8-98

NEW YORK POWER AUTHORITY
BLENHEIM-GILBOA PROJECT - FERC L. P. No. 2685-NY
STREAM STABILIZATION PROJECT

FINAL REPORT ON THE GEOMORPHOLOGIC ASSESSMENT AND REVIEW OF SPILLWAY FLOOD EROSION REPAIR DESIGN PLANS

CLEAR CREEKS CONSULTING

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FINAL REPORT ON THE GEOMORPHOLOGIC ASSESSMENT AND REVIEW OF SPILLWAY FLOOD EROSION REPAIR DESIGN PLANS

PREPARED FOR

NEW YORK POWER AUTHORITY
WHITE PLAINS, NEW YORK

PREPARED BY

CLEAR CREEKS CONSULTING
JARRETTSVILLE, MARYLAND

AUGUST 1998

INTRODUCTION

The New York Power Authority (NYPA) owns and operates the Blenheim-Gilboa Power Project, a pumped-storage hydroelectric project located on Schoharie Creek, approximately 40 miles southwest of Albany, New York (Fig. 1). The Blenheim-Gilboa Project is licensed by the Federal Energy Regulatory Commission (FERC).

During the January, 1996 storm, flood flows deposited a large quantity of sediment and eroded the right bank of Schoharie Creek downstream of the spillway. The flood overtopped the bank and eroded a cut-off channel through the floodplain. Records indicate that Schoharie Creek has historically overtopped at this same point creating a by-pass channel and braiding pattern over the floodplain. The Soil Conservation Service attempted to block the by-pass channel and restore the banks following the 1955 flood. Remedial restoration work was also conducted by NYPA in 1980 and 1988. These stabilization efforts did not last and the banks have been by-passed by flooding in subsequent years.

FERC has directed NYPA to restore and maintain this section of Schoharie Creek to its pre-1996 flood condition. To comply with FERC's directive, NYPA developed a flood erosion repair design plan which included: reconstructing the right bank to block the by-pass channel along the lower portion of the reach; installing rip-rap protection along the new bank; removing excess gravels and cobbles from the interior of the bend (point bar); adjusting the channel invert to approximate the pre-project elevation; and performing periodic maintenance along the bend area to allow for continued passing of flows in the main channel of Schoharie Creek.

NYPA completed and submitted design drawings and construction specifications to FERC, the U.S. Army Corps of Engineers (COE) and the New York State Department of Environmental Conservation (DEC). As a coordinating agency in the federal permit process, the U.S. Fish and Wildlife Service (FWS) recommended that NYPA review fluvial geomorphologic techniques and applications to ensure that the project objectives will be met and habitat will be preserved for fish, wildlife, and invertebrates. FWS also recommended that biotechnical erosion controls be evaluated.

Therefore, New York Power Authority contracted Clear Creeks Consulting to: conduct a site inspection of the spillway channel and Schoharie Creek; review the joint COE/DEC permit application, design drawings and construction specifications; conduct a geomorphologic assessment of Schoharie Creek; and review and comment on the current NYPA design and the applicability of Rosgen methodologies to the project objectives and the preservation of habitat.

TECHNICAL REPORT

Study Area

Schoharie Creek is a tributary in the Mohawk-Hudson River drainage. Its headwaters are located in the Catskill Mountains southwest of Albany, New York. The Blenheim-Gilboa Power Project is located approximately 2.8 miles downstream of New York City's Schoharie Reservoir and includes: an on-line reservoir along Schoharie Creek (i.e.,the Lower Reservoir) and a pump-storage reservoir (i.e., the Upper Reservoir) on the mountain above the NYPA substation. The study area for the current proposal includes a reach of the creek from the spillway of the Lower Reservoir to a point 2300 feet downstream (Fig.2). The drainage area to the project reach is 358 square miles.

Assessment and Evaluation Methods

1. Verification of Bankfull Discharge and Bankfull Channel Dimensions

Utilizing the USGS streamflow gaging station on Schoharie Creek at North Blenheim, N.Y., a field survey was conducted of the reach upstream and downstream of the gage. This field exercise was critical for verifying field indicators associated with the bankfull or channel forming discharge. This information was necessary for conducting the geomorphic stream assessment. In addition, the field data and gage records were the key to developing reliable estimates of bankfull discharge and bankfull channel dimensions for comparison to the design discharge and channel dimensions. Due to the long period of record, proximity to the project (less than 1 mile downstream and no tributaries entering Schoharie Creek between the project reach and the gage), and its relatively stable condition, the gage reach provided an excellent reference for evaluating the project reach and the design proposal.

Discharge estimates were developed from the gage rating curve and checked against discharge estimates developed using field data and Manning's equation, and estimates determined from regional curves of drainage area to bankfull discharge.

2. Geomorphic Stream Assessment

Following the assessment procedures of Rosgen (1996), a geomorphic assessment was conducted to characterize the current channel morphology of Schoharie Creek and evaluate its departure from a potential stable form. Utilizing USGS quadrangle maps, recent and historic aerial photography, topographic survey information provided by NYPA, and standard field procedures outlined by Rosgen (1996), Schoharie Creek was classified by Rosgen stream type.

Schoharie Creek was also assessed for stream channel condition and influencing factors including riparian vegetation, meander pattern, depositional pattern, debris and channel blockages, sediment supply, vertical stability, streambank erosion potential, and near bank stress.

3. Review of Design Plan

Design Discharge and Channel Dimensions

The current NYPA design plans were reviewed to evaluate the proposed design discharge and channel cross-section, meander geometry, and longitudinal profile relative to the information gathered from the gage reach survey. Consideration was given to: conveyance of the bankfull flow, as well as larger, less frequent floodflows; maintenance of sediment transport capacity; long-term channel stability; and maintenance of instream habitat.

Channel Stabilization Techniques

The project reach was also evaluated relative to the applicability of standard bioengineering streambank stabilization techniques and the use of Rosgen's native materials approach. Consideration was given to: meander geometry; channel hydraulics associated with larger, less frequent floodflows; long-term channel stability; and instream and riparian habitat.

Summary of Findings and Recommendations

1. Historic and Existing Conditions

The results of the field survey and analysis of the gage data indicate that a reasonable estimate of the bankfull discharge is in the range of 6000 - 6500 cfs, with a recurrence interval of 1.4 - 1.5 years. This is consistent with the regional curve relationship of drainage area to bankfull discharge for this hydrophysiographic province. See Appendix A.

The project and gage reaches are C3 stream types (i.e., meandering, riffle-pool, cobble-bed channels, with a well-developed floodplains). The following bankfull channel dimensions were measured in the stable gage reach: channel width - 155 feet, mean depth - 5.1 feet, cross-sectional area - 790 square feet, and average water surface slope - .005. The D_{50} of the bed material is 70 mm (small cobble). See Figure 3 and accompanying data in Appendix B.

