14. ALTERNATIVES ANALYSIS

SEQRA and CEQR procedures require that alternatives to the Proposed Action be identified and evaluated in an EIS, including a No Action Alternative. Objectives of the alternatives analysis are to: determine whether alternatives reduce, mitigate, or eliminate impacts while substantively meeting goals and objectives of the Proposed Action; demonstrate a reasonable range of options to the Proposed Action; and compare potential impacts and benefits under alternative approaches. The alternatives evaluated in this EIS include:

- Reasonable infrastructure and operational alternatives at Ashokan Reservoir that could reduce turbidity levels in flows from Ashokan Reservoir;
- A range of alternatives related to operation of the Catskill Aqueduct involving discharge of water from the aqueduct prior to Kensico Reservoir; and
- Reasonable structural alternatives at Kensico Reservoir that minimize the area of floc deposition resulting from the application of alum.

The alternatives analysis for this EIS also considered the No Action Alternative, which has been determined to be the continued operation of the Ashokan Release Channel in accordance with the IRP and assumes delay of dredging of alum floc at Kensico Reservoir until repairs to the RWBT are complete. Pursuant to the 2020 Modification to the Catalum Administrative Order on Consent, this EIS also evaluates the further delay of Kensico Reservoir dredging until after DEP constructs a filtration plant for the Catskill/Delaware water supply.

As indicated in the Final Scope, alternatives that were previously evaluated are included and summarized herein. As required by the FAD and the Catalum and Shandaken Tunnel SPDES permits, DEP previously completed several extensive studies including modeling and evaluation of potential structural and non-structural alternatives for reducing turbidity in the Catskill/Delaware Water Supply System (see **Figure 1-7**). A summary of these studies was prepared by DEP in 2014.[1] The alternatives analysis incorporates results from these studies and modeling efforts and adds other alternatives for consideration: Bypass of Low Turbidity upper Esopus Creek directly to Ashokan East Basin, four Catskill Aqueduct Alternatives, and Further Delay of Kensico Reservoir Dredging. **Table 14.1-1** provides a brief description of each alternative examined in this section.

[1] CTC Control Alternatives Report, 2014.

Table 14.1-1. List of Alternatives Evaluated

Alternative	Description
No Action Alternative	Continued operation of Ashokan Release Channel at Ashokan Reservoir in accordance with the IRP; delay of dredging alum floc at Kensico Reservoir until the RWBT repairs are complete.
Ashokan Reservoir Alternatives	
Alternative 1 – West Basin Outlet Structure	Construction of an outlet structure in the west basin discharging to lower Esopus Creek downstream of Olivebridge Dam.
Alternative 2 – Dividing Weir Crest Gates	Construction of inflatable gates on the Ashokan Dividing Weir to temporarily increase west basin storage capacity.
Alternative 3 – East Basin Diversion Wall and Channel Improvements	Extending the height and length of the diversion wall directing flow from west to east basin and possible widening of adjacent east basin spillway channel.
Alternative 4 – Upper Gate Chamber Modifications	Replacement of existing stop shutters and installation of sluice gates to provide enhanced multi-level withdrawal capability.
Alternative 5 – East Basin Intake Structure	Construction of an intake toward the center of the east basin to provide an alternative withdrawal location that is potentially less susceptible to elevated turbidity conditions.
Alternative 6 – Changed Ashokan Release Channel Operations	Different Ashokan Release Channel operational scenarios from those in the IRP.
Alternative 7 – Bypass of Low Turbidity Upper Esopus Creek Water to Ashokan East Basin	Construction of a bypass tunnel or other structural improvement to convey water from upper Esopus Creek directly to the east basin of Ashokan Reservoir.
Alternative 8 – Bypass of Upper Esopus directly to Lower Esopus Creek	Construction of a bypass tunnel or other structural improvement to convey water from upper Esopus Creek directly to lower Esopus Creek.
Catskill Aqueduct Alternatives	
Alternative 1 – Hudson River Drainage Chamber	Use of Moodna/Hudson River Tunnel Drainage Chamber to discharge turbid water from the Catskill Aqueduct to the Hudson River.
Alternative 2 – Croton Lake Siphon	Use of Croton Lake Siphon downtake shaft blow-off to discharge turbid water from the Catskill Aqueduct to New Croton Reservoir.
Alternative 3 – Rondout Pressure Tunnel	Use of Rondout Pressure Tunnel Siphon Drain to discharge turbid water from the Catskill Aqueduct to Rondout Creek.
Alternative 4 – Wallkill Pressure Tunnel Siphon Drain or the Wallkill Blow-off Chamber	Use of Wallkill Pressure Tunnel Siphon Drain or Wallkill Blow-off Chamber to discharge turbid water from the Catskill Aqueduct to Wallkill River.

Table 14.1-1. List of Alternatives Evaluated (Continued)

Kensico Reservoir Alternatives	
Alternative 1 – Perforated Target Baffle	Installation of a perforated vertical baffle wall to dissipate energy of water entering the CATIC Cove.
Alternative 2 – Sedimentation Basin	Installation of two baffles on the east bank and one on the west bank of the CATIC Cove to interrupt high velocity current and increase particle residence time in the cove.
Alternative 3 – Perforated Baffle Wall	Installation of a perforated baffle wall perpendicular to general flow direction to make flow uniform before it leaves the cove.
Alternative 4 – Submerged Weir	Installation of a submerged weir to act as a baffle to make flow uniform and trap large particles.
Alternative 5 – Boom and Silt Curtains	Installation of an oil boom and two silt curtains to create a large settling basin.
Alternative 6 – Large Settling Basin	Installation of a perforated wall to homogenize flow, and an effluent weir in the open area of the cove to form a large settling basin.
Alternative 7 – Further Delay of Kensico Reservoir Dredging	Delay of Kensico Reservoir dredging until DEP constructs a filtration plant for the Catskill/Delaware water supply.

14.1 APPROACH

For an alternative to be successful, it must be a practical substitute for the Proposed Action that achieves its original goals and reduces the potential for impacts or enhances benefits when compared to the Proposed Action. Therefore, an analysis was conducted to consider the following criteria to assess each alternative:

- Water Supply Reliability: Ability for DEP to meet multiple objectives for its water supply system (e.g., water supply, water quality, operational flexibility);
- Constructability: Overall feasibility, taking into consideration existing technology, logistics in light of the project purpose, and construction; and
- Reduced Impacts and Enhanced Benefits: Potential for reducing, mitigating, or eliminating impacts and/or potential for enhancing benefits as compared to the Proposed Action.

An assessment of each alternative was conducted using prior modeling, data analysis, and reports.

NO ACTION ALTERNATIVE

The No Action Alternative was defined as the continued operation of the Ashokan Release Channel in accordance with the IRP and delay of dredging at Kensico Reservoir until repairs to the RWBT are complete. Therefore, the No Action Alternative is the same as the Proposed Action and would have the same impacts and benefits as disclosed in the future with the Proposed Action.

14.2 ANALYSIS OF ALTERNATIVES

14.2.1 ASHOKAN RESERVOIR ALTERNATIVES

In Phase III of the 2007 Catskill Turbidity Control Study, potential turbidity control alternatives were evaluated at Ashokan Reservoir.[2] This study included modeling of alternatives and evaluation of potential water supply benefits of these alternatives. It was determined that the structural alternatives (Alternatives 1-5 and 8) would not provide a water supply benefit and/or would result in significant construction and environmental impacts. Instead of pursuing these structural alternatives, DEP decided to construct the Catskill/Delaware Interconnection at Shaft 4, stop shutter improvements, and the Croton Water Filtration Plant, and to modify operations using OST. These investments enhanced operational flexibility of DEP's water supply system, which provided water quality benefits, and use of Shaft 4, the Catskill Aqueduct stop shutters, and Croton Water Filtration Plant were incorporated into the evaluation of the Proposed Action and Ashokan Alternative 6, Changed Ashokan Release Channel Operations. As part of the EIS, the structural alternatives were also evaluated to identify potential impacts or benefits to lower Esopus Creek. Ashokan Alternative 7 was also added for consideration in the EIS as a variation on Ashokan Alternative 8 (**Figure 14.2-1**). Specific details on the alternatives are described below.

[2] Ashokan Alternatives 1 through 6 were included in Phase III Final Report, Catskill Turbidity Control Study, 2007. Ashokan Alternative 8 was evaluated as part of the Catskill Turbidity Control Phase III Value Engineering Study Workshop, 2008 and Alternative 7 is a variation on suggested alternatives as part of the 2008 workshop.

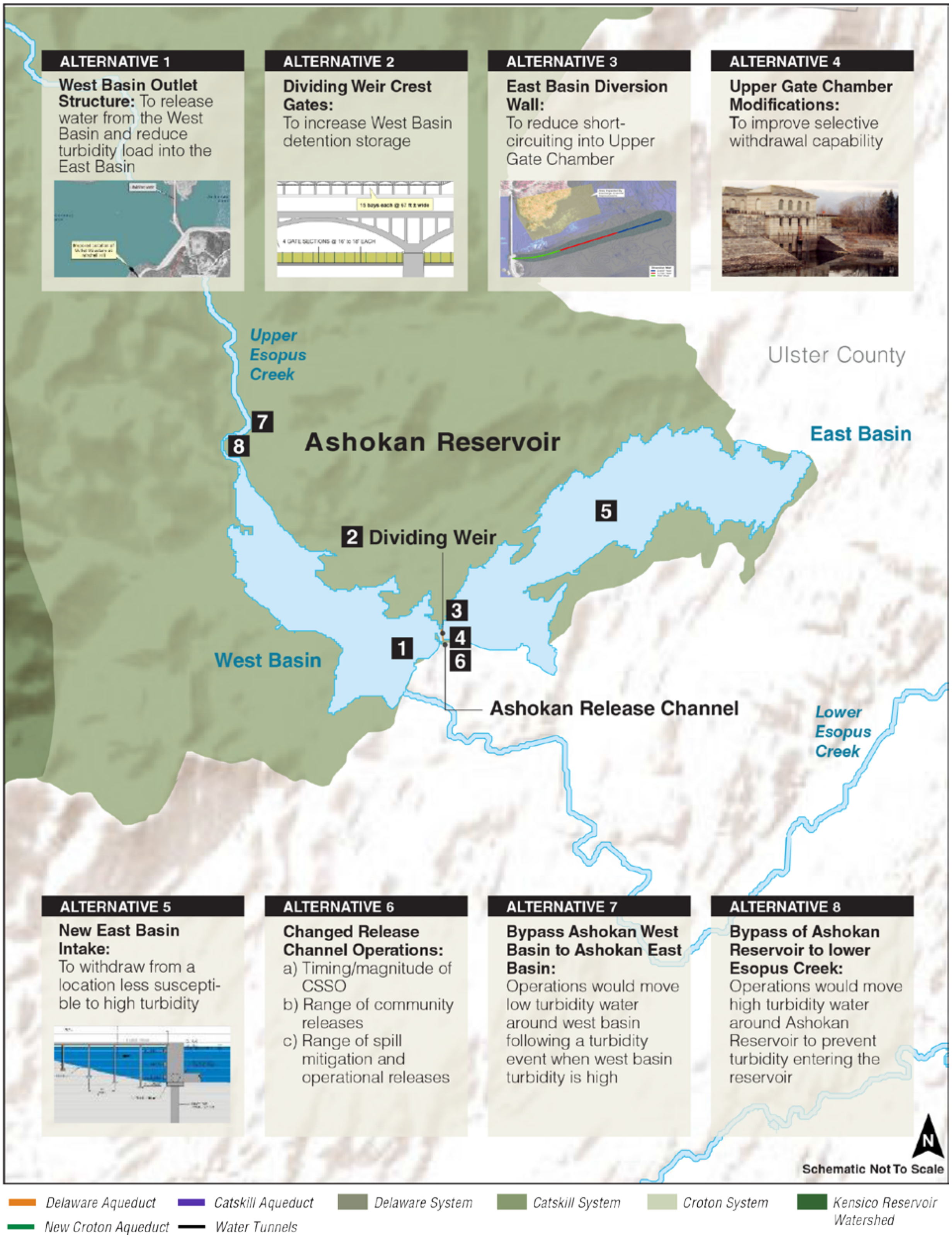

Figure 14.2-1
Ashokan Reservoir Alternatives

ASHOKAN RESERVOIR ALTERNATIVE 1 – WEST BASIN OUTLET STRUCTURE

This alternative would involve construction of a new outlet structure in the west basin of Ashokan Reservoir, consisting of a gated weir discharging west basin water to lower Esopus Creek downstream of the Olivebridge Dam. A west basin outlet structure would be used in a manner similar to the existing Ashokan Release Channel to maintain the CSSO and prevent uncontrolled transfer of turbid water from the west basin over the Dividing Weir to the east basin. As part of the prior Catskill Turbidity Control studies, conceptual designs were evaluated for a single weir and multi-level outlet structures, with capacities of 2,000, 4,000, and 6,000 MGD (3,094, 6,189, and 9,283 cfs). Turbidity control benefits for water diverted to Kensico Reservoir were proportional to the size of the release capacity. The outlet structure could be constructed without major impacts to operation of the Ashokan Reservoir facilities. However, the designs were not pursued because of demonstrated low to moderate benefits for DEP in addressing turbidity events in Ashokan Reservoir. Potential impacts would include temporary construction impacts related to increases in traffic, noise, and dust in the area as well as temporary impacts to recreation. The project would also require the regrading of approximately 7 acres of land, of which one-quarter to one-third would be paved or have permanent structures.

This alternative was re-evaluated in the EIS to identify potential impacts or benefits to lower Esopus Creek. At the time of prior analyses, a Mount Marion flow trigger had not been established to limit the potential for flooding based on forecasted streamflow at the Mount Marion USGS gage. Per the IRP, DEP cannot release water via the Ashokan Release Channel when streamflow is within one foot of the flood Action Stage at the Mount Marion USGS gage (17 feet at a flow of approximately 1,693 MGD [2,619 cfs]) and is forecasted to reach the flood "Action Stage" (18 feet at a flow of approximately 2,500 MGD [3,868 cfs]). It also sets maximum release magnitudes to no more than 600 million gallons per day (MGD) (928 cfs) and requires DEP to throttle releases as necessary so that the combined flow from the spillway and Ashokan Release Channel does not exceed 1,000 MGD (1,547 cfs) to ensure releases maintain streamflow that is well below the flood Action Stage downstream. HEC-RAS modeling identified flooding of some structures in low-lying areas of lower Esopus Creek at flows as low as 4,000 to 7,000 MGD (6,189 to 10,831 cfs). Releasing flows in the range of 2,000 to 6,000 MGD (3,094 to 9,283 cfs) from a west basin outlet either alone or in combination with operation of Ashokan Reservoir in accordance with the IRP would increase the potential for flooding in these low-lying areas along lower Esopus Creek, particularly when there are localized storms in the downstream watershed that increase the magnitude of local streamflow.

Based on the assessment above, a new west basin outlet structure was not pursued.

ASHOKAN RESERVOIR ALTERNATIVE 2 – DIVIDING WEIR CREST GATES

As part of this alternative, gates would be installed on the Dividing Weir crest and could be operated to temporarily increase the west basin overflow elevation by four feet which would enhance the storage in the west basin and reduce the uncontrolled transfer of turbid water to the east basin, providing some water quality benefit under certain storm events. As part of prior Catskill Turbidity Control studies, modeling simulations indicated that the crest gates would provide some benefit for the east basin during the onset of a storm event by delaying the transfer of turbid water, but moderate to large storm events would eventually fill the west basin void, resulting in spill of turbid water into the east basin. In particular, flows during large storm events, which often result in the transfer of turbidity to the Reservoir, can exceed 10 billion gallons per day based on historical inflow records at the USGS gage at Coldbrook. The total additional storage provided by Ashokan Alternative 2 would be approximately 3-4 billion gallons. Therefore, large storm events would be anticipated to exceed the additional storage capacity provided by the crest gates within a single day.

As part of prior Catskill Turbidity Control studies, the construction-related impacts on Ashokan Reservoir operations were projected to be minimal, provided that construction was scheduled during one or more periods when the water level of both basins was below their respective overflow elevations. However, it was estimated that approximately 240 acres of DEP property would have to be cleared above the present shoreline of the west basin for water quality and vegetation management purposes to facilitate operation at a higher pool elevation with the crest gates raised. Affected areas would include an estimated 33 acres of jurisdictional wetlands. Existing points of public access, parking areas, and related facilities in these areas would have to be relocated upland to maintain recreational usage of the Reservoir.

For lower Esopus Creek, implementation of the crest gates as a stand-alone alternative without Ashokan Release Channel releases would result in similar flows as the future without the Proposed Action, with perhaps some delay in the onset of spill due to added storage and resulting attenuation. As a combined alternative with the IRP, releases to lower Esopus Creek would still be required from the west basin to prevent turbid spill to the east basin and meet the CSSO, and turbidity levels of these releases would be similar to those that occur in accordance with the IRP. The limited water quality benefits of Dividing Weir Crest Gates do not outweigh the potential impacts to the Reservoir's shoreline.

