November 15, 2016

VIA ELECTRONIC FILING

Ms. Kimberly D. Bose
Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, DC 20426

Re: FirstLight Hydro Generating Company, FERC Project Nos. 2485 and 1889
October 31 and November 1, 2016 Study Meeting Summary

Dear Secretary Bose:

Pursuant to the schedule set forth in the Federal Energy Regulatory Commission's (FERC or Commission) Revised Process Plan and Schedule (Revised Schedule) issued May 5, 2016 for relicensing the Turners Falls Hydroelectric Project and Northfield Mountain Pumped Storage Project, FirstLight Hydro Generating Company (FirstLight) filed ten study reports and three addenda on October 14, 2016. Pursuant to the Revised Schedule, on October 31 and November 1, 2016, FirstLight held meetings to discuss the ten reports filed on October 14, 2016. Attached as Attachment A is FirstLight's meeting summary for both days.

In addition to the meeting summary, attached as Attachment B is the PowerPoint presentation made at the October 31 and November 1, 2016 meetings. FirstLight is filing its meeting summary and PowerPoint presentation with the Commission electronically. To access the document on the FERC website (http://www.ferc.gov), go to the "eLibrary" link, and enter the docket number, P-1889 or P-2485, to access the document. FirstLight is also making the same available for download at the following website: http://www.northfieldrelicensing.com.

Sincerely,

Gus Bakas

Attachment A: Meeting Minutes
Attachment B: PowerPoint Presentation

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ATTACHMENT A: MEETING SUMMARY

Location: Northfield Mountain Visitors Center, Northfield, MA

Date: October 31, 2016

Attendees:

Federal Energy Regulatory Commission
Patrick Crile
Nick Ettema (phone)
Brandon Cherry
Steve Kartalia (phone)
Bill Connelly

United States Fish and Wildlife Service
John Warner
Melissa Grader
Ken Sprankle
Julianne Rosset (phone)

USGS Conte Lab
Alex Haro
Ted Castro-Santos

National Marine Fisheries Service
Bill McDavitt
Bjorn Lake
Jeff Murphy (phone)
Sean McDermott

Massachusetts Division of Fish and Game
Caleb Slater
Jessie Leddick
Misty Anne Marold
Peter Hazelton

Crab Apple Whitewater
Frank Mooney

Appalachian Mountain Club
Norm Sims

American Whitewater
Bob Nasdor

Foley Hoag
Adam Kahn (phone)

BioDrawversity
Ethan Nedeau

Kleinschmidt Associates
Chris Tomichek
Kevin Nebiolo
Bryan Apell
Brandon Kulik

Van Ness Feldman
Julia Wood
Mike Swiger

FirstLight
Doug Bennett
Don Traester
Jim Donohue
Gus Bakas
Joe Lucas
Len Greene
Bob Stira

Massachusetts Department of Environmental Protection
Lealdon Langley

The Nature Conservancy
Katie Kennedy

No Affiliation
Don Pugh
Karl Meyer
Fred Errington

Connecticut River Watershed Council
Andrea Donlon
David Deen (phone)

Hampshire College
Sanon Rosen

Gomez and Sullivan Engineers
Tom Sullivan
Gary Lemay
John Hart
Kirk Smith
Jason George
Mark Wamser

Introductions, Meeting Purpose and Process Timeline

In advance of the meeting, the PowerPoint presentation (Attachment B) was posted to the FirstLight website and stakeholders were notified accordingly.

Mark Wamser (Gomez and Sullivan) opened the meeting and welcomed everyone. Mark asked everyone to introduce themselves. Mark noted that there were lots of studies to cover in the next 1.5 days, and that he was going to make an effort to stick to the agenda. He noted that the only studies being discussed were the 10 studies that were filed with FERC on October 14, 2016. He noted that seven studies would be reviewed today and the remaining three would be discussed tomorrow. Mark reviewed the FERC schedule relative to when stakeholder comments are due, when FirstLight (FL) responds to comments, and when FERC will issue its Determination.

Andrea Donlon (Connecticut River Watershed Council) asked about Odonate Study and when the study plan would be posted. Mark explained that the second year of field work was conducted by FL on its own due to the lower numbers of odonate observations detected in 2014 and that a study plan was not developed. Andrea noted that there was supposed to be an analysis of the Turners Falls Impoundment (TFI) and odonates in the original report. She asked if the revised report (2nd year of the study) would address this issue. Jason George (Gomez and Sullivan) indicated that FL is looking at the water level fluctuations in the TFI, and indicated that there were observations made at two sites in the TFI in 2016. The 2016 survey sites were selected in consultation with MA NHESP. The additional year of field work associated with icthyoplankton entrainment at Northfield Mountain (NFM) was also briefly discussed as it was additional field work that FL decided to do on its own. Mark and Jason stated that at this point they do not plan to have a study meeting for the addendums which will be filed in December 2016.

Bill McDavitt (National Marine Fisheries Service) asked about the juvenile shad study and whether comments on the study plan are due. Mark indicated that if the study is conducted in the fall of 2017, FL would reach out to stakeholders to finalize a study plan.

Study No. 3.3.1- Instream Flow Study in Bypass Reach and below Cabot

Kirk Smith (Gomez and Sullivan) reviewed the instream flow study results. He explained that the study entailed approximately 36 miles of river that were divided into five study reaches- Reaches 1-5. Kirk reviewed the geographic extents of Reach 1, Reach 2A, Reach 2B, Reach 3, and Reach 4. Reach 2 was subdivided into two sections—Reach 2A which was a 1D hydraulic model and Reach 2B which was a 2D hydraulic model. Reach 3 extends from Rawson Island to the Montague USGS Gage. Reach 4 (1D hydraulic model) extends from the Montague USGS Gage to the Sunderland Bridge (Route 116 Bridge).

Relative to Reach 1, Kirk reviewed five components as follows:

- Analysis of the plunge pool.
- Left Channel- a transect was placed at the most limiting barrier to fish passage. A zone of passage evaluation was conducted in the left channel.
- Center Channel – a HEC-RAS hydraulic model was conducted to evaluate the hydraulics in this channel. Kirk noted that the center channel has limited value in terms of habitat, and thus was assessed relative to fish passage.
- Right Channel- a habitat assessment using PHABSIM was conducted which included one transect.
- A habitat assessment was conducted in Reach 1 at Transects T-10 and T-11 located upstream of the Station No. 1 tailrace.

Bill McDavitt asked if FL apportioned the flow among the channels based on the bascule gate release. It was explained that flow was measured (gaged) at three locations including the Fall River, the outlet of the plunge pool, and the Right Channel. Then, based on the known releases from the bascule gate, flows through the Left and Center Channels were calculated.

Kirk showed the wetted area and volume versus flow at the plunge pool. He also reviewed a transect in the left channel showing the depth and wetted width of water under flows of 500, 1,500, 2,500 and 4,000 cfs (relative to zone of passage).

Kirk showed the mean column velocities of five transects through the center channel under four flows relative to the sustained and burst speed of adult shad. Kirk indicated that for the three center transects, the mean column velocities exceed the sustained swimming speed for all four flows. He noted that the cruising swim speed of adult shad was not shown on the plot, but the literature suggests it is approximately 7 feet/sec. Relative to the single transect in the right channel, Kirk reviewed the steady state habitat results. A table was presented showing for each target species the maximum weighted usable area (WUA) as well as the percentage of peak WUA provided at various flows. Melissa Grader (U.S. Fish and Wildlife Service) sought clarification that the column labeled as maximum WUA total flow represented the total flow release and the column labeled as maximum WUA flow was for the right channel flow only. Kirk confirmed that this was correct noting that the total flow included flow released from the bascule gate, plus the fishway release flow, plus the measured 49 cfs from the Fall River.

Kirk reviewed the same steady state habitat results table for Transects T-10 and T-11 of Reach 1. He explained that two scenarios were evaluated—a high backwater when Station No. 1 is operating and low backwater when Station No. 1 was not operating. For most species there was not much a difference in the shape of the WUA versus flow curves between the low and high backwater. He then reviewed the same steady state habitat results table for Reach 2 (which combined the results for Reach 2A, a 1D hydraulic model and Reach 2B a 2D hydraulic model).

Kirk noted that the Reach 3 hydraulics are influenced by the bypass flow (including Station No. 1 operation), Cabot operations and the Deerfield River flow. He explained that for the steady state habitat assessment various scenarios were assessed as shown below.

