VIA Electronic Filing

March 18, 2016

Kimberly Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, D.C. 20426

Re: Blenheim-Gilboa Pumped Storage Power Project, FERC No. 2685-026; Filing of ISR Meeting Summary

Dear Secretary Bose:

The New York Power Authority (Power Authority) is relicensing the Blenheim-Gilboa Pumped Storage Project (FERC No. 2685) (Project) using the Federal Energy Regulatory Commission's (Commission) Integrated Licensing Process (ILP). Pursuant to the ILP, on February 19, 2015, the Commission issued a Final Study Plan Determination approving six relicensing studies for the Project. After completing its first study season, the Power Authority filed its Initial Study Report (ISR) with the Commission on February 19, 2016. On March 3, 2016, the Power Authority held a public ISR meeting with resource agencies and stakeholders to discuss study results, as well as any proposals to modify the study plans in light of the Power Authority's progress in implementing the Commission-approved study plans and the data collected. Pursuant to Section 5.15(c)(3) of the Commission's regulations, 18 C.F.R. § 5.15(c)(3), the Power Authority hereby submits a summary of the March 3, 2016 ISR meeting.

The Power Authority appreciates the contribution of resource agencies and stakeholders, through their participation in the ISR meeting. In response to comments received at the meeting, the Power Authority's proposal for second year studies remains the same as proposed in the ISR. The Power Authority is not proposing any modified or new studies, as the study plan approved by the Commission in February 2015 will provide sufficient information for the Commission, resource agencies, and other relicensing participants to assess effects of the continued operation and maintenance of the Project under a new license.

In accordance with the ILP schedule issued by the Commission on September 18, 2014, as part of Scoping Document 2, comments on the enclosed ISR meeting summary must be filed with the Commission by April 19, 2016. Any request for a new or modified study that accompanies such comments must adhere to the requirements of Section 5.15(d) or (e) of the Commission's ILP regulations, 18 C.F.R. §§ 5.15(d), 5.15(e), as appropriate.

If you have any questions regarding the ISR meeting summary, please direct them to me at (914) 681-6564 or Rob.Daly@NYPA.gov.

Sincerely,

Robert Daly
Manager, Licensing

Location

Inn at Cobleskill, Cobleskill, NY

Attendees

A list of attendees appears at Attachment A.

Agenda

- Introduction
- Effect of Project Operations On Downstream Flooding Study
- Historic Structures Survey, Phase 1A Archaeological Survey
- Fish Entrainment/Protection Assessment Study
- Socioeconomics
- Recreation Use/User Contact Study, Recreational Boating Desktop Feasibility Assessment
- Wrap-up

Meeting Summary

Introduction

Mark Slade of the New York Power Authority (Power Authority or NYPA) opened the Initial Study Report meeting at 9:00 a.m. with an introduction that described the purpose of the meeting. He noted that stakeholders could provide comments during the meeting, but that the relicensing process also allowed stakeholders to provide written comments following the meeting.

Rob Daly of the Power Authority then discussed the relicensing process, including upcoming deadlines. He noted that although the slide stated that the stakeholder comment deadline was April 17th, that it should be extended by 2 days so that comments would be due to FERC by April 19th. Subsequent deadlines on the slide should also be extended by 2 days. The schedule on the Project website is correct.

Several consultants to the Power Authority then presented the progress of the studies using the attached PowerPoint presentation (Attachment B), which serves as a summary of the Power Authority's presentation for each study in the Federal Energy Regulatory Commission (FERC) approved study plan. Following the presentation of each study, the Power Authority opened the meeting for discussion. A summary of major discussion points for each study is provided below.

Effect of Project Operations on Downstream Flooding Study
Slides 6–30 (Attachment B)
Presenter: Kevin Miller, Gomez and Sullivan Engineers

The Power Authority noted that the Flooding Study is an ongoing study. The hydrologic and hydraulic model have been developed and are undergoing quality assurance and quality control on the calibration and verification. The operations model is under development. When all three models are completed, production runs to assess downstream flooding without the dam, for existing operations, and alternative high flow operations will be conducted and the report will be written.

A member of Dam Concerned Citizens noted that Schoharie County hired McDonald Engineering to perform a flood analysis study of Tropical Storm Irene which included evaluating B-G Project operations and potential alternative operations. The commenter provided a hard copy of the report to the Power Authority and FERC, and requested that the Power Authority consider this study's findings when considering high flow operating alternatives.

Several stakeholders asked questions about how the Probable Maximum Flood (PMF) for the B-G Project was calculated and questioned why it is a different value than the PMF calculated by the New York City Department of Environmental Protection (NYCDEP) for the Gilboa Dam. The Power Authority explained that the calculation of the PMF for the B-G Project is overseen by an Independent Board of Consultants and approved by FERC as part of its dam safety program, and that Gilboa Dam is not regulated by FERC.

Several stakeholders asked about the ability of the dam to pass the PMF event through the Tainter gates and during seismic events. The Power Authority noted these questions, and explained that these issues are not part of the relicensing process, as they are governed under FERC's Part 12 dam safety program, which includes inspections and reviews every 5 years. FERC staff explained that FERC's rigorous dam safety program is applied to all FERC projects across the country. FERC staff noted that if stakeholders have further questions about FERC's dam safety program or the Part 12 process that stakeholders could contact the FERC regional engineer.

A member of the Schoharie County Relicensing Committee noted that there are three new gaging stations along Schoharie Creek downstream of the B-G Project at Middleburgh, Esperance, and Fox Creek. The Power Authority responded that it is aware of them, but the period of record for the new gages is not long enough to be useful for this study. The commenter acknowledged that a historical record is needed.

A member of Dam Concerned Citizens noted that the USGS station at the bridge (i.e. USGS gage 01350000 at Prattsville) has over a 100-year record. The commenter expressed the view that 3 of 4 annual peak flow events recorded on that gage occurred during the winter months from rain on snow events, and opined that the B-G Project could respond to these "flashy" situations.

FERC staff asked if installation of the new low level outlet at NYCDEP's upstream Gilboa Dam was considered in the study. The Power Authority responded that it is not known how New York City intends to operate the low level outlet, or even when it would be coming on line. For these reasons, the Power Authority explained, the low level gage at Gilboa Dam was not considered in the study.

A member of the Blenheim Long Term Community Recovery Committee noted that they have suggested to the Federal Emergency Management Agency that the Blenheim Covered Bridge be rebuilt and elevated. The commenter expressed hope that information from the study can be used to determine these levels and that the Power Authority gives consideration to mitigation and how they can regulate the flows to downstream areas.

FERC staff asked a question regarding the period of record used for the hydrologic analysis, and provided a reference to a 2014 U.S. Geological Survey report (SIR 2014-5084) that may be relevant to this study. The Power Authority agreed to review this reference. A copy of this report is included in Attachment C of this ISR meeting summary.

A stakeholder asked if the study was considering climate change/potential for more frequent flood events. The Power Authority responded that the study analyzes Project operations under different flows, of a set frequency (e.g. 50, 100, year return interval) based on historic records.

FERC staff asked when the flooding study would be completed. The Power Authority responded that it anticipates completion of the study in the 4th quarter of 2016. Additional meeting participants asked questions about time for stakeholders to review the study, and the Power Authority explained that there would be sufficient time to review the study as the Updated Study Report would be filed in February of 2017, and that public comments will not be due until sometime after that.

Historic Structures and Phase 1A Archaeological Surveys
Slides 32–38 (Attachment B)
Presenters: Sarah Verville and David Price, TRC

The Power Authority explained that these studies were complete, that draft reports for these studies had been filed with the New York State Historic Preservation Office (NY SHPO), and that copies were appended to the Initial Study Report as Appendices A and B.

One stakeholder requested clarification on why the Baldwin House was not considered eligible for listing on the National Register of Historic Places (NRHP). The Power Authority explained that the extent of upgrades (i.e. additions, new doors/windows) affected its eligibility. Further, it was part of a larger farmstead complex and the other structures no longer existed. The Power Authority also noted that the eligibility criteria only considers the exterior of the building.

Several stakeholders asked about the Area of Potential Effect (APE) as it was defined in the

study. The Power Authority noted that the APE had been defined in consultation with the NY SHPO and approved by FERC in its February 2015 study plan determination letter.

One stakeholder asked if the fossil record was evaluated during the archaeology study. The Power Authority explained that the archaeology study is concerned with human interactions with the land, as opposed to paleontological resources. The commenter also asked whether there are any ruins on the Power Authority's property. The Power Authority reported that the archaeology sensitivity model focused on the fluctuation zone as opposed to uplands, and explained that if the Power Authority proposes any ground-disturbing activity within the Project boundary, the Power Authority would conduct an archaeological investigation of the property proposed to be disturbed before proceeding.

Fish Entrainment/Protection Assessment Study
Slides 39–76 (Attachment B)
Presenter: Jason George, Gomez and Sullivan Engineers

The Power Authority explained that this study was complete and a copy was provided in the Initial Study Report as Appendix C.

A stakeholder asked about the potential for impingement on racks at the Upper Reservoir. The Power Authority explained that the spacing between grates is five inches, so impingement is unlikely. Moreover, the Power Authority explained that impingement was not included in the FERC-approved study plan at the request of the U.S. Fish and Wildlife Service.

A stakeholder asked if any field study of entrainment was conducted. The Power Authority explained that the FERC-approved study plan required a desktop study.

A stakeholder asked how the Power Authority selected the fish species to be evaluated in the study. The Power Authority responded that SUNY-Cobleskill performed an inventory of fish in the Upper Reservoir during a reservoir drawdown during the Life Extension and Maintenance work performed from 2006 to 2010. The Lower Reservoir fish species list was determined from surveys conducted by the New York State Department of Environmental Conservation (NYSDEC) in the 2000s.

FERC staff asked for clarification on the selection process for determining comparable entrainment studies for the desktop evaluation. Staff suggested adding a table to the study report that compares turbine characteristics of the different projects used for the entrainment analysis.

Socioeconomics Study
Slides 78–93 (Attachment B)
Presenter: Diane Reilly, TRC

The Power Authority noted that the Socioeconomic Study is an ongoing study and is targeting the summer of 2016 for releasing a final report to resource agencies and other relicensing

participants—well in advance of the Updated Study Report due in February 2017.

Several stakeholders asked for clarification on the input data to the REMI model (i.e. source of GRP, dollar value, timeframe). The Power Authority explained that REMI maintains a database of inputs for each category.

Several stakeholders opined that the Project value contained in the Schoharie County Assessment roll is not accurate and suggested that the Power Authority retain an independent appraisal firm to determine the Project's value. The Power Authority acknowledged the request and noted that stakeholders could make the request as part of their written comments on the ISR meeting summary.

Several stakeholders asked about providing employee data by town (as opposed to by zip code), noting that that many towns have multiple zip codes. The Power Authority responded that it would look into whether it could provide employee data by town.

One stakeholder asked if the payout to retirees in the region is considered in the REMI model. The Power Authority explained the model takes into account employee payroll, and clarified that retirement funds are not paid out of the Project budget.

A stakeholder asked if the REMI model forecasts out into the future. The Power Authority confirmed that the model covers from present-day to 2060.

One stakeholder noted that the Project has not paid property taxes since its inception. The Power Authority noted this comment, indicating that its tax exempt status is a matter of state law.

A stakeholder asked if Project enhancements were factored into the model. The Power Authority responded that the model considers the continued operation of the Project as it is today.

Another stakeholder noted that communities provide services other than first responders to the Project, such as roads and road maintenance. The Power Authority explained that FERC had previously determined in its February 2015 Study Plan Determination letter that other services such as roads and road maintenances should not be in included in the scope of the study.

Several stakeholders noted that the first responder portion of the study should consider that effects to first responders trickle through the region because of the need for back-up and stand-by coverage by other areas. The Power Authority noted these comments.

Recreation Use/User Contact Survey
Slides 94-99 (Attachment B)
Presenter: Heather Seiders, TRC

The Power Authority noted that the Recreation Use/User Contact Survey is an ongoing study, that field work was recently completed in February 2016, that the Power Authority is targeting the

summer of 2016 for releasing a final report to resource agencies and other relicensing participants—well in advance of the Updated Study Report due in February 2017.

One stakeholder asked if regional recreation initiatives currently being planned by other entities would be considered in the study. The Power Authority explained that it would take into account these regional recreation initiatives when considering what recreational measures to propose as part of the license application.

A stakeholder asked if the survey asked people what they would like to do at the property, or if it allowed for people to refer others to fill out the survey to account for people who have recreated in the area in the past. The Power Authority explained that the survey asks recreationists what recreational activities they participate in and for their opinion of the recreational facilities/opportunities at the Project.

Recreational Boating Desktop Feasibility Assessment
Slides 100–122 (Attachment B)
Presenters: Dave Dominie, TRC, and Michele Stottler, Gomez and Sullivan Engineers

The Power Authority noted that it had conducted a desktop recreational boating feasibility assessment using the Phase I methodology contained in Whitaker as recommended by FERC in its February 2015 Study Plan Determination, that the Phase I desktop study was complete, and that the report for the study was appended to the ISR as Appendix D.

FERC staff asked how the seepage and evaporative loss values were calculated. The Power Authority responded that those values were calculated at Project construction, and were vetted and cited in the FERC approved Settlement Agreement from 1975 between NYPA and several downstream communities.

One stakeholder requested that the scale of the hydrographs be changed, asserting that doing so would make them more readable at lower flows. The Power Authority explained that the report presented the hydrographs so that they were all at the same scale.

A stakeholder asked how boating flows were determined. The Power Authority explained that the study included a desktop analysis to calculate water depths at multiple locations along the stream at given flows, and used that to determine if the reach would be boatable at a given flow.

FERC staff asked for information regarding how often the available storage is used for low flow augmentation and how much storage would potentially be available to provide boating releases. The Power Authority noted FERC's request.

FERC staff asked for clarification on what interviewees cited as water quality issues. The Power Authority reported that interviewees said things like it was muddy and stagnant.

A stakeholder opined that the study should consider that not all recreation users are looking for rivers with a more difficult rating. The Power Authority agreed. A stakeholder suggested that access points should be evaluated for adequacy and condition, and that portage should be available around the lower dam. The Power Authority noted that the study was a desktop initiative as recommended by FERC in its February 2015 Study Plan determination.

A stakeholder requested clarification on which areas are closed to public access. The Power Authority responded that there are boat barriers for safety in the reservoir near the dam and warning signs below the dam.

A stakeholder speculated that interviewees may not have known what the flows were on the day that they were boating, and that the Power Authority may need to modify the study to understand what flows are needed for boating. The commenter acknowledged that the Project could not manufacture water, but suggested a number of measures that NYPA could implement, such as updating the boating guidebook or improving access points. The Power Authority noted that the study (the hydrologic and hydraulic analyses) did assess what flows may be needed to provide a recreational boating experience.

A stakeholder asked whether the study evaluated upstream boating opportunities. The Power Authority explained that the FERC-approved Study Plan Determination did not require an evaluation of upstream boating opportunities.

Closing

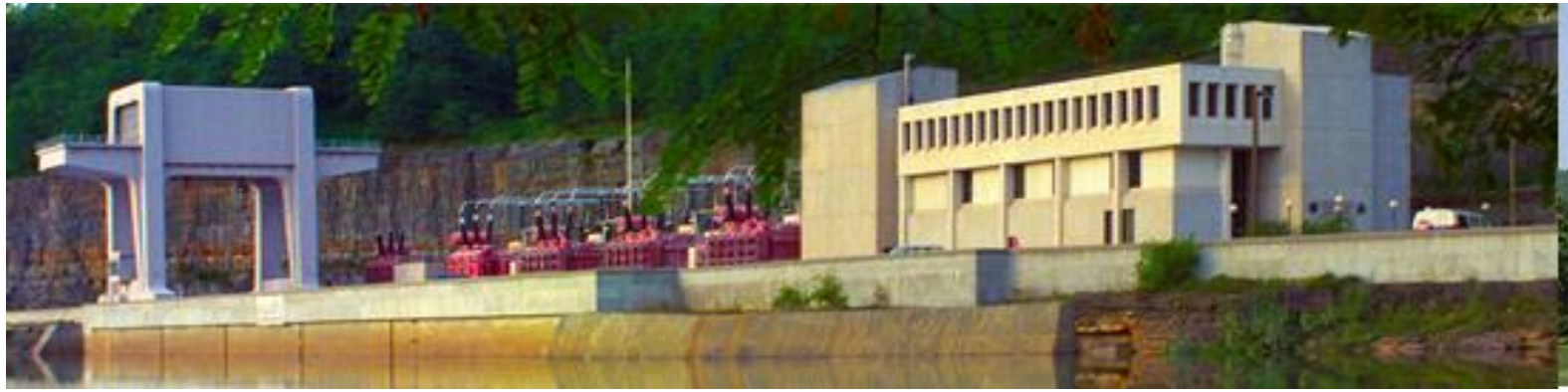
The Power Authority closed the meeting at 2:30 pm, and recapped upcoming deadlines for comments and responses on the ISR, in accordance with FERC's Integrated Licensing Process regulations and the schedule established by FERC staff.

Attachment A – Attendance List

Name	Affiliation
Don Airey	Blenheim Long Term Community Recovery Committee
Taitana Babo	Office of Assemblyman Pete Lopez
Howard Bartholomew	Dam Concerned Citizens
Andrew Bernick	Federal Energy Regulatory Commission
James Buzon	Citizen
Emily Carter	Federal Energy Regulatory Commission
Woohee Choi	Federal Energy Regulatory Commission
Gerald Coppolo, SR.	Town of Middleburgh
Laura Cowan	Kleinschmidt Associates
Rob Daly	New York Power Authority
Dave Dominie	TRC
Jason George	Gomez and Sullivan Engineers
Jeff Gerlach	New York Power Authority
Howard Goebel	New York Power Authority
Steven Gosset	New York Power Authority
Renee Grabowski	Town of Blenheim
Tara Groom	New York Power Authority
Lynn Hait	New York Power Authority
Margaret Hait	Town of Jefferson
Michael Higgins	NY State Department of Environmental Conservation
Jack Joyce	New York Power Authority
Umair Kahn	New York Power Authority
Joseph Leary	New York Power Authority
Ben Lenz	New York Power Authority
Anna Mattice-Strauch	Town of Blenheim
Kevin Miller	Gomez and Sullivan Engineers
Richard Mix	Town of Fulton
John Mundre	Federal Energy Regulatory Commission
Robert Nasdor	American Whitewater
Timothy Oakes	Kleinschmidt Associates
Mark Olig	New York Power Authority
Robert Panepinto	New York Power Authority
Lester Parker	Town of Gilboa
Steve Patch	U.S. Fish and Wildlife Service
Diane Reilly	TRC
Mario Roefaro	New York Power Authority

Brian Saez	New York Power Authority
Karen Santulli	New York Power Authority
Heather Seiders	TRC
Gail Shaffer	Citizen
Philip Skowfoe, Jr.	Town of Fulton
Mark Slade	New York Power Authority
Michele Stottler	Gomez and Sullivan Engineers
Thomas Sullivan	Gomez and Sullivan Engineers
Anthony Van Glad	Town of Gilboa
Earl Van Wormer III	Town of Esperance
Sarah Verville	TRC
Susan Watson	New York Power Authority
Scott Wells	DEC Region 4
Julie Wood	Van Ness Feldman, LLP
David Price via phone	TRC

Attachment B – Presentation Slides



INITIAL STUDY REPORT MEETING

March 3, 2016

NEW YORK STATE OF OPPORTUNITY.

NY Power Authority

Purpose for Meeting

- Per 18 C.F.R. § 5.15:
- To discuss study results, and
- the applicant's and/or other participant's proposals, if any, to modify the study plan in light of the progress of the study plan and data collected .

Relicensing Process

Apr 10, 2014	Power Authority filed NOI and PAD
Jul 7-9, 2014	FERC held scoping meetings
Aug 1, 2014	Public filed comments on PAD and Scoping Document
Sep 22, 2014	Power Authority filed Proposed Study Plan
Oct 16, 2014	Power Authority held Study Plan Meeting
Dec 1, 2014	Public filed comments on Proposed Study Plan
Jan 20, 2015	Power Authority filed Revised Study Plan
Feb 1, 2015	Public filed comments on Revised Study Plan
Feb 19, 2015	FERC issued Study Plan Determination
Aug 19, 2015	Power Authority filed Study Progress Report
Feb 19, 2016	Power Authority filed Initial Study Report
Mar 3, 2016	Power Authority holds Initial Study Report meeting

Next Steps

Mar 18, 2016	Power Authority will file meeting summary
Apr 17, 2016	Public may file comments
May 17, 2016	Power Authority will respond to comments, including revised study plans if warranted
Jun 16, 2016	FERC will amend approved study plan(s) as appropriate

Agenda

9:00	Introduction
9:30	Effect Of Project Operations On Downstream Flooding Study
	Break
10:30	Historic Structures Survey, Phase 1A Archaeological Survey
11:00	Fish Entrainment/Protection Assessment Study
	Lunch
12:30	Socioeconomics
1:15	Recreation Use/User Contact Study, Recreational Boating Desktop Feasibility Assessment
2:00	Wrap-up
2:15	Adjourn

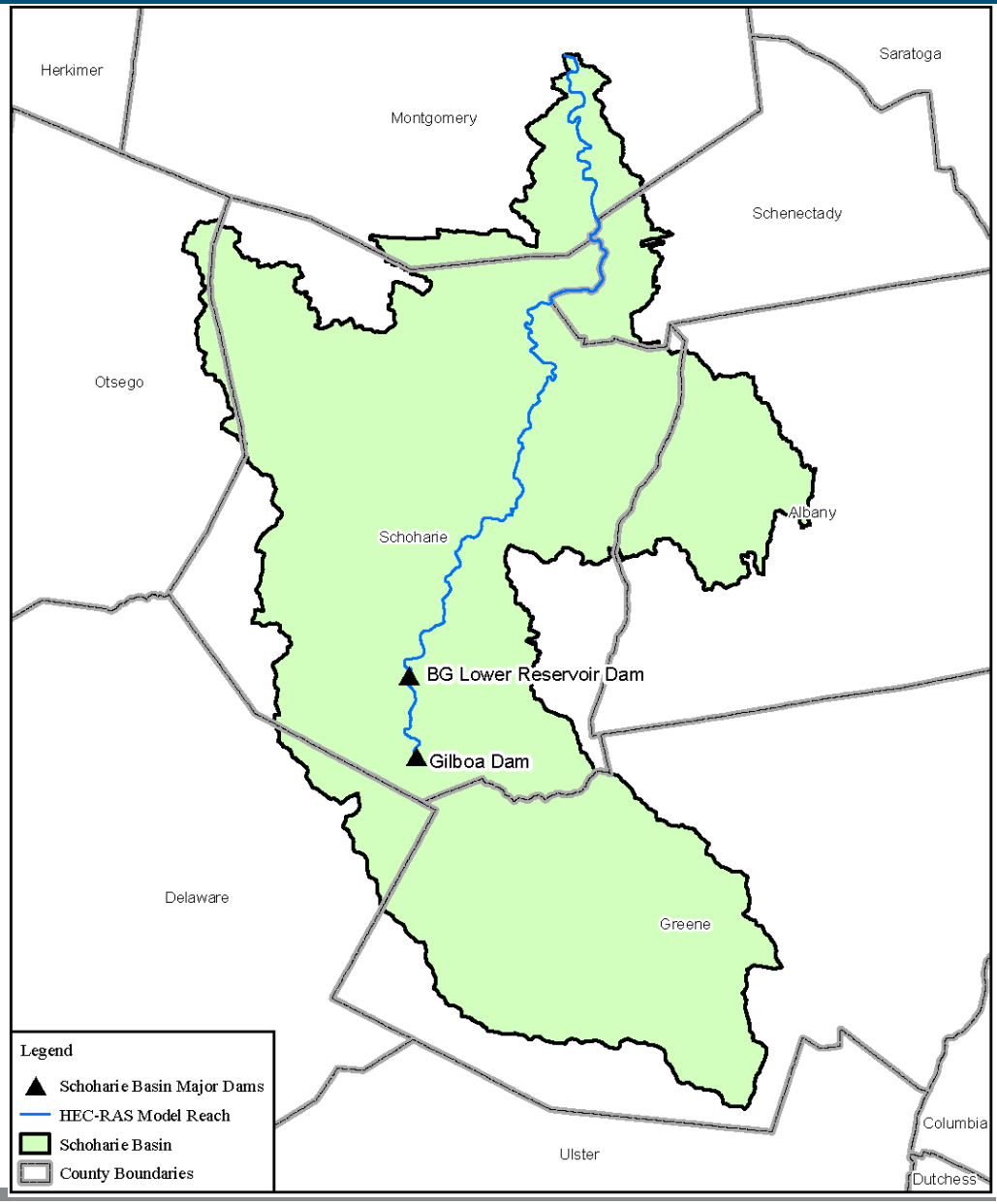
Effect Of Project Operations On Downstream Flooding Study

Study Goals and Objectives

- Goal
  - Provide an analysis of the potential effect of the B-G Project on downstream flooding and potential operational measures that could alleviate downstream flooding.
- Objectives
  - Estimate streamflows, water surface elevations, and extent of flooding along Schoharie Creek downstream of the Lower Reservoir Dam for the 10-year, 50-year, 100-year, and 500-year precipitation events for three scenarios.
  - Identify the impact of existing operations on downstream water surface elevations, depths, and extent of flooding.
  - Identify any reasonable, credible, and prudent operational measures that potentially could reduce downstream flooding during high-flow events.
  - For any operational measures determined to be feasible, conduct an analysis to determine their effect on flooding on the Schoharie Creek downstream of the Lower Reservoir Dam.

Geographic Scope

- Hydrologic Model – entire Schoharie Creek watershed
- Hydraulic Model – Schoharie Creek from Gilboa Dam to Mohawk River
- Operations Model – B-G Project

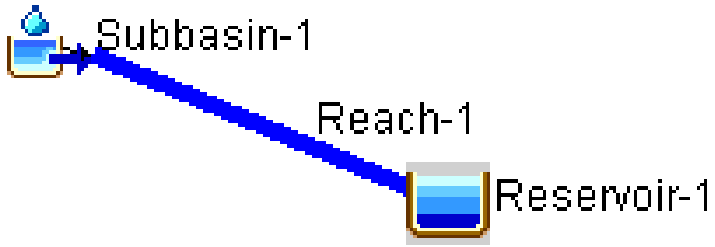


Study Progress

- Hydrologic Model (HEC-HMS/Regression Analysis)
  - Collected/processed precipitation, flow, and operations data for Tropical Storm Irene event
  - Verification and production runs substantially complete, QA/QC in progress
- Hydraulic Model (HEC-RAS)
  - Collected/processed topographic, flow, and high water mark data for Tropical Storm Irene and January 1996 events
  - Calibration/Verification substantially complete, QA/QC in progress
  - Production Runs awaiting completion of operations model development
- Operations Model (HEC-ResSim)
  - Under development
- Study Report
  - In progress

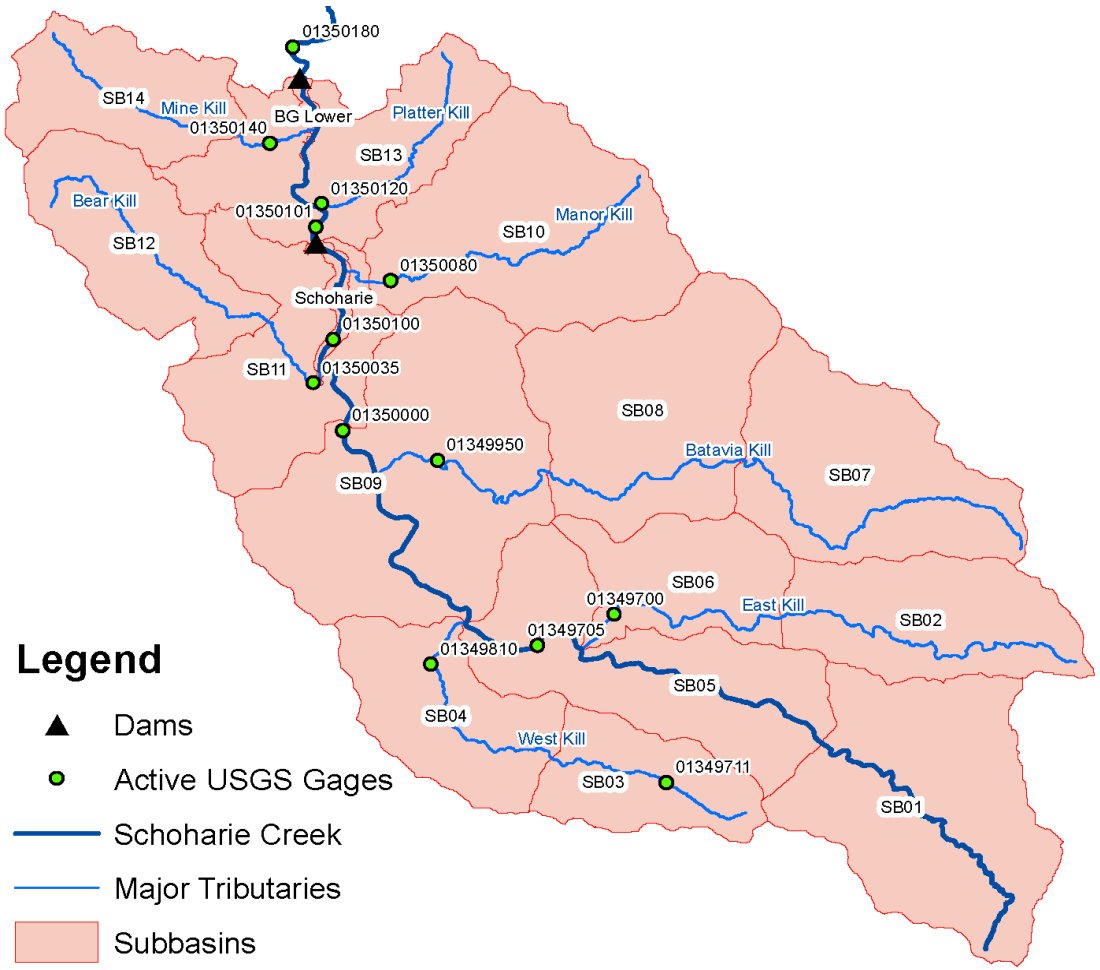
Hydrologic Model (HEC-HMS)

- Objective: Convert precipitation over time (hyetograph) to streamflow over time (hydrograph)
- Methodology: Various model elements determine this conversion including subbasins, reaches, and reservoirs.
  - Some of the parameters for these model elements are representative of physical characteristics of the watershed, while others are specific to the storm being modeled.