The limited increase in storage capacity of the west basin from installation of Dividing Weir Crest Gates does not outweigh the potential impacts. Based on the assessment above, this alternative was not pursued.

ASHOKAN RESERVOIR ALTERNATIVE 3 – EAST BASIN DIVERSION WALL AND CHANNEL IMPROVEMENTS

The existing diversion wall in the east basin is submerged by 20 feet or more and is not a fully effective barrier to flow from the west basin that short-circuits over the Dividing Weir towards the Upper Gate Chamber (**Figure 14.2-2**). Extending the height and length of the Diversion Wall would direct flows from the west basin farther out into the east basin and would reduce short-circuiting to the Upper Gate Chamber and increase the travel time and dilution of flows prior to withdrawal for diversion to Kensico Reservoir. As part of prior Catskill Turbidity Control studies, conceptual designs and cost-benefit analyses were developed for three alternative wall lengths (750 feet, 1,700 feet and 2,400 feet) using jetty wall and closed-cell coffer cell construction methods. In addition, excavation to widen the discharge channel was also considered.

As part of prior Catskill Turbidity Control studies, modeling simulations indicated that diversion wall improvements would result in the reduction of peak turbidity levels within Catskill Aqueduct diversions and the time it would take to reach peak levels, with the magnitude of reduction being proportional to the length of the wall. However, for events in which west basin inflow turbidity levels remain high for an extended period, the benefit of diversion wall improvements is limited. Further, overall reductions in the number of days when Catskill Aqueduct diversion turbidity is elevated and the number of days of alum application to water in the Catskill Aqueduct upstream of Kensico Reservoir were minor.

There are numerous potential project impacts associated with improvements to the diversion wall and the adjacent discharge channel. Construction activities could last up to four years. Earthwork associated with extending the diversion wall and channel improvements would be a significant undertaking, with substantial land and water impacts. Access due to road widths and weight limits would be problematic for the substantial truck traffic that would occur during construction. Construction would result in temporary, but protracted, impacts on Reservoir operations, and permanent impacts on the Reservoir environment.[3] Any improvements to the spillway channel would permanently alter the area northeast of the Dividing Weir used for fishing and rowboat storage and launching.

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[3] Operational impacts could include Reservoir drawdown for construction and limited diversions in the event of increased turbidity from construction activities.

For lower Esopus Creek, implementation of this as a stand-alone alternative without the IRP would result in similar flows from Ashokan Reservoir as anticipated in the future without the Proposed Action, because the diversion wall would not affect flow rates through Ashokan Reservoir. There is a potential for a small reduction in the turbidity of spills. As a combined alternative with the use of the Ashokan Release Channel in accordance with the IRP, flows to lower Esopus Creek would be similar to the future with the Proposed Action because releases to lower Esopus Creek would still be required from the west basin to prevent turbid spill over the Dividing Weir. Turbidity levels of releases would also be similar to those that occur with the IRP, but there could be a marginal reduction in turbidity levels of spill.

Based on the above assessment, this alternative was not pursued.

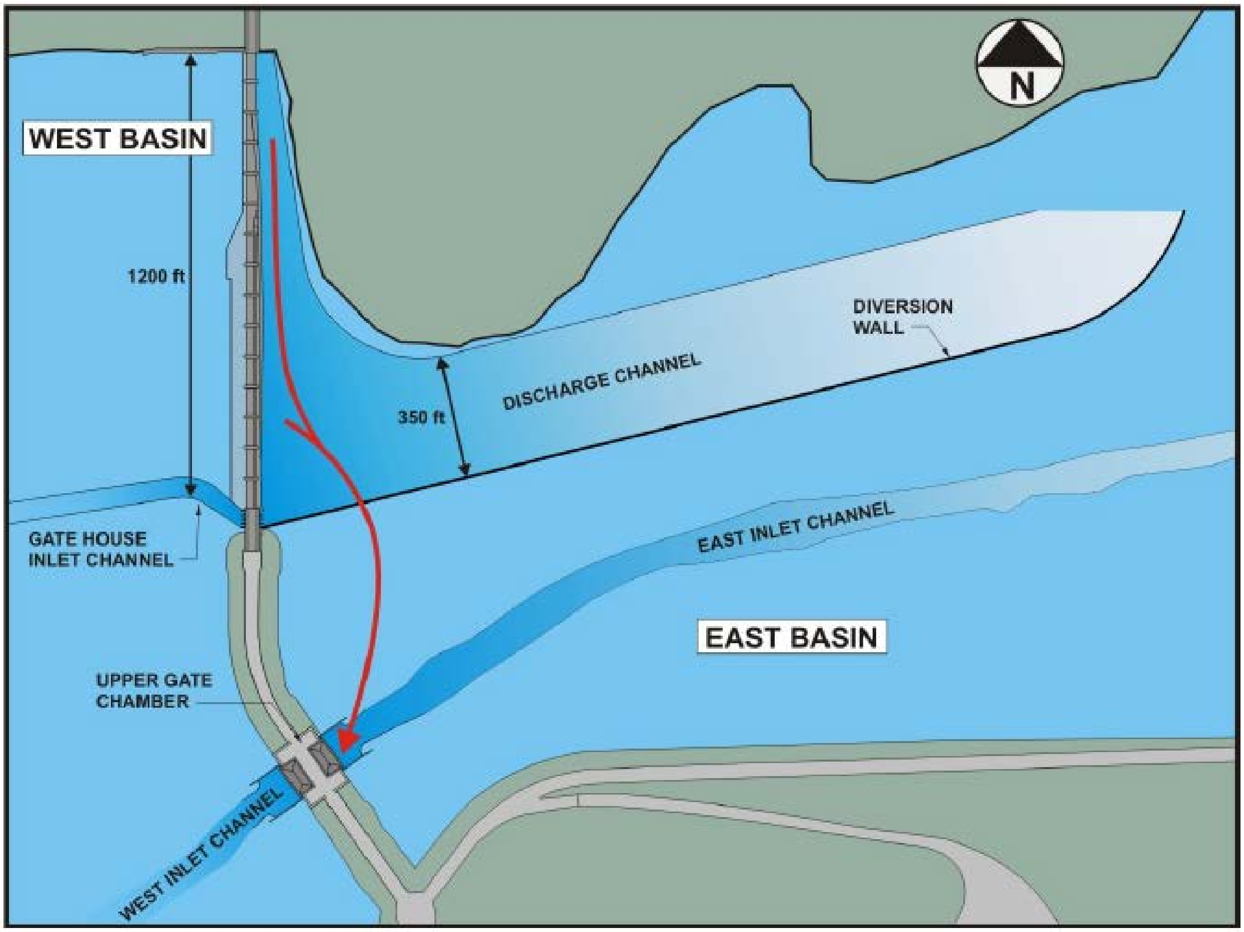

Figure 14.2-2
Existing East Basin Dividing Weir and Diversion Wall
(Red lines show short-circuiting of flows over existing diversion wall)

ASHOKAN RESERVOIR ALTERNATIVE 4 – UPPER GATE CHAMBER MODIFICATIONS

Multi-level withdrawal capability at the Upper Gate Chamber is currently provided by an arrangement of fixed stop shutters and open ports in the four bays on the east and west sides of the intake. Adjustment of intake elevation in response to water quality conditions is feasible but involves a labor-intensive and time-consuming stop shutter removal process. As part of this alternative, modifications to the Ashokan Reservoir Upper Gate Chamber would be implemented to improve multi-level withdrawal capability, which would allow for greater flexibility in choosing optimal withdrawal elevations.

As part of prior Catskill Turbidity Control studies, modeling of the performance of improved multi-level intake capabilities at the Upper Gate Chamber indicated that turbidity stratification within Ashokan Reservoir is limited, and selective withdrawal benefits would only be seen for a short period of time following a large storm event. Once the waterbody becomes vertically mixed, selective withdrawal would provide no benefit for releases or Catskill Aqueduct diversions. Upper Gate Chamber modifications are anticipated to provide limited reductions of turbidity loads in the Catskill Aqueduct and alum application rates to water in the Catskill Aqueduct upstream of Kensico Reservoir. It is anticipated that there would be limited construction impacts from this alternative. DEP is already required to make reasonable efforts to release water from the elevation with the least turbidity as part of the Proposed Action. This alternative would provide limited additional reduction in turbidity levels of spills and releases to lower Esopus Creek as a stand-alone alternative or in combination with operation of Ashokan Reservoir, in accordance with the IRP. As a combined alternative, flows from Ashokan Reservoir would be comparable to those in the future with the Proposed Action.

Based on the above assessment, this alternative was not pursued.

ASHOKAN RESERVOIR ALTERNATIVE 5 – EAST BASIN INTAKE

Construction of a new intake towards the center of the east basin, where water quality is less susceptible to elevated turbidity conditions, would provide an alternative withdrawal location to the existing Upper Gate Chamber. As part of prior Catskill Turbidity Control studies, conceptual designs were developed for a variety of single and multi-level intakes employing various construction methods (microtunneling, underwater pipelines, and regular tunneling) to connect to the Catskill Aqueduct. The existing Upper Gate Chamber would remain operational, and the use of each intake would be based on water quality and facility operation considerations in order to divert the highest quality water to Kensico Reservoir. A second intake in the east basin would enhance DEP's operational flexibility. Moreover, prior modeling identified the potential for a small to moderate benefit for reducing alum application to water in the Catskill Aqueduct upstream of Kensico Reservoir. Construction of a new East Basin Intake would be a major undertaking and would entail several construction-related impacts (e.g., suspension of withdrawals from the east basin of Ashokan Reservoir, increases in traffic, and air and noise emissions) and have the potential to cause impacts to land above and below water.

When considered as a stand-alone alternative, a new East Basin Intake would result in spill from Ashokan Reservoir to lower Esopus Creek with water quality similar to the future without the Proposed Action. In combination with releases via the Ashokan Release Channel, spills, releases, and water quality from Ashokan Reservoir to lower Esopus Creek would be similar to the future with the Proposed Action since conceptual designs developed during the prior Catskill Turbidity Control studies indicated a new East Basin Intake could not be connected to the existing Ashokan Release Channel.

Based on the above assessment, this alternative was not pursued.

ASHOKAN RESERVOIR ALTERNATIVE 6 – CHANGED RELEASE CHANNEL OPERATIONS

In Ashokan Reservoir Alternative 6, operation of Ashokan Release Channel would be adjusted as compared to the IRP. The objective of Ashokan Reservoir Alternative 6 would be to balance water supply needs for DEP, while enhancing benefits to lower Esopus Creek as compared to the Proposed Action. This alternative also has the potential to benefit DEP operations as compared to the Proposed Action. Additionally, there would be no construction impacts associated with this alternative.[4] This alternative was modeled using OST to identify potential differences between changes to release channel operations and the Proposed Action. A Revised Operating Protocol based on this alternative is presented in Section 14.3, "Ashokan Reservoir Alternative 6 – Revised Operating Protocol."

ASHOKAN RESERVOIR ALTERNATIVE 7 – BYPASS OF LOWER TURBIDITY UPPER ESOPUS CREEK WATER DIRECTLY TO THE ASHOKAN EAST BASIN

As part of Ashokan Reservoir Alternative 7, a bypass tunnel or other structural improvement would be constructed to enable the routing of low turbidity Ashokan Reservoir inflow from upper Esopus Creek directly to the east basin of Ashokan Reservoir. A bypass would allow for the isolation of the west basin following a turbidity event when turbidity in the west basin would be high. As a result, particles in the west basin would have more time to settle, while low turbidity water would be routed to the east basin.

This alternative could be effective in reducing the turbidity load of water diverted from Ashokan Reservoir to Kensico Reservoir when there is sufficient time between turbidity-causing storm events for west basin turbidity to settle. However, if an upper Esopus Creek turbidity event were to occur when the west basin was full of turbid water, turbid inflows would not be diverted and instead would enter the west basin, resulting in spill of turbid water into the east basin over the Dividing Weir, increasing turbidity in the east basin. Additionally, the size of a structure to convey natural creek flows in the range of 15,000 to 45,000 MGD (23,208 to 69,625 cfs) around the west basin of Ashokan Reservoir would be substantial. Upper Esopus Creek and Ashokan Reservoir currently follow the natural topography through the Catskills. A bypass around the west basin large enough to contain the range of flows that occur in upper Esopus Creek would be infeasible due to land disturbance and earthwork. The project would be a major undertaking and the environmental impacts from a construction project of this magnitude would be significant.

For lower Esopus Creek, the volume of water entering Ashokan Reservoir under this alternative would remain unchanged. By sending flows directly to the east basin, the flood attenuation benefit provided by storing water in the west basin would be lost, potentially increasing the magnitude or frequency of spill. As a stand-alone alternative, spill would be the same as that anticipated in the future without the Proposed Action. For singular events where turbid water is stored in the west basin, it is anticipated there would be a reduction in the turbidity level of spill. However, when turbid inflows to the Reservoir exceed the west basin storage capacity, spill or transfer of turbid water from the west to east basin would still occur and turbidity levels of spill from Ashokan Reservoir would be anticipated to be the same as in the future with the Proposed Action. In combination with operation of Ashokan Reservoir in accordance with the IRP, releases would still occur to maintain the CSSO and would be anticipated to be of similar quality to those that would occur in the future with the Proposed Action. Releases cease when spills exceed 1,000 MGD (1,547 cfs) or the flow trigger at Mount Marion. During this time the Reservoir could be spilling with similar quality water to the future with the Proposed Action. This alternative would provide limited effectiveness for turbidity management with significant construction-related environmental impacts.

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[4] DEP is pursuing construction of dedicated infrastructure for the community release under the Ashokan Century Program. Construction impacts would be minor and are considered as part of that project.

Given the loss of flood attenuation provided by storing water in the west basin of Ashokan Reservoir and the potential for significant adverse impacts due to construction, this alternative was not pursued.

ASHOKAN RESERVOIR ALTERNATIVE 8 – BYPASS OF UPPER ESOPUS DIRECTLY TO LOWER ESOPUS CREEK

As part of this alternative, a bypass tunnel or similar structure would be constructed to enable movement of Ashokan Reservoir inflow from upper Esopus Creek around or through Ashokan Reservoir, discharging to lower Esopus Creek below the Reservoir. This tunnel would be used during turbidity events to route high turbidity water around Ashokan Reservoir. This would preserve low turbidity water in the Reservoir. This alternative would increase DEP's operational flexibility and potentially reduce turbidity load in water transferred through the Catskill Aqueduct. Similar to the assessment provided for Ashokan Alternative 7, the size of a structure to convey natural creek flows in the range of 15,000 to 45,000 MGD (23,208 to 69,625 cfs) around Ashokan Reservoir to lower Esopus Creek would be substantial. The project would be a major undertaking and the environmental impacts from a construction project of this magnitude would be significant.

As both a stand-alone alternative and in combination with operation of Ashokan Reservoir in accordance with the IRP, bypass of upper Esopus Creek directly to lower Esopus Creek could reduce the duration of spills and releases to lower Esopus Creek from Ashokan Reservoir with high levels of turbidity. However, because turbidity events are typically associated with high flow events, this bypass would negate any flood attenuation provided by Ashokan Reservoir for lower Esopus Creek. It would also prevent the attenuation of turbidity within Ashokan Reservoir. Under this alternative, turbidity levels entering lower Esopus Creek from upper Esopus Creek would be higher than the turbidity levels of spills and releases from the Reservoir in the future without and with the Proposed Action. Additionally, in combination with operation of Ashokan Reservoir in accordance with the IRP, flows to lower Esopus Creek through the bypass would have the potential to exceed the Mount Marion flow trigger established to reduce the potential for flooding along lower Esopus Creek.

Given the loss of flood and turbidity attenuation provided by Ashokan Reservoir for lower Esopus Creek and the potential for significant adverse impacts due to construction, this alternative was not pursued.

14.2.2 CATSKILL AQUEDUCT ALTERNATIVES

The following alternatives for operation of the Catskill Aqueduct consist of multiple options to discharge water from the Catskill Aqueduct prior to discharge at Kensico Reservoir (**Figure 14.2-3**). Each alternative would move some level of turbidity load out of Ashokan Reservoir, which could reduce turbidity in Ashokan Reservoir and prevent turbid water from entering Kensico Reservoir. However, as presented in Section 1.2.1, "Overview of the Water Supply System and System Operations," DEP supplies water to approximately 20 communities via the Catskill Aqueduct upstream of Kensico Reservoir through 15 water supply connections (outside community connections) serving a total population of approximately 150,000. This service would need to continue regardless of water quality conditions in Ashokan Reservoir. Any alternative that discharges water upstream of any or all of the outside community connections would not allow DEP to provide water to these communities.

Since connections between the Catskill Aqueduct and supporting infrastructure exists or is under repair for these alternatives, there would be no construction-related impacts for the Catskill Aqueduct Alternatives.

For lower Esopus Creek, implementation of the Catskill Aqueduct Alternatives as stand-alone alternatives without use of the Ashokan Release Channel would eliminate the discharge of all release flows into lower Esopus Creek. The only flows to lower Esopus Creek from Ashokan Reservoir would be through spill as described for the future without the Proposed Action. There would be no potential benefits to lower

Esopus Creek from enhanced flood attenuation provided by the CSSO or sustained flow from the community release. Spill from Ashokan Reservoir is anticipated to be the same as in the future without the Proposed Action.

