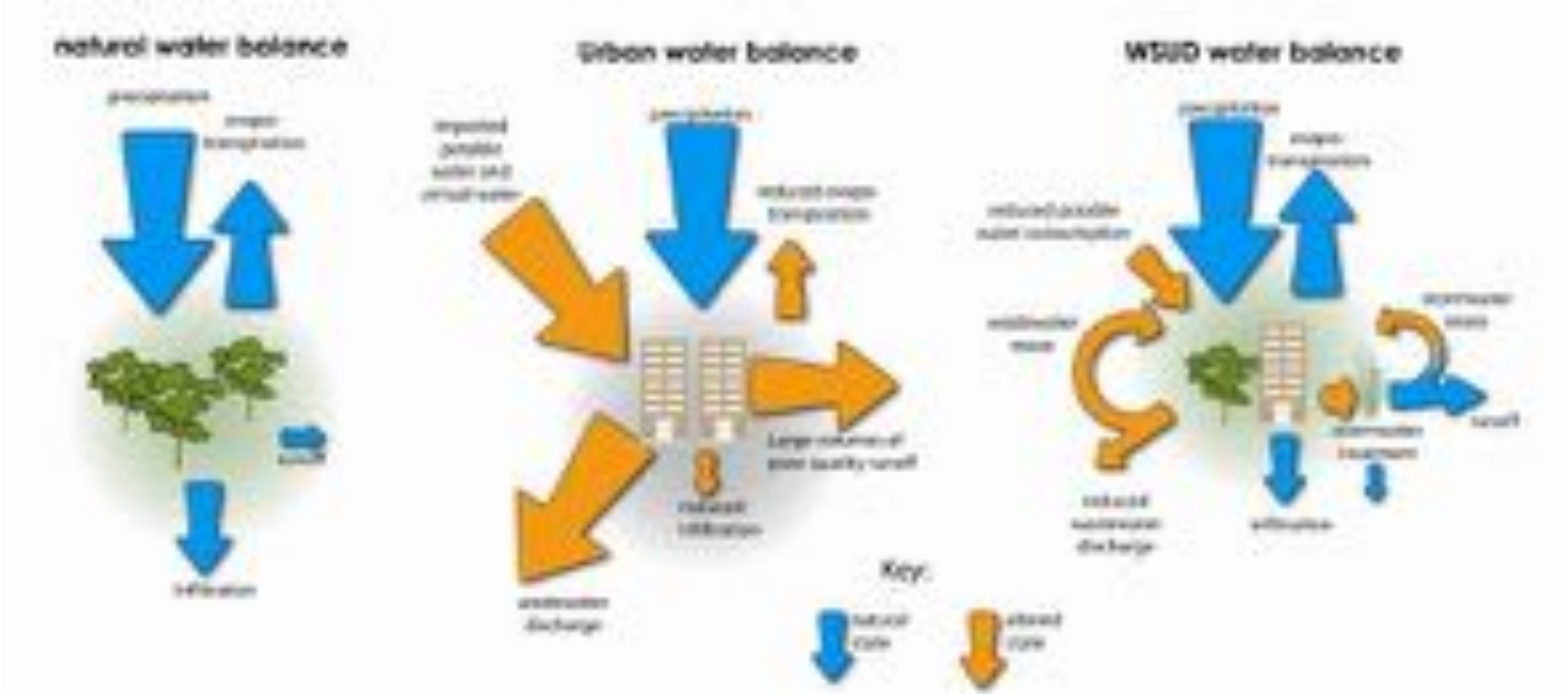

- What do we mean by *Integrated*?
  - Looking at the entire urban water cycle
    - Source
    - Transport of water
    - Treatment and Use
    - Treatment and Disposal
    - Stormwater collection and disposal

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What to we mean by Manage?

- Manage might suggests more than it is
- Perhaps a collection of actions better:
  - Study
  - Understand
  - Predict
  - Prepare
  - Respond
  - Adapt
  - Mitigate

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Can we "Manage" the entire urban water cycle?

- Urban Water system too complex to fully manage.
- Approach is to coordinate policies and systems from source to discharge in as flexible a manner possible
- Identify the largest issues to tackle
- Maximize other benefits through the actions we take

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Philadelphia Facts

1.4 million people

130 sq mi

~60 sq mi rooftops, streets, sidewalks, and parking

~43 in average annual rainfall

Schuylkill River

Center City

Delaware River

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Philadelphia's Waterways

- Philadelphia urban water system:
  - Water enters via two rivers, taken up at three water treatment plants, is treated, used, treated as wastewater: back to the rivers
  - Water also enters as rainfall: collected, treated and/or discharged to the rivers and creeks.
  - Those are the elements to be managed.

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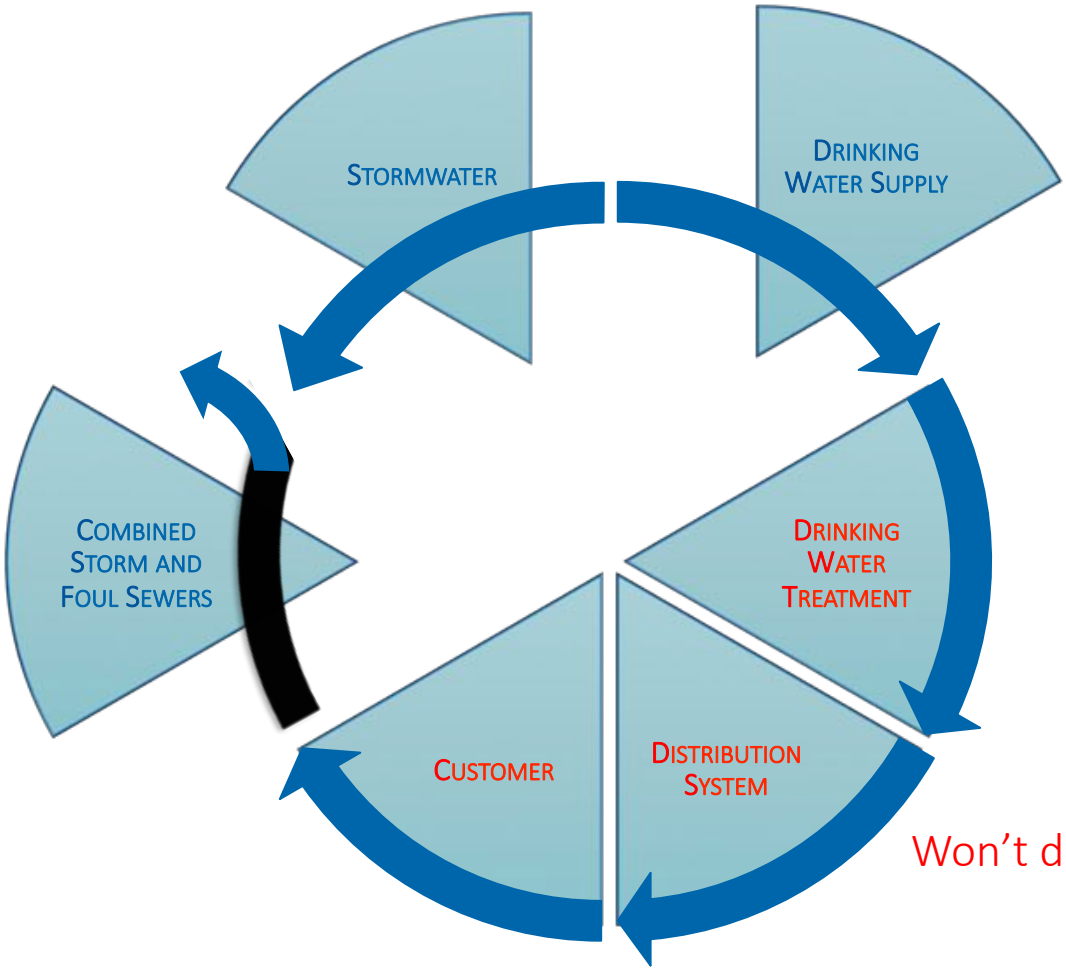
Water Comes into Philadelphia, is used, and discharged via sewers



Won't discuss these elements

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Philly's Version of Management

- Some Primary Management Goals:
  - Improve and protect quality of water entering the city for water supply under all flow conditions
  - Collect foul and surface runoff and treat before discharging
  - Avoid flooding
  - Reduce combined sewer overflows
  - Provide solutions that provide additional societal benefits where possible

- Here is how we try: watershed partnerships, green stormwater infrastructure, optimized sewer systems, river amenities

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Protecting an Urban Supply

- First attempts:
  - Get water upstream of where you live (or where everybody else lives)
  - dispose of waste downstream of where you live (but don't worry about your downstream neighbors)

  - Some cities still do this on a grand scale

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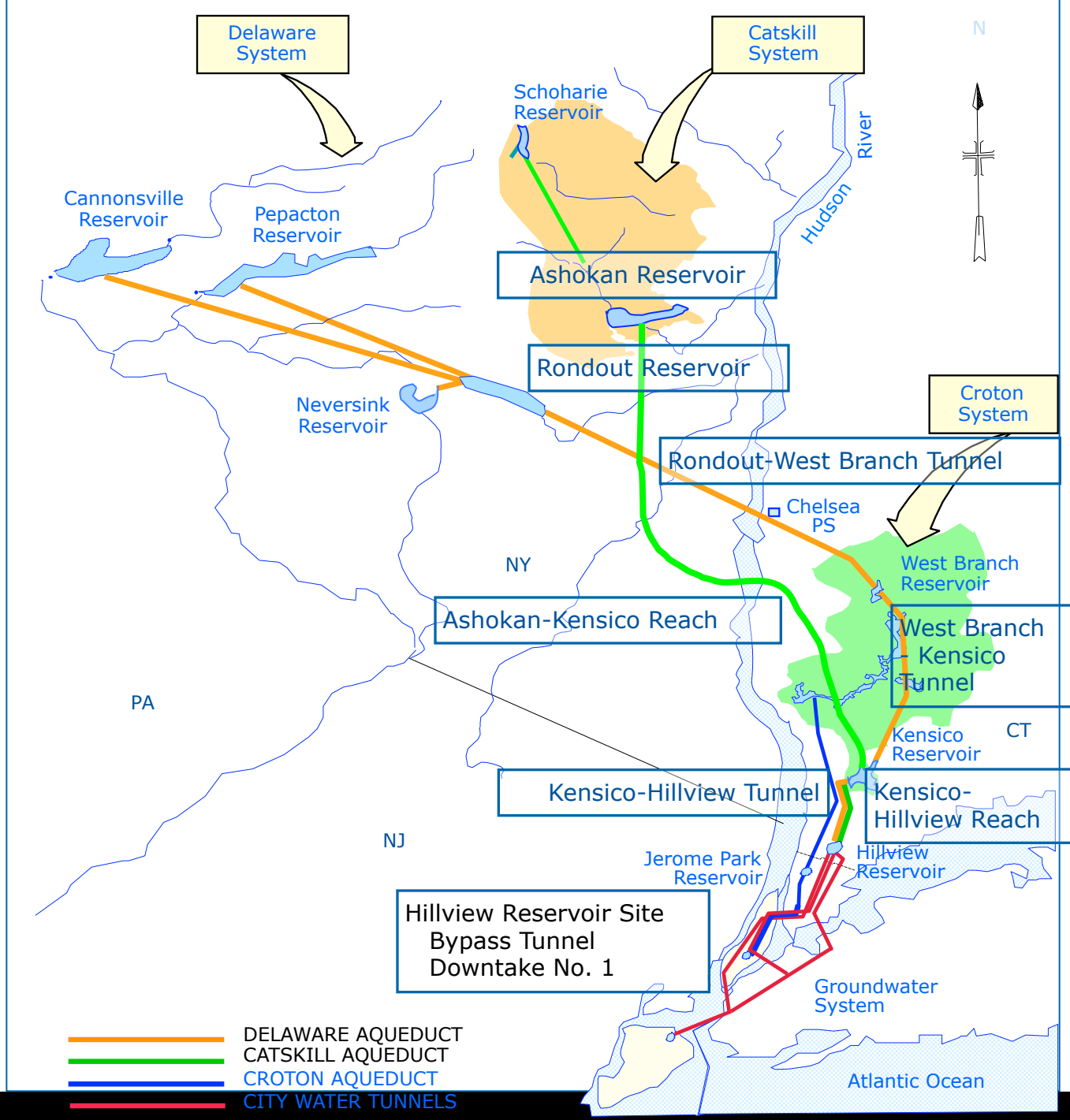
New York City gets water hundreds of miles from it point of use (also upstream of Philadelphia)



