Belleayre Mountain Ski Center UMP-DEIS

Appendix J
Woythal Memo – Birch Creek Base Flow Needs

July, 2007

Prepared by:

New York State Department of Environmental Conservation
Division of Fish & Wildlife – Instream Flow and Wind Unit
625 Broadway
Albany, New York 12233

New York State Department of Environmental Conservation
Division of Fish, Wildlife & Marine Resources
Bureau of Habitat, 5th Floor
625 Broadway, Albany, New York 12233-4756
Phone: (518) 402-8847 • **FAX:** (518) 402-8925
Website: www.dec.state.ny.us

Alexander B. Grannis
Commissioner

M E M O R A N D U M

To: Instream Flow Unit File

From: Mark Woythal; Instream Flow & Wind Unit Leader

Date: July 24, 2007

RE: An Investigation of the Seasonal Aquatic Base Flow Needs of Birch Creek, Ulster County, New York

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Introduction

The Instream Flow and Wind Unit, within the Bureau of Habitat was requested by the Bureau of Design and Construction (Division of Operations) to assess the seasonal instream flow needs of the aquatic resources within Birch Creek, located in Ulster County. The assessment was necessary to provide information on water withdrawal potentials from Birch Creek for snowmaking operations at Belleayre Mountain. This state-owned ski area, located off County Route 28, is owned and operated by the Department of Environmental Conservation. Belleayre currently has 47 trails, parks and glades and 8 lifts, with a vertical drop of 1,404 ft. The present level of snowmaking provides man-made snow to 96% of the terrain.

The snowmaking operations at Belleayre Ski Center are supported primarily by water withdrawals from Birch Creek. The watershed above the withdrawal point covers approximately 7.9 square miles. A water control structure is installed in Birch Creek that is designed to divert water into Pine Hill Lake, a 30 million gallon water supply pond. Pump stations adjacent to the lake and a water transmission pipeline deliver the water to the snowmaking system on the mountain.

The current water withdrawal structure is designed to remove water from Birch Creek while maintaining a constant conservation flow of 5 cubic feet per second (cfs) in the

downstream reaches of the stream. At the lowest instream flow, 5 cfs is passed solely through a steep-pass fish passage structure that allows stream fishes to pass upstream over the diversion weir. Trout Unlimited has reported that the fish passage system has been successful at passing trout upstream of the weir (see Figure below).

When streamflow is above 5 cfs the additional flow is available to be diverted into Pine Hill Lake. If water is not being pumped for snowmaking it is returned to the stream via the Lake outlet structure, or if the pipeline is shut off, all water flows downstream over the weir. Periodic maintenance may be required to remove accumulated sediment upstream of the diversion structure to ensure that water is effectively diverted, continuous fish passage is maintained and the necessary downstream flows are released.

<u>Instream Flow Investigation</u>

The generalized approach for developing a site-specific numeric flow criteria for Birch Creek at the Belleayre Mountain water control structure was as follows:

- Conduct a field visit to evaluate the channel configuration below the water withdrawal point to determine how changes in stream flow might influence the physical characteristics (e.g. average water depth, thalweg depth, velocity, pool/riffle ratio, split channel formation) and the biological attributes (riparian cover, macroinvertebrate production, available fish spawning and nursery habitat) within the downstream reaches of the stream;

- Evaluate available hydrological statistics for the watershed to assist in developing generalized thresholds using standard-setting approaches (e.g. ABF or Tennant Method);

- Evaluate all available habitat-flow information for the watershed to determine when flow thresholds below which ecological impairments are likely to occur seasonally;

- Initiate additional habitat-flow and ecosystem field investigations as necessary to fill biological information gaps; and

- Refine the existing flow thresholds within the watershed as deemed necessary.

1. Field Visit

On June 21, 2007, the Instream Flow & Wind Unit was joined by Tom Miller, Chief of the Bureau of Design & Construction (Division of Operations) and Tony Lanza, Superintendent of Belleayre Mtn Ski Center, to inspect Birch Creek. The field visit began at the water control structure where water is diverted from Birch Creek to Pine Hill Lake. Observations were made of the downstream reach of Birch Creek to a distance of approximately 0.5 miles below the control structure in the vicinity of where the first tributary, Giggle Brook, enters the stream. Most of this reach of stream is composed of the reconstructed bypass channel that was designed by DEC during the construction of Pine Hill Lake in the late 1980's. Additional observations of the stream were made approximately 1.5 miles downstream from the control structure at the Winding Mountain road crossing below the sewage treatment plant, and approximately 2.0 miles downstream from the control structure at the USGS stream gauge (#013621955) located on Birch Creek at Big Indian. The goal of the site visit was to properly characterize the physical and ecological characteristics of Birch Creek. Streambed and channel morphology plays an important role in determining available habitat for fish and wildlife resources within the stream and riparian corridor. Seasonal variability in streamflow determines usable aquatic habitat within the corridor. In headwater streams such as Birch Creek, the maintenance of wild trout populations is predicated on temporal habitat needs that enable trout to successfully reproduce and populate the stream.

a. Site Physical Description

During the site visit, the average channel width of Birch Creek was approximately 10 feet and the average depth was approximately 1 foot. Deeper segments of approximately 18"-24" were common, which provide sufficient cover and lower velocity areas to hold trout. The pool to riffle ratio favored riffles due to the moderate gradient (see photo below).