The gage reach is relatively stable (Figs. 4a and 4b). However, the project reach exhibits a number of characteristics associated with instability. The meander bend has a tight radius of curvature (482 feet), with a radius of curvature to bankfull width ratio (Rc/Wbf) of 1.8 (Fig.5). By contrast, historic aerials indicate that the same meander bend had a pre-project radius of curvature of 607 feet, with a Rc/Wbf of 3.9 (Fig. 6). The aerials also indicate that the meander apex was originally located near the center of the rock cliff. Subsequent meander rotation in a down-valley direction has shifted the apex 350 feet downstream to its current location.

The downstream end of the project reach apparently aggraded as a result of the high discharge, high sediment supply event of January, 1996. The considerable near-bank stress associated with the tight radius of the bend, a reduction in channel capacity caused by the aggradation, and the overtopping flood waters resulted in: the erosion of a wide by-pass channel in the right bank; the scouring and uprooting of what little riparian vegetation may have been growing here; and the cutting of multiple channels in the floodplain. This condition currently persists (Figs.7 -10). The bar on the inside of the meander bend is continuing to build. Overtopping of the right bank reportedly occurs more frequently, with flows less than or equal to bankfull barely conveyed by

the main channel. The floodplain on the inside of the meander bend has been isolated from the channel by a berm. It appears that only larger flow events have access to this floodplain area. This places additional stress on the outside of the bend.

There are a few existing features which are contributing to stability in the meander bend. The rock cliff deflects flows downward into an adjacent pool and outward toward a large, man-made boulder dike located along the outside of the meander bend (Fig. 11). This boulder dike is functioning like a rock vane. That is, a flow diverting structure that slows and rolls the flow away from the banks. The pool adjacent to boulder dike is also dissipating energy by forcing water into water during high flow events.

Upstream of the meander bend, the spillway channel appears to have adjusted to bankfull flows as reflected by its cross-sectional geometry and longitudinal profile. The banks are raw and lacking vegetation (Figs. 12 and 13). The deep pool at the upstream end of the spillway channel, as well as the velocity dissipater blocks in the pool are functioning to reduce the energy associated with the higher flows.

2. Review of Design Plans

Design Discharge and Channel Dimensions

The first important issues relative to the design are the design discharge and channel dimensions. The proposed design discharge of 6500 cfs is consistent with that determined from the gage analysis and Manning's/field data estimates. The regional curve predicted a significantly higher flow (9000 cfs). However, this is probably not a reliable estimate for this reach given that the effect of the two reservoirs upstream of the project and the gage would be attenuation of the more frequent flows.

I understand that the proposed design does not call for significant modifications to the meander geometry. Due to the tight meander radius the lower third of this bend will continue to be a weak point. Consequently, developing the appropriate cross-sectional geometry (size and shape) and longitudinal profile (riffle-pool slopes and depths) is critical.

The review of the proposed dimensions for the reconstructed channel shown in the plans indicate they are appropriate and generally consistent with the natural variability one would expect to find moving through a meander bend into a crossover reach. The pool along the apex of the meander is wider (approximately 1.5 x) than the riffle in the cross over reach. The channel narrows in the reconstructed portion of the riffle transitioning into the existing channel width, which very closely approximates the channel width in the stable gage reach. Assuming a bankfull elevation of 810 feet, the mean depth of the reconstructed riffle is consistent with the depth of the gage reach. This provides a bankfull cross-sectional area similar to the gage reach.

Aside from the proper dimensions, channel shape is also critical for distributing the flow velocity across the channel to maintain sediment transport capacity, yet dissipating energy to reduce near-bank stress. The thalweg should be along the outside of the meander in the pool and generally in the center of the channel through the riffle in the crossover reach. The point bar should not be completely removed. It should not be graded too steep either. Generally a slope of 7-10% for the apex of the point bar is preferred. The existing pool in the meander apex (adjacent to the boulder dike) should be enlarged. That is, it should be excavated deeper and extended upstream and downstream as shown in Figure 14.

Reconstructing the lower third of the outside of the meander bend is appropriate. However, the new bank should tie-in immediately downstream of the boulder dike (Figs.14 and 15), not overlap it. Overlapping will diminish the "rock vane effect" (slowing and rolling the flow away from the bank). In addition, the elevation of the top of the new bank should be raised to at least 812 feet. This will prevent more frequent flows from overtopping the bank and initiating a headcut from the floodplain side into the project. This will buy time allowing vegetation to reestablish, thereby adding to the stability of this area.

Finally, the floodplain on the inside of the meander bend should be reconnected allowing more frequent flows (any flow greater than bankfull) access to this area. This will help alleviate stress on the outside of the bend and can be accomplished by removing the berm and grading this area to a lower elevation.

The plan indicates that the dimensions of the spillway channel will remain the same. This is appropriate since it appears to have adjusted to the bankfull flows and has a flood prone area toward the right overbank. Instream habitat in this area could be enhanced by adding structure for velocity cover (e.g., random boulder placement, and boulder clusters). See Figure 16 for recommended locations of habitat enhancement features.

Channel Stabilization Techniques

Due to the tight meander radius and high near-bank stress, traditional bioengineering techniques (e.g., brush bundles, branch layering, soil fabric lifts, etc.) would not be effective. Although these techniques can be extremely effective when used for the types of situations for which they were developed, they are not designed to withstand the velocities and shear anticipated in this area. Less traditional approaches (e.g., rootwads) may not be feasible. They probably would do well for flows near and even slightly above bankfull. However, under the conditions anticipated during larger, less frequent flow events, they could be scoured during overtopping, dislodge and fail.

Hard techniques are more appropriate here. The use of large boulders with flowing diverting structures (e.g., rock vanes, cross vanes) to reduce near-bank stress is more likely to provide long-term stability. The boulders should be sized to withstand the larger, less frequent flow events. Figure 14 shows the recommended location for a proposed cross vane. This structure will provide grade control, preventing the riffle from headcutting into the pool, and it will function to roll the flows coming out of the meander bend away from the bank and into the center of the riffle. The construction of a scour pool immediately downstream of the cross vane is critical to its proper function. Figures 17,18, and 19 illustrate typical details for the cross vane in cross-section, planview, and profile, respectively.

The proposed rip-rap in the spillway channel is not extensive and does not alter the existing cross-sectional channel dimensions. However, since concern has been expressed about this area, the design could be modified to soften its look and improve habitat. This could be accomplished by backfilling the rip-rap with soil and planting grasses. Trees and shrubs could be planted at the top of the slope to provide long-term stabilization.

Figure 4a. North Blenheim Gage Reach
View upstream of cross-section.

Figure 4b. North Blenheim Gage Reach
View downstream of cross-section.

Figure 5. Aerial view of meander bend in project reach - 1996.