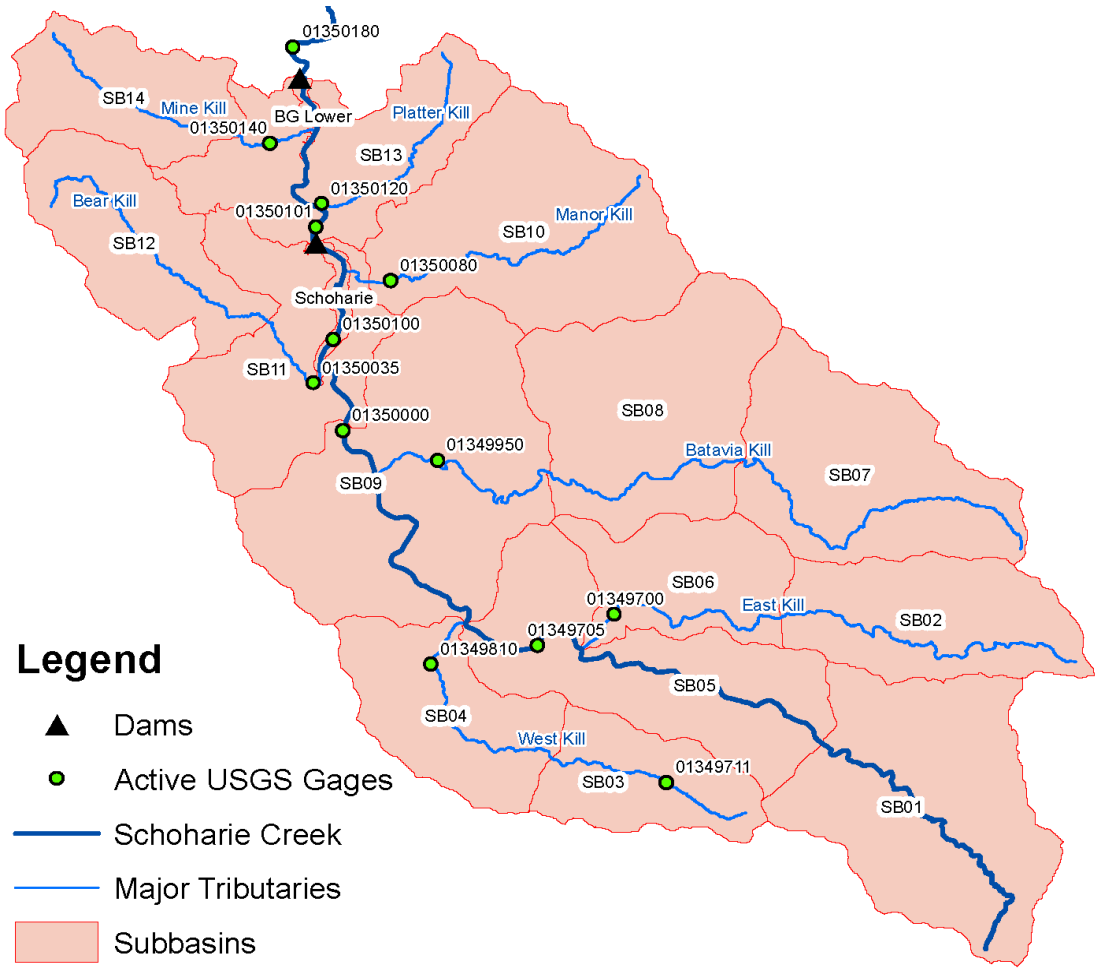
Hydrologic Model (Existing)

- Existing Hydrologic Model (HEC-HMS)
  - Reviewed and Approved by the Federal Energy Regulatory Commission (FERC) and an Independent Board of Consultants (November, 2009)
- Intended Use
  - Provide estimated inflow to the Lower Reservoir for the operations model
  - First verify adequacy of existing model to predict future storm events with information from August 2011, Tropical Storm Irene (Irene)



Hydrologic Model (Existing)

- Subbasin Parameters
  - Basin Related: Driven by size, shape, slope, land use
  - Storm Related: Driven by infiltration capacity of the soil when the storm begins
- Verification only alters Storm Related Parameters

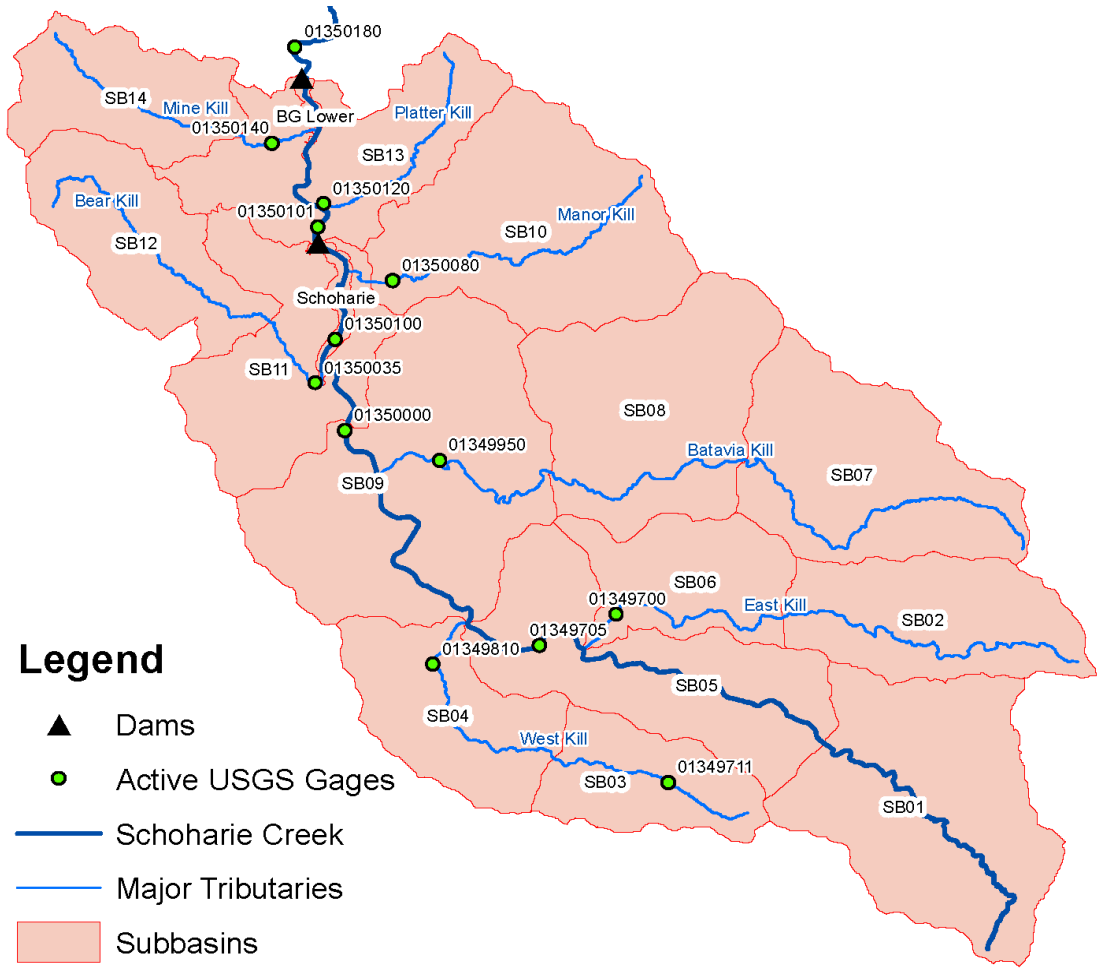


Irene Precipitation Data

- Precipitation Data Collected
  - Ground Measurements
    - National Weather Service (NWS)
    - New York City Department of Environmental Protection (NYCDEP)
    - Applied Weather Associates (AWA)
  - NWS Radar
- Used as input to model
- Data reported for this storm is imperfect

Irene Flow Data

- United States Geological Survey (USGS) Data Collected
  - Gage Records
  - USGS Report: Floods of 2011 in New York (SIR 2014-5058)
- Compared reported flows to modeled flows
- Data reported for this storm is imperfect
  - USGS acknowledges potential errors in their reported flow estimates

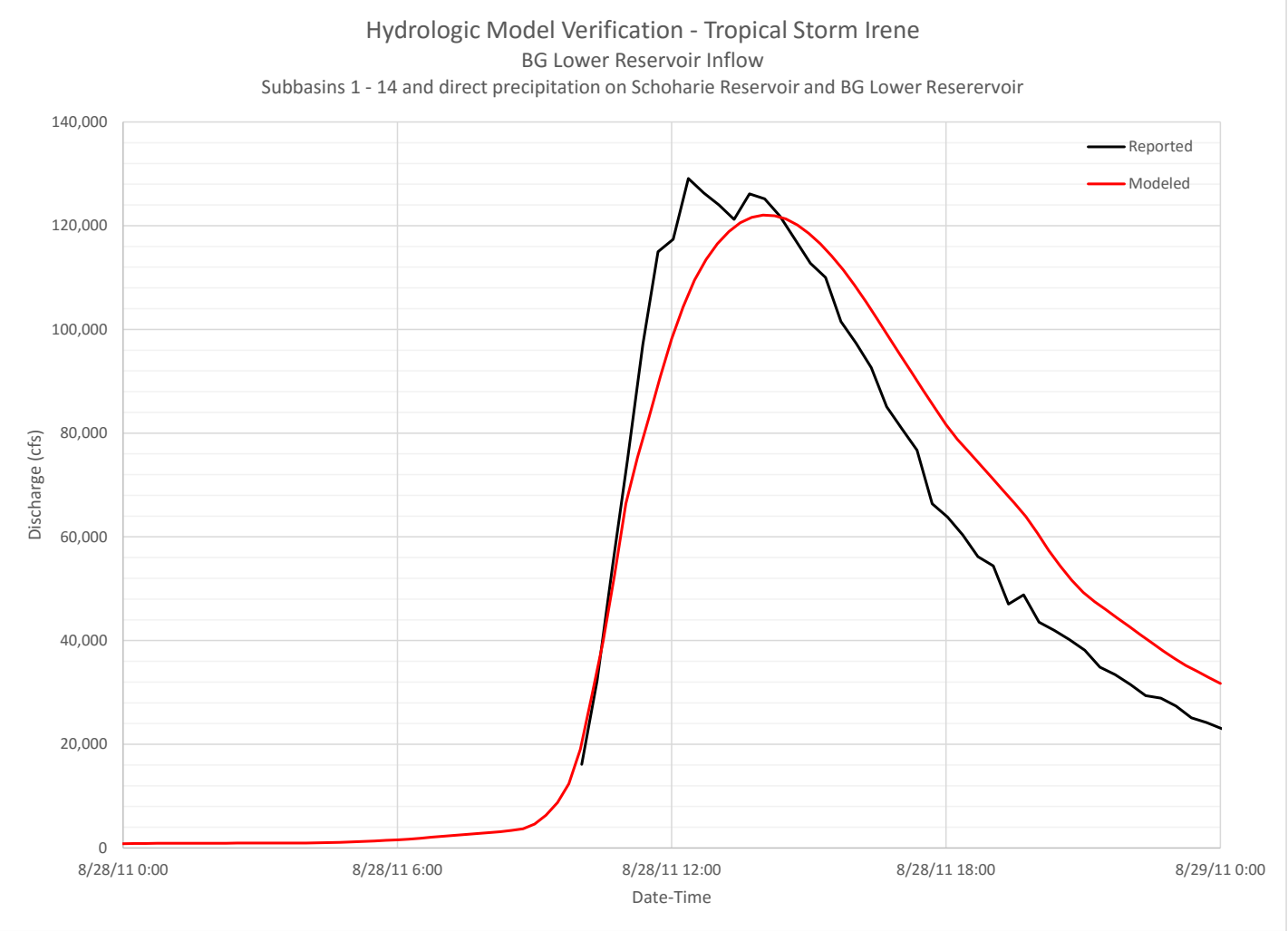


Irene Operations Data

- Reservoirs
  - Schoharie Reservoir/Gilboa Dam (NYCDEP)
  - Blenheim-Gilboa Pumped Storage Project (Power Authority)
- Irene Operations
  - Reservoir Storage Rating Curves
  - Spillway Discharge Rating Curves
  - Reservoir Elevation Measurements
  - Estimated Reservoir Discharge
  - Estimated Inflow (Power Authority Only)

Hydrologic Model Verification

- Preliminary Results
  - Compared USGS flow data with model results for Irene
  - Simulated inflow to the Lower Reservoir was within approximately 5% of the reported discharge



Hydrologic Model (Next Steps)

- Upstream Methodology (HEC-HMS)
  - Update reservoir parameters
  - Maintain existing storm related parameters
  - Precipitation Inputs (10-year, 50-year, 100-year, and 500-year)
  - Flow versus time results (hydrographs) used as input to HEC-ResSim and HEC-RAS models

Hydrologic Model (Next Steps)

- Downstream Methodology (Regression Analysis)
  - USGS Report: Magnitude and Frequency of Floods in New York (SIR 2006-5112)
  - Estimated peak discharge is based on data at the USGS gages along the Schoharie Creek as well as regional regression equations
  - These estimates will be used as downstream tributary inflows into the Hydraulic Model.

Hydraulic Model (HEC-RAS)

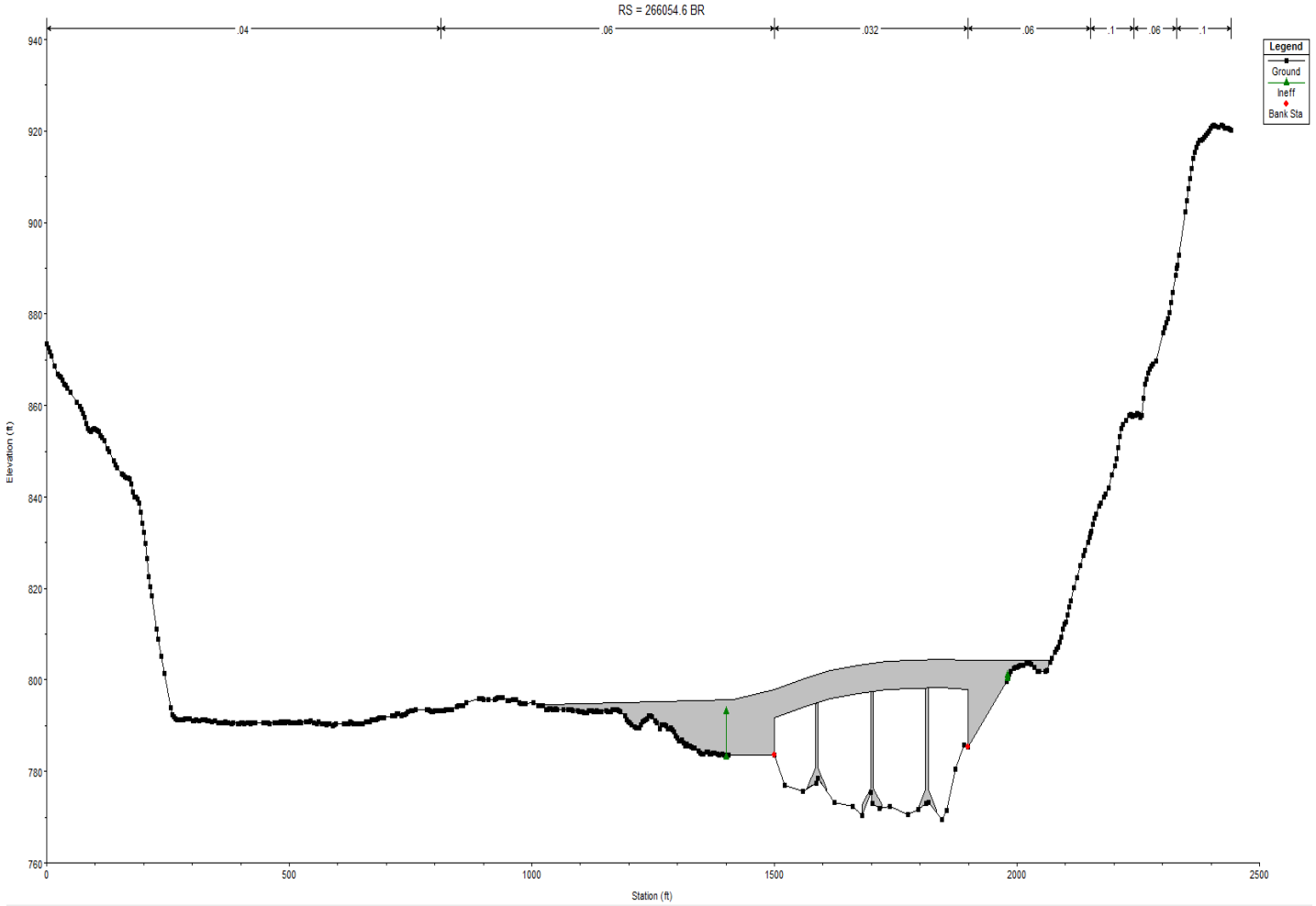
- Objective: Route flow versus time data (hydrograph) to estimate water surface elevations
- Methodology: Elevation, structure, and roughness data are used to evaluate the routing of the flow.

Hydraulic Model (Existing)

- Existing Hydraulic Model (HEC-RAS)
  - Reviewed and Approved by the Federal Energy Regulatory Commission (FERC) (June 2014)
- Intended Use
  - Provide estimated water surface elevations along the Schoharie Creek for different flows
  - First calibrate and verify existing model with information from August 2011, Tropical Storm Irene (Irene) and January 1996 flooding events

Hydraulic Model (Existing)

- 16 bridges updated
  - Surveys (New York State Canal Corporation 2014)
- 230 cross sections updated
  - Light Detection and Ranging (LiDAR) data (United States Geological Survey 2014)
  - Channel bottom (e.g. bathymetry, bridge surveys, Flood Insurance Study models, structure drawings, USGS quadrangle maps)



Hydraulic Model (Calibration/Verification)

- Differences between the storm events
  - Channel Geometry
  - Bridge Geometry
  - Roughness Elements
- Calibration and Verification will only alter the roughness values
  - Calibrate each event independently
  - Verify each event with a common set of roughness values

Flow Data for Calibration

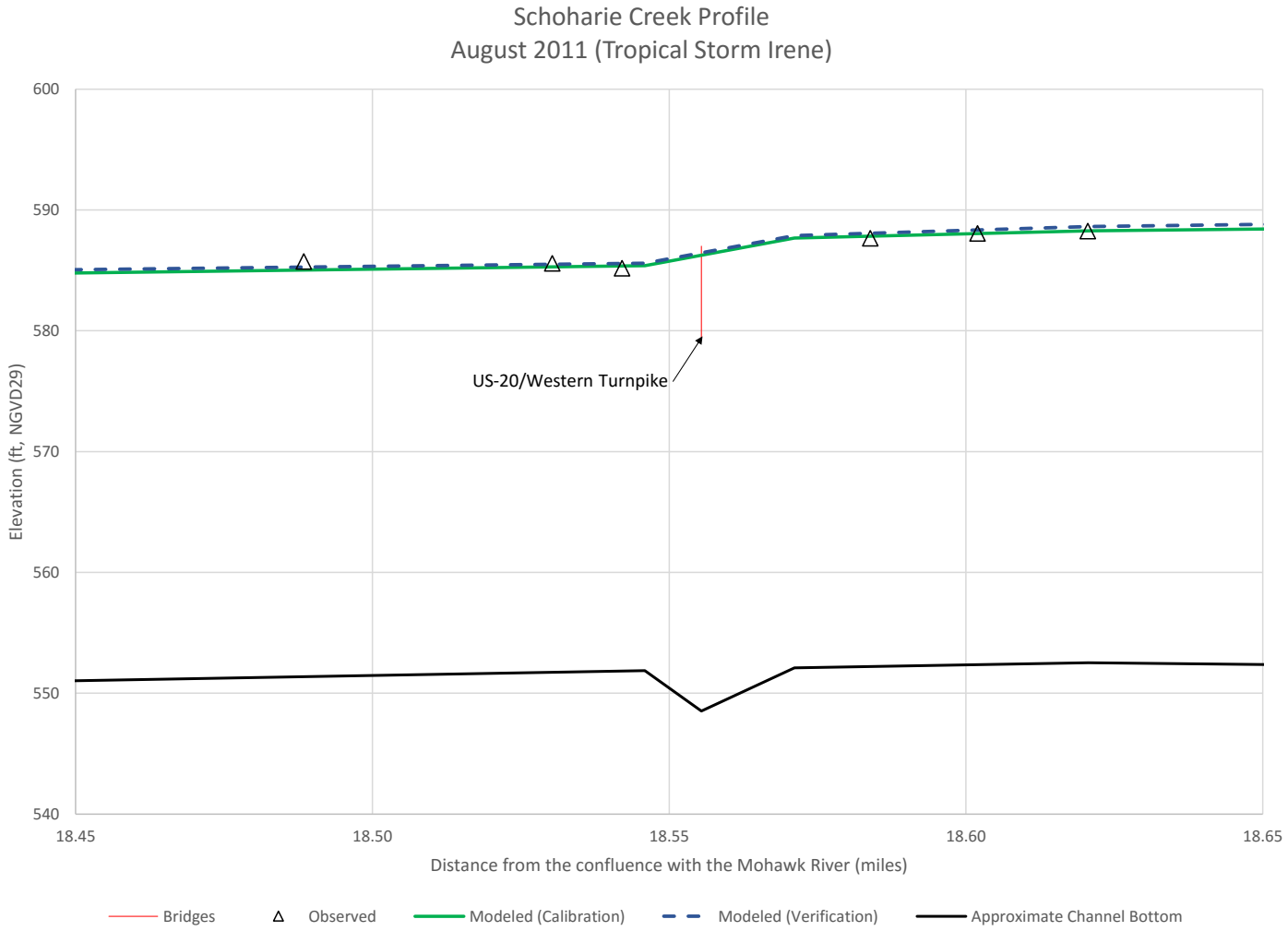
- Hydrograph Data Collected
  - USGS Gage Data
  - USGS Reports
    - Floods of 2011 in New York (SIR 2014-5058)
    - Flood of January 19-20, 1996 in New York State (WRIR 97-4252)
  - B-G Project Discharge

High Water Marks for Calibration

- High Water Mark (HWM) Data Collected
  - USGS Reports
    - Floods of 2011 in New York (SIR 2014-5058)
    - Flood of January 19-20, 1996 in New York State (WRIR 97-4252)
  - Power Authority Reports
- Data reviewed for outliers
  - Number of Marks used for Final Analysis
    - Jan-96: 74
    - Irene: 80
- Available HWMs generally concentrated near bridges

Hydraulic Model Calibration

- Preliminary Results
  - Compared flow and high water mark data with model results for Irene and January 1996 events
  - Model calibration yielded estimated WSELs that were within 0.5 feet for approximately 75% of the observed HWMs

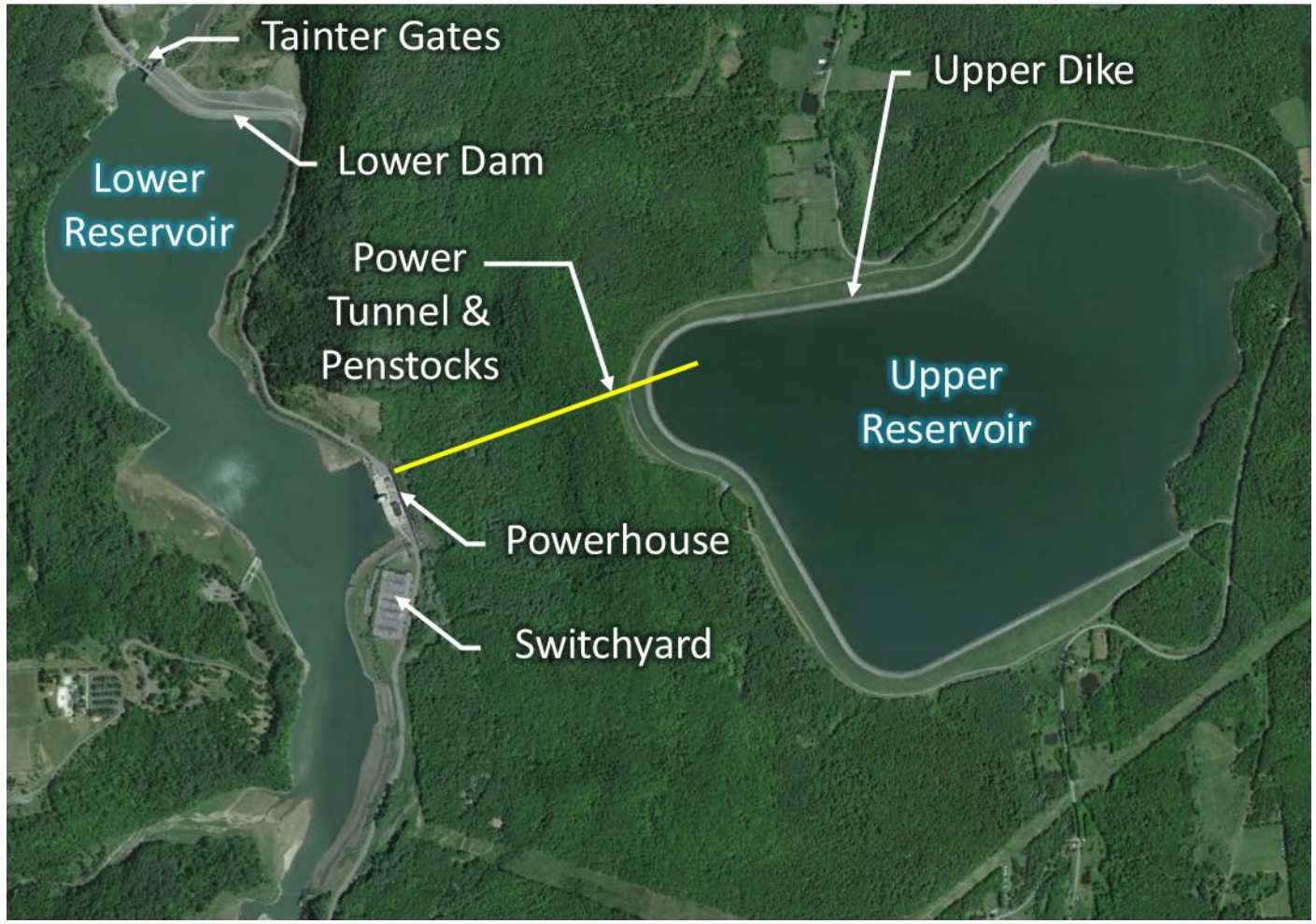


Operations Model (HEC-ResSim)

- Objective: Simulate various reservoir operations
- Methodology: Uses a rule based description of operational goals and constraints to make discharge decisions.
  - Discharge decisions are limited by the physical constraints of the system.

Operations Model (Development)

- B-G Project Features
  - Lower Reservoir
    - gated spillway
    - low level outlets
    - low discharge outlets
    - storage
  - Upper Reservoir
    - storage
  - Powerhouse
    - 4 pump-turbine units
- Intended Use
  - Simulate Existing Operations and High Flow Operation Alternatives



Operations Model (Development)

- Existing Operations
  - License Requirements
    - Releases from the Lower Reservoir should be no greater than flows which would have occurred in the absence of the B-G Project.
  - 1975 Settlement Agreement
    - Attempt to maintain a constant total reservoir volume during the rising flood inflows, so outflow will closely match inflow
    - Fluctuations in outflow will be controlled and minimized to the extent practicable

Operations Model (Development)

- Alternative Operations During High Flow Events
  - Physical Limitations
    - Lower and Upper Reservoir Storage
    - Tainter Gate Capacity
    - Pump-Turbine Capacity and Operability
  - Operational Limitations
    - Dam Safety
    - National Weather Service (NWS) Flood Forecasting Reliability
    - Reliability of Real-Time Observations (e.g. availability and accuracy of flow gages)
    - Regional Power Requirements

Hydraulic Model (Next Steps)

- Without B-G Project for 10-, 50-, 100-, and 500-year events
  - Flows from HEC-HMS and gage regression
- Current Operations for 10-, 50-, 100-, and 500-year events
  - Flows from HEC-ResSim and gage regression
- Alternative Operations during High Flow Events for 10-, 50-, 100-, and 500-year events
  - Flows from HEC-ResSim and gage regression

Break

Historic Structures Survey
and
Phase 1A Archaeological Survey

Study Goals and Objectives

- Meet requirements of Section 106 of National Historic Preservation Act of 1966 as amended (Section 106)
- Identify historic properties (historic structures and archaeological resources) that may be eligible for listing or listed in the National Register of Historic Places within the Project's Area of Potential Effect (APE)
- Review archaeological data that are pertinent to the formulation of a sensitivity model to determine where archaeological resources may be located in the APE
- Offer a field strategy for archaeological testing to determine whether archaeological resources are present in the Project's APE

Geographic Scope

- Area of Potential Effect (APE) are lands within the Project boundary
  - NY State Historic Preservation Office (SHPO) concurred with APE 1/2/2015

Study Progress

Historic Structures Survey

- Consulted with NY SHPO, Schoharie County Historical Society, local historians
- Conducted background research to identify known historic structures
- Conducted fieldwork including searching file archives and a survey of all resources 50 years and older.
- Prepared a historic context to aid in determining NRHP eligibility
- Evaluated structures for NRHP eligibility
- Submitted draft report to the NY SHPO
- On February 22, 2016, NY SHPO concurred with findings in the draft report.
- Have begun update of the 1992 Lansing Manor Historic Structure Report

Study Progress

Phase 1A Archaeology Study

- Reviewed existing information from NY SHPO and maps
- Developed sensitivity model to identify locations that may contain resources
- Conducted field reconnaissance survey
- Submitted draft report to the NY SHPO on February 1, 2016

Summary of Findings

Historic Structures Survey

- Seven resources evaluated for eligibility to NRHP

Resource	Eligibility Recommendation
Lansing Manor	Listed
Mattice Cemetery	Not eligible
The Baldwin House (aka Park Manager's House)	Not eligible
Lansing Turnpike	Not eligible
Coyne Cottage	Not eligible
The B-G Project and Mine Kill State Park	Eligible when 50 years old

Summary of Findings

Phase IA Archaeological Study

- Sensitivity model identified four variables needed for potential presence of archaeological resources
  - Location of known archaeological site
  - Steepness of terrain
  - Proximity to a waterbody
  - Presence of arable soils
- Field Reconnaissance with NYSHPO (October 15, 2015)
  - Mouth of Mine Kill Creek
  - Portions of old floodplain
  - Fluctuation zone of Lower Reservoir on date of reconnaissance
- Conclusions
  - Only those bottomlands with little topographic relief in proximity to the former creek channel likely to be sensitive for presence of archaeological resources.
  - Substrates in the fluctuation zone were jumbled throughout meaning any archaeological materials, observed or buried, would not be in their primary context.
  - Phase IB testing (shovel test pits) therefore is not recommended in connection with the relicensing.

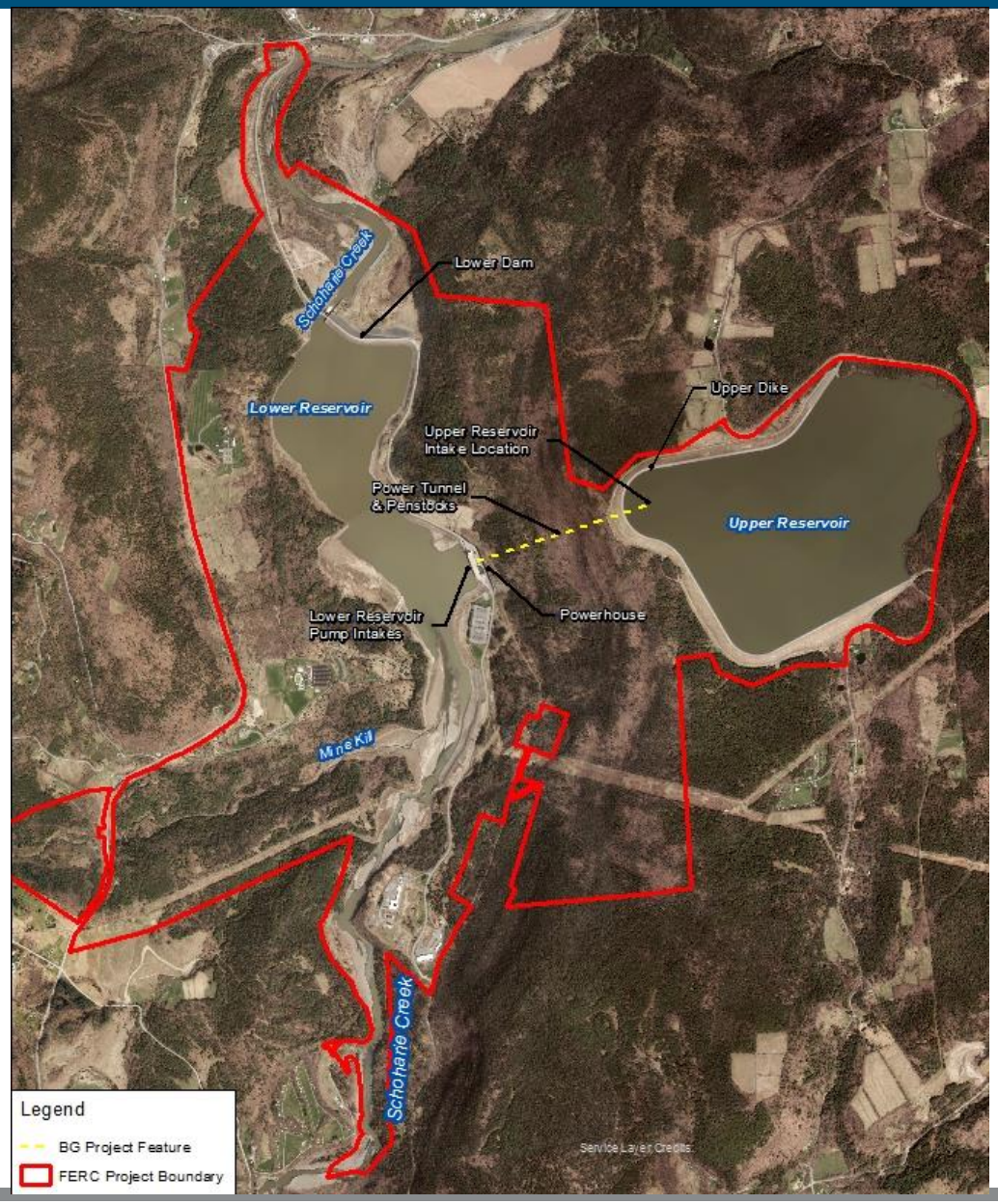
Fish Entrainment/Protection Assessment Study

Study Goals and Objectives

- **Goal:**
  - Conduct qualitative analysis of potential fish entrainment at the Project
- **Objectives:**
  - Describe Project characteristics
  - Summarize fish species present in the Upper and Lower Reservoir
  - Evaluate water quality and velocity conditions at intake locations
  - Evaluate which fish species and life stages have potential for entrainment
  - Review related studies conducted at similar projects
  - Estimate turbine passage survival based on available information

Geographic Scope

- Lower and Upper Reservoir



What is Entrainment and Survival?