Stream flow at Pine Hill was calculated to be approximately 16 cfs, as prorated from the Big Indian gauge (discussed below). The stream channel configuration in the man-made portion of the stream is well maintained due to placement of large stones and the well-armored stream margins. The thalweg is well defined, providing deeper mid-channel flows under low flow conditions. The channel structure also tends to concentrate higher energy flows in the mid-channel area which allows for the deposition and protection of finer “gravel” substrates along the stream margins that are utilized during trout spawning and incubation. Very little finer substrates (e.g. sands, silt) are found in Birch Creek, which are typically detrimental to a healthy cold water aquatic ecosystem. Very limited

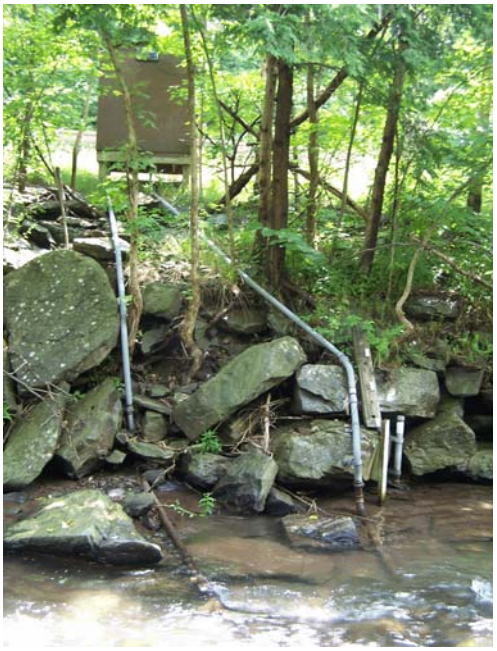
split channel configurations exist which result in shallower stream depths with generally less fisheries value.

b. Site Ecological Description

Birch Creek maintains a cold water fishery which supports rainbow trout, brown trout and brook trout natural reproduction. Numerous trout were observed as were black-nosed dace and unidentified daters. The aquatic insect community was very productive with stonefly, mayfly and caddisfly larvae present. Riffle dwelling species were dominated by caddisfly (see photo at right). Water temperatures were very suitable for trout, although the temperature was not measured. The stream channel morphology was such that higher velocities were found in the center of the channel which allows for accumulation of suitable substrate gravels for trout spawning and incubation. Slower water velocities at the stream margins and abundant riparian vegetation cover provide suitable nursery conditions for juvenile trout.

2. Hydrological Statistics

a. Watershed information



The USGS stream gauge (#013621955) located on Birch Creek at Big Indian has recorded daily stream flow since 1998 (photograph at right). Since the gauge is downstream of the Pine Hill Diversion structure, the recorded flows during snowmaking season do not include the water that is withdrawn from Birch Creek to make snow. Birch Creek carries additional flow in the spring that is attributed to the meltwater that comes from Belleayre Mountain; therefore, average annual flow measurements at the gauge are likely accurate for the drainage basin above the measurement location.

The drainage area upstream from the Big Indian gauge is 12.5 square miles. The drainage area at the Belleayre Mountain diversion structure on Birch Creek, located at Pine Hill, is 7.9 square miles. If you assume that surface runoff and groundwater contribute proportionally, the

flow measured at Big Indian can be prorated to Pine Hill by multiplying the Big Indian values by 0.632 for any given point in time.

The annual average daily flow recorded at the Big Indian Gauge is presented in Table 1 for the period 2000-01-01 through 2005-12-31.

Table 1. Annual Average Daily Flow

Year	Annual average daily flow
2000	32.1
2001	21.8
2002	17.7
2003	37.0
2004	40.2
2005	27.9
Mean of annual average flow @ Big Indian gauge: @ Pine Hill diversion structure:	 29.45 cfs 18.6 cfs (prorated)

b. Developing Generalized Flow Thresholds

There are various decision-making processes regarding flow, that range from recommending an instream flow requirement to guide general decisions for which a limit is set below which water cannot be diverted (i.e. conservation flows or aquatic base flows), to resolving conflicts over incremental differences in flow levels (Stalnaker, et.al., 1996). The Instream Flow Incremental Methodology is recommended for use in establishing a site-specific instream flow criterion for more complex, controversial flow issues. This fully quantitative stream assessment method, although providing the best recommendations for aquatic streamflow needs, would be cost-prohibitive for this investigation.

For general, low intensity decisions, the Instream Flow & Wind Unit employs the use of standard setting approaches such as the Modified Aquatic Base Flow (ABF) method (Larson, 1981), or the Tennant Method (Tennant 1975). These methods, based on hydrological data, are valuable tools to provide initial guidance when site-specific ecological information is not fully available. Whenever available, a combination of ecological and hydrological information rather than solely hydrological data should be used as the basis for determining site-specific numerical flow requirements. It is important to look at the aquatic community structure and how they have adapted to the stream's historical, natural flow regime that are influenced by both the climate and

geography of any given watershed. Natural seasonal variability result in critical periods (e.g. seasonal windows/thresholds) when flows can have a significant influence on individual species, communities, and ecosystems in general. Properly identifying these critical flow needs is necessary during any instream flow investigation where the goal is to establish a seasonal aquatic base flow.

Aquatic Base Flow Method

The Aquatic Base Flow (ABF) method is a standard-setting approach that uses hydrologic statistics as a surrogate for aquatic habitat, and is a component of the USFWS's New England Flow Policy (Annear, et.al., 2002). This method assumes that the most critical flows to be maintained are in August when stress to aquatic communities is at its highest due to high water temperatures, reduced wetted perimeter, low dissolved oxygen, and possible lack of adequate food supply. It was determined by the USFWS that the historical (unaltered) median flows will protect critical reproductive functions. Where adequate records (25 years of unaltered, free-flowing, 50 $mi.^2$ or greater USGS gaging measurements) exist the USFWS recommends that using the median of the monthly means of August flows will be adequate throughout the year unless additional flow releases are necessary for fish spawning and incubation. If spawning and incubation are an issue, the USFWS recommends flow releases equivalent to the historical median of monthly means stream flow throughout the applicable spawning and incubation period. Unfortunately, only 6 full years of hydrological records are available for Birch Creek, at the Big Indian gauge and the drainage area is 1/4 of that recommended for using the monthly means of August or the median of monthly means for determining appropriate spawning flows.

