Environmental Protection

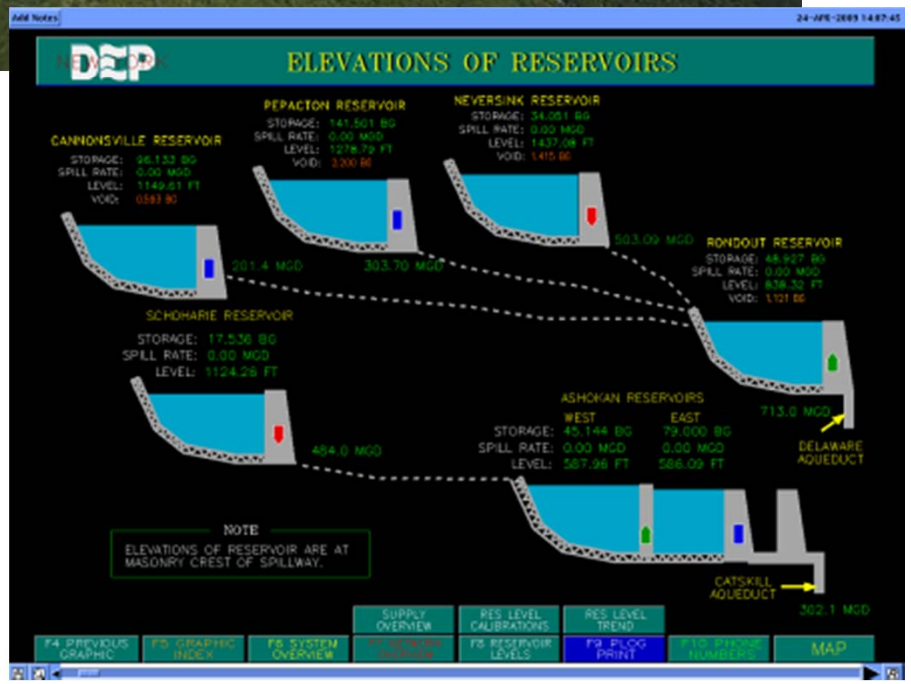
New York City's Operations Support Tool (OST)

Delaware River Basin RFAC Meeting

December 14, 2010

Presentation Outline

- What is OST?
- Background
- OST Components
- Forecasts
- OST Usage
- OST vs. Safe Yield
- Project Schedule



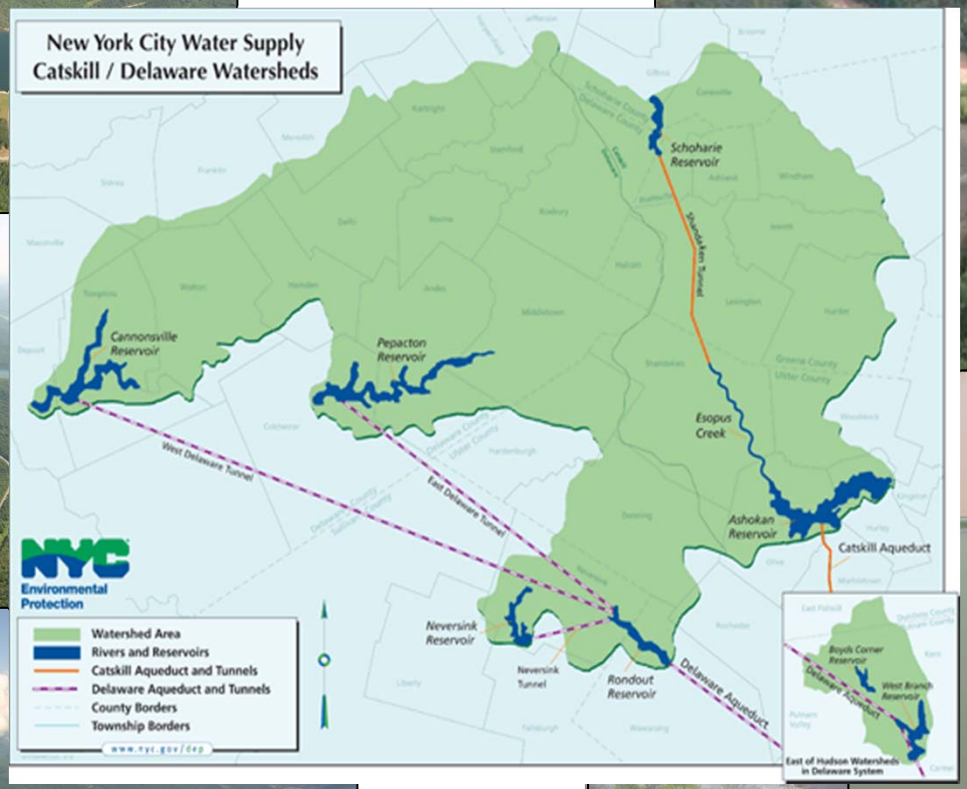
What is OST?

- Decision Support System
  - ***quantifies*** performance of alternative operations
  - help make operating decisions
- Provides robust quantitative assessment of:
  - Expected inflows
  - Diversion needs
  - Release requirements
  - Storage levels
  - Drought risk

- Better defines capacity of the system to meet water quality and environmental objectives
  - Maximize additional benefits while maintaining water supply reliability
  - More robust water quality-based operation

- **DOES NOT** tell operators what to do
- **DOES** help operators examine how they can best meet multiple objectives
- **DOES** provide quantitative basis for decision-making

Background


New York City Water Supply
Catskill / Delaware Watersheds
Schoharie Reservoir
Schoharie Tunnel
Cannonsville Reservoir
Pepacton Reservoir
West Delaware Tunnel
East Delaware Tunnel
Esopus Creek
Ashokan Reservoir
Catskill Aqueduct
Neversink Reservoir
Neversink Tunnel
Rondout Reservoir
Delaware Aqueduct
NYC Environmental Protection
Watershed Area
Rivers and Reservoirs
Catskill Aqueduct and Tunnels
Delaware Aqueduct and Tunnels
County Borders
Township Borders
www.nyc.gov/dep
Boyds Corner Reservoir
West Branch Reservoir
East of Hudson Watersheds in Delaware System

New York City Water Supply

- 3 systems – Delaware, Catskill, and Croton
- 19 reservoirs & 3 controlled lakes
- 2,000 square mile watershed in parts of 8 upstate counties
- Serves 9 million people (1/2 of population of New York State)
- Delivers ~ 1.1 billion gallons per day
- 45% of demand met by Delaware basin reservoirs
- Unfiltered supply (Cat/Del)

Operational Challenges

- Complex system
  - 19 reservoirs
  - Design allows flexibility
  - Infrastructure service
  - New infrastructure
- Multiple Objectives
  - Water supply reliability
  - Highest quality water
  - Environmental benefits
  - Spill mitigation
- Complex rules
  - Delaware Basin rules
  - Part 670 & SPDES
  - Croton System

OST Impetus

- Catskill System turbidity control
  - Reduce frequency/duration of alum treatment
  - Filtration Avoidance Determination (FAD)
    - Granted 1997, renewed 2002, 2007
    - Catskill System turbidity a major concern
    - 2007 FAD *required* OST be part of turbidity management