The Catskill Aqueduct Alternatives would be used during episodic turbidity events. During these events, Ashokan Reservoir would still spill and turbidity levels of flows to lower Esopus Creek would be comparable to the future without the Proposed Action (see Section 7.1.1, "Flow Regime and Water Quality in Lower Esopus Creek"). As discussed below, each of these alternatives would also limit the ability of DEP to use the Catskill Aqueduct for drinking water purposes and would limit operational flexibility of the system.

CATSKILL AQUEDUCT ALTERNATIVE 1 – USE OF THE HUDSON RIVER DRAINAGE CHAMBER

As part of this alternative, the existing Moodna/Hudson River Tunnel Drainage Chamber (HRDC) was evaluated to allow for discharges of turbid water from Ashokan Reservoir via the Catskill Aqueduct directly into the Hudson River on the east side of the river near the borders of Putnam and Dutchess counties. The existing HRDC was designed to drain water from the Catskill Aqueduct for purposes of inspecting the aqueduct and has never been used. Improvements to the HRDC are currently being designed. Its future release capacity of about 415 MGD (642 cfs) would still be less than the Ashokan Release Channel. Use of the HRDC for this purpose would reduce turbidity load to Kensico Reservoir but would preclude DEP from delivering water to outside community connections downstream. Further, when discharging turbid water via the HRDC, DEP would not be able to use Shaft 4.[5]

The Hudson River at this location is tidal and water surface elevations can vary by over five feet on a daily basis. The addition of 415 MGD (642 cfs) of flow would have a negligible influence on the flows in the typical range of the river.[6] Further, given the size of the Hudson River, 415 MGD (642 cfs) would be unlikely to have a measurable water quality influence on the river. Note that all releases and spills from Ashokan Reservoir eventually flow from lower Esopus Creek to the Hudson River. Therefore, discharging the water via the HRDC would simply bypass lower Esopus Creek and a portion of the Hudson River. DEP is in the process of designing repairs to the HRDC, so there would be no additional construction required for this alternative.

While this option is feasible and would likely result in minimal impacts, the intended use of the Catskill Aqueduct is for water supply purposes. Use of the HRDC to discharge turbid water from Ashokan Reservoir limits the ability to use the Catskill Aqueduct for water supply for the City and outside community connections. It is anticipated the magnitude and turbidity level of spill from Ashokan Reservoir during episodic turbidity events would be comparable to the future without the Proposed Action. This alternative would impact the water supply for the City and outside community connections.

Based on the above assessment, this alternative was not pursued.

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[5] Shaft 4 is located upstream of the HRDC. Operating Shaft 4 when discharging Catskill Aqueduct flows via the HRDC would: (1) limit capacity for discharging turbid water; and (2) discharge high quality Delaware System water intended for water supply purposes to the Hudson River.

[6] While tidal flow rates are not measured, the flow rates measured at the nearest gauge in the non-tidal portion of the Hudson River at Troy, NY (approximately 100 miles upstream of the HRDC) indicate that flows must exceed 40,000 MGD (61,889 cfs) to result in flooding impacts.

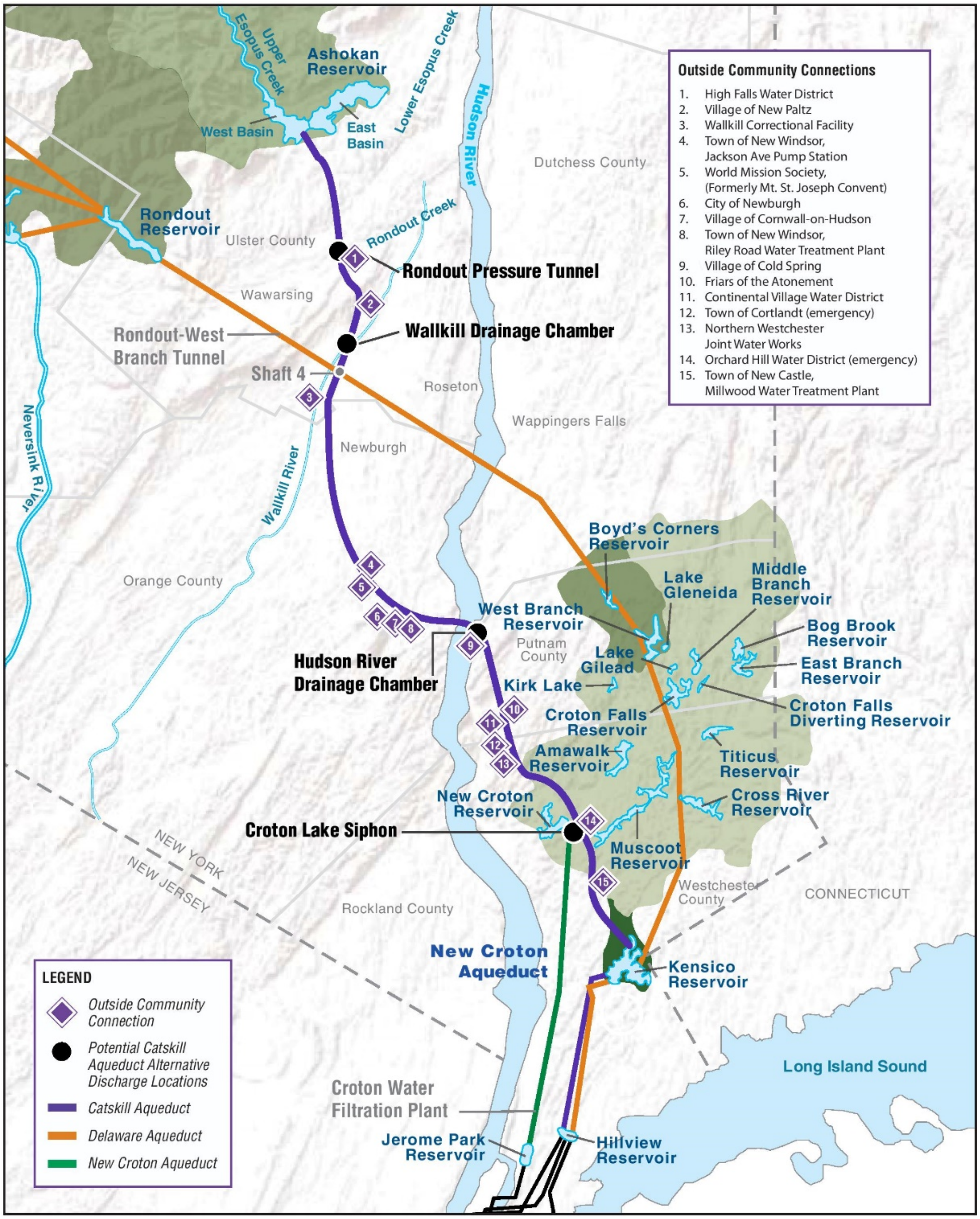

Figure 14.2-3
Catskill Aqueduct Alternatives

CATSKILL AQUEDUCT ALTERNATIVE 2 – USE OF THE CROTON LAKE SIPHON

Catskill Aqueduct Alternative 2 would use the blow-off at the downtake shaft of the Croton Lake Siphon to allow for discharges of turbid water from the Catskill Aqueduct directly into New Croton Reservoir.

Discharging turbid water from the Catskill Aqueduct to New Croton Reservoir via the Croton Lake Siphon would compromise the Croton System, which is constrained by the capacity of the Croton Water Filtration Plant (WFP). Water stored within the Croton System typically exceeds this treatment capacity. Therefore, diversion of additional, lesser quality water has some potential to adversely impact operation of the WFP. During a turbidity event in Ashokan Reservoir, diversions from the Catskill System would need to be minimized to protect Kensico Reservoir water quality; transfer of turbid water to New Croton Reservoir would substantially limit Croton System deliveries due to the capacity constraints mentioned above. As a result, operation of the water supply system would be nearly fully reliant upon the Delaware System, which greatly reduces supply redundancy and overall water supply reliability. Additionally, when discharging turbid water via the Croton Lake Siphon, DEP would not be able to use Shaft 4, limiting delivery capacity from the Delaware System.[7]

Because Catskill Aqueduct Alternative 2 would use the Croton Lake Siphon to discharge turbid Catskill System water to New Croton Reservoir, there are potential water quality concerns with this alternative. The water quality classification for New Croton Reservoir is Class AA throughout its entire length. The Reservoir supports numerous fish species and is popular for recreational fishing. The Croton Lake Siphon is periodically utilized by DEP to blend low turbidity Catskill System water with Croton System water to improve overall water quality. The connection between the Catskill Aqueduct and Croton Lake Siphon exists, so there would be no construction required for this alternative. It is anticipated that the magnitude and turbidity level of spill from Ashokan Reservoir during episodic turbidity events would be comparable to the future without the Proposed Action.

Based on the above assessment, this alternative was not pursued.

CATSKILL AQUEDUCT ALTERNATIVE 3 – USE OF THE RONDOUT PRESSURE TUNNEL SIPHON DRAIN

As part of this alternative, the Rondout Pressure Tunnel Siphon Drain was evaluated to allow for discharges of turbid water from the Catskill Aqueduct to Rondout Creek, which flows to the Hudson River after its confluence with the Wallkill River. Discharging turbid water from the Catskill Aqueduct to Rondout Creek via the Rondout Pressure Tunnel Siphon would reduce turbidity load to Kensico Reservoir but would preclude DEP from delivering water to outside community connections downstream.

Alternative 3 would transfer turbid flows from upper Esopus Creek via the Catskill Aqueduct to Rondout Creek. The connection between the Catskill Aqueduct and Rondout Pressure Tunnel Siphon Drain exists, so there would be no construction required for this alternative. It is anticipated that the magnitude and turbidity level of spill from Ashokan Reservoir during episodic turbidity events would be comparable to the future without the Proposed Action Use of the Rondout Pressure Tunnel Siphon Drain to discharge turbid water from the Catskill Aqueduct would impact the water supply for the City and outside community connections.

Based on the above assessment, this alternative was not pursued.

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[7] Shaft 4 is located upstream of the Croton Lake Siphon. Operating Shaft 4 when discharging Catskill Aqueduct flows via the siphon would: (1) limit capacity for discharging turbid water; and (2) discharge high quality Delaware System water intended for water supply purposes to New Croton Reservoir where this water could spill.

CATSKILL AQUEDUCT ALTERNATIVE 4 – USE OF THE WALLKILL PRESSURE TUNNEL SIPHON DRAIN OR THE WALLKILL BLOW-OFF CHAMBER

As part of Catskill Aqueduct Alternative 4, either the Wallkill Pressure Tunnel Siphon Drain would be modified for use or the Wallkill Drainage Chamber would be used to allow for discharges of turbid water from the Catskill Aqueduct to the Wallkill River. These structures are located on the Wallkill River, which is a tributary of the Hudson River. Turbid water discharged to the Wallkill River would flow to the Hudson River after its confluence with Rondout Creek. Discharging turbid water from the Catskill Aqueduct to the Wallkill River via the Wallkill Pressure Tunnel Siphon Drain or Wallkill Drainage Chamber would reduce turbidity load to Kensico Reservoir but would preclude DEP from delivering water to outside community connections downstream.

Alternative 4 would transfer turbid flows from upper Esopus Creek via the Catskill Aqueduct to the Wallkill River and Rondout Creek. The connections between the Catskill Aqueduct and Wallkill Pressure Tunnel Siphon Drain and Walkill Drainage Chamber exist, or could be modified, so there would be no to limited construction required for this alternative.

However, as stated previously, the intended use of the Catskill Aqueduct is for water supply purposes. It is anticipated that the magnitude and turbidity level of spill from Ashokan Reservoir during episodic turbidity events would be comparable to the future without the Proposed Action. Use of the Wallkill Pressure Tunnel Siphon Drain or the Wallkill Drainage Chamber to discharge turbid water from the Catskill Aqueduct would impact the water supply for the City and outside community connections.

Based on the above assessment, this alternative was not pursued.

14.2.3 KENSICO RESERVOIR ALTERNATIVES

The existing Catalum SPDES Permit required DEP to analyze alternatives that minimize the area of floc deposition at Kensico Reservoir resulting from the application of alum. Several studies have been previously conducted at Kensico Reservoir with respect to alum application and alum floc deposition within the Reservoir. These studies provide the framework and data for the Kensico Reservoir Alternatives analyzed in this section.

A 2007 technical report evaluated alum floc deposition at 263 MGD (407 cfs), 465 MGD (719 cfs), and 589 MGD (911 cfs) flows through the Catskill Aqueduct.[8] To analyze the present deposition patterns and the potential benefits of any structural alternatives to minimize the area of alum floc deposition, a computational fluid dynamics computer model of Kensico Reservoir near the CATIC Cove was developed and six structural alternatives were identified and analyzed (**Figure 14.2-4**). Each alternative had the same objective of slowing the flow of water through the cove to allow particles to settle and prevent their movement deeper in the Reservoir. A brief summary of these previously considered alternatives is presented below.

[8] "Report on the Feasibility of Minimizing the Area of Alum Floc Deposition in Kensico Reservoir," October 2007.

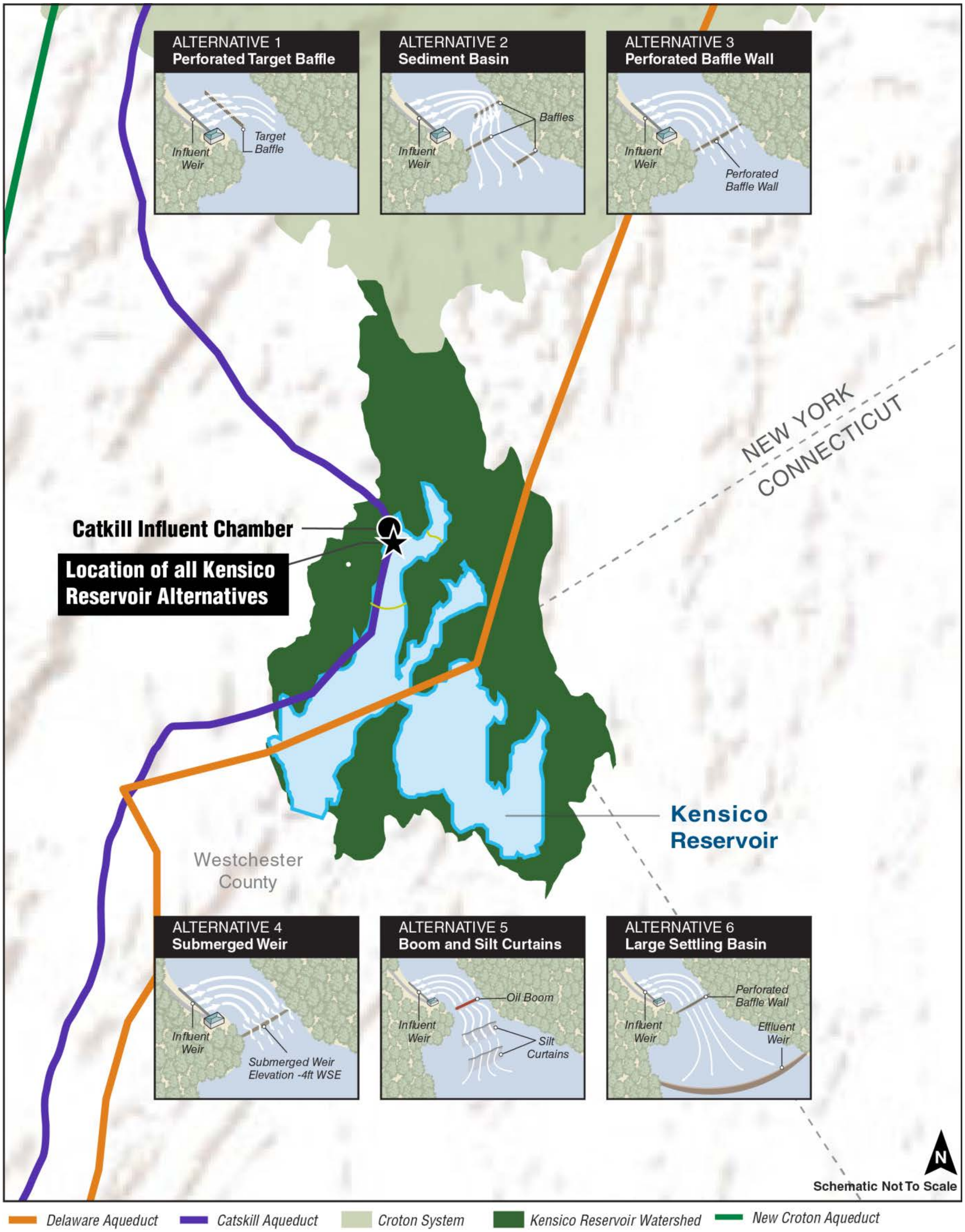

Figure 14.2-4
Kensico Reservoir Alternatives

KENSICO RESERVOIR ALTERNATIVE 1 – PERFORATED TARGET BAFFLE

This alternative would involve the installation of a perforated vertical baffle wall to dissipate the energy of water as it enters the CATIC Cove and would make the flow leaving the cove more uniform.