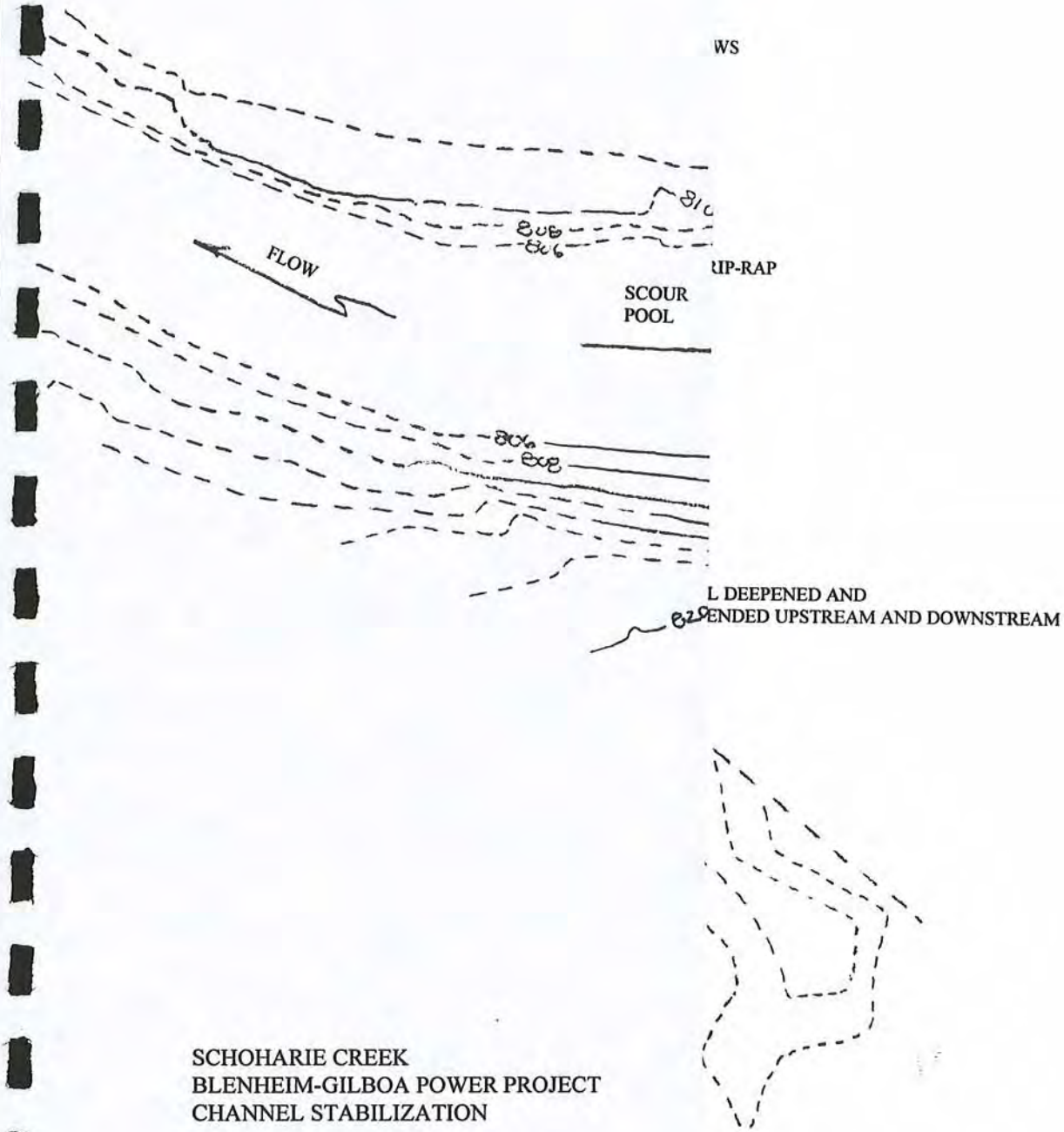
Figure 6. Aerial view of meander bend in project reach - 1969.

Figure 7. View of bar on inside of meander in project reach.

Figure 8. View of cutoff channel on outside of meander bend in project reach.

Figure 9. Cutoff channel in floodplain adjacent to Eastside Road.

Figure 10. Cutoff channel in floodplain adjacent to Eastside Road.



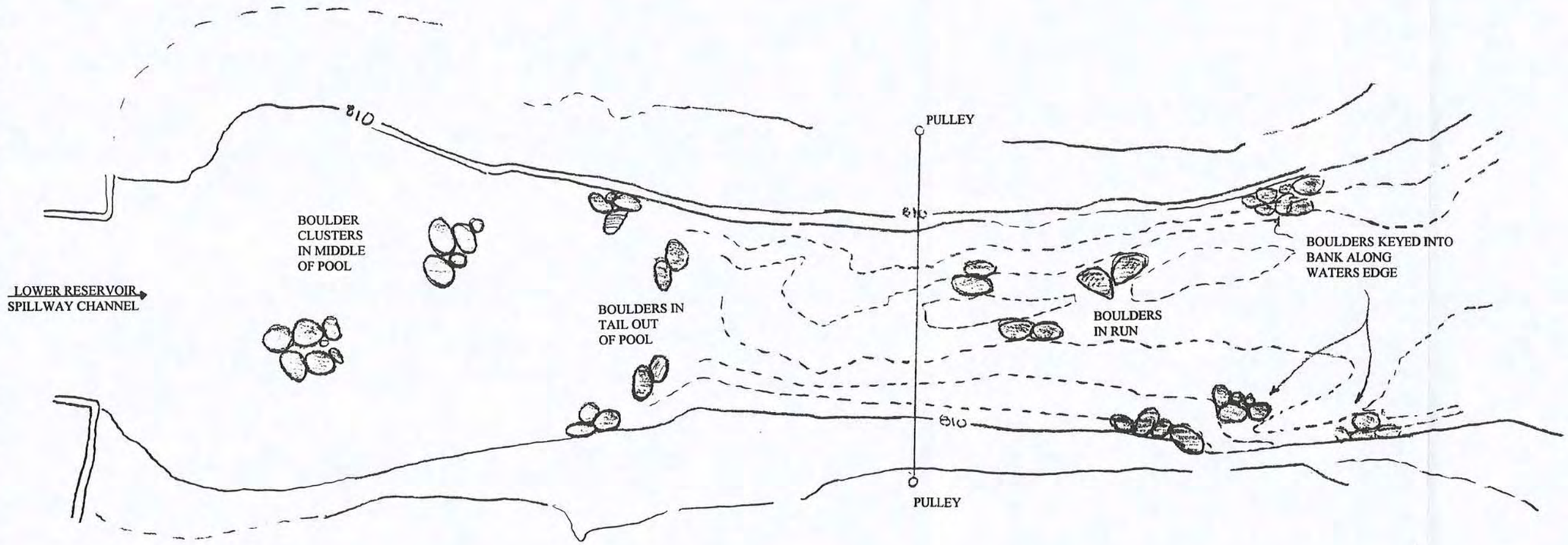
SCHOHARIE CREEK
BLENHEIM-GILBOA POWER PROJECT
CHANNEL STABILIZATION

RECOMMENDED MODIFICATIONS
TO LOWER 1/3 OF PROJECT REACH

SCALE 1" = 100'