Where inadequate records exist or for rivers regulated by dams or upstream diversions, the USFWS recommends using 0.5 cubic feet per second per mile of drainage area (cfsm), unless spawning and incubation are a concern where the recommendation is 1.0 cfsm in the fall/winter and 4.0 cfsm in the spring. This policy has been successfully defended in court and is widely used in New England. This ABF methodology would be an acceptable approach for determining seasonal flows in Birch Creek in the vicinity of Pine Hill Lake. In addition to the 0.5 cfsm during the summer/fall periods, the presence of successfully spawning trout would require that 1.0 cfsm remain in the stream downstream from the water control structure during the winter months.

The Birch Creek drainage area upstream of the water diversion structure at Pine Hill Lake is 7.9 square miles. For Birch Creek and similar streams where inadequate stream flow data are available and it is impractical to conduct a detailed, site-specific study, the summer ABF can be conservatively estimated as: 0.5 cfsm (approximately 4.0 cfs); and for trout waters in the winter the winter ABF can be estimated as: 1.0 cfsm (approximately 8cfs) to protect fall-spawning trout species (brown trout and brook trout) and subsequent egg incubation and larval fish protection. An ABF of 4.0 cfsm (approximately 32cfs) is recommended during the spring to provide adequate flushing flows that maintain the stream channel morphology.

Tennant Method

The Tennant Method (Tennant 1975) for determining instream flow requirements for fish involves using percent of average annual flow (AAF) to maintain some level of fish habitat. This method qualitatively determines fish habitat level corresponding to a percentage of average annual flow. Tennant determined that 10% average annual flow is the minimum for short term fish survival, 30% is considered to be able to sustain good survival conditions, and 60% of average flow is excellent to outstanding habitat (Tennant 1975). This method is widely used since determining instream flows for fish requires only a hydrograph of average annual flow.

The average annual flow for the period of record 2000-2005 from the Big Indian gauge, prorated for the drainage area above the Pine Hill Lake diversion, was 18.6 cfs. The Tennant Method would recommend that for minimum short-term fish survival, a base flow of 1.8 cfs be provided. This recommendation clearly would not allow current management objectives to be reached and would jeopardize the aquatic community and wild fish populations of Birch Creek. To be able to sustain good survival conditions for the aquatic community, the Tennant Method recommends that approximately 5.5 cfs be maintained below the diversion structure. This standard-setting approach recommends a continuous flow of 11.3 cfs to maintain excellent to outstanding habitat in Birch Creek downstream of the diversion structure at Pine Hill Lake.

3. Habitat-flow Information

Habitat-flow information is developed in various ways. Typically a comparison is made between hydrological data and habitat needs of either species-specific life stages and their habitat needs or aquatic community needs as a whole. Birch Creek supports multiple trout species that are both spring (April-May) and fall (late September-early November) spawners. Flows during the fall months range from approximately 5cfs to 25 cfs (see annual hydrographs in Appendix A).

During years when there is low flow the spawning gravels, those sought by brown and brook trout, are very sparse due to the flushing of these fine substrate from the thalweg of the stream during extreme annual flows. During these years it is likely that spawning success is reduced in Birch Creek. During years when there is average or high fall flows, many suitable spawning locations are accessible along the stream margins. It is during these years that it is essential that adequate flows be provided during the winter months to provide protection for the eggs and developing young found within the pocket gravels at or near the stream margins. These immobile eggs and young fish would suffer mortality if de-watered for even short periods of time. Proper protection of these early life stages ensure that trout populations are maintained from year to year. This is especially important in Birch Creek since year class strength likely varies from year to year.

Natural flows within Birch Creek during the spring are adequate to protect spawning and rearing of rainbow trout that typically spawn in the spring. Flows ranging from 20 cfs to 50 cfs are typical. This species of trout is the dominant sportfish in Birch Creek. Channel morphology and substrate composition is maintained by annual high flow events (see Appendix A).

4. Additional Field Investigations

On July 5, 2007 the IF&WU re-visited Birch Creek to qualitatively assess the amount of aquatic habitat that would be available if a winter baseflow of 8cfs was maintained, as the natural flow provided by the drainage area above the Pine Hill Lake diversion structure on that date was approximately 8cfs (see photo at right). The flow observed provided adequate coverage of the pocket gravel areas that were common near the stream margins. The channel structure provided for a well-defined thalweg that ensures that aquatic organisms can move longitudinally throughout the stream See photograph at right). This is especially important during the winter months when icing conditions can alter the flow distribution within the stream channel cross-section and fish and macroinvertebrates are required to seek deeper sections of the stream. There were limited areas of stream channel where the water was spread out evenly with equal depths across the stream. The lack of this type of stream channel feature minimizes the formation of split channels which can be problematic during low-flow events. An additional series of photographs are available in Appendix B.

5. Determination of Flow Thresholds

Based of the limited availability of hydrological information, the IF&WU determined that the ABF Method and the Tennant Method would be appropriate tools to approximate the flow needs of Birch Creek downstream of the Pine Hill Lake diversion structure. Field investigations were used to verify the whether the recommendations from the standard-setting methodologies would adequately protect the aquatic resources within the stream.

The Instream Flow and Wind Unit recommends that aquatic base flows be maintained in Birch Creek as follows:

- from October 15 through April 15, a base flow of no less than 8 cubic feet per second (cfs) or natural flow provided by the watershed upstream from the Pine Hill Lake water diversion structure, whichever is less, should be continuously maintained in Birch Creek immediately downstream from the water withdrawal structure; and

- from April 16 through May 31, a base flow of no less than 36 cfs or natural flow provided by the watershed upstream from the Pine Hill Lake water diversion structure, whichever is less, shall be continuously maintained in Birch Creek immediately downstream from the water diversion structure; and

- from June 1 through October 14, a base flow of no less than 5 cfs or natural flow provided by the watershed upstream from the Pine Hill Lake water diversion structure, whichever is less, shall be continuously maintained in Birch Creek immediately downstream from the water diversion structure.

During all instances, the first 5cfs is to be passed through the steep-pass fish passage structure built into the diversion structure. Any additional recommended flow amounts should be allowed to flow over the concrete weir to the downstream reach of Birch Creek.