Management of NYC Source

- Buy up the watersheds to protect the quality
- Management focused on demand management and reservoir storage and release

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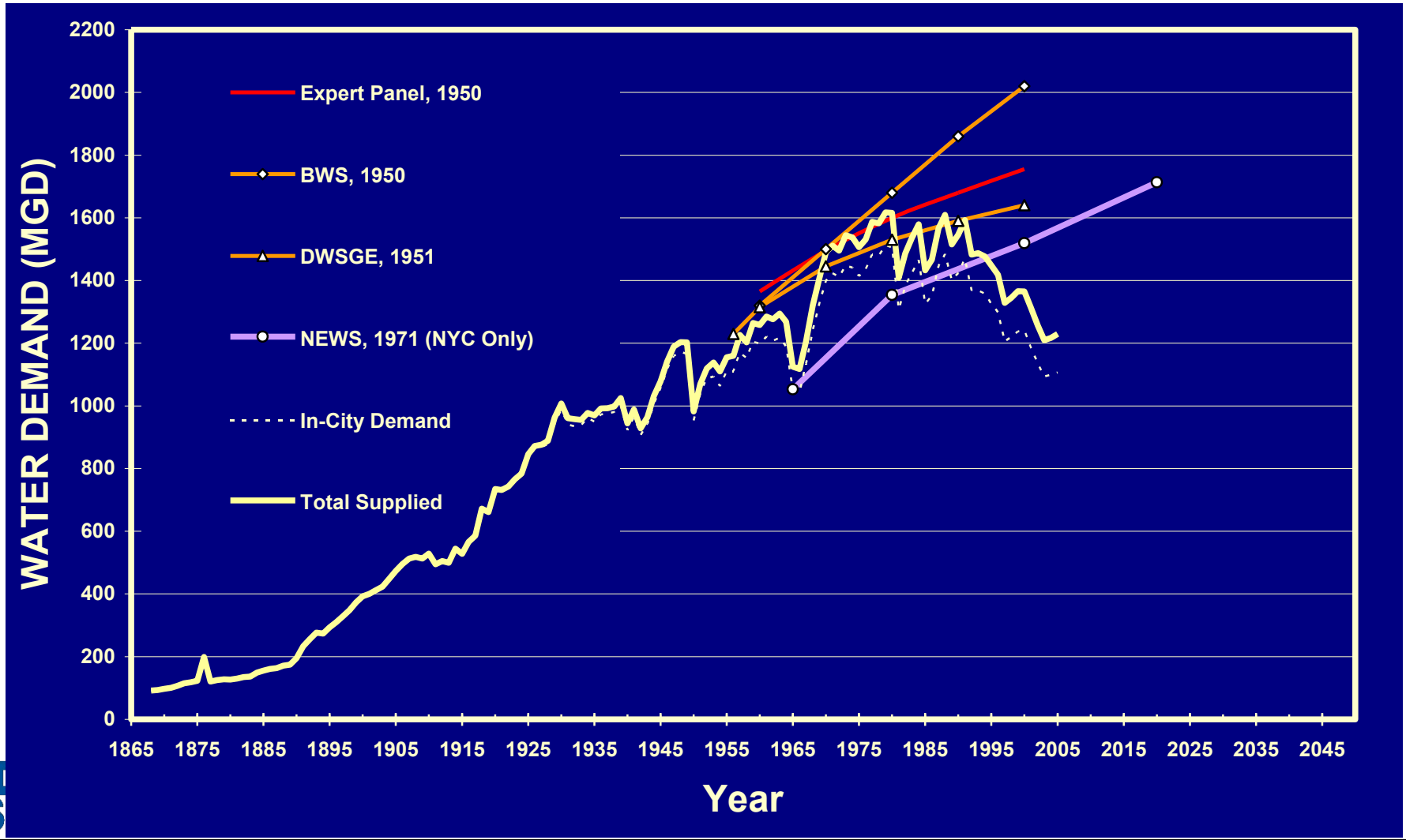
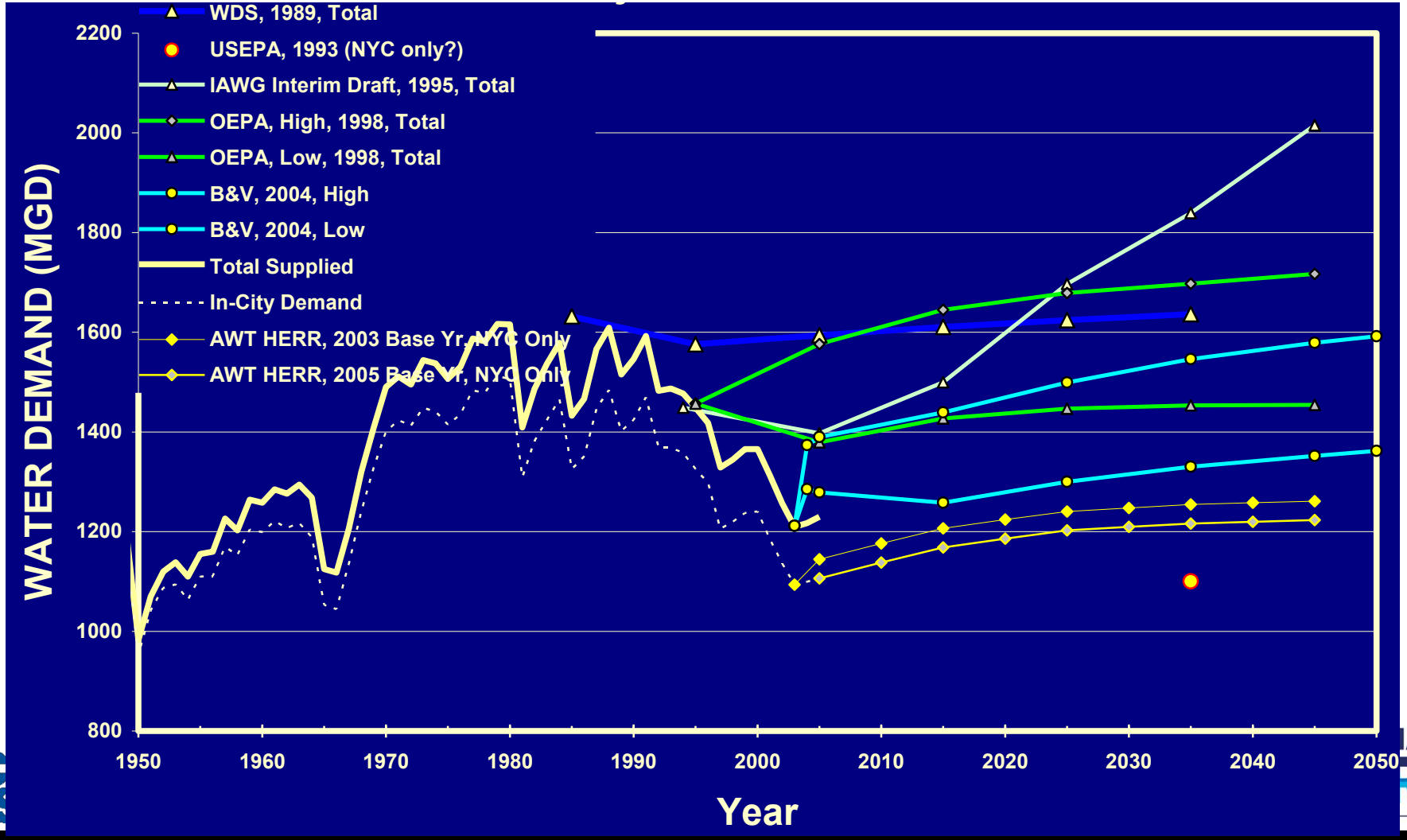
Demand Projections : 1950's – 1970's



Demand Projections : 1990's - 2004



PWD gets its water in the city from the rivers

Schuylkill Watershed

- 1,911 sq. miles
- 1.36 million people*

Delaware Watershed

- 8,108 sq. miles
- 2.72 million people*

PWD provides drinking water to

~1.6 million people

**U.S. Census Bureau, 2010 Census*

Managing Quantity

- Philadelphia is wholly dependent on river flows
- Managing means understanding flow patterns and drought and managing demand accordingly

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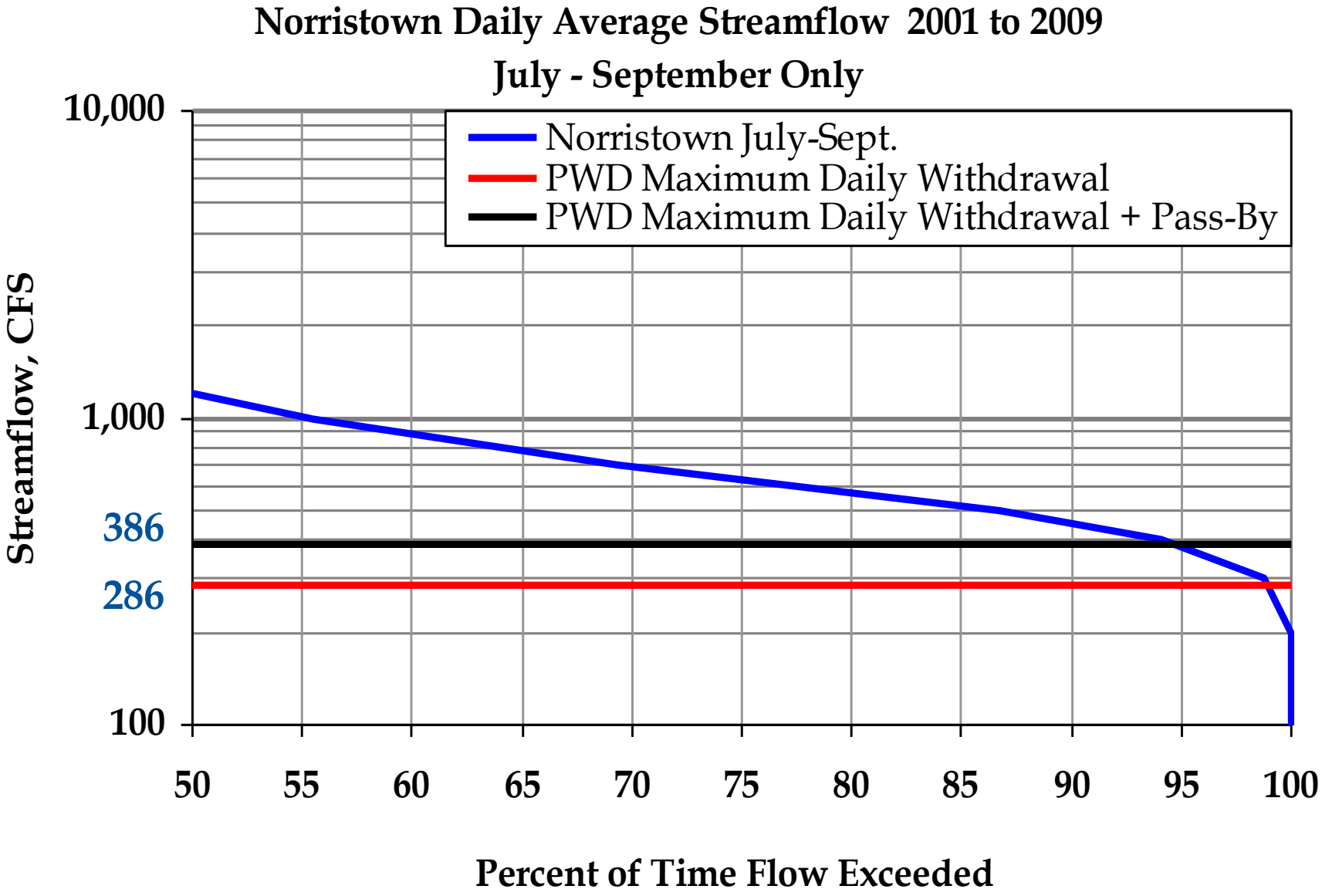
Norristown Daily Average Streamflow 2001 to 2009
July - September Only
10,000
1,000
386
286
100
Streamflow, CFS
Norristown July-Sept.
PWD Maximum Daily Withdrawal
PWD Maximum Daily Withdrawal + Pass-By
50
55
60
65
70
75
80
85
90
95
100
Percent of Time Flow Exceeded

Protecting Philadelphia's Supply

- First attempts 18th century:
  - Philadelphia: protected upstream parts of city in Fairmont Parks
  - Took water from Schuylkill and Delaware Rivers
  - Disposed of foul water and surface runoff downstream in tidal rivers

  - This worked fine, until the rest of the watershed above the city developed

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Protecting Philadelphia Water today

- At the bottom of two watersheds
- Upstream are cities, towns, industry, mining, farms
- Manage the Source? Not really.
  - Study – Understand – Predict – Cooperate - Mitigate

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Philadelphia's Approach to Source Water Protection: Watershed Management



Regional thinking is paramount!