KENSICO RESERVOIR ALTERNATIVE 2 – SEDIMENTATION BASIN

This alternative would involve the installation of two baffles on the east bank and one baffle on the west bank of the CATIC Cove. These baffles would be designed to interrupt the high velocity current and increase particle residence time in the area near the cove.

KENSICO RESERVOIR ALTERNATIVE 3 – PERFORATED BAFFLE WALL

This alternative would involve the installation of a perforated baffle wall perpendicular to the general flow direction within the CATIC Cove. The purpose of this influent control alternative would be to create uniform flow before the influent leaves the cove.

KENSICO RESERVOIR ALTERNATIVE 4 – SUBMERGED WEIR

This alternative would involve the use of a submerged weir, which would act as a baffle to create uniform flow, and to trap large particles that settle quickly. The submerged weir would create more uniform flow from the cove into the open area outside the cove.

KENSICO RESERVOIR ALTERNATIVE 5 – BOOM AND SILT CURTAINS

This alternative would involve the use of an oil boom and two silt curtains. These features would create a large settling basin. The oil boom would float on the water surface and extend 4 feet below the surface, allowing water to pass underneath. The silt curtains would be full-depth and impermeable. The oil boom would partially break the high velocity current along the east bank of the CATIC Cove, creating a more uniform outgoing flow pattern from the cove. The oil boom and silt curtains would form a large and enclosed settling basin.

KENSICO RESERVOIR ALTERNATIVE 6 – LARGE SETTLING BASIN

This alternative is a combination of concepts evaluated in Kensico Reservoir Alternatives 3 and 4. For this alternative, a perforated wall would be placed upstream to homogenize inflow, and an effluent weir would be placed in the open area of the CATIC Cove to control outflow, making the cove and part of the open area a large settling basin. The arrangement would be designed to mimic a formal water treatment plant settling basin.

POTENTIAL IMPACTS OF KENSICO RESERVOIR STRUCTURAL ALTERNATIVES 1-6

The results of the 2007 study of the Kensico Reservoir Structural Alternatives did not show significant improvement to alum floc depositional patterns as compared to baseline conditions. None of the six structural alternatives evaluated provided major changes to the area of floc deposition, and the baseline conditions at Kensico Reservoir were best able to limit migration of very small size floc to the deeper parts of the Reservoir. The modeled configurations could not maximize the available area within the cove or prevent the short-circuiting of alum floc particles; all structural alternatives had the tendency to disrupt the natural eddy current that facilitates particle settling that prevents particles from leaving the CATIC Cove. Construction of any of the Kensico Reservoir Alternatives would temporarily disturb the existing benthic community in this area. Because of the limited effectiveness to reduce the area of floc deposition and the potential for adverse construction-related impacts, these alternatives would not enhance benefits or reduce, eliminate, or mitigate impacts as compared to the Proposed Action.

In addition, while engineering controls would be used during dredging of alum floc within Kensico Reservoir in the future, this work would introduce equipment and result in disturbance that would increase turbidity to the Reservoir. Therefore, the work would pose a risk to DEP's ability to meet the stringent site-specific filtration avoidance criteria of their Filtration Avoidance Determination that allows the City to comply with EPA's Surface Water Treatment Rule. Further, as discussed in Section 8.3.2, "Aquatic (Fish and Benthic) Resources," prior benthic studies within the CATIC Cove area found that organisms within the existing area of deposition are not adversely impacted by the alum floc particles in the cove area.

KENSICO RESERVOIR ALTERNATIVE 7 - FURTHER DELAY OF KENSICO RESERVOIR DREDGING

This alternative evaluates the impact of further delaying the Kensico Reservoir dredging until after DEP constructs a filtration plant for the Catskill/Delaware water supply. As presented in Section 8.2, "Kensico Reservoir Dredging Analysis," the Proposed Action includes a delay in dredging until other DEP infrastructure improvements associated with the Water for the Future (WFF) Program, specifically the RWBT repairs, have been completed. This was discussed in further detail within Section 8.2.1, "Delay of Dredging."

As described in the Upstate Water Supply Resiliency FEIS, DEP anticipates using alum as part of the WFF Program. Pursuant to the 2018 Modification to the Catalum Administrative Order on Consent, DEP would be required to dredge the associated alum floc deposited as a result of alum application in accordance with the WFF Alum Treatment Plan, along with alum floc associated with alum use authorized under the Catalum SPDES Permit and two Emergency Orders in 2005. Dredging would occur after completion of the WFF Program.

The occurrence of future alum use after completion of the WFF Program would be rare but still possible. As presented in Section 7.1.2, "Summary of Effects of the Proposed Action on DEP Water Supply Reliability," there is anticipated to be 0.3 percent alum days in the future without and with the Proposed Action. In addition, DEP has projected that, due to the ongoing effects of climate change through 2060, there is the potential for more frequent and extreme weather events that may also result in the future need for alum. These events are projected to increase alum days by 23 percent to approximately 0.4 percent alum days (see Section 5.2.1, "Analysis Approach – Climate Change Considerations"). As a result, alum could be deposited after the WFF Program is complete and, as a result and in connection with the Catalum SPDES Permit, DEP could be required to remove those additional deposits.

Dredging is an inherently disruptive process both to the proposed dredging area, as well as to its immediately surrounding environment. As discussed in Section 8.2.2, "Environmental Considerations of Dredging" and Section 8.3, "Potential Impacts and Benefits of the Proposed Action on the Kensico Reservoir Study Area," there are environmental considerations associated with dredging in Kensico Reservoir. Environmental considerations include but are not limited to, the effects of elevated levels of turbidity on water resources, water quality and aquatic resources, and the effects of construction activities on aquatic resources (fish and benthic invertebrates). While engineering controls would be used during dredging of alum floc from Kensico Reservoir in the future, this work would introduce equipment and result in sediment resuspension that would increase turbidity in the Reservoir. Therefore, dredging would pose some risk to DEP's ability to comply with criteria for avoiding filtration under the Surface Water Treatment Rule, 40 CFR § 141.71, and potentially to public health. The potential for multiple dredging events could result in multiple mobilization and demobilization efforts causing both upland and in-water disturbances, thereby resulting in additional and recurring effects within areas that would have been affected by any prior dredging event. The potential need to conduct dredging of alum floc over two or more separate periods, as opposed to a single dredging event, would lengthen the duration of potential effects and/or would extend the period of time necessary for long-term recovery and/or recolonization of dredged areas by a more diverse benthic community.

It is anticipated that future deposition of alum floc within Kensico Reservoir would occur within the same lateral extent of CATIC Cove that was modeled and disclosed within the WFF: Upstate Water Supply Resiliency FEIS (see **Figure 8.2-1**). Under this alternative, dredging of any alum floc would be delayed and occur as a single event after DEP constructs a filtration plant for the Catskill/Delaware water supply.

By postponing dredging as part of this alternative, any potential water quality impacts of dredging would be managed by a future filtration facility downstream of Kensico Reservoir, thereby reducing the potential for impacts to public health. Additionally, with filtration downstream of Kensico, alum addition would no longer be required during episodic turbidity events in the Catskill System. Under this alternative, general ongoing compliance with current water quality standards would remain unchanged. Likewise, achievement of NYSDEC-designated best uses for Kensico Reservoir, a Class AA water, including its use as a drinking water supply, would continue largely unimpeded.

This further delay in dredging would also minimize the potential for cumulative impacts to water quality since there would be no overlap with DEP's Kensico Eastview Connection (KEC) Project, which would involve multiple elements, including work within and adjacent to Kensico Reservoir (see Section 8, "Proposed Action in the Kensico Reservoir Study Area").

Further delay of dredging may result in a potential increase in the deposition of new alum floc in Kensico Reservoir, in addition to the deposits that would occur as part of the WFF Program, as discussed above. However, as discussed in Sections 8.2.1, "Delay of Dredging" and 8.3.1, "Water Resources and Water Quality," the presence of alum floc in Reservoir sediments has not, and would not, be expected to adversely affect the continued ability to achieve designated uses for Kensico Reservoir. Existing alum floc within Reservoir sediments has not resulted in adverse effects to public health or the environment as demonstrated through DEP's extensive, long-term water quality monitoring. Likewise, existing water quality conditions that are not suitable to support the bioavailability of aluminum within Reservoir waters is expected to continue consistent with historic, long-term water quality data. No significant adverse impacts from existing floc or the addition of new floc would therefore be anticipated as a result of a delay in dredging until after DEP constructs a filtration plant for the Catskill/Delaware water supply.

Existing benthic communities currently present within previously deposited alum floc would be expected to continue to exist and recover as documented from a comparison of 2007 and 2014 benthic sampling events completed after several larger historical alum additions. Likewise, impacts to other aquatic species, specifically fish, would not be expected due to any potentially newly-deposited alum floc due to DEP operations (e.g., temporary system outages) or climate-induced changes. No water quality or wetland impacts would occur, as these would remain comparable to current conditions. Adverse impacts from existing floc have not been observed and long-term water quality characteristics of Kensico Reservoir (i.e., neutral pH levels) are expected to continue. The Reservoir would not be supportive of the conditions necessary for changing the bioavailability of aluminum that would potentially affect benthos or fish.

This alternative would also not result in potential impacts to the community. No active site preparation or construction activities would occur and as a result no impacts to transportation, air quality, or noise is expected due to a further postponement of dredging. Potential impacts to historic resources, open space and recreation, aesthetics or upland habitat due to actual dredging or required site preparation, such as clearing and site access road construction, would also not occur.

Similar to the delay in dredging that was evaluated as part of the Proposed Action, further postponing dredging would not be anticipated to result in significant adverse environmental impacts.

Therefore, the further delay of Kensico Reservoir dredging until after DEP constructs a filtration plant for the Catskill/Delaware water supply would not be anticipated to result in significant adverse environmental impacts and would reduce the potential for impacts to public health since any potential water quality impacts of dredging would be managed by a future filtration facility downstream of Kensico Reservoir.

14.2.4 SUMMARY COMPARISON OF ALTERNATIVES

While each of the structural alternatives described would have the potential to cause multiple construction-related or operational impacts, they also would not enhance benefits or reduce, eliminate or mitigate potential impacts of the Proposed Action. The Ashokan Reservoir structural alternatives would have the potential to cause environmental, flooding, and construction impacts without substantial benefits to DEP water supply or turbidity reduction benefits to lower Esopus Creek. The Catskill Aqueduct Alternatives would have the potential to negatively affect the water supply of the City and the outside community connections. The Kensico Reservoir structural alternatives would have the potential to cause construction-related impacts without changing alum floc deposition or migration within Kensico Reservoir. A summary of the assessment of each alternative is provided in **Table 14.2-1**.

Table 14.2-1. Summary of Alternatives Analyses

Alternative	Conclusions
Ashokan Reservoir Alternatives	
Alternative 1 – West Basin Outlet Structure	Demonstrated low to moderate benefits for DEP in addressing turbidity events in Ashokan Reservoir. Temporary construction impacts, disturbance to adjacent land and potential for increased flood impacts to lower Esopus Creek from increasing releases to 2,000 MGD (3,094 cfs) or higher.
Alternative 2 – Dividing Weir Crest Gates	Limited effectiveness in increasing west basin storage to capture flow from large storm events, so limited DEP water supply benefit. Potential impacts to west basin shoreline wetlands and vegetation with a higher pool level when crest gates are raised. In combination with operation of Ashokan Reservoir in accordance with the IRP, releases to lower Esopus Creek would still be required from the west basin to prevent turbid spill to the east basin and meet the CSSO, and turbidity levels of these releases would be similar to those that occur in the future with the Proposed Action.
Alternative 3 – East Basin Diversion Wall and Channel Improvements	Limited effectiveness in reducing the number of days of elevated turbidity in Catskill Aqueduct diversions or alum application to water in the Catskill Aqueduct upstream of Kensico Reservoir. Environmental and construction impacts associated with disturbance to land within the Reservoir. In combination with operation of Ashokan Reservoir in accordance with the IRP, flows to lower Esopus Creek would be similar to the future with the Proposed Action, because releases to lower Esopus Creek would still be required from the west basin to prevent turbid spill over the Dividing Weir.
Alternative 4 – Upper Gate Chamber Modifications	Limited effectiveness in reducing turbidity loads in the Catskill Aqueduct or alum application rates to water in the Catskill Aqueduct upstream of Kensico Reservoir. It is anticipated there would be limited construction impacts from this alternative. This alternative would provide limited additional reduction in turbidity levels of spills and releases to lower Esopus Creek compared to current operational capabilities.

Table 14.2-1. Summary of Alternative Analyses (Continued)

Alternative	Conclusions
Alternative 5 – East Basin Intake Structure	Would enhance DEP's operational flexibility, potentially provide a small to moderate benefit for reducing alum application to water in the Catskill Aqueduct upstream of Kensico Reservoir. Construction would be a major undertaking and would entail several construction-related impacts (and have the potential to cause impacts to land above and below water). Limited effectiveness in reducing turbidity levels in releases to lower Esopus Creek, as the new intake could not be connected to the existing Ashokan Release Channel. In combination with operation of Ashokan Reservoir in accordance with the IRP, the magnitude and turbidity of releases would be similar to the future with the Proposed Action.
Alternative 6 – Changed Ashokan Release Channel Operations	See Section 14.3, "Ashokan Reservoir Alternative 6 – Revised Operating Protocol."
Alternative 7 – Bypass of Low Turbidity Upper Esopus Creek Water to Ashokan East Basin	Limited effectiveness for addressing turbidity in Ashokan Reservoir and potential for significant construction-related environmental impacts due to required size of the bypass (15-45,000 MGD, 23 to 69,625 cfs). The volume of water entering Ashokan Reservoir would be the same as in the future without and with the Proposed Action. By sending flows directly to the east basin, the flood attenuation benefit provided by storing water in the west basin would be lost, potentially increasing the magnitude or frequency of spill events.
Alternative 8 – Bypass of Upper Esopus directly to Lower Esopus Creek	This alternative would increase DEP's operational flexibility and potentially reduce turbidity load in water transferred through the Catskill Aqueduct. The project would be a major undertaking and there is a potential for significant environmental impacts from a construction project of this magnitude. Potential for increased flood impacts and higher levels of turbidity in flows to lower Esopus Creek from loss of flood and turbidity attenuation benefits within Ashokan Reservoir.
Catskill Aqueduct Alternatives	
Alternative 1 – Hudson River Drainage Chamber	The Catskill Aqueduct Alternatives would be used during episodic turbidity events. During these events, Ashokan Reservoir would still spill and turbidity levels of flows to lower Esopus Creek would be comparable to the future without with the Proposed Action (see Section 7.1.1, "Flow Regime and Water Quality in lower Esopus Creek"). Each of these alternatives would also limit the ability of DEP to use the Catskill Aqueduct for drinking water purposes and would limit operational flexibility of the system.
Alternative 2 – Croton Lake Siphon	
Alternative 3 – Rondout Pressure Tunnel	
Alternative 4 – Wallkill Pressure Tunnel Siphon Drain or the Wallkill Blow-off Chamber	

Table 14.2-1. Summary of Alternative Analyses (Continued)

Alternative	Conclusions
Kensico Reservoir Alternatives	
Alternative 1 – Perforated Target Baffle	Ineffective at reducing the area of alum floc deposition and increased migration of small-sized floc to deeper parts of Kensico Reservoir, and potential impact of construction on water quality.
Alternative 2 – Sedimentation Basin	
Alternative 3 – Perforated Baffle Wall	
Alternative 4 – Submerged Weir	
Alternative 5 – Boom and Silt Curtains	
Alternative 6 – Large Settling Basin	
Alternative 7 – Further Delay of Kensico Reservoir Dredging	Dredging of alum floc would occur as a single event after DEP constructs a filtration plant for the Catskill/Delaware water supply. Therefore, any water quality impacts associated with dredging would be managed by a future filtration facility downstream of Kensico Reservoir, reducing the potential for impacts to public health. Since alum floc within Reservoir sediments has not resulted in adverse effects to public health or the environment as demonstrated through DEP's extensive, long-term water quality monitoring, further postponement of dredging would not be anticipated to result in significant adverse health or environmental impacts. See Section 14.2.3, "Kensico Reservoir Alternatives."

14.3 ASHOKAN RESERVOIR ALTERNATIVE 6 – REVISED OPERATING PROTOCOL

As described in Section 14.2.4, "Summary Comparison of Alternatives," Ashokan Reservoir Alternative 6 – Changed Release Channel Operations – was further evaluated for its potential to enhance benefits to DEP water supply operations and to lower Esopus Creek as compared to the operation of Ashokan Reservoir in accordance with the IRP. As part of this alternative, operation of Ashokan Reservoir would be adjusted to explore improvements to the IRP evaluated in the future with the Proposed Action.

