MAINE DEPARTMENT OF TRANSPORTATION

2006 CONSTRUCTION
MONITORING REPORT:

South Bog Stream, Rangeley Plantation

Year 2 of 5

Compensation for Phillips &Madrid Route 4 Highway Improvement Projects
(MDOT PIN 9205.00 & 10019.00)

ACOE Permit Number: NAE-2004-250

March 2007

Prepared by

MAINE DEPARTMENT OF INLAND FISHERIES AND WILDLIFE
Fisheries Division, Region D
689 Farmington Road
Strong, Maine 04983

2006 Post-construction Monitoring Report:
South Bog Stream, Rangeley Plantation

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1.0 Introduction

This report presents the results of the 2005 pre-construction and 2006 post-construction monitoring at the South Bog Stream mitigation site in Rangeley Plantation, Franklin County (Figure 1). The site provides partial compensation for 95,012 square feet (approximately 3.05 acre) of wetland impacts associated with the rebuilding of Route 4 in Phillips and Madrid by the Maine Department of Transportation (MDOT), as described in Wetland Mitigation Plan for the project submitted in March, 2005. Compensation at the site consisted of restructuring a portion of the stream to improve brook trout (*Salvelinus fontinalis*) habitat.

2.0 Stream Restoration Summary

Stream restoration work was completed from August 16-18, 2005 by M&H Logging of Rangeley, Maine, and extended from the South Shore Road Bridge to 258 feet upstream. Parish Geomorphic Ltd. prepared the design and provided construction oversight. This over-widened section of channel was narrowed to improve sediment transport and to concentrate flows for the benefit of aquatic life, including brook trout. A large gravel bar that had formed on the inside curve upstream of the bridge was lowered and reshaped into a floodplain to improve high-flow water passage through the east side of the bridge. Finally, the outside bank of the re-aligned channel section was strengthened with boulders and root wads to reduce erosion during high-water events and to provide additional aquatic habitat (see before and after photos, Appendix C).

The reconstructed stream channel was rebuilt with a series of pools and riffles. Within the riffle features, keystones were implanted in rows across the channel to form small cascades, thereby controlling the grade and "anchoring" the riffle structure. We expect that small pools will be scoured below each series of larger stones, thereby creating a variety of microhabitat niches that will benefit both macroinvertebrates and brook trout.

Both reshaped banks received a covering of loam that was seeded and planted with riparian shrubs.

3.0 Mitigation Goals and Performance Standards

Rosgen stream types were determined for the reaches of South Bog Stream proximate to the South Shore Road Bridge during the 2001 survey (Bonney 2002) (Table 1). The entire restoration site lies within a B2 reach; the reach immediately downstream of the bridge is C4, indicating a more gentle gradient and smaller average substrate size (See Appendix A for an explanation of these stream types).

The restoration goal is to restore the width to depth ratio to concentrate flow and encourage sediment transport, as well as to create riffle-pool sequences as enhancement for adult brook trout habitat.

4.0 Monitoring Methods

Standard methods for physical stream measurements (Harrelson et al. 1994) are being used to monitor the response of this reach of South Bog Stream to restoration efforts. This procedure consists of longitudinal and cross sectional profiles that measure thalweg depth and location, water elevation at the time of the survey, top of bank elevations, and bankfull elevations. In addition, pebble counts were conducted at transect sites to determine substrate size and changes over time. The longitudinal profile also documents riffle and pool locations. Four semi-permanent transects were established in the study reach above the bridge and one transect below the bridge over a distance of 468 feet (Table 2; Figure 2). Cross-sectional Transects 1 and 5 are within the upper and lower control areas, and Transects 2, 3, and 4 are within the treatment area. They are measured annually, in 1-foot increments. The cross-sectional transects will allow measurement of lateral stream movement, and the longitudinal profile will monitor changes in riffle/pool elevations.

Fish collections were made by one-run electrofishing. All fish were counted and identified to species. Aquatic insects were collected at five locations during each year's sampling event with a 500-micron mesh knit net. Samples were preserved in alcohol, and later identified to family.

5.0 Results and Discussion

Data for physical measurements collected both pre- and post-construction are presented in Tables 3 to 5 and Figures 3 to 8. Data for biological sampling are presented in Tables 6 and 7. Figures 6 and 7 graphically demonstrate the changes in cross sectional profile within the treatment area as the streambed was reconfigured to concentrate the flow into one channel (by eliminating the side channel), and to reestablish a more suitable width to depth ratio. Longitudinal profiles document the increase in the number of pools within the section (Table 3; Figure 3). The pools are relatively shallow, but are numerous and mimic the step pool morphology of a natural B type stream. The frequency of measurements used to determine the longitudinal profile was not adequate to capture each riffle-pool sequence, and will be measured more intensively beginning in 2007.