Enhanced System-wide Operations

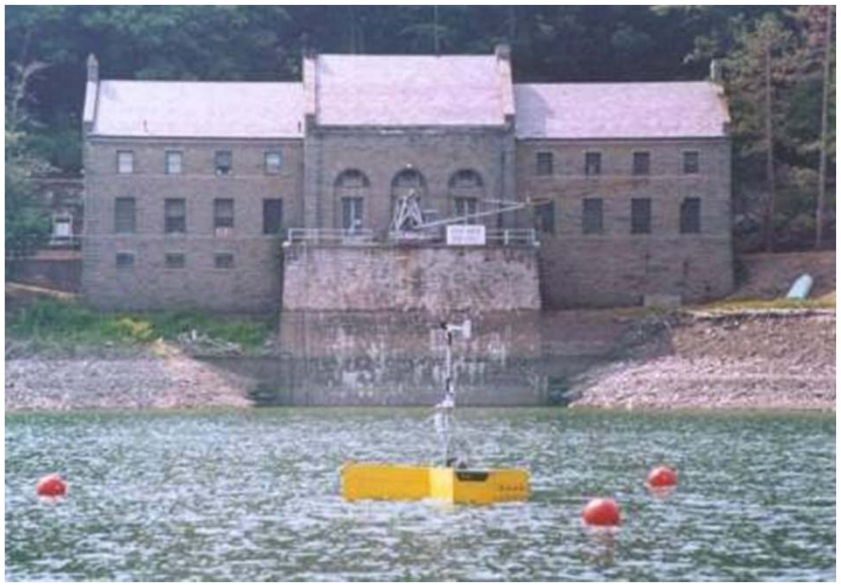
- OST will provide decision support for *entire* NYC system
  - Delaware Basin releases
  - Peak flow mitigation (snowpack management)
  - Planning for major facility outages
  - Support for emergency / contaminate spill response
  - Delaware and Catskill Shaft 4 interconnection
  - Catskill – Delaware Ultraviolet Facility
  - Croton Filtration Plant
  - Advanced warning of turbidity events via forecasts
  - Simulate turbidity control strategies in near-real time
- OST will help address multiple water quality and environmental objectives while still fulfilling core water supply reliability requirements

Water Supply Reliability: Quantity

- Priority: meet water supply needs
- Goal: ensure overall system reliability
  - Reservoirs full at start of drawdown (~ June 1)
  - Balance reservoir drawdown
  - Considerations:
    - probability of refill
    - release requirements
    - economics
    - infrastructure
- OST can help quantify risk

Water Supply Reliability: Quality

- Priority: meet water supply needs
- Goal: provide highest quality water
  - Extensive real-time monitoring
  - Response to turbidity events, chemical spills
- OST can help quantify risk

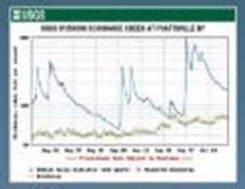


Environmental Objectives

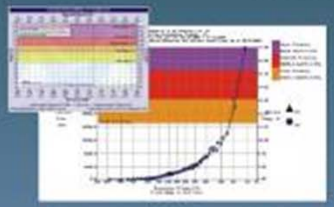
- NYC reservoirs provide benefits to downstream interests
- Regulatory Framework
  - 1954 Supreme Court Decree
  - FFMP
  - NYCRR Parts 670-672
- Potential for OST to provide additional releases to benefit downstream interests