References Cited

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Larson, H. N. 1981. New England flow policy. Memorandum, interim regional policy for New England stream flow recommendations. U. S. Fish and Wildlife Service, Region 5, Boston, Massachusetts. 3 pp.

Stalnaker, C. B., B. L. Lamb, J. Henriksen, J. D. Bovee, and J. Bartholow. 1994. The Instream Flow Incremental Methodology: a primer for the IFIM. National Ecology Research Center, internal publication, National Biological Service. Fort Collins, Colorado. 99 pp.

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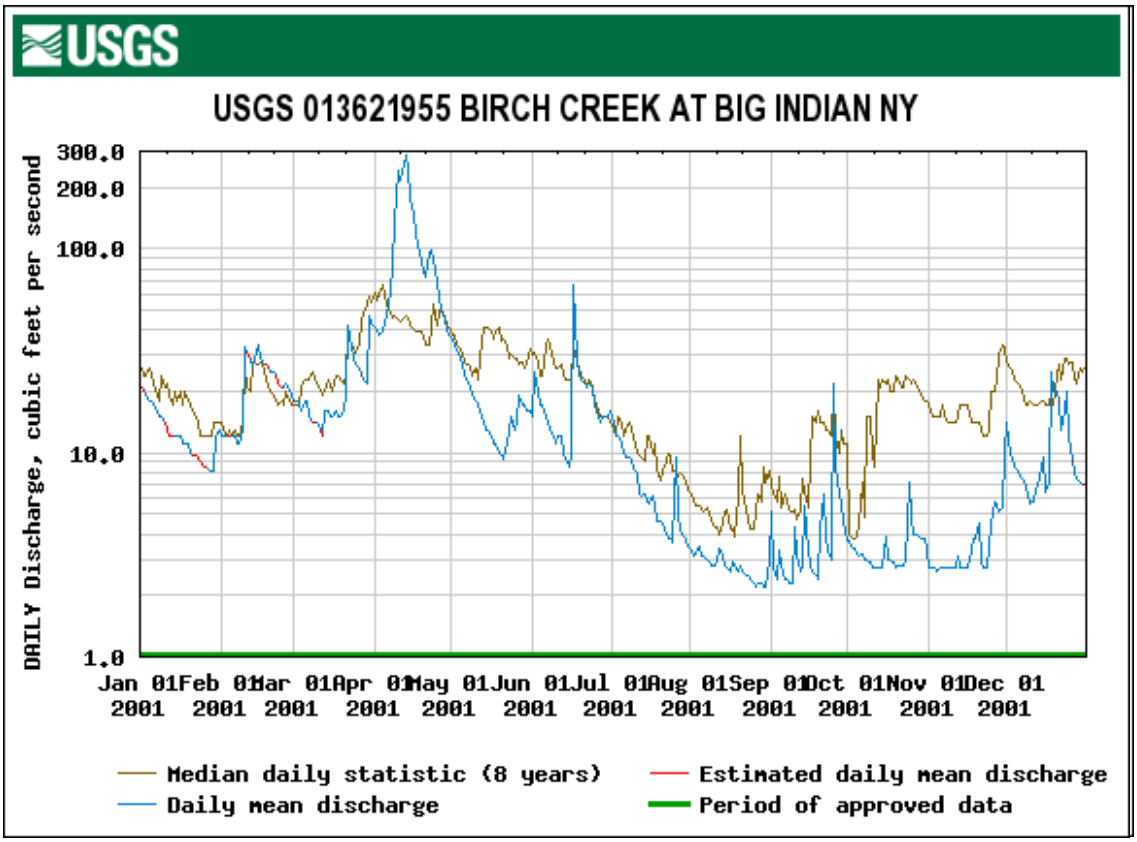
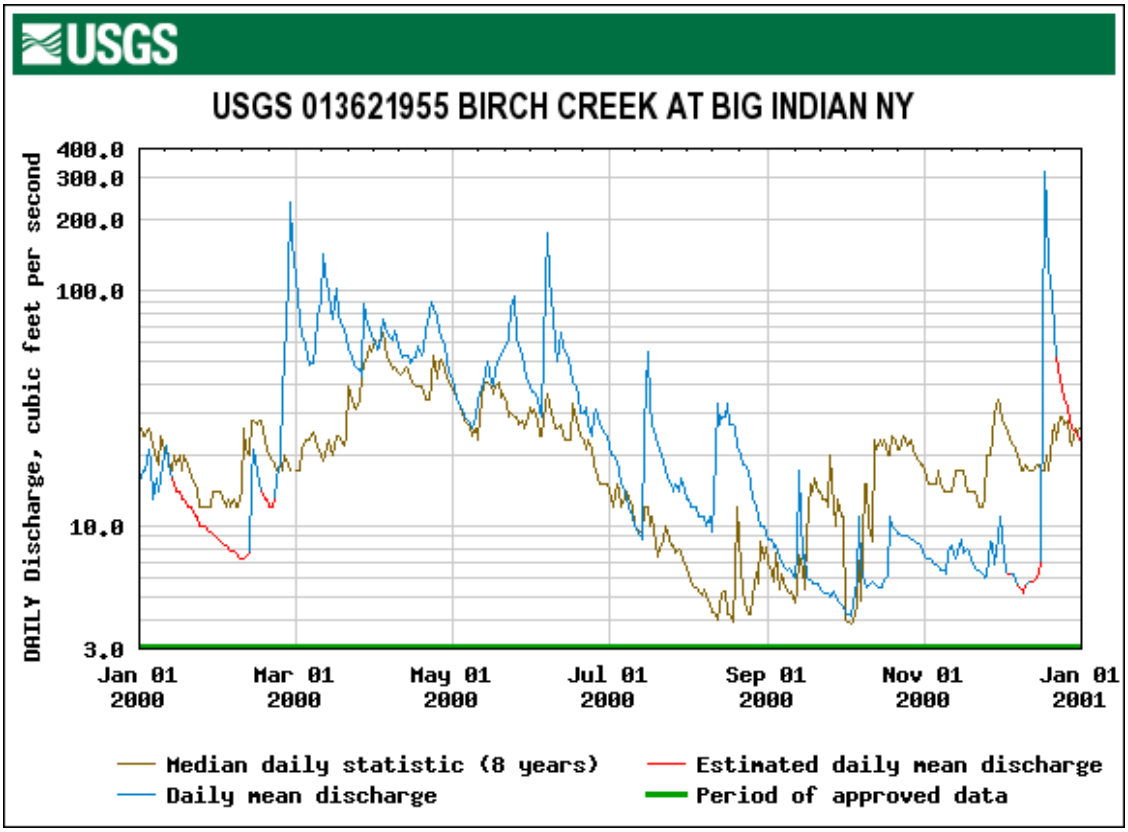
Appendix A