The year 2005 was the wettest on record in Franklin County, and multiple high post-construction flows (during a normally dry period of the year) resulted in erosion of an estimated 25-33% of the topsoil placed on disturbed areas of the site before protective seeding germinated. The lost topsoil will not be replaced. Other than the loss of topsoil, however, the project withstood the high flows and its structural integrity was not compromised. Flows were also above average in 2006, but there was no further loss of topsoil or damage to the project.

Three years of electrofishing data were collected from 2004-2006 to determine pre-construction brook trout abundance (the 2006 electrofishing sample was collected post-construction but in the upstream control site). There was an average of 8.0 brook trout per 100 square yards of habitat within the project area (Table 6). Beginning in 2007, the project area will be electrofished annually to determine the number of brook trout within the restoration site. Brook trout abundance figures for two downstream sites are included for comparison.

The dominance of Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddis flies) indicates good water quality. Plecoptera species in particular are indicators of cold water temperatures. The apparent increase in Heptageniidae (flattened grazing mayflies) and Philopotamidae (small net filter feeding caddis flies) may reflect an

increase in water velocities and/or a decrease in fines as both require clean cobbles and good flow to thrive.

6.0 Recommendations

- Remeasure all variables and re-photograph reaches annually and report conclusions in the final report.
- Change upper electrofishing site from control area to project area beginning 2007.
- Make detailed measurements of the restored channel, including length of riffles and pools, as well as depths of pools.

7.0 References

Bonney, Forrest R. 2002. Biological Survey of South Bog Stream. Fishery Interim Summary Report Series No. 02-3. Maine Department of Inland Fisheries and Wildlife, Augusta, Maine. 33pp.

Harrelson, Cheryl C.; Rawlins, C.L.; Potyondy, John P. 1994. Stream channel reference sites: an illustrated guide to field technique. Gen. Tech. Rep. RM-245. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 61 pp.

Maine Department of Transportation 2005. Wetland Mitigation Plan for the Maine Department of Transportation's Phillips & Madrid Route 4 Highway Improvement Projects (MDOT PIN 9205.00 & 10019.00). MDOT Environmental Office, Augusta, Maine. 12 pp.

Parish Geomorphic Ltd. 2001. South Bog Stream and Bemis Stream Fluvial Geomorphological Assessment (Memo to F. Bonney). 10 pp.

Pfankuch, D.J. 1975. Stream reach inventory and channel stability evaluation. USDA Forest Service, RI-75-002. Government Printing Office #696-260/200, Washington, D.C. 26 pp.

Rosgen, Dave. 1996. Applied River Morphology. Wildland Hydrology, Pagosa Springs, Colorado.

Table 1. South Bog Stream reach classification proximate to South Shore Road Bridge, 2001.

Location above/below S Shore Dr Bridge	Bankfull width (ft.)	Mean depth (ft.)	W/D ratio	Entrench-ment ratio	Slope	Predominant channel material	Rosgen stream type	Pfankuch stability rating
1,000 ft above	41	1.5	27	1.7	0.03	Boulder	B2	Poor
900 ft below	42	1.6	26	>2.2	0.011	Cobble	C4	Fair

Table 2. Relative elevation and location of semi-permanent cross sectional transects.

Transect No.	Station	Left pin elevation	Flow type	Comment
1	0	103.04	Riffle	Upstream reference transect
2	100	99.65	Riffle	Upstream reference transect
3	207	99.05	Riffle	Within project area
4	270	102.18	Riffle	Within project area
	358			Upper end of bridge; end project
	392			Lower end of bridge
5	468	95.18	Riffle	Downstream reference transect

Table 3. Longitudinal profile, beginning 358 feet upstream of South Shore Drive bridge.