Because our watersheds are shared across county and state boundaries, we must share responsibility for regional water management to ensure that water quality issues are stopped at the source



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DELAWARE RIVER PARTNERSHIPS

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United States Coast Guard
U.S. Department of Homeland Security

Delaware River Basin Commission
DELAWARE · NEW JERSEY
PENNSYLVANIA · NEW YORK
UNITED STATES OF AMERICA

PARTNERSHIP FOR THE DELAWARE ESTUARY INC.

USGS
science for a changing world

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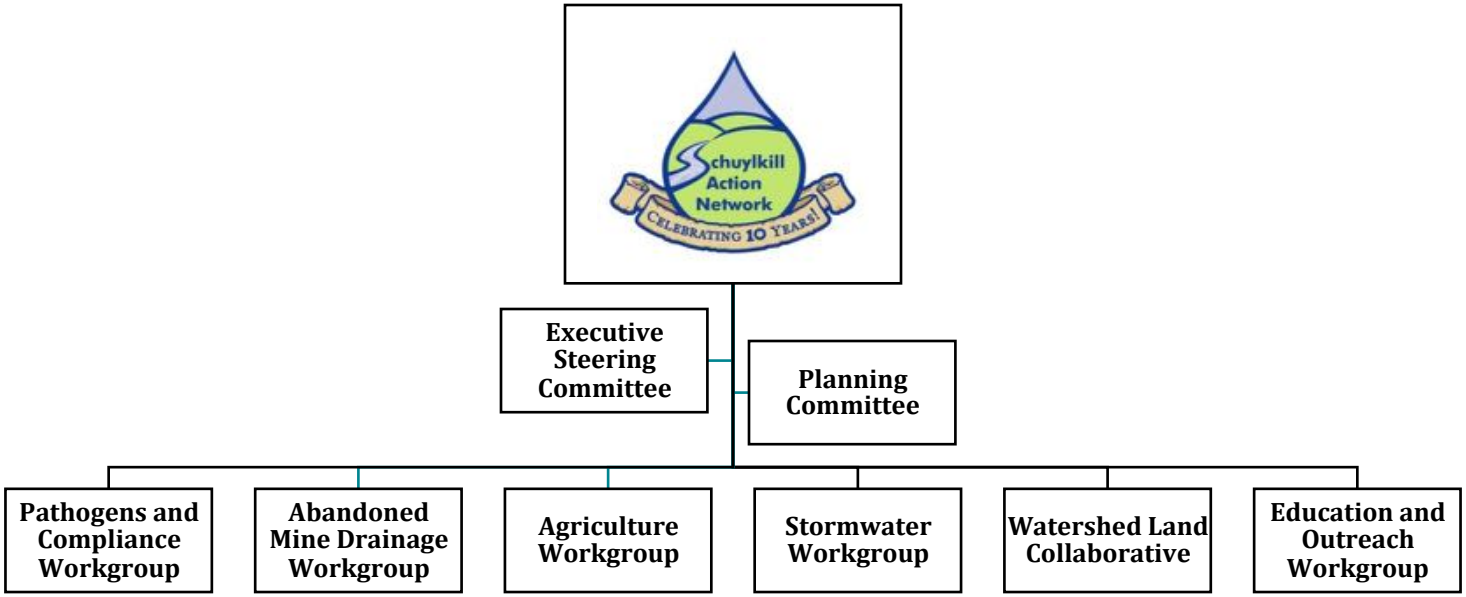
Schuylkill Action Network (SAN)

- The SAN was founded in 2003 by PWD, EPA, PADEP, Partnership for the Delaware Estuary and the Delaware River Basin Commission
- A watershed-wide organization with a mission to improve the water resources of the Schuylkill River watershed



- Through the SAN, PWD is able to support projects upstream to meet regulatory requirements and protect Philadelphia's drinking water source

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Water Quality

- Study and understand source water quality
- Which pollutants are of concern?
- Where are they coming from?
- How do we mitigate impacts?

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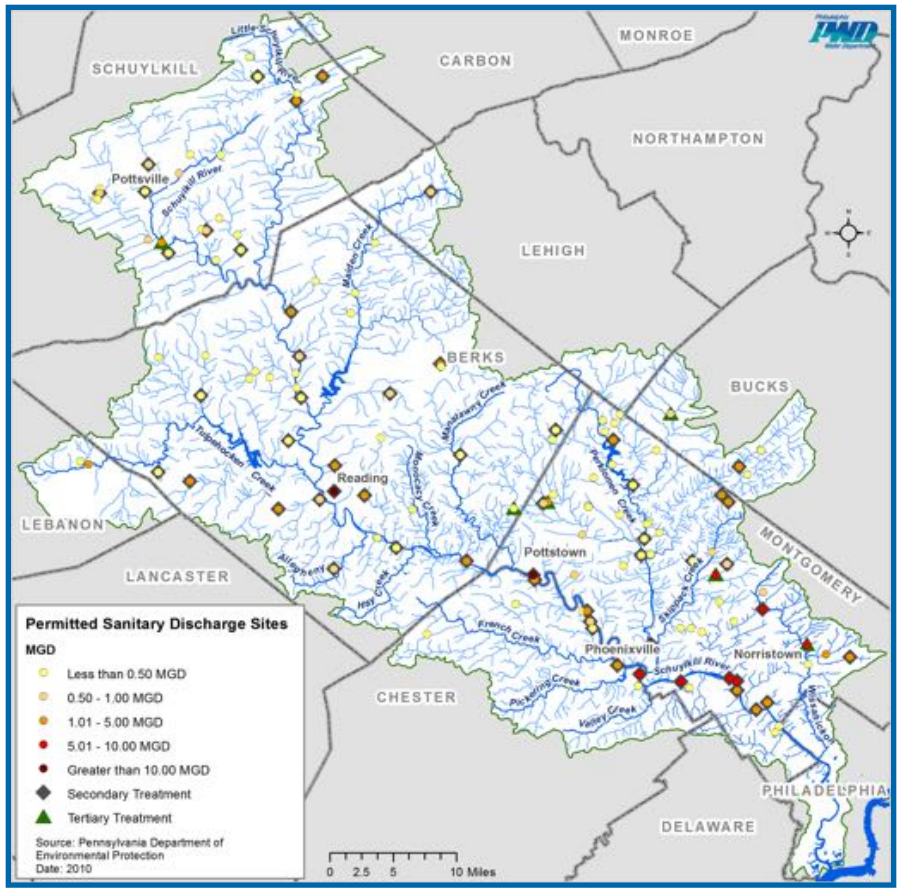
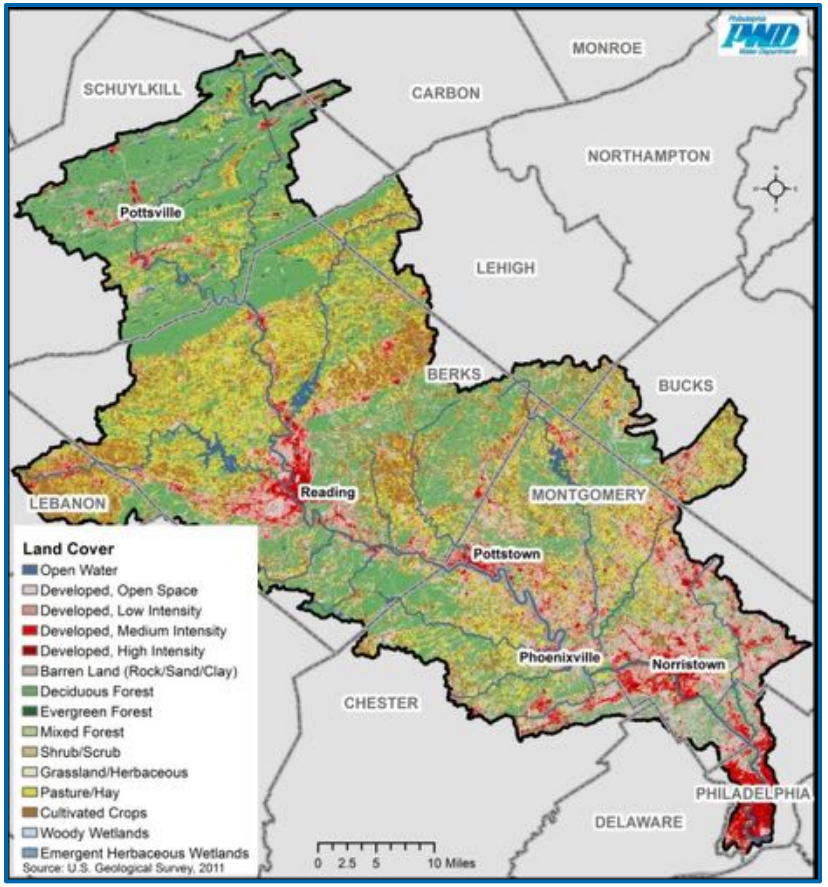
Schuylkill River Watershed: Sources of Pollution





Over 100 wastewater treatment plants discharge to the Schuylkill River watershed upstream of Philadelphia

Major Sources of non-point source pollution:

- Abandoned Mine Drainage
- Agriculture
- Stormwater Runoff

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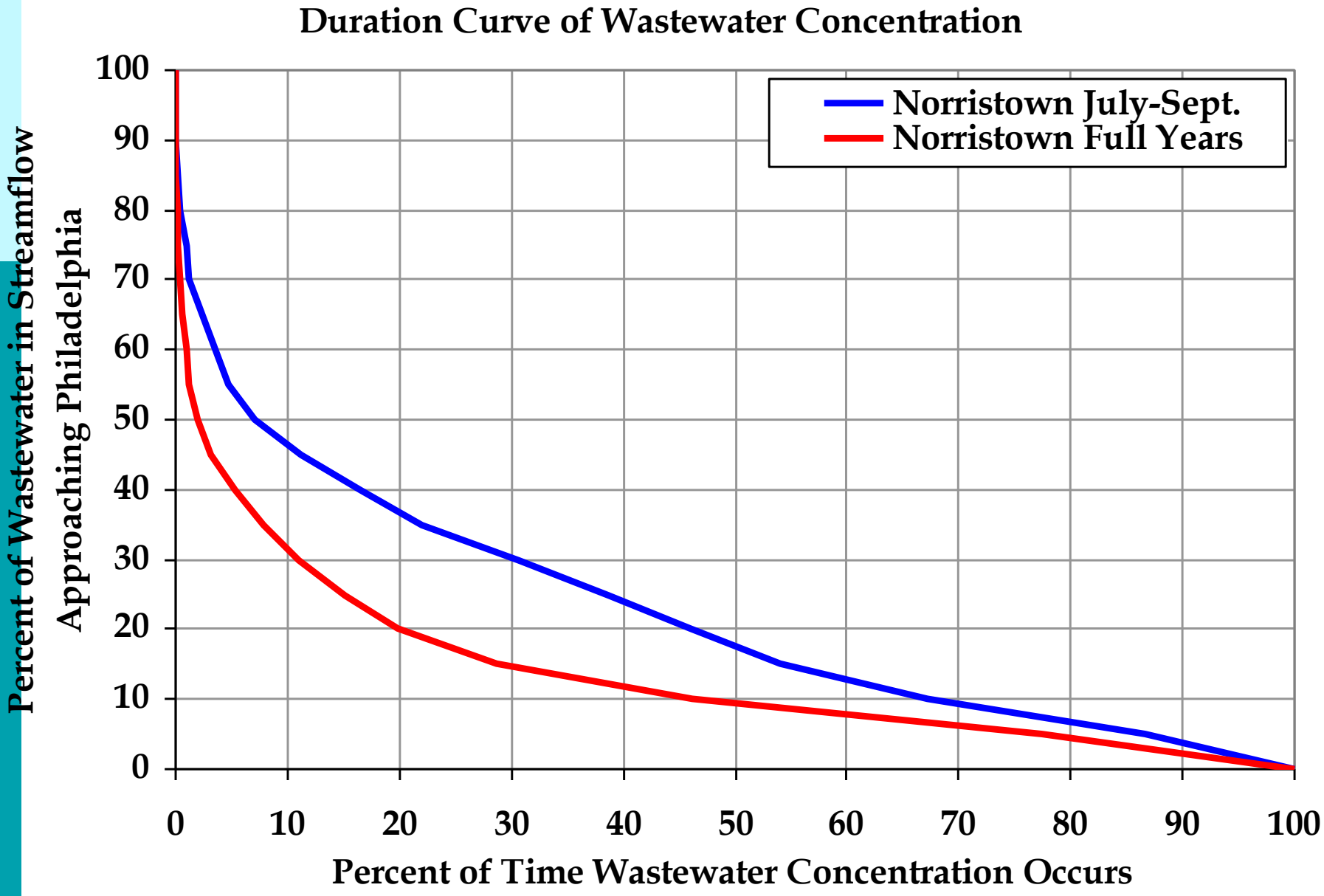