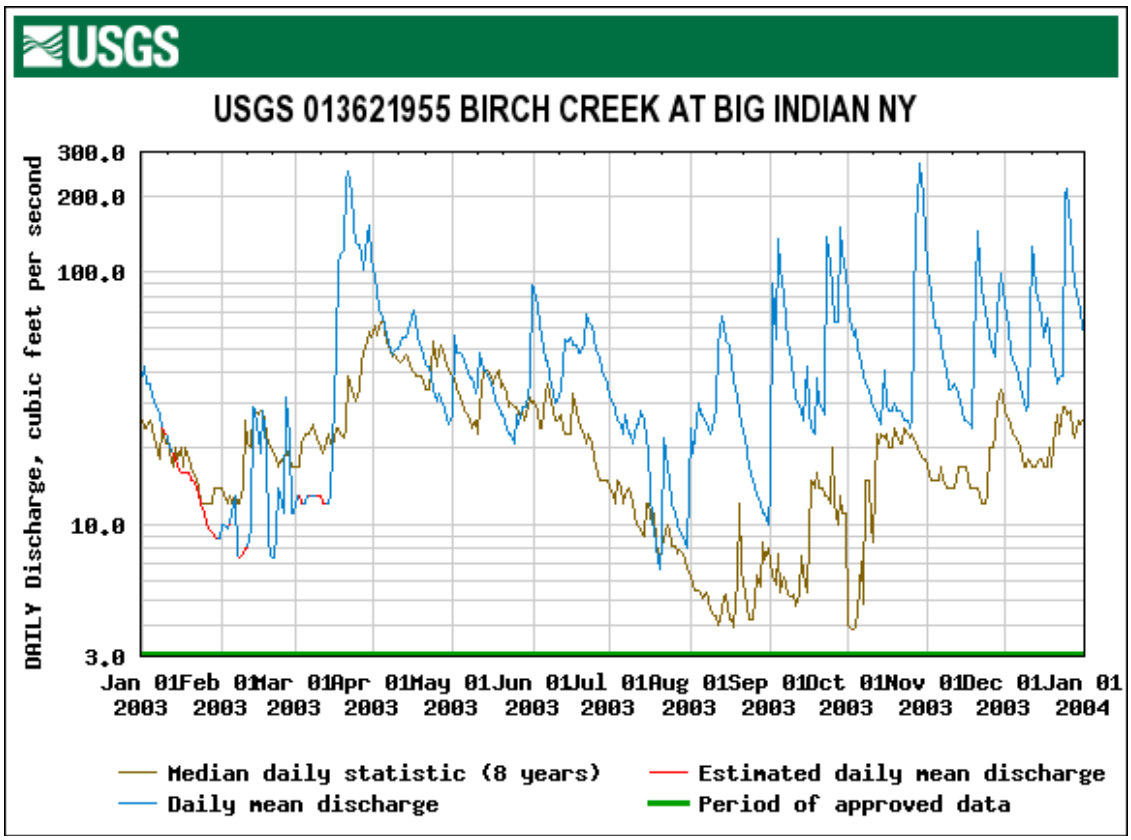
Streamflow Data

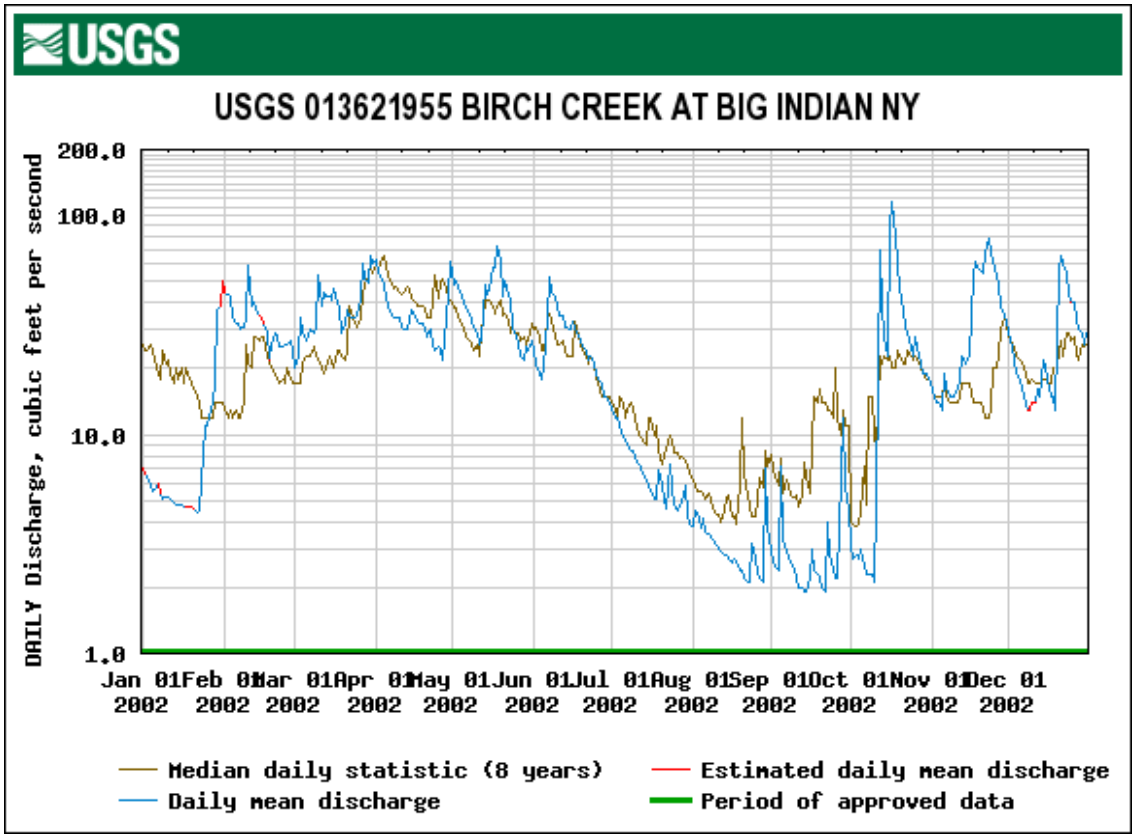
Annual Hydrological Data from Birch Creek
USGS stream gauge (#013621955)
located on Birch Creek at Big Indian
1999-2007