- Entrainment:
  - The passage of organisms (e.g. fish) through the intake structure

- Survival:
  - The successful passage through the turbines so that the fish lives

Methodology

Tasks:

1. Describe Project Reservoir, Intake and Turbine Configurations
2. Field Collection of Intake Velocities
3. Water Level and Water Quality Data Analysis
4. Entrainment Analysis
   - Fish species
     - Evaluate biological and ecological factors
     - Habitat preference
     - Size, swim speed
   - Literature review of fish entrainment and survival studies at similar projects

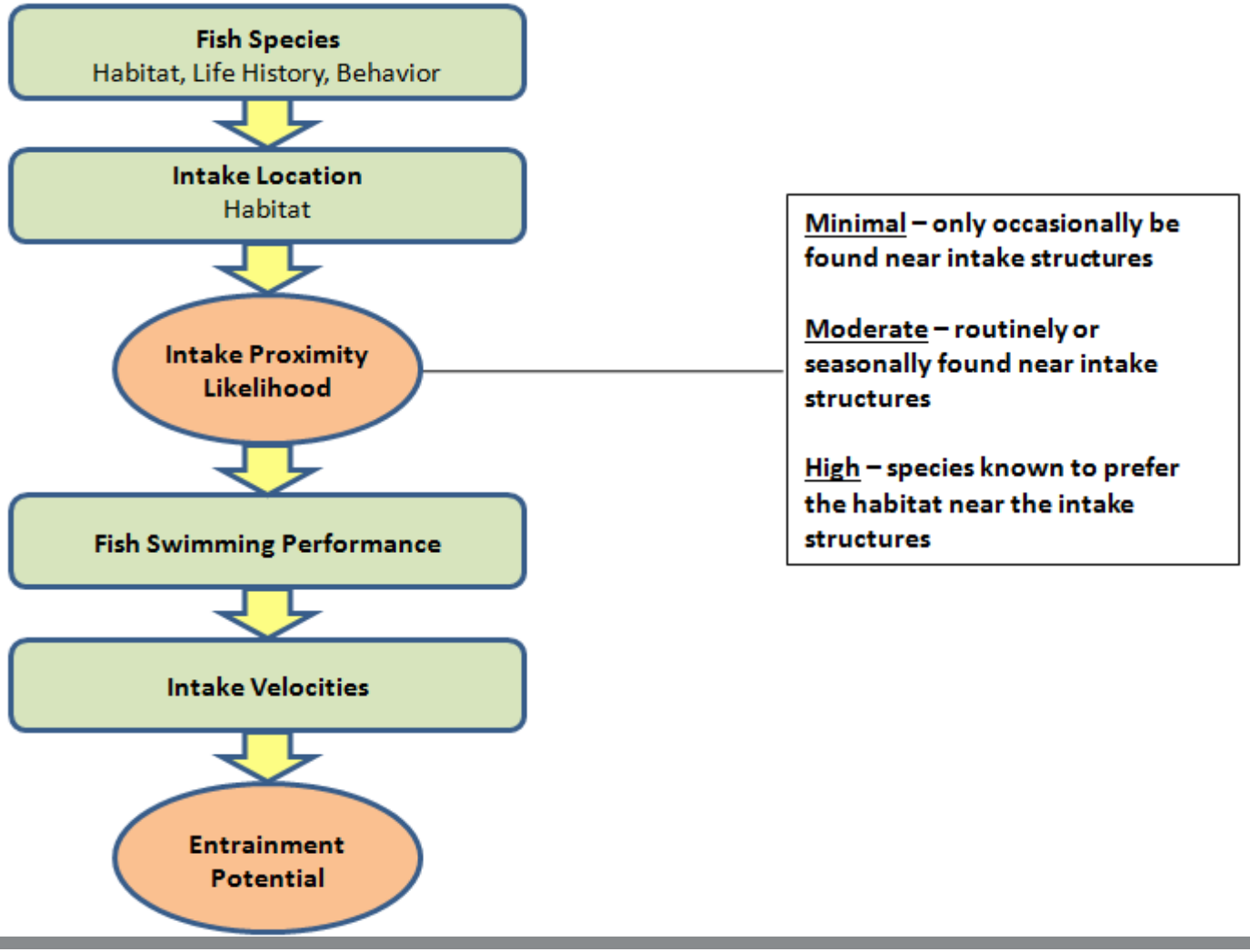
Methodology (cont.)

5. Assessment of Turbine Passage Survival
   - Estimated from similar hydroelectric projects
   - Blade strike model
   - Pressure calculations
6. Study Report

Factors that Affect Entrainment and Survival

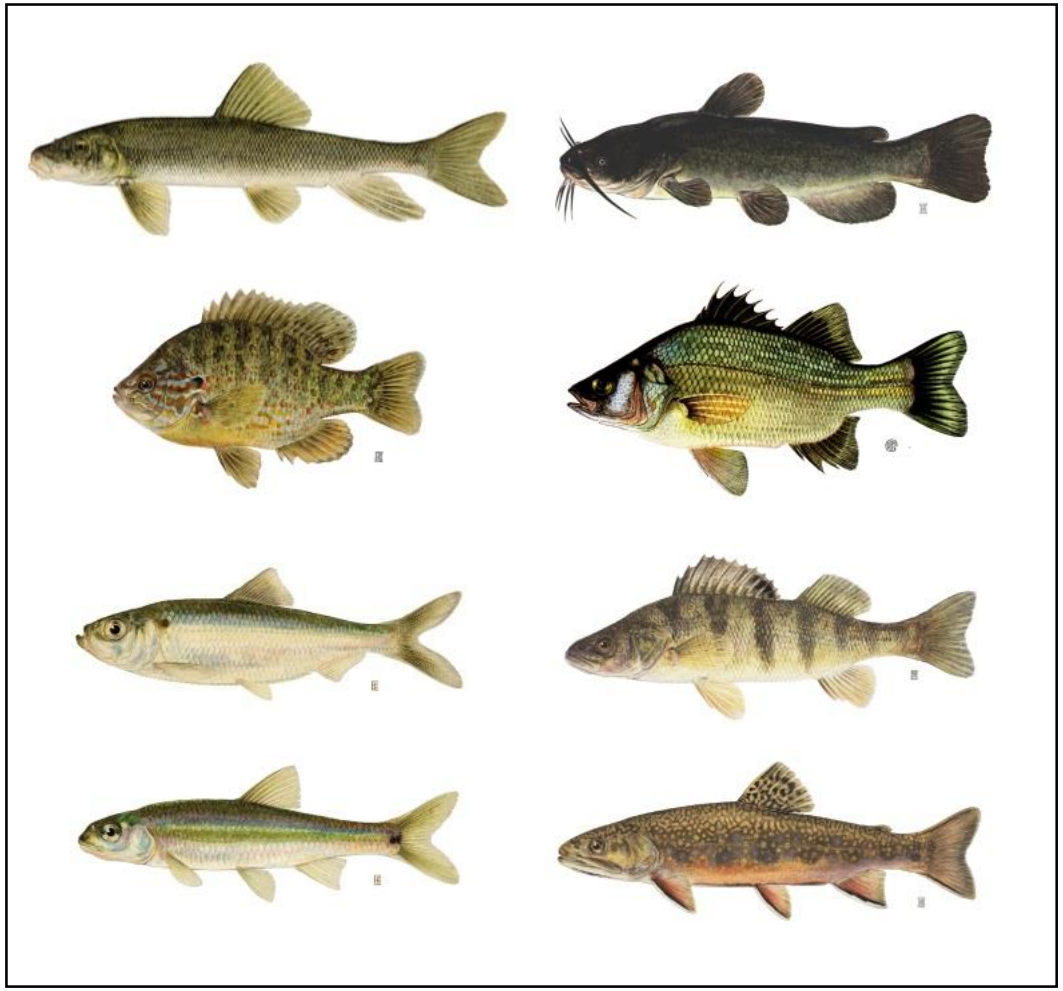
- Ecological
  - Environmental preferences (habitat)
  - Behavior (foraging, avoidance)
- Biological
  - Morphology (size/swimming performance)
  - Physiology (swim bladder)
  - Life History (migratory habits)
- Engineering
  - Size, location of intake, trashrack spacing
  - Intake velocity
  - Turbine type, number of blades, rotational speed, hydraulic capacity
  - Change in water pressure
  - Operations (water levels)

Entrainment Assessment Framework



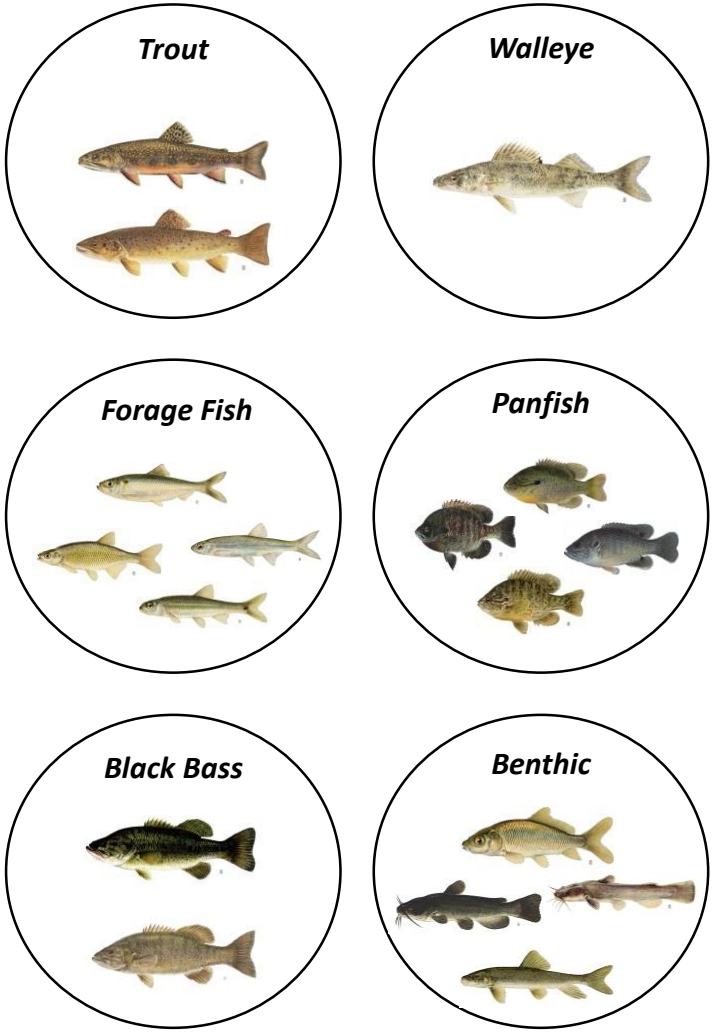
The Fishery

- Warmwater/Coolwater fishery
- Stocking of Trout and Walleye
- Bass, Perch, Sunfish, Forage, Bullhead
- No sea-run (diadromous) species
- No Threatened or Endangered species



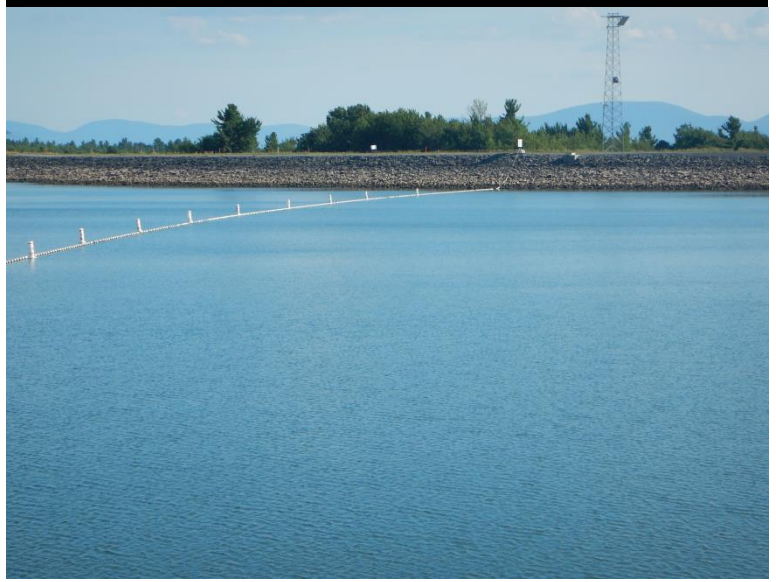
Fish Species – Grouping

- Grouping:
  - Species with similar traits
    - Life histories
    - Habitat requirements
    - Behavior
- Life-stages:
  - juvenile, adults, spawning

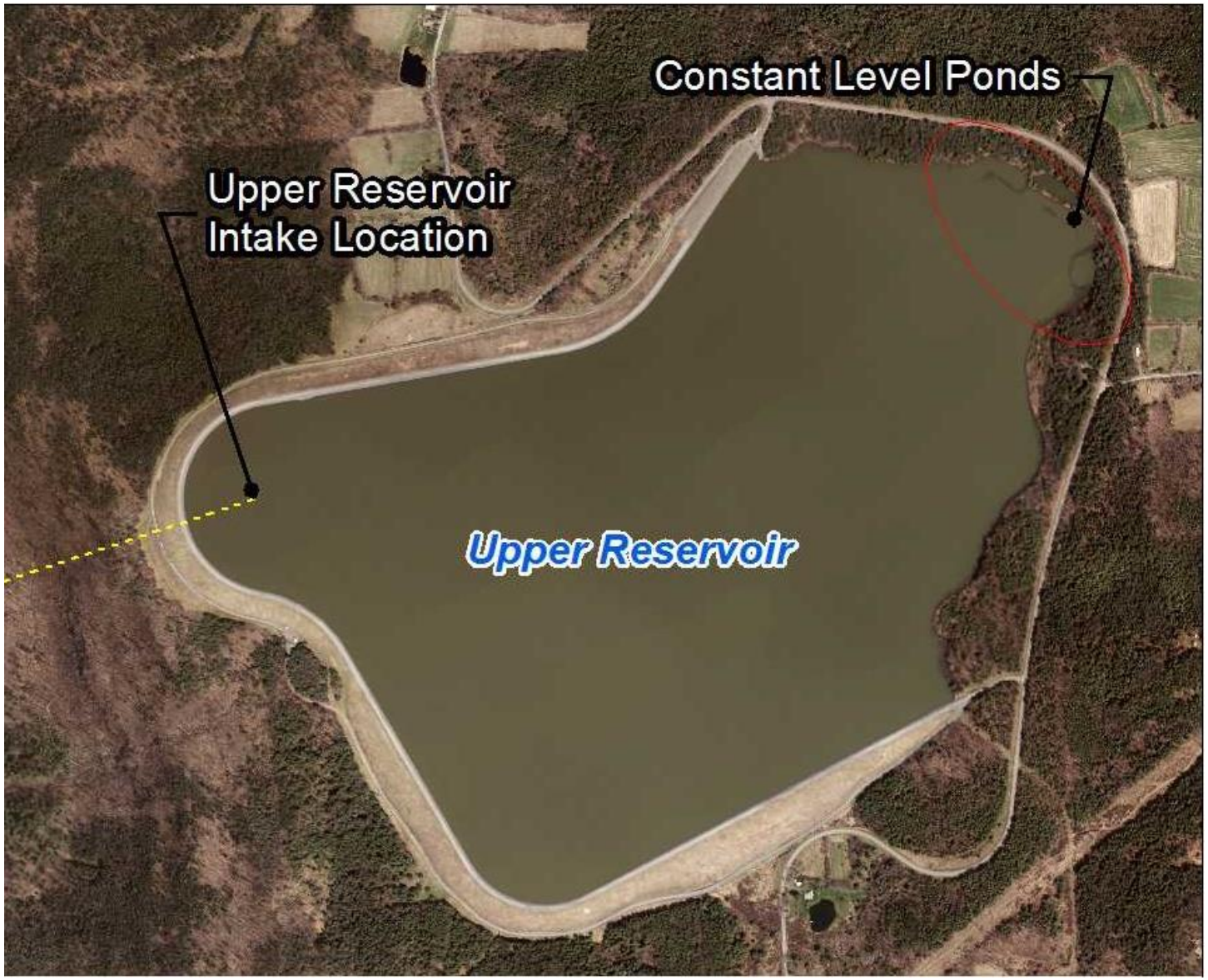


Upper Reservoir Habitat

- Steep slopes, bowl shape
- Open water pelagic
- Limited littoral zone
- Constant Level Ponds
  - Littoral area, vegetation



Upper Reservoir

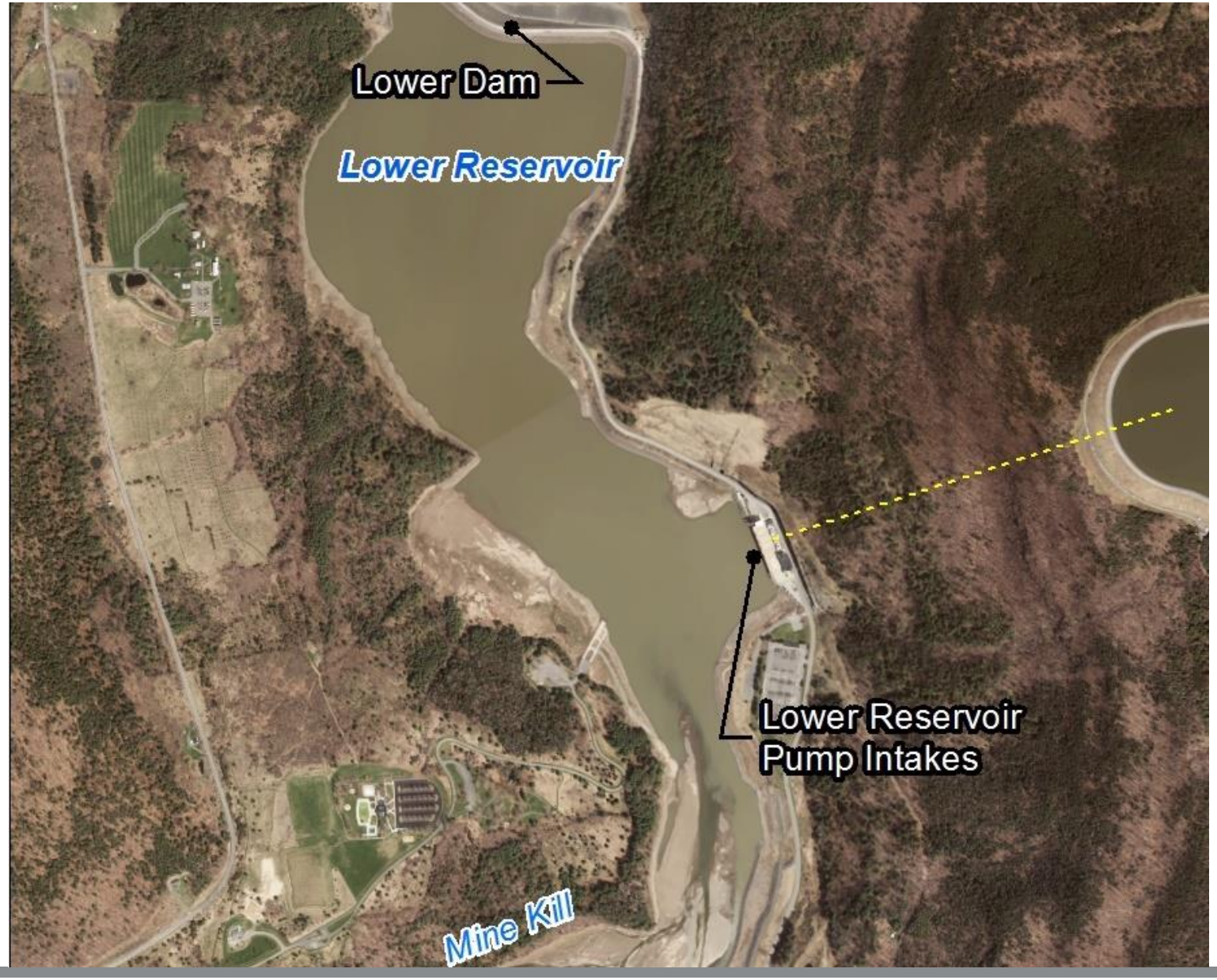


Upper Reservoir Intake

Depth and Habitat:

- 36.5 ft (min), 84.5 ft (max)
- No natural shoreline near intake
- Counter sunk with steep sides
- Sand, silt, bedrock substrate

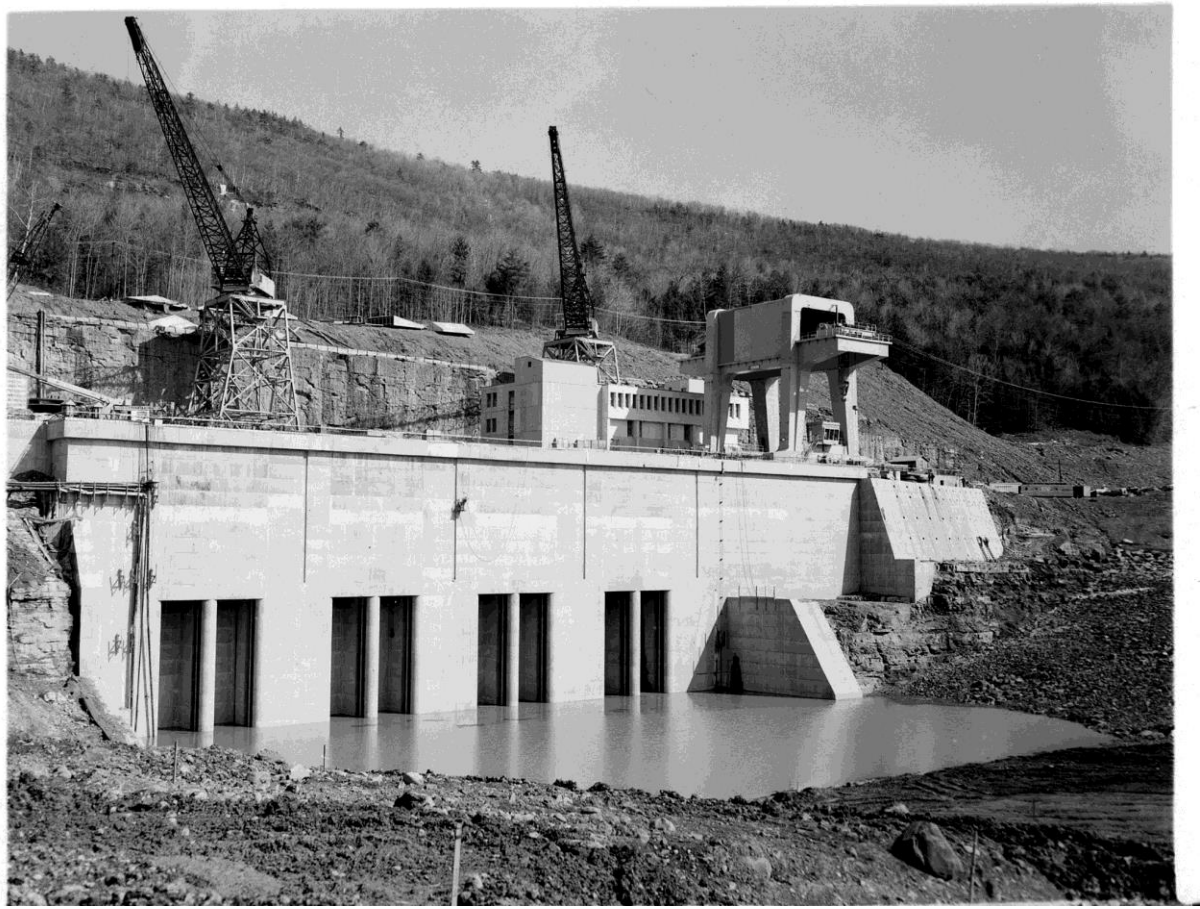
Lower Reservoir



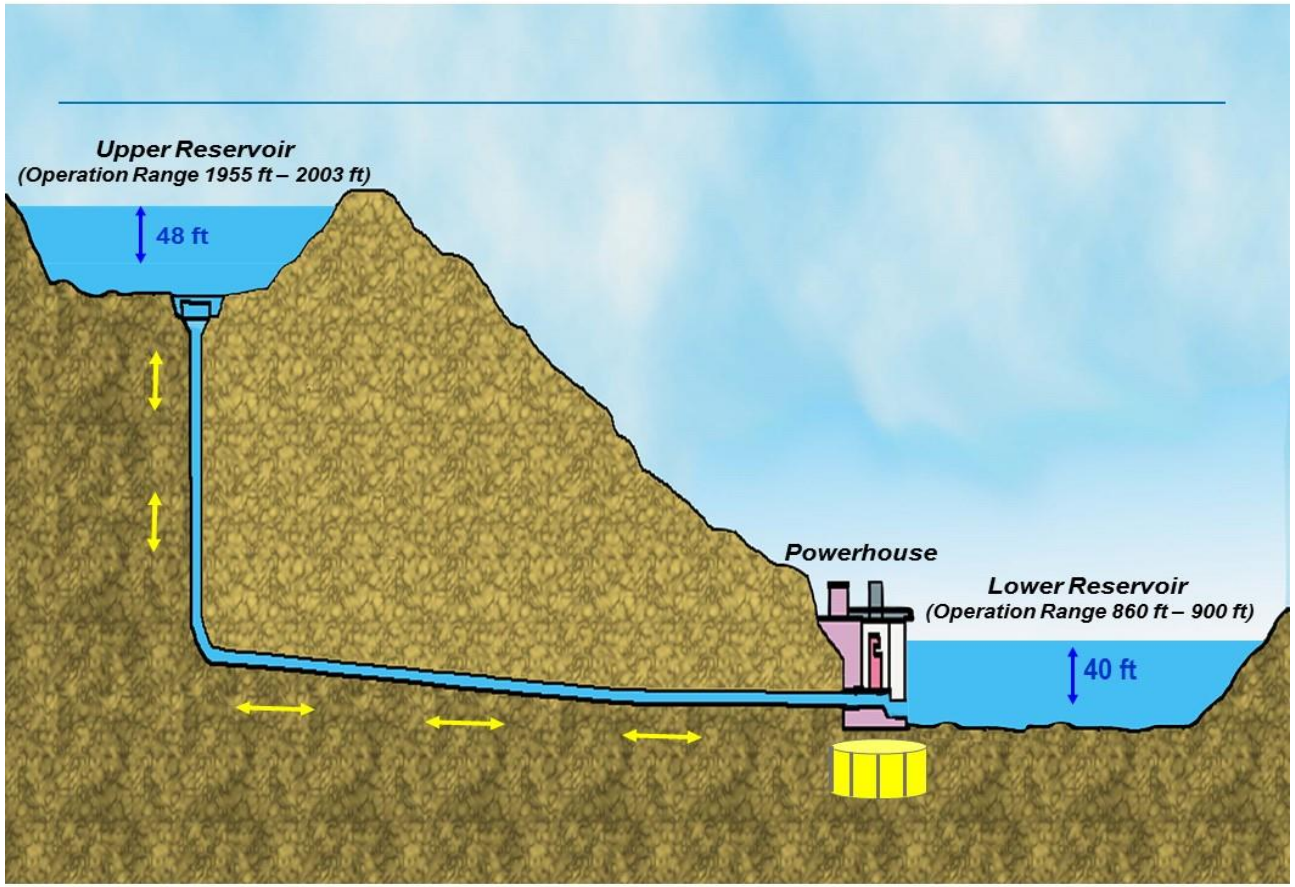
Lower Reservoir Intake

Depth and Habitat:

- Intake openings are 66 ft high
- Excavated channel with steep sides
- Sand, silt substrate
- Lack of littoral zone near intake



Schematic of Project Operations



Turbines

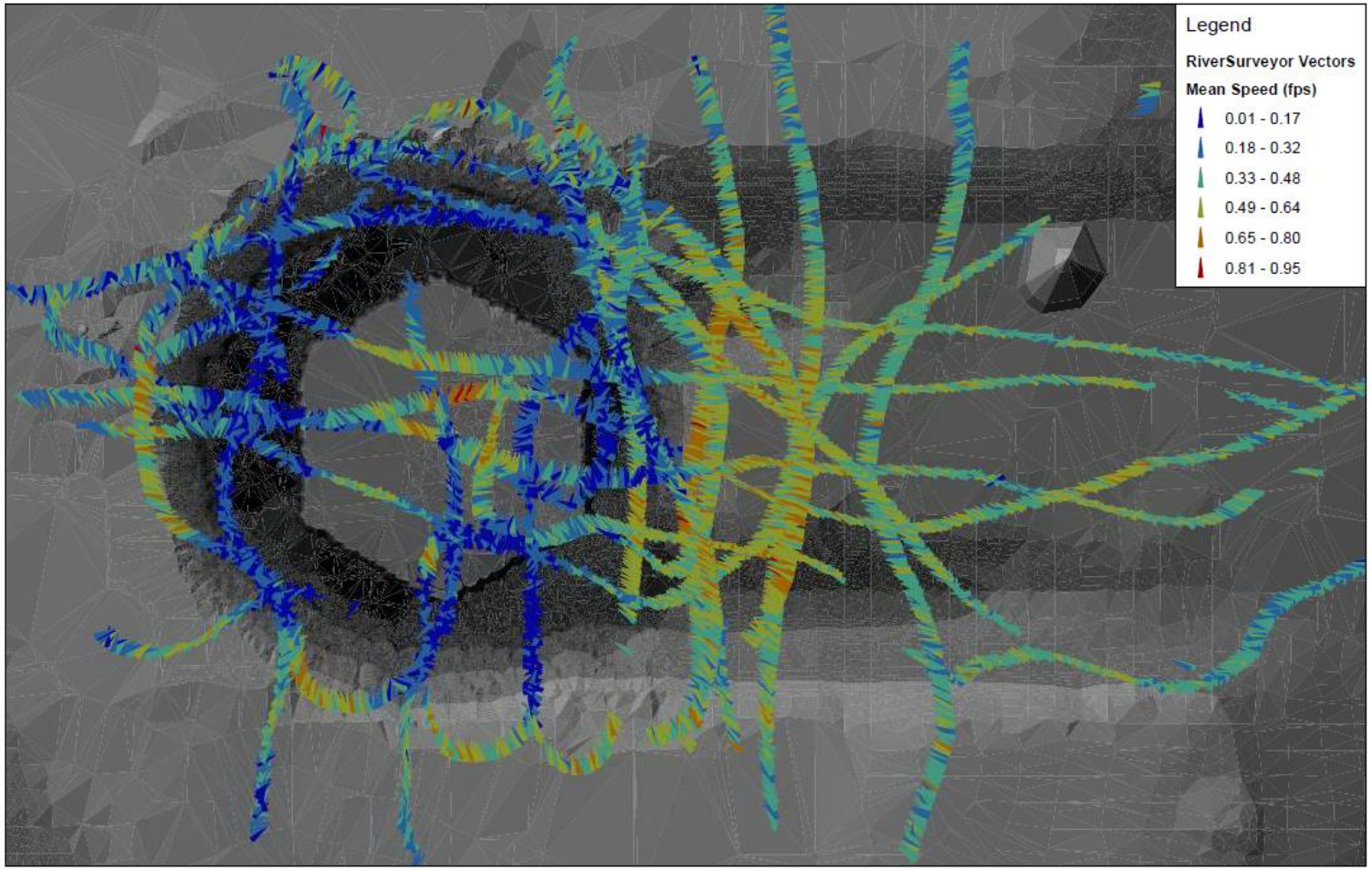
- 4 Reversible modified vertical Francis-type
  - 20 ft runner
  - 7 blades
  - 257 rpm
  - Hydraulic capacity
    - 3,200 cfs (generating)
    - 2,550 cfs (pumping)
  - Calculated Intake Velocities
    - Upper Reservoir 3.28 ft/s (1 ft in front)
    - Lower Reservoir 1.38 ft/s (1 ft in front)