Scenario	Bypass Q	Cabot Q	Deerfield River Q
1	120, 200, 300, 500, 700, 1,000, 2,000, 3,000, and 5,000 cfs	2,500 cfs	200 cfs
2	Same as Scenario 1	7,000 cfs	200 cfs
3	Same as Scenario 1	14,000 cfs	200 cfs

Kirk noted that based on discussions in September with the stakeholder group, FL narrowed the number of combinations as a first cut. He noted that further discussion with stakeholders may be necessary to identify the other scenarios that they may be interested in. Mark Wamser indicated that we will need to convene a stakeholder meeting to discuss not only the other scenarios but also habitat time series. Andrea Donlon asked if the meeting would occur before comments are due on the study reports (due by December 15, 2016). Mark Wamser indicated that FL would strive to have the meeting before that date.

The analysis in Reach 3 included a steady habitat assessment, persistent habitat mapping, and habitat time series. Kirk noted that the habitat time series still needs to be completed and will be included in an addendum to the report.

For Reach 3, Kirk reviewed example steady state habitat result maps for American shad spawning and incubation. He reviewed two types of plots showing the WUA curves based on combinations of Cabot discharges, bypass flows and a constant flow of 200 cfs from the Deerfield River. Don Pugh noted that the color on the steady state WUA curves was difficult to read.

Kirk then reviewed example steady state habitat result findings showing composite suitability index map for American shad spawning and incubation. The map was colored coded for composite suitability ranges of 0-0.25, 0.25-0.5, 0.5-0.75 and 0.75-1. Kirk showed an example persistent habitat map for American shad spawning and incubation under two different Cabot discharges of 2,500 cfs and 14,000 cfs (and under a single bypass flow of 500 cfs. Kirk explained that "quality habitat" shown on the maps was determined to be a combined Suitability Index value greater than 0.5. Don Pugh asked if persistent habitat maps could be

developed for higher bypass flows. Kirk indicated yes. Kirk said that tables were provided in the report, which include the actual square footage of persistent habitat. In yellow is the quality habitat for Scenario 1 (Cabot Q -2,500 cfs). In blue is the quality habitat for Scenario 2 (Cabot Q-14,000 cfs). The overlapping or green habitat shows the persistent habitat. [Correction: At a break in the meeting, John Warner (U.S. Fish and Wildlife Service) questioned if the color coding on the persistent habitat map was correct. In fact, he was correct and FirstLight will issue updated maps with the correct legend. The map coloring won't change; however, the yellow was for Scenario 2 (Cabot Q-14,000 cfs) and the blue was for Scenario 1 (Cabot Q-2,500 cfs). The overlapping green color is correct].

Jessie Leddick asked if persistent habitat maps were developed for yellow lampmussel since a relic was detected in Reach 3 years ago. Jason indicated that this work still needs to be completed.

Karl Meyer indicated that for the Reach 3 hydraulic model (specifically Rock Dam) it is important to note where flow in the bypass is coming from such as via the dam or Station No. 1. Tom Sullivan clarified that with the River2D model developed for Reach 2B and 3, it accounts for the magnitude of the flow input at the upper model boundary—the model does not discern the source(s) of the inflow.

Kirk explained that there were three components to the Reach 4 analysis- steady state habitat analysis, dual flow analysis and habitat time series. Kirk reviewed the same table showing the percentage of maximum WUA for various flows and life stage and species. Kirk reviewed an example habitat time series results for spawning, juvenile and adult American shad based on Montague USGS Gage hourly flows for the period Jan 1, 2000 to September 30, 2015.

He then summarized the work completed and outstanding.

Study No. 3.3.16- Habitat Assessment, Surveys and Modeling of Suitable Habitat for State-Listed Mussel Species in the Connecticut River below Cabot Station

Jason George reviewed the study objectives for the mussel study. He summarized the work completed to date which included a mussel survey and habitat assessment in 2014, which was completed with a report filing. He noted that no state-listed mussels were found in Reach 4. The second component of the study was to develop binary habitat suitability index (HSI) curves for three state listed mussels. He noted that three state-listed mussels were located in Reach 5 as follows: eastern pondmussel, yellow lampmussel and tidewater mucket.

Jason then reviewed the various rounds of developing the HSI curves with the panel of experts. The experts included Dr. David Strayer, Dr. Barry Wicklow, Dr. Cynthia Loftin and Ethan Nedeau while Jason George served as the moderator. A fifth panelist was invited but did not participate. The habitat parameters the panelist considered included: depth, velocity, substrate, cover, shear stress, relative shear stress. Jason said that there were three rounds of developing the binary HSI curves. Jason indicated that developing a number for shear stress and relative shear stress was difficult and, in the end, the panelists developed HSI criteria for depth, benthic velocity, substrate, and cover; panelists could not quantify a criteria for the relative shear stress in the river.

Melissa Grader noted that from Round 2, it appeared the moderator overrode the scoring. She indicated that she couldn't find consensus on the overrides and asked if we circled back with panelists. Jason George indicated that any changes made were sent back to the panelists for agreement/disagreement. Jason said that he has email documentation showing consensus of the panelists, and indicated that it could be provided.

Melissa noted that she read several comments on shear stress and asked why we did not include them. Jason indicated that he evaluated only high flows, since only at these high flows did shear stress seem to make a difference. Peter Hazelton asked how the panel could make a decision on the Cabot Station design flows if we only looked at high flows (1.5-year to 5-year flood flows). He asked what the relative shear stress would be at full Cabot discharge at the mussel beds.

Jason reviewed the binary HSI tables for benthic velocity, depth and velocity and then explained how the HEC-RAS hydraulic model was used to estimate depths and velocities in Reach 5. He explained that there were a total of 15 transects assessed for purposes of the mussel assessment and that the hydraulic model produces a mean column velocity, which was converted to benthic velocity using a model/formula from the literature. Jessie Leddick asked if field measurements were taken to validate that the measured benthic velocity was similar to that produced with the model/formula. Jason indicated that velocity data was collected under one flow and that the field equipment cannot be used to measure velocity immediately above the channel bed. Gary Lemay noted that an ADCP was used to measure velocity about 1 foot above the bed and then used a logarithmic velocity distribution to fit the existing field data, which was then used to develop the benthic velocity near the bed.

Jessie asked if it the velocity data was collected under one flow. Gary indicated yes, but did not know the exact flow although noted it was a low flow since the data was collected this past summer.

Jason reviewed the five flow scenarios that were assessed in the hydraulic model (Side 41) and then stepped people through the process of computing the percentage of cells along a transect that met the suitability criteria. For example, 65% may indicate that 13 of 20 cells across the transect are suitable for the given species and life stage of mussel. Jason indicated that a qualitative categorization was developed based on the percentage of cells that met the HSI criteria as follows:

- None (No effect)- 0%
- Minimal- up to 10%
- Low- 10-20%
- Moderate- 20-40%
- Moderate-High- 40-60%
- High- 60-80%
- Severe- 80-100%

Misty Anne Marold (Massachusetts Division of Fish and Wildlife) asked how the qualitative categorization was developed and noted that the percentages in each category are not equal. Jason indicated it was our best estimate of grouping, but we are open to categorizing a different way.

Jason reviewed the conclusions of the study.

John Warner noted that the analysis assumed that all of Reach 5 had suitable habitat. Given this, how can FL conclude that flow is not the issue? Jason noted that based on the aquatic habitat mapping conducted in 2013 the substrate was sand. Jason said that the substrate was assumed suitable to tease out the depth and velocity impacts. John Warner asked how this assumption be applied to presence and absence.

Andrea Donlon asked if Delphi panelists are considered neutral. Jason indicated that FL reached out to several panelists and those willing to participate were approved by Natural Heritage. Tom Sullivan indicated that we felt comfortable having Ethan Nedeau on the panel given his long history with mussel work in New England. Tom also noted that Ethan was only 1 of the 5 panelists and if there was disagreement it would have been fleshed out.

In regard to relative shear stress Jason indicated that the panelists recognize that it is important factor, but they could not quantify it into a binary suitability criteria. He noted that the state-listed mussels are large and can anchor into the substrate, thus mobilizing them would require scouring of the substrate. Peter Hazelton noted that this was based on adult mussels; it would take less relative shear stress to mobilize a juvenile mussel. He would like to see more relative shear stress analysis for juvenile mussels. Misty Anne Marold also noted that one needs to factor in the rate of change of flow as it takes time for the mussel to burrow into the substrate. She indicated that no rate of change information was in the report. Tom Sullivan indicated that in regard to relative shear stress, stakeholders involved in a similar study on the Susquehanna

River (Conowingo Project) had the same problem—they could not reach consensus on how to assess relative shear stress.