PREPARED BY ROCKY POWELL
AUGUST 20, 1998

Figure 14. Plan view of recommended modifications to lower third of pr

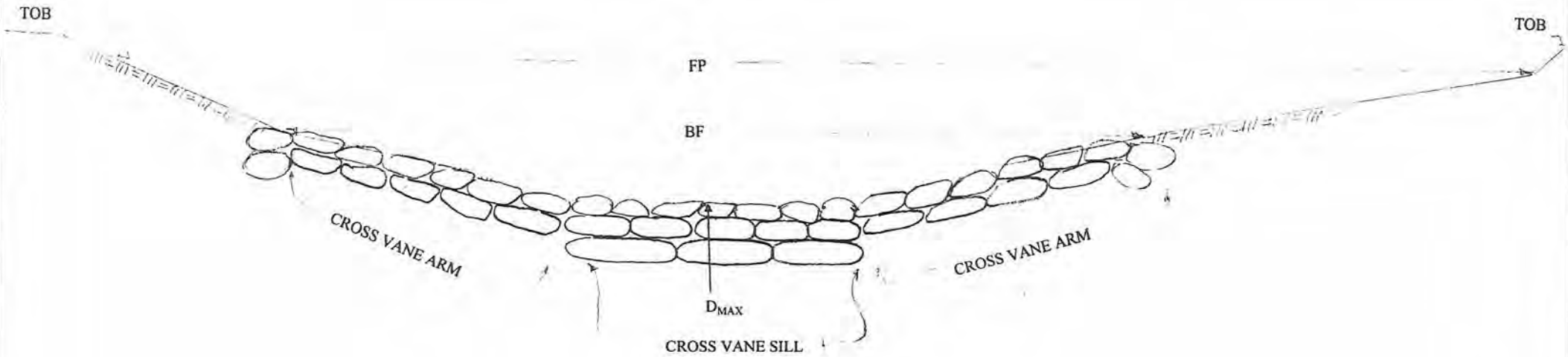


BLENHEIM-GILBOA POWER PROJECT
CHANNEL STABILIZATION

RECOMMENDED HABITAT ENHANCEMENT
FEATURES FOR UPPER 1/3 OF PROJECT REACH

SCALE 1" = 100'

PREPARED BY ROCKY POWELL
AUGUST 20, 1998



SCHOHARIE CREEK
CROSS VANE TYPICAL
CROSS SECTION

NO SCALE

PREPARED BY ROCKY POWELL
AUGUST 20, 1998

gure 17 Cross-vane typical details - cross-section.

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Z01350180                          USGS
H01350180        422757074274500363609 5SW02020005    358              800
N01350180                  SCHOHARIE CREEK AT NORTH BLENHEIM NY
Y01350180
301350180        19710513   5270 6              6.75 36
301350180        19720623  41400 6             12.29
301350180        19730630  15400 6             10.77
301350180        19731221  32400 6             13.34
301350180        19741208  21600 6             11.96
301350180        19760217   6730 6              9.00
301350180        19770314  17100 6             11.47
301350180        19771108  35300 6             13.75
301350180        19790325  16700 6             11.37
301350180        19800321  42900 6             14.72 5
301350180        19810221   7350 6              8.98
301350180        19820606   9810 6             10.07
301350180        19830425  12200 6             11.00
301350180        19840405  29200 6             13.34 25      0405    13.34 5
301350180        19850312    482 6              3.20 2       0224     2.72 1
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301350180        19920503   2330 6              5.65
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301350180        19960119  75600 6             17.61
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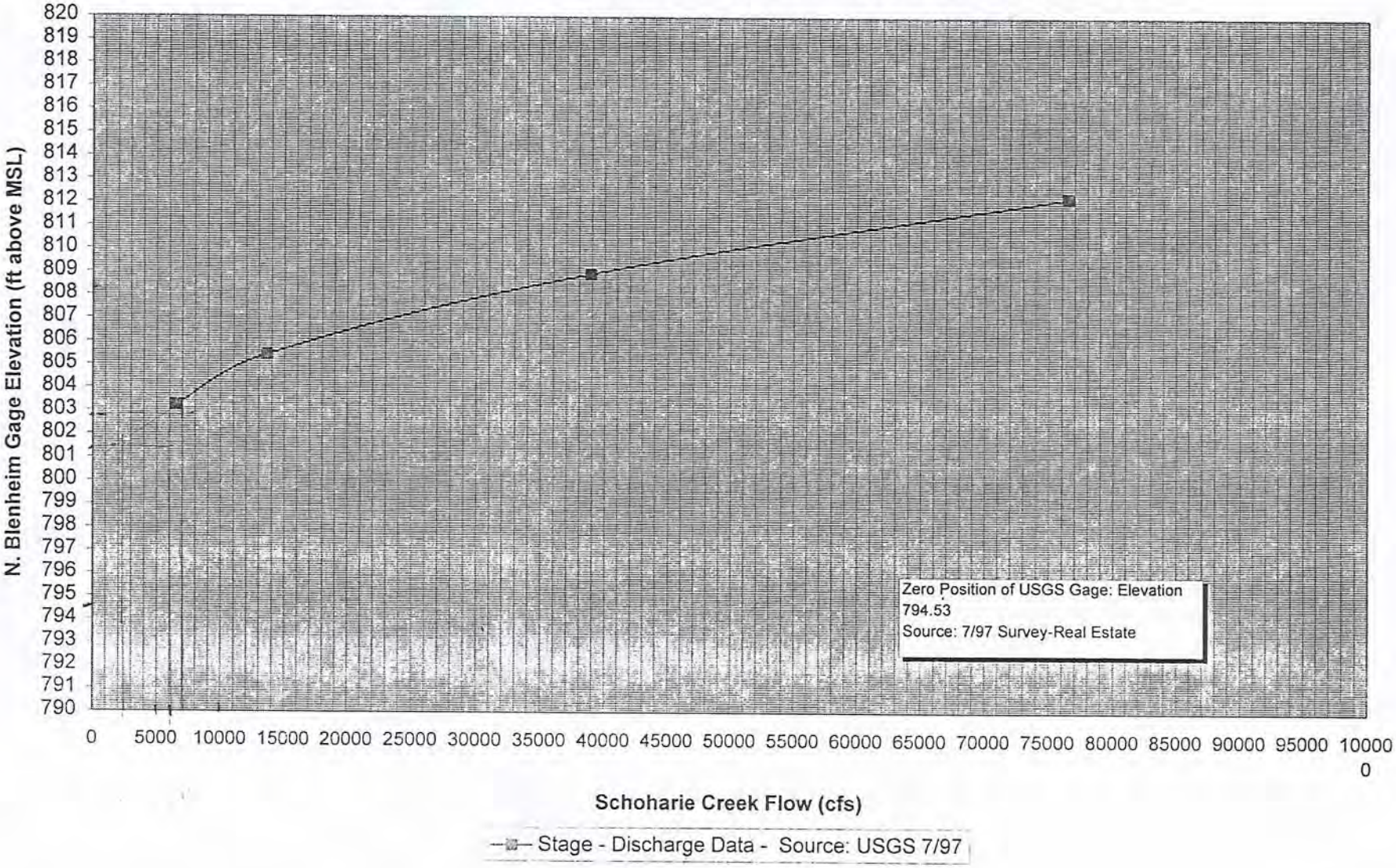
Blenheim-Gilboa Pumped-Storage Power Project - FERC L.P. No. 2685-NY
North Blenheim USGS Gaging Station - Stage - Discharge Curve - Schoharie Creek



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BASED ON _____ DISCHARGE MEASUREMENTS, NOS _____, AND _____, AND IS _____ WELL DEFINED BETWEEN _____ AND _____ CFS
COMP BY _____ DATE _____ CHK. BY _____ DATE _____
AT AND ABOVE 4.1FT RAT NOS 16 & 17 ARE IDENTICAL

currently in use, 8/98.