Field Velocity Measurements: Upper Reservoir

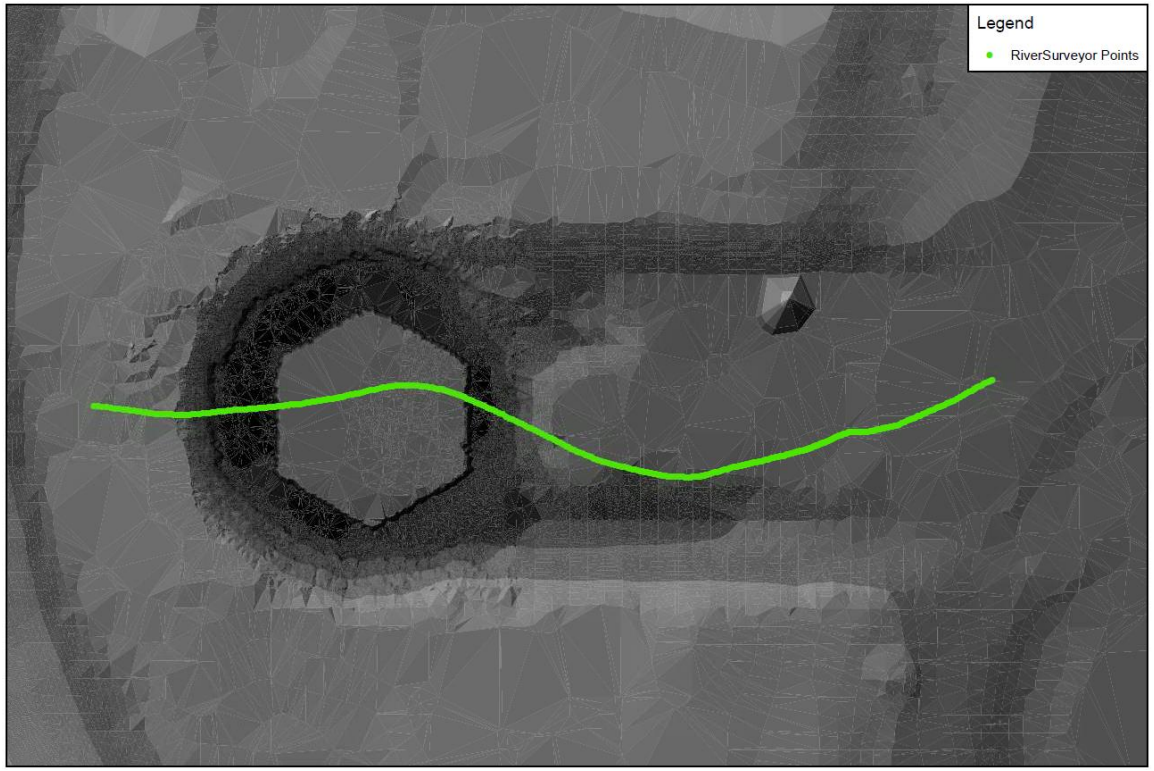
Water velocity in the vicinity of the intake in the Upper Reservoir measured 7/29/15

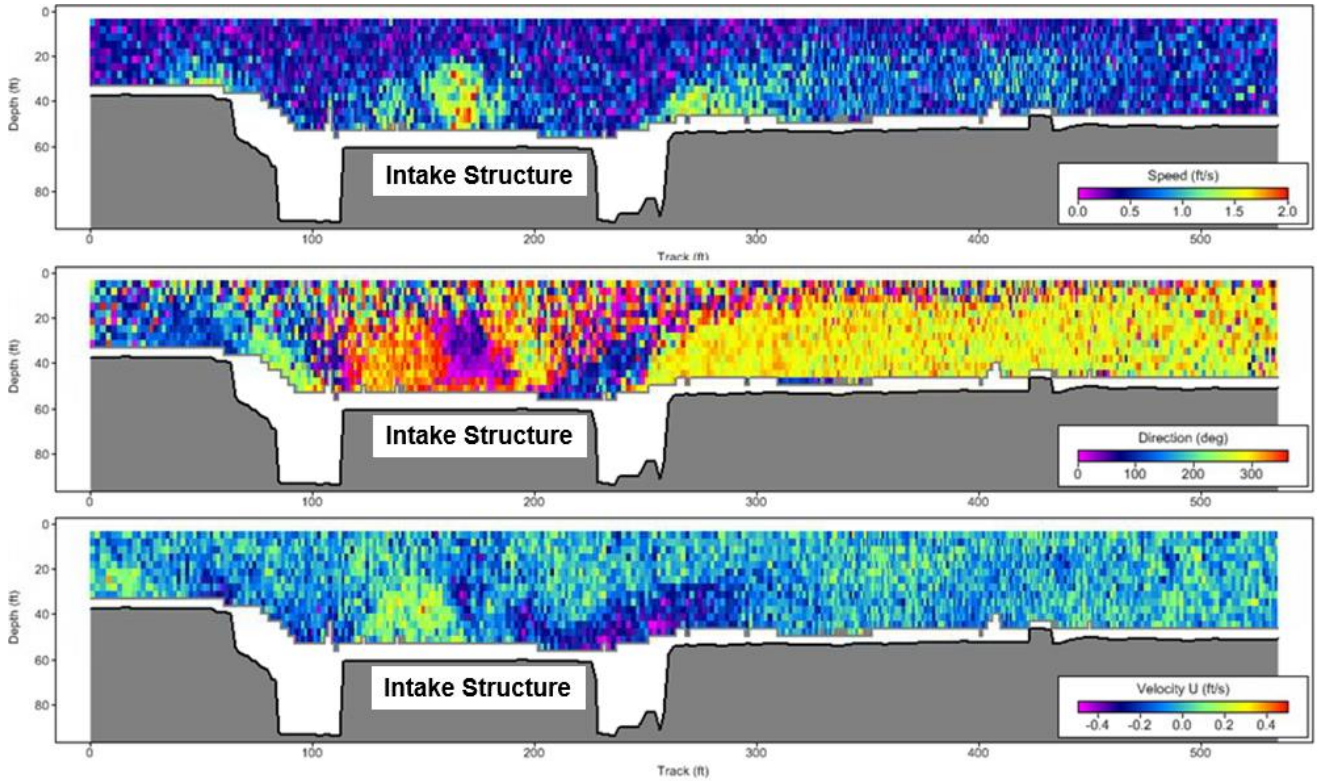
- Four units were generating at approximately full load
- Most (~90%) velocities measured were below 1.5 fps
- Max value: 2.95 fps

Sampling tracks during four units generating



Field Velocity: Upper Reservoir





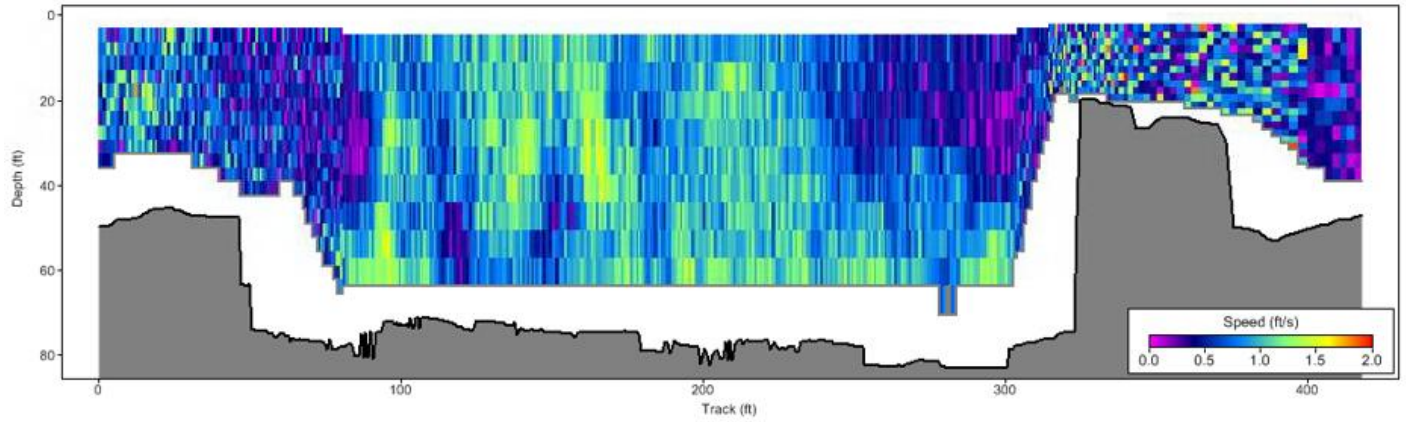
Field Velocity Measurements: Lower Reservoir

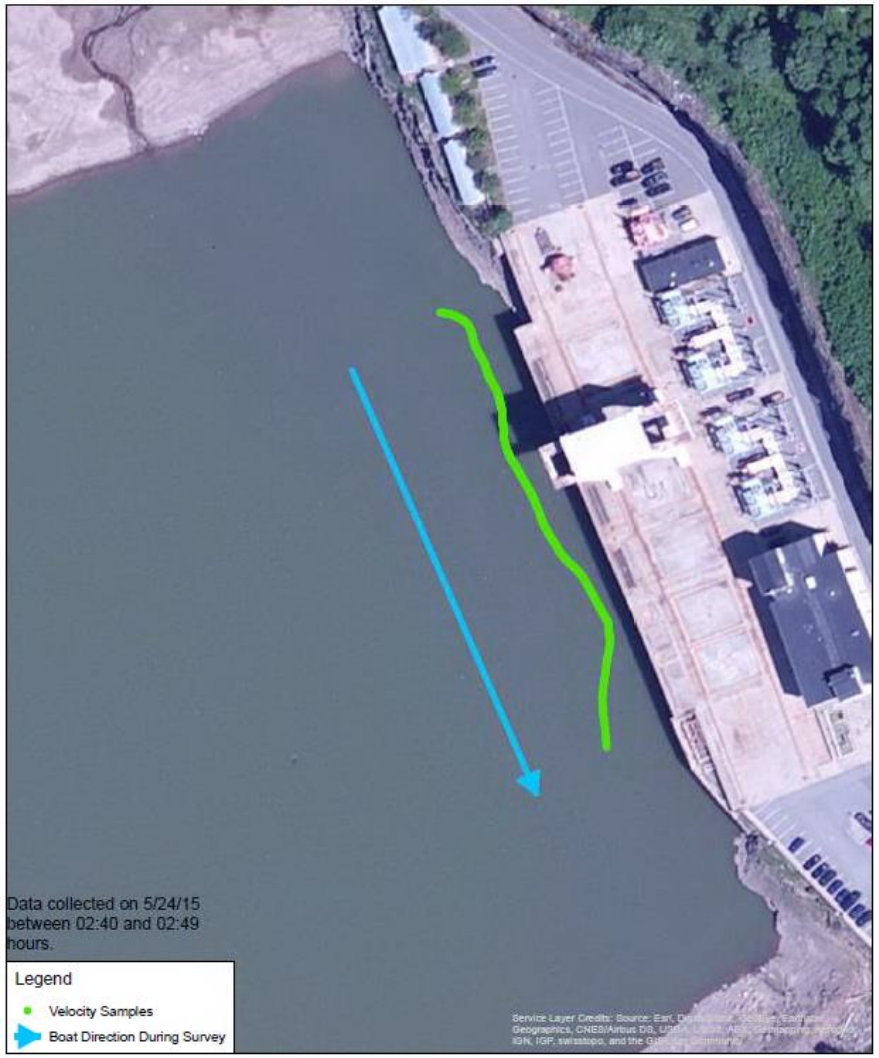
Water velocity in the vicinity of the intake in the Upper Reservoir measured 5/24/15

- During this time, four units were pumping at approximately -1,185 MW
- Maximum velocities were slightly higher than the 1.38 fps calculated velocity
  - Max velocity = 1.95 fps
  - Variable across intake

Field Velocity Measurements: Lower Reservoir

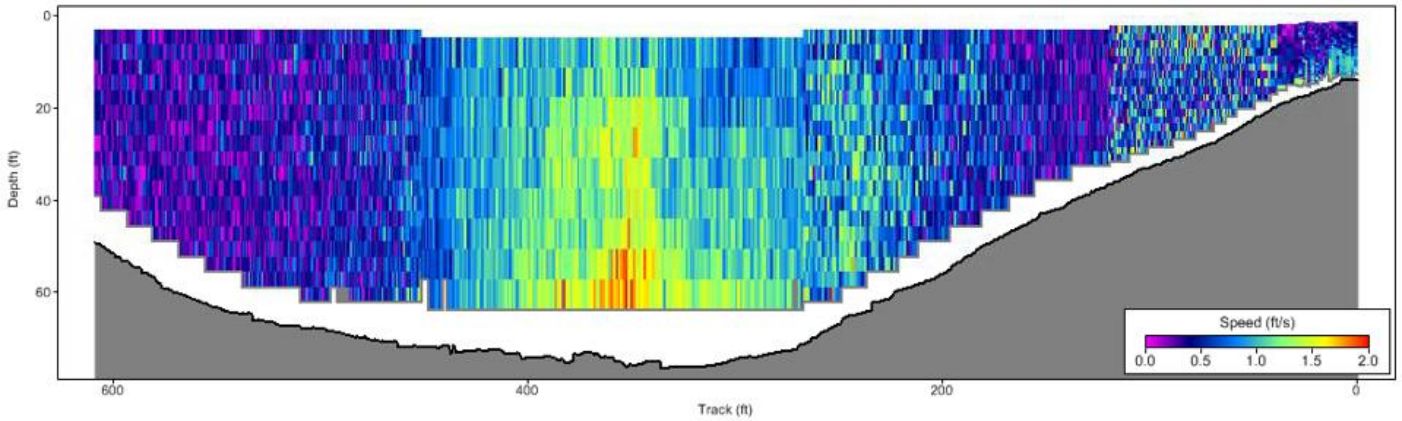
Parallel, nearest to the intake, 25-35 feet from the wall

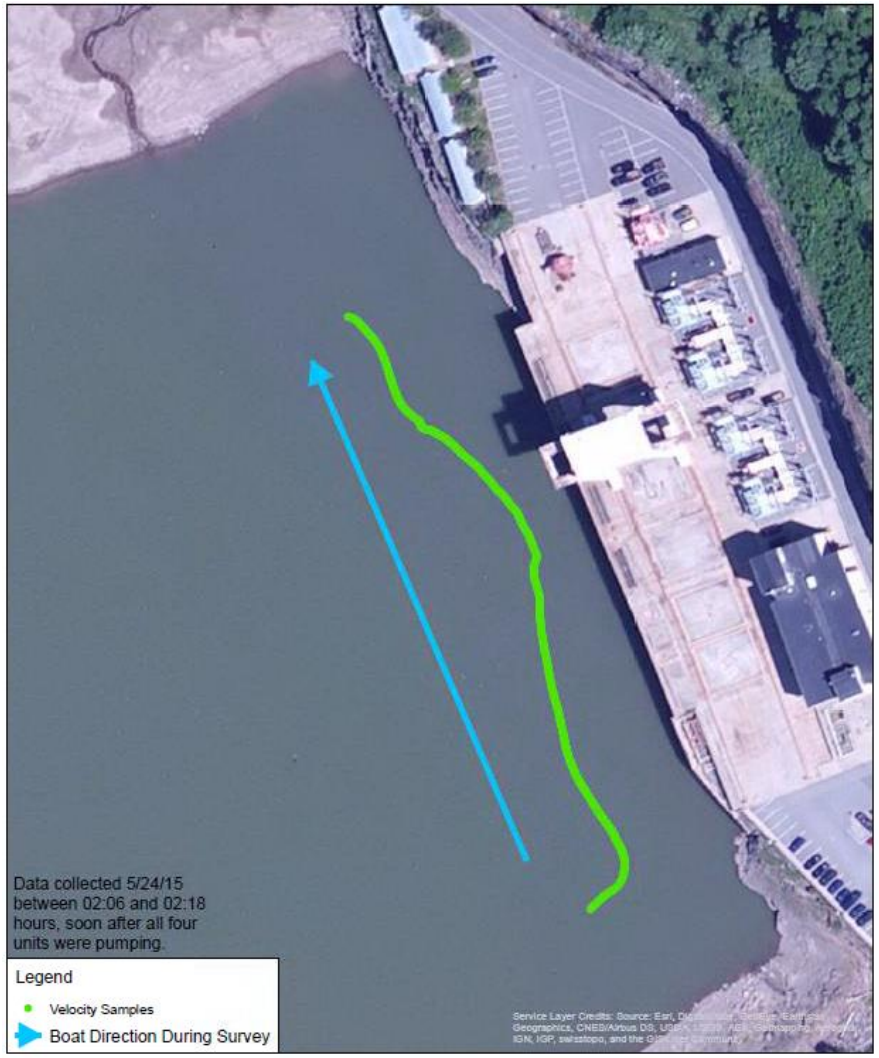




Field Velocity Measurements: Lower Reservoir

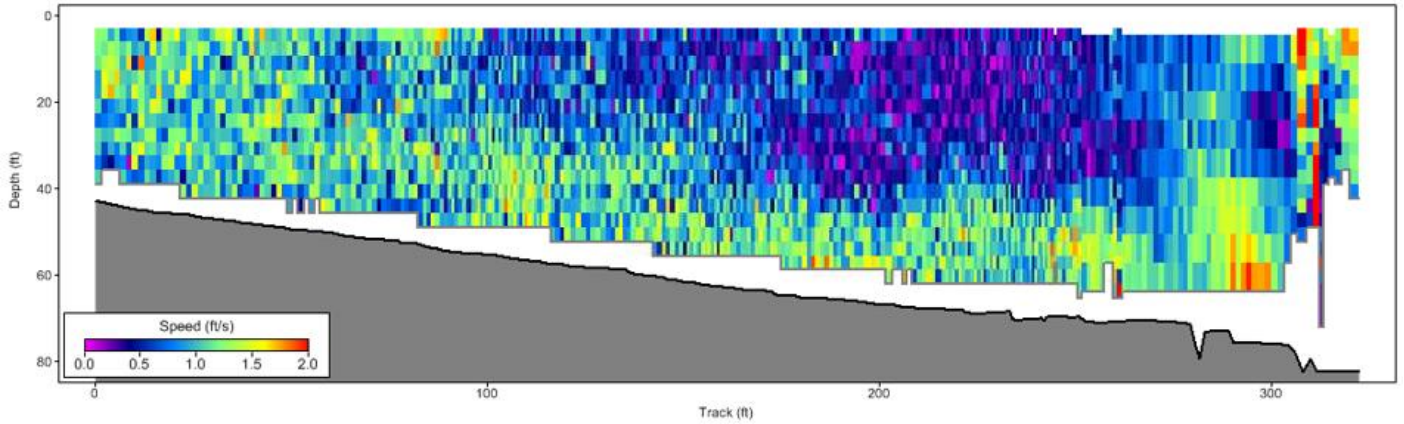
Parallel, approximately 60-100 feet away from the intake, soon after all four units were online and pumping

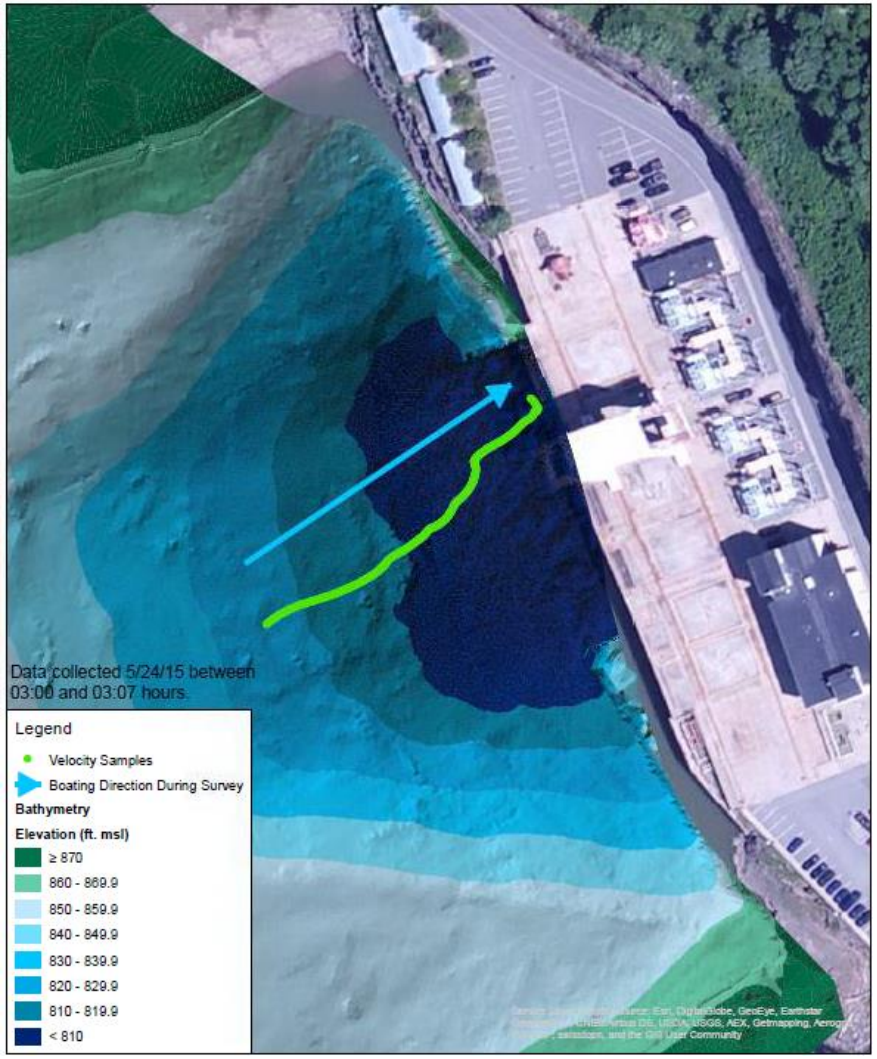




Field Velocity Measurements: Lower Reservoir

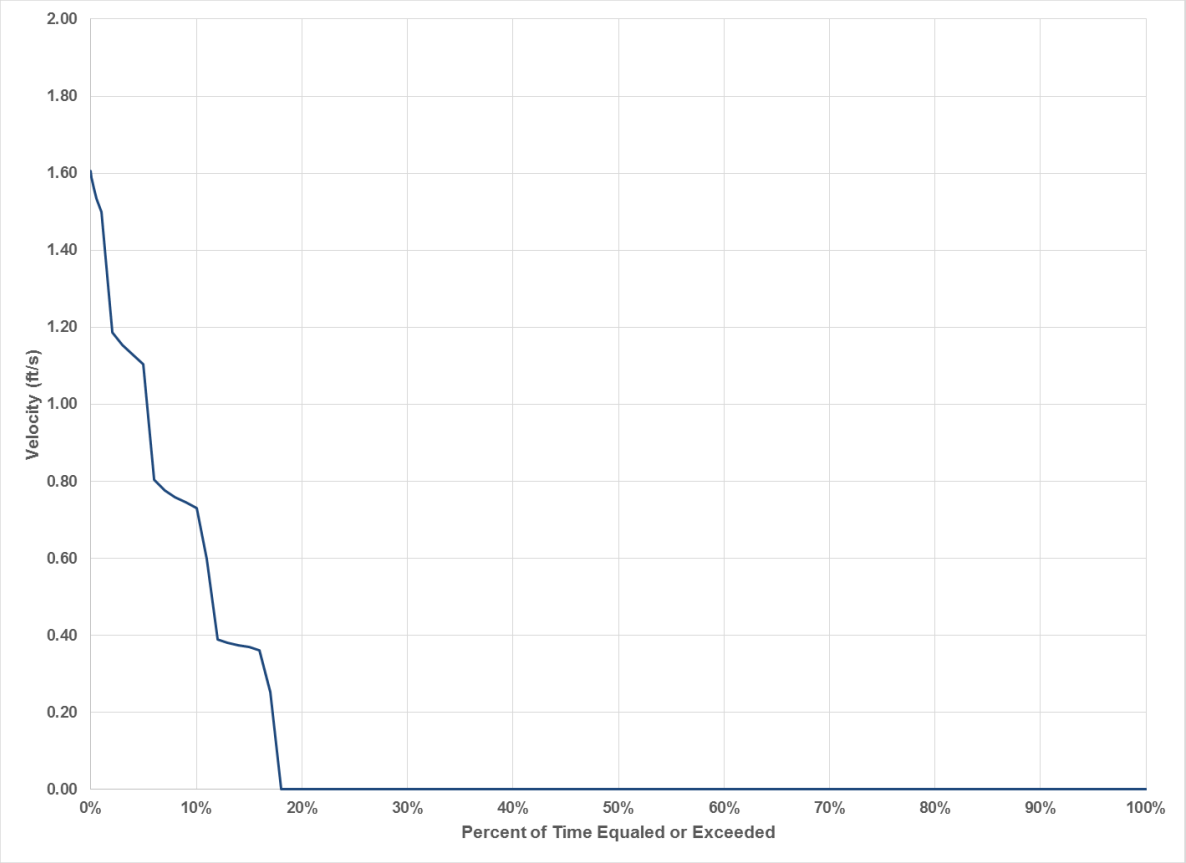
Perpendicular, collected in a direction towards the intake



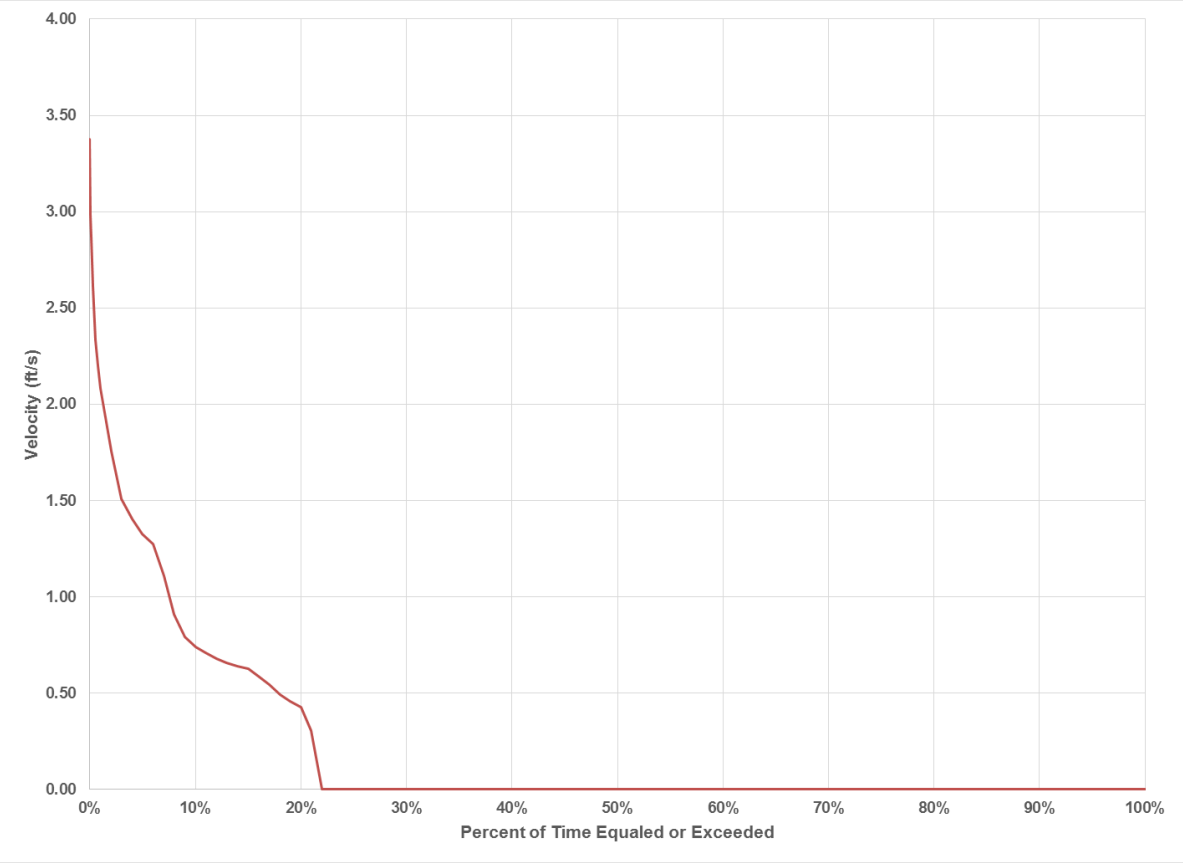


Annual Velocity Duration Curves (Calculated)

Lower Reservoir (Pumping) Years 2002-2014



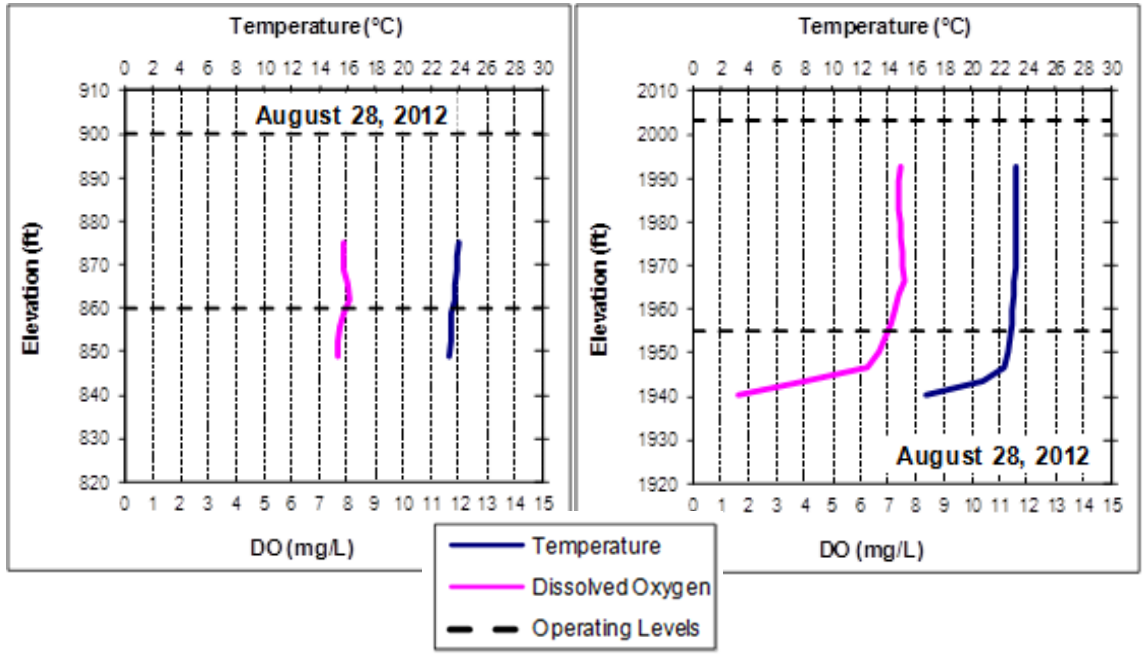
Upper Reservoir (Generating) Years 2002-2014