Misty Anne Marold asked who specifically wrote the memos that went to the panelists. Jason indicated he did after consulting with Ethan and others. Misty Anne questioned the impartiality of Delphi panel assessment. He also indicated that the memos covered far more information than the habitat suitability information covered by the panel. Tom explained that the panelists were vetted by Natural Heritage and the method for conducting the Delphi assessment was explained in the study plan.

Study No. 3.3.2- Evaluate Upstream and Downstream Passage of Adult American Shad

Two people presented the adult shad study- Bryan Apell (Kleinschmidt) went through the study objectives and field component of the study and Kevin Nebiolo (Kleinschmidt) went through the data analysis.

Bryan indicated in March 2015, FL installed 29 radio telemetry and 14 PIT monitoring stations. He reviewed the maps showing the location of the radio telemetry system (Slides 49 and 50). Bill McDavitt asked if the fish detected at T-11 are considered to "encounter the Project". Kevin Nebiolo indicated yes, it is included in his model. Bill McDavitt asked where in the Northfield Mountain (NFM) tailrace the yagi was located. Bryan said the antennae was on the south side aimed at a 45 degree angle.

Don Pugh asked about the gatehouse ladder—do you consider "starting" at the new entrance as opposed to the vertical slot. Kevin indicated anywhere between P31 and P33.

Karl Meyer asked where the Station No. 1 antennae was located. Bryan indicated that a double yagi antenna was mounted on 20-foot pole on the backside of the Station No. 1 Powerhouse. Bryan indicated that the antennae was able to detect the entire channel and extends about 2/3rds across the bypass reach.

Bryan reviewed the model for the telemetry network starting downstream, including the fishways, and upstream to Turners Falls Impoundment. He explained that tagging was conducted over 12 days in May and June, 2015. The total number of tagged and released fish was 793 fish, including 397 double tagged fish and 396 PIT tagged fish. Bryan also reviewed TransCanada's number of tagged shad—an additional 154 fish were added to the overall sample size from the TransCanada study.

He explained that other operational data was obtained during the field study including temperature, dissolved oxygen (DO), and flow on a 15-minute interval.

Kevin Nebiolo then reviewed the results indicating that there were five main statistical approaches as follows:

- Hot Spot analyses
- Multi-State Markov Model (MSM)
- Cox Proportional Hazards
- Cormack-Jolly-Seber
- Catch Curve analysis for mortality

Ted Castro Santos (U.S. Geological Survey) asked if the MSM is conditional on movement happening. Kevin indicated yes it is conditional on movement.

Kevin explained that the analysis took a geographic approach starting downstream- below Cabot, and moving upstream to TFI, and then downstream for post-spawned adult shad. For each subnetwork model (such as Holyoke to Project, Montague Spoke, Cabot Ladder Attraction, etc.), Kevin reviewed the analysis objectives and the analytical method (see Slides 56-58 of the presentation).

Kevin indicated that a 3-step reduction and false positive removal was conducted between fall 2015 and spring 2016. The three steps included Naïve Bayes classifier algorithm, SQL database reduction (MS Access) and Visual Inspection. He noted that in July 2016 there was a data dissemination meeting for

interested stakeholders. He summarized the stats involved with the project—1,034 tagged fish in the spring 2015, over 19M records that were reduced to 16M records.

Don Pugh asked when reducing the data how FL dealt with single detections with yagis. Kevin noted that he looked at each receiver and based on professional judgment made the decision that if that fish was there, it stayed in. Ted Castro Santos asked if Naïve Bayes was applied to each antenna. Kevin indicated yes.

Bjorn Lake (National Marine Fisheries Service) asked of the 215 shad at Holyoke, did FirstLight look at early versus late season fish. Kevin indicated no.

Relative to Slide 63: Cabot Ladder Attraction, Don Pugh asked if fish were attracted to the proximity or the entrance to the ladder. Kevin indicated that if we picked up a fish at T7 (dipole for Cabot) it was concluded that the fish was in the ladder.

Karl Meyer stated that when Station No. 1 is operating fish stack up (resulting in potential delay) and suggested that information on Station No. 1 discharges are missing from the study.

Relative to Slide 64: Cabot Ladder Attraction, Don Pugh asked if 7.55 hours starts when they arrive at Montague. Kevin indicated yes.

Kevin indicated that the entrance and internal efficiency of the Cabot ladder (Slide 65) was 68% and 15.3%, respectively, for an overall efficiency of 10.2% (product of entrance and internal efficiency). The time to event analysis showed that all fish that passed did so within 40 hours.

Relative to Slide 66: Bypass Reach, Bill Connelly asked if there were poor detection strings. Kevin indicated yes, 59% were dismissed. Bill noted that it may be worth relooking at how many fish were retained or thrown out at Rock Dam.

Kevin reviewed the spillway attraction findings indicating that the probability that an adult shad survives, transitions from the spillway and is detected within the spillway ladder is 65% at a low flow (2,569 cfs) and drops to 41% at a high flow (6,226 cfs). He then reviewed the findings of the spillway ladder entrance efficiency, which was 91%, and the overall ladder efficiency, which was 32.7%.

Bill McDavitt asked if the eel ladder was deployed in the Spillway ladder in 2014. It was noted that it was deployed, but not until the adult shad study was over.

Andrea Donlon noted that in the past there were not many fish reaching the Spillway ladder, but during the adult shad study there was more water passed in the bypass reach hence more fish at the Spillway ladder.

Kevin noted that overall gatehouse ladder efficiency was 76.9% and the internal efficiency was 91%.

Kevin also noted that no fish were detected in the Upper Reservoir.

Ken Sprankle noted that for survival/mortality, he would like to see these categories broken out in tabular form as opposed to a rate.

Don Pugh asked if we knew the flow during the route selection data analysis at the TF Dam and how many fish were present during each event. Kevin said we would have to look into this.

Ted Castro-Santos suggested that in the report we use different terminology for the downstream fish bypass and the bypass channel. Kevin agreed and stated the downstream fish bypass is also referred to as the sluiceway.

Don Pugh requested tables showing the numbers of fish.

Bob Stira noted that telemetry data has some limitations. He compared passage counts with passage efficiencies.

Ted Castro Santos wanted clarification that the entrance to the log sluice was station T-9.

Andrea Donlon noted that Karl Meyer had requested a hydraulic study of power canal that FERC dismissed early on. She asked Kevin if he had a sense of how the hydraulics impacts fish. Kevin replied no.

Bob Stira noted that in reviewing these findings we need to be aware that there is a tagging effect on fish. He noted that this study showed it took approximately 10 days for fish released at Holyoke to appear in the Turners Falls Project area, which is longer than past studies have shown.

Study No. 3.3.3- Evaluate Downstream Passage of Juvenile American Shad

Bryan Apell presented the downstream juvenile shad study findings. Bryan reviewed the work that was completed that included using a combination of techniques including hydroacoustics, radio telemetry and HI-Z Turb'N tags. He showed drawings of Cabot intake and indicated that 10% of the intake area was sampled with the hydroacoustics. There were 4 transducers located at the bottom of the canal that pointed in an upward direction that sampled approximately 9% of the canal area. At the NFM intake, transducers were placed in front of the trash racks and measured 24% of the intake area.

In addition to hydroacoustics, verification sampling was also conducted at the Cabot Station bypass sampler over several discrete (15) events to determine the species identity of targeted observed in the hydroacoustic data, which was compared to the proportion of juvenile shad passing via the downstream bypass sampler. Sampling was conducting during the evening hours beginning on September 9, 2015 and continuing until October 28, 2015.

Bryan noted that the location of the hydroacoustic equipment at NFM and in the power canal did not allow for data reduction to accurately estimate the run timing, duration and magnitude or entrainment of juvenile shad. Thus, some of the study objectives could not be accomplished. Bryan explained that at these two locations fish were engaging in milling behavior rather than moving in a downstream direction. He noted that this behavior reduces the ability of the hydroacoustic equipment to enumerate individual targets and would yield an overestimation as fish could move in and out of the beam multiple times.

Melissa Grader noted that the report states milling at NFM was due to low velocities and questioned why milling was not exhibited at Cabot station where velocities were lower. Bryan explained that velocities at the Cabot Station intake rack were likely lower than those at the NMPS intake rack but not where monitoring occurred at Cabot. The hydroacoustics were positioned behind the trash racks and at the precipice of going into the penstock where velocities were much greater and fish were committed.