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Abandoned Mine Drainage

- Commercial coal mining began in Schuylkill River headwaters in 1820
- Over 100 abandoned mine drainage locations impacting the Upper Schuylkill River watershed
- Abandoned Mine Drainage Pollution
  - Iron sulfide-bearing materials exposed to oxygen in air and water during mining produce hydrogen sulfide
  - Acidic pH
  - Leaches metals from rock layers: aluminum, iron, manganese, calcium, magnesium
- Silver Creek AMD Treatment System

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Runoff from Agricultural Land

- About one third of the land area in Schuylkill River watershed is used for agriculture
- Pollution from agriculture runoff:
  - Nutrients
  - Pathogens
  - Sediment
  - Herbicides and pesticides
  - Fertilizers

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Funding Farm Improvements

Suburban Stormwater Runoff

- Stormwater Best Management Practices upstream support drinking water protection for Philadelphia
  - Rain gardens
  - Riparian buffers
  - Basin retrofits
- Schuylkill Action Network distributes stormwater management guides to communities upstream in the watershed

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Funding: The Restoration Fund

- Provides grants to support projects that improve and protect water quality in the Schuylkill River watershed
- Public-private partnership with contributions from:
  - Exelon
  - PWD
  - Partnership for Delaware Estuary
  - Aqua

Leveraging Funds for Watershed Improvements

In 2013, for every $1 of PWD's annual contribution to the SRRF….approximately $30 from federal state, local and private sources went towards SAN priority projects.

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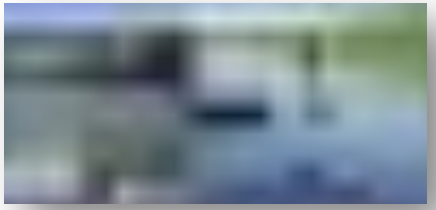
And when you can't manage…

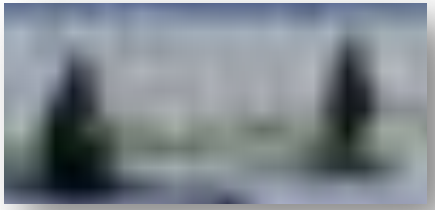
- Predict and respond

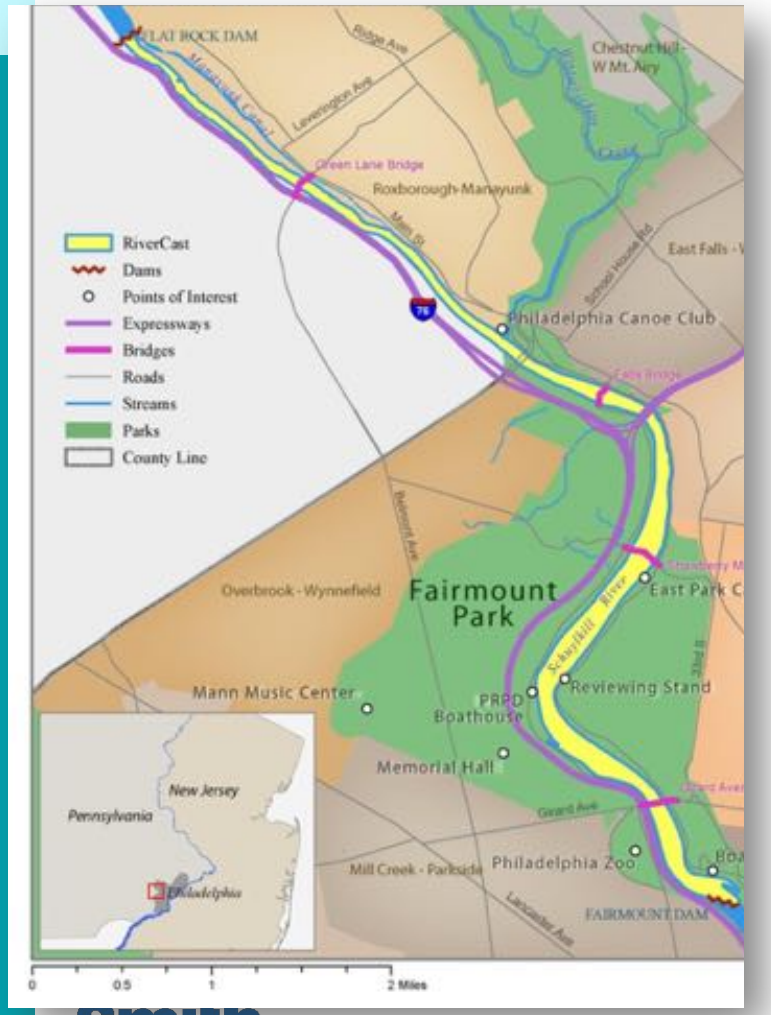
Pollution Events do happen!

Philly RiverCast

PhillyRiverCast.org







A public health bacteria-forecasting tool for recreational activity in the Schuylkill River

Algorithm based on real-time turbidity, flow, and precipitation generates

RED, YELLOW, or GREEN ratings

Ratings are based on EPA health-based recommendations for water recreation:

HIGH	ELEVATED	LOW

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Delaware Valley
Early Warning System

Partnership of Water Suppliers, Industries, and Regulatory Agencies

River Contamination Report

System-Generated Notifications

Real-Time Water Quality Monitoring

DATABASE

SECURE WEBSITE
- Event and Water Quality Data
- Spill Routing/Arrival Times
- Spill Simulation Tool

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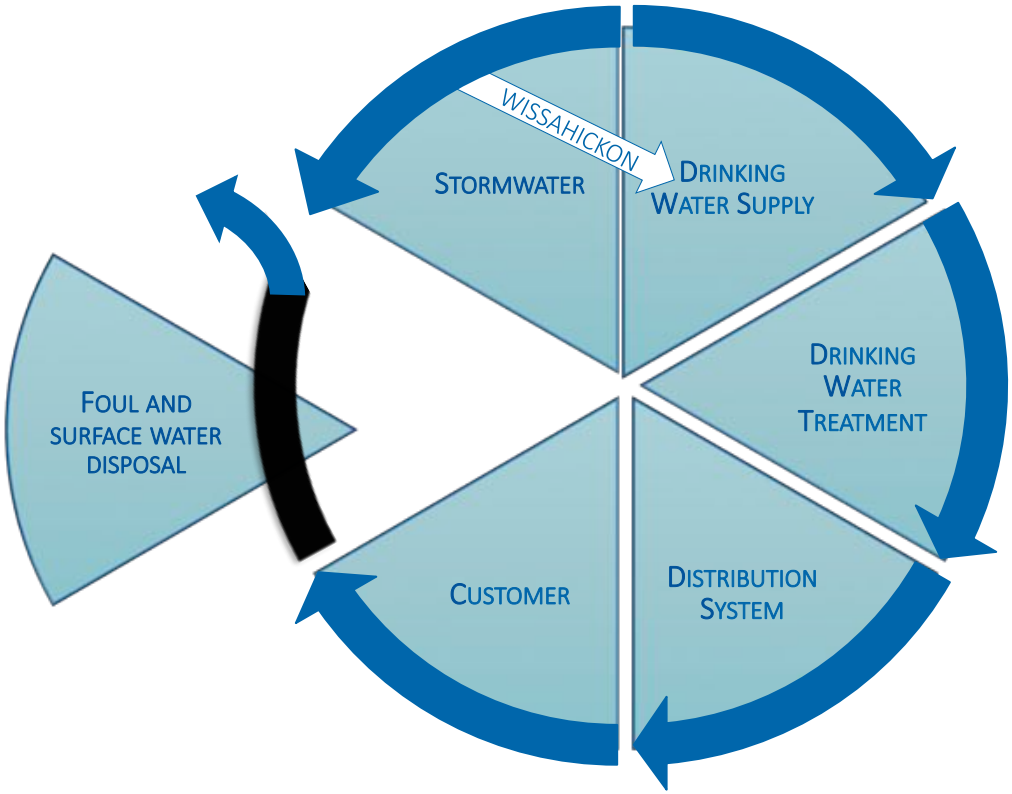
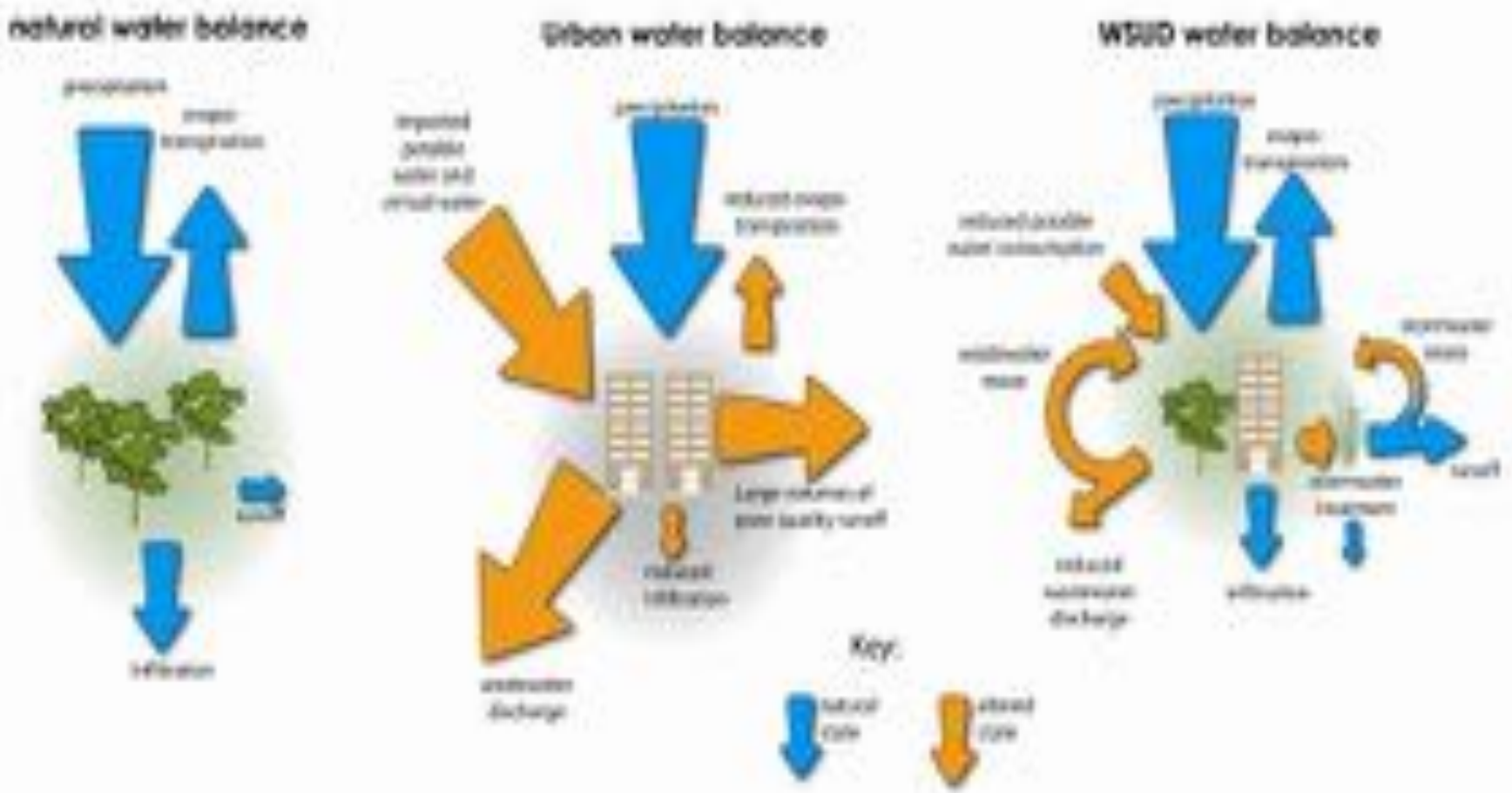
PWD's 'One-Water' Approach




natural water balance
Urban water balance
WSUD water balance
Key:

Storm and foul water: the end of the urban cycle

What happens to our “used” drinking water (now “foul water”?