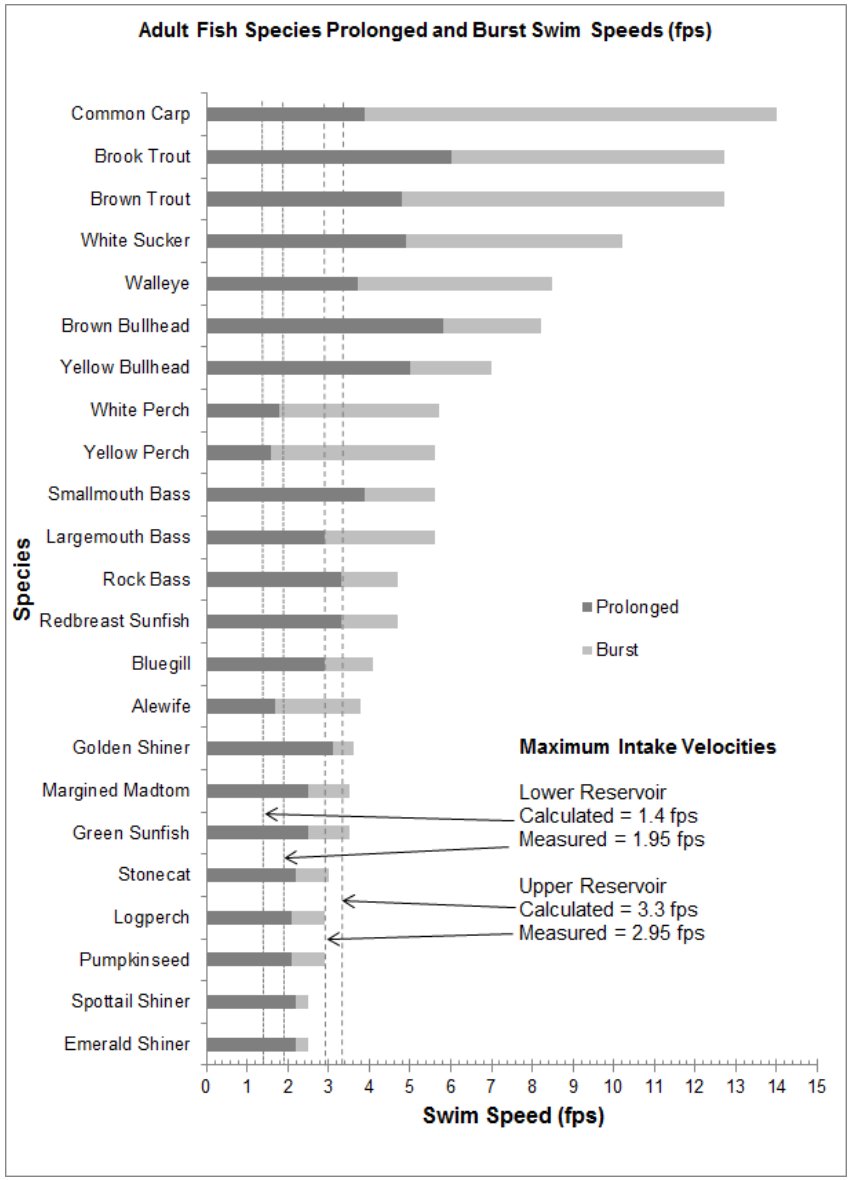
Water Level and Water Quality

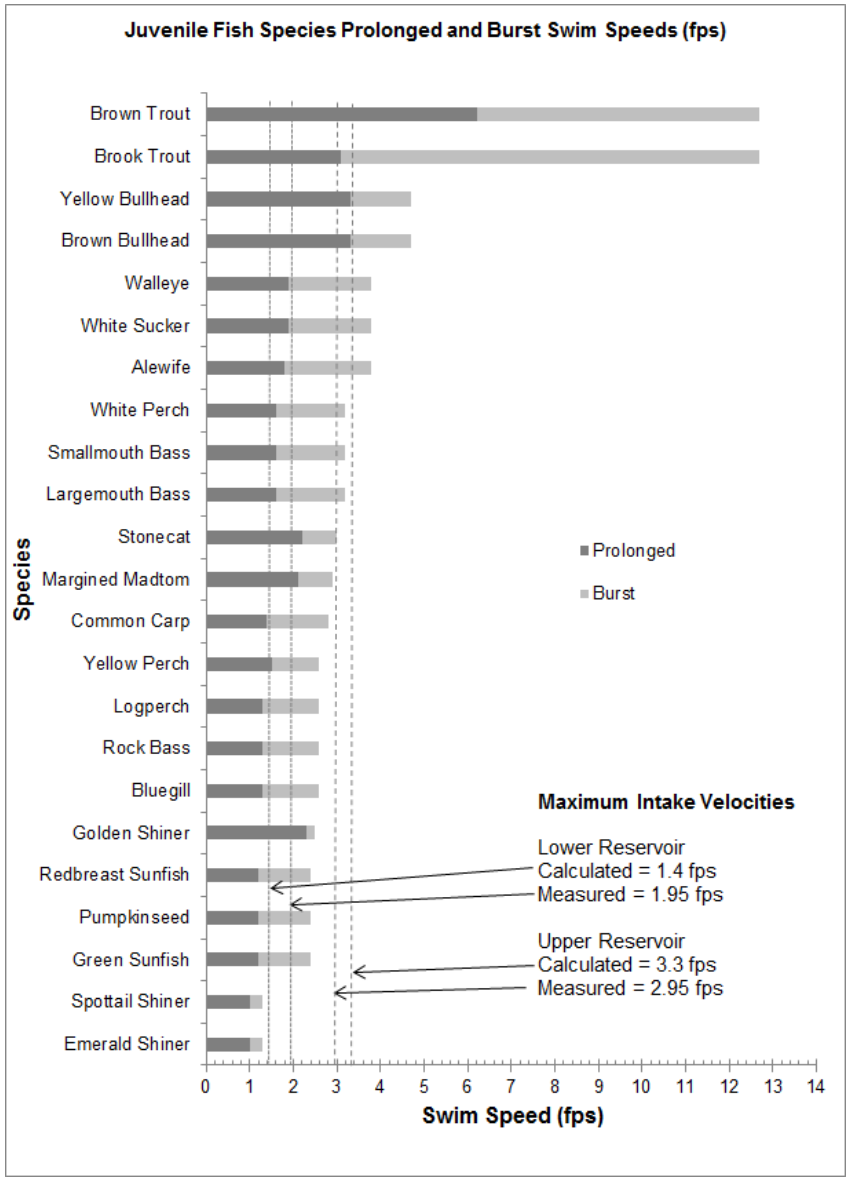
- Depth to intake changes with operations
- No seasonal drawdown
- Water temperature and dissolved oxygen
  - Thermal and dissolved oxygen preference/tolerance

Lower Reservoir Intake *Upper Reservoir Intake*



Swim Speeds


Adult Fish Species Prolonged and Burst Swim Speeds (fps)
Species
Common Carp
Brook Trout
Brown Trout
White Sucker
Walleye
Brown Bullhead
Yellow Bullhead
White Perch
Yellow Perch
Smallmouth Bass
Largemouth Bass
Rock Bass
Redbreast Sunfish
Bluegill
Alewife
Golden Shiner
Margined Madtom
Green Sunfish
Stonecat
Logperch
Pumpkinseed
Spottail Shiner
Emerald Shiner
Prolonged
Burst
Maximum Intake Velocities
Lower Reservoir
Calculated = 1.4 fps
Measured = 1.95 fps
Upper Reservoir
Calculated = 3.3 fps
Measured = 2.95 fps
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Swim Speed (fps)


Juvenile Fish Species Prolonged and Burst Swim Speeds (fps)
Species
Brown Trout
Brook Trout
Yellow Bullhead
Brown Bullhead
Walleye
White Sucker
Alewife
White Perch
Smallmouth Bass
Largemouth Bass
Stonecat
Margined Madtom
Common Carp
Yellow Perch
Logperch
Rock Bass
Bluegill
Golden Shiner
Redbreast Sunfish
Pumpkinseed
Green Sunfish
Spottail Shiner
Emerald Shiner
Prolonged
Burst
Maximum Intake Velocities
Lower Reservoir
Calculated = 1.4 fps
Measured = 1.95 fps
Upper Reservoir
Calculated = 3.3 fps
Measured = 2.95 fps
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14
Swim Speed (fps)

Entrainment Potential – Lower Reservoir (At Maximum Pumping Capacity)

- Species susceptible to entrainment
  - Forage Group –
    - Alewife (juvenile), Emerald Shiner (juvenile), Spottail Shiner (juvenile), Logperch (juvenile)
      - Vertical movements
      - Preference for open water
      - Burst swim speed < intake velocity of 1.95 fps
  - Benthic Group
    - Brown and Yellow Bullhead, Margined Madtom, Stonecat (juvenile)
      - Bottom-oriented
      - Burst swim speed likely less than intake velocity of 1.95 fps

Ways Fish May Enter Upper Reservoir

- Stocking
  - Bass, Trout, Walleye
- “Bait bucket” introductions
- Bird-mediated dispersal
- Entrainment of small/early life stages
  - High survival rate due to small size

Entrainment Potential – Upper Reservoir (At Maximum Generating Capacity)

- Species susceptible to entrainment
  - Walleye Group
    - Walleye (juvenile)
      - Prefer moderately deep, Burst swim speed < intake velocity of 3.3 fps
  - Panfish Group
    - Bluegill, Green Sunfish, Pumpkinseed, Redbreast Sunfish, and Yellow Perch (adult)
      - Deep water in winter, thermal refuge, Burst swim speed < intake velocity of 3.3 fps
  - Forage Group
    - Alewife (juvenile), Emerald Shiner, Golden Shiner, Spottail Shiner and Logperch (adult and juvenile)
      - Forage in mid-water, vertical migrations in limnetic zone, Burst swim speed < intake velocity of 3.3 fps
  - Benthic Group
    - White Sucker (juvenile), Brown and Yellow Bullhead (juvenile), Margined Madtom and Stonecat (adult and juvenile)
      - Benthic oriented, Burst swim speed < intake velocity of 3.3 fps

Literature Review of Field Studies

- Several Pumped-Storage Projects Reviewed
  - *Bad Creek (SC)*
  - *Balsam Meadow (CA)*
  - *Northfield Mountain (MA)*
  - *Muddy Run (PA)*
  - *Richard B. Russell (GA)*

Literature Review of Field Studies

- Common findings:
  - *Focus is on effects of pumping*
  - *Diadromous species more susceptible due to migrations*
  - *Juvenile fish are most commonly found to be entrained*
  - *The location of the intake in relation to habitat has been shown to affect entrainment*

Turbine Passage Survival

Factors potentially influencing fish survival or injury during turbine passage:

- Turbine type and size
- Turbine speed
  - Higher speeds increase the likelihood of fish contact with structural elements.
- Fish size
  - Smaller fish have less likelihood of contact with mortality-inducing factors.

Turbine Passage Survival Database

Fish Survival Rates (Immediate) by Fish Size Class for Francis Turbine with Rated Flow >2400 cfs from EPRI Database

Site Characteristics Relevant to Turbine Passage Survival

Site Name	Unit # Tested	Turbine Type	Rated Head (ft)	Rated Power (MW)	Rated Flow (cfs)	Speed (rpm)	Runner Diameter (in)	No. of Runner Blades
E.J. West	3	Francis (vertical)	63	12.8	2450	112.5	131	15
Finch Pruyn	4	Francis (horizontal, quad)	49	14	4600	-	-	-
	5	Francis (horizontal, double)	49	14	4600	-	-	-
B-G	-	Francis (vertical)	1123	290	3200	257	240	7

Turbine Passage Fish Survival Rates

Site Name	Turbine Type	Fish Size (inches)	*N*	Average Immediate Survival *(all species combined)*		
				Minimum (%)	*Maximum (%)*	*Mean (%)*
E.J. West	Francis (vertical)	3.9	-	-	-	-
		3.9-7.8	12	59.2%	97.1%	84.8%
		7.9-11.8	6	72.2%	105.3%	88.0%
		11.8+	-	-	-	-
Finch Pruyn	Francis (horizontal)	3.9	-	-	-	-
		3.9-7.8	2	94.12%	94.92%	94.52%
		7.9-11.8	4	70.73%	92.59%	83.93%
		11.8+	-	-	-	-

Predicted Survival Calculations

Analysis of turbine survival was performed using the formula developed by Franke *et al.* (1997)

- Five representative fish lengths and two blade strike correlation factors were selected for both generating and pumping modes of operation
- Results similar for generation and pumping, and indicate higher predicted survival of smaller fish
- 82-99% survival depending on fish size

Pressure Differential

- Rapid changes in pressure can be a source of mortality
  - Vented swim bladder
    - Physostomous: Trout, minnows, catfish
  - Non-vented swim bladder (more susceptible)
    - Physoclistous: Basses, sunfish, perch
- Potentially detrimental during pumping
  - LR is at maximum
  - UR is at minimum

Summary of Survival Trends

- Empirical data from hydroelectric projects with similar turbine types and hydraulic capacities as the Project indicates that turbine passage survival ranges from 85-95% depending on fish size.
- The empirical data also indicates that turbine passage survival trends by fish size (smaller fish are more likely to survive turbine passage).
- Blade strike probability equations specific to the Project turbines indicate that fish survival is similar during pumping and generation phases of operations. The calculations support the empirical data results relative to higher survival of smaller fish.
- Pressure gradients may be detrimental to entrained fish during the pumping phase of operation when the Lower Reservoir is full and the Upper Reservoir is at its minimum elevation.

Conclusions

Entrainment and turbine passage mortality risk to fish resources at the B-G Project is low

- Intake configuration in relation to habitat
- Low intake velocities
- Infrequent operations

Conclusions

- There are no diadromous or threatened/endangered species present
- Fishery is enhanced with stocking
- Of those fish likely to be entrained, most are either forage species or juveniles that are small in size and are expected to have high turbine passage survival
- Larger fish are not likely to be involuntarily entrained due to swimming performance

Lunch

Socioeconomics

Study Goals and Objectives

- To develop a demographic and economic profile of the Local and Neighboring Communities.
- To evaluate potential impacts on the Local Communities from the Power Authority's tax-exempt status.
- To evaluate potential impacts associated with the Local and Neighboring Communities providing first responder services.
- To evaluate potential socioeconomic impacts resulting from the production of power by the Project.

Geographic Scope

- **New York State**
- **The B-G Region** – *Schoharie County and its adjacent counties:*
  - Albany County
  - Delaware County
  - Greene County
  - Montgomery County
  - Otsego County
  - Schenectady County
- **Local Communities** - *those government entities in which the Power Authority owns Project Lands:*
  - Schoharie County
  - Town of Gilboa
  - Town of Blenheim
  - Gilboa-Conesville School District
- **Neighboring Communities** - *those government entities outside of the Project FERC-boundary that support the Project by providing first responder services:*
  - Town of Conesville
  - Town of Jefferson
  - Town of Middleburgh
  - Town of Roxbury (taxing jurisdiction containing the Hamlet of Grand Gorge)

Study Progress

- Task 1. Describe the Economics of the Project
- Project-specific data have been collected from Power Authority records:
  - Expenditures by type, including total payroll;
  - Past contributions to first responders organizations; and
  - Employee data by ZIP code
    - B-G Project has 150 employees
    - 57% of employees live in Schoharie County; 29% of employees live in a Local or Neighboring Community
    - Payroll associated with employees who live in Schoharie County totals $6,858,788 (55% of total payroll)
- The consulting firm ICF has been hired to:
  - Evaluate the Project's effect on energy markets and
  - Conduct REMI modeling of the Project's effects on Local and Neighboring Communities

Integrated Planning Model (IPM®)

- ICF is using its Integrated Planning Model (IPM) to evaluate the B-G Project's effects on the New York State energy markets.
- The model works through a multi-phased process:
    1. Identifies demand for generation and capacity;
    2. Determines existing resources available to meet demands and ranks by generation cost;
    3. Models the operation of facilities to meet load requirements;
    4. Utilizes transmission resources, up to available capacity;
    5. Calculates emissions and compares to limits; revises the operation of facilities (step 3) if necessary to reach compliance;
    6. Evaluates new capacity options when needed; and
    7. Calculates required returns for investment and re-evaluates the model with new capacity.

IPM, continued

- Outputs from IPM include projections of:
  - Electricity prices
  - Need for and timing of additional capacity builds
- Prices and build decisions are used in the next step of the study: the modeling of the economies of New York State, the B-G Region, Local Communities, and Neighboring Communities.

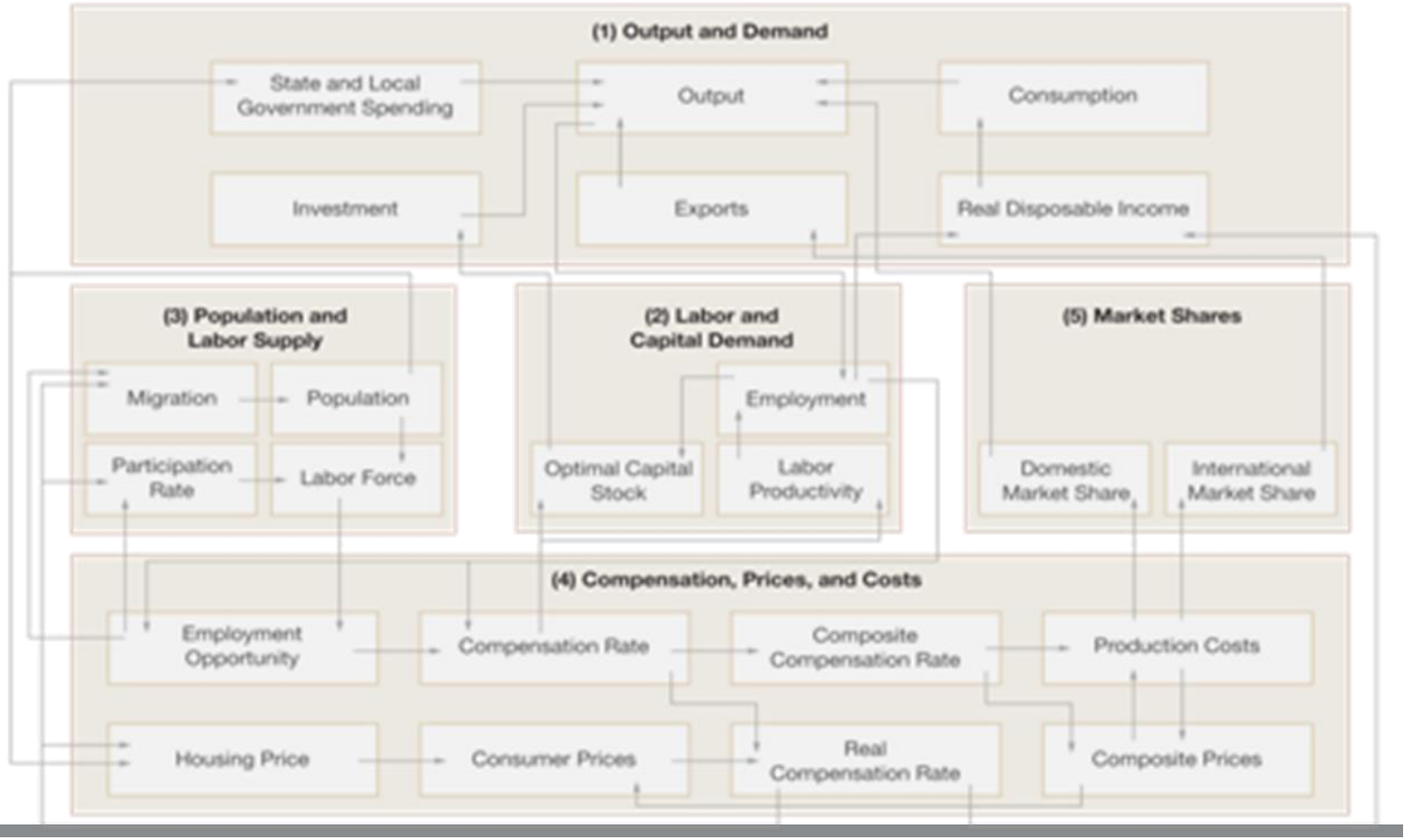
Regional Economic Models, Inc. (REMI®)

- ICF uses Regional Economic Models, Inc. (REMI) Policy Insight Plus to evaluate the socioeconomic effects of various energy projects and policies.
- REMI can be customized with a variety of industrial sectors and different modeling regions.
  - Regions can be individual states, counties (districts) or the entire country.
- REMI provides the ability to forecast economic effects over time. For the US, current version has the ability to forecast effects to 2060.
  - For this study, results will be provided in 10-year increments through 2060.

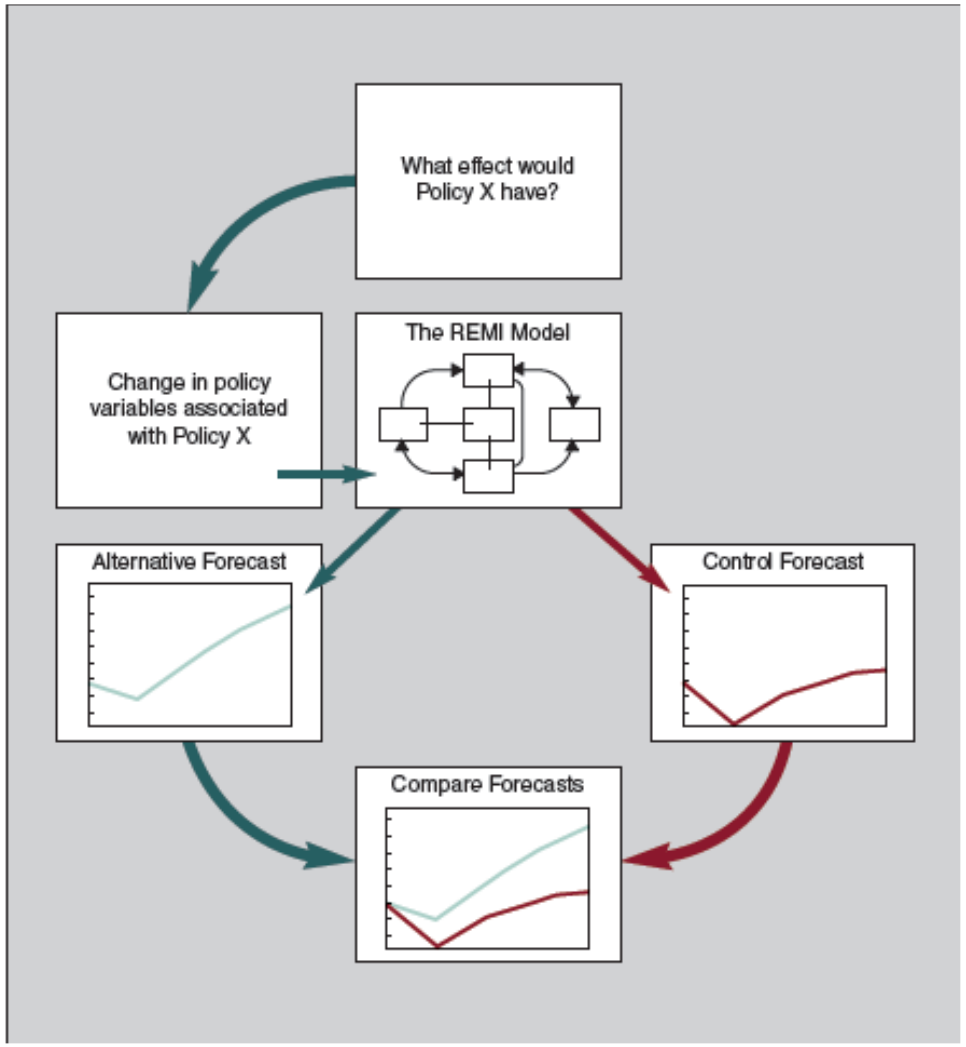
REMI, continued

- REMI takes into account the inter-relationships between various components of the economy and between industries.
- REMI includes multiplier effects (effects as spending cycles through the economy).

REMI Model Linkages (Excluding Economic Geography Linkages)



Conceptual Approach to Modeling with REMI



- Effects of the Project will be identified by comparing the alternative forecast to a control forecast.
  - With the Project's operation vs. without the Project's operation
  - With tax-exempt status vs. without the tax-exempt status
- Results will include effects on population, employment, income, and Gross Regional Product (GRP).
- Current status of REMI modeling:
  - Model has been leased and customized by ICF.
  - Different modeling runs are being undertaken.

Study Progress

- Task 2. Establish the Demographic Baseline Conditions
- Population, Income/Poverty, Industry, and Housing:
  - Data are being collected from the 2014 American Community Survey—this information was released in December 2015.
  - Data are an average of the 2010 through 2014 period.
  - Data are at the town and school district level.
- Real Estate Transactions and Median Residential Sales Prices
  - 2014 data have been obtained from the New York Department of Taxation and Finance.
  - Data are available at the county-level.

Study Progress

- Task 2. Establish the Demographic Baseline Conditions, continued
- Bureau of Labor Statistics Labor Force data:
  - Data are being collected from the Bureau of Labor Statistics (Nov 2015).
  - Data are available at the county-level.
  - Available data include total labor force, employment level, and unemployment rate.
- American Community Survey Labor Force data:
  - Data are available at the town and school level.
  - Data are an average of the 2010 through 2014 period. Data provides a general picture of the economic health of the communities over the past five years.

Study Progress

- Task 3. Analyze the Impact of Tax-Exempt Status on Local Communities
- The analysis is being conducted on the Project as it exists today.
- Data have been gathered from the Schoharie County Real Property Tax Office.
  - Total tax base of Blenheim, Gilboa, Gilboa-Conesville Consolidated School District, and Schoharie County
  - Equalization rates and tax rates
  - Project assessed value

Data from Schoharie County Real Property Tax Office

- Project full market value
  - Town of Blenheim: 3 parcels with a total full market value of $100,641,875
  - Town of Gilboa: 2 parcels with a total full market value of $1,077,679
  - Gilboa-Conesville Consolidated School District: includes above 5 parcels with a total full market value of $101,719,554
  - Schoharie County: includes above 5 parcels with a total full market value of $101,719,554

Study Progress

- Task 3. Analyze the Impact of the Tax-Exempt Status on Local Communities, continued
- Direct effects are being calculated.
  - Effect on tax rates
  - Hypothetical Project-related tax levies
- ICF is conducting REMI modeling based on direct effects of the Project's tax-exempt status.
  - Results will include effects on population, employment, income, and GRP.

Study Progress

- Task 4. Analyze the Impacts Relating to First Responders
- The Power Authority has completed its initial analysis of first responders. This effort included:
  - On-site interviews with first responders
  - On-site interviews with Power Authority staff
  - Existing documentation of Power Authority contributions
- Results of the study include:
  - Cost and benefits of providing recurring payments for the services of first responder units.

Study Progress

- Task 5. Prepare the Study Report
- Initial drafting is underway.
- On schedule to file report with the Updated Study Report in February 2017.
- But targeting a final report to be available for stakeholder review and comment in summer 2016.

Recreation Use/User Contact Study

Study Goals and Objectives

Goals:

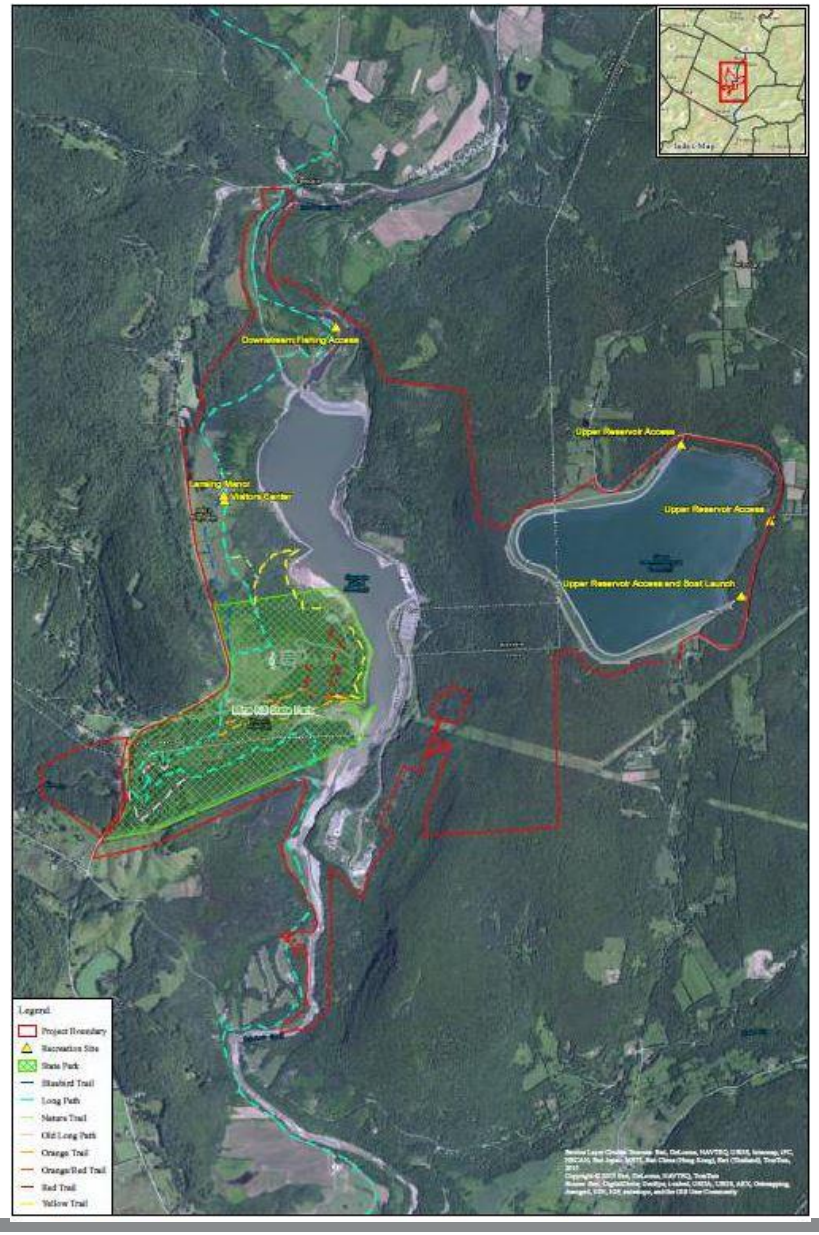
- Evaluate recreational use at the Project.
- Determine the adequacy of existing Project recreation sites/facilities in meeting recreation needs and demand at the Project.

Objectives:

- Determine the amount and types of recreation use at the Project;
- Interview the recreating public to determine users' perceptions with regard to their use of Project recreation sites and facilities;
- Evaluate recreational demand at the Project and determine if existing recreation sites and facilities are meeting the current demand; and
- Evaluate the effects of Project operation and maintenance on the recreation use at the Project and the usability of Project recreation sites and facilities.

Geographic Scope

- Lansing Manor Complex (including Visitors Center)
- Mine Kill State Park (including Mine Kill State Park Overlook)
- Downstream fishing access
- Three access areas on the Upper Reservoir



Study Progress

Task 1. Background Research

- Included review of:
  - B-G Project's 1995 Revised Exhibit R
  - 2015 FERC Form 80
  - Recreation Facilities Summary
- Collected Actual Use Records
  - Collected actual use numbers recorded for the Visitors Center, Lansing Manor, and boating use in the Upper Reservoir for 2014 and 2015. Collecting January and February 2016 actual use numbers for these.
  - Also collecting Mine Kill State Park use information collected by NYSOPRHP for 2015.

Study Progress

Task 2. Field Work (March 2015 - February 27, 2016)

- *Spot Counts*
  - One weekday and one weekend day a month, randomly selected
  - Twice a day counts, at various times during operating hours
  - **24 days of spot counts** conducted at each site
- *Calibration Counts*
  - One weekday and weekend day a month, randomly selected
  - Additional calibration counts on holidays and in peak summer season
  - Varied start times
  - **35 days of calibration counts** conducted at each site
- *Traffic Counters*
  - May 22, 2015 – Oct 30, 2015
  - Counters visited two times a week, typically Monday and Friday
- *Collection of water depth data at Mine Kill boat launch and Upper Reservoir boat launch*
  - Study Modification: Proposed to use bathymetric data for Upper and Lower Reservoir in conjunction with the minimum operating limits, in place of snapshot field measurements, to provide more complete information for assessing usability of these two boat launches than can be obtained from collection of water depth measurements on a given day and time.