Don Pugh asked if we would be able to look at the milling in the canal as an index of fish as opposed to counting fish to get an indication of run timing. Bryan stated that the data from Cabot Station is likely the best estimate of run timing.

Relative to entrainment at Cabot Station (Slide 88), Bryan indicated that about 1,660,166 shad -sized targets were estimated to be entrained at Cabot Station between August 1 and November 14, 2015. He also noted that almost half (46%) of the overall estimate was attributed to fish moving through Unit 6, yet it was operated less than Units 1 or 2 over the study period. Bill Connelly asked if there was a rationale as to why fish would move more through Unit 6; Bryan speculated that perhaps the wall leading up to Unit 6 could potentially play a role.

Bryan stated that based on concurrent observations at the bypass sampler and Cabot Station intake, it was estimated that an average of roughly 43% of juvenile shad exit the canal via the downstream bypass and 57% are subject to entrainment at Cabot Station. These results were contradictory to earlier studies conducted in the early 1990, which estimated much higher bypass efficiency. Diel movement was investigated at the Cabot Station intake using hydroacoustics methods. Shad size targets were observed to be entrained during each hour of the day at Cabot Station but were most prevalent during the afternoon and evening hours, with a peak of 20:00.

Bryan noted that the entrainment findings from this study are different from earlier studies. Melissa Grader asked if there were any operational or structural changes between the older and current studies. Bryan

indicated that Cabot turbines were swapped out to gain electrical capacity, but that there was no change in the flow capacity. Relative to operations, Doug Bennett (FL) indicated that deregulation did not have an impact on the timing of generation at Cabot.

Don Pugh requested the operational data for Cabot generation, Station No 1 generation, and Turners Falls Dam spill for the period the study was conducted. FirstLight agreed to provide the data.

Andrea asked if the study was conducted when Unit 4 at NFM was operational. Bryan indicated no, Unit 4 was out of operation during the study.

Melissa asked how we would overcome using hydroacoustics at NFM to get a better idea of the number of fish entering the intake. Bryan stated that ideally the hydroacoustics would be placed further down the intake tunnel such that fish would be committed at this point; however, after many discussions with FL it is not possible to access that area due to safety and engineering logistics issues.

Bjorn Lake asked when milling was occurring. Bryan indicated that only data collected during pumping and idle (i.e. the absence of generation or pumping) was analyzed due to limitations of entrained air during the generation cycle. The milling was only occurring during pumping operations and was not evident during idle conditions.

Don Pugh asked if we were going to see the same problem with adult eel at this location. Bryan said he did not think so because FL did not propose hydroacoustics for eel. FL is using DIDSON cameras.

Bill Connelly asked if we saw a temporal signal in the hydroacoustic data at NFM. Bryan explained that entrainment was observed throughout the study period at Cabot Station with three distinct peaks.

Bryan then reviewed the radio telemetry component of study, noting that tagged juvenile shad were monitored at 13 locations in the study area using both aerial yagi and in-water dropper antennas. Bryan explained that originally hatchery fish were going to be used, but there was poor survival, thus all juvenile shad in the study were wild fish. Bryan reviewed aerial maps showing the telemetry monitoring stations.

Don Pugh noted that were a lot of undetected tags and asked if we found the same condition with the adult shad. Bryan did not believe it was an issue with adult shad. He noted that the undetected juvenile shad is probably related to tag retention or mortality.

Bryan explained that all juvenile shad were collected at the Cabot bypass sampler, put in a 90-gallon live well and then were trucked to the Turners Falls Dam Gatehouse where they were divided into 3-1,000-gallon circular holding tanks with flow-through ambient river water supplied from the impoundment. Juvenile shad from the holding tanks were transported in small groups to release locations by boat in a live well. A Lotek NanoTag Series Model NTQ-1 was externally affixed to 218 juvenile shad.

Don Pugh asked what was the time from capture to release of the juvenile shad. Bryan indicated it varied, but on average, it was less 48 hours and they strived for 24 hours. Bryan indicated they had a control group and tagged fish with tin BB weights of the same weight as the nano-tags. Bryan said that no untagged fish were held as part of the control.

Bryan explained how the rate of movement was determined. He reviewed Side 99 relative to the canal escapement after drawdown noting that prior to the drawdown, 17 juvenile shad were tagged and released into the canal the evening of October 4, 2015. Don asked if after releasing the fish were they immediately tracked. Bryan indicated they were not tracked immediately, but it was confirmed the tags were active.

Ken Sprankle asked about the detection probability of the tags and specifically if it is possible that a fish pumped to the Upper Reservoir could lose its tag. Bryan said yes, it is possible. Bryan did say that they observed fish shedding tags in the control group.

Melissa noted that there seemed to be quite a difference in weight distribution in the dummy tag as opposed to the real tag and asked if we ever saw a fish with real tags swimming on their side. Bryan said he did observe it in real tagged fish, but that it was a low percentage.

Andrea asked for clarification of the numbers presented on Slide 100 and Don Pugh reiterated that tabular data would help.

Norm Sims asked if tagged juvenile shad are eaten by a larger fish would they still be captured by telemetry. Bryan said yes, potentially but it would depend on depth of the fish.

Don stated that mobile tracking after the drawdown should have detected tags since the power canal is not deep. Bryan noted that they either missed some in the mobile survey or some escaped the canal without detection at the stationary monitoring stations. Bryan noted that the whole canal was tracked from Gatehouse to Cabot Station. Melissa asked relative to the canal drawdown was there any thought of doing a second tracking event after re-watering to determine if the fish were still around. Bryan stated that they did not conduct another mobile survey after re-watering.

Bryan presented information on entrainment estimates and flow at Cabot Station.

Andrea asked if FL abandoned the re-doing the juvenile shad telemetry study this fall 2016. Bryan said yes due to extremely low flows. He indicated that FL is evaluating whether we can meet the study objectives without re-doing the study in fall 2017.

Misty Anne Marold requested that tables in the mussel report be provided in a usable format, other than PDF.

Bill Connelly asked what we thought the problem was with the collecting, holding and tagging methods and if we'd do anything different. Bryan thought maybe releasing fish closer to NFM, but FL would have to get back to him later on this issue.

Study No. 3.3.7- Fish Entrainment and Turbine Passage Mortality Study

Brandon Kulik and Chris Tomichek presented the findings of the fish entrainment and turbine passage mortality study. Brandon reviewed study objectives and discussed the resident fish species assessment. He noted that the velocity near the intakes was computed at Station No. 1, Cabot and NFM and compared against fish swimming speeds (using cruising speed as a metric) as a way to assess risk of involuntary entrainment or impingement. For entrainment, if the swim speed was less than the mean intake velocity, then the fish were assumed to be at risk to entrainment or impingement. Morphometric literature was used to determine critical width using skull width as the critical factor as this body part is non-compressible, Fish with critical widths less than the trashrack spacing were assumed to be susceptible to impingement. If critical width was greater than the trashrack spacing, the fish could potentially be impinged if cruising speed was estimated to be less than mean intake velocity. Turbine passage mortality estimates for resident species were obtained from applicable empirical datasets of more than 30 candidate hydro projects with similar characteristics (head, runner velocity, and hydraulic capacity) as Station No. 1, and Cabot. Fish entrainment mortality loss at NFM was conservatively assumed to be 100% to avoid untested assumptions about the number of times a fish could be entrained during pump back and subsequent generation.

Species-specific information was assembled and scored using a Traits Based Analysis. Based on categories of habitat and biology, swim speed, survival, likelihood, and population impact, a "risk" score was assigned to each criterion and then summed to produce a net "risk score" for each species independently for Station No. 1, Cabot and NFM. A category value of 0 meant no impact to the given fish, while a value of 3 meant highest potential impact to the given fish. Net risk scores could potentially range up to 15; a risk score of 0-5 could thus be characterized as "low" risk; 6-10 "moderate", and 11-15 as "high" risk. Most species scored as either "low" or "moderate".

Andrea Donlon asked if fish could get impinged sideways. Brandon indicated that healthy fish will orient facing into the current (*i.e.* parallel to trash rack openings) so our analysis looked at body/head width to determine impingement.

Bill McDavitt asked where the velocities estimates were taken. Brandon indicated immediately in front of the trashracks.

Melissa asked if FL ran the Franke model for Station No. 1, Cabot and NFM. Brandon indicated no, but they used the supporting empirical database behind the Franke model. He said they correlated the Francis turbines at each of the three facilities (Station No. 1, Cabot and NFM) to other source studies that were included in the 1990s studies based on turbine characteristics and applicable study species. In cases where species-specific study data were unavailable, FirstLight applied data from surrogate species with similar or more fragile body characteristics.