Year	Station	Water surface	Thalweg	Bankfull elevation	Physical feature
2003	100	96.83	95.51	98.65	Riffle
	175	95.70	94.21	96.64	End riffle; begin pool
	207	95.53	94.22	96.74	Top riffle
	350	92.37	89.97	.	End riffle; begin pool
	358				Upper end of bridge
	392				Lower end of bridge
	450	92.40	90.48	93.92	Top riffle
2005	0	99.16	98.33	99.53	Riffle
	50	97.3	96.34	98.75	Riffle
	100	96.46	95.31	97.74	Run
	150	95.75	94.58	96.75	
	200	95.35	93.47	96.76	Pool
	250	94.79	93.87	97.27	
	300	93.66	92.75	95.64	Riffle
	350	92.05	90.73	.	Run
	358				Upper end of bridge
	392				Lower end of bridge
	400	91.86	90.51	.	
	450	91.74	90.79	.	Riffle
2006	100	96.70	95.00	98.69	Riffle
	150	96.15	94.21	97.86	Riffle
	170	95.26	94.71	96.91	Head of pool; **begin project**
	200	95.21	92.91	97.01	Riffle
	216	95.16	93.71	97.06	Foot of pool
	250	94.16	93.01	96.31	Riffle
	257	93.75	92.79	96.21	Riffle; Transect 3
	300	93.46	91.70	92.65	Riffle
	314	93.20	92.37	92.37	Riffle; Transect 4
	350	92.40	91.50	93.91	Riffle
	375	91.96	91.11	93.66	Riffle; upper end of bridge; **end project**.

Table 4. Cross sectional transect summary by transect and year.

Transect	Station	Flow type	Year	Treatment	Bankfull width	Thalweg depth	Mean depth	Xc area (ft²)	Width/ depth ratio
1	0	Riffle	2005	Control	42	4.8	4.34	182	9.7
			2006	Control	42	5.1	4.46	187	9.4
2	100	Riffle	2004	Control	37	2.9	3.33	123	11.1
			2005	Control	37	3.1	3.31	122	11.2
			2006	Control	37	4.7	3.22	119	11.5
3	207	Riffle	2004	Pre	73	4.0	2.16	158	33.8
			2005	Pre	73	4.1	2.17	158	33.6
			2005	Post	17	2.7	3.67	62	4.63
			2006	Post	26	2.9	3.44	89	7.56
4	270	Riffle	2005	Pre	115	5.5	2.57	296	44.7
			2005	Post	20	5.0	4.30	86	4.7
			2006	Post	36	5.0	4.64	167	7.8
5	468	Riffle	2004	Control	33	5.7	3.90	129	8.5
			2005	Control	33	5.2	3.97	131	8.3
			2006	Control	33	5.2	4.07	134	8.1

Table 5. Pebble counts conducted at transects. Percent of dominant substrate types and average particle sizes (D50) are bolded.

		Percent					Particle size indices				
Transect	Year	Sands	Gravels	Cobble	Boulder	Bedrock	D16	D35	**D50**	D84	D95
1	2005	2	**42**	38	17	1	18	50	**85**	250	500
	2006	6	39	**44**	11	0	15	40	**65**	160	300
2	2005	0	28	**54**	17	1	30	70	**95**	250	400
	2006	4	28	**45**	23	0	10	65	**90**	230	350
3	2005	3	**49**	39	9	0	15	32	**50**	160	260
	2006	0	27	**66**	7	0	38	65	**80**	180	260
4	2005	6	29	**51**	14	0	20	55	**80**	190	375
	2006	0	38	**56**	6	0	40	65	**70**	140	230
5	2005	1	**51**	37	11	0	6	22	**55**	160	360
	2006	0	30	**51**	19	0	48	65	**75**	200	400

Table 6. Fish species occurrence and abundance determined by one-run electrofishing.

				Fish species abundance[1]							
		Length	Area	Brook trout[2]				Other fish species[3]			
Date	Transects	(ft.)	(ft.²)	Small	Mid	Legal	All	BND	CCB	SCL	WHS
7/30/04	2-4	160	3,979	5.7	5.4	0.2	11.3	3.4	0.5	4.8	0.2
8/9/05	2-3	107	4,280	4.0	2.1	0	6.1	2.3	0	1.5	0
8/25/06	1-3	207	6,003	3.4	2.5	0.6	6.6	2.2	0.4	1.5	0
7/30/04	7-8	111	3,750	3.6	1.2	0	4.8	4.5	1.9	4.5	0
8/9/05	7-8	111	4,329	6.2	5.4	0.2	11.8	2.9	0.2	2.5	0
8/25/06	7-8	111	3,774	7.4	1.9	0.2	9.5	6.4	1.4	1.9	0
8/9/05	12-14	130	4,030	3.8	5.1	0.2	9.5	3.6	0.2	1.8	0
8/25/06	12-14	130	2,680	4.4	2.2	0.3	6.9	7.5	0.3	1.9	0

[1] Number per 100 yd.[2]
[2] Small = <3.5" (young of year); mid = 3.5 to 6"; legal = 6" and longer.
[3] BND = blacknose dace; CCB = creek chub; SCL = slimy sculpin; WHS = white sucker.