GAGE HEIGHT (FEET)	DISCHARGE IN CUBIC FEET PER SECOND (EXPANDED PRECISION) .00	.01	.02	.03	.04	.05	.06	.07	.08	.09	DIFF IN Q PER TENTH FT
.80	2.570*	2.753	2.993	3.142	3.350	3.565	3.790	4.023	4.266	4.518	2.208
.90	4.778	5.049	5.329	5.619	5.918	6.228	6.548	6.878	7.219	7.570	3.154
1.00	7.932	8.305	8.689	9.084	9.490	9.908	10.34	10.78	11.23	11.70	4.238
1.10	12.17	12.66	13.17	13.68	14.21	14.75	15.30	15.87	16.45	17.04	5.480
1.20	17.65	18.27	18.90	19.55	20.21	20.88	21.57	22.28	23.00	23.73	6.830
1.30	24.48	25.24	26.02	26.82	27.62	28.45	29.29	30.15	31.02	31.90	8.330
1.40	32.81	33.73	34.67	35.62	36.59	37.57	38.58	39.60	40.63	41.69	9.950
1.50	42.76	43.85	44.96	46.08	47.22	48.38	49.56	50.76	51.97	53.21	11.70
1.60	54.46	55.73	57.02	58.33	59.66	61.00	62.37	63.75	65.16	66.58	13.57
1.70	68.03	69.49	70.98	72.48	74.01	75.55	77.12	78.70	80.31	81.94	15.56
1.80	83.59	85.26	86.95*	88.57	90.21	91.87	93.54	95.24	96.95	98.68	16.81
1.90	100.4	102.2	104.0	105.8	107.6	109.5	111.4	113.2	115.1	117.1	18.60
2.00	119.0	121.0	123.0	125.0	127.0	129.1	131.1	133.2	135.3	137.5	20.60
2.10	139.6	141.8	144.0	146.2	148.4	150.7	152.9	155.2	157.6	159.9	22.70
2.20	162.3	164.6	167.0	169.5	171.9	174.4	176.9	179.4	181.9	184.5	24.80
2.30	187.1	189.7	193.3	194.9	197.6	200.3	203.0	205.7	208.5	211.3	27.00
2.40	214.1	216.9	219.8	222.6	225.5	228.4	231.4	234.4	237.3	240.4	29.30
2.50	243.4	246.5	249.5	252.6	255.8	258.9	262.1	265.3	268.6	271.8	31.70
2.60	275.1	278.4	281.7	285.1	288.4	291.8	295.3	298.7	302.2	305.7	34.10
2.70	309.2	312.8	316.3	319.9	323.6	327.2	330.9	334.6	338.3	342.1	36.60
2.80	345.8	349.6	353.5	357.3	361.2	365.1	369.0	373.0	377.0	381.0	39.20
2.90	385.0	389.1	393.2	397.3	401.5	405.6	409.8	414.1	418.3	422.6	41.90
3.00	426.9	431.2	435.6	440.0	444.4	448.8	453.3	457.8	462.3	466.9	44.60
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3.40	622.0	627.5	633.0	638.5	644.1	649.7	655.3	660.9	666.6	672.3	56.10
3.50	678.1	683.8	689.6	695.5	701.3	707.2	713.1	719.1	725.1	731.1	59.00
3.60	737.1	743.2	749.3	755.5	761.6	767.8	774.1	780.3	786.6	792.9	62.20
3.70	799.3	805.7	812.1	818.6	825.0	831.6	838.1	844.7	851.3	857.9	65.30
3.80	864.6	871.3	878.0	884.8	891.6	898.5	905.3	912.2	919.2	926.1	68.50
3.90	933.1	940.1	947.2	954.3	961.4	968.6	975.8	983.0	990.3	997.6	71.90
4.00	1005	1012	1020	1027	1035	1042	1050	1057	1065	1072	75.00
4.30	1080*	1088	1096	1105	1113	1121	1130	1138	1147	1155	84.00
4.20	1164*	1171	1177	1184	1191	1197	1204	1211	1217	1224	67.00
4.30	1231	1238	1245	1251	1258	1265	1272	1279	1286	1293	69.00
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AT AND ABOVE 4.1FT RAT NOS 16 & 17 ARE IDENTICAL

GAGE HEIGHT — DISCHARGE IN CUBIC FEET PER SECOND (EXPANDED PRECISION) — DIFF IN Q PER

(FEET)	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	TENTH FT
4.50	1371	1378	1385	1392	1400	1407	1414	1422	1429	1436	73.00
4.60	1444	1451	1458	1466	1473	1481	1488	1496	1503	1511	75.00
4.70	1519	1526	1534	1541	1549	1557	1564	1572	1580	1588	76.00
4.80	1595	1603	1611	1619	1627	1635	1643	1650	1658	1666	79.00
4.90	1674	1682	1690	1698	1707	1715	1723	1731	1739	1747	81.00
5.00	1755	1764	1772	1780	1788	1797	1805	1813	1822	1830	83.00
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5.50	3191	2200	2209	2218	2228	2237	2246	2256	2265	2274	93.00
5.60	2284	2293	2303	2312	2322	2331	2341	2350	2360	2369	95.00
5.70	2379	2389	2398	2408	2418	2427	2437	2447	2457	2466	97.00
5.80	2476	2486	2496	2506	2516	2526	2536	2546	2556	2566	100.0
5.90	2576	2586	2596	2606	2616	2626	2636	2646	2657	2667	101.0
6.00	2677	2687	2698	2708	2718	2728	2739	2749	2760	2770	104.0
6.10	2781	2791	2801	2812	2822	2833	2844	2854	2865	2875	105.0
6.20	2886	2897	2907	2918	2929	2940	2950	2961	2972	2983	108.0
6.30	2994	3005	3016	3026	3037	3048	3059	3070	3081	3092	110.0
6.40	3104	3115	3126	3137	3148	3159	3170	3182	3193	3204	111.0
6.50	3215	3227	3238	3249	3261	3272	3283	3295	3306	3318	114.0
6.60	3329	3341	3352	3364	3375	3387	3399	3410	3422	3434	116.0
6.70	3445	3457	3469	3481	3492	3504	3516	3528	3540	3552	119.0
6.80	3564	3575	3587	3599	3611	3623	3635	3648	3660	3672	120.0
6.90	3684	3696	3708	3720	3733	3745	3757	3769	3782	3794	122.0
7.00	3806	3819	3831	3843	3856	3868	3881	3893	3906	3918	125.0
7.10	3931	3943	3956	3968	3981	3994	4006	4019	4032	4045	126.0
7.20	4057	4070	4083	4096	4109	4121	4134	4147	4160	4173	129.0
7.30	4186	4199	4212	4225	4238	4251	4264	4277	4291	4304	131.0
7.40	4317	4330	4343	4357	4370	4383	4397	4410	4423	4437	133.0
7.50	4450*	4464	4478	4492	4506	4520	4534	4549	4563	4577	141.0
7.60	4591	4605	4620	4634	4648	4663	4677	4691	4706	4720	144.0
7.70	4735	4749	4764	4778	4793	4807	4822	4837	4851	4866	146.0
7.80	4881	4895	4910	4925	4940	4955	4969	4984	4999	5014	148.0
7.90	5029	5044	5059	5074	5089	5104	5119	5134	5150	5165	151.0
8.00	5180*	5197	5214	5231	5247	5264	5281	5298	5315	5332	169.0
8.10	5349	5367	5384	5401	5418	5435	5453	5470	5487	5505	173.0
8.20	5522	5540	5557	5575	5592	5610	5627	5645	5663	5680	176.0