Chris Tomichek led the second part of the study presentation regarding migratory fish entrainment and survival. She noted that no adult shad were entrained at NFM or Station No. 1. Relative to juvenile shad, of the 16 that went through the power canal, only one was detected at Station No. 1, but no entrainment was confirmed.

Chris explained that turbine mortality studies of juvenile shad and adult eel were conducted at Cabot, Station No. 1and over bascule gates 1 and 4 at the Turners Falls Dam. Three flows were passed over the bascule gates- 1,500 cfs, 2,500 cfs and 5,000 cfs. Chris reviewed the juvenile shad findings where 120 fish were passed through Cabot Unit 2 (Cabot), 90 through Units 2/3 (Station No. 1) and 90 through Unit 1 (Station No. 1). One-hour survival of juvenile shad at Cabot Unit 2 was 95%, whereas survival at Station Unit 1 and Units 2/3 were 68% and 77%, respectively. In terms of mortality at bascule gate 1 under discharges of 1,500 cfs, 2,500 cfs and 5,000 cfs, there was 69%, 48% and 76% survival, respectively. In terms of mortality at bascule gate 4 under discharges of 1,500 cfs, 2,500 cfs and 5,000 cfs, there was 64%, 59% and 74% survival, respectively.

Relative to the adult eel findings, there were 50, 30 and 30 eels passed through Cabot Unit 2, Station No. 1 Units 2/3 and Station No. 1 Unit 1, respectively. In addition, 35, 30 and 30 adult eels were passed over bascule gates 1 and 4 under flows of 1,500 cfs, 2,500 cfs and 5,000 cfs. One-hour survival at Cabot Unit 2 was 98%, whereas survival at Station Unit 1 and Units 2/3 were 62% and 90%, respectively. In terms of mortality at bascule gate 1 under discharges of 1,500 cfs, 2,500 cfs and 5,000 cfs, there was 88%, 86% and 86% survival, respectively. In terms of mortality at bascule gate 4 under discharges of 1,500 cfs, 2,500 cfs and 5,000 cfs there was 89%, 90% and 93% survival, respectively.

Andrea Donlon asked about the 48-hour juvenile shad survival rate. Chris stated that a 48-hour survival could not be calculated because control mortality was too high.

Study No. 3.3.15- Assessment of Adult Sea Lamprey Spawning within the Turners Falls Project and Northfield Mountain Project Area

Bryan Apell reviewed the study objectives for the sea lamprey spawning study. A total of 40 adult sea lamprey were tagged of which 20 were released in the early portion of the run (5/21/15) and 20 released in the later portion of the run (5/28/16) at two locations. Bryan indicated that mobile tracking was conducted.

The assessment looked at 29 redds in five spawning sites, near Stebbins Island, Fall River, Millers River confluence, Deerfield River and the Hatfield S Curve below the Route 116 Bridge. Marked redds were routinely monitored for depth, velocity, temperature, substrate, damage and general observations. The five sites were capped and two caps produced ammocoetes --at the Hatfield S Curve and Fall River.

Bryan explained that site specific data was collected at each site when visited over the spawning period including depth, velocity and the dominant substrate. He showed a table (Slide 131) showing the range of depths and velocities collected during site visits as well as the averages of each. He noted that the highest depths and velocities were measured at the seven redds around Stebbins Island.

Melissa Grader asked if river elevation and flow data was available from the start to end of the monitoring period. Mark Wamser indicated that we have information on the Vernon tailrace elevation and flow, flow in the Ashuelot and Millers River since both have USGS Gage, and flow at the Hatfield S Curve from the Montague USGS Gage. Mark noted that we don't have river elevation data at any of the sites other than the

Vernon tailrace and no data (flow or elevation) is available at the Fall River site. Mark noted that we could provide the information we have available.

Bryan noted that there was not a lot of spawning habitat in the Turners Falls Impoundment other than near Stebbins Island.

Don Pugh asked if we determined, based on the site visits, when the sea lamprey were actually building the nests as the depths/velocities you have recorded are over the entire period. Don noted that the range of depths and velocities shown on Slide 131 were outside the HSI criteria for sea lamprey spawning. Bryan indicated that they were not continuously at the spawning site so he could not tell exactly the river stage and flow relative to when the sea lamprey were building the nests but nest building was observed and could be cross referenced to river discharge via the USGS gage.

John Warner also noted that at the five sites depth and water velocity data were collected outside the range of the HSI criteria. Bryan stated the he would look at their field notes to see if anything was noted relative to when the sea lamprey were building nests to potentially refine the HSI criteria.

Melissa Grader asked if the five sites were selected based on radio telemetry or habitat mapping. Bryan indicated both; they surveyed the area for the criteria that makes for good spawning habitat and relied on radio telemetry as well. He indicated that at least two nest building sites were discovered through the tracking of tagged lamprey including the Hatfield S curve spawning location.

Study No. 3.3.13- Impacts of the Turners Falls Project and Northfield Mountain Project on Littoral Zone Fish Habitat and Spawning Habitat

Brandon Kulik presented the findings of the littoral zone spawning. He noted that studies were conducted during the early spring (broadcast adhesive eggs) and late spring (nearshore shoal areas, nest builders) periods. All field work was conducted via visual observation; no telemetry was used. All spawning sites found were geo-positioned with an RTK-GPS so that the elevation as well as the location of the nests could be documented. The bulk of the spawning was located near Stebbins Island, and below the French King Gorge near Bartons Cove during both periods. A total of 17 sites were located in the early spring and 15 sites in the late spring (total of 32 sites). Julianne Rossett (U.S. Fish and Wildlife Service) asked of the 32 spawning sites, how many were occupied or showed evidence of egg masses. Brandon stated that it was on the order of 60-70% of them. He also noted that in some cases during the early spring the species that created spawning redds had to be identified by inference based on habitat use since it was not possible to observe the adults.

Brandon presented a map of where observed spawning activities occurred. He then went through how the hydraulic model (developed as part of Study No. 3.2.2) was used to determine if Project operations had an impact on spawning areas. Melissa Grader asked if the hydraulic model was used to assess sea lamprey redds. Brandon indicated that the hydraulic model was not used but lamprey spawning was assessed as a part of study 3.3.15. Bryan Apell noted that they obtained GPS coordinate data on the sea lamprey redds. Mark Wamser noted that the hydraulic model is of the mainstem Connecticut River only, so the redds found in the Ashuelot, Millers and Fall Rivers could not be assessed with the model.

Location: Northfield Mountain Visitors Center, Northfield, MA

Location: November 1, 2016

Attendees:

Federal Energy Regulatory Commission
Patrick Crile
Brandon Cherry
Bill Connelly
Nick Palso (phone)
John Baummer (phone)

US Environmental Protection Agency
Toby Stover (phone)

National Marine Fisheries Service
Bill McDavitt (phone)

Massachusetts Department of Environmental Protection
David Cameron
Brian Harrington
David Foulis
Bob Kubit

Connecticut River Watershed Council
Andrea Donlon
David Deen (phone)

Connecticut River Streambank Erosion Committee
Tom Miner
Maryanne Gallagher
Mike Bathory

Franklin Regional Council of Governments
Kimberly MacPhee

Appalachian Mountain Club
Norm Sims

Crab Apple Whitewater
Frank Mooney

Hampshire College
Sanon Rosen

TransCanada
John Ragonese

FirstLight
Doug Bennett
Don Traester
Jim Donohue
Gus Bakas
Joe Lucas
Len Greene
Ed Hathaway
Chuck Momnie

Simon & Associates
Bob Simons

Cardno
Andrew Simon
Jen Hammond

Consultant
Kit Choi (phone)

TRC Solutions
Sarah Verville
Wendy Bley

American Whitewater
Bob Nasdor

New England Flow
Tom Christopher

Foley Hoag
Adam Kahn

Gomez and Sullivan Engineers
Tom Sullivan
Tim Sullivan
John Hart
Mark Wamser

Van Ness Feldman
Julia Wood
Mike Swiger

Study No. 3.1.3 Sediment Management Plan

Tim Sullivan (Gomez and Sullivan) presented an update of the Sediment Management Plan. He explained that the focus of the presentation was what has been done in the past year, which was completion of the physical model and development of proposed management measures (items 1-9 on Slides 143 and 144).

Tim noted that Alden Research Laboratory had developed three models: a Computational Hydrodynamic Sedimentation model of the Upper Reservoir (UR model); a CFD model of the Northfield Mountain tailrace area, and a physical model of the tailrace area. Tim also reviewed the findings of the pilot dredge of the Upper Reservoir (UR).