Table 7. Orders of aquatic insects collected 100 feet upstream of the South Shore Drive Bridge, by year.

Order	Family	Year 2003	2004	2006
Coleoptera	Hydrophilidae	0	1	0
Diptera	Blephariceridae	0	2	3
Diptera	Chironomidae	1	0	1
Diptera	Simuliidae	7	0	6
Diptera	Tabanidae	1	1	0
Diptera	Tipulidae	0	1	2
Ephemeroptera	Baetidae	14	15	5
Ephemeroptera	Baetiscidae	0	0	6
Ephemeroptera	Ephemerellidae	6	1	5
Ephemeroptera	Ephemeridae	16	0	2
Ephemeroptera	Heptageniidae	8	11	23
Ephemeroptera	Isonychiidae	0	0	2
Ephemeroptera	Leptophlebiidae	8	2	0
Megaloptera	Corydalidae	0	1	0
Megaloptera	Sialidae	0	0	2
Odonata	Cordulegastridae	9	1	0
Odonata	Gomphidae	0	0	3
Odonata	Lestidae	1	0	0
Plecoptera	Capniidae	1	0	0
Plecoptera	Chloroperlidae	0	0	2
Plecoptera	Peltoperlidae	2	0	5
Plecoptera	Perlidae	0	0	9
Plecoptera	Pteronarcydae	10	6	0
Trichoptera	Brachycentridae	0	1	0
Trichoptera	Glossosomatidae	0	2	4
Trichoptera	Hydropsychidae	2	1	1
Trichoptera	Limnephilidae	2	14	0
Trichoptera	Philopotamidae	1	4	30
Trichoptera	Phryganeidae	0	2	0
Trichoptera	Polycentropodidae	3	0	0

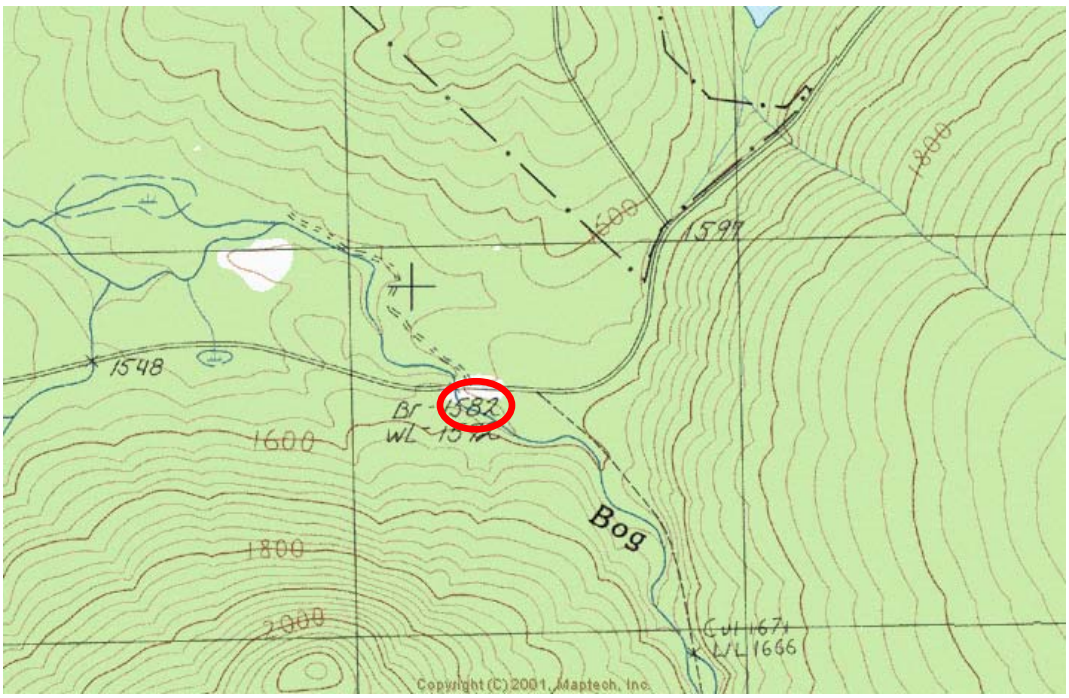

Figure 1. South Bog Stream restoration site.