OST Components

Near Real Time Data Sources



USGS Streamflow Data



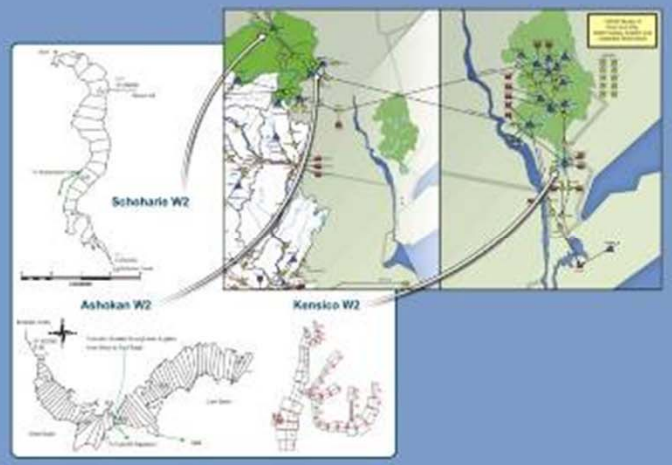
National Weather Service Forecast Data

NYCDEP SCADA Data

NYCDEP Keypoint Water Quality Data

Near Real Time Network Water Quality Data

OASIS W-2 Model



OST Databases

Raw Data

Automated QA/QC

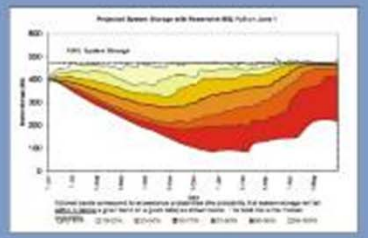
Clean Data

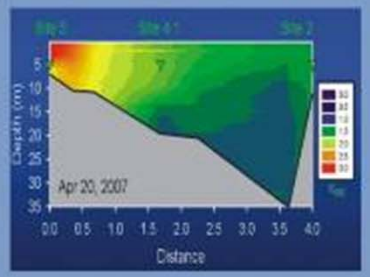
Automated Model Input

Model Output

Archived Historical Data

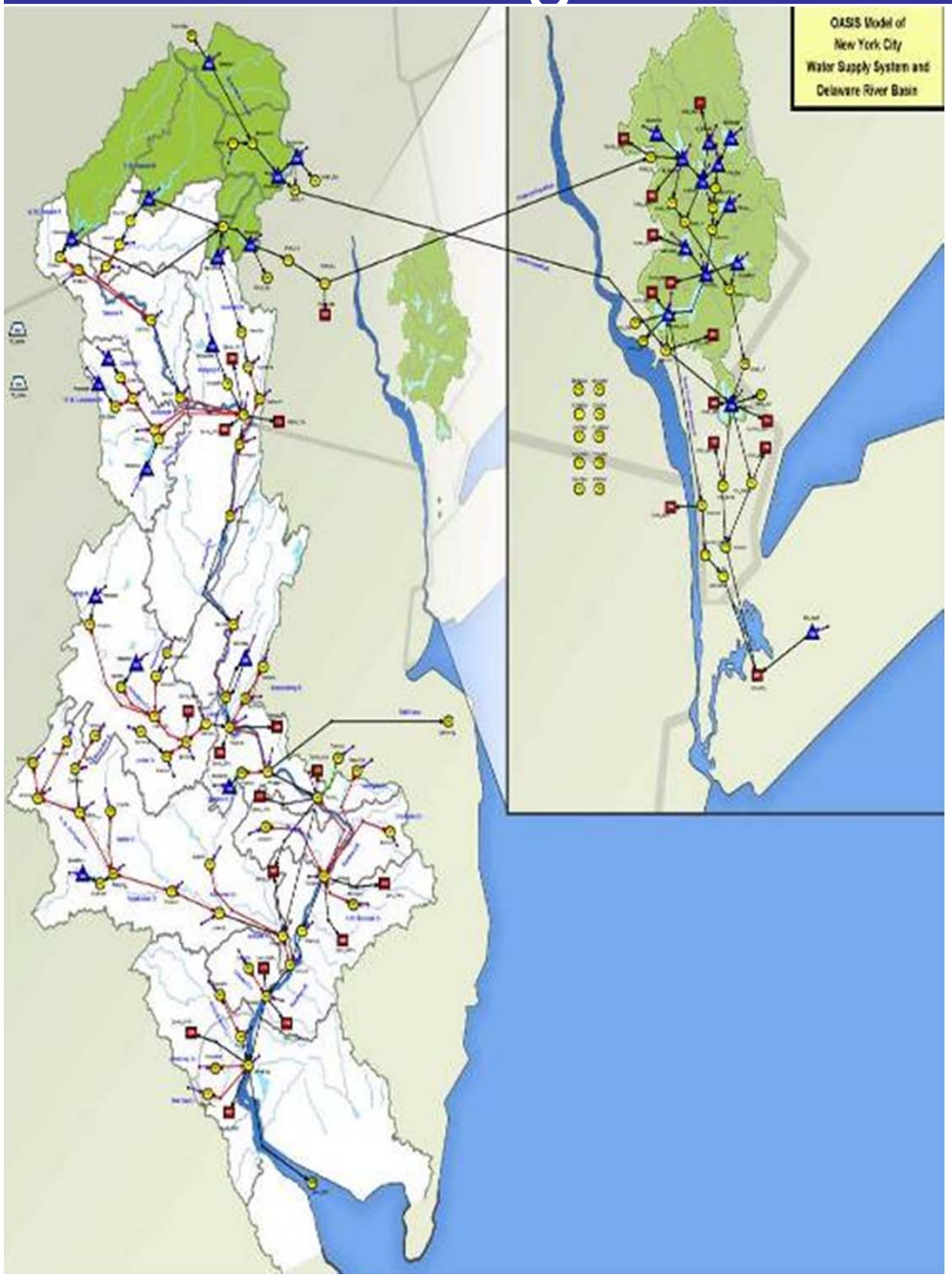
Post-Processors





Graphical User Interface

OST Background - OASIS-W2 Model



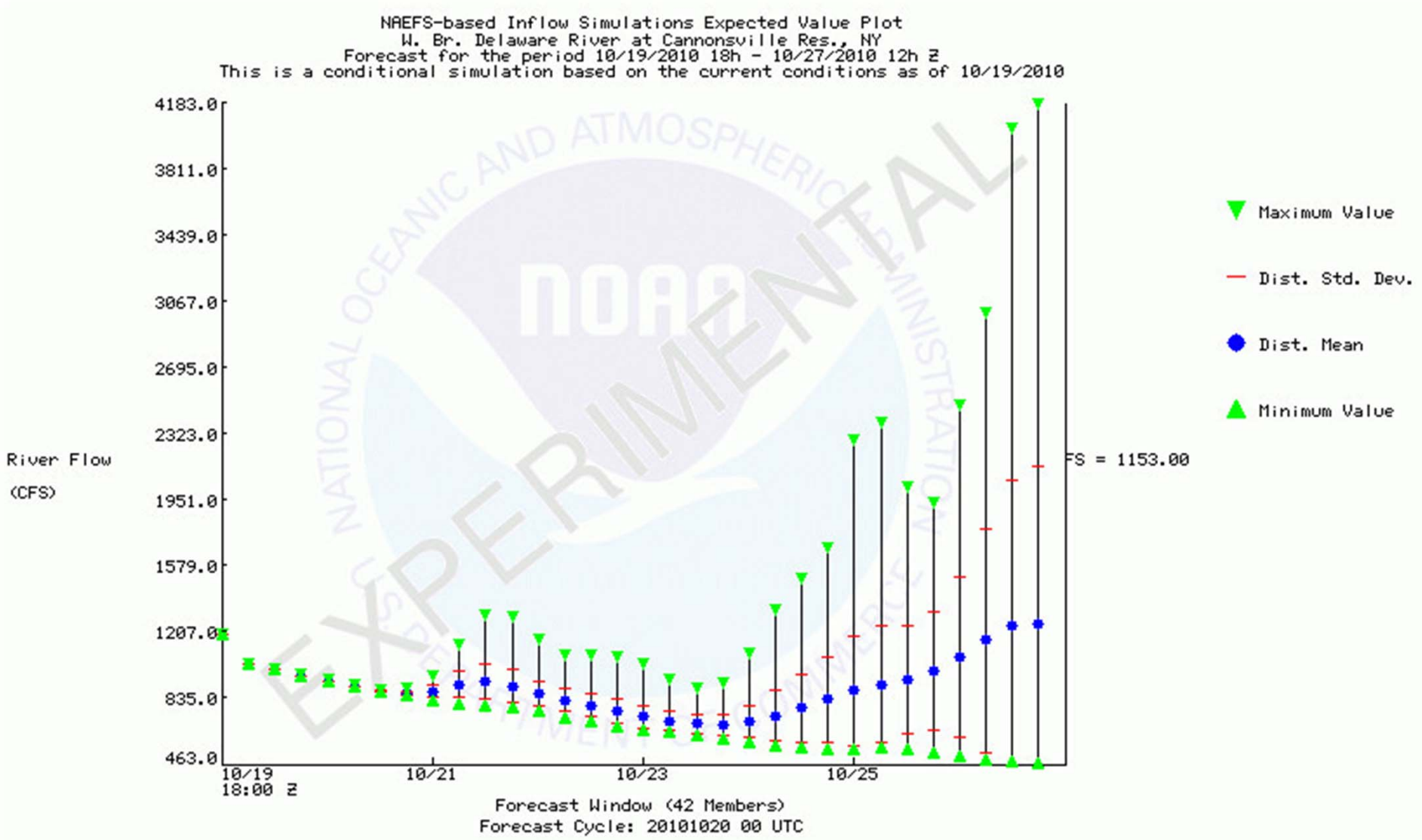
- Builds off OASIS-W2
  - OASIS: Mass-balance reservoir system model
  - W2: 2D hydrodynamic and water quality model
- Simulates system operations
- Operates on daily time step

Existing Oasis-W2 vs OST

	Existing OASIS Model	Operations Support Tool
Underlying Engine	**NYC OASIS-W2 Linked Water Supply-Water Quality Model**	
Main Purpose	Evaluate long-term operating rules	Support near-term decision-making (evaluate *exceptions* to the rules)
Simulation Mode	Long-term time series	Position Analysis (today's system status, looking forward *x* months)
Reservoir Inflows	Historical	Probabilistic Forecasts -Account for current basin conditions
Reservoir Status	Static (manual updates)	Dynamic (linked to SCADA, etc.)
User Interface & Reporting	Standard	Customized for Operators

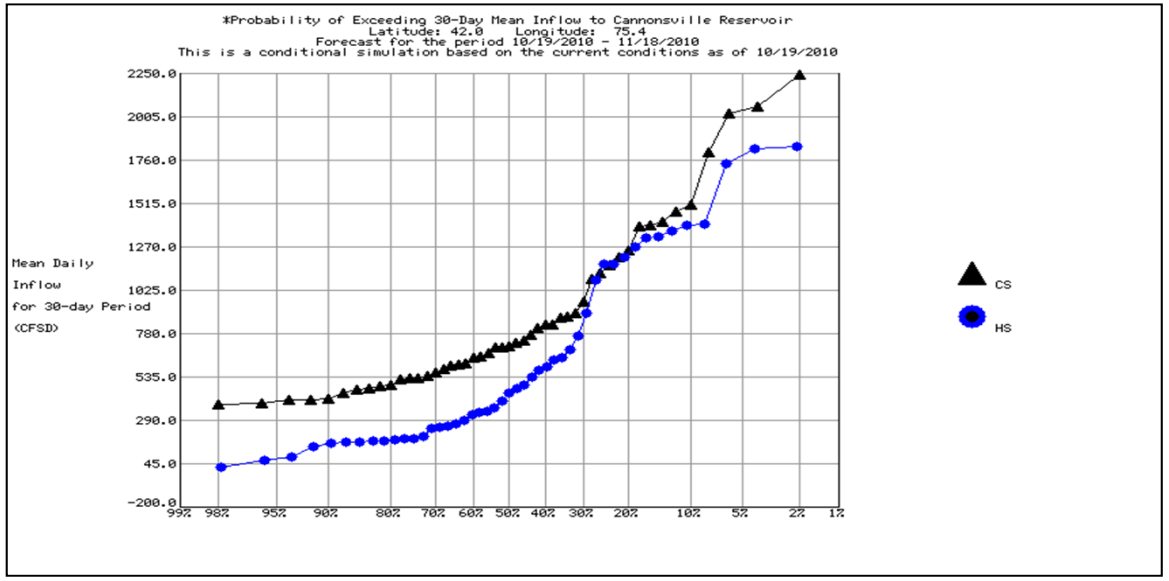
Probabilistic (Ensemble) Forecasts in OST