The UR model found that the root cause of sedimentation in the UR likely begins with relatively high concentrations of entrained bed and suspended sediment loads from the Connecticut River transported during pumping phases. The UR model also found that potential changes in UR operating procedures or physical modifications to the UR intake configuration would only result in a minimal impact on reducing sediment uptake. Thus, changes in UR operating procedures and physical modifications to the UR intake configuration were eliminated from further consideration.

The CFD model of the NFM tailrace area found that the majority of sediment uptake to the UR occurred during operational conditions with three or four pumps. The CFD model examined the feasibility of two potential sediment exclusion structures which would span the mouth of the NFM tailrace in order to prevent the entrainment of sediment into the Project works. Based on the results of the modeling, the sediment exclusion structures were found to be more effective than the UR alternatives, however, they were still found to have limited effectiveness in reducing sediment entrainment. Tim noted that based on the results of the tailrace modeling, FirstLight decided to investigate the potential for a sediment exclusion structure at the tailrace further by developing a physical model.

The physical model assessed two different structures – one with a fixed crest overflow and one with a moveable crest overflow. The modeling showed that a moveable crest overflow was slightly more effective than a fixed crest overflow; however, the effectiveness of either structure was limited and therefore eliminated from further consideration.

Tim then discussed the pilot dredge project, which showed that hydraulic dredging could be a viable management measure. The nine sediment management measures proposed by FirstLight were then reviewed and discussed. The intent of the management measures are to monitor and manage the amount of sediment in the UR. The recommended measures are those which have the potential to be most effective in minimizing sediment entrainment into Project works and the Connecticut River during dewatering of the UR.

Andrea Donlon asked whether the reason the sediment that was pulled into the shaft in 2010 was due to too much sediment, the location of the sediment or that the UR was drained too fast. Andrea asked why there are no trigger points included in the report as to when dredging would be conducted. Andrea asked how often the dredge would be conducted. Tim responded that Alden's UR modeling report (filed 3 years ago) examined the conditions at which the bed sediment would become mobilized. Tim also noted that bathymetric surveys of the UR would be conducted every 1-2 years, in order to provide data on how much sediment has accumulated in the UR between surveys.

Tom Miner asked if the high concentration of sediment in the river was a contributor to the sediment in the UR, why the study didn't look at erosion as a potential source of high sediment concentrations, and why the recommended management measure didn't look at methods to reduce erosion as a way to reduce sediment. Tim responded that the erosion causation study, which was to be discussed next, examined the cause of erosion in the TFI. Tim also indicated that both bedload and suspended sediment contribute to the sediment seen in the UR. Tom Sullivan noted that during high flow events in the river there is a high suspended sediment concertation throughout the river, including upstream of Vernon. Tom also noted that

the modelling showed that dredging the UR was more effective as a management tool than constructing a structure in the tailrace area to reduce sediment entrainment during pumping operations.

Andrea Donlon read from a page in the Alden report regarding historic project operation and asked whether the UR had ever historically been drawn down to elevation 920', and if the intent of such a drawdown was to flush out sediment so that it doesn't accumulate. Mark Wamser explained in the data Gomez and Sullivan had for the past 15 years, he did not think that the UR was lowered below elevation 938'. Mark said he would look at the Alden report reference to 920' and see what was intended. Tim asked that Andrea put this question in her written comments and FL will provide a response in the written response to stakeholder comments.

John Baummer from FERC asked if a sediment management plan was going to be filed by FL with the Final License Application. Tim explained that the final study report, which includes the recommended management protocols is the sediment management plan. John noted that two different methods for collecting bathymetric data had been used in the past—single beam and multi-beam, thus making it difficult to quantify any change in sediment volume between years. Tim recognized this and noted that ideally a multi-beam unit will be used consistently. John also recommended that the management measures use the same methods for the bathymetry surveys so that an apples to apples comparison could be made going forward and Tim agreed.

Study No. 3.1.2 Erosion Causation Study (Tim Sullivan – GSE)

Tim then presented the results of the Erosion Causation Study. He noted that, in accordance with the study plan, potential causes of erosion had been broken into two categories- potential primary causes and potential secondary causes. Potential primary causes are those thought to be most prevalent throughout the Turners Falls Impoundment (TFI).

Tim explained that the study found that potential secondary causes had minimal impact on erosion processes throughout the TFI other than a few localized areas. Thus, the bulk of study focused on the potential primary causes, which are land management practices and anthropogenic influences, ice, hydraulic sheer stress due to flowing water, water level fluctuations due to high flows, and boat waves.

Detailed study sites were one of the cornerstones of the study. There were 25 sites evaluated. The sites represent the geographic range of the TFI but also the full range of river bank features and characteristics, erosion conditions, and hydraulic conditions. The 25 sites included both restored and non-restored sites. The 25 sites also included 16 sites, which have been surveyed since the 1990s and 9 newly identified sites. The 16 sites established in the 1990s were classified as calibration sites. Representative sites were sites that provided supplemental information or filled gaps in information. Bank Stability and Toe Erosion Model (BSTEM) analysis was run at all 25 sites and field data was collected at all sites. Potential primary causes were examined in depth at each site. Results were then extrapolated throughout the entire TFI such that the entire TFI shoreline was assigned a cause or causes of erosion. Two sets of maps were developed, which identified the causes of erosion at each individual site and then at every river bank segment.

Hydrology and Hydraulics findings (slides 150 -153)

Tim emphasized the importance of understanding the maximum generating capacity of Vernon, Northfield Mountain, and the Turners Falls (TF) Hydroelectric Projects. He noted that at flows above the maximum hydraulic capacity of 17,130 cfs at Vernon, Vernon operations are run of river and that inflow to the TFI is "natural." Tim also noted that at flows greater than 30,000 cfs, the French King Gorge, where the TFI narrows, becomes the primary hydraulic control for the middle and upper portions of the TFI.

Tim explained that the study found that there were four distinct hydraulic reaches. He explained that each of the plants evaluated can only affect their specific reach (Reach 1 – Lower reach; Reach 2 – Northfield Mountain reach, Reach 3- Middle reach and Reach 4 – Upper reach). For instance, Northfield Mountain operations can only potentially impact erosion in the reach in which NFM is located.

Norm Sims asked in which reach is the French King Bridge located. Tim responded that it is located in Reach 1.

Tim continued with the key hydraulic findings. In the lower three reaches there are three flow thresholds. Low – below the hydraulic capacity of Vernon (17,130 cfs); Moderate (17,130 cfs to 37,000 cfs) and High (above 37,000 cfs). He reiterated that above a flow of 37,000, the river flow was beyond the combined control of Vernon and NFM and therefore is considered a naturally occurring high flow. In Reach 4 (from Vernon to the state line), there are two flow thresholds. One is above 17,130 cfs and the second is below 17,130 cfs (Vernon's hydraulic capacity). Tim noted that while NFM can operate at flows above 37,000 cfs, data analyzed on an hourly basis over the 15 year period (2000-2014) found that it did so only from 0.025% of the time with 4 units operating to 2.6% of the time with 1 unit operating. Tim also noted that one of the primary findings was that low flows rest on the lower bank; moderate range flows rest on the lower or upper bank; and high flows rest on the upper bank.

Norm asked when NFM doesn't operate, what's the flow at NFM if 17,130 is coming out of Vernon? Can it be 37,000 cfs? Tim responded that 37,000 cfs can occur without NFM operating due to naturally occurring high flow events.

Bill McDavitt (on phone) asked what the range of head pond fluctuations was. Tim responded that the water levels during the low flow periods were generally within a 2 ft daily fluctuation throughout the TFI. At moderate to high flows, there is about a 1 ft fluctuation in the vicinity of NFM that dampens as you move upstream before being approximately a ½ ft fluctuation above Stebbins Island. He noted that those fluctuation ranges were under typical operations, but that the TFI fluctuations rarely exceeded 4 ft per day.

Bill also asked how much higher the water level at 37,000 cfs is. Tim said he couldn't give the exact numbers (they are in the report) and the level would vary at different points within the TFI, but that the key is that the elevation goes from the lower bank to upper bank at 37,000 cfs. John Hart noted that the figures in Section 5 of the report show water level variations at different river flows and downstream boundary conditions. Bill said that he understands the 37,000 cfs threshold but noted that given the impoundment's "backwater environment", and the low slope on bank, that it doesn't seem like there is a lot of potential for sheer stress. Bob Simons noted that 37,000 cfs is the low end of the high flow threshold and that erosion at some sites didn't start until flows are much higher than 37,000 cfs.