14.3.1 ANALYSIS FRAMEWORK

The purpose of the alternatives analysis was to examine reasonable alternatives to the future with the Proposed Action, specifically the IRP, that achieve the goals and objectives of the protocol and reduce, mitigate, or eliminate potential impacts. Since there are no anticipated significant adverse impacts associated with operation of Ashokan Reservoir in the future with the Proposed Action, Ashokan Alternative 6 must identify whether changes to the IRP could enhance benefits to lower Esopus Creek while maintaining or improving DEP's ability to reliably provide water of sufficient quality to meet customer water demands under various hydrologic conditions, without compromising the flexibility of the water supply system. Therefore, an initial analysis of each component of the IRP was conducted to eliminate those variations that would result in increased impacts to DEP operations or lower Esopus Creek.

The primary components of the IRP that could be adjusted as part of Ashokan Reservoir Alternative 6 include the magnitude of the community release, the CSSO curve for spill mitigation releases, the magnitude of the maximum release level through the Ashokan Release Channel, turbidity levels for releases, and the Mount Marion flows that would restrict releases. Modeling scenarios were used to assess the effects of changes to these components, both individually and in combination, on DEP water supply operations and lower Esopus Creek.

As stated in Section 7.1, "Water Resources and Water Quality," several metrics were used to evaluate how a given operational protocol affects DEP's water supply reliability. One of these metrics is the probability of refill which determines how likely the reservoirs are to meet a system-wide water supply storage target of 100 percent storage capacity on or around June 1st of each year. For DEP operations, the primary consideration of Ashokan Reservoir Alternative 6 was whether or not there would be a decrease in the ability of the overall system and individual surface water supply systems to meet this target as compared to the future with the Proposed Action. For lower Esopus Creek, combinations were not considered that would be anticipated to cause significant adverse impact as compared to the IRP.

14.3.2 VARIATIONS TO THE INTERIM ASHOKAN RELEASE PROTOCOL

COMMUNITY RELEASES

The existing IRP community release rules are summarized in **Table 14.3-1.**

Table 14.3-1. IRP Community Release Rules

Dates	Normal Conditions	Drought Warning or Turbidity > 30 NTU[1]	Drought Emergency or Turbidity > 30 NTU[1]
November 1st to April 30th	10 MGD (15 cfs)	4 MGD (6 cfs)	No community release
May 1st to October 31st	15 MGD (23 cfs)	10 MGD (15 cfs)	

Note:
[1] Turbidity measurements will be at the Ashokan Reservoir west basin. When substantial contrast in turbidity exists with varying depths in the west basin of the Ashokan Reservoir, DEP will make reasonable efforts to make releases from the elevation with the least turbidity.

Variations to the community release during normal (non-drought) conditions were evaluated as follows: (1) in increments of 5 MGD (8 cfs) up to 30 MGD (46 cfs), and; (2) in 15 MGD (23 cfs) increments from 30 to 90 MGD (46 to 139 cfs). No changes were evaluated for the community release magnitudes during drought conditions or when turbidity levels were above 30 NTU. An initial assessment found that a community release greater than 20 MGD (31 cfs) would lower the probability of refill of the Catskill System compared to the future with the Proposed Action. Community release magnitudes from 20 to 90 MGD (31 to 139 cfs) result in decreasing probabilities of refill to as low as 69 percent. Therefore, seasonal community releases of 10/15 MGD (15/23 cfs), 10/20 MGD (15/31 cfs), and 15/20 MGD (23/31 cfs) were evaluated.

CONDITIONAL SEASONAL STORAGE OBJECTIVE

The CSSO component of the IRP was originally developed based on the Flexible Flow Management Plan (FFMP) and is 90 percent from October 14 through the following March 15 and 100 percent on May 1 and July 1, transitioning between these values during periods of the year. The FFMP was updated in 2017 to have an 85 percent CSSO target with an associated curve shape for the reservoirs in DEP's Delaware System. As part of the Ashokan Reservoir Alternative 6 analysis, DEP looked at alternatives that matched both the existing Ashokan CSSO curve shape in the IRP and the CSSO curve shape to the shape in the 2017 FFMP.[9] The 2017 FFMP CSSO curve shape (referred to as the DEL or Delaware curve shape) reaches its minimum level from November 1 through the following February 1 and is at 100 percent from April 16 through June 15. Decreasing minimum CSSO levels were evaluated for both curve shapes in 5 percent increments (90, 85, and 80 percent, etc.). **Figure 14.3-1** presents the differences in the two curve shapes at an 85 percent minimum CSSO level as compared to the 90 percent CSSO in the IRP. OST modeling found that lowering the minimum CSSO level below 85 percent was associated with a lowered system probability of refill as compared to the future with the Proposed Action for both curve shapes (e.g., a 65 percent CSSO target resulted in a system probability of refill of 83 percent). Therefore, 85 percent was the minimum CSSO level further evaluated. **Figure 14.3-2** shows the historic storage levels at Ashokan Reservoir from 2013 to 2019 with the CSSO storage curves.

[9] Note that the time period from May 1st to June 30th is noted as no CSSO in the IRP. However, modeling in the EIS assumed a 100 percent CSSO definition for this time period, similar to the FFMP.

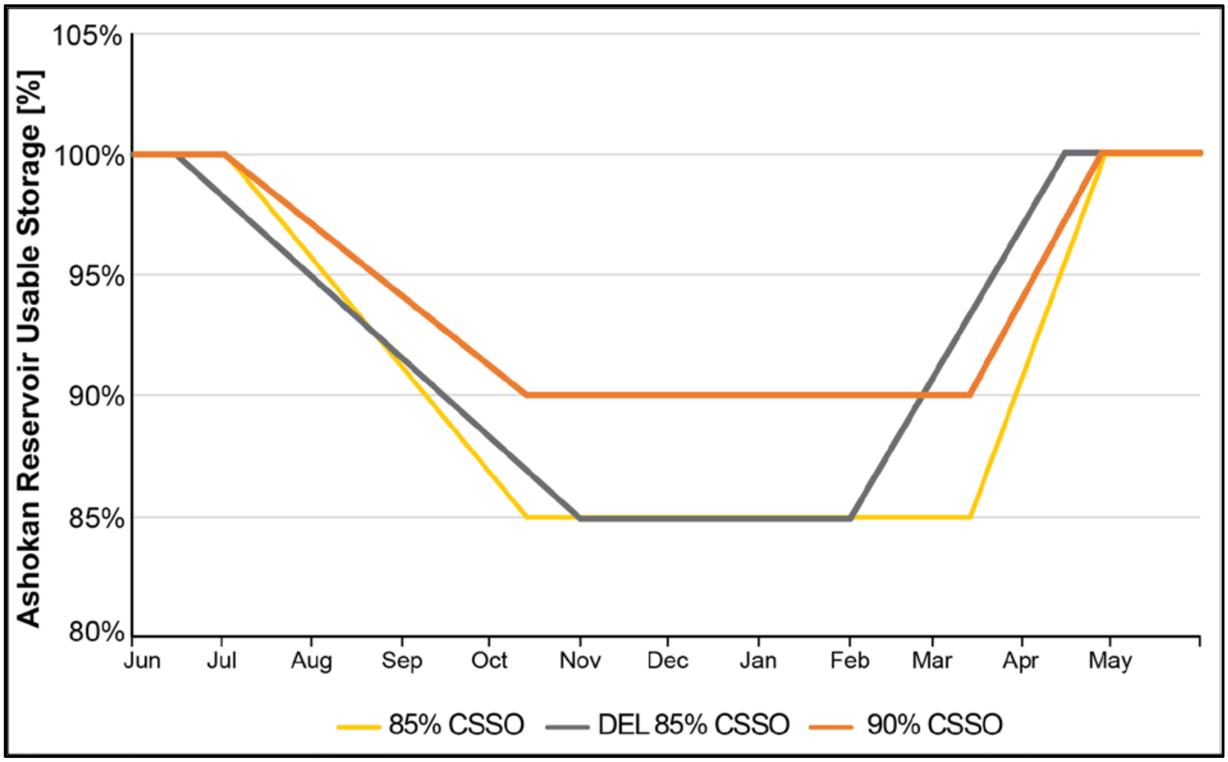

Figure 14.3-1. Alternate CSSO Curves for Ashokan Reservoir

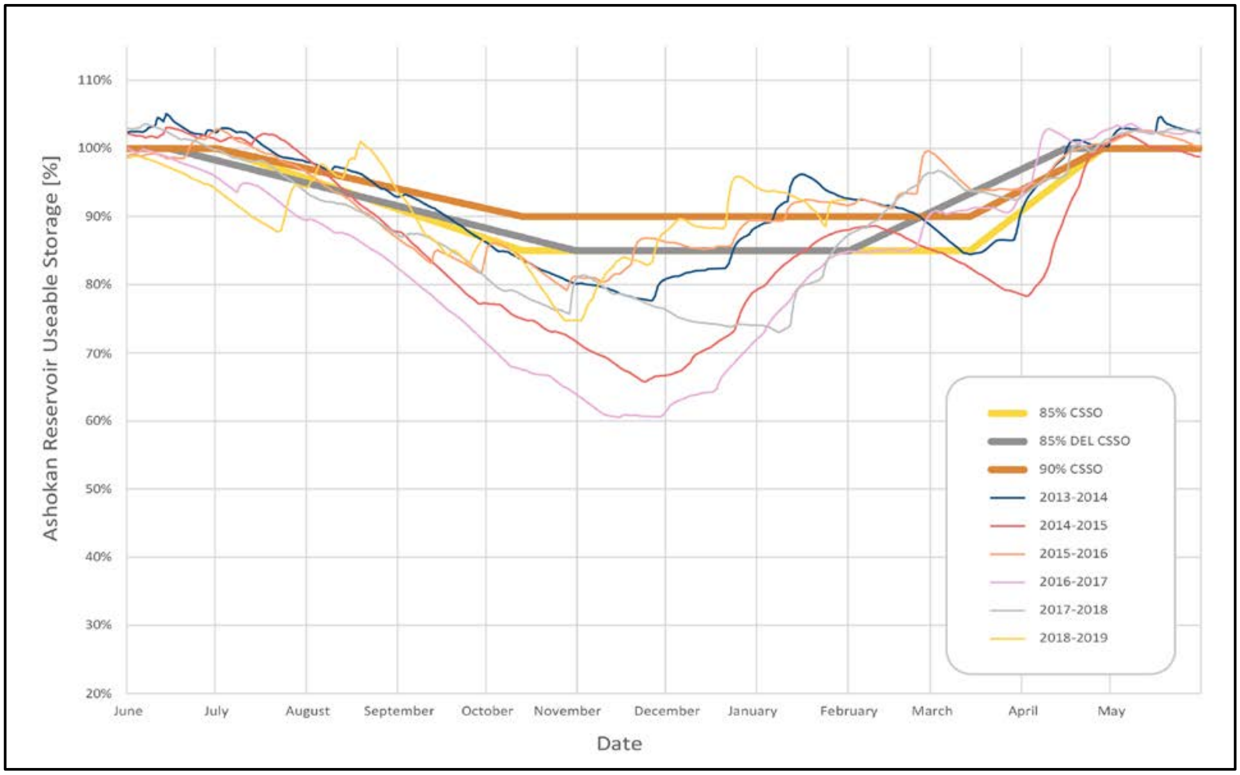

Figure 14.3-2. Observed Storage Levels at Ashokan Reservoir (2013-2019)

ASHOKAN RELEASE CHANNEL MAXIMUM RELEASE LEVEL

In accordance with the IRP, releases through the Ashokan Release Channel are limited to 600 MGD (928 cfs), while the functional maximum capacity of the Ashokan Release Channel is approximately 1,200 MGD (1,857 cfs). In addition, the IRP requires DEP to throttle releases as necessary so that the combined flow from the spillway and Ashokan Release Channel does not exceed 1,000 MGD (1,547 cfs). Alternate maximum release rates of 900 MGD (1,393 cfs) and 1,200 MGD (1,857 cfs) were considered under Ashokan Reservoir Alternative 6. HEC-RAS inundation mapping of lower Esopus Creek for release rates of 900 MGD and 1,200 MGD indicates they would not flood structures or roads, and OST indicates these higher release rates would occur infrequently (approximately five percent of the time over the OST simulation period) (see **Figure 14.3-3** and **Table 14.3-2**). In addition, increasing the maximum release level to 900 or 1,200 MGD (1,393 or 1,857 cfs) provides only a small additional benefit to flood recurrence probabilities as compared to the IRP (e.g., approximately a 5 percent reduction in streamflow for an event with a 10-year recurrence interval as compared to approximately a 25 percent reduction in streamflow between the future without and with the Proposed Action for the same recurrence interval) (see **Figure 14.3-4**). Increasing releases to 900 or 1,200 MGD (1,393 or 1,857 cfs) would not provide any additional reduction in the need to apply alum during certain events as shown in **Table 14.3-3**. Therefore, DEP has decided not to pursue variations in the IRP maximum release rate at this time.

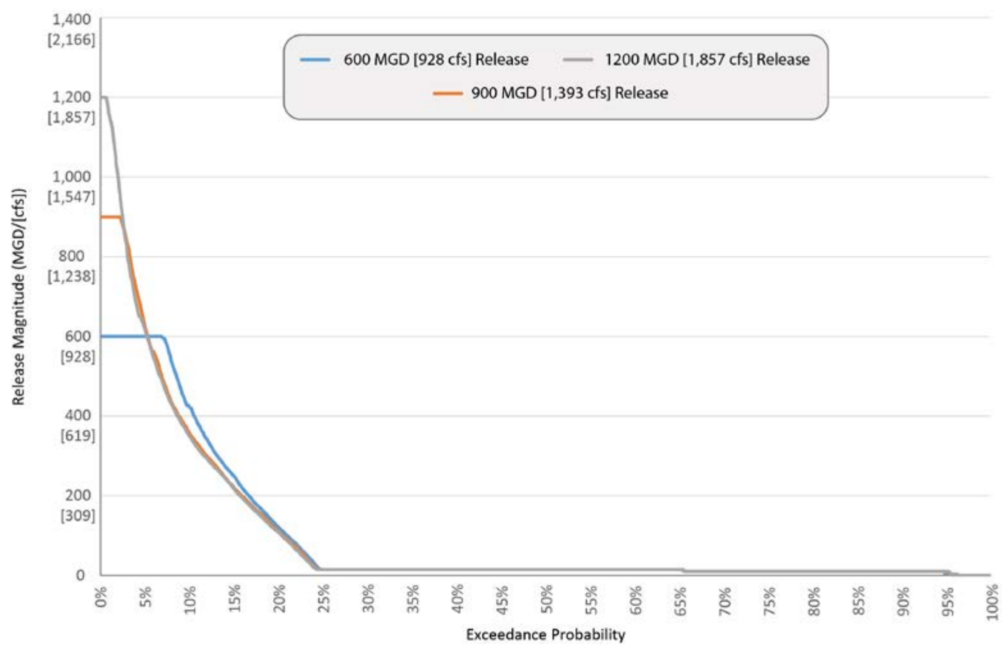

Figure 14.3-3. Maximum Release Level Comparison

Table 14.3-2. Maximum Release Level Comparison

Release Level	Percent of Days Simulation at Max Release	Percent of Days Simulation >/= 600 MGD
IRP (Releases of 600 MGD, 928 cfs)	6.8%	6.8%
ROP (Releases of 900 MGD, 928 cfs)	2.2%	5.3%
ROP (Releases of 1,200 MGD, 928 cfs)	0.6%	5.2%