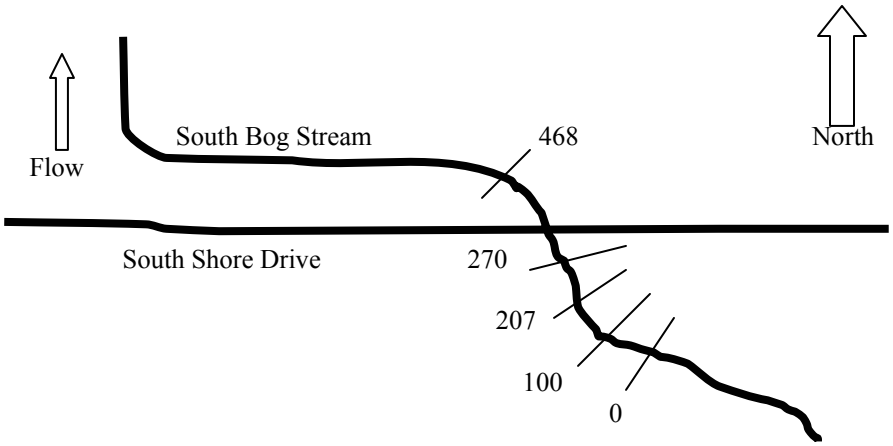

Figure 2. Location of transects. Numbers indicate distance in feet from uppermost transect. Not to scale.

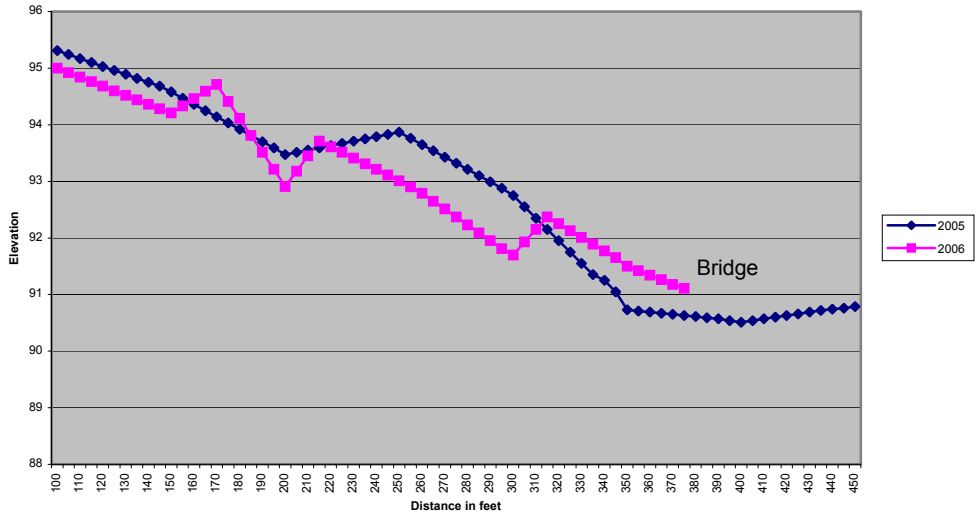

Figure 3. Longitudinal profile, delineating thalweg elevation in 2005 (pre-restoration) and 2006 (post-restoration.

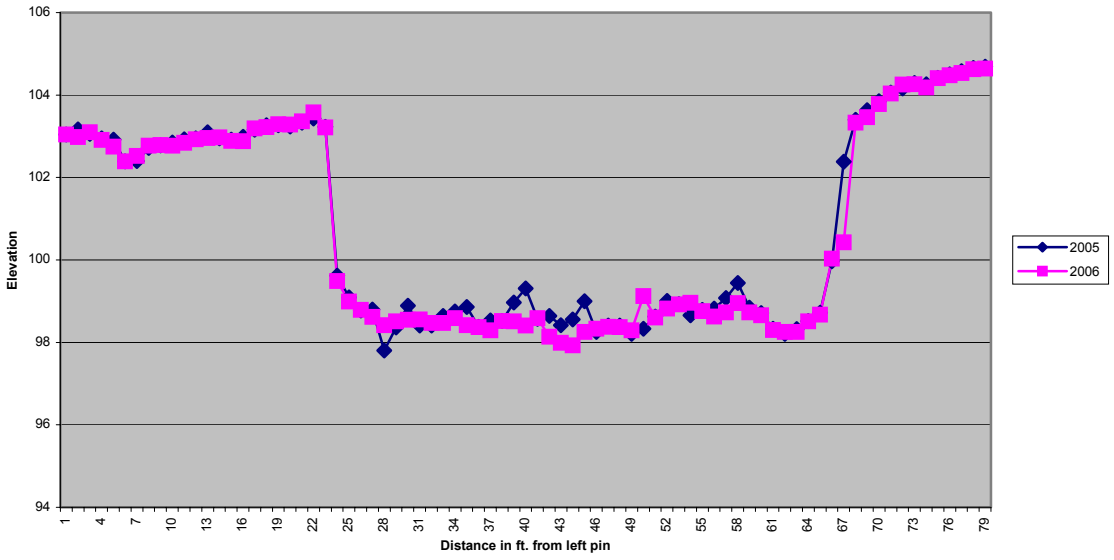

Figure 4. Transect 1, Station 0 (run), upper control area.