Reservoir Inflow Expected Value Plot

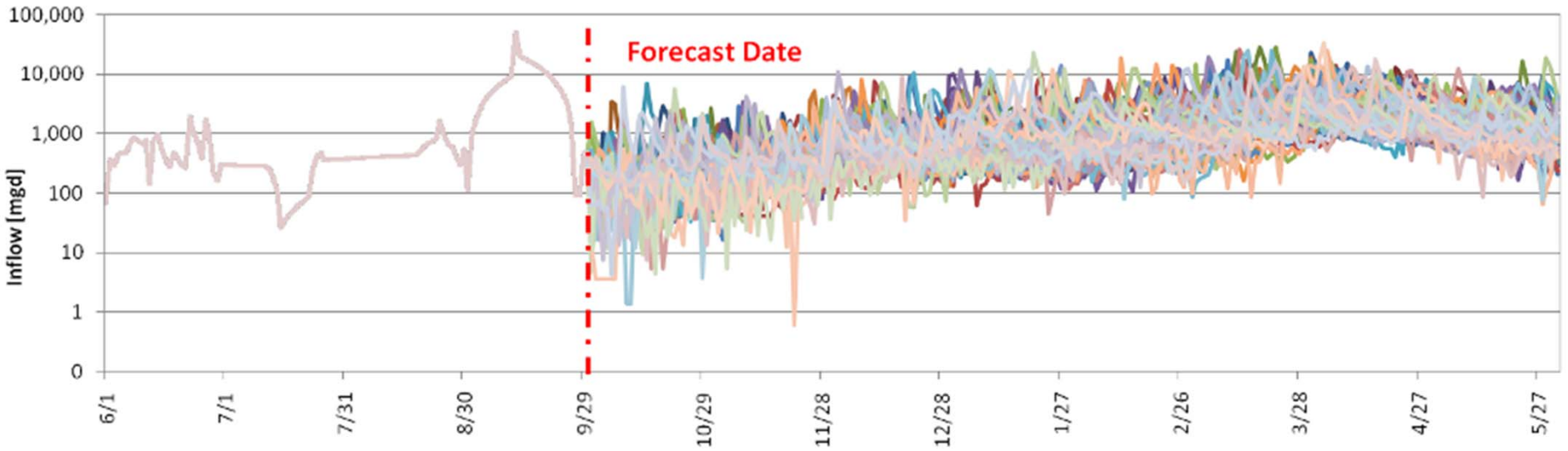


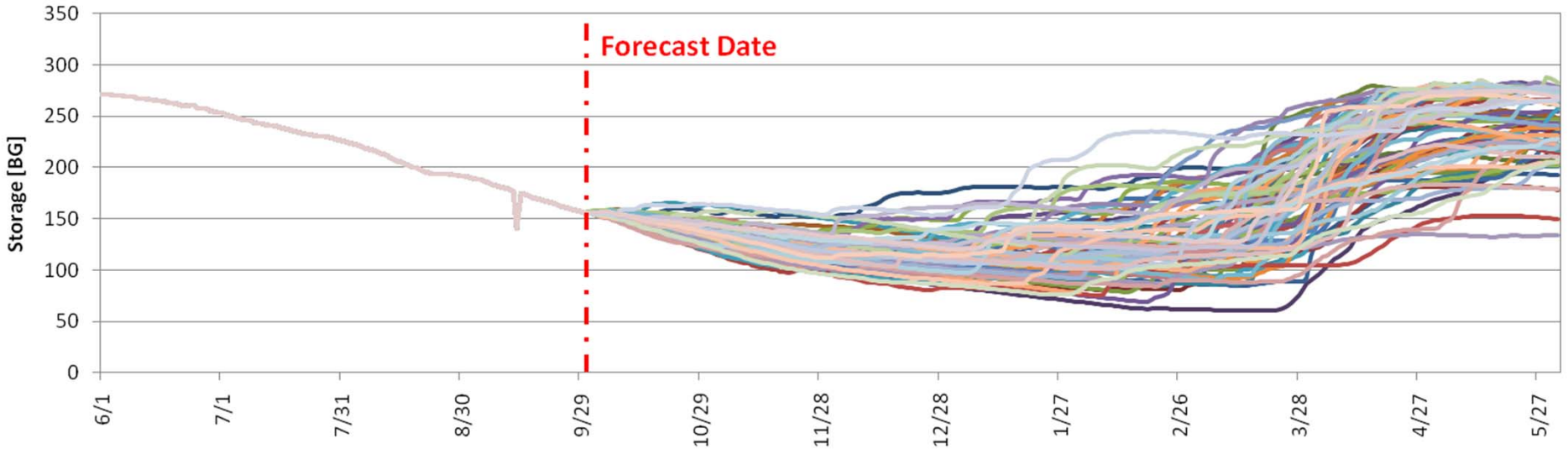
Why Probabilistic Forecasts?

- Effectiveness of today's operating decisions depends on future inflows
- Decisions can thus be improved with inflow forecasts
- Probabilistic forecasts give range and likelihood of future inflows
- Help managers quantify risk associated with operations decisions