What about that dirty surface water runoff?

In Philadelphia, some parts of the city combined in sewers. Other parts, handled in separate sewers

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Rome 2015:
Built 50 BC

We have had 2000 years to advance our urban drainage technology

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Rome 2015:
Built 50 BC

Philadelphia 2015:
Built 1900 AD

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We can't always manage the rain!

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Our Sewers can’t always manage either

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Our New Approach: Green City, Clean Waters

Green Stormwater Infrastructure

$1.67 billion

Wet Weather Treatment Plant Upgrades

$345 million

Collection System Optimization

$420 million

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Optimize sewers that you have

- Look for collection system constrictions and remove
- Line the sewers to increase capacity, reduce infiltration and inflow
- Keep clear of grit

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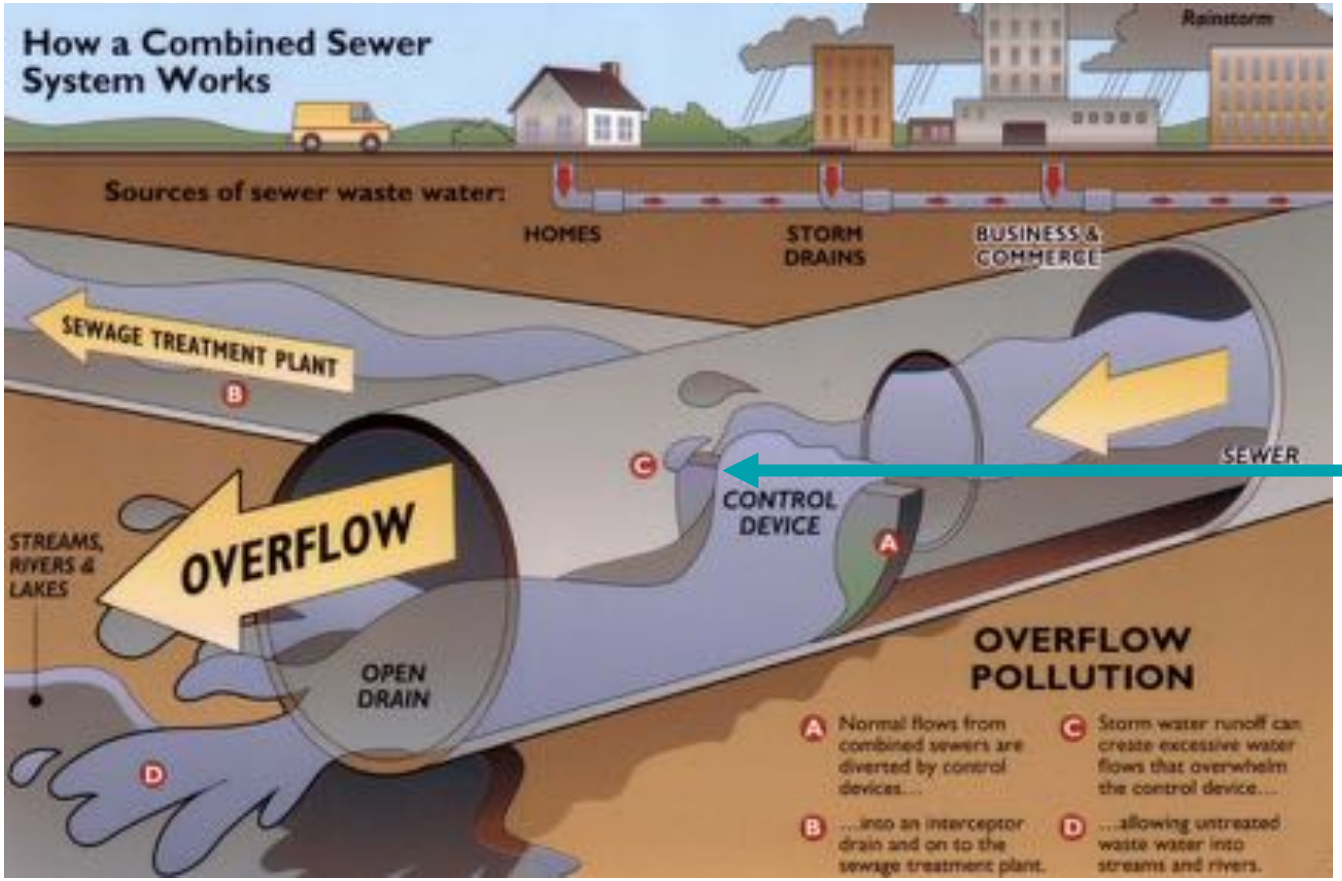
Optimize flow between overflow pipe and pipe to treatment works



Control Device can be optimized

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Optimize sewers that you have

- Balance regulator chambers (this avoids too much flow in some chambers, too little in others) by controlling dam height, overflow pipe diameter

- Use real time control where possible (this allows the chambers to be controlled depending on when and how hard the rain falls)

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Then: reduce the inflow

- Once system is optimized, look to reduce the surface water flows into the sewer system
- This is the Green Stormwater Infrastructure or Sustainable Drainage Approach
- In Philadelphia, the program is called Green City Clean Waters

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Some Challenges of a major Sustainable Urban Drainage program

- What does it take to implement on this scale?
- Where can we find that much “green opportunity”?
- How can we convince the regulatory agencies that it works?
- How do we keep improving?
- How do we keep the systems working?

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Challenges of a major LID program

- What does it take to implement on this scale?
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Program 5-year Ramp Up

- The SUDs program is not static, but growing at an increasing pace
- This is fundamentally different from other PWD functions (water, wastewater)

- PWD started from scratch, and needed to build a production system to plan, design, and build GSI projects
- Production of between 500 and 1000 projects per year

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The PWD Approach

- How can a utility make this happen?
  - Add new core service: GSI Implementation
  - Create a whole new Division Structure that matches the key program elements
  - Staff it with about 50 PWD staff and 35 in-house consultant staff
  - Contract out to multiple planning and design firms

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Challenges of a major program

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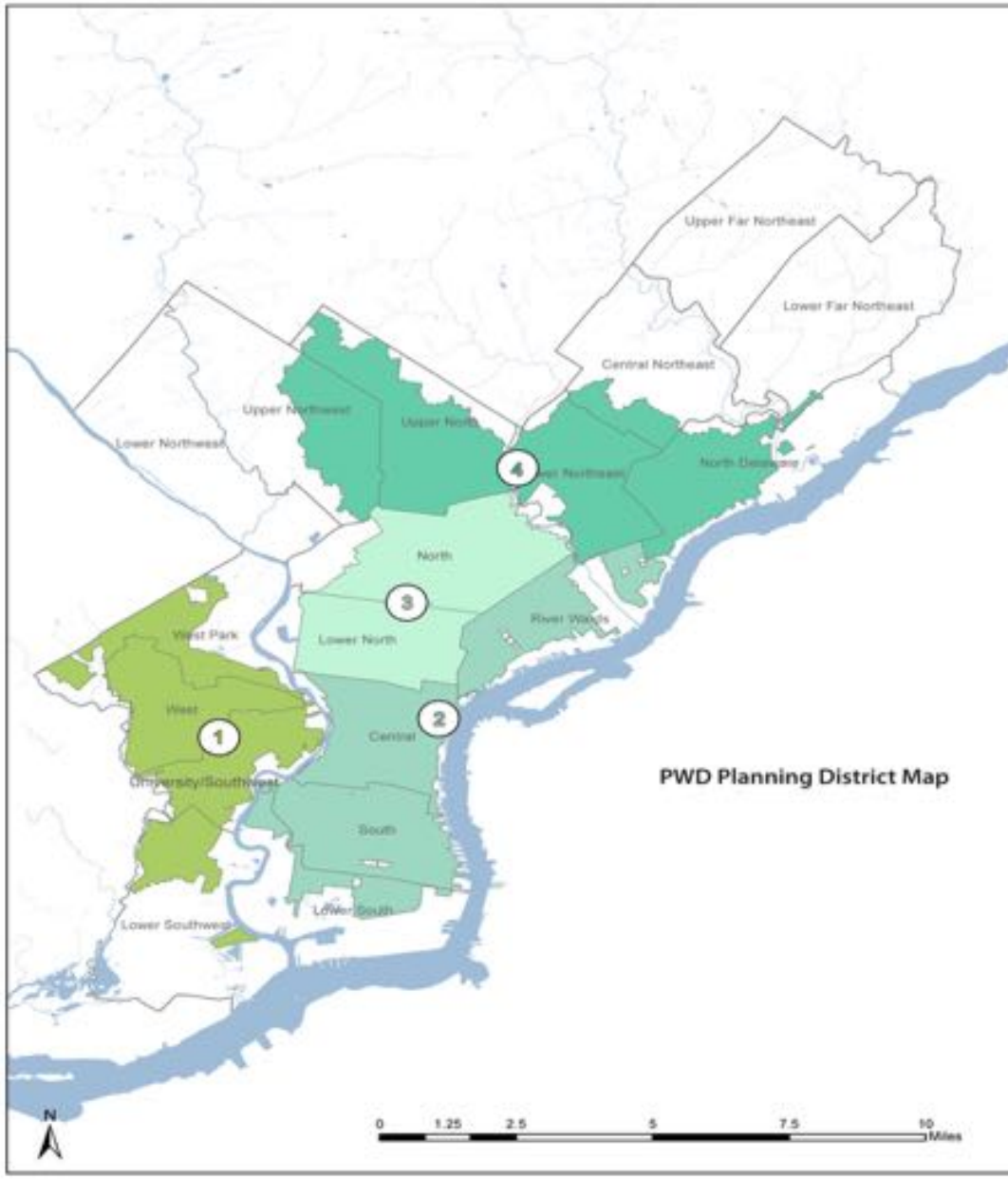
Planning

based on district and district teams

*physical opportunities
*lack of policy constraints
*potential partners
*following City Planning initiatives

*10 contract planning teams



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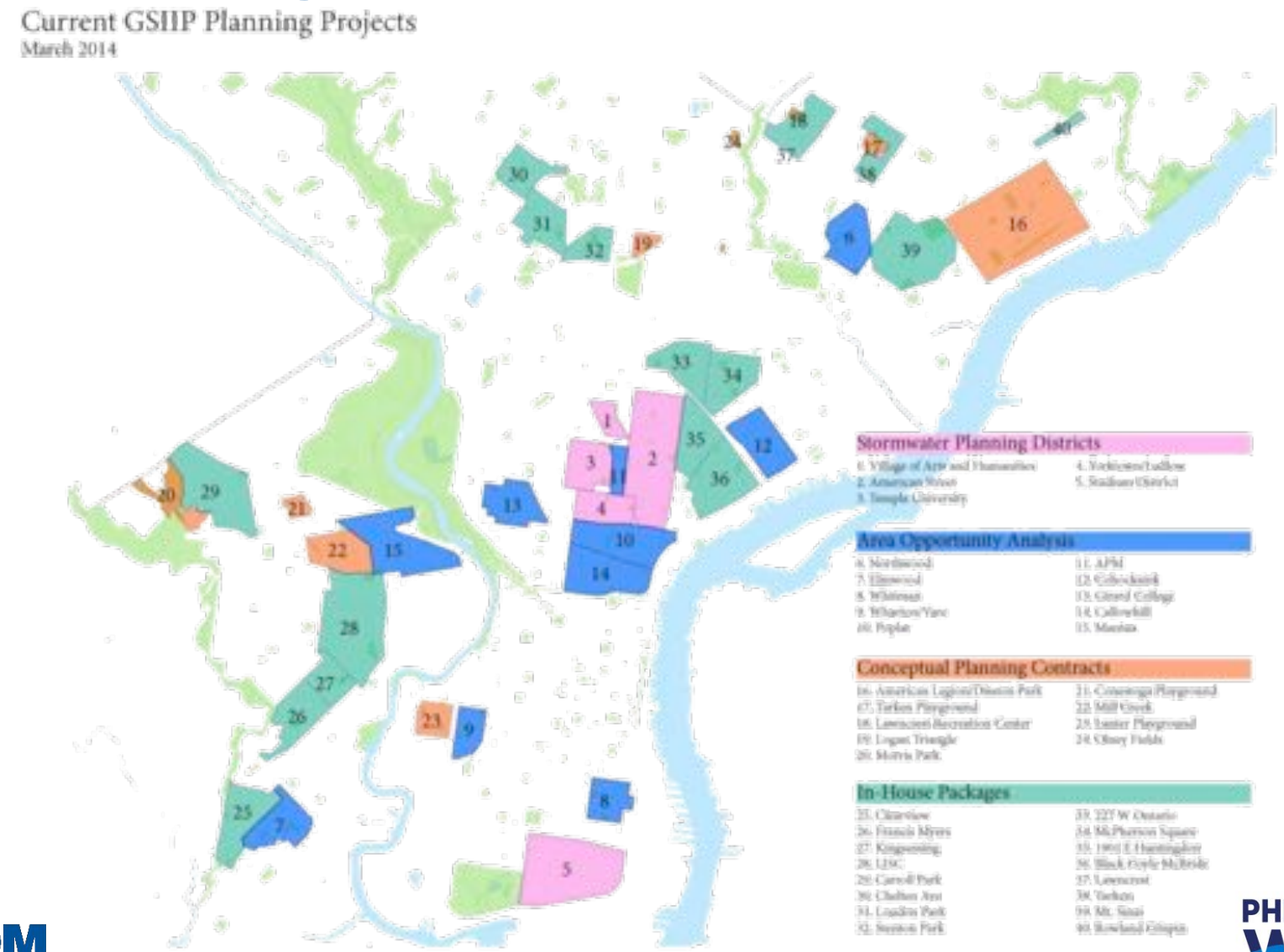
Planning