1 UNITED STATES DEPARTMENT OF INTERIOR - GEOLOGICAL SURVEY - WATER RESOURCES DIVISION PAGE 3

EXPANDED RATING TABLE

01350180 DATE PROCESSED: 08-24-199: TYPE: LOG

SCHOHARIE CREEK AT NORTH BLENHEIM NY

OFFSET: .40 BREAK.OFFSET: (4.10,.45) (13.50,7.50) DD: 3 TYPE: 001 RATING NO: 17.0

START DATE/TIME: 11-23-91 (0122)

AT AND ABOVE 4.1FT RAT NOS 16 & 17 ARE IDENTICAL

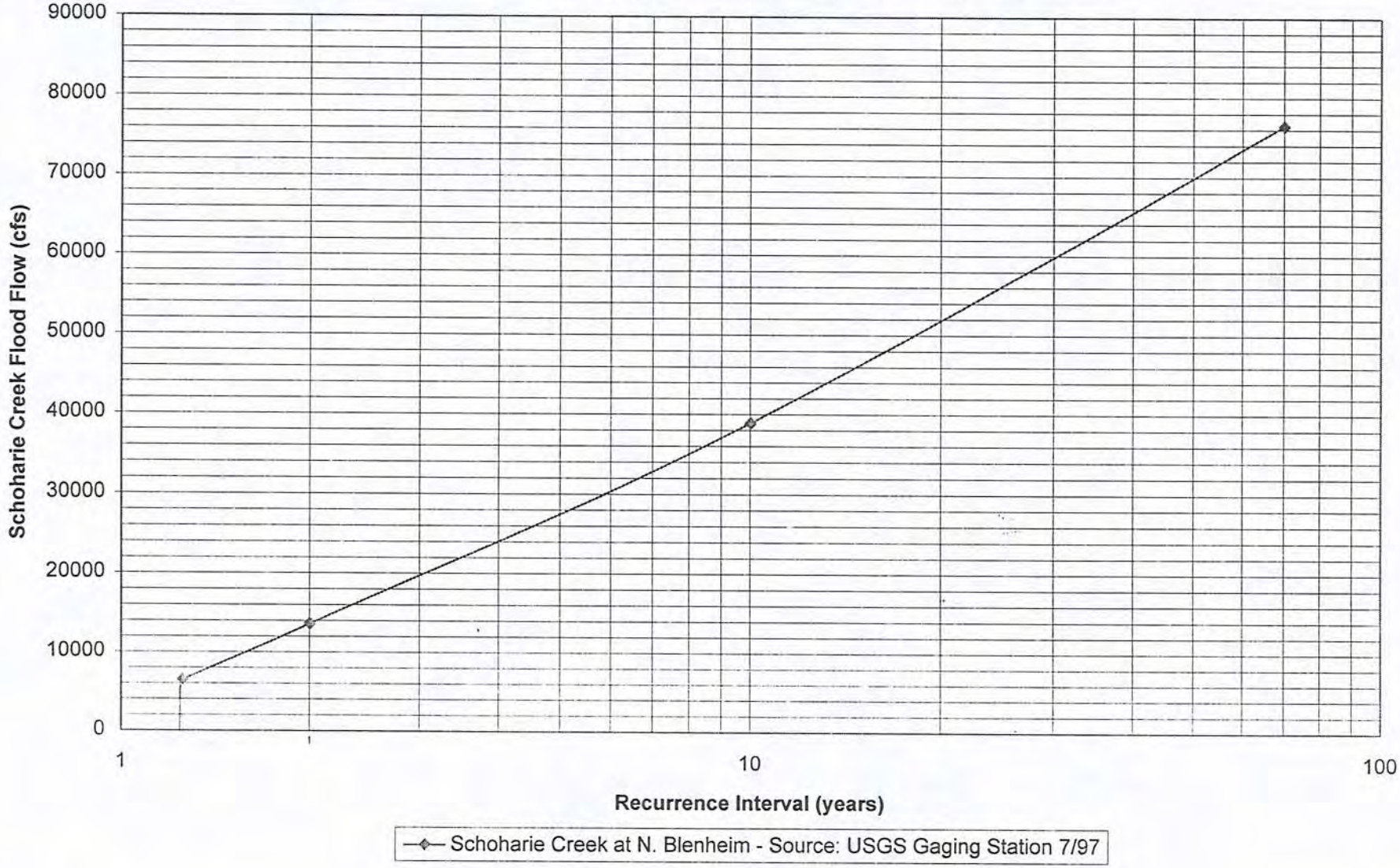
GAGE HEIGHT (FEET)	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	DIFF IN Q PER TENTH FT
	DISCHARGE IN CUBIC FEET PER SECOND (EXPANDED PRECISION)										
8.30	5698	5716	5734	5752	5770	5787	5805	5823	5841	5859	179.0
8.40	5877	5896	5914	5932	5950	5968	5987	6005	6023	6042	183.0
8.50	6060*	6081	6101	6122	6142	6163	6184	6204	6225	6246	207.0
8.60	6267	6288	6309	6330	6351	6372	6393	6415	6436	6457	212.0
8.70	6479	6500	6521	6543	6564	6586	6608	6629	6651	6673	216.0
8.80	6695	6716	6738	6760	6782	6804	6826	6848	6871	6893	220.0
8.90	6915	6937	6960	6982	7004	7027	7049	7072	7095	7117	225.0