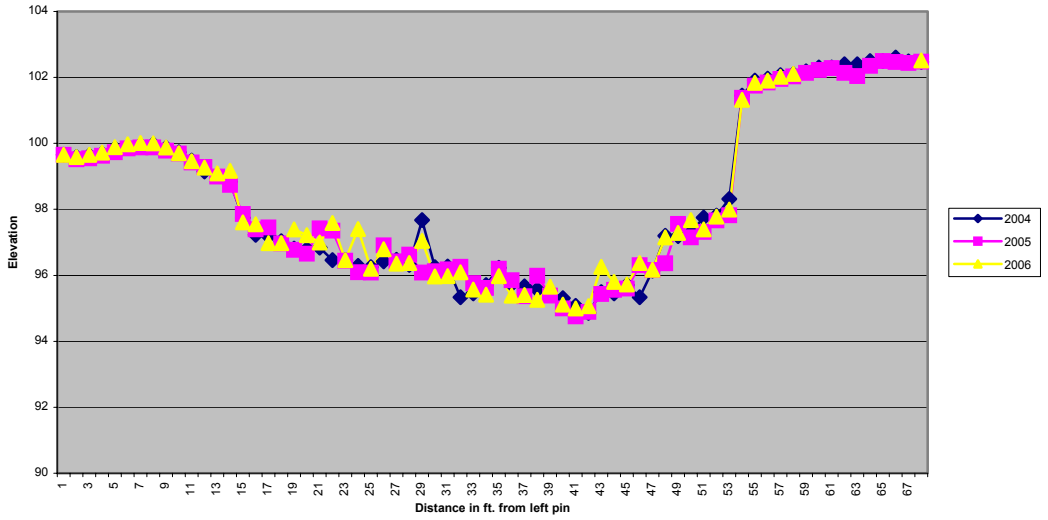

Figure 5. Transect 2, Station 100 (riffle), upper control area.

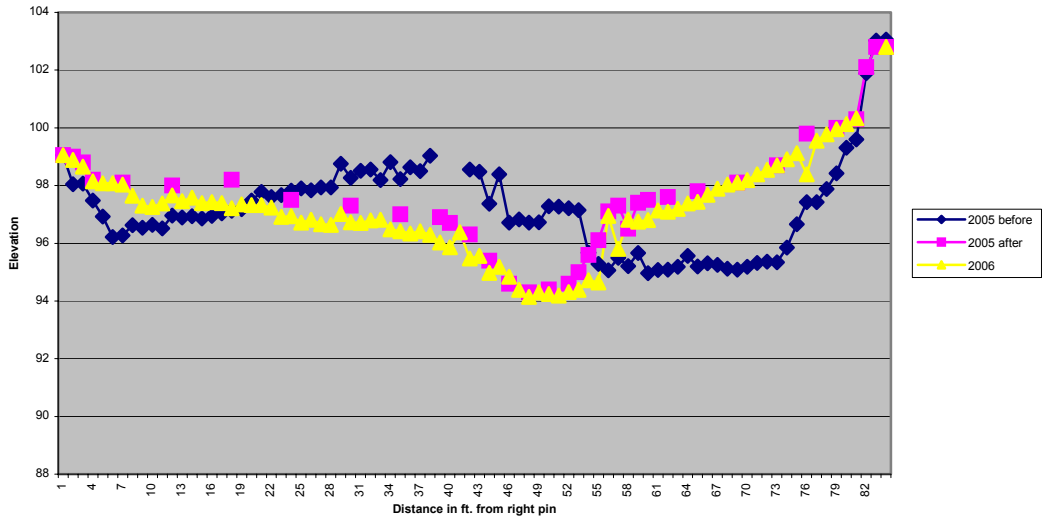

Figure 6. Transect 3, Station 207 (riffle), project area.