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Design

Tools:

- Evaporation
- Transpiration
- Infiltration
- Water harvesting
- Interception
- Storage

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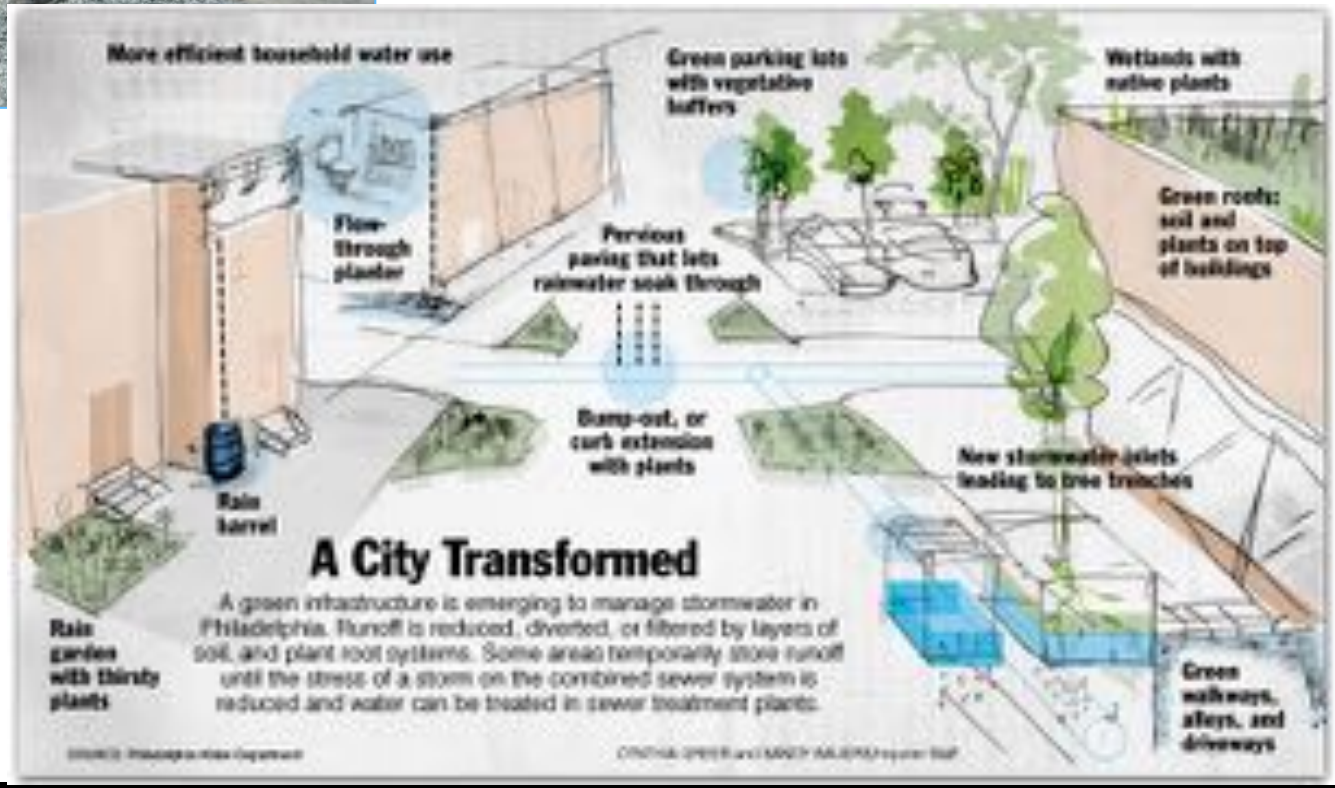
Design

- In-house design team
- Designers aligned with district planners by district
- 8 contract design teams



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Strategic Policy & Coordination Solving Impediments on the fly

- Identify and remove implementation hurdles (legal, policy, financial)
- Capital alignment with other city agency investments
- Create and develop partnerships with city agencies, non-city public agencies and private partners

Challenges of a major program

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Capital Planning & Regulatory Compliance a staff focused on compliance

- Support of permit and regulatory negotiations
- Compliance Assurance
  - Deliverables
  - Annual Reports
- Compliance Tracking and projections
  - Green City, Clean Waters Volume and Mass
  - Risk analyses
- Development of Evaluation and Adaptation Plans (EAP)

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Comprehensive Monitoring

- PWD's Program for monitoring and assessing:
  - Surface Waters: biological, chemical, physical
  - Groundwater: groundwater levels
  - Rainfall: 23 stations, radar data
  - Collection system flow monitoring

  - Green Infrastructure Performance: site level monitoring

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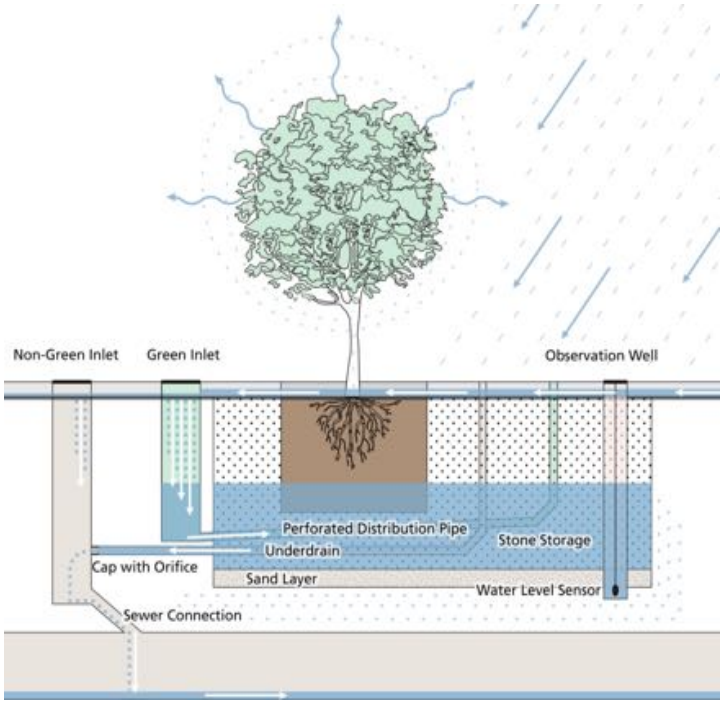
GSI Monitoring

- GSI project sites being actively monitored
  - Pressure transducers in monitoring wells
  - Water level logging stations (Tree Trench, Porous Pavement, Infiltration Trench
- Barometric Pressure Stations
- Rain Gages
- Groundwater Wells



PilotDB 0.2

Main | Problem systems | Systems summary | System events summary | Event data | System analysis | ANOVA

System

19 (Hartranft School)

Event filter

All events

Event

2013-06-06 18:30

- 2013-04-19 20:15
- 2013-05-07 20:45
- 2013-05-10 21:30
- 2013-05-23 14:45
- 2013-06-02 23:00
- 2013-06-06 18:30
- 2013-06-10 06:00
- 2013-06-13 08:30

Quality Assurance

Flag

Good

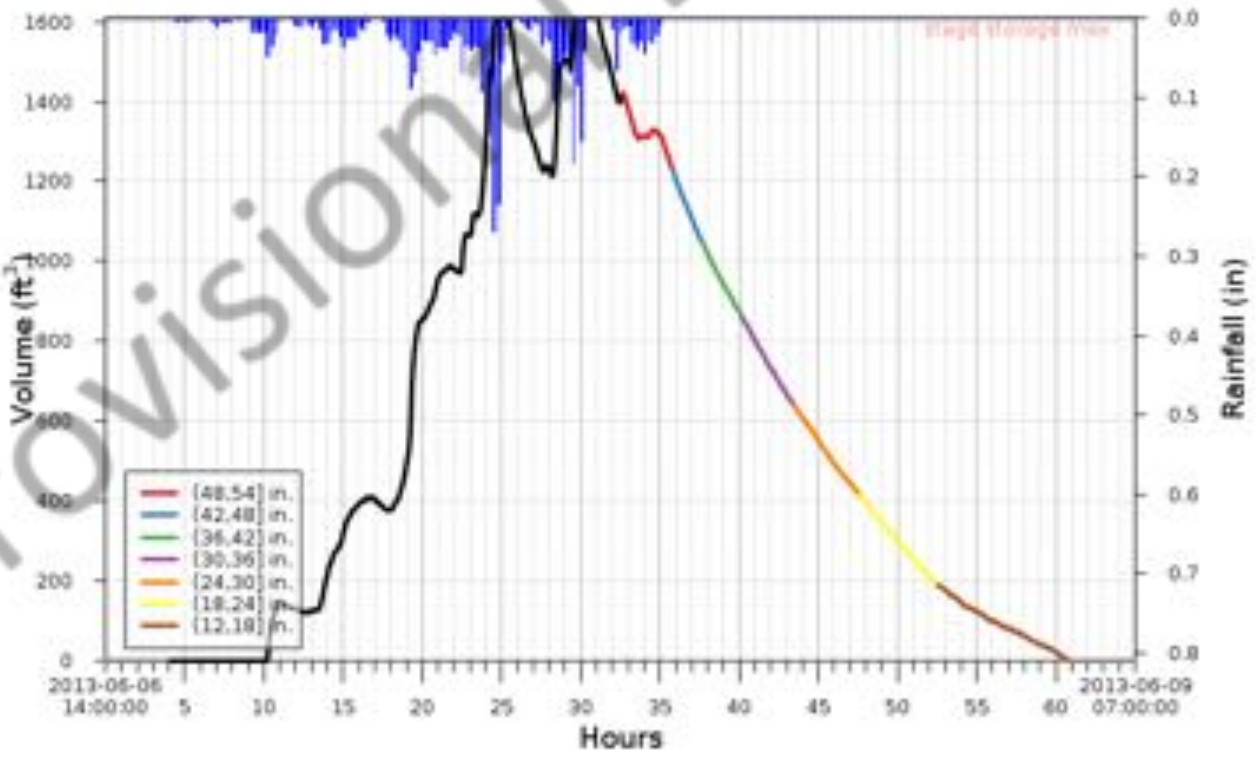
pilotdb's comment

Update

Metrics

recession_rate_in_hr	vpr	ssr	total_rainfall_in
1.52	3.75	1.00	3.76

Volume



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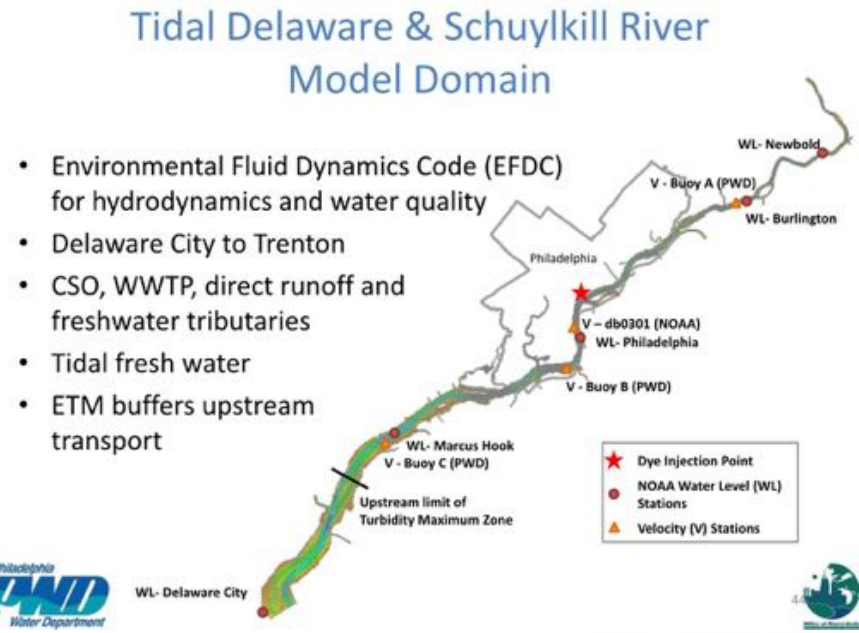
Surface Water Investigation & Modeling