Study Progress

Task 3. User Contact Survey

- Administered survey to determine users' perceptions of recreation use and existing sites and facilities for the period March 1, 2015 – February 27, 2016
- Conducted during calibration counts at Project recreation sites
- **174 user contact surveys** were completed over the course of the study

Task 4. Study Report

- Data entry, QA/QC, and statistical analysis underway
- Preparation of a technical report will commence shortly
- Report is on track to be filed with USR in February 2017
- But targeting a final report to be available for stakeholder review and comment in summer 2016

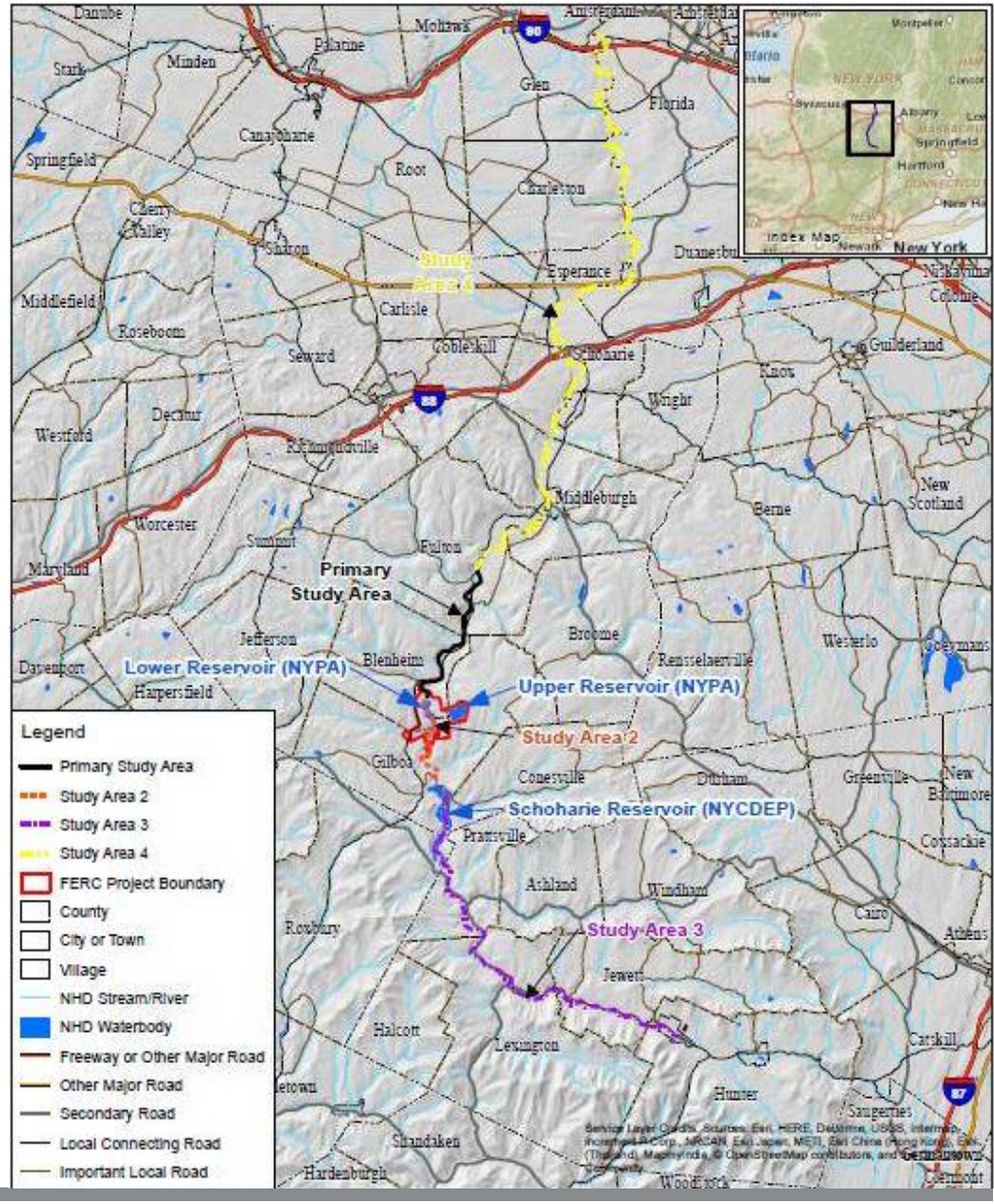
Recreational Boating Desktop Feasibility Assessment

Introduction

- In accordance with FERC's February 2015 Study Plan Determination letter, the Power Authority conducted a Level 1 boating flow analysis as outlined in *Flows and Recreation – A Guide to Studies for River Professionals* (Whittaker et al. 2005),
- Level 1 approach focuses on "desk top" methods using existing information, or limited interviews with people familiar with flows and recreation on the study reach
- The analysis consisted of:
    - Literature Review
    - Hydrology Assessment
    - Hydraulic Assessment
    - Structured Interviews

Geographic Scope

- **Primary Study Area:**
  - Schoharie Creek downstream of the Lower Dam to Max V. Shaul State Park, 9.2 miles
- **Additional Schoharie Creek:**
  - **Area 2** – Gilboa Dam downstream to the Lower Dam, including the Lower Reservoir, approximately 5.5 river miles;
  - **Area 3** – upstream from the Gilboa Dam, including Schoharie Reservoir, approximately 24 river miles;
  - **Area 4** – downstream from Max V. Shaul State Park to the confluence with the Mohawk River, approximately 43.1 river miles.
- **Regional**
  - 50 mile radius from Project



Methodology

Task 1. Literature Review

- Literature searches were conducted via the Internet, libraries, tourist/visitor bureaus, agencies, municipalities, and recreation-user-group documents (boating guides, etc.)

Task 2. Hydrology/Hydraulic Assessment

- Statistical analysis and hydrographs using USGS gages
- Stream bottom profile & depths at various flows from hydraulic model

Task 3. Structured Interviews

- Outreach and contact with knowledgeable boaters (phone or e-mail)
- Standardized questionnaire

Summary of Findings

Literature Review

Primary Study Area

- Adirondack Mountain Club (ADK) guide describes a segment of the primary study area in a write-up of Schoharie Creek (North Blenheim to Middleburgh).
  - Class I to I+, normally runnable in April and early May or after a storm that causes Schoharie Reservoir to spill water.
  - Usually paddled at water levels in the range of 1.5 to 3 feet
  - Below 1.5 feet too shallow; above 4 feet current swift, with high waves and possible floating debris
- Now out-of-print ADK guide last published in 2005; pre-Tropical Storm Irene.

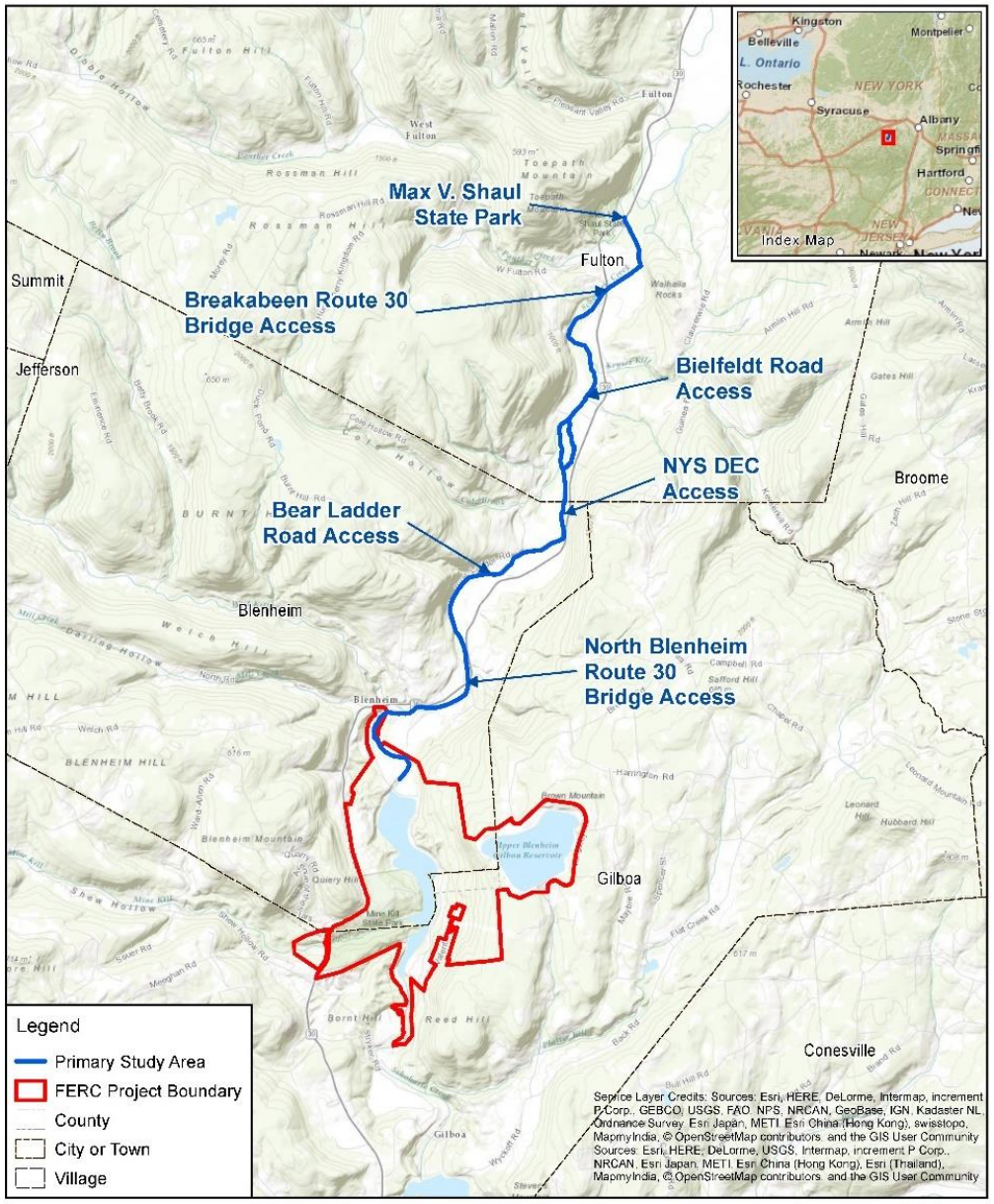
Summary of Findings

Literature Review

Primary Study Area

Six (6) public recreational boating access points were identified in the primary study area

- North Blenheim Route 30 bridge
- NYSDEC access
- Breakabeen Route 30
- Max V. Shaul State Park
- Bear Ladder Road
- Bielfeldt Road



Summary of Findings

Literature Review

Schoharie Creek Areas 2-4

American Whitewater Inventory, ADK guide, informal user's reviews

- Variable flows due to seasonal precipitation
- Provided relationship between runnability and stage/cfs at nearest USGS gage

- Access points
  - Area 2 - OPRHP launch at Mine Kill State Park (Lower Reservoir)
  - Area 3 - NYCDEP access (Schoharie Reservoir)
  - Area 4 - 11 recreational boating access points

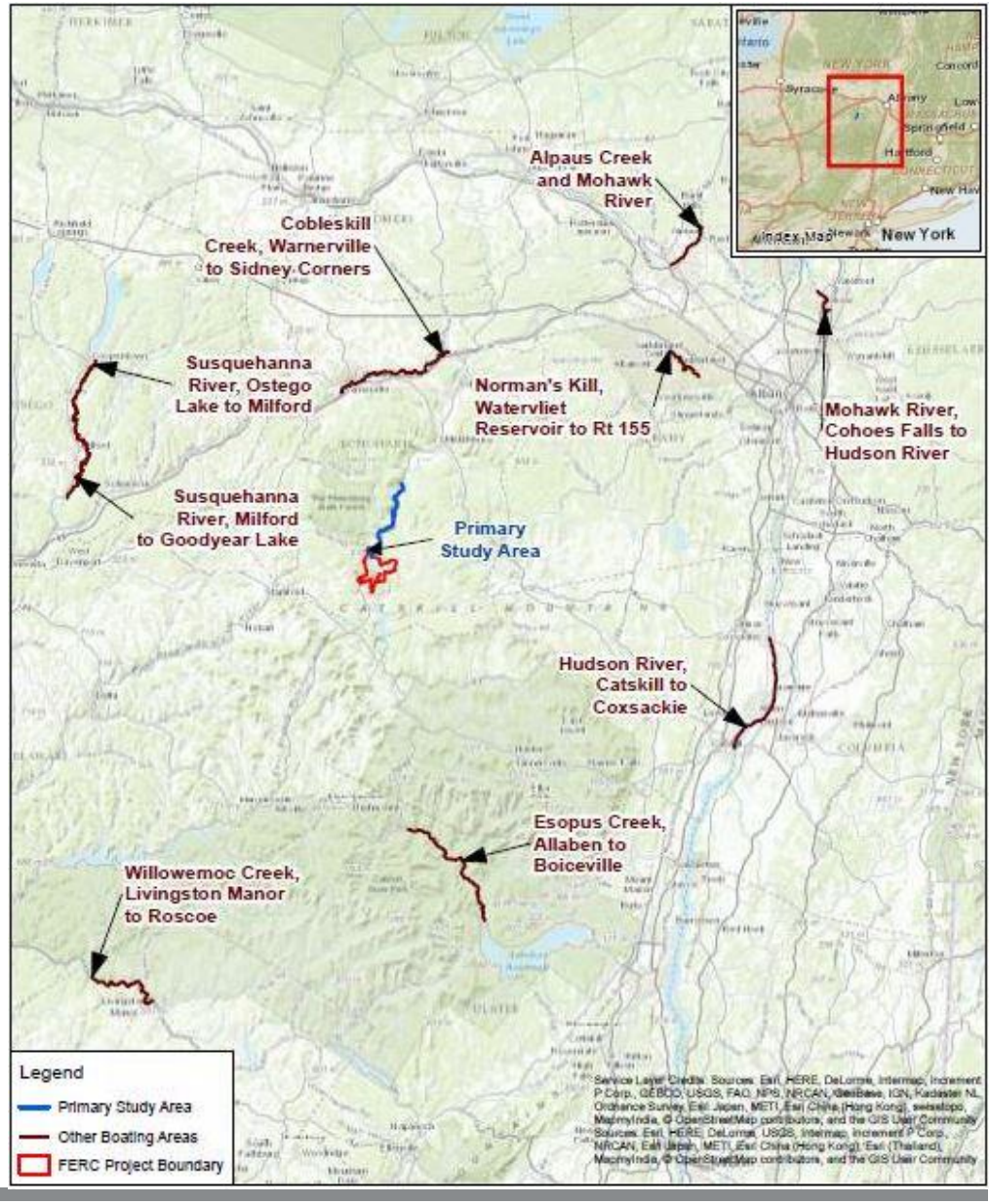
Summary of Findings

Literature Review

Similar sources as for Schoharie Creek Areas 2-4

Regional Boating Opportunities within a 50 mile radius of the Project

- Alplaus Creek
- Cobleskill Creek
- Esopus Creek
- Hudson River
- Mohawk River
- Normans Kill
- Susquehanna River
- Susquehanna River
- Willowemoc Creek



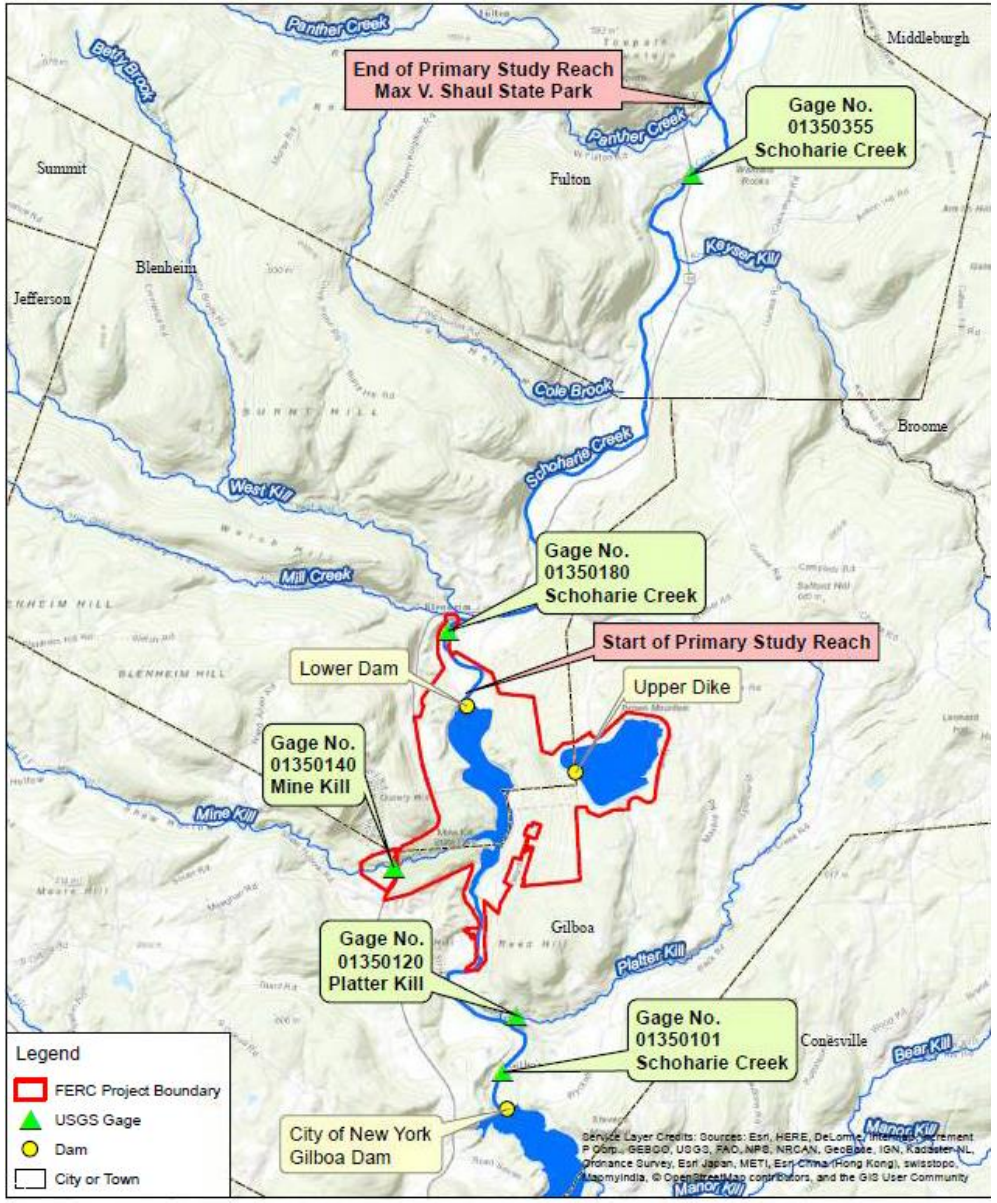
Summary of Findings

Hydrology Assessment

Locations and Drainage Areas of USGS Gages Used for All Analyses

USGS Gage Number	Location	Drainage Area (sq. mi.)
01350101	Schoharie Creek at Gilboa, NY	316
01350120	Platter Kill at Gilboa, NY	10.9
01350140	Mine Kill Near North Blenheim, NY	16.2
01350180	Schoharie Creek at North Blenheim, NY	358
01350335	Schoharie Creek at Breakabeen, NY	444

Analyses based on 40 year period of record (1976-2015)



Summary of Findings

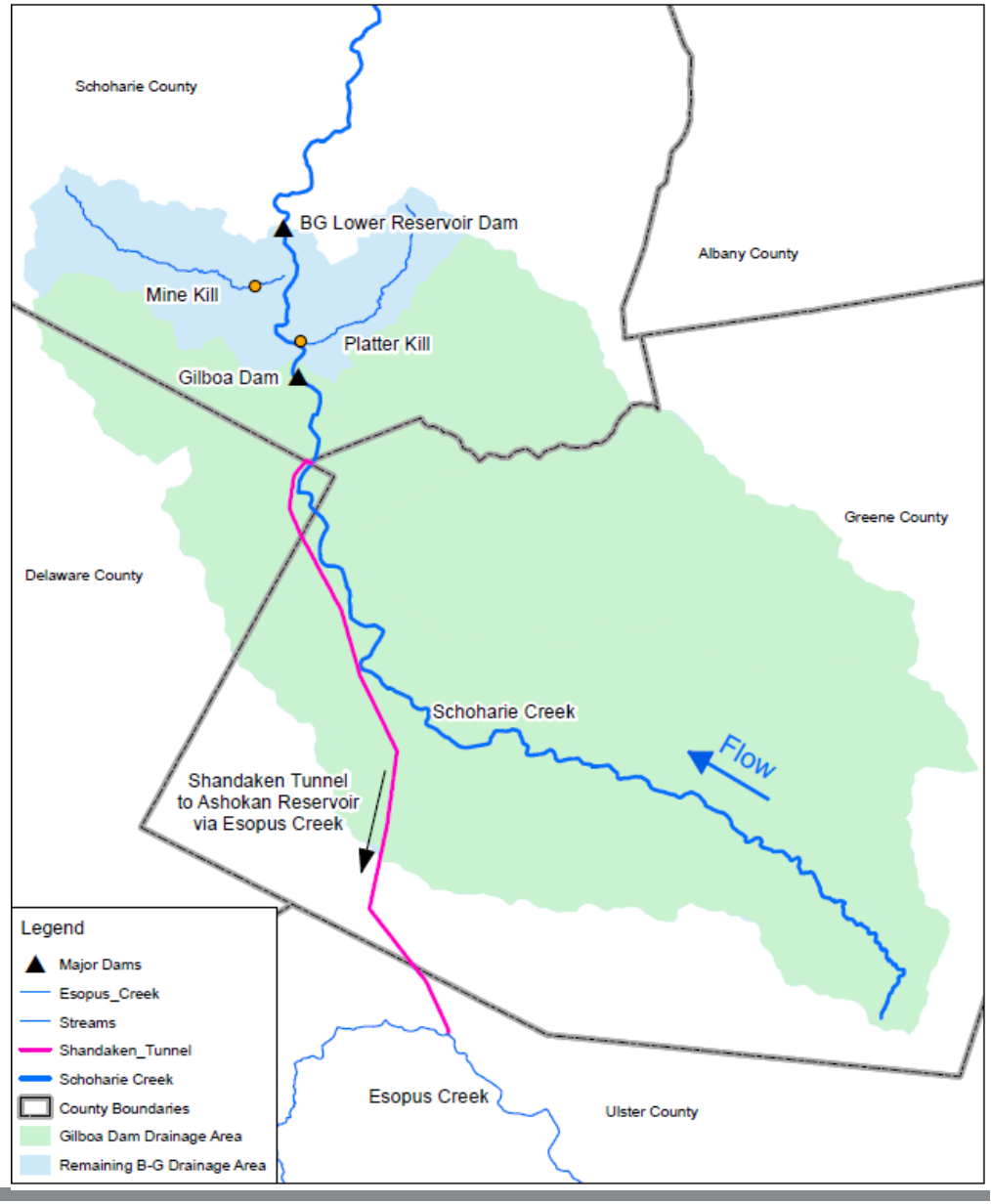
Hydrology Assessment

Project Drainage Area = 356 sq. mi.

Watershed diverted for Water Supply = 316 sq. mi.

Project inflows provided by intervening drainage between Gilboa Dam and Lower Reservoir Dam

Effective Drainage Area = 40 sq. mi.



Summary of Findings

Hydrology Assessment

Flows at Gilboa Dam (Water Years 1976-2015)

Flow (cfs)	Total days flow occurs over period of record	Average number of days per year flow occurs	Percent of time flow occurs	Average number of days per year that flow occurs in:						
				April	May	June	July	August	September	October
<10	8,778	220	60.10%	6.7	12.6	19.4	25.8	28.3	27.1	23.3
10-99	555	14	3.80%	0.4	1.5	1.7	0.9	0.8	0.2	0.4
100-199	518	13	3.50%	0.7	1.4	1.0	1.0	0.4	0.2	0.6
200-499	1,391	35	9.50%	2.6	5.1	2.9	1.9	0.8	0.5	2.4
500-999	1,652	41	11.30%	6.7	5.5	2.9	1.0	0.3	1.0	2.3
1000+	1,720	43	11.80%	12.9	5.0	2.3	0.4	0.5	1.1	2.2

Summary of Findings

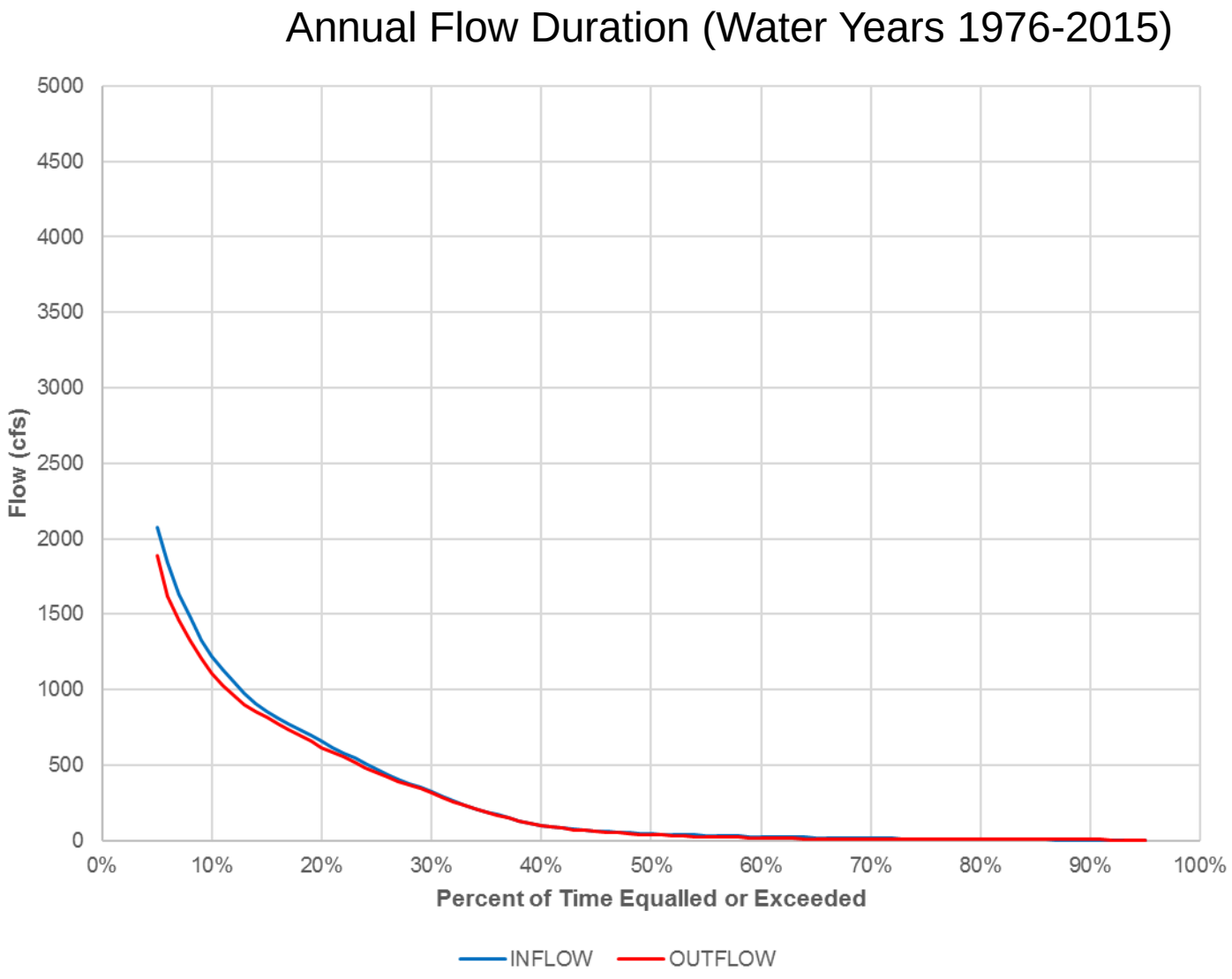
Hydrology Assessment

Project Operations

- Project outflow equals inflow
- 2,378 acre-ft of storage due to the difference in storage between two reservoirs.
- This water is used to replenish losses due to evaporation and minor seepage.
- This water is also used to supplement inflows < 10 cfs.

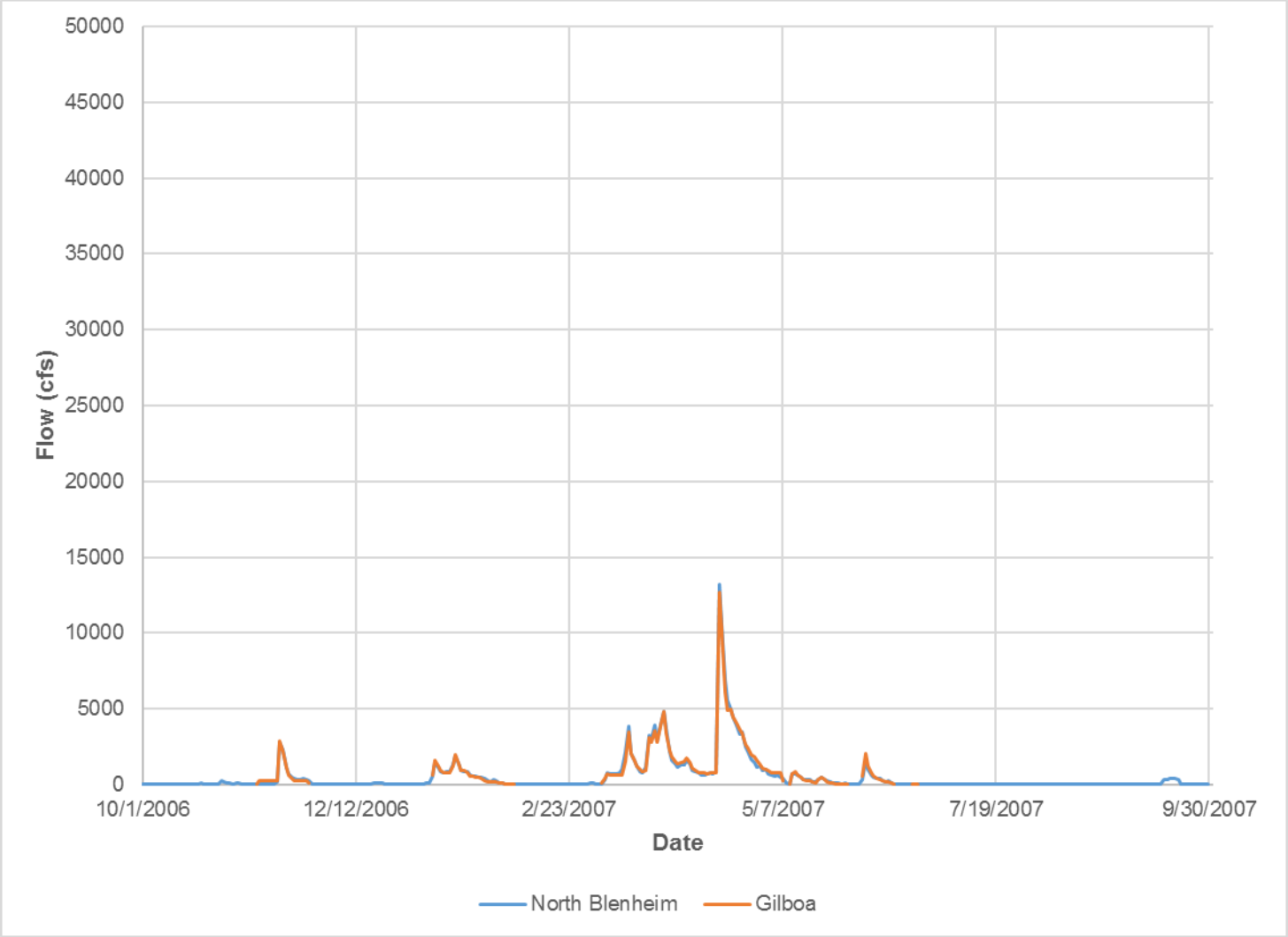
Project Median Flows

- Annual – 40 cfs
- June – 23 cfs
- July – 9 cfs
- August – 8 cfs
- September – 8 cfs
- October – 10 cfs



Water Year 2007 Hydrograph (Typical Year)

- Inflow and outflow hydrographs plotted for typical, wet, and dry years
- Pattern of high flows during spring freshet months followed by low flows. Sporadic high flow events the rest of the year.
- During dry years, no spillage at Gilboa Dam so smaller sporadic events. In 1985, two highest daily flows were 334 cfs and 150 cfs. In 2002, highest daily flow was 461 cfs.