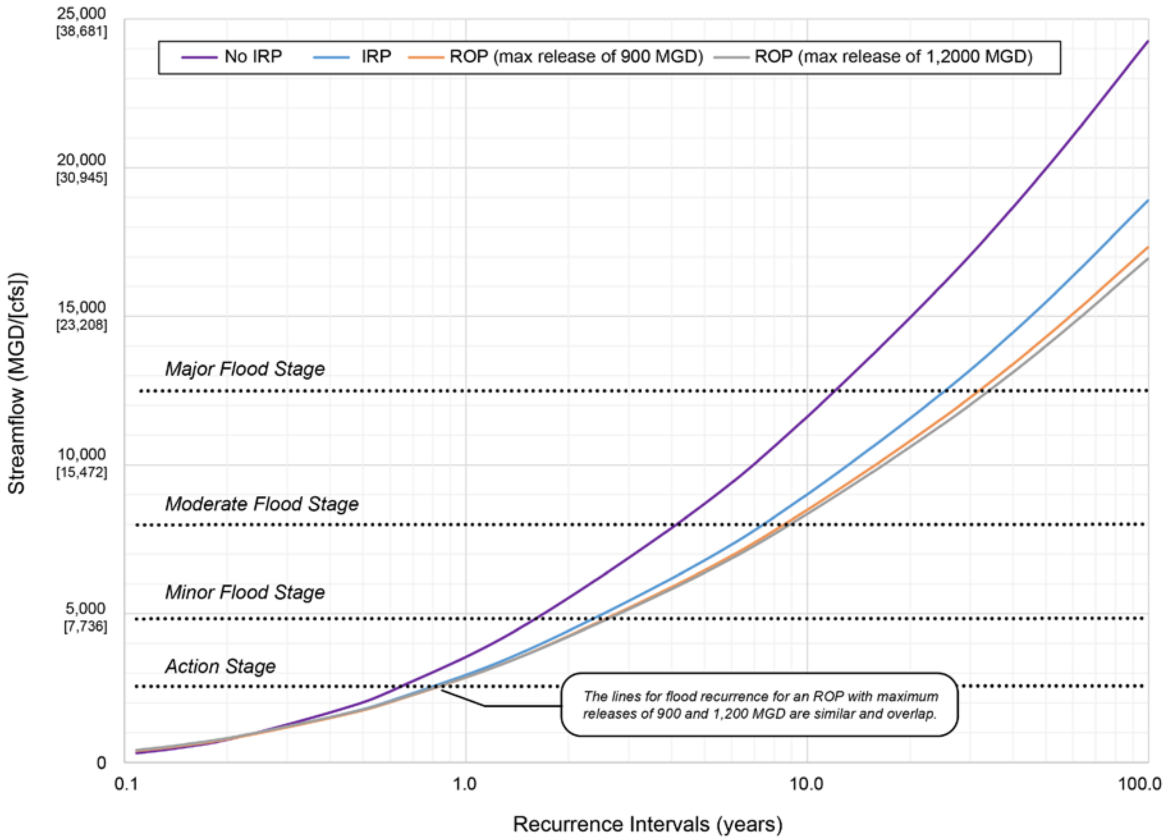

Figure 14.3-4. Maximum Release Level Comparison – Flood Recurrence

Table 14.3-3. Maximum Release and Alum Days

Operating Protocol	ARC Max (MGD/[cfs])	Max Cons Rel (MGD/[cfs])	Max CSSO	% Alum Days (Full Record)
No IRP	--	--	--	0.3%
IRP	600 [928]	15 [23]	90	0.3%
ROP	900 [1,393]	15 [23]	90	0.3%
ROP	1,200 [1,857]	15 [23]	90	0.3%

TURBIDITY LEVELS

Turbidity levels are used in the IRP to reduce the magnitude of the community release, trigger flushing, and restrict spill mitigation and operational releases during periods of elevated turbidity. The 30 NTU level reduces the community release by 6 MGD (9 cfs) in the winter and 5 MGD (8 cfs) in the summer. As shown in **Table 14.3-4**, 36 hours of flushing is triggered for spill mitigation and operational releases when turbidity levels are between 30 NTU and 60 NTU for 12 consecutive days.[10] Five days over a turbidity level of 60 NTU activates 36 hours of flushing for spill mitigation and operational releases. A turbidity level of 100 NTU curtails the community release entirely and limits operational releases during the period from November 1st through the following April 30th.

Table 14.3-4. IRP Turbidity Levels

<table>
<tr><th>Type of Release</th><th>>0 to ≤ 30 NTU</th><th>> 30 to ≤ 60 NTU</th><th>> 60 to ≤ 100 NTU</th><th>>100 NTU</th></tr>
<tr><td>Community</td><td>15/10 MGD[1]
(23/15 cfs)</td><td colspan="2">10/4 MGD
(15/6 cfs)</td><td>0 MGD
(0 cfs)</td></tr>
<tr><td>Spill Mitigation (up to 600 MGD, 928 cfs)</td><td>Unlimited</td><td>12 days followed by flushing for 36 hours</td><td colspan="2">5 days followed by flushing for 36 hours</td></tr>
<tr><td>Operational (up to 600 MGD, 928 cfs)</td><td>Unlimited</td><td>12 days followed by flushing for 36 hours</td><td>5 days followed by flushing for 36 hours</td><td>Only when turbidity of upper Esopus Creek is >100 NTU</td></tr>
</table>

Note:
1 The community release follows a seasonal pattern (15 MGD (23 cfs) May 1st to October 31st and 10 MGD (15 cfs) November 1st through April 30th).

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10 A flushing duration of 36-hours was selected during development of the IRP because it represents approximately two full flushes of lower Esopus Creek based on an 18-hour travel time of flow from Ashokan Reservoir to the Hudson River.

Based on the assessment of the effect of turbidity on aquatic species in Section 7.7, "Aquatic Resources," variations to the 30 and 60 NTU turbidity levels included in the IRP were considered. As discussed in Section 7.7, "Aquatic Resources," warm water species are resilient to higher levels of turbidity (around 50-75 NTU), but trout are sensitive to turbidity with potential effects reported in the literature around 25 NTU. As part of the analysis for Ashokan Reservoir Alternative 6, turbidity levels of 25 and 50 NTU were evaluated. Flushing that is prescribed in accordance with the IRP is modeled to rarely occur over the OST simulation period. The purpose of flushing is to limit prolonged periods when release turbidity is elevated that could affect aquatic species (i.e., above 25 NTU). By stopping releases when turbidity in both basins is over 25 NTU, in lieu of flushing with high turbidity water, it is anticipated that the background flow in lower Esopus Creek would provide lower turbidity streamflow for the purposes of 'flushing' lower Esopus Creek, particularly in Valley Reaches 1A and 1B where trout are found. Therefore, Ashokan Alternative 6 also evaluated replacement of flushing in accordance with the IRP with equivalent periods of no releases when turbidity in both basins is over 25 NTU (see **Table 14.3-5**).

Table 14.3-5. ROP Turbidity Levels

Type of Release	>0 to ≤ 25 NTU	> 25 to ≤ 50 NTU	> 50 to ≤ 100 NTU	>100 NTU
Community	15/10 MGD[1] (23/15 cfs)	10/4 MGD (15/6 cfs)		0 MGD (0 cfs)
Spill Mitigation (up to 600 MGD, 928 cfs)	Unlimited	12 days followed by flushing for 36 hours when best available water from one of the two basins is <25 NTU[2]	5 days followed by flushing for 36 hours when best available water from one of the two basins is <25 NTU[2]	
Operational (up to 600 MGD, 928 cfs)	Unlimited	12 days followed by flushing for 36 hours when best available water from one of the two basins is <25 NTU[2]	5 days followed by flushing for 36 hours when best available water from one of the two basins is <25 NTU[2]	Only when turbidity of upper Esopus Creek is >100 NTU

Notes:

[1] The community release follows a seasonal pattern (15 MGD (23 cfs) May 1st to October 31st and 10 MGD (15 cfs) November 1st through April 30th).

[2] When turbidity in both basins is >25 NTU, flushing would be replaced by a period of 36 hours with no releases.

MOUNT MARION FLOW TRIGGER

In accordance with the IRP, DEP is required to stop releasing water from Ashokan Reservoir when the USGS gage at Mount Marion is within 1 foot of the flood Action Stage (17 feet) and is forecasted to reach Action Stage (18 feet), as predicted on the National Weather Service's Advanced Hydrologic Prediction Service web page. The analysis conducted for Ashokan Reservoir Alternative 6 evaluated the Mount Marion flow trigger at longer forecast horizons. Specifically, the analysis considered the review of forecasted flood flow stages when Mount Marion is within 1.5 feet and 2 feet of Action Stage. While the IRP does not include a flow trigger at the Lomontville gage, one could be established with input from the National Weather Service, and Ulster County Office of Emergency Management and NYSDEC once there is a sufficient period of record at this location (i.e., 10 total years of measurements).

COMBINATIONS OF VARIATIONS TO THE IRP

Considering the variations to each component of the IRP described above, the Ashokan Reservoir Alternative 6 assessment evaluated a mix of combinations of these variations. Variations to the IRP that were evaluated within these combinations include:

- A seasonal community release of 10/15 MGD (15/23 cfs), 10/20 MGD (15/31 cfs), and 15/20 MGD[11] (23/31 cfs);
- Minimum CSSO drawdowns of 85 percent for both curve shapes (Ashokan and Delaware System);
- Reduction of turbidity levels to 25 and 50 NTU, with flushing releases converted to periods of no release; and
- Mount Marion forecast triggers at 1.5 feet and 2 feet.

Results of the analysis of these Ashokan Reservoir Alternative 6 combinations are presented in the following section.

14.3.3 EFFECT OF ASHOKAN RESERVOIR ALTERNATIVE 6 ON DEP WATER SUPPLY RELIABILITY

WATER SUPPLY

To identify how probability of refill differed between the Ashokan Reservoir Alternative 6 combinations, statistics for the probability of refill were calculated over the OST model simulation period and compared to the future with the Proposed Action. Results are presented in **Table 14.3-6** and the future without the Proposed Action (No IRP) metric is provided for reference. Note that each combination is referred to as a potential Revised Operating Protocol or "ROP." The 85 percent minimum CSSO target using the Ashokan CSSO curve shape with a 15/20 MGD (23/31 cfs) seasonal community release was not further evaluated as it resulted in a reduced system probability of refill as compared to the other combinations presented in the table.

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[11] Community release magnitudes are presented as winter/summer.

Table 14.3-6. Probability of Refill

Protocol	CSSO	Community Release	System Probability of Refill	Catskill System Probability of Refill	Delaware System Probability of Refill	Croton System Probability of Refill
No IRP	0	0	90%	90%	90%	91%
IRP	90 Ashokan	10/15	90%	88%	90%	91%
ROP	90 Ashokan	10/20	90%	88%	90%	90%
ROP	90 Ashokan	15/20	90%	84%	90%	91%
ROP	85 Ashokan	10/15	90%	82%	90%	91%
ROP	85 Ashokan	10/20	90%	82%	90%	92%
ROP	85 Ashokan	15/20	88%	80%	90%	92%
ROP	85 Delaware	10/15	90%	90%	90%	90%
ROP	85 Delaware	10/20	90%	88%	90%	92%
ROP	85 Delaware	15/20	90%	88%	90%	91%

Note:
Ashokan and Delaware refer to the shape of the CSSO curve

As shown in **Table 14.3-6**, increasing the magnitude of the community release decreases the probability of refill for the Catskill System for both the Ashokan and Delaware CSSO curve shapes. The Delaware CSSO curve with an 85 percent void target provides the same probability of refill for the overall system and balances probability of refill between the Catskill, Delaware, and Croton systems, making it protective of DEP water supply reliability. In particular, the ROP that combines the 85 percent Delaware CSSO curve and maintains the magnitude of the community release at 10/15 MGD (15/23 cfs), results in 90 percent probability of refill for the Catskill, Delaware, and Croton systems and the water supply system as a whole.

In years where DEP is not able to meet its system-wide water supply storage target on June 1st, the system has the potential to enter a drought condition, which can make it more challenging for DEP to meet its water supply objectives. Therefore, DEP also evaluates water supply reliability using established drought metrics that are based on reservoir storage conditions. In addition, DEP operates its three surface water supply systems (Catskill, Delaware, and Croton systems) to maintain balance across the total system storage. That is, it is undesirable for one system to be full (and therefore, spilling), while another is drawn down, which would mean there is water being lost from the system that could otherwise be stored for later use. Given the importance of meeting the FFMP, Delaware releases were evaluated seasonally to ensure there were no shifts in seasonal releases. These metrics were compared for the future with the Proposed Action and various ROP combinations evaluated as part of Ashokan Alternative 6. There was no substantial increase in drought days or differences in diversions or releases from the three water supply systems that would reduce DEP's operational flexibility or compromise the FFMP for any of the combinations. Similarly, seasonal Shandaken Tunnel diversions were reviewed and were comparable to diversions in the future with the Proposed Action for most months but for February and March were higher with the Delaware 85 percent CSSO curve due to its shape (**Figure 14.3-5**). Therefore, all remaining combinations considered as part of Ashokan Alternative 6 were further evaluated for their potential effect on DEP water supply operations and lower Esopus Creek, as compared to the IRP.

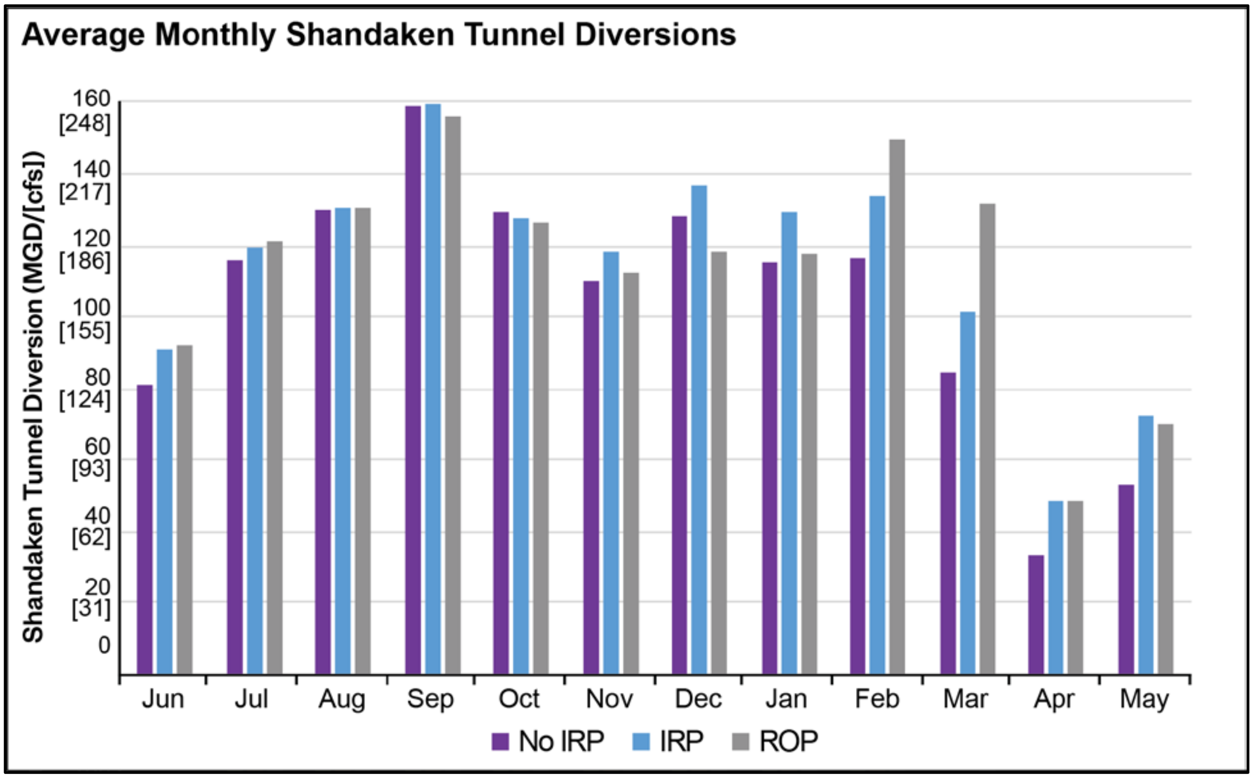

Figure 14.3-5. Shandaken Diversions for the Future Without and With the Proposed Action and the 85% Delaware CSSO Curve with 10/15 MGD (15/23 cfs) Community Release ROP

WATER QUALITY

DEP regularly monitors turbidity levels in Ashokan Reservoir, the Catskill Aqueduct, and Kensico Reservoir and runs short-term simulation models using OST to make decisions on operational adjustments that are required to maintain water quality within the drinking water system to meet regulatory requirements. These decisions are summarized in the model as a series of threshold values for turbidity and turbidity load.[12]

In OST, when Ashokan Reservoir diversion turbidity reaches 4 NTU, it triggers a decision by DEP to consider reducing Catskill Aqueduct flows. If Ashokan Reservoir diversions increase to 8 NTU, it triggers DEP to consider initiation of the Catskill/Delaware Interconnection at Shaft 4 or the installation of stop shutters to further reduce diversions from Ashokan Reservoir while maintaining service for outside community connections along the aqueduct.[13] With the recently completed Croton WFP, upgraded stop shutters, and the Catskill/Delaware Interconnection at Shaft 4, DEP can maintain minimum flows through the Catskill Aqueduct for a longer duration than it could historically, without causing water quality issues for the City's water supply. However, as described in Section 1, "Introduction," even with

[12] Turbidity load is the product of flow and turbidity level in the Catskill Aqueduct.

[13] Outside community connection taps need a certain depth of flow to maintain the ability for them to divert water. Augmenting aqueduct flows from the Catskill/Delaware Interconnection at Shaft 4 or using stop shutters to cause pooling within the aqueduct can maintain required depths of flow at lower Ashokan Reservoir diversion rates.

these turbidity control measures in place, conditions can occur that result in the need for DEP to apply alum to water in the Catskill Aqueduct upstream of Kensico Reservoir.

Water quality conditions were also compared between the future with the Proposed Action and Ashokan Reservoir Alternative 6 combinations. Specifically, modeling was conducted to compare the number of days Catskill Aqueduct turbidity would be above 8 NTU and the overall number of days that DEP would need to apply alum over the OST simulation period. Results are presented in **Table 14.3-7.** As discussed in Section 7.1, "Water Resources and Water Quality" assessment for lower Esopus Creek, the reduction of alum days in the future without and with the Proposed Action, as compared to historical conditions, is a result of the increased operational flexibility provided by DEP's other turbidity control measures – specifically operation of the Catskill/Delaware Interconnection at Shaft 4 and installation of stop shutters. This infrastructure reduces the percent of alum days anticipated over the OST simulation period to 0.3 percent.