- Forecasting effect of GCCW on meeting bacteria and DO standards in tidal receiving waters, and local tributaries

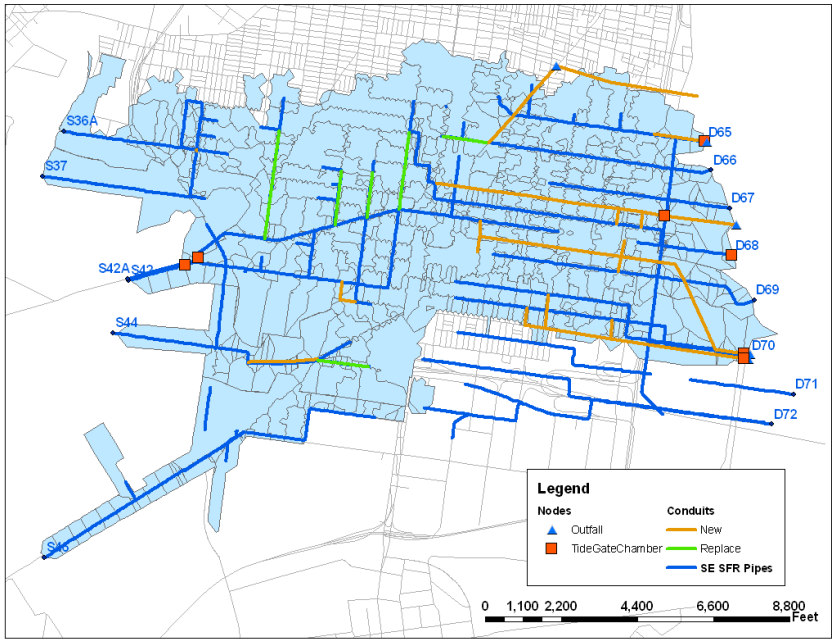
- Detailed understanding of discharge plumes

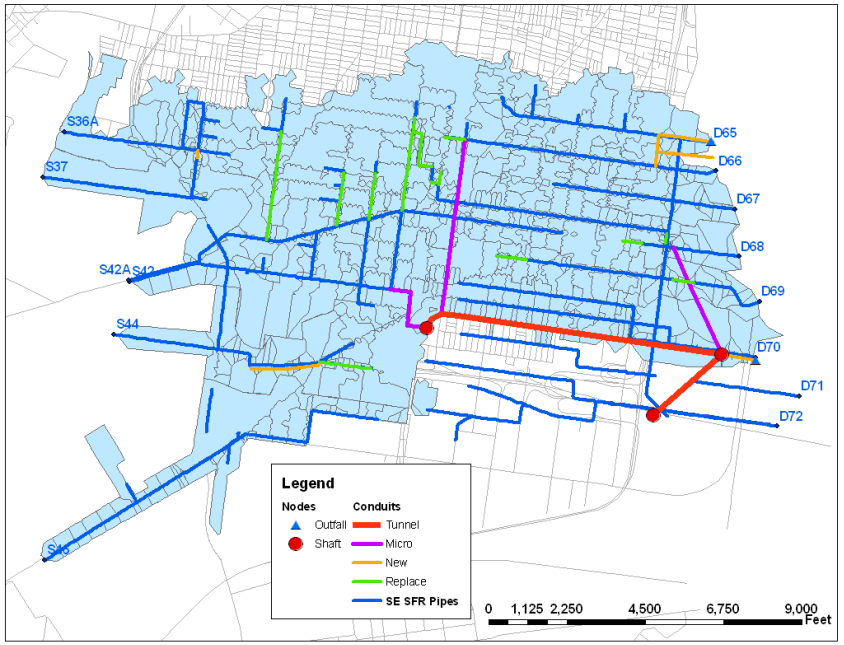
- Effects on receiving waters, and source water intakes



Hydrologic & Hydraulic Modeling

- Technical support group of 6 to 8 modelers for compliance assurance (CSO & stormwater)
- Hydrologic & Hydraulic data management and analyses
- model simulations for design, tracking, and compliance





Challenges of a major program

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Create a Piloting and Research Group

- Identify pilot variables that affect implementation
- Target projects for piloting and research
- Analyze data to assess and improve effectiveness
- Perform site specific research on designs, materials
- Work with local universities for grant funding and coordinated GSI research

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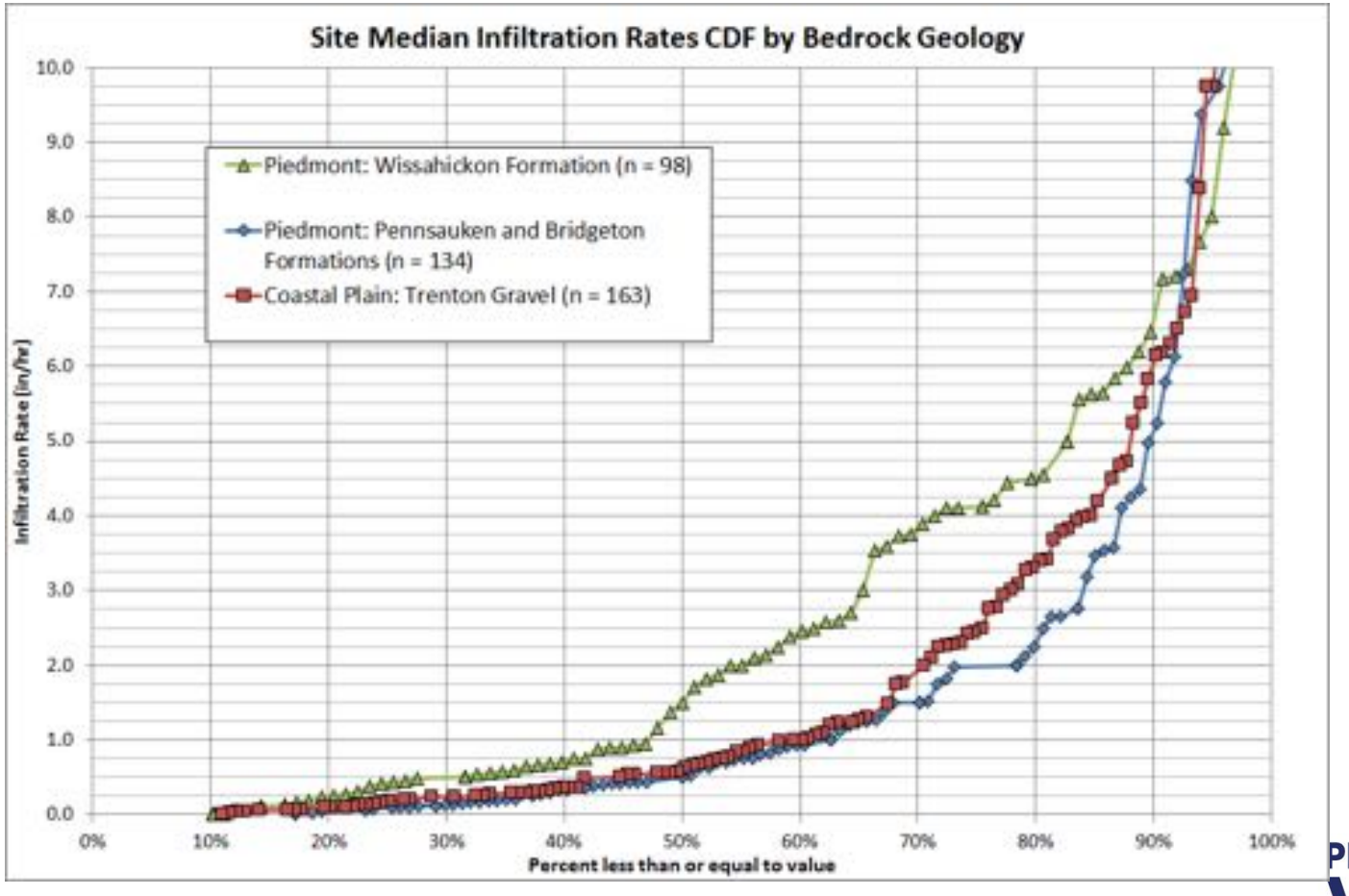
Focus: applied, practical research



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GSI Maintenance

- Maintenance Split between Private and Public Projects
  - Private Projects: 40 year maintenance agreement must be signed
    - construction inspectors at site
    - enforcement unit to make sure projects remain active
  - Public Projects:
    - Develop a maintenance unit within PWD

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Contracted Maintenance

- Trash and sediment removal
- Weeding, pruning, etc.
- New product testing
- Structural repairs
- Erosion control
- Reseeding
- Watering

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PWD Maintenance

Video Inspection

Inlet Cleaning

Pipe Flushing

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So how are we doing?

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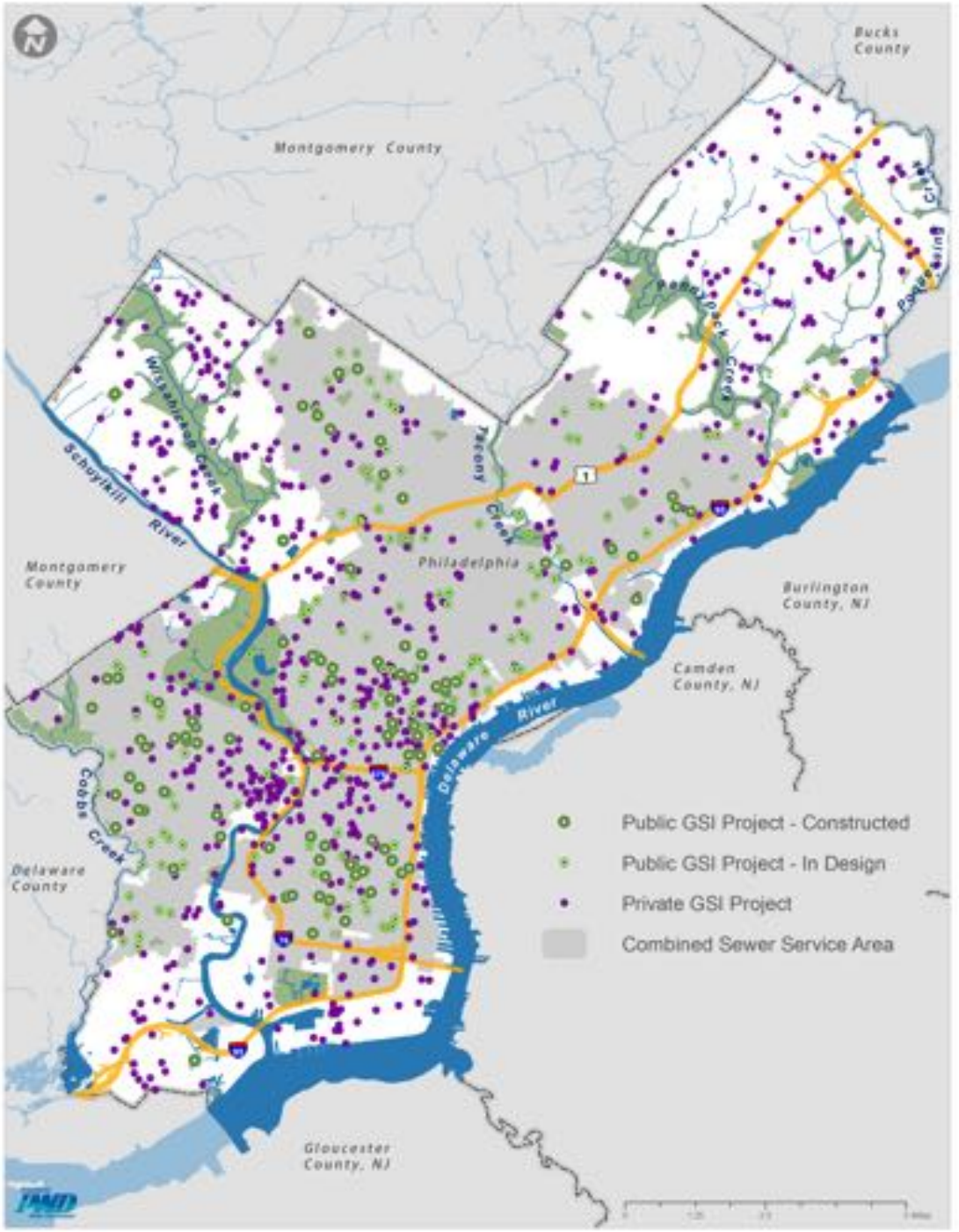
Ever Increasing number of projects, and this only year 4!