Summary of Findings

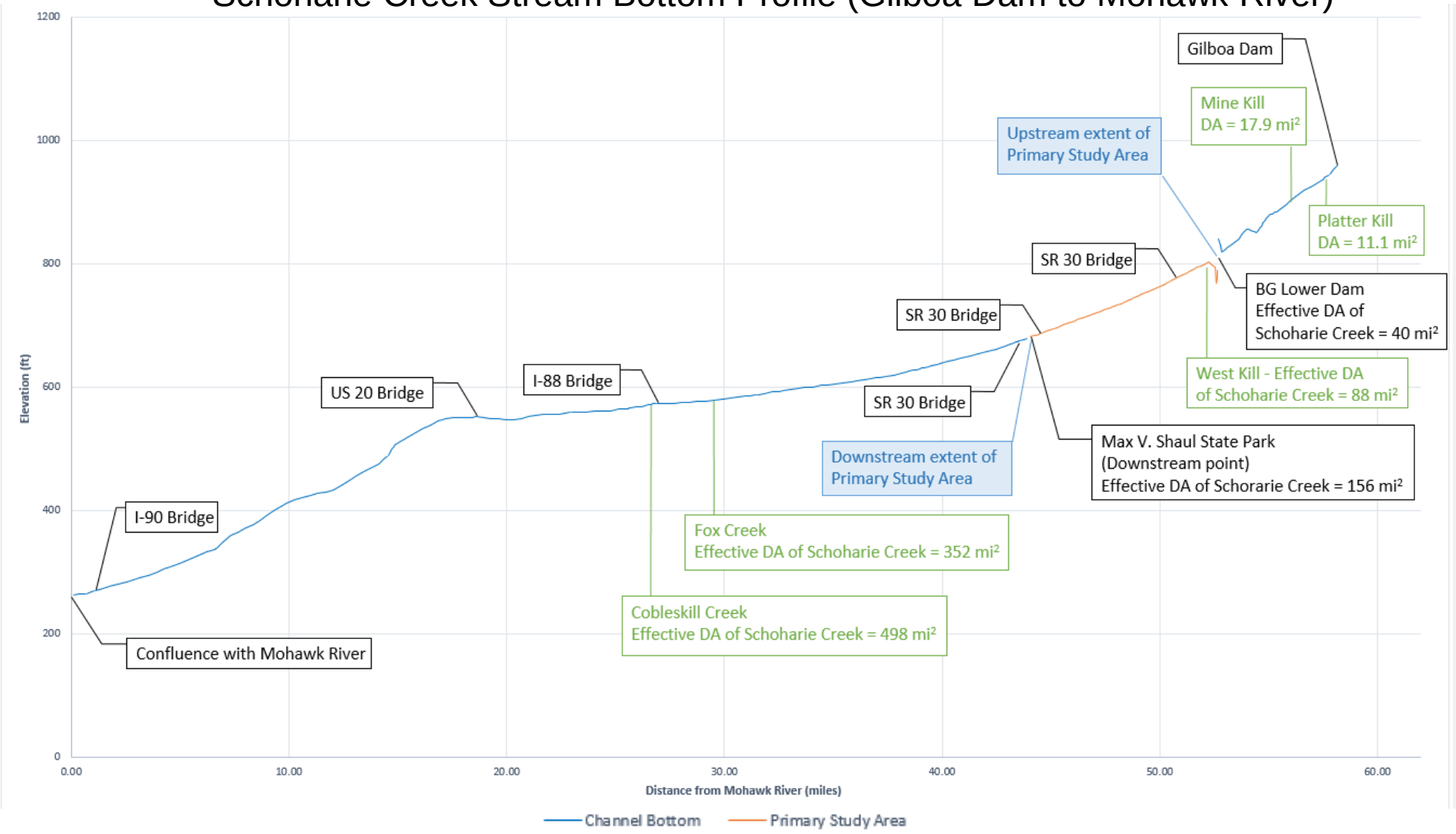
Hydrology Assessment

Streamflows in Schoharie Creek Downstream of Lower Dam (50% Exceedance)

Location	Total Drainage Area (sq. mi.)	Effective Drainage Area (sq. mi.)	Miles from Lower Dam	50% Annual Flow (cfs)	50% Apr Flow (cfs)	50% May Flow (cfs)	50% Jun Flow (cfs)	50% Jul Flow (cfs)	50% Aug Flow (cfs)	50% Sep Flow (cfs)	50% Oct Flow (cfs)
Schoharie Creek at Lower Dam	356	40	0	39	833.5	243	23	8.8	7.8	7.5	9.8
Schoharie Creek at North Blenheim	358	42	1.0	39	834	243	23	8.8	7.8	7.5	9.8
Schoharie Creek DS of West Kill	404	88	1.04	88	982	326	56	19	14	13	27
Schoharie Creek DS of Cole Brook	424	108	6.28	109	1046	362	71	24	17	16	34
Schoharie Creek DS of Keyser Kill	442	126	6.5	128	1104	394	83	28	20	18	41
Schoharie Creek at Breakabeen	444	128	6.6	130	1110	398	85	29	20	19	42
Schoharie Creek DS of Max V. Shaul State Park	472	156	9.2	160	1201	448	105	35	24	22	52
Schoharie Creek at Middleburgh*	534	218	15.04	226	1400	560	150	49	32	30	75

*Downstream of primary study area

Schoharie Creek Stream Bottom Profile (Gilboa Dam to Mohawk River)



Summary of Findings

Hydrology Assessment

Hydraulic Analysis

- Used hydraulic model to predict maximum depths at 54 locations over 9.2 mile primary study reach
- ADK Guide states that depths < 1.5 feet are “too shallow” for boating
  - 500 cfs, 52% locations < 1.5 feet
  - 750 cfs, 20% locations < 1.5 feet
  - 1000 cfs, 5% locations < 1.5 feet
- Using storage for boating releases would jeopardize Project’s ability to provide outflows comparable to those that would occur if B-G Project was not present.

Summary of Findings

Structured Interviews

Outreach and communication with:

- Local State Park Manager
- Town Officials
- Race Organizers
- American Whitewater
- Adirondack Mountain Club
- Individuals known to paddle primary study area

32 individuals contacted:

- 14 completed surveys
- 7 additional individuals via telephone

Summary of Findings

Structured Interviews

Survey Respondents (Questions 2-5)

- Median age: 46
- More than half had 20+ years of paddling experience
- Affiliations with boating organizations included Adirondack Mountain Club (3) and Schoharie County Kayaking (2)

Summary of Findings

Structured Interviews

Schoharie Creek General Boating Experience (Questions 6 and 7)

- Have boated at least some portion of the primary study area (9)
  - Six of the nine respondents (11+ trips), have done so since Tropical Storm Irene in 2011.
  - Three of the respondents have paddled portions of the primary study area 10 to 20 times, but have not done so in the past 10 years.
- Gilboa Dam to Mine Kill (2 respondents)
- Max V. Shaul State Park to Middleburgh or beyond (10)
- Esperance to Burtonsville (6)

Summary of Findings

Structured Interviews

Schoharie Creek Primary Study Area Experience (Questions 8 and 9)

- Kayak (8), Canoe (4), Raft (2)
- Of the 11+ post-Irene trips:
  - 9+ trips put-in at North Blenheim
  - 1 put-in at Fultonham
  - 1 put-in at the “B-G Power Plant”
  - Most common take-out was in Middleburgh (Area 4)
- Class I or II (6 of 9), Class II+ (1 of 9), Class III (1 of 9)
- *Qualitative comments:* Survey respondents and interviewees commented along the lines of the Creek being “rough to paddle” under low flow conditions.

Summary of Findings

Structured Interviews

Schoharie Creek Primary Study Area Experience (Questions 10 and 11)

Topics of interest

- Water releases – 6 comments
- Low water levels – 4 comments
- Post-Irene changes – 3 comments
- Water Quality issues – 3 comments
- Fisheries – 2 comments
- Whitewater Rafting – 2 comments
- Access availability – 2 comments

Conclusions

- Primary study area does not get a lot of boating use
- Most boating occurs in early spring
- Most of boating season water depth is too low for boating (≤ 1.5 feet)
- Adequate number of boating access points in primary study area
- Numerous nearby, and higher Class-rated boating opportunities exist
- Using storage for boating releases would jeopardize Project's ability to provide outflows comparable to those that would occur if B-G Project was not present

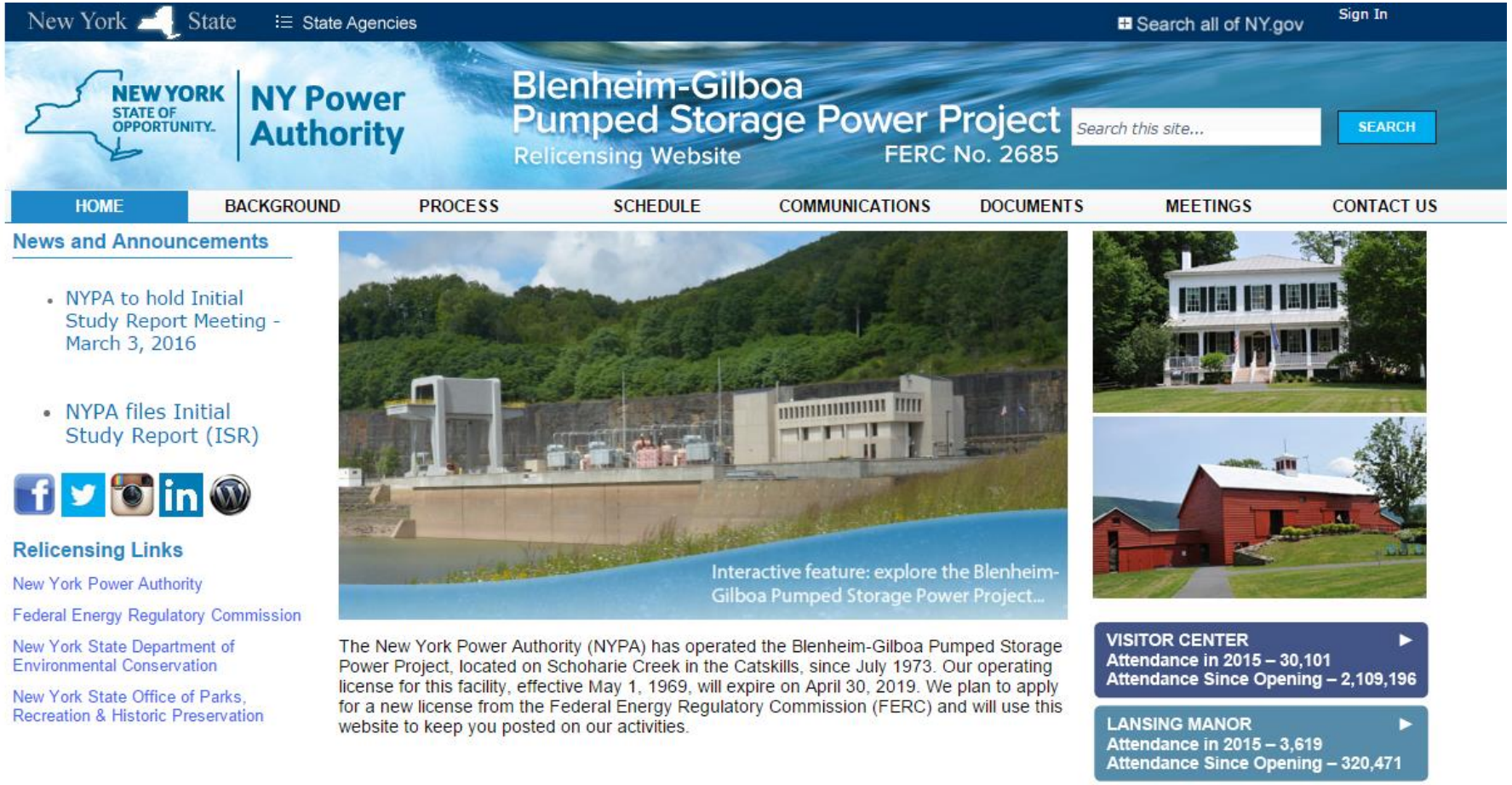
Closing

Recap of Next Steps

March 18, 2016	Power Authority will file meeting summary
April 17, 2016	Public may file comments on the meeting summary, including any requests for modifications to ongoing studies or a new study.
May 17, 2016	Power Authority may file responses to comments, including revised study plans if warranted
June 16, 2016	FERC will amend approved study plan(s) as appropriate

Project Website

http://www.bg.nypa.gov



Attachment C – USGS Report

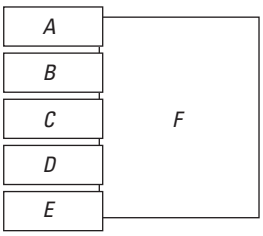
USGS
science for a changing world

Prepared in cooperation with the New York State Department of Transportation

Maximum Known Stages and Discharges of New York Streams and their Annual Exceedance Probabilities through September 2011

Scientific Investigations Report 2014–5084

U.S. Department of the Interior
U.S. Geological Survey



Cover. Effects of August and September 2011 flooding in New York State along the *A*, Mohawk River in Glenville, *B*, Schoharie Creek in Lexington, *C*, East Kill near Jewett, *D*, Hollow Tree Brook near Lanesville, *E*, Mohawk River at Cohoes Falls, and *F*, Susquehanna River in Westover.

Maximum Known Stages and Discharges of New York Streams and their Annual Exceedance Probabilities through September 2011

By Gary R. Wall, Patricia M. Murray, Richard Lumia, and Thomas P. Suro

Prepared in cooperation with the New York State Department of Transportation

Scientific Investigations Report 2014–5084

U.S. Department of the Interior
U.S. Geological Survey

U.S. Department of the Interior
SALLY JEWELL, Secretary

U.S. Geological Survey
Suzette M. Kimball, Acting Director

U.S. Geological Survey, Reston, Virginia: 2014

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The authors also wish to acknowledge the many talented and dedicated U.S. Geological Survey (USGS) personnel who contributed to data collection and analyses for this report, as well as Mark Roland and Scott Olson of the USGS, who provided valuable technical reviews of this report.

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7. Boxplot showing distribution of maximum known A, discharge and B, runoff from 1,362 locations across six hydrologic regions in New York and Long Island (Region LI) 11

Table

1. Maximum known stages and discharges of New York streams through September 30, 2011, and annual exceedance probabilities for those streams with sufficient data for analysis *(http//pubs.usgs.gov/sir/2014/5084)* ....

Conversion Factors and Datums

Multiply	By	To obtain
	Length	
inch (in.)	2.54	centimeter (cm)
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
Area		
square mile (mi^2)	259.0	hectare (ha)
square mile (mi^2)	2.590	square kilometer (km^2)
	Flow rate	
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)
cubic foot per second per square mile [$(ft^3/s)/mi^2$]	0.01093	cubic meter per second per square kilometer [$(m^3/s)/km^2$]
cubic foot per day (ft^3/d)	0.02832	cubic meter per day (m^3/d)
	Mass	
ton per day (ton/d)	0.9072	metric ton per day
ton per day (ton/d)	0.9072	megagram per day (Mg/d)

Maximum Known Stages and Discharges of New York Streams and their Annual Exceedance Probabilities through September 2011

By Gary R. Wall, Patricia M. Murray, Richard Lumia, and Thomas P. Suro

Abstract

Maximum known stages and discharges at 1,400 sites on 796 streams within New York are tabulated. Stage data are reported in feet. Discharges are reported as cubic feet per second and in cubic feet per second per square mile. Drainage areas range from 0.03 to 298,800 square miles; excluding the three sites with larger drainage areas on the St. Lawrence and Niagara Rivers, which drain the Great Lakes, the maximum drainage area is 8,288 square miles (Hudson River at Albany). Most data were obtained from U.S. Geological Survey (USGS) compilations and records, but some were provided by State, local, and other Federal agencies and by private organizations.

The stage and discharge information is grouped by major drainage basins and U.S. Geological Survey site number, in downstream order. Site locations and their associated drainage area, period(s) of record, stage and discharge data, and flood-frequency statistics are compiled in a Microsoft Excel spreadsheet. Flood frequencies were derived for 1,238 sites by using methods described in Bulletin 17B (Interagency Advisory Committee on Water Data, 1982), Ries and Crouse (2002), and Lumia and others (2006).

Curves that "envelope" maximum discharges within their range of drainage areas were developed for each of six flood-frequency hydrologic regions and for sites on Long Island, as well as for the State of New York; the New York curve was compared with a curve derived from a plot of maximum known discharges throughout the United States. Discharges represented by the national curve range from at least 2.7 to 4.9 times greater than those represented by the New York curve for drainage areas of 1.0 and 1,000 square miles. The relative magnitudes of discharge and runoff in the six hydrologic regions of New York and Long Island suggest the largest known discharges per square mile are in the southern part of western New York and the Catskill Mountain area, and the smallest are on Long Island.

Introduction

Information on the stages and discharges of streams during or following flooding is useful to designers of bridges, culverts, and dams and to floodplain managers. For over a century, the U.S. Geological Survey (USGS) has been collecting and documenting peak-stage and discharge data at continuous-record streamgages, partial-record streamgages, and at miscellaneous-measurement sites (see glossary) during and (or) after floods. Data are accessible through the USGS Peak Streamflow for the Nation website (*http://nwis.waterdata.usgs.gov/usa/nwis/peak*) and in USGS annual data reports that list peak stage and discharge data (Wells, 1960; U.S. Geological Survey, 1961–2011). Several USGS reports have documented maximum stages and discharges of New York streams (U.S. Geological Survey, 1960; Hendricks, 1964; Dunn, 1970; Leonard and Dunn, 1976; Robideau and others, 1984; and Lumia and Murray, 1993). The data presented in this report by the USGS, in cooperation with the New York State Department of Transportation, supersede those given in earlier reports.

This report is a compilation of all known maximum stages and discharges of New York streams on record at the USGS and includes some data furnished by State and local agencies and other Federal and private organizations. Data from 1,400 sites on 796 streams were compiled. The report (1) lists the sources and categories of data, (2) presents the maximum stage and discharge of each site in downstream order by river basin, (3) presents flood-frequency statistics for discharges on 1,238 of the sites, and (4) presents an analysis of the relation between discharge and drainage area for the State of New York and the timing of maximum discharge events recorded in New York since 1900. The report also includes a glossary of technical terms used in the text and table.

Data Compilation and Computation

Several sources of data and categories of peak-stage and discharge data were researched and documented. In addition, flood frequency analyses were performed on 1,238 sites; a description of the methodologies employed in these analyses follows a description of the data compilation.

Sources of Data

Most of the peak-stage and discharge data in this report were obtained through the USGS National Water Information System (NWIS) database (accessed at *http://nwis.waterdata.usgs.gov/usa/nwis/peak*) and from miscellaneous-measurement files in the USGS offices in Troy, Ithaca, and Coram, N.Y. Most miscellaneous-discharge measurements were made by indirect methods (slope-area, contracted-opening, flow-over-dam, or flow-through-culvert; see glossary for definitions). Information from previous USGS publications was used to supplement the peak-stage, discharge, and miscellaneous-measurement site data. Other sources of peak-stage and discharge information were local organizations and Federal or State agencies such as the U.S. Army Corps of Engineers, the National Weather Service, and the New York State Department of Transportation.

Categories of Data

The categories of data included in this report are grouped according to the type of peak stage and (or) discharge measurement site: (1) continuous-record streamgage, (2) partial-record streamgage, and (3) miscellaneous-measurement site. A definition of each category is given in the glossary. Continuous-record and partial-record streamgages are sites established by the USGS for specific hydrologic and (or) hydraulic studies, and their data are published in the resulting interpretive or data reports. Miscellaneous-measurement sites are mostly sites where the USGS has made a peak-discharge measurement by indirect method. The miscellaneous-site category also includes stream sites at which State, local, and other Federal agencies and private organizations have determined peak stage or discharge and published the values. Locations of 1,400 sites at which peak discharge and (or) stage were recorded are shown in figure 1, along with areas of the State representing hydrologic regions of New York defined by Lumia and others (2006). The peak discharges at continuous- and partial-record sites represent periods of record ranging from 1 to over 100 years. A miscellaneous-measurement site peak represents the maximum peak at the site over an unknown period of time. Figure 2 shows site locations and geographic features discussed in this report.

Flood Frequency

Frequency analysis of annual flood-peak data recorded at streamgages provides a means of estimating the probability of occurrence of a given discharge. Flood frequency is commonly expressed in terms of a recurrence interval or the probability of being exceeded (one is the reciprocal of the other). The 100-year flood, for example, has an annual exceedance probability (AEP) of 0.01, equating to a 1-percent chance of being equaled or exceeded in any given year.

AEP discharges for streamgages listed in *table 1* (available for download as a Microsoft Excel spreadsheet by clicking the blue “table 1” text) were computed by: (1) a log-Pearson type III analysis, (2) regional flood-frequency equations, (3) a log-Pearson type III analysis weighted by results derived from regional flood-frequency equations, or (4) adjustments to the frequency statistics of a nearby site based on methods described in Ries and Crouse (2002) or Lumia and others (2006). For streamgages with at least 10 years of record (503 sites), AEP discharges were computed on the basis of annual peak streamflow data fit to a log-Pearson type III distribution by following methods described in Bulletin 17B of the Interagency Advisory Committee on Water Data (1982). Of those 503 sites, 359 were considered rural and unregulated on the basis of criteria in Lumia and others (2006)—for these sites (identified as “Rural10” in table 1)—generalized skew was determined from Lumia and Baevsky (2000) and used for the log-Pearson type III computations. Regional flood frequency equation results were then used to weight the log-Pearson type III results according to methods described in Lumia and others (2006). A drop-down menu in table 1 (activated by selecting cell F3) can be used to view the results of the log-Pearson type III, regional regression equation, and weighted log-Pearson analyses for these sites.

Flood frequency statistics at streamgages with at least 10 years of record and substantial regulation or urbanization were calculated from statistical analyses of annual peak discharges during the regulated period only, except for three sites along the main stem of the Delaware River at Callicoon, N.Y. (USGS Site ID 01427405); above the Lackawaxen River near Barryville, N.Y. (01428500); and at Port Jervis, N.Y. (01434000); these frequency statistics were calculated as part of a multiagency workgroup (Schopp and Firda, 2008) and have not been updated. These sites, indicated as “Urban” or “Regulated” in *table 1*, are not weighted with results from regional flood-frequency equations because these equations are only appropriate in rural settings. Flood frequency statistics at 15 sites (indicated as “Regulated*” or Urban*”) with substantial regulation or urbanization, without at least 10 years of record, but located along the same stream as an “Urban” or “Regulated” site were calculated on the basis of equation 5 in Lumia and others (2006) when the drainage area at the Regulated* or Urban* site was within 50 to 150 percent of that of the gaged site.

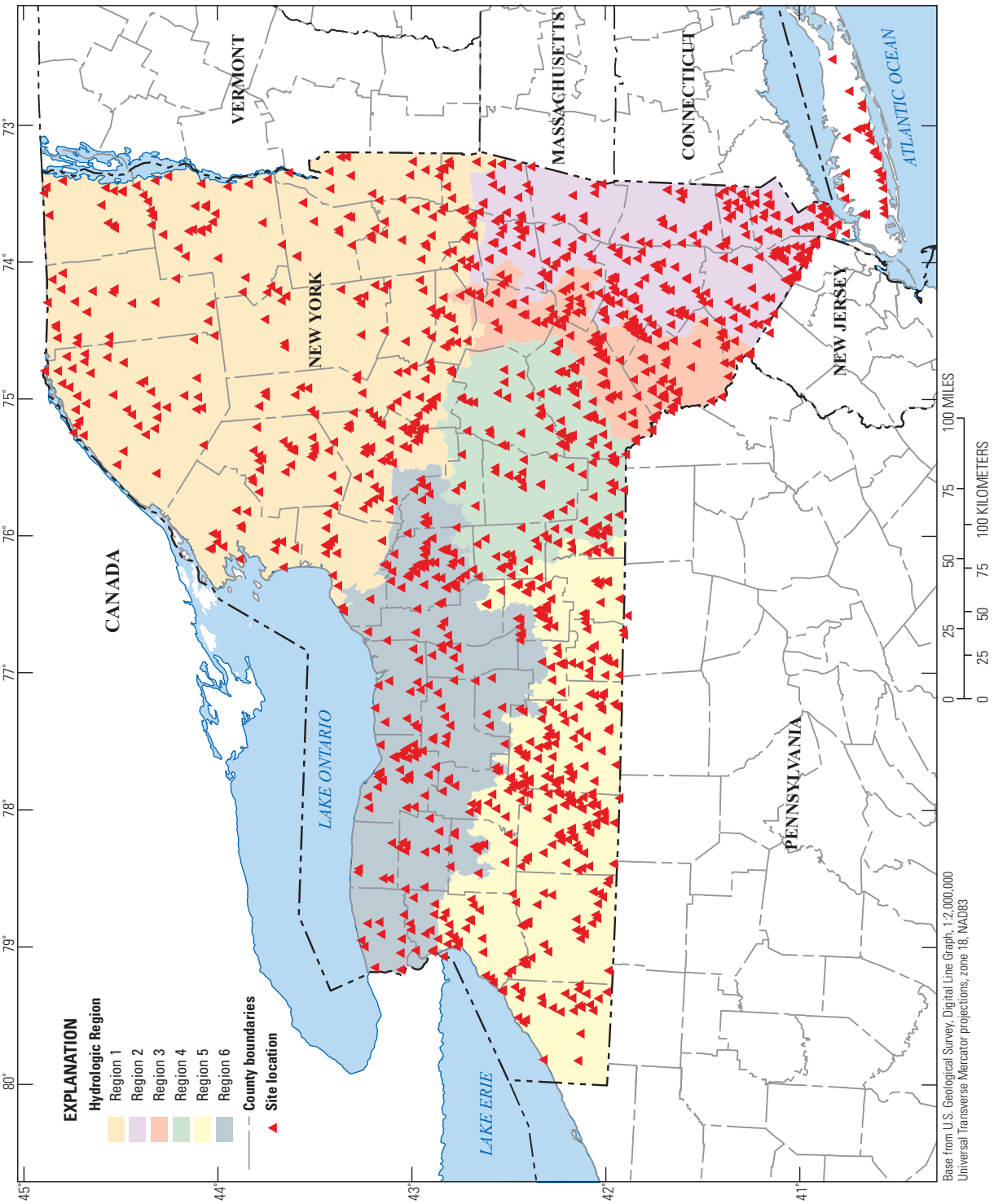

Figure 1. Locations of 1,400 sites in the State of New York with peak discharge and (or) stage information.

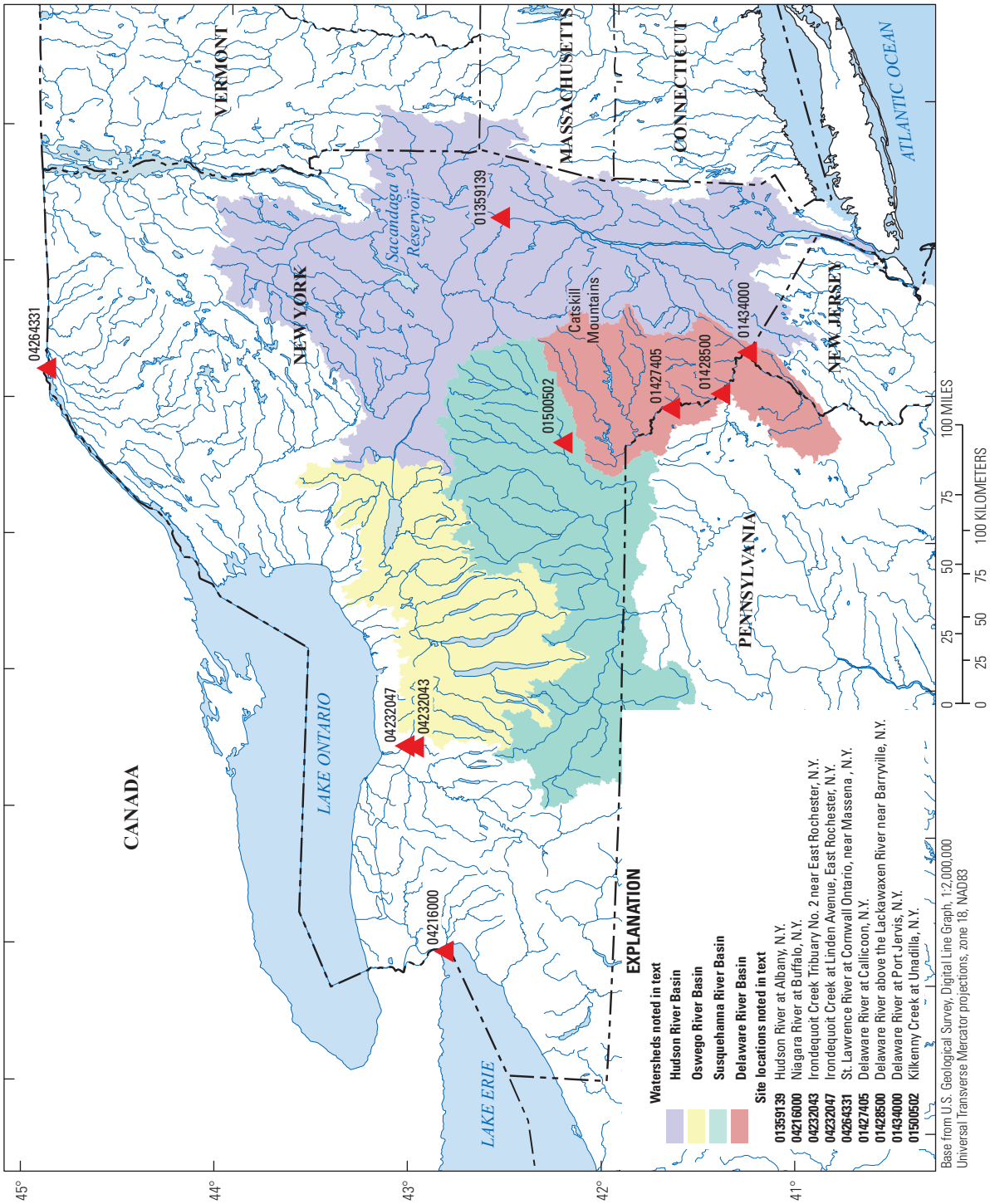

Figure 2. Locations and geographic features noted in text.

For rural sites in *table 1* with less than 10 years of record (666 sites identified as "Rural" in table 1) the flood-frequency statistics are based solely on the regional flood-frequency equations. Caution should be exercised in the use of these AEP values because watershed conditions, such as the amount of impervious land cover, may have changed since the time of the peak discharge event. Watershed characteristics used in the regional equations were derived from the StreamStats for New York online tool (*http://water.usgs.gov/osw/streamstats/new_york.html*, accessed June 5, 2013). Flood frequency statistics at 59 sites (indicated as "Rural10*") meeting the rural criteria, without at least 10 years of record, but located along the same stream as a "Rural10" site were calculated on the basis of methods in Ries and Crouse (2002) when the drainage area at the Rural10* site was within 50 to 150 percent of that of the gaged site.

No adjustments were made for the amount of available storage in reservoirs before or during floods or for changes in regulation procedures during the period of regulation. These flood frequency statistics supersede previously published statistics.

Evaluation of Maximum Known Discharges

In the State of New York, the maximum known discharge of 378,000 cubic feet per second (ft^3/s) (a daily average) occurred on the St. Lawrence River at Cornwall, Ontario, near Massena, N.Y, (04264331), on three occasions, May 20, 1993; May 28, 1993; and June 8, 1993. The streamflow associated with this streamgage is highly regulated, and the basin drains water from an area 5.5 times greater than the entire State of New York; therefore, conditions here and at the Niagara River at Buffalo, N.Y. (04216000) (4.8 times the size of New York), are not typical of New York rivers and watersheds. The maximum known discharge, other than those recorded on the Niagara and St. Lawrence Rivers, was 240,000 ft^3/s on the Hudson River at Albany (01359139) on March 28, 1913.

The maximum recorded runoff (discharge divided by watershed area) event in New York State of 10,326 cubic feet per second per square mile ($ft^3/s/mi^2$) was the result of a break in the Erie Canal on October 29, 1974, which drained into a tributary of Irondequoit Creek Tribuary No. 2 near East Rochester (04232043); this site and the runoff computed in the receiving river (04232047) were not used to evaluate statewide maximum runoff. The maximum known runoff resulting from "natural" circumstances was estimated at 4,600 $ft^3/s/mi^2$ on July 29, 1961, on the 0.5 mi^2 basin of Kilkenny Creek at Unadilla, N.Y. (01500502), following approximately 6 inches of rain over 4 hours (Robison, 1961).

Temporal Distribution of Peak Discharges

The temporal distribution of known peak discharges less than or equal to the 1-percent AEP discharge is illustrated in figure 3. Because the number of recorded peaks at streamgages is in part a function of the number of continuous- and partial-record sites in operation at the time of a peak, period-of-record (see glossary) peaks from sites are shown numerically (fig. 3A) and normalized (fig. 3B) by the number of streamgages in operation for a given water year. Flooding associated with Tropical Storms Irene and Lee in 2011 and Hurricane Agnes in 1972 ranked 1 and 2 for the most peaks recorded in a particular water year (fig. 3A). Agnes flooding ranks sixth (8.3 percent) however, when normalized by the number of active gages at the time. The year 1902 ranks second, with 14.3 percent of the streamgages at the time experiencing a period-of-record peak less than or equal to the 1-percent AEP; however, this number is tempered somewhat by the fact that one of the three sites had a period of record of only 1 year. Third (10.8 percent) was March 1936 when heavy rain from four successive storms, and a melting snow pack, caused flooding in the Susquehanna, Delaware, and Hudson River watersheds (Grover, 1937). Fourth (9.6 percent) was July 1935 when thunderstorms dumped over 9 inches of rain across the headwaters of the Susquehanna and Oswego River watersheds in central New York (Johnson, 1936). Fifth (9.4 percent) was March 1913 when 4 days of heavy rains brought flooding to much of north-central New York and the Hudson River watershed (Gravlee and others, 1991). Hudson River flooding in 1913 generally is considered the final impetus for construction of the Sacandaga Reservoir as a Hudson River flood control measure.

Figure 3C depicts the temporal distribution of peak discharges less than or equal to the 1-percent AEP discharge at miscellaneous-measurement sites across New York. Although the high number of peaks in 1935 and 1972 is consistent with high numbers seen at streamgages across the State, it should be kept in mind that the number of peaks depicted in figure 3C is highly biased by the call (or lack of call) for flood documentation beyond the streamgage network.