Table 14.3-7. Stop Shutters, Shaft 4 and Percent Alum Days

Protocol	CSSO	Community Release	Avg Days/ Yr Shaft 4 On	Avg Days/ Yr Stop Shutters Installed	Average Days Diversion Turbidity is over 8 NTU	Percent Alum Days (OST Simulation Period)
No IRP	0	0	48	4	48	0.3%
IRP	90	10/15	41	4	39	0.3%
ROP	90	10/20	41	4	39	0.3%
ROP	90	15/20	41	4	39	0.3%
ROP	85	10/15	38	4	36	0.3%
ROP	85	10/20	38	4	36	0.3%
ROP	85Del	10/15	39	4	37	0.3%
ROP	85Del	10/20	40	4	38	0.3%
ROP	85Del	15/20	40	4	38	0.3%

As shown in the table, because the Catskill/Delaware Interconnection at Shaft 4 and stop shutters already reduce the number of alum days to 0.3 percent, water quality benefits of the IRP and any alternatives to the IRP are related to a small change in the average number of days per year the Catskill/Delaware Interconnection at Shaft 4 would be operated and diversion turbidity would exceed 8 NTU. However, the average number of days that stop shutters would be installed or alum would be applied to water in the Catskill Aqueduct upstream of Kensico Reservoir is the same between all of the Ashokan Reservoir Alternative 6 combinations.

14.3.4 EFFECT OF ASHOKAN RESERVOIR ALTERNATIVE 6 ON LOWER ESOPUS CREEK

In general, variations to the release protocol resulted in minor flow differences between combinations evaluated as part of the Ashokan Reservoir Alternative 6 analysis and the future with the Proposed Action. **Figure 14.3-6** to **Figure 14.3-8** show the changes to streamflow occurrence, seasonal flows in wet, normal, and dry years, and flood recurrence for the Ashokan Reservoir Alternative 6 combinations as compared to the future with the Proposed Action. Note that these results are presented considering the adjustment of the Mount Marion flow trigger to two feet below flood Action Stage. There is no difference in the results for any of the Mount Marion triggers.

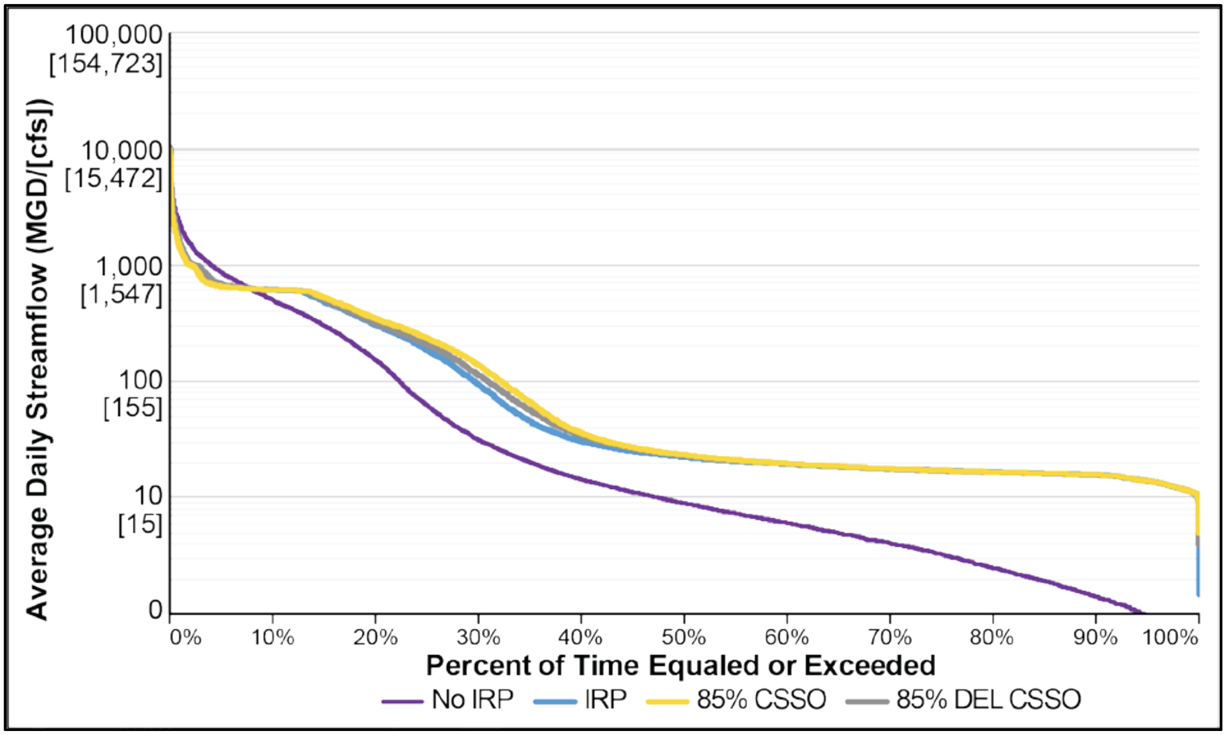

Figure 14.3-6. Flow Duration Curves at the Spillway Confluence, 1971–2017

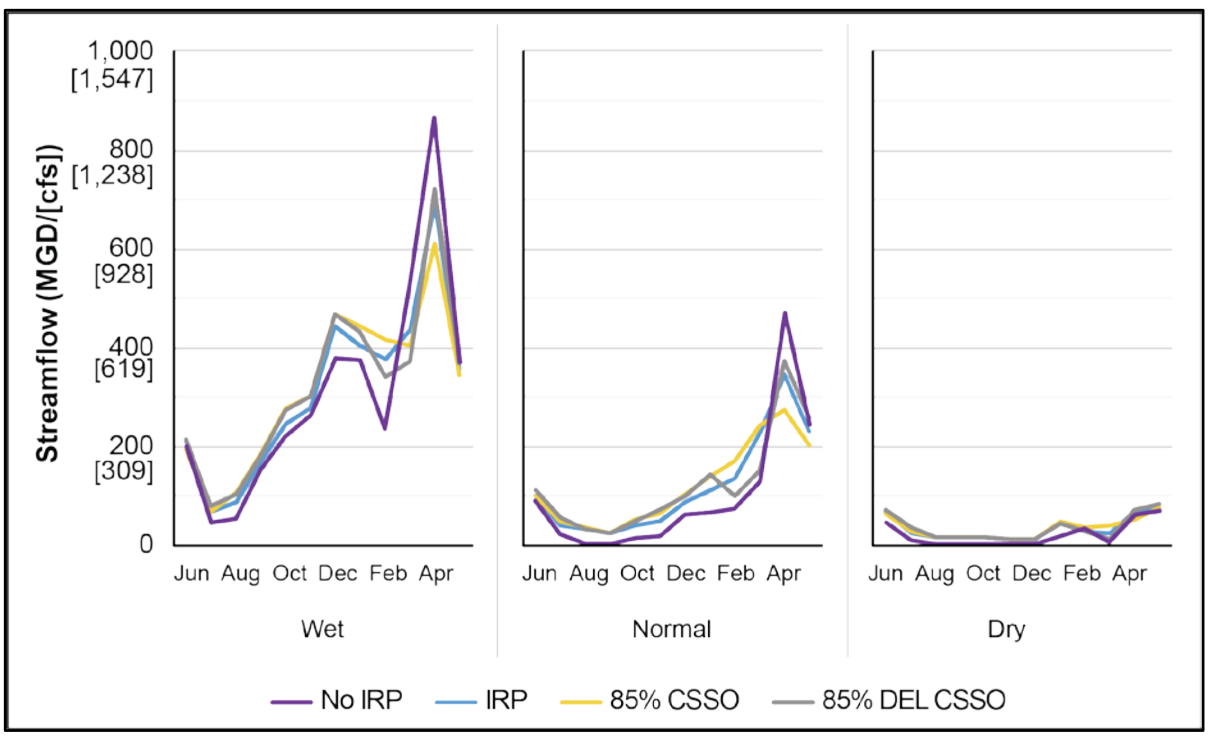

Figure 14.3-7. Streamflow at the Spillway Confluence

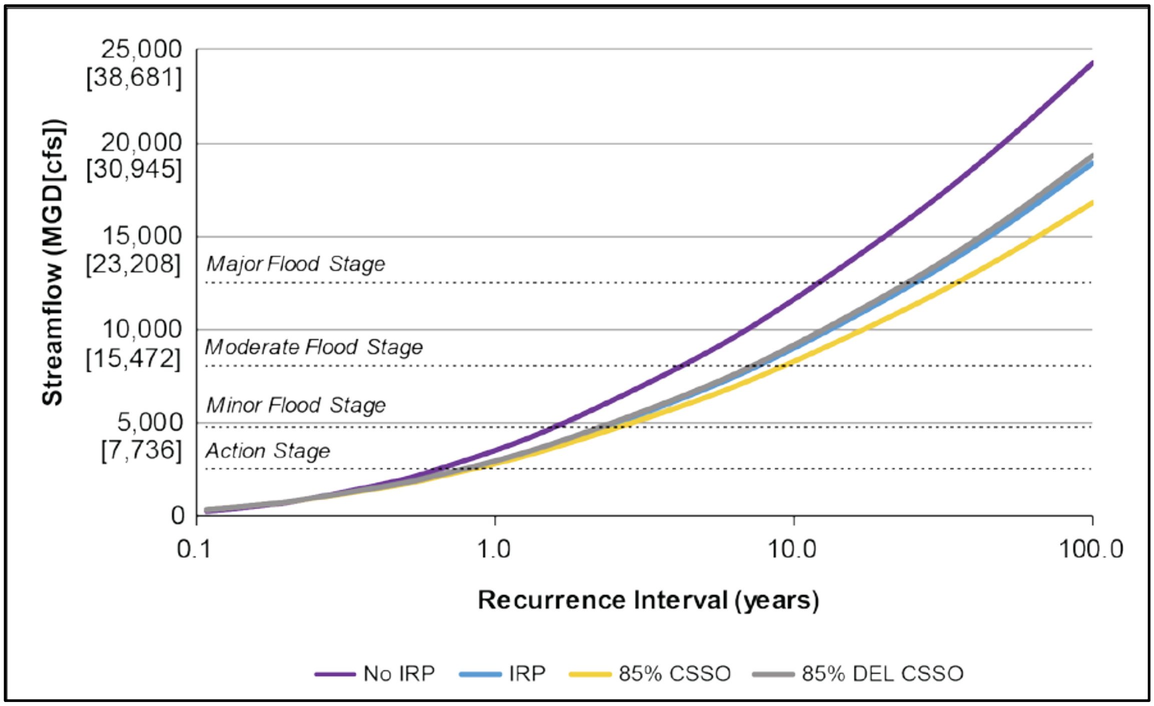

Figure 14.3-8. Flood Magnitudes at Mount Marion for 2-Month to 100-Year Recurrence Intervals[14]

14.3.5 PROPOSED REVISED OPERATING PROTOCOL

After consideration of the model results, it was decided that the preferred ROP would consist of:

- No change to the community release;
- No change to maximum release rate of 600 MGD (928 cfs) with 1,000 MGD (1,547 cfs) maximum of spill and releases combined for Spill Mitigation and Operational Releases;
- Adjustment of the CSSO to the 85 percent Delaware System curve;
- Modification of the turbidity levels from 30 NTU and 60 NTU to 25 NTU and 50 NTU, respectively;
- Increasing the forecast horizon for the Mount Marion trigger to two feet below Action Stage with the potential to move the flow trigger to Lomontville; and
- Flushing when best available water from one of the two basins is below 25 NTU. When turbidity in both basins is greater than 25 NTU, flushing would be replaced by a period of 36 hours with no releases.

[14] While the difference looks large at larger recurrence intervals, the IRP 95-percent confidence bounds are wide and encompass all of the alternate release protocols.

The proposed ROP for Ashokan Reservoir reflects recent updates to the CSSO curves on the Delaware System under the revised FFMP. The ROP turbidity level modification was based on the results of the fisheries assessment (see Section 7.7, "Aquatic Resources"). The increased Mount Marion trigger included in the ROP may provide DEP with additional advance notice for shutting down releases under high flow conditions at Mount Marion. The flushing would be replaced by a period of no releases when turbidity levels are higher than 25 NTU in both basins because it was determined to be more protective of trout in the portion of lower Esopus Creek upstream of the spillway confluence under these conditions. The figures below provide select comparison of the ROP with the future without and with the Proposed Action.

As shown on **Figure 14.3-9**, the ROP would result in a similar distribution of releases as compared to the IRP. In both cases, it is anticipated operational releases would occur less than five percent of the time over the OST model simulation period and last a median of three days. Similarly, there would be only minor differences (on the order of one to two days) between release turbidity levels with the ROP as compared to the future with the Proposed Action (**Figure 14.3-10** and **Figure 14.3-11**). Note there is a potential for release turbidity levels to exceed 25 NTU for short periods (on the order of days) upstream of the spillway confluence which, similar to the IRP, would not result in a significant adverse visual impact.

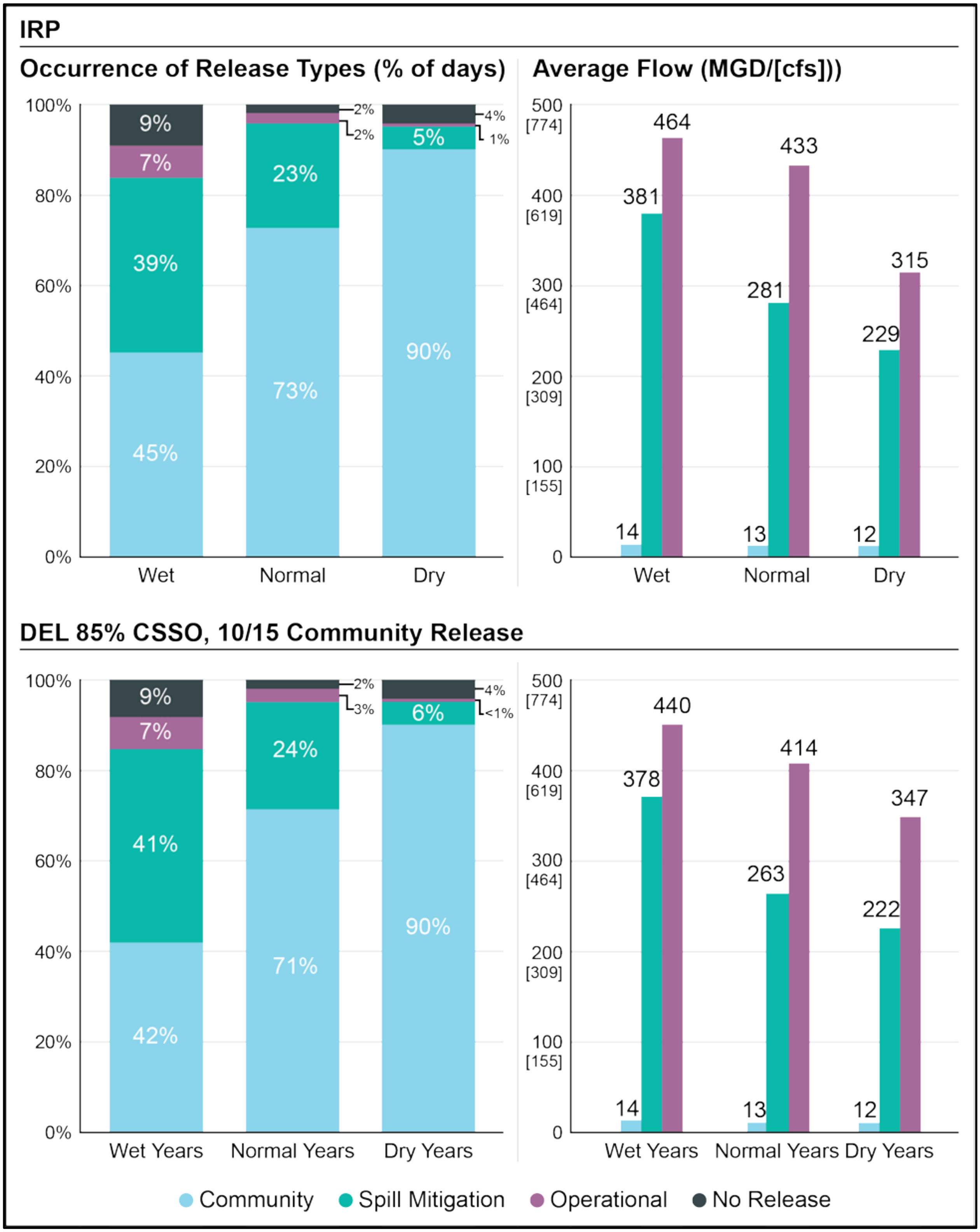

Figure 14.3-9. Occurrence and Average Magnitude of Various Release Types Between the Future With the Proposed Action and the Proposed ROP