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Making a difference on the ground

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We can go small

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Or Large: 28th and Passyunk

28th and Passyunk

Womrath

Womrath

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With the occasional misstep

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Is there enough space?

- It doesn’t necessarily mean using up space (single purpose)
- It means repurposing existing space

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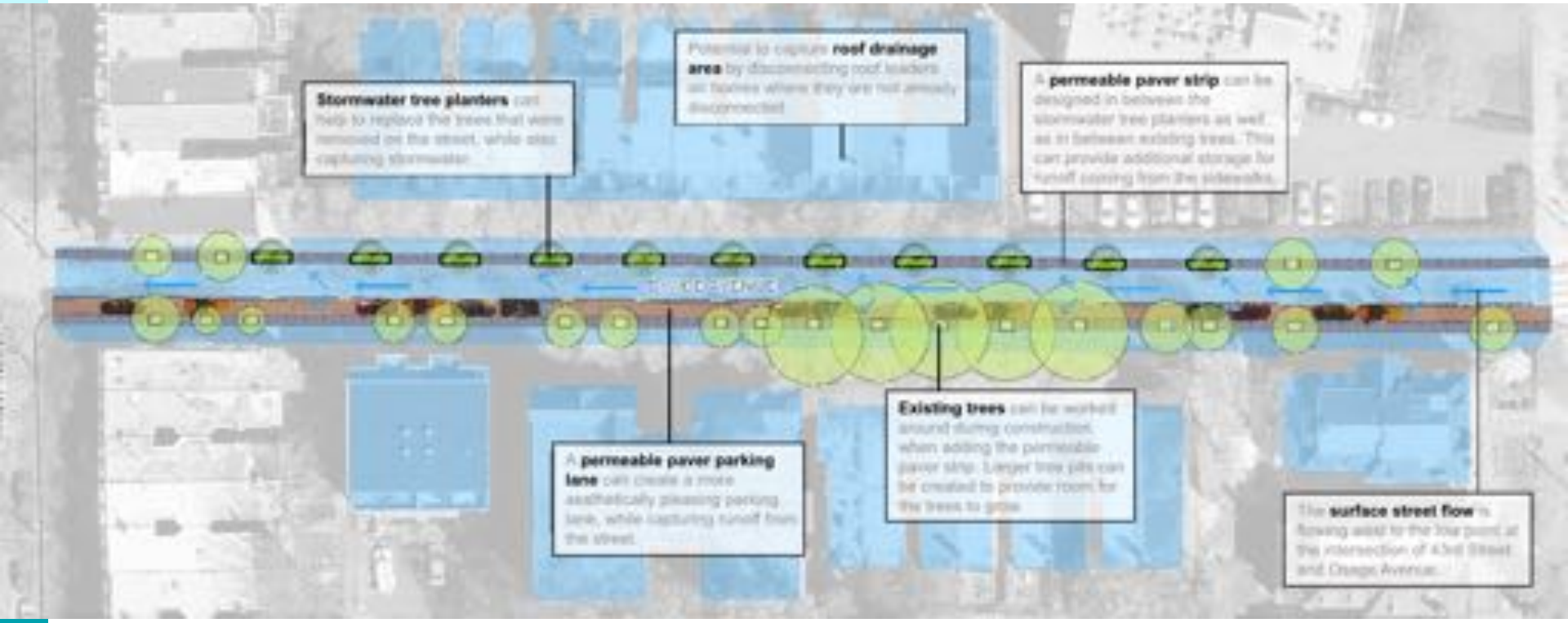
50109 – Osage Ave. from 42nd St. to 43rd St.



Rain Garden

Pervious Pavement

Stormwater Wetland

Stormwater Tree Trench

Stormwater Planter

Stormwater Bump-out

Green Roof

Rain Barrel

Flow-Through Planter

Cost

- The inevitable question: what does it cost to "manage" the urban part of the cycle with green?
- How do we pay for it
- Multiple ways….
- Focus on some of the newer mechanisms

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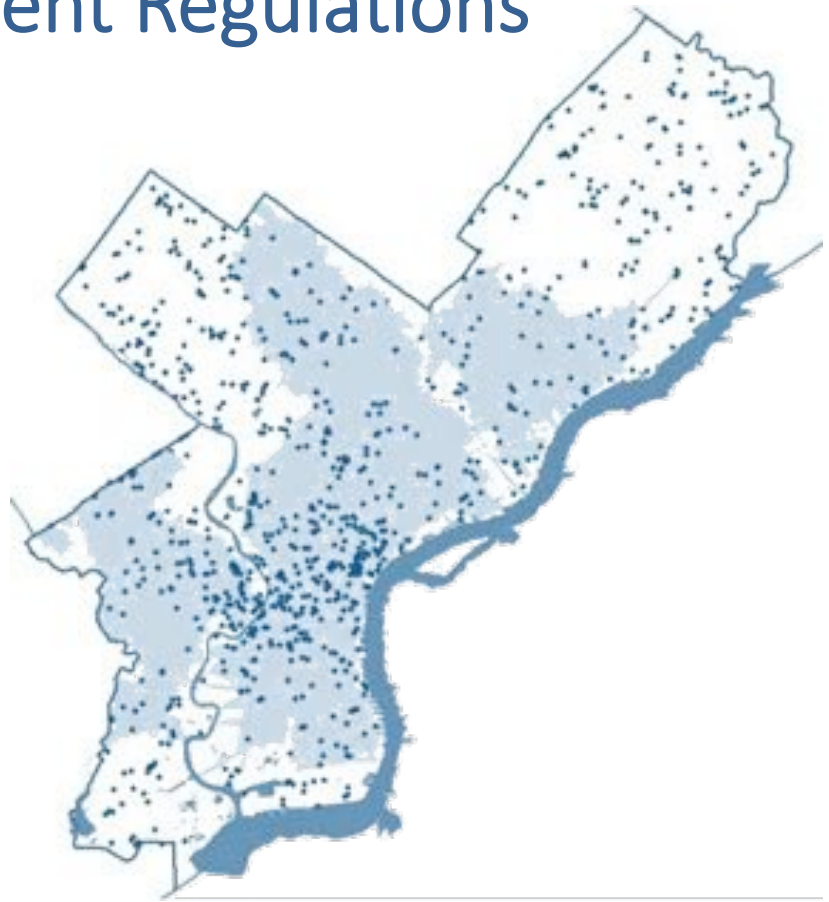
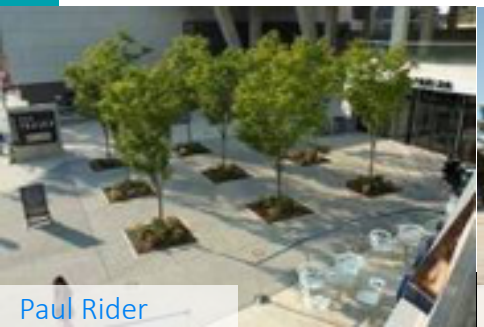
Stormwater Development Regulations

Since 2006,
nearly 500 development projects
have been approved

Managing over **1.5 billion gallons**
of rainfall annually




Paul Rider


Paul Rider


Dan Reed


Marissa Huber

Stormwater Credits

PWD offers up to 80% credit on stormwater bills for the management of 1” of stormwater

Two new funding mechanisms: SMIP and GARP

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Stormwater Management Incentives Program

- Financial assistance for constructing systems that manage private property runoff: single property approach
- Grantees are eligible to receive stormwater fee credits
- Grantees are required to execute an Operations & Maintenance Agreement
- Any non-residential or multi-family residential property eligible
- 36 projects approved to date

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Stormwater Management Incentive Program (SMIP) Facts & Figures

- **Total Estimated Cost to PWD: $15.2 million**
- **Greened Acres : 205**
- **Estimated PWD Cost Per Acre: $75,000**

  (Not Including Billing Credits)

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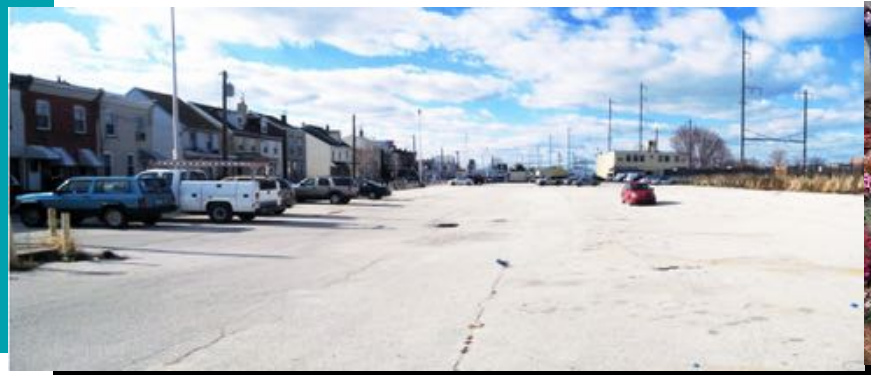
Greene Street Friends School

Greened Acre Retrofit Program: our newest financing approach

- Targeted CSO program to streamline **large-scale GA construction on private property**
- Agreement with private sector aggregator of properties for retrofit
- Unlike SMIP, GARP is direct agreement between City and project aggregator allowing for more administrative ease, saving time and money
- Allows PWD to attract a wider audience, not just property owners



BIGGEST THING, IT TAKES A "VILLAGE"

OR A LOT OF PARTNERS….

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Green Infrastructure Policy & Partnerships

PARTNERSHIP PROGRAMS

1. Green Streets with Streets Dept.
2. Green Schools with Schools Dept.
3. Parks and Recreation Centers with Parks Dept.
4. Vacant Lands (with Properties Dept.)
5. Strategic Partners: Temple, SEPTA,
6. Private Development: Green Streets buy backs
7. With homeowners: Rooftop Disconnection & Green Alleys

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In Summary

- *Integrated total Managing* for a city's urban water system is a series of steps:
- Philadelphia is doing all it can:
  - Studying and Understanding the entire urban water cycle
  - Predicting Effects on source water and collection system
  - Preparing to manage most storms
  - Responding when storms are too big
  - Adapting the program to climate change
  - Mitigating the effects of urbanization on its waterways through both green and grey projects

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Concluding Thoughts

- Philadelphia's 25-year Green City Clean Waters program is a major new core function for the Water Department
- An entire Office of Watersheds created with:
  - 7 New units
  - Over 50 PWD in-house staff
  - Over 35 in-house consulting support staff
  - 18 contract planning, design, and maintenance contractors

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Concluding Thoughts

- Philadelphia's approach is the leading edge of a new paradigm in **urban** stormwater management (source control, infiltration, reuse)
- Don't underestimate the degree of commitment
- Embrace the need to accept great change, new assignments and skills, and high visibility.

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Last thought: don't be afraid of change

You have to go out on limb sometimes because that is where the fruit is.

CSO Comparison: London and Philadelphia

	Philadelphia	London
Overflows per year	0 - 55	0 - 60
Area (sq. km)	370	1710
% of impervious cover	48% (citywide)	54% (Becton), 24% (Crossness)
# of Combined Sewer Outfalls:	166	57
Estimated Annual CSO Volume (million m^3)	61	39
Rain Events per Year:	80	164
Rainfall per year (Inches)	45	23

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