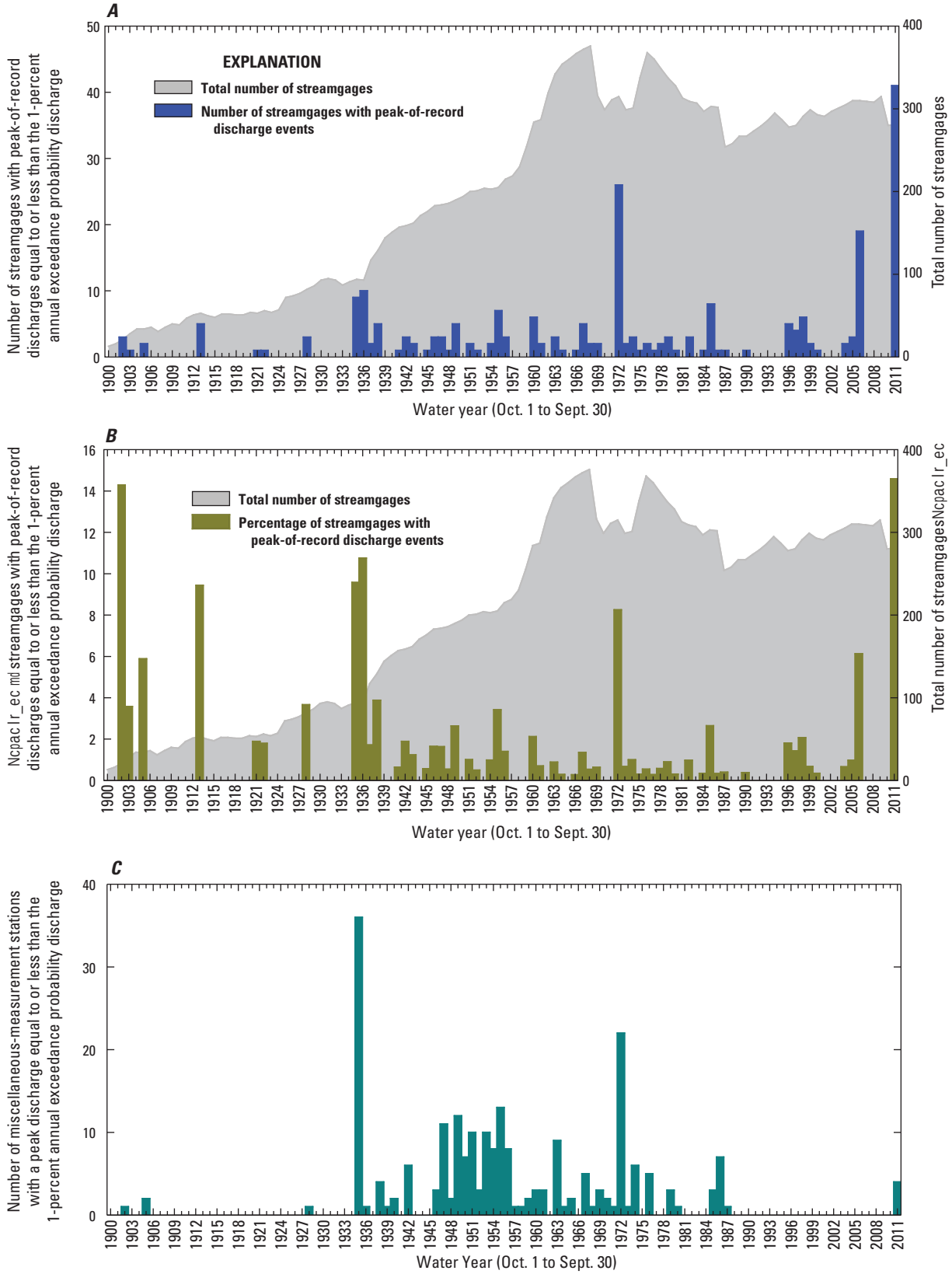

Figure 3. Timing of known peak discharges in the State of New York: *A*, number; *B*, percentage of streamgages with peak-of-record discharge less than or equal to the 1-percent annual exceedance probability (AEP), relative to the number of streamgages in operation; and *C*, peak discharges less than or equal to the 1-percent AEP discharge determined at miscellaneous-measurement sites.

Spatial Distribution of Maximum Known Discharges and Runoffs

Maximum known discharge and runoff values (*table 1*) for the State of New York, each of six hydrologic regions identified by Lumia and others (2006), and Long Island are plotted against drainage area in figures 4 and 5; also plotted are computed 1-percent AEP discharges and associated runoff for unregulated sites with at least 10 years of annual peak-flow data. The wide scatter of observed data (figs. 4–5) could result from differences in (1) periods of record, (2) magnitudes and types of basin characteristics that affect hydrologic response at a specific site, (3) degrees and periods of regulation, (4) detail and extent of documentation of notable floods in an affected area, and (5) measurement errors. The scatter of the 1-percent AEP discharges and runoff values within each hydrologic region can be attributed to local differences in basin characteristics that affect streamflow. Lumia and others (2006) found peak-discharge response affected significantly by 10 basin characteristics including drainage area, channel slope, percentage of basin storage, mean annual precipitation, percentage of basin forest cover, a basin lag factor, mean annual runoff, maximum snow depth, a basin slope ratio, and the percentage of a basin above 1,200 ft.

The magnitude of maximum known discharges and associated runoff for the State in relation to drainage area is represented by a New York State "envelope curve" depicted in each of the panels in figures 4 and 5. Maximum discharge and runoff in regions 3–5 predominantly determine the shape of the New York State curve. Envelope curves for each region and Long Island are depicted in figure 6 along with the New York State curve and the maximum envelope curve for the United States from Crippen and Bue (1977). The position of the New York curve in relation to the national curve suggests that the maximum flood-discharge potential (per square mile) of New York streams is less than that of streams in other parts of the United States. Rainfall-intensity maps and a regional analysis of maximum known discharges in the United States by Crippen and Bue (1977) support this conclusion. Discharges (fig. 6A) represented by the national curve range from at least 2.7 to 3.2 times greater than those represented by the New York curve for drainage areas of 1.0 and 1,000 mi^2, respectively; similarly, the national runoff (fig. 6B) envelope is at least 2.6 to 3.8 times greater than New York for the same range of drainage areas. Comparative factors between the New York and United States curves are considered minimum values as the United States curves have possibly increased with respect to discharge and runoff events since their publication in 1977.

Boxplots of peak discharge, plotted by region (fig. 7A), indicate that the magnitude of peak discharges is highest in Region 3 (Catskill Mountains area), with the 90th, 75th, 50th, and 25th percentiles all ranking highest across regions. The ranking of runoff distributions (fig. 7B) is mixed, with Region 4 having the highest 90th percentile value and Region 3 ranking first at the 75th, 50th, 25th, and 10th percentile; Region 5 ranks just behind Region 3 at the 90th, 75th, and 50th percentiles.

Users of this report are invited to submit evidence of peak stages and discharges at sites not listed in this compilation, or data that are known to exceed those listed, to:

U.S. Geological Survey, New York Water Science Center
425 Jordan Road
Troy, New York 12180

Summary

The U.S. Geological Survey (USGS), in cooperation with the New York State Department of Transportation, compiled maximum known stages and discharges of New York streams from 1865 to 2011. Most of the peak data were obtained from files and previous reports of the USGS, although State, local, and other Federal agencies and private organizations contributed additional peak-data information. Data from 1,400 sites on 796 streams are presented. Data are listed by major drainage basin and by USGS site number (downstream order), site name, latitude and longitude, county, period of record, drainage area, date of flood, gage height, discharge, discharge per square mile, remarks on gage height and discharge, and flood frequency information.

A comparison of maximum known discharges in New York with those from sites throughout the United States suggests a smaller peak-discharge potential in New York than in other areas of potentially high peak discharge within the country. Curves that envelope the upper limit of maximum known discharge and runoff of the six hydrologic regions and Long Island in New York indicate that parts of western New York (Region 5) and the Catskill Mountains (Regions 3 and 4) have the largest documented discharges and discharges per square mile in the State, and Long Island has the smallest.

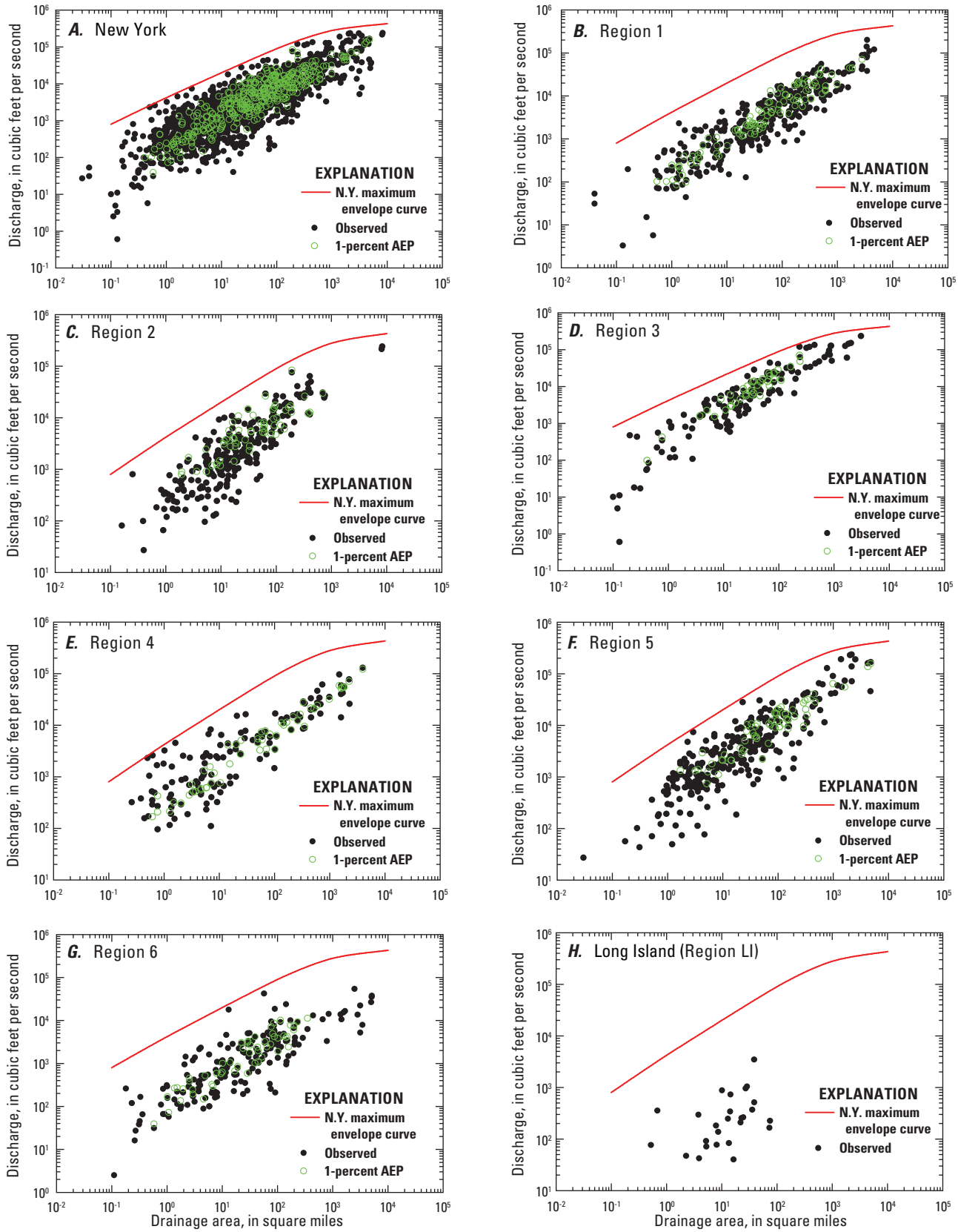

Figure 4. Maximum known discharges, known 1-percent annual exceedance probability (AEP) discharges for Rural10 sites, and the State of New York discharge envelope curve for *A*, State of New York; *B*–*G*, six hydrologic regions in New York; and *H*, Long Island.

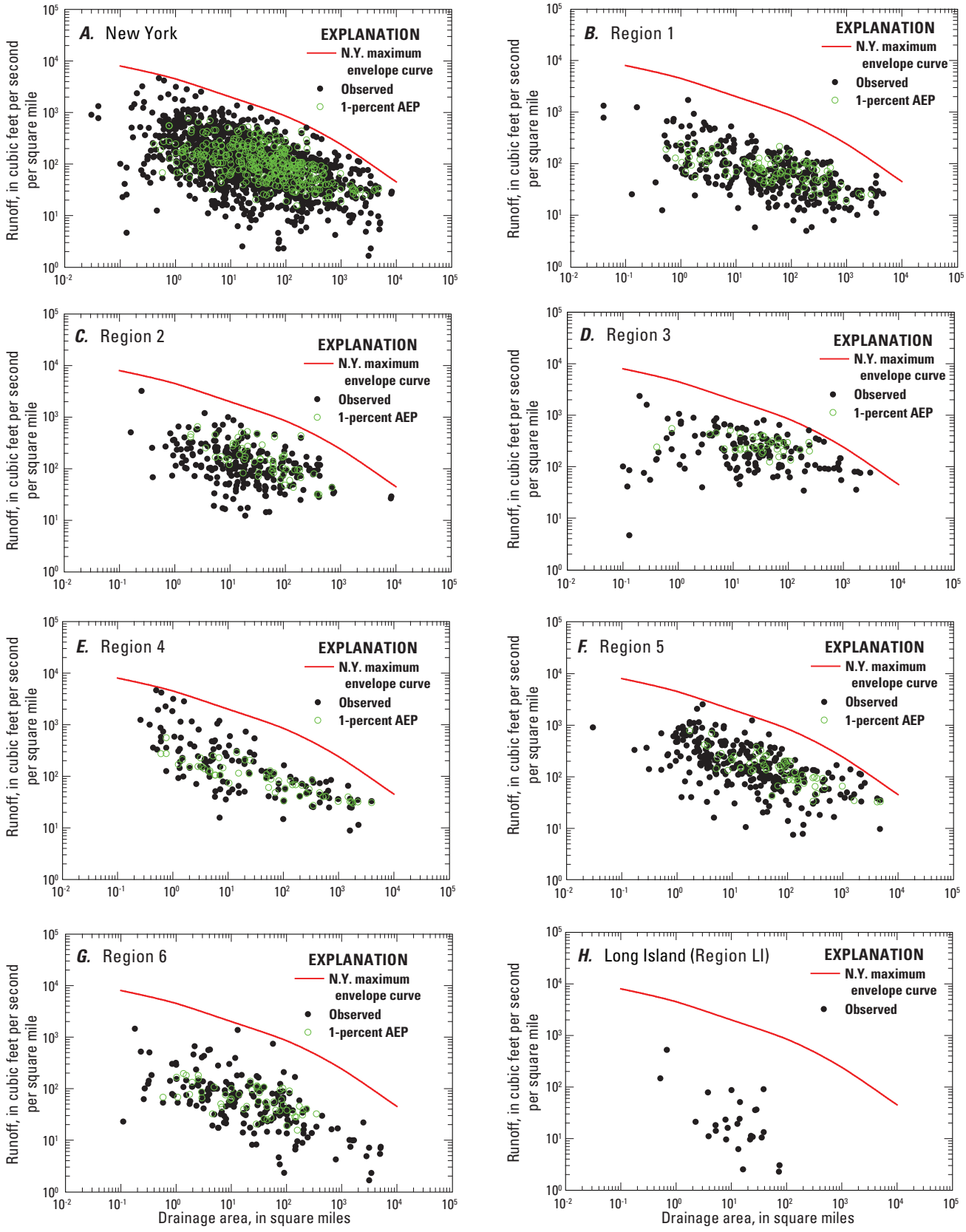

Figure 5. Maximum known runoff, known 1-percent annual exceedance probability (AEP) runoff for Rural10 sites, and the State of New York runoff envelope curve for *A*, State of New York; *B*–*G*, six hydrologic regions in New York; and *H*, Long Island.

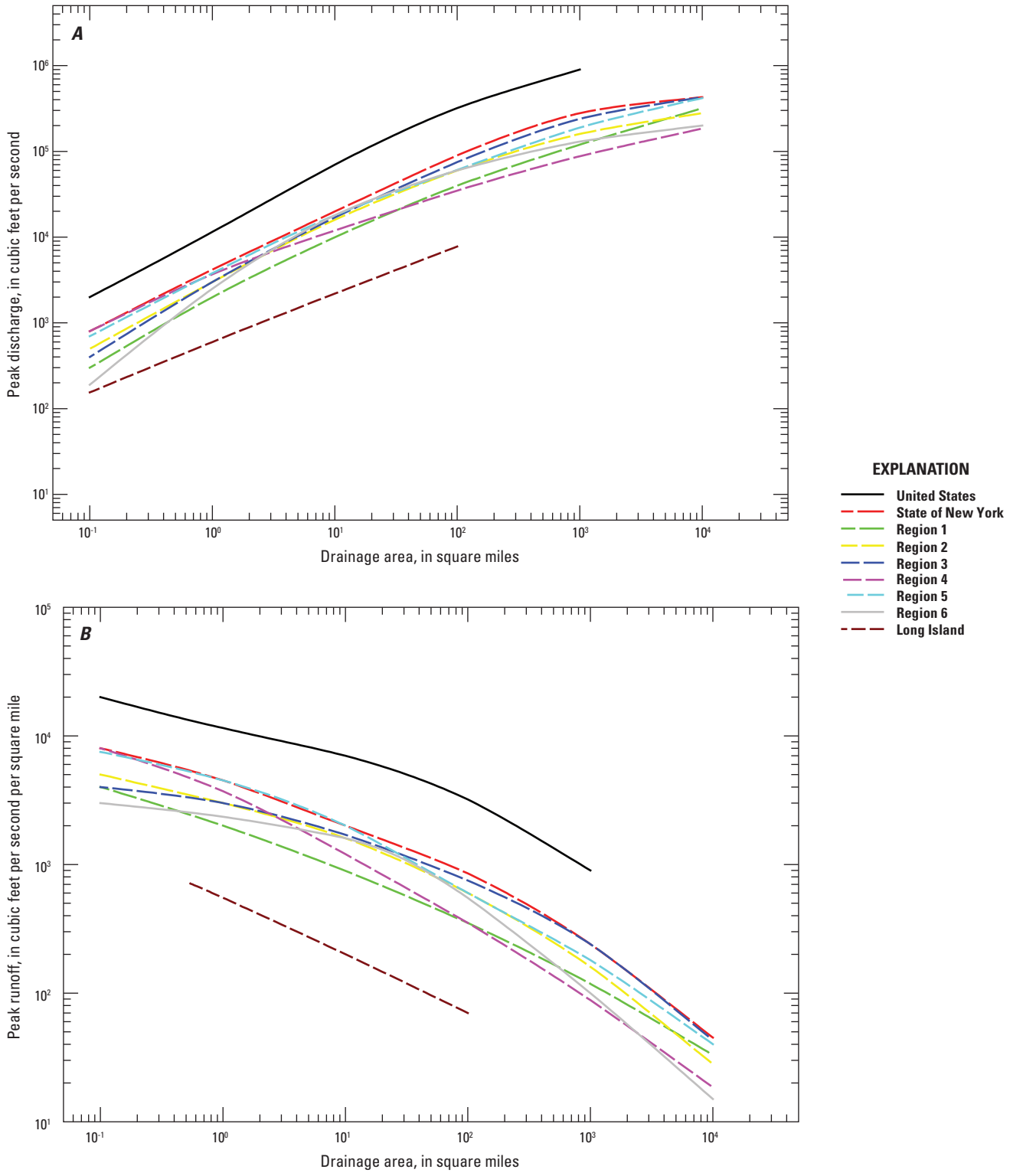

Figure 6. Envelope curves for *A*, discharge and *B*, runoff for the United States (Crippen and Bue, 1977), State of New York, six hydrologic regions in New York, and Long Island.

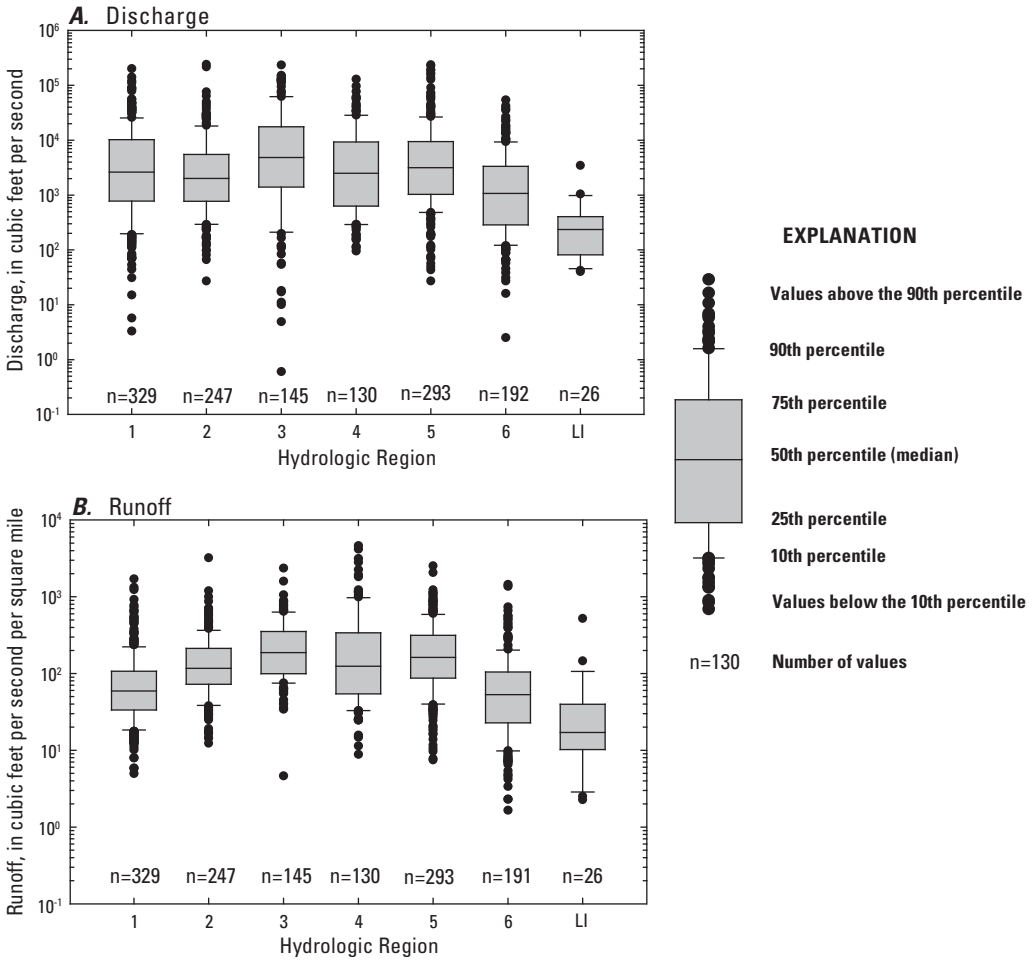

Figure 7. Distribution of maximum known *A*, discharge and *B*, runoff from 1,362 locations across six hydrologic regions in New York and Long Island (Region LI). Runoff was not computed at one location in Region 6 (Erie (Barge) Canal at Lock 30, at Macedon, NY), because the location drainage area could not be determined.

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Glossary

Annual Exceedance Probability The probability that flooding of a specified magnitude will be equaled or exceeded in a given year.

Backwater The increased depth of water upstream from a dam or other obstruction in a stream channel resulting from that obstruction.

Continuous-record site A site where data are collected with sufficient frequency to define daily mean values and variations within a day.

Contracted-opening discharge measurement A determination of peak discharge after a flood by field survey of high-water marks and channel and bridge geometry at a bridge constriction. Discharge is computed from an evaluation of energy changes between the approach section and the downstream side of the constriction (Matthai, 1967).

Control Designates a feature in the channel that physically affects the water-surface elevation and thereby determines the stage-discharge relation at the gage. This feature may be a constriction of the channel, a bedrock outcrop, a gravel bar, an artificial structure, or a uniform cross section over a long reach of the channel.

Datum A surface or point relative to which measurements of height and (or) horizontal position are reported. A vertical datum is a horizontal surface used as the zero point for measurements of gage height, stage, or elevation; a horizontal datum is a reference for positions given in terms of latitude-longitude.

Discharge, or flow The rate that matter passes through a cross section of a stream channel or other water body per unit of time. The term commonly refers to the volume of water (including, unless otherwise stated, any sediment or other constituents suspended or dissolved in the water) that passes a cross section in a stream channel, canal, pipeline, and so forth, within a given period of time (cubic feet per second). Discharge also can apply to the rate at which constituents, such as suspended sediment, bedload, and dissolved or suspended chemicals, pass through a cross section, in which cases the quantity is expressed as the mass of constituent that passes the cross section in a given period of time (tons per day).

Downstream order system Since October 1, 1950, hydrologic-site records in U.S. Geological Survey reports have been listed in order according to downstream direction along the main stream. All sites on a tributary entering upstream from a main-stream site are listed before that site.

Drainage area For a stream at a specific location, the area upstream from the location, measured in a horizontal plane, which has a common outlet at the site for its surface runoff from precipitation that normally drains by gravity into a stream. Drainage areas given herein include all closed basins, or noncontributing areas, within the area unless otherwise specified.

Drainage basin A part of the Earth's surface that contains a drainage system with a common outlet for its surface runoff. (*See* "Drainage area")

Elevation Generally refers to height in feet above North American Vertical Datum of 1988 (formerly mean sea level).

Flood A relatively high flow as measured by gage height or discharge quantity.

Flood recurrence interval The average time interval between occurrences of a flood of equal or greater magnitude. A 100-year flood has a 1- percent chance of occurring in any 1-year period.

Flow-over-dam discharge measurement A determination of peak discharge after a flood, by field survey of high-water marks and channel and dam geometry. Discharge is computed on the basis of an evaluation of energy changes between the approach section and the control (dam) section (Hulsing, 1967).

Flow-through-culvert discharge measurement A determination of peak discharge after a flood, by field survey of high-water marks and channel and culvert geometry. Discharge is computed from an evaluation of energy changes between the approach section and the culvert control section (Bodhaine, 1968).

Gage datum A horizontal surface used as a zero point for measurement of stage or gage height. This surface usually is located slightly below the lowest point of the stream bottom such that the gage height is usually slightly greater than the maximum depth of water. Because the gage datum is not an actual physical object, the datum is usually defined by specifying the elevations of permanent reference marks such as bridge abutments and survey monuments, and the gage is set to agree with the reference marks.

Gage height The water-surface elevation, in feet above the gage datum. If the water surface is below the gage datum, the gage height is negative. Gage height often is used interchangeably with the more general term "stage," although gage height is more appropriate when used in reference to a reading on a gage.

Glossary—Continued

Pearson type III A statistical distribution used in flood frequency analysis to determine the probability that a given flow will occur within a given time interval.

Miscellaneous-measurement site A site where streamflow, sediment, and (or) water-quality data or water-quality or sediment samples are collected once, or more often on a random or discontinuous basis, to provide better areal coverage for defining hydrologic and water-quality conditions over a broad area in a river basin.

Partial-record site A site where discrete measurements of one or more hydrologic parameters are obtained over a period of time without continuous data being recorded or computed. A common example is a crest-stage gage partial-record site, at which only peak stages and flows are recorded.

Peak stage The maximum water-surface elevation, above an arbitrary datum of reference, that occurs at a given place over a relatively short period.

Period of record Period of time during which a systematic effort was made at a site to record hydrologic data, including the annual peak stage and discharge.

Runoff That part of precipitation that appears in streams. As used in this report, it is the average number of cubic feet of water flowing per second from each square mile of area drained, assuming that the runoff is distributed uniformly in time and area.

Skew A numerical measure of asymmetry in a frequency distribution.

Slope-area discharge measurement A determination of peak discharge made after a flood, by field survey of a reach of channel and high-water marks at selected cross sections. The U.S. Geological Survey applies the Manning equation to compute peak discharge in open channels (Dalrymple and Benson, 1967).

Stage (*See* “Gage height”)

Step-backwater computation The general procedure for establishing a stage-discharge relation by the step-backwater method includes a transit-stadia survey of a long reach downstream from the gage, an estimate of a stage-discharge relation at the downstream end of the reach, and a computation of water-surface profiles in the reach for selected discharges. The end result of this procedure is a computed water-surface elevation at the streamgage corresponding to each selected discharge.

Streamgage An instrumented site on a stream, where the annual peak discharge is observed (or estimated) for each year observations are obtained.

Water year A continuous 12-month period, arbitrarily selected for the presentation of data relative to hydrologic or meteorologic phenomena. The U.S. Geological Survey water year represents October 1 through September 30 and it is designated by the calendar year in which it ends. For example, October 1, 1980, through September 30, 1981, is the 1981 water year.

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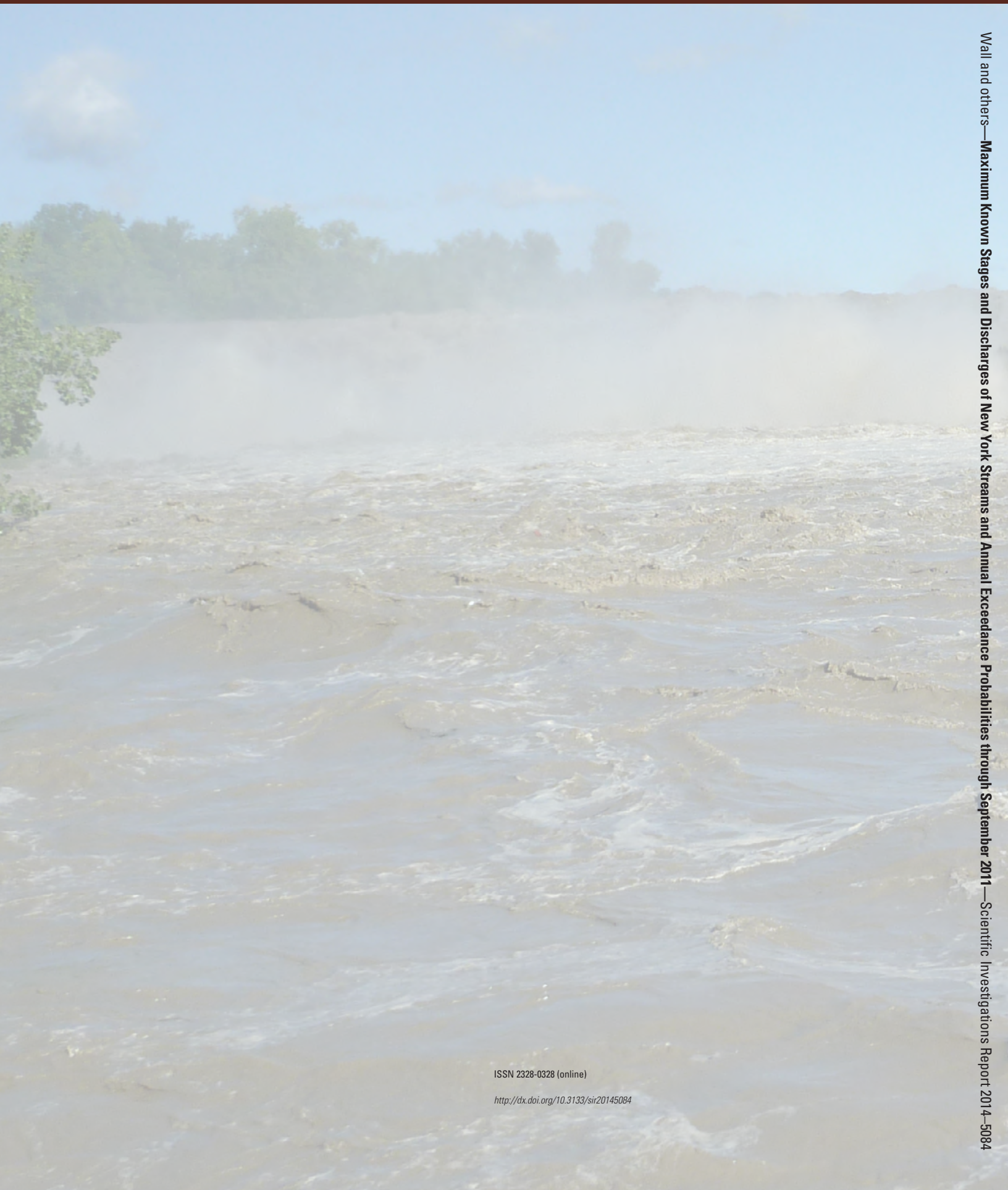

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