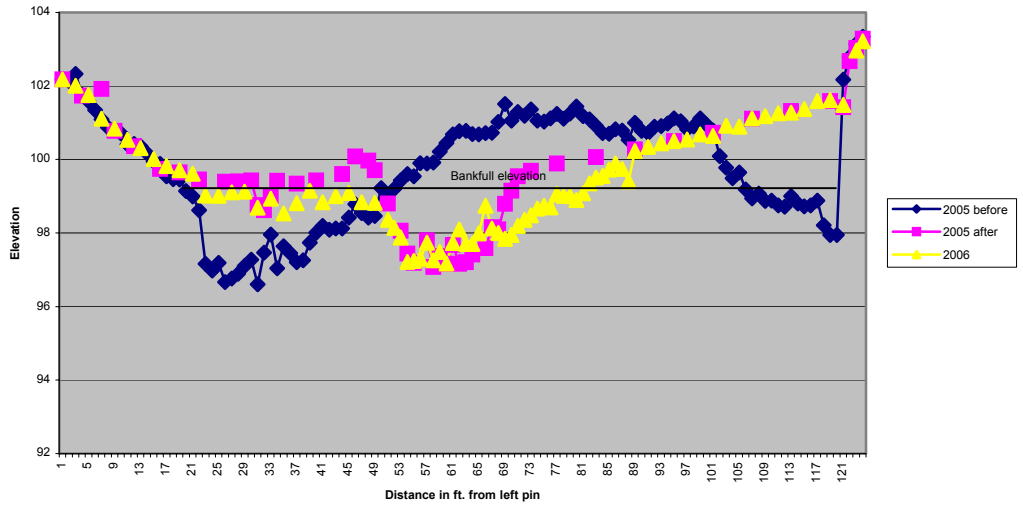

Figure 7. Transect 4, Station 270 (riffle), project area.

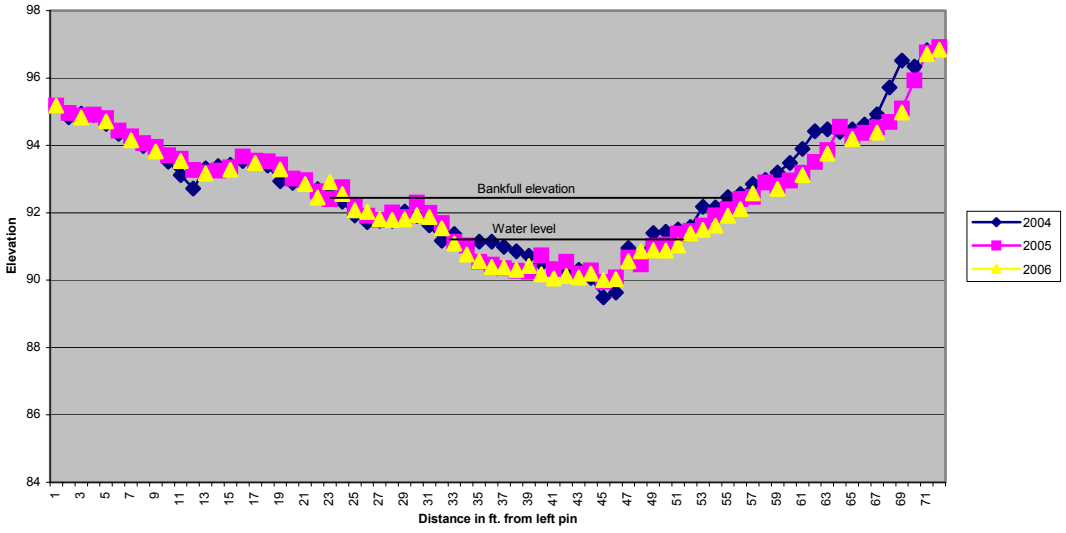

Figure 8, Transect 5, Station 468 (riffle), control downstream of bridge.

Appendix A

Rosgen Stream Classifications

Description of level I stream types.

Stream type	Gradient (%)	Profile	Pool spacing	Entrenchment	Width/depth ratio	Sinuosity
A	4-10	Cascades or step pools	2-3	<1.4	<12	1.0-1.2
B	2-4	Riffle, rapids	4-5	1.4-2.2	>12	>1.2
C	<2	Riffle/pool, point bars	5-7	>2.2; well defined floodplain	>12	>1.4
D	<4	Braided; eroding banks			>40	
E	<2	Broad meadow valleys	>2.2		<12	

Description of level II stream types from Rosgen Stream Classification, 1996.