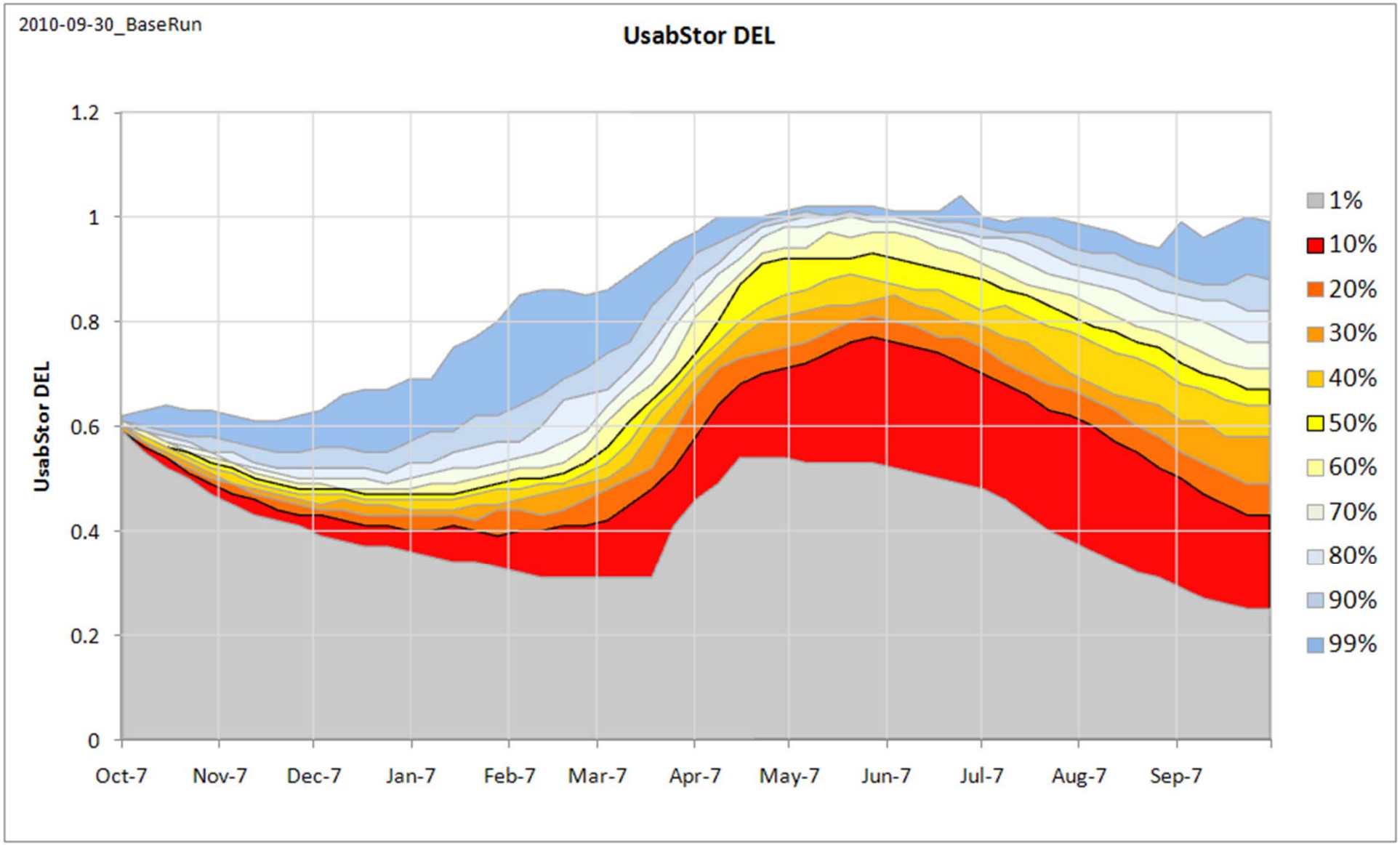


Pepacton/Cannonsville/Neversink Forecasts





Probabilistic Output: Delaware Storage



Using Forecasts for Real-Time Decisions

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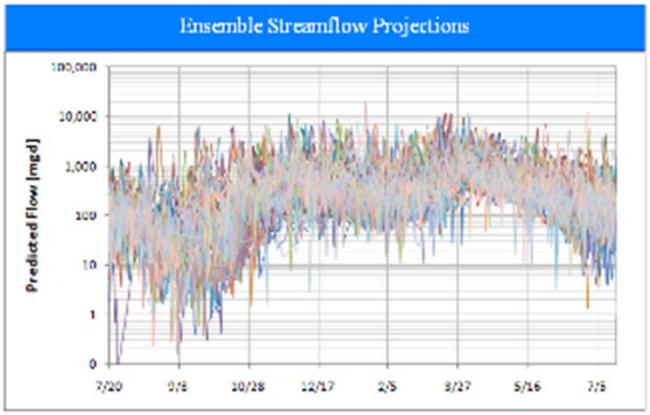
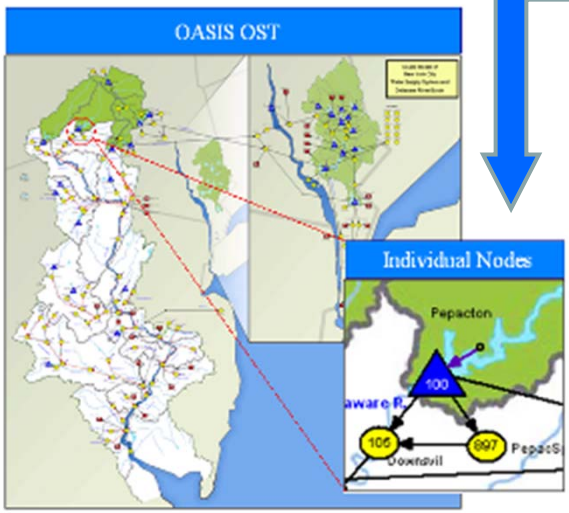
Long-Term Operating Policy