Annual Peak Streamflow from Birch Creek
USGS stream gauge (#013621955)
located on Birch Creek at Big Indian
1999-2006


USGS
USGS 013621955 BIRCH CREEK AT BIG INDIAN NY
DAILY Discharge, cubic feet per second
300.0
200.0
100.0
10.0
1.0
Jan 01 2001
Feb 01 2001
Mar 01 2001
Apr 01 2001
May 01 2001
Jun 01 2001
Jul 01 2001
Aug 01 2001
Sep 01 2001
Oct 01 2001
Nov 01 2001
Dec 01 2001
Median daily statistic (8 years)
Daily mean discharge
Estimated daily mean discharge
Period of approved data


USGS
USGS 013621955 BIRCH CREEK AT BIG INDIAN NY
DAILY Discharge, cubic feet per second
400.0
300.0
200.0
100.0
10.0
3.0
Jan 01 2000
Mar 01 2000
May 01 2000
Jul 01 2000
Sep 01 2000
Nov 01 2000
Jan 01 2001
Median daily statistic (8 years)
Daily mean discharge
Estimated daily mean discharge
Period of approved data


USGS
USGS 013621955 BIRCH CREEK AT BIG INDIAN NY
DAILY Discharge, cubic feet per second
300.0
200.0
100.0
10.0
3.0
Jan 01 2003
Feb 01 2003
Mar 01 2003
Apr 01 2003
May 01 2003
Jun 01 2003
Jul 01 2003
Aug 01 2003
Sep 01 2003
Oct 01 2003
Nov 01 2003
Dec 01 2003
Jan 01 2004
Median daily statistic (8 years)
Daily mean discharge
Estimated daily mean discharge
Period of approved data