13.70	32390	32480	32570	32660	32750	32850	32940	33030	33120	33210	910.0
13.80	33300	33390	33490	33580	33670	33760	33850	33950	34040	34130	920.0
13.90	34220	34320	34410	34500	34600	34690	34780	34880	34970	35060	940.0
14.00	35160	35250	35350	35440	35530	35630	35720	35820	35910	36010	940.0
14.10	36100	36200	36290	36390	36480	36580	36670	36770	36860	36960	950.0
14.20	37050	37150	37250	37340	37440	37540	37630	37730	37830	37920	970.0
14.30	38020	38120	38210	38310	38410	38510	38600	38700	38800	38900	970.0
14.40	38990	39090	39190	39290	39390	39490	39580	39680	39780	39880	990.0
14.50	39980	40080	40180	40280	40380	40480	40580	40680	40780	40880	1000
14.60	40980	41080	41180	41280	41380	41480	41580	41680	41780	41880	1000
14.70	41980	42080	42180	42290	42390	42490	42590	42690	42790	42900	1020
14.80	43000	43100	43200	43300	43410	43510	43610	43720	43820	43920	1020
14.90	44020	44130	44230	44330	44440	44540	44650	44750	44850	44960	1040
15.00	45060	45170	45270	45370	45480	45580	45690	45790	45900	46000	1050
15.10	46110	46210	46320	46430	46530	46640	46740	46850	46950	47060	1060
15.20	47170	47270	47380	47490	47590	47700	47810	47910	48020	48130	1060
15.30	48230	48340	48450	48560	48660	48770	48880	48990	49090	49200	1080
15.40	49310	49420	49530	49640	49750	49850	49960	50070	50180	50290	1090
15.50	50400	50510	50620	50730	50840	50950	51060	51170	51280	51390	1100
15.60	51500	51610	51720	51830	51940	52050	52160	52270	52380	52490	1100
15.70	52600	52720	52830	52940	53050	53160	53270	53390	53500	53610	1120

01350180
SCHOHARIE CREEK AT NORTH BLENHEIM NY DD: 3 TYPE: 001 RATING NO: 17.0
OFFSET: .40 BREAK,OFFSET: (4.10,.45) (13.50,7.50) START DATE/TIME: 11-23-91 (0122)
AT AND ABOVE 4.1FT RAT NOS 16 & 17 ARE IDENTICAL

GAGE HEIGHT (FEET)	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	DIFF IN Q PER TENTH FT
	DISCHARGE IN CUBIC FEET PER SECOND (EXPANDED PRECISION)										
15.80	53720	53830	53950	54060	54170	54280	54400	54510	54620	54740	1130
15.90	54850	54960	55080	55190	55300	55420	55530	55640	55760	55870	1140
16.00	55990	56100	56220	56330	56440	56560	56670	56790	56900	57020	1140
16.10	57130	57250	57370	57480	57600	57710	57830	57940	58060	58180	1160
16.20	58290	58410	58520	58640	58760	58870	58990	59110	59220	59340	1170
16.30	59460	59580	59690	59810	59930	60050	60160	60280	60400	60520	1180
16.40	60640	60750	60870	60990	61110	61230	61350	61470	61580	61700	1180
16.50	61820	61940	62060	62180	62300	62420	62540	62660	62780	62900	1200
16.60	63020	63140	63260	63380	63500	63620	63740	63860	63980	64100	1200
16.70	64220	64350	64470	64590	64710	64830	64950	65070	65200	65320	1220
16.80	65440	65560	65680	65810	65930	66050	66170	66300	66420	66540	1230
16.90	66670	66790	66910	67030	67160	67280	67400	67530	67650	67780	1230*
17.00	67900*										

Blenheim-Gilboa Pumped-Storage Power Project - FERC L.P. No. 2685-NY
North Blenheim USGS Gaging Station - Flood Flow Frequency Curve



[redacted] Wa[redacted]ed: [redacted] [redacted]

Drainage Area: N. [illegible]

Date: 8/15/98

[redacted] [redacted]art) [redacted]

XSection Location:

Reach (end):

[redacted]eam [redacted]

K. Knowlton

CHANNEL DIMENSIONS at BANKFULL STAGE		
Bankfull Width	103.5	Ft.(W)
Bankfull Cross-Sectional Area	79.2	Sq.Ft.(A)
Bankfull Mean Depth	0.1'	Ft.(A/W=D)
Bankfull Max. Depth	9.79'	
2 x Bankfull Max. Depth		Ft./Ft.(W/D=WDR)
Floodprone Width	347' +	Ft.(2MD)
Floodprone Area Width		
Entrenchment Ratio	[illegible]	
Bankfull Velocity	7.59 fps	
Estimated Bankfull Discharge	[illegible]	
Wetted Perimeter (WP)	[illegible]	
Hydraulic Radius (A/WP=R)	4.85	

LONGITUDINAL PROFILES		
Length of Reach Surveyed		Ft.(L)
Length for Water Surface		Ft.(Lws)
Length for Thalweg		Ft.(Lfw)
Length of Bankfull		
Elevation Diff.-Water Surface		Ft.(ED)
Elevation Diff.-Thalweg		Ft.(ed)
Elevation Diff.-Bankfull		Ft.(edb)
Overall Water Surface Slope		Ft./Ft.(ED/Lws=S)
		%(S x 100=%)
Overall Thalweg Slope		Ft./Ft/(ed/Ltw=s)
		%(s x 100=%)
Overall Bankfull Slope		Ft./Ft.(edh/LBF=s)
		%(S x 100=%)
Ave. Riffle Slope		%
Ave. Pool Slope		%
Facet Slope @ xsec.		%

U.S. El 5.86

295'
108' (403)

D.S. El. 8.0

2.14
403

MEANDER GEOMETRY		
Sinuosity (SL/VL) (VS/CS)		Ft.
Sinuosity (meander ratio)	1.44	Ft./Ft. (ratio)
Meander Length		Ft.
Meander Length Ratio		Ft./Ft. (LM/Wbkf)
Radius of Curvature	1.8	Ft.
Radius of Curvature Ratio		Ft./Ft. (RC/Wbkf)
Belt Width		Ft.
Belt Width Ratio		Ft./Ft. (BW/Wbkf)
Meander Arc Length		Ft.
Riffle to Riffle spacing		Ft.
Ave. Riffle Depth (@bkf)		Ft.
Ratio: Riffle spacing /W		
Pool to Pool spacing		Ft.
Ave. Pool depth (@bkf)		Ft.
Ratio Pool spacing /W		

CHANNEL MATERIALS		
% Sand	D95	mm
% Gravel	D80	mm
% Cobble	D50	mm
% Boulder	D35	mm
% Bedrock	D15	mm

D84 on riffle

RC = [illegible]²/[illegible] + [illegible]/2

Rc Rc/Wbkf

Pool [illegible] (100)²/5(250) = 432 432 + 175 = 607 607 3.9

Pool [illegible] = 950' W = 400' (950)²/5(400) = 282 282 + 200 = 482 482 1.8

PEBBLE COUNT

Watershed: [illegible] Team: [illegible], R. Knowlton

Reach: [illegible] BLENHEIM

Date: 8/15/[illegible] [illegible]