Tim finished reviewing the key findings of the hydrology and hydraulics analysis.

Tim characterized the lower bank (showed pictures) as being relatively flat, and generally un-vegetated. The upper bank is steeper and often has vegetation, though there is typically no vegetation, where most erosion occurs. He explained that the modeling showed that erosion really only occurs once the water level reaches the upper bank. Fluctuations on the lower bank creates little or no erosion. Only when the water level reaches upper bank is there significant erosion.

Tim described that they did a water level duration analysis at a subset of the detailed study sites and found that the water level of the TFI was on the lower bank 78-99% of the time depending on the location of the site in the TFI.

Tim noted that flows required to reach the upper bank for the vast majority of sites was greater than 37,000 cfs. He noted that the BSTEM analysis showed that 95% of all erosion occurred at flows greater than 37,000 cfs for the majority of detailed study sites.

Application of BSTEM

Andrew Simon gave an overview of how the BSTEM model was developed and how it was used for this study. He noted that it included evaluating modeled energy grade line slopes and water surface elevations at an hourly basis over the 15-year study period and that every other input to the BSTEM model is from field collected data at all 25 sites. Bob Simons reiterated that the BSTEM model was calibrated based on

15 years of actual data. He explained that this is an unusually strong modeling application, and that typically there is no historic site-specific data to calibrate the model. Tim then provided an example of the BSTEM results (see slide 154).

Bill McDavitt asked how they ran BSTEM at sites with restoration that occurred sometime during the 15 year modeled period. Tim explained that at such sites, they modeled the same site with two different runs – pre- and post-restoration for the same site.

Tim then reviewed the findings of the modeling effort. He explained that the results of the modeling found that there were both dominant and contributing causes of erosion at each site. Dominant causes were those that were responsible for >50% of erosion at a given site. Contributing causes were those that were responsible for more than 5% of erosion, but less than 50%.

Tim described that the dominant cause for the majority of erosion was natural high flows, which was responsible for 78% of all bank erosion, and had the greatest impact on erosion at all 25 sites. Boat waves are a dominant cause of erosion at 13% of all TFI riverbanks (Reach 1, mostly in the Barton Cove area). Vernon operations were found to be the dominant cause of erosion at 9% of all TFI riverbanks (Reach 4). Northfield Mountain and Turners Falls operations were not found to be a dominant cause of erosion at any riverbank segment.

Tim explained that there are seven detailed study sites in the Northfield Mountain reach (Reach 2) and that NFM operations contributed to less than 5% of the total erosion at five of those sites. At one site NFM operations contributed to approximately 20% of the erosion and at the last site, it contributed to 7% of the erosion.

Tim also noted that the dominant primary causes followed a spatial pattern. Vernon operations were a dominant primary cause in the area from Vernon Dam to Stebbins Island; high flows were a dominant primary cause from Stebbins Island to upstream of the entrance to Barton Cove; and boat waves were a dominant primary cause from upstream of the entrance to Barton Cove to Turners Falls Dam.

Tim noted that natural high flows are such a dominant cause of erosion that there were no contributing primary causes of erosion for 68% of the riverbank length. Land use was found to be a potential contributing cause at 44% of the riverbank segments.

Maryanne Gallagher asked whether the rate of water level fluctuation is included in the PowerPoint. Tim responded that the rate of fluctuation is in the report.

Andrea asked about the difference in the terms “dominant” and “primary” causes that were used in the report. Tim agreed the nomenclature could be confusing, but noted the term “primary” cause came from the study plan and that the study plan identified those causes which would be considered primary causes of erosion. The model results were consistently described as having dominant and contributing causes. He also noted that both dominant and contributing causes could be primary causes.

With respect to the finding that Vernon operation was a dominant primary cause of erosion, John Ragonese asked where the 9% or 4 miles came from. Bob responded that the total length of river miles included both river banks and did not mean river miles. John then asked if Tim could review the map legend for the group, which Tim did. Tim also explained the nomenclature used in the mapping key.

Extrapolation Methodology

Tim explained the extrapolation method (see slide 150), describing each of the 7 major steps in the process. This was a multi-step process to extrapolate the BSTEM results of the 25 study sites to every riverbank segment identified during the 2013 Full River Reconnaissance survey.

Evaluation Regarding Impacts of Ice on Erosion

Tim then explained how ice was evaluated. He noted that ice had been added as a primary cause of erosion as a result of the closure of Vermont Yankee. He noted that the impact of ice on erosion was not quantified

because it was not a cause of erosion examined in BSTEM. Tim noted that they looked at historic analysis of ice formation and breakup in the TFI, in other river systems, and then did field monitoring in the winter of 2014-2015 and 2015-2016. They found that ice that melts in place doesn't cause much erosional impact. Ice floes moving downstream and creating ice jams is when/where the ice can cause erosion. He noted that there was no significant ice breakup event in winter of 2014-15. He explained that Project operations do not cause ice break-up events, and that these are naturally occurring events that are the result of the right combination of weather and flow. He noted that ice could be a dominant primary cause of erosion in the future given the right weather and hydrologic conditions.

Evaluation of Land Management Practices

Tim then discussed how land management practices were evaluated (slide 162). The evaluation looked at agricultural and developed areas, using data from the 2013 Full River Reconnaissance survey. Areas where the riparian buffers were less than 50 feet and the adjacent land use was either agricultural or developed were classified as being a potential contributing cause of erosion. The analyses found that 44% of river bank (19 miles) is in this category.

Questions

Patrick Crile (FERC) asked Tim to review again how they took the study/model sites and extrapolated those findings to the rest of the river. Tim reviewed the extrapolation method again. Patrick asked if for the restoration sites they used pre-restoration site characteristics. Tim said they did. Tim provided an example of how this was done.

Andrea asked how the hydraulics were used in the model. Tim explained that the hydraulic model reaches were not used in BSTEM. They were used to perform the extrapolation and classify the varying hydraulic conditions. Andrew added some further explanation of the role of the hydraulic model in the BSTEM modeling, energy grade line slope, and stage which varied over the 15 year period every hour.

Bob Nasdor asked about water level fluctuations in reaches 1 and 2, noting that he understood that the Barton Cove area can fluctuate 5-6 feet, and wondering why such fluctuations would have no impact on erosion, while boat wakes do. John Hart pointed Bob to figures in Section 5 of the report, which show the daily TFI fluctuation over the 15 year modeled period. He noted that the median daily fluctuation is about 2 feet/day in Barton Cove. The maximum daily fluctuation daily is 5-6 feet, but this occurs less than 5 % of days.

Bob reiterated his question of how typical 2-3 ft fluctuation was found not to have any impact on the erosion. Tim explained that there were 3 erosion sites in the Barton Cove area. The BSTEM analysis showed that boat waves were found to be the dominant cause of erosion. Tim noted that this area of the TFI is more lake like as opposed to riverine and the repeated impact of boat waves on a relatively narrow band of riverbank has a significant impact on erosion. In the more riverine portion of Reach 1, he noted that fluctuations of 2-3 feet occurs mostly on the lower bank, which is largely bedrock and boulders or low-lying wetland areas in this reach. Therefore there is little impact to erosion from the typical fluctuations. Bob asked if there is less fluctuation in Reach 2 than Reach 1. John Hart indicated they were about the same.

Kimberly McPhee (FRCOG) asked a question about the energy grade line slope (EGLS), as defined in report. She wondered if this was used as a proxy for calculating the shear stress in BSTEM. Andrew explained how the how EGLS was used in the model. This led to some detailed technical discussion about the relationship between EGLS, Manning's Equation, and how EGLS is used in the BSTEM model. Andrew concluded by indicating that using EGLS is actually an enhancement over modeling shear stress by using just water surface elevation.

Kimberly asked another technical question about how water pressure and erosion due to water moving in and out of the river bank were modeled with BSTEM. She suggested that her own observations of how erosion occurs, and the type of erosion that occurs, seem different from what the model results show.

Andrew explained that the BSTEM model handles the types of erosion she was describing, which was the particle-by-particle erosion that occurs by hydraulic forces from the water flowing in the channel. It also accounts for the shear stresses imposed by impacts from boat waves. He went on to explain that the hydraulic erosion process was what she was observing. Andrew also explained that although the model includes a dynamic groundwater table to move up and down as water moves into the bank according to the hourly stage data, that the model does not specifically simulate seepage erosion. He then went on to describe the types of erosion accounted for in the BSTEM model, including hydraulic, particle-by-particle erosion from flows, cantilever failure due to undercutting, and planar failure. He also noted that the model inputs started with geometry data from the year 2000. He noted that in situ river-bank materials have not changed since 2000, and that the geotechnical-material information came from tests within holes augured into the banks and surface erodibility was from surficial testing.