USGS
USGS 013621955 BIRCH CREEK AT BIG INDIAN NY
DAILY Discharge, cubic feet per second
200.0
100.0
10.0
1.0
Jan 01 2002
Feb 01 2002
Mar 01 2002
Apr 01 2002
May 01 2002
Jun 01 2002
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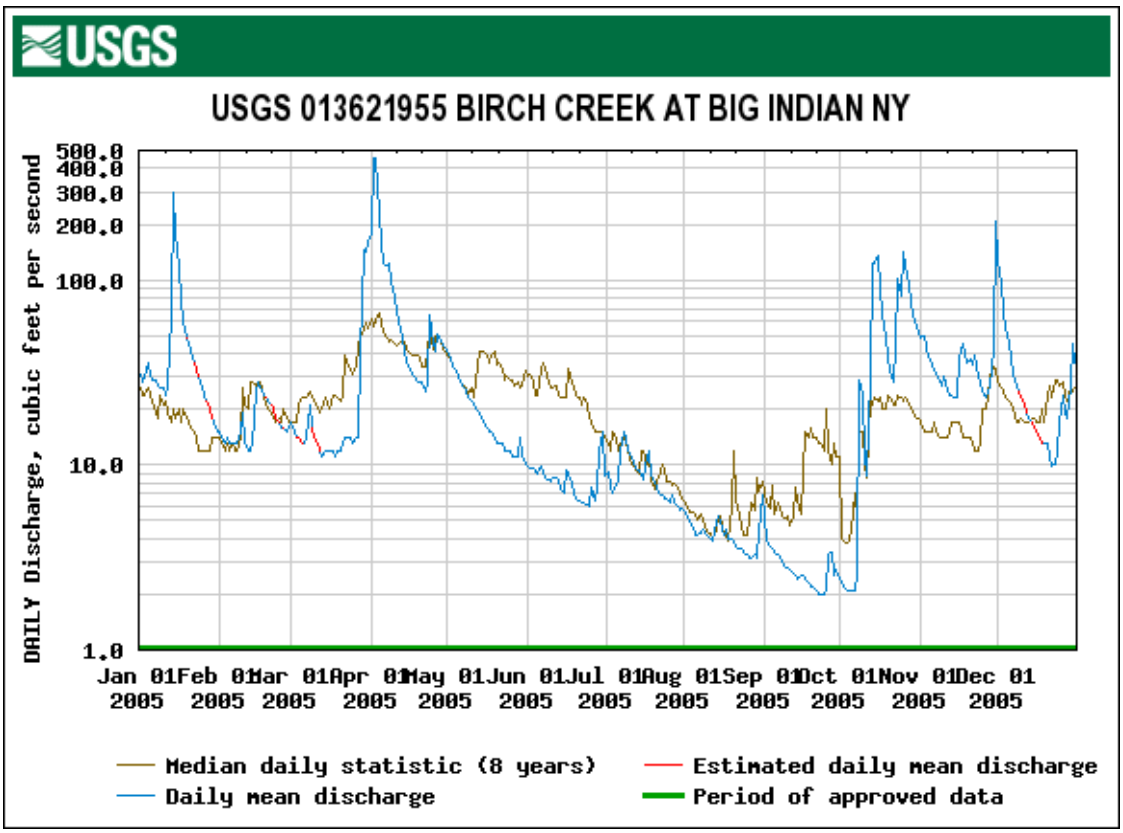
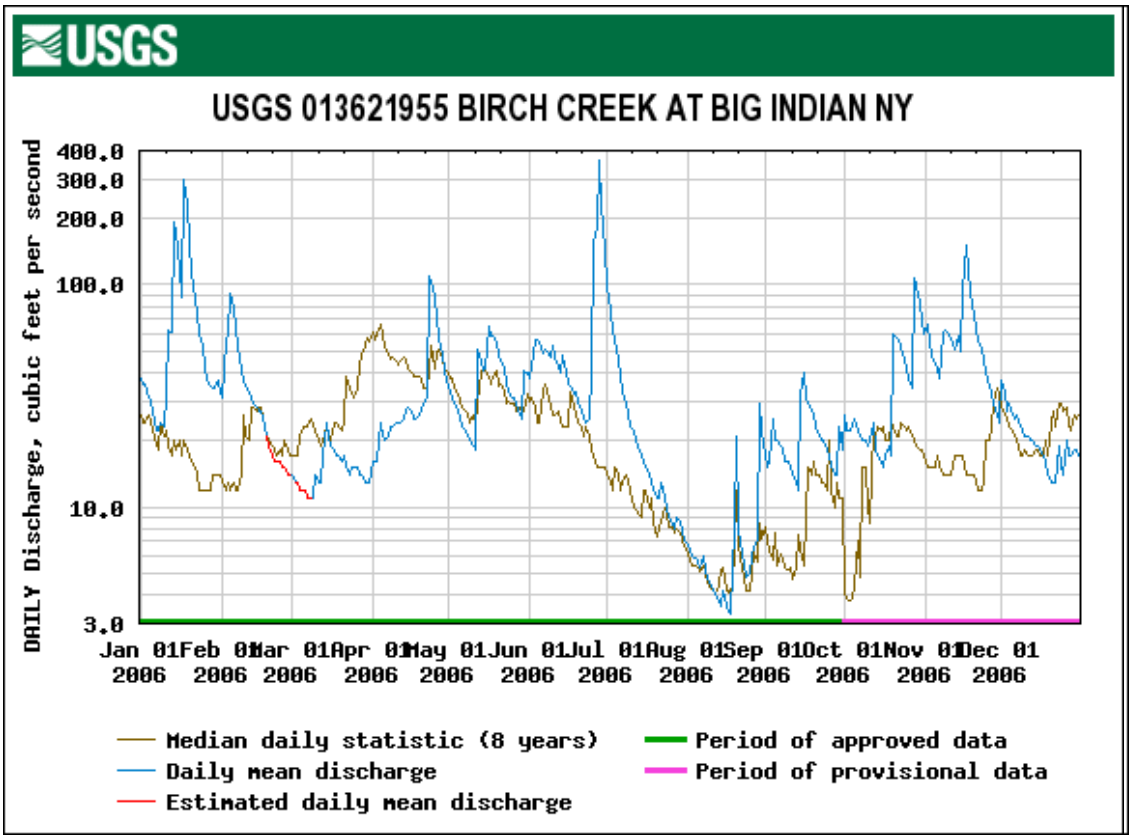
Median daily statistic (8 years)
Daily mean discharge
Estimated daily mean discharge
Period of approved data


USGS
USGS 013621955 BIRCH CREEK AT BIG INDIAN NY
DAILY Discharge, cubic feet per second
500.0
400.0
300.0
200.0
100.0
10.0
1.0
Jan 01 2005
Feb 01 2005
Mar 01 2005
Apr 01 2005
May 01 2005
Jun 01 2005
Jul 01 2005
Aug 01 2005
Sep 01 2005
Oct 01 2005
Nov 01 2005
Dec 01 2005
Median daily statistic (8 years)
Daily mean discharge
Estimated daily mean discharge
Period of approved data