INCHES	PARTICLE	MILLIMETER		Feature: RIFFLE Particle Ct.	TOT#	Item	%CUM	458 PM Feature: RUN Particle Ct.	TOT#	Item	%CUM	17:12 Feature: POOL Particle Ct.	TOT#	Item	%CUM
	silt/clay	<.062	S/C				[illegible]				[illegible]				[illegible]
	very fine	.062-.125	S					I			[illegible]		1	1	.5%
	fine	.125-.25	A	卌 II	7	7	[illegible]	IIII	[illegible]	[illegible]	[illegible]	卌	15	16	8.2
	medium	.25-.50	N	I	1	[illegible]	[illegible]	I	1	[illegible]	[illegible]/10.7%	IIII	6	21	10.8
	coarse	.50-1.0	D	I	1	[illegible]	[illegible]				15/11.5		1	[illegible]	11.3
	very coarse	1.0-2	S					II	[illegible]	[illegible]	[illegible]		2	[illegible]	12.4
.04-.08	very fine	2-4													
.08-.16	fine	4-6	G	I	1	10	[illegible]	I	1		19/[illegible]	I	2		13.9
.16-.24	fine	6-8	R									I	1		[illegible]
.24-.31	medium	8-12	A					II	2	[illegible]	21/16%	IIII	6	[illegible]	17.5
.31-.47	medium	12-16	V	I	1	[illegible]	[illegible]	III	3	[illegible]	25/19		4	[illegible]	19.6
.47-.63	coarse	16-24	E	I II	[illegible]	[illegible]	18.9	II	2		30/23	II	5	[illegible]	22.2
.63-.94	coarse	24-32	L					II	2		32/[illegible]		2	[illegible]	23.2
.94-1.26	very coarse	32-48	S	II III	[illegible]	[illegible]	25.7	卌	[illegible]		42/32	卌 II	[illegible]	[illegible]	31.9
1.26-1.9	very coarse	48-64		II 卌	7	26	35.1	III	[illegible]		52/39.7	卌 II	7	79	40.7
1.9-2.5	small	64-96	C	卌 卌 IIII	15	41	55.1	卌 卌 IIII	14	40	81/[illegible]	卌 卌 II	[illegible]	120	61.9
2.5-3.8	small	96-128	O	卌 II 卌	12	53	71.6	III	[illegible]	73	96/73.3	卌 IIII	[illegible]	144	74.2
3.8-5.0	large	128-192	B	卌 卌 II	14	65	87.8	卌 卌	[illegible]	[illegible]	[illegible]/90	卌 卌	32	176	[illegible]
5.0-7.6	large	192-256	L	IIII I	[illegible]	70	[illegible]	IIII	1	[illegible]	127/96.[illegible]	IIII	13	[illegible]	97.4
7.6-10	small	256-384	B	I II	[illegible]	[illegible]	[illegible]				130/[illegible]	I	4	193	99.5
10-15	small	384-512	L	I	1	[illegible]	[illegible]				[illegible]		1	[illegible]	100
15-20	medium	512-1024	D												
20-40	lrg.-very lrg	1024-4096	R												
40-160	bedrock														

CHANNEL CROSS SECTION

1/2

Watershed: SCHOHARIE CREEK

Date: 8/15/98

Location: BLENHEIM - GILOA

Team: R. Powell, R. Knowlton

Reach: USGS GAGE STATION (NORTH BLENHEIM)

Cross Section				Cross Section			
pt.	Station/Distance from LEFT pin	Rod Elevation Depth (ft.)	Notes	pt.	Station/Distance from LEFT pin	Rod Elevation Depth (ft.)	Notes
1	0.0	4.12	Left Pin	27	76.0	12.07	
2	2.0	4.16		28	79.0	13.25	
3	4.0	4.16		29	84.0	13.94	LEW
4	7.0	4.30		30	89.0	14.4	
5	10.0	4.57		31	94.0	15.27	
6	14.0	4.44		32	97.0	15.55	
7	18.0	4.80		33	102.0	16.42	
8	22.0	5.20		34	104.0	16.47	Thalweg
9	25.0	5.80	LTOB	35	107.0	16.09	
10	27.0	6.48		36	112.0	15.33	
11	27.5	6.68	LBF (?)	37	118.2	14.98	
12	29.0	7.09		38	122	14.77	
13	30.0	7.33		39	126.7	14.26	
14	30.9	7.72		40	132	14.06	REW
15	31.7	8.22		41	135	13.75	
16	33.0	9.21		42	140	13.15	
17	35.0	9.87		43	145	12.83	
18	37.0	10.2		44	149.5	12.53	
19	39.0	10.53		45	155.4	11.74	
20	44.0	11.28		46	161.6	11.29	
21	46.5	11.44		47	165.7	11.88	
22	51.0	11.49		48	169	10.2	
23	55.0	11.73		49	171	9.34	
24	61.0	11.27		50	173.5	8.54	
25	66.0	11.55		51	174.7	8.22	
26	71.0	11.47		52	178	7.2	

LPIN = Left Pin	RPIN = Right Pin	BTM = Channel Bottom
LTOB = Left Top of Bank	RTOB = Right Top of Bank	G = Ground Surface
LBF = Left Bankfull Stage	RBF = Right Bankfull Stage	TW = Thalwag
LEW = Left Edge of Water	REW = Right Edge of Water	LEFT BANK = Left Side, Facing Downstream

3:15 pm

8.02 LBF

8.36

8.22 RBF

Max Depth 16.47 − 8.22 RBF = 8.25 × 2 = El. Flood Depth ≈ 50 yr.

Gage Height 6.8' → LBF: 8.22 ft – corresponds to gage ht = 6.8 ft

→ LBF: 6.68 ft – corresponds to gage ht = 8.25 ft

CHANNEL CROSS SECTION

2/2

Watershed: SCHOHARIE CREEK

Date: 8/15/98

Location: BLENHEIM - GILBOA

Team: R. Powell, R. Knowlton

Reach: USGS [illegible] Station

[illegible] (BLENHEIM)

Cross Section				Cross Section			
pt.	Station/Distance from LEFT pin	Rod Elevation Depth (ft.)	Notes	pt.	Station/Distance from LEFT pin	Rod Elevation Depth (ft.)	Notes
1	181	6.67	RBF(2)	27			
2	184	6.1		28			
3	187	5.9		29			
4	189	5.82		30			
5	193	6.22		31			
6	196	5.98		32			
7	198	6.04		33			
8	201	5.68	RPIN	34			
9		14.01	RB Water Slce	35			
10				36			
11				37			
12				38			
13				39			
14				40			
15				41			
16				42			
17				43			
18				44			
19				45			
20				46			
21				47			
22				48			
23				49			
24				50			
25				51			
26				52			

343 PM
356 PM

LPIN = Left Pin	RPIN = Right Pin	BTM = Channel Bottom
LTOB = Left Top of Bank	RTOB = Right Top of Bank	G = Ground Surface
LBF = Left Bankfull Stage	RBF = Right Bankfull Stage	TW = Thalwag
LEW = Left Edge of Water	REW = Right Edge of Water	LEFT BANK = Left Side, Facing Downstream

Entrance Limit Width
46' Left Bank + width Measured + 30' Right (201)

≅ 347' C Type Stream Classification