Andrea asked about the 3 different flow ranges and how they were used or not used in the modeling. Tim explained that two separate analyses conducted. The HEC-RAS hydraulic model was used to model the hydraulic characteristics of the TFI. BSTEM was used to get the flow at which 50% or 95% of erosion occurred at a given site. Based on the results of the moderate or high flow analysis, the results of the models and the previously established flow thresholds were used to look at each site and assign dominant cause and contributing causes of erosion related to natural high flows, natural moderate flows, or Vernon operations. Andrew reviewed the details of how the 15 year hourly time step (131,000 time steps) was used in the model. Bob Simons added that cumulative distribution of erosion is a function of flow and that cumulative distribution of erosion plots were developed based on the BSTEM results. He also noted that suspended sediment concentration follows the same pattern, and is a function of river flow.

Bill McDavitt asked about what the model showed during the period of 2001-2002 (August and September), which was a period of very low flows. He wondered if during such a period normal project operations/fluctuations were more of a contributing factor to erosion. This led to a discussion of the potential differences in erosion causation during particular periods in the modeled record. Tim explained that the study took the whole 15 year period into account. Thus any periods of very low flow, and the erosion that occurred during that period, would have been taken into consideration. Bill asked a follow up question about whether the NFM erosion effect might be enhanced when the river is very low. Tim reiterated that when water levels and flows are low, the fluctuations occur on the lower bank, so there isn't much erosion. Bill's final question was about cross section geometry data. He asked if the BSTEM model was calibrated on an annual basis and if the model results were checked against the changes observed from the annual surveys. Andrew answered yes, that they calibrated the model for the period and a calibration check was run to compare against actual results.

Bob Simons added that the study was very robust because in a typical application of BSTEM, there is not before and after cross-section data to calibrate to. After further discussion, Tom Sullivan indicated that if someone was interested in looking at the model results for a specific time period, they should request exactly what they want in written comments.

John Ragonese asked why modeled WSEL data was used in the BSTEM model, rather than actual WSEL data. Mark Wamser reminded John that the hydraulic model was calibrated with data from an array of water level loggers in the TFI in 2014 and the calibration was very good. The hydraulic modeling data allowed a 15 year period for BSTEM modeling at the 25 sites throughout the TFI. The information regarding calibration of the hydraulic model is in Study Report No. 3.2.2.

John Ragonese asked several questions about how Vernon operations were handled in the model. It was explained that FL had used historic hourly Vernon discharge data, and Tim described how Vernon was handled in more detail. John Hart noted that they did not model Vernon "off" in the BSTEM model. John Ragonese said he understood and suggested that it might be better to characterize Vernon operations as "discharge below Vernon" rather than as Vernon operations.

Andrea asked a question about how the BSTEM model looks at the erosion process over time. She noted that some of the bank restoration projects have failed and then been reconstructed. Andrew explained that the BSTEM model's determination of erosion was cumulative over time, so that it did consider the cumulative effect of the causes and amount of erosion, including all intervening events.

Mike Bathory read a quote from a newspaper about observed erosion and erosion effects in TFI. He asked how the model results could be reconciled with the newspaper's assessment. This led to further discussion about the validity of the BSTEM model, and in particular how boat waves impact portions of the shoreline. Tim noted that it is the repeated striking of the boat-wave along the bank that causes erosion. Tim reiterated that wave impacts were identified by turning waves "on" and "off" in the model and comparing the results.

Patrick Crile asked a question about the EGLS and how it is different for a natural flow of 20,000 cfs, versus a flow of 20,000 comprised of 10,000 natural flow plus 10,000 NFM flow. This led to further discussion about the EGLS. It was noted that the EGLS is pretty flat under the lower flows and that the EGLS changes with changing NFM flows.

Kimberly asked about how sensitive the EGLS is to NFM operations. She wondered if the same conditions would exist absent the Vernon and TF dams. Tom Sullivan reminded everyone that the study did not look at "no dam" conditions. Andrew indicated that there is no way to speculate what the EGLS condition would be or what the model results would show under a "no dam" condition. Tom also reiterated that at high flows (generally over 30,000 cfs), the hydraulic control on the river shifts to the French King Gorge, not the TF dam.

Norm indicated that he would like to see the discharge data from NFM over past 5 years, as well as the changes in TFI elevation over the past five years. Mark said they could share the actual data, if Norm would specify in writing exactly what data and for what periods he wanted.

Mary Gallagher asked for the sections of river bank where NFM was a contributing cause to erosion – what type of erosion was it, and what action of operation contributes to that. Tim noted that there are figures in the report showing the type of erosion that is occurring. He also pointed to a section of the report that goes through what is happening in each reach and at each site.

Study No. 3.6.6 Assessment of Effects of Project Operation on Recreation and Land Use

Wendy Bley (TRC) summarized the results of the Assessment of Effects of Project Operation on Recreation and Land Use. She noted that the assessment focused on project operational effects (water levels and flows) on water-based recreation sites and facilities. Land use was considered in three other studies (3.1.2 Erosion Causation Study), (3.1.1 Full River Reconnaissance Study), and (3.6.5 Land Use Inventory. Wendy then identified the sites that were assessed (slides 166-167). With respect to methodology, Wendy described that the results of the other recreation studies were reviewed, as well as studies that contained relevant information including a) the hydraulic study of TFI, b) instream flow studies in the bypass reach and below Cabot Station, c) the River2D modelling study of the NFM intake/tailrace area, and d) the erosion causation study. With respect to the recreation studies, the surveys from the Recreation Use/User Contact survey were reviewed to glean recreationists' comments on water levels and flows at a particular site.

Wendy noted that each site was evaluated based on hydraulic conditions at the closest modeled transects. An assumption was made that 3 feet of water depth was needed to launch motor boats and 2 feet of water depth was needed to launch canoes and kayaks. Wendy then presented two examples of how the analysis was conducted – Pauchaug Boat Launch and Riverview Boat Dock.

Questions on Pauchaug Boat Launch

Bob Nasdor asked if the analysis was based on using a median water surface elevation (WSEL). Wendy indicated no, stating that the WSEL duration curves for each recreation site are based on 15 years of hourly WSEL data.

Andrea Donlon asked how often the WSEL goes below 181. Wendy responded that 15% of the time on average it's below 181 during the recreation season.

Bob Nasdor suggested that the analysis should be based on daylight hours because boaters don't use the sites at night.

Tom Miner stated that based on his personal experience, he cannot launch a power boat in the early morning.

Norm Sims stated that launching canoes can also be difficult due to mud and that on a recent experience he was unable to get across a mud flat.

Questions on Riverview Boat Dock

Norm Sims stated that he does not think that Riverview is a launch site because the carry from the parking lot to the boat dock is a long way. He also noted that power boats cannot launch from this site.

Andrea Donlon asked whether the study looked at paddlers paddling downstream who are facing an upstream flow (when NFM is pumping). Wendy noted that the assessment focused on the QII and powerboats because Riverview is designed for paddling access. She also noted that the velocity is relatively low (2 fps) here, which equates to 1.4 miles per hour. Norm Sims noted that it is relatively easy to paddle against a velocity in this range.

Bob Nasdor stated that the WSEL assessment at Poplar Street is not useful when it's so difficult to get down the bank to the water to launch a canoe or kayak.

Norm Sims stated that launching canoes at the Sunderland Bridge on river left this summer was not possible because of low water levels. Doug Bennett of FirstLight noted that the northeast was in a drought this past summer hence the low summer flow. Norm also commented that there should be an assessment of a put-in immediately below the TF Dam on river left.

Andrea Donlon asked whether flows in the bypass reach affected fishing. She also noted that swimming takes place at Rock Dam although FirstLight discourages swimming at this location. Wendy responded that the assessment focused on whether water levels affected the ability to access the site. The study didn't try to make any judgments on the suitability of a flow for a recreational activity such as fishing or swimming in the river.

Mark Wamser then concluded the meeting. He reminded the participants of the schedule for next steps, including that FirstLight would be filing a meeting summary within 15 days. He reminded participants that if they have information requests, they should put those requests in their written comments, which are due 30 days after the meeting summary.

ATTACHMENT B: POWERPOINT PRESENTATION