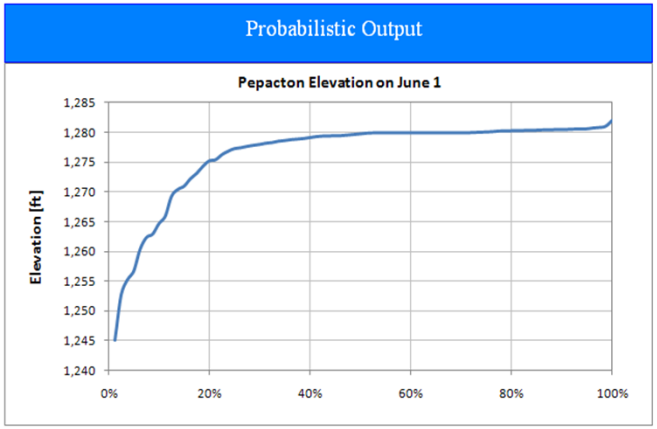
Individual Traces





Initial Reservoir Conditions

- Storage / Elevation
- Spill
- Demand
- Releases

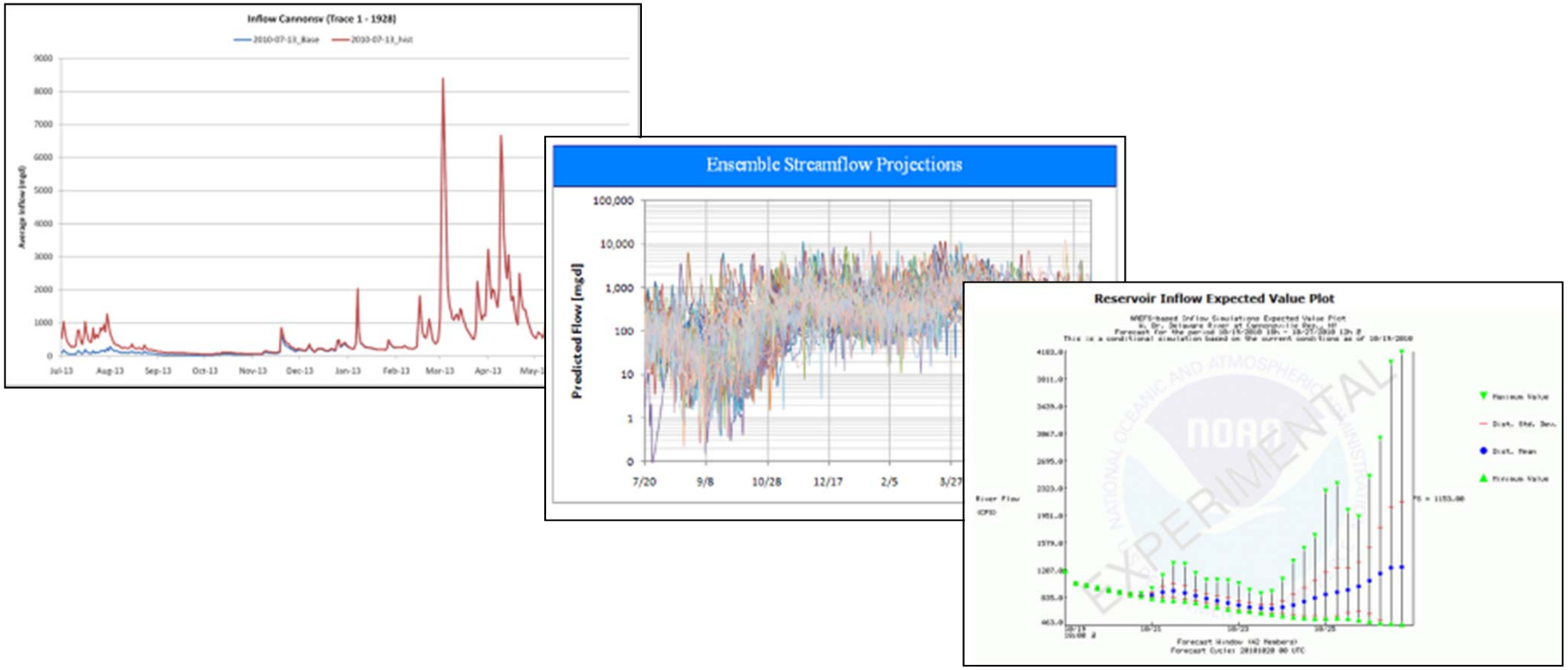


Risk Assessment

Operation Policy Adjustments

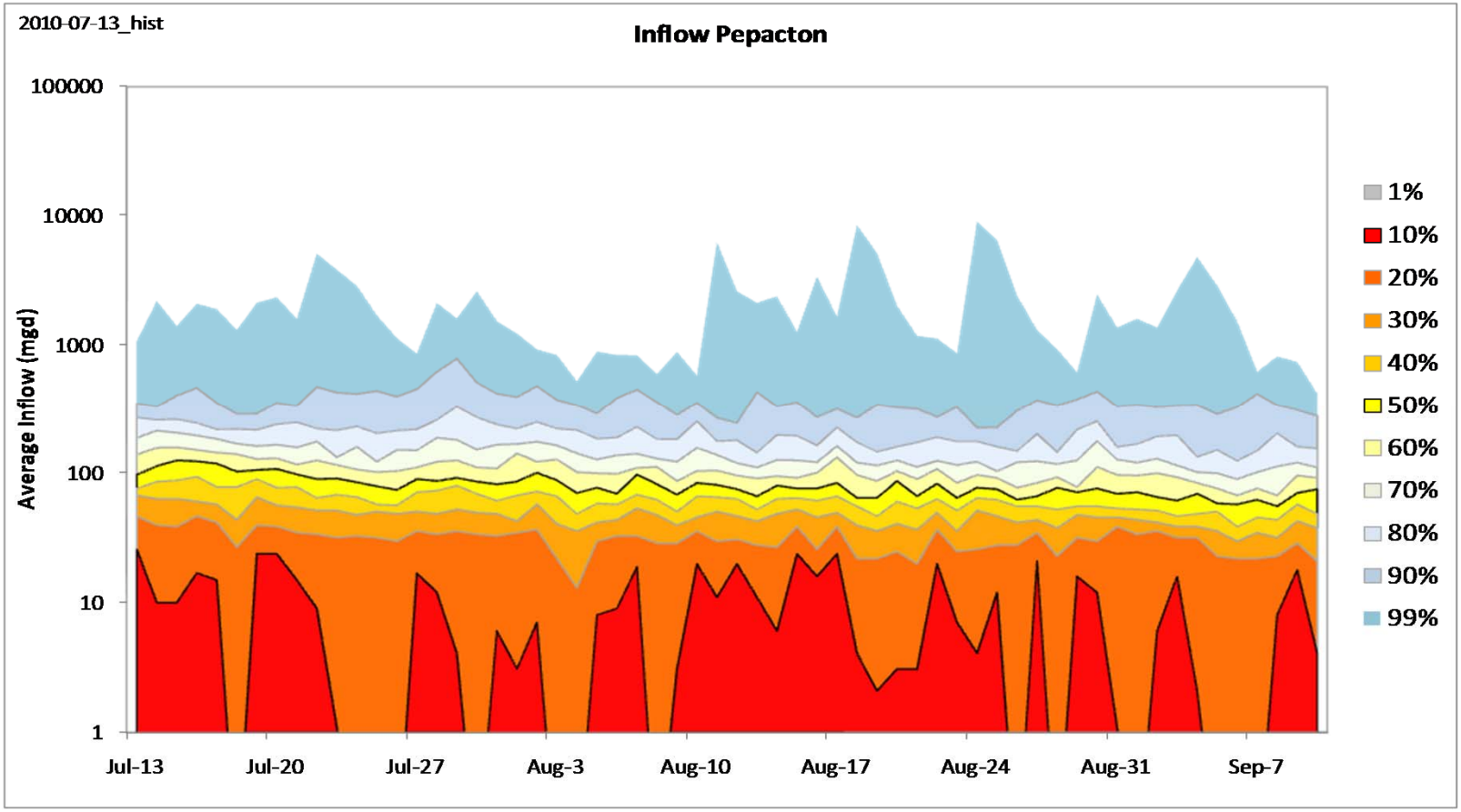
Ensemble Forecast Sources

- Historical inflows
- Conditional inflows (“Hirsch”)
- NWS ensemble forecasts



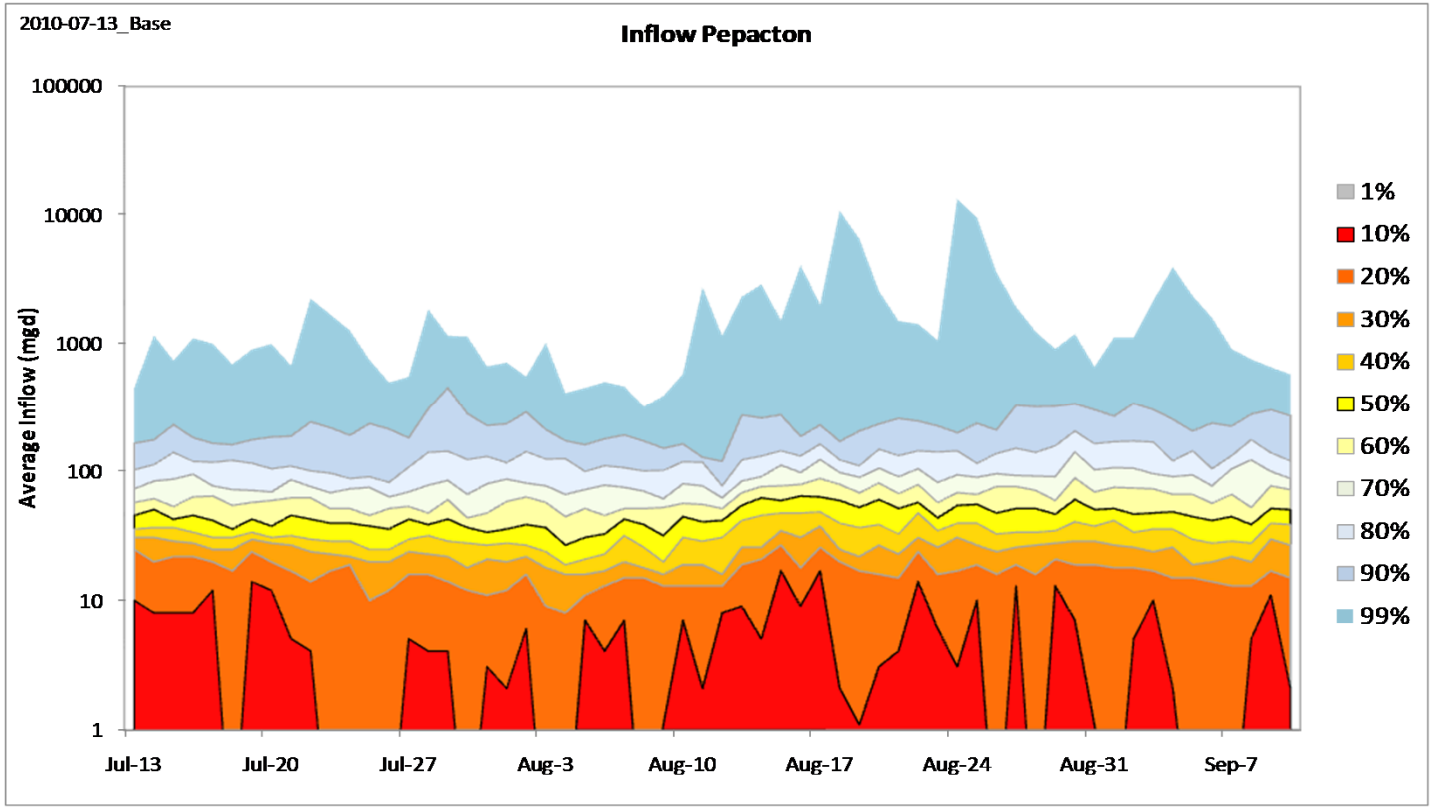
Historical Inflows

- Simplest approach
- 1927 – 2008
- Does not account for current conditions or meteorological forecasts

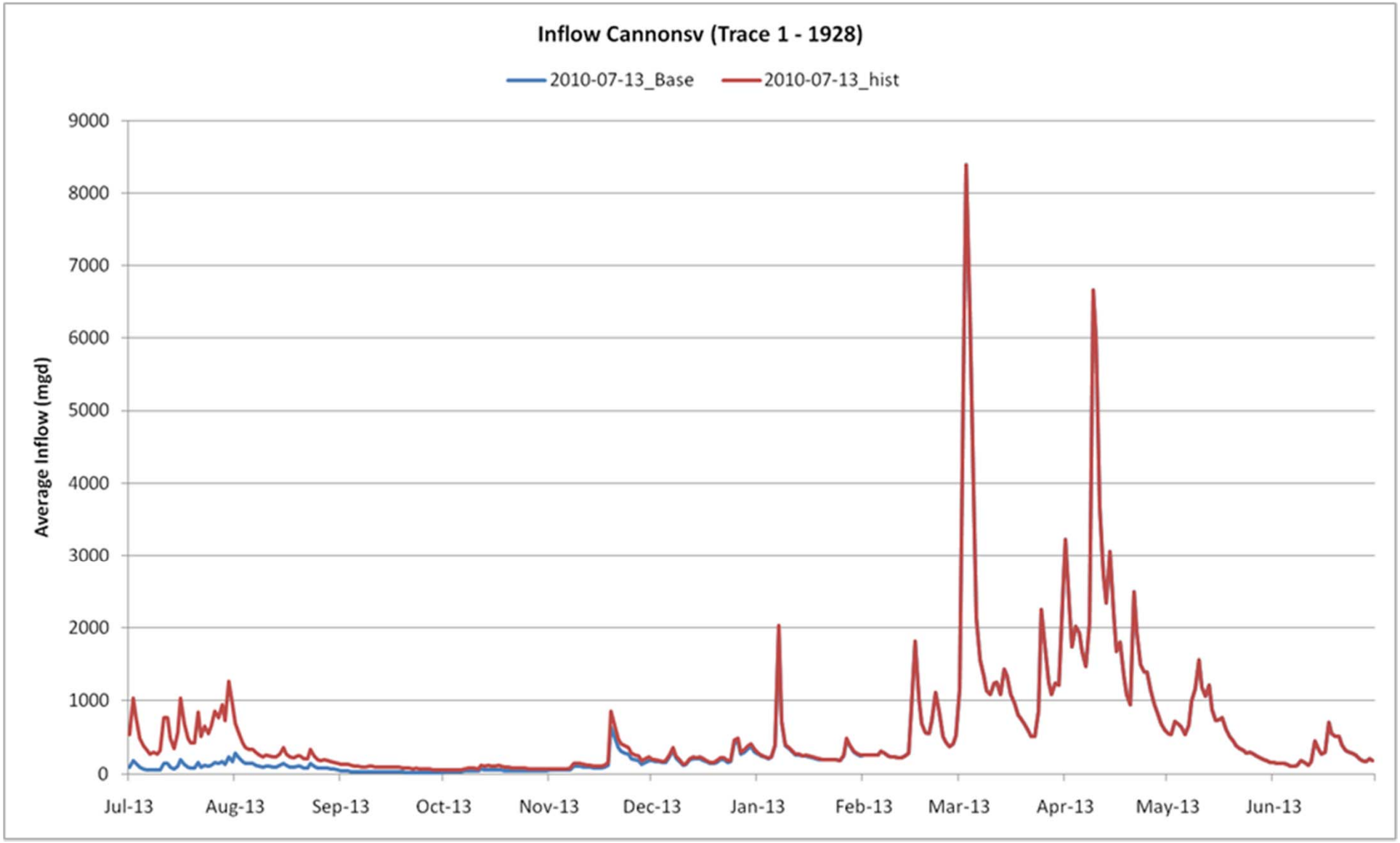


Conditional ("Hirsch") Forecasts

- Developed by Dr. Robert Hirsch, USGS, 1979