USGS
USGS 013621955 BIRCH CREEK AT BIG INDIAN NY
DAILY Discharge, cubic feet per second
400.0
300.0
200.0
100.0
10.0
3.0
Jan 01 2006
Feb 01 2006
Mar 01 2006
Apr 01 2006
May 01 2006
Jun 01 2006
Jul 01 2006
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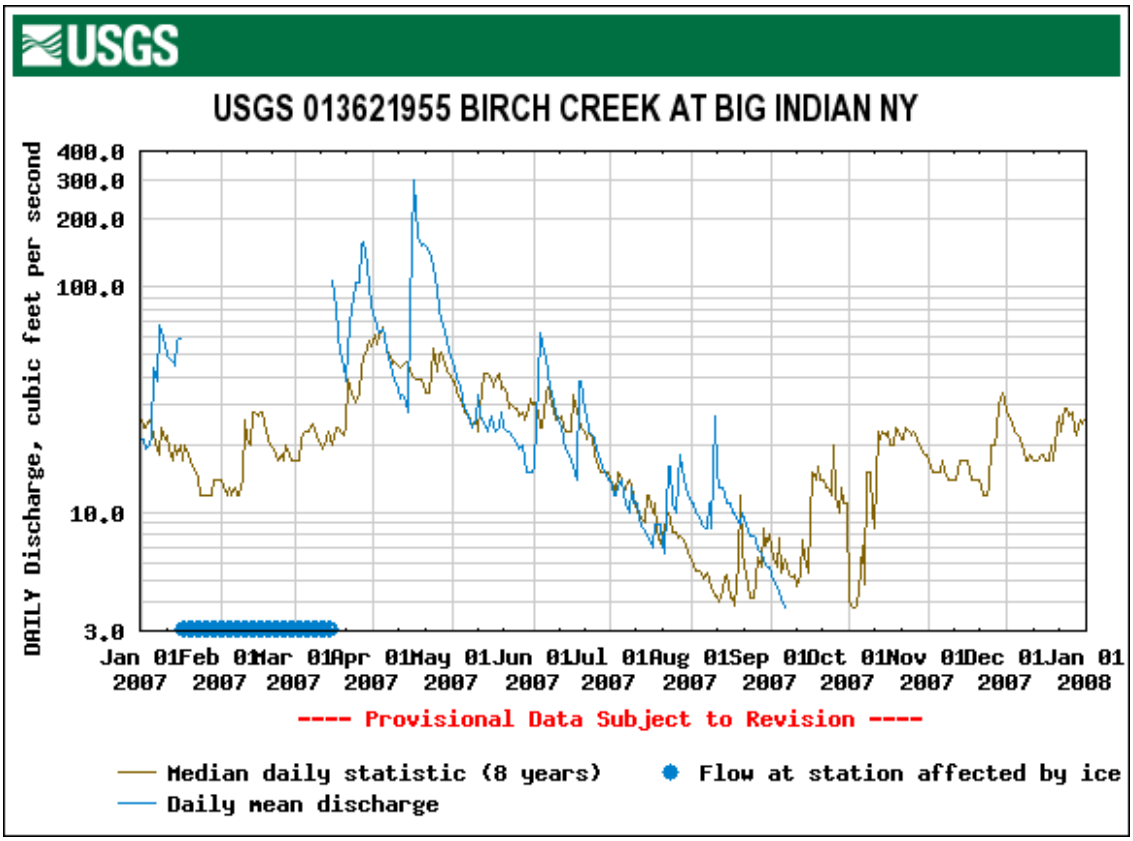
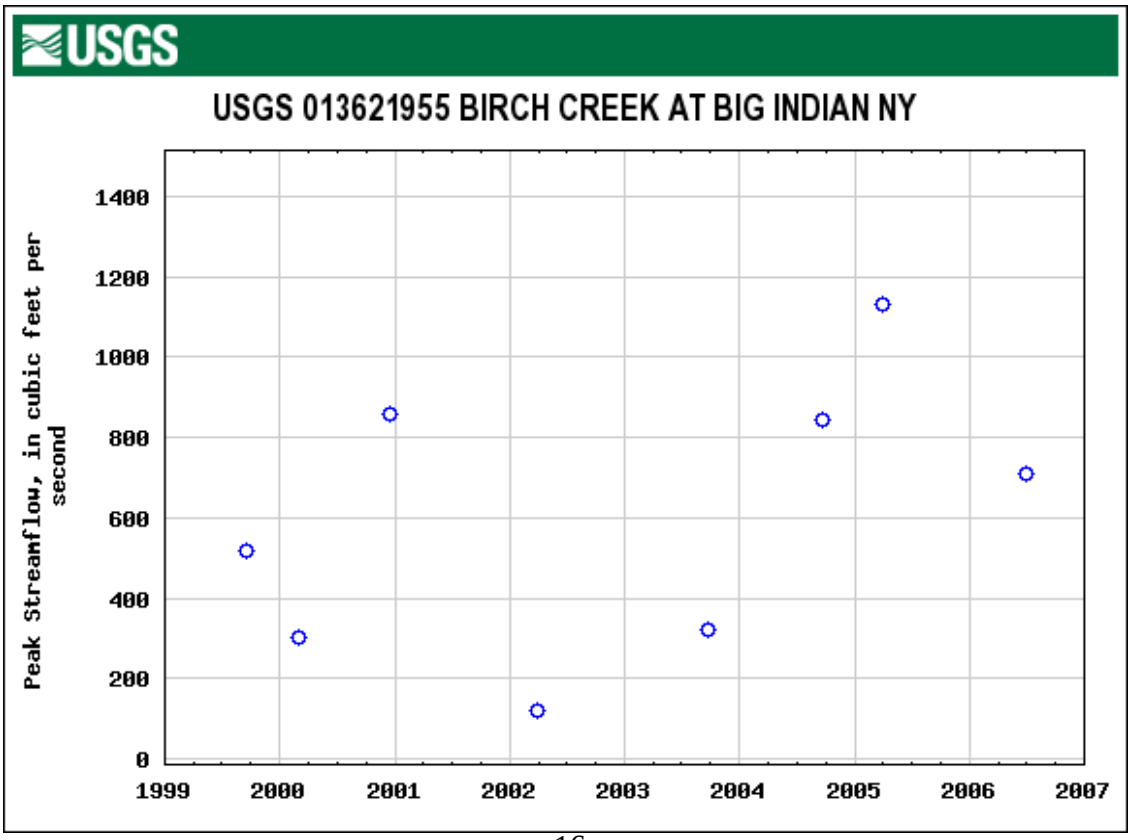
Daily mean discharge
Estimated daily mean discharge
Period of approved data
Period of provisional data


USGS
USGS 013621955 BIRCH CREEK AT BIG INDIAN NY
DAILY Discharge, cubic feet per second
400.0
300.0
200.0
100.0
10.0
3.0
Jan 01 2007
Feb 01 2007
Mar 01 2007
Apr 01 2007
May 01 2007
Jun 01 2007
Jul 01 2007
Aug 01 2007
Sep 01 2007
Oct 01 2007
Nov 01 2007
Dec 01 2007
Jan 01 2008
---- Provisional Data Subject to Revision ----
Median daily statistic (8 years)
Daily mean discharge
Flow at station affected by ice


USGS
USGS 013621955 BIRCH CREEK AT BIG INDIAN NY
Peak Streamflow, in cubic feet per second
0
200
400
600
800
1000
1200
1400
1999
2000
2001
2002
2003
2004
2005
2006
2007

Appendix B

Photographs taken of Birch Creek

All photographs were taken below Pine Hill Lake diversion Structure,
but upstream from the Belleayre Mt Beach bridge,
except where noted

July 5, 2007

(Flow was approximately 8 cfs)

Diversion Structure

Immediately below confluence with Giggle Brook