Days Per Year Within Each Turbidity Bin

NTU	Wet	Normal	Dry
0-5	184	270	313
5-10	73	57	25
10-15	37	16	6
15-20	21	7	3
20-25	9	4	2
25-30	4	2	0
30-40	2	1	1
40-50	2	1	0
50-60	0	0	0
60-100	1	0	0
> 100	0	0	0
No Release	33	7	15
Total	**366**	**365**	**365**

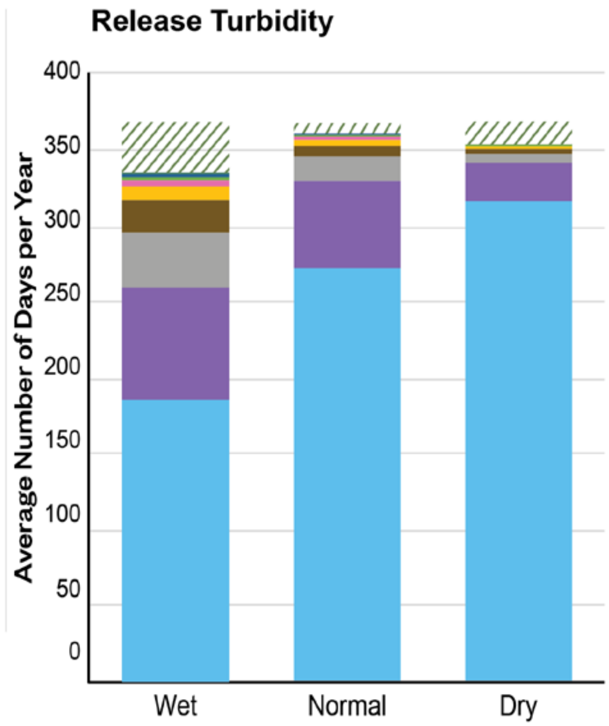

Figure 14.3-10. Occurrence of Release Turbidity Levels by Type of Year with the IRP

Days Per Year Within Each Turbidity Bin

NTU	Wet	Normal	Dry
0-5	183	269	313
5-10	75	58	25
10-15	36	16	6
15-20	22	7	3
20-25	9	4	2
25-30	3	2	0
30-40	1	1	1
40-50	1	1	0
50-60	0	1	0
60-100	1	1	0
> 100	0	0	0
No Release	35	7	15
Total	**366**	**367**	**365**

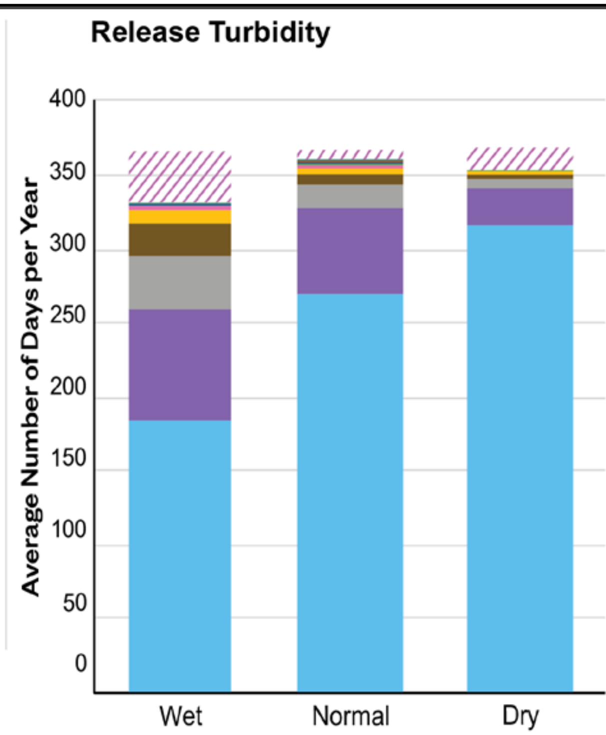

Figure 14.3-11. Occurrence of Release Turbidity Levels by Type of Year with the ROP

The ROP would provide additional time for reduction of releases as compared to the future with the Proposed Action since it would include lower forecast triggers for tracking releases. The ROP would be more protective of rainbow trout and brown trout as a result of lowering the turbidity levels from those in the future with the Proposed Action. It also lowers the 60 NTU release turbidity level that would trigger flushing after 5 days to 50 NTU. Additionally, by stopping releases when turbidity in both basins is over 25 NTU, in lieu of flushing with high turbidity water, it is anticipated that the background flow in lower Esopus Creek would provide lower turbidity streamflow for the purposes of 'flushing' lower Esopus Creek, particularly in Valley Reaches 1A and 1B where trout are found. Since the magnitude, frequency, duration, and seasonality of releases would not change with the ROP as compared to the future with the Proposed Action, there are no anticipated changes to the parameters evaluated to identify potential differences between the future without and with the Proposed Action (water depth, water velocity, inundation, erosion, and deposition). By reducing turbidity levels that trigger flushing to 25 and 50 NTU, and replacing flushing with a period of no releases when the turbidity in both basins of Ashokan Reservoir are greater than 25 NTU, there are no anticipated impacts to the quality of releases for the proposed ROP as compared to the future with the Proposed Action. Therefore, the findings of the impact assessment for the future with the Proposed Action, presented in Section 7, "Potential Impacts and Benefits of the Proposed Action on Lower Esopus Creek," are applicable to the ROP and no significant adverse impacts are anticipated from the ROP. As discussed above, the proposed ROP enhances benefits already provided by the IRP.

14.4 PROPOSED REVISED MONITORING PLAN

As part of this EIS, DEP evaluated the Water Quality Monitoring Plan incorporated into the Interim Ashokan Release Protocol. In connection with the requirement to develop a Revised Operating Protocol, the Consent Order specifically required DEP to consider the potential need to monitor "temperature, turbidity, total suspended solids, biomonitoring, physical geomorphic factors, and flow data" and to identify at what locations this monitoring (if required) should occur along lower Esopus Creek. As part of development of this EIS, and as described in Section 7.1, "Water Resources and Water Quality," DEP has collected the following data along lower Esopus Creek over the past several years:

- Water quality data in accordance with the Water Quality Monitoring Plan (see **Figure 14.4-1**):
    - Weekly turbidity and temperature data at the Ashokan Release Channel (M-1), lower Esopus Creek above Saugerties (LEC AS) and Saugerties Beach (LEC Saugerties Beach) when the release channel was operating;
    - Weekly turbidity and temperature data at the spillway (ASP) and spillway confluence (ASP-M1 Conf) when the Reservoir was spilling;
    - Flow monitoring at the Ashokan Release Channel (when it was operating), and spillway (when the Reservoir was spilling), and flow and turbidity monitoring at the Lomontville and Mount Marion gages.[15]
- To support the EIS assessments, DEP also collected voluntary temperature and turbidity measurements weekly at the Saw Kill and Plattekill tributaries. The Saw Kill and Plattekill sample locations were not included in the Water Quality Monitoring Plan incorporated into the Interim Ashokan Release Protocol.
- Topographic survey data at 17 locations upstream of the spillway confluence and approximately 30 locations along lower Esopus Creek downstream of the spillway confluence;
- Geomorphic data at 17 cross-sections downstream of the spillway confluence;
- Wetland and floodplain forest data upstream and downstream of the spillway confluence;
- Fish and benthic data upstream and downstream of the spillway confluence;
- SAV bed mapping at the confluence of lower Esopus Creek with the Hudson River; and
- Photographic monitoring along the lower Esopus Creek at various points under varying flow conditions.

Based on the results of the assessments conducted to support the EIS, additional collection of physical geomorphic data and biomonitoring data is not warranted. In addition, collection of water quality data at the three existing sampling sites within lower Esopus Creek (the spillway confluence, lower Esopus Creek above Saugerties Beach, and Saugerties Beach) would not need to continue. Water quality and flow would continue to be monitored at the Ashokan Release Channel (when operating) and spillway (when spilling) and at the Lomontville and Mount Marion gages. DEP no longer conducts weekly water quality monitoring of the Saw Kill and Plattekill that was conducted to support the EIS. The Lomontville gage is located upstream of the Saw Kill and Plattekill and the Mount Marion gage is located downstream of these tributaries. The gages provide a more complete and continuous set of data (i.e., every 15 minutes) to help understand how the water quality of these tributaries may be affecting water quality within lower Esopus Creek without the need for additional data collection. Therefore, DEP is proposing the following Revised Monitoring Plan to be implemented with the proposed ROP (see **Table 14.4-1** and **Figure 14.4-2)**.

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[15] Pursuant to the Consent Order, DEP provided funds for installation of a turbidity monitor at the existing USGS Mount Marion gage and a new flow and turbidity gage at Lomontville.

Table 14.4-1. Proposed Revised Monitoring Plan

Site/Type	Sites	Analytes	Collection Frequency
Upper Esopus Creek	E16i (confluence)	turbidity, temperature total suspended solids	Weekly Monthly
Limnology	1EA-4EA (in Reservoir)	turbidity, temperature total suspended solids	2x/Month[1] Monthly[1]
Reservoir Effluent	EARCM	turbidity, temperature total suspended solids	5 Days/Week Monthly
Ashokan Upper Gatehouse	ES, EM, EB, WS, WM, WB	turbidity, temperature	Weekly
Ashokan Release Channel	M-1	turbidity, temperature total suspended solids, flow	Weekly when releases are occurring
Ashokan Spillway Channel	ASP	turbidity, flow	Weekly when Reservoir is spilling
Lower Esopus Creek	Lomontville and Mount Marion gages	turbidity, flow	USGS gage data collected every 15 minutes

Notes:
[1] Reservoir conditions permitting, March through December.

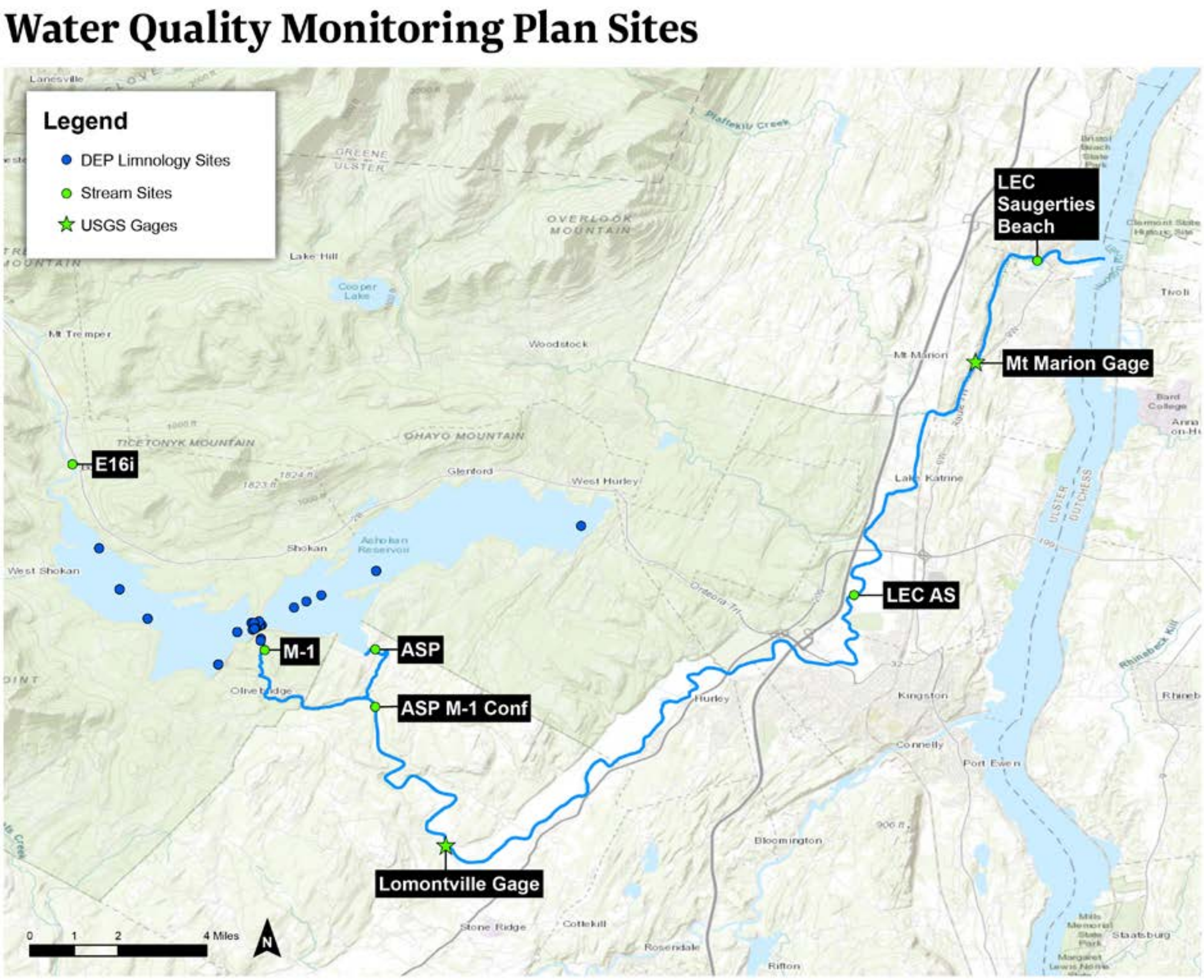

Figure 14.4-1. Monitoring Sites Along Lower Esopus Creek Included in the Water Quality Monitoring Plan Incorporated Into the IRP

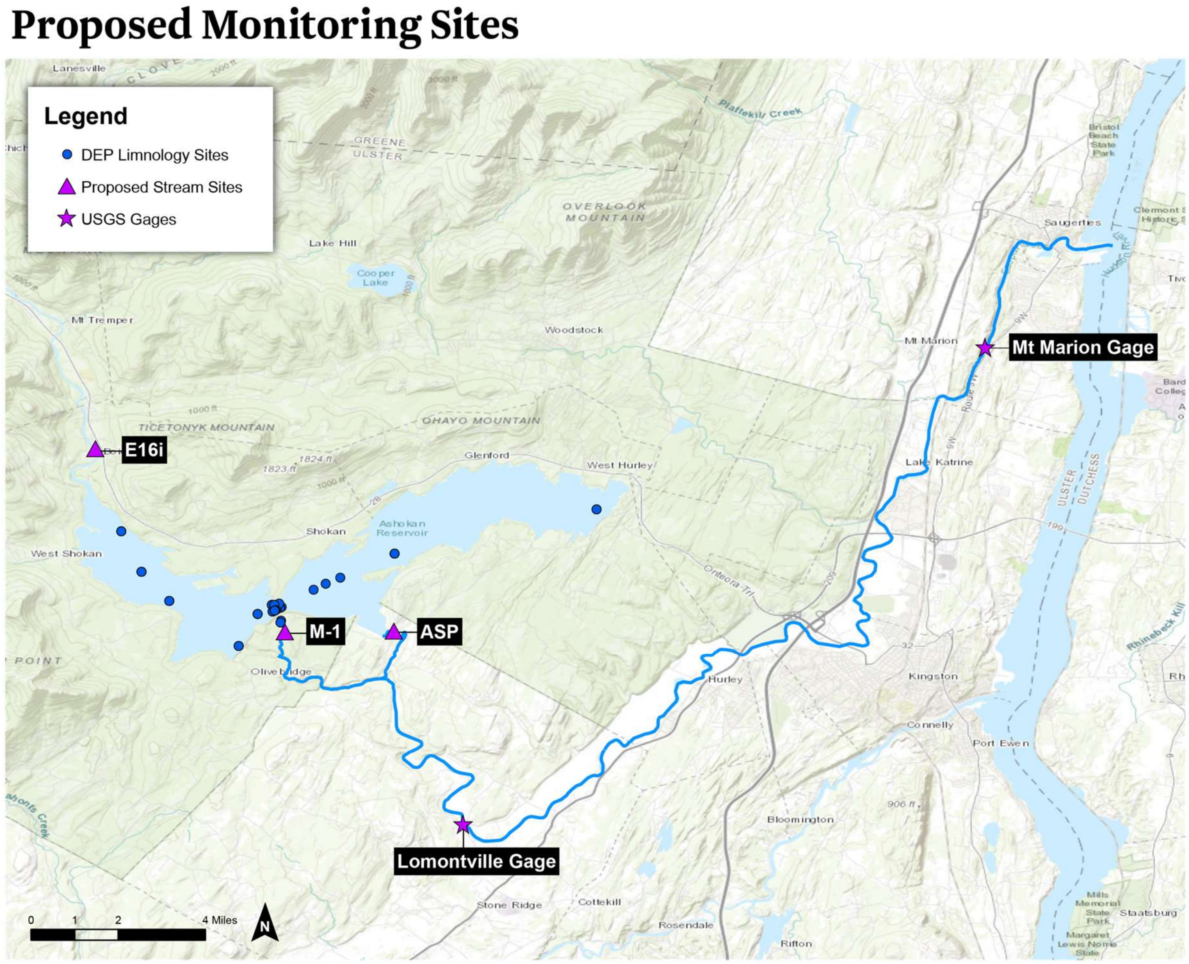

Figure 14.4-1. Proposed Monitoring Sites Along Lower Esopus Creek Included in the Proposed Revised Monitoring Plan