- Account for current conditions but not meteorological forecasts
- Historical inflows "conditioned" by recent inflows
- Relies on serial correlation between recent and future inflows
- Monthly Hirsch in use by DEP, daily Hirsch by late 2010

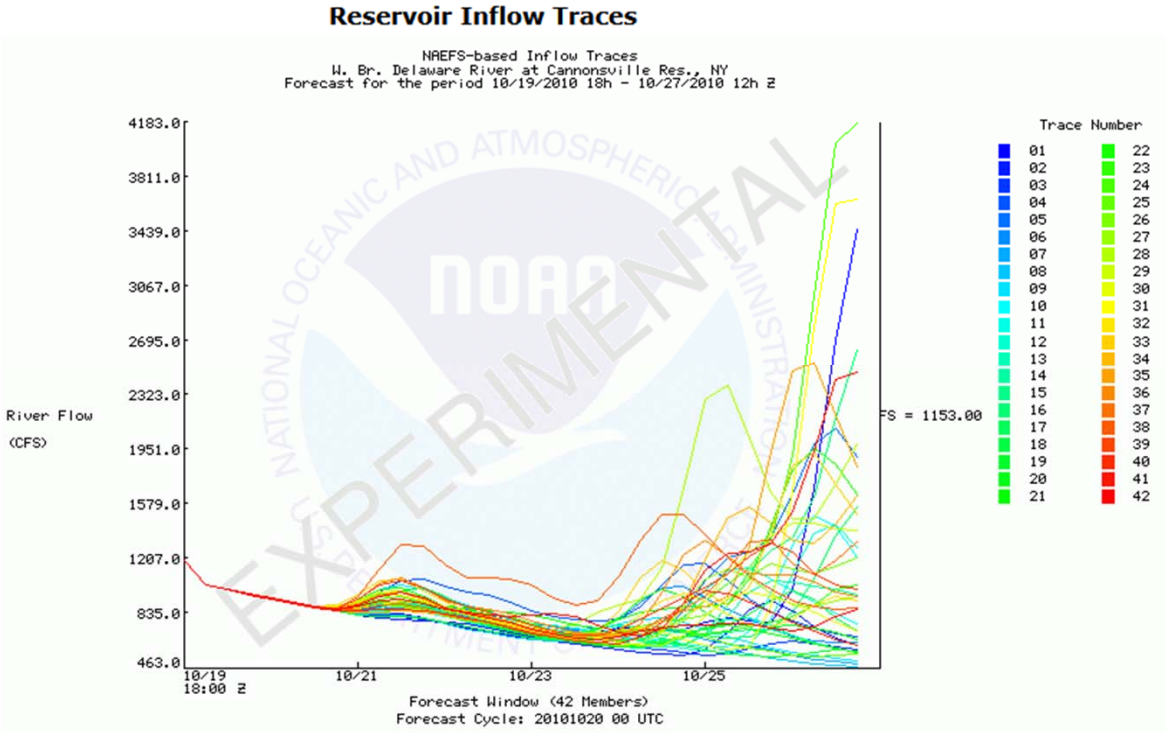


Timeseries: Historical vs. Conditional



NWS Ensemble Forecasts

- Currently under development by NWS
- Existing AHPS forecasts are deterministic, not probabilistic
- DEP providing substantial support to expedite
- Will account for current conditions and meteorological forecasts
- Will include hindcasts
- Will be primary forecast for OST



OST Usage: System-wide

- Refill Probability & Drought Risk Analysis
- Outage Planning & Emergency Management
- Operating Rule Development & Water Supply Planning
- Climate Change Planning & Demand Management Studies
- New Infrastructure

OST Usage: Delaware Basin

- Predict how much water may be available for release while maintaining water supply reliability
- Develop & evaluate alternative release plans
- Support Delaware basin release programs
  - Probabilistic, risk-based approach to define excess release volumes available
  - Requires commitment from other Decree Parties to long-term sustainable water supply sources
- Potential for increasing net system benefits
  - Dual ability to protect NYC supply while providing downstream benefits

OST Usage: Modified Release Plan Example

- Modification of the FFMP release tables
  - Based on the Joint Fisheries White Paper
  - Modified releases for drought day neutrality, protection of Neversink supply
- Select appropriate release table based on OST output

FFMP support: 100 mgd available vs 35 mgd available

	Winter		Spring		Summer			Fall		
Cannonsville	1-Dec -	1-Apr -	1-May -	21-May-	1-Jun -	16-Jun -	1-Jul -	1-Sep -	16-Sep -	1-Oct -
Storage Zone	31-Mar	30-Apr	20-May	31-May	15-Jun	30-Jun	31-Aug	15-Sep	30-Sep	30-Nov
L1-a	1500/1500	1500/1500	*	*	*	1500/1500	1500/1500	1500/1500	1500/1500	1500/1500
L1-b	250/250	*	*	*	*	*	525/350	400/300	300/275	250/250
L1-c	150/110	400/110	400/200	400/250	500/275	525/275	525/275	400/275	300/140	150/110
L2-High	135/80	325/80	325/190	350/240	400/260	425/260	425/260	350/260	250/115	135/80
L2-Low	115/80	300/80	300/190	325/240	400/260	400/260	400/260	325/260	250/115	125/80
L3	100/70	125/70	150/100	175/100	200/175	200/175	200/175	150/95	125/95	100/70
L4	55/55	55/55	75/75	75/75	130/130	130/130	130/130	55/55	55/55	60/60
L5	50/50	50/50	50/50	50/50	120/120	120/120	120/120	50/50	50/50	50/50

OST Usage: Modified Release Plan

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OST INPUT

Today's Conditions

- Reservoir Levels
- Infrastructure Status
- Water Quality
- Demand Projections

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Operating Rules

- System Reliability
- Reservoir Balancing
- Drinking Water Quality
- Releases

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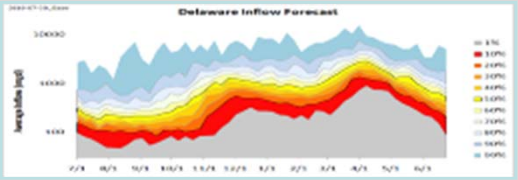
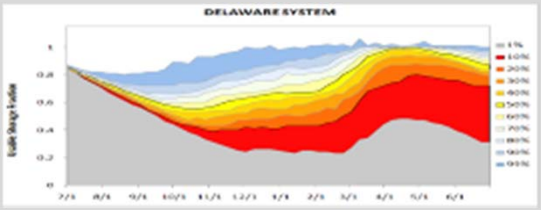
Ensemble Inflow Forecasts

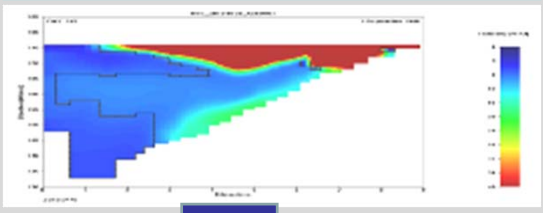


OST OUTPUT

Storage Levels



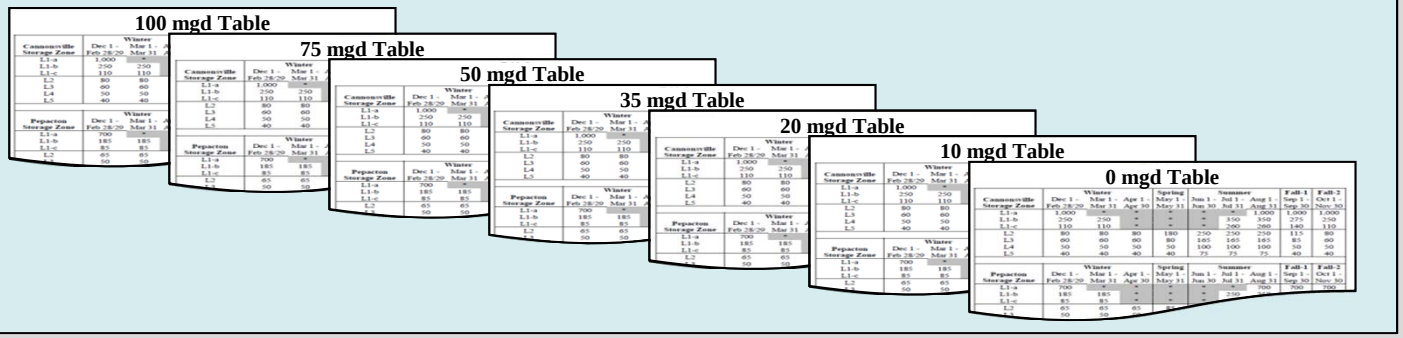
Water Quality



Refill Probability

DELAWARE RELEASE DECISIONS

High Water Availability — **Probability of Excess Water At Specified Risk Level** — **Low Water Availability**



OST vs. Safe Yield

- Safe Yield is used as a drought planning tool - not the basis for normal operations with an adequate supply of water
- NYC operates based on quantity, quality, and economics
- Reservoirs are chosen for diversions to:
  - deliver the highest quality water
  - maintain the FAD
  - avoid chemical treatment
  - be fiscally responsible
- OST will enhance our ability to continue to deliver a reliable supply of high quality water
- OST can provide downriver benefits while preserving the City's rights under the Decree whereas safe yield operations harm the City

OST Project Schedule

- Phased deployment:
  - June 30 2010 OASIS in PA mode w/ Hirsch forecasts
  - Aug 30 2010 OASIS-W2 in PA mode w/ Hirsch forecasts
  - Dec 30 2010 Signal Acquisition, Database, Daily Hirsch
  - Jun 30 2011 Prototype Graphical User Interface
  - Feb 2012 Upgrades to Graphical User Interface
- October 2012: Full beta version
- October 2013: Final version

Discussion