Numeric descriptor	1	2	3	4	5	6
Channel material	bedrock	boulders	cobble	gravel	sand	silt/clay
Size	>80 in	10.1-80 in	2.5-10.1 in	0.08-2.5 in	0.062-0.125 mm	<0.062mm

Appendix B

Permits

DEPARTMENT OF THE ARMY
NEW ENGLAND DISTRICT, CORPS OF ENGINEERS
696 VIRGINIA ROAD
CONCORD, MASSACHUSETTS 01742-2751

REPLY TO:
ATTENTION OF:

MAINE PROGRAMMATIC GENERAL PERMIT (PGP)
AUTHORIZATION LETTER AND SCREENING SUMMARY

Forrest Bonney
Dept of Inland Fisheries & Wildlife
689 Farmington Road
Strong, Maine 04983

CORPS PERMIT # NAE-2004-250
CORPS PGP ID# 04-089
STATE ID# PBR

DESCRIPTION OF WORK:
To excavate and place fill in 1,100 liner feet of South Bog Stream in conjunction with a realignment/reconfiguration of the stream bed and stream bank reinforcement project off South Shore Road at Rangeley Plantation, Maine.

Special Condition: In stream work is restricted to July 15 through October 1 of any year.

UTM GRID COORDINATES : 4974532 N 365350 E **USGS QUAD:** Rangeley, ME

I. CORPS DETERMINATION:
Based on our review of the information you provided, we have determined that your project will have only minimal individual and cumulative impacts on waters and wetlands of the United States. Your work is therefore authorized by the U.S. Army Corps of Engineers under the enclosed Federal Permit, the Maine Programmatic General Permit (PGP).

You must perform the activity authorized herein in compliance with all the terms and conditions of the PGP [including any attached Additional Special Conditions and any conditions placed on the State 401 Water Quality Certification including any required mitigation]. Please review the enclosed PGP carefully, including the PGP conditions beginning on page 5, to familiarize yourself with its contents. You are responsible for complying with all of the PGP requirements; therefore you should be certain that whoever does the work fully understands all of the conditions. You may wish to discuss the conditions of this authorization with your contractor to ensure the contractor can accomplish the work in a manner that conforms to all requirements.

If you change the plans or construction methods for work within our jurisdiction, please contact us immediately to discuss modification of this authorization. This office must approve any changes before you undertake them.

Condition 36 of the PGP (page 12) provides one year for completion of work that has commenced or is under contract to commence prior to the expiration of the PGP on September 29, 2005. You will need to apply for reauthorization for any work within Corps jurisdiction that is not completed by September 29, 2006.

No work may be started unless and until all other required local, State and Federal licenses and permits have been obtained. **This includes but is not limited to a Flood Hazard Development Permit issued by the town if necessary.** Also, this permit requires you to notify us before beginning work and allow us to inspect the project. Hence, you must complete and return the attached Work Start Notification Form(s) to this office no later than 2 weeks before the anticipated starting date. (For projects requiring mitigation, be sure to include the MITIGATION WORK START FORM).

II. STATE ACTIONS: PENDING [ ], ISSUED[ ], DENIED [ ] DATE

APPLICATION TYPE: PBR: X, TIER 1:___, TIER 2:___, TIER 3:___, LURC: ___ DMR LEASE: ___ NA: ___

III. FEDERAL ACTIONS:

JOINT PROCESSING MEETING: 3/18/04 LEVEL OF REVIEW: CATEGORY 1:___ CATEGORY 2: X

AUTHORITY: SEC 10___, 404 X 10/404___, 103___

EXCLUSIONS: The exclusionary criteria identified in the general permit do not apply to this project.

ESSENTIAL FISH HABITAT (EFH): EFH PRESENT Y / N (CIRCLE ONE)
IF YES: Based on the terms and conditions of the PGP, which are intended to ensure that authorized projects cause no more than minimal environmental impacts, the Corps of Engineers has preliminary determined that this project will not cause more than minimal adverse effects to **EFH** identified under the Magnunson-Stevens Fisheries Conservation and Management Act.

FEDERAL RESOURCE AGENCY OBJECTIONS: EPA NO, USF&WS NO, NMFS NO

If you have any questions on this matter, please contact my staff at 207-623-8367 at our Manchester, Maine Project Office.

Rodney A. Howe
RODNEY A. HOWE
SENIOR PROJECT MANAGER
MAINE PROJECT OFFICE
623-8367 x5

6-15-04
FRANK J. DELGIUDICE **DATE**
CHIEF, PERMITS & ENFORCEMENT BRANCH
REGULATORY DIVISION

STATE OF MAINE
DEPARTMENT OF CONSERVATION
MAINE LAND USE REGULATION COMMISSION
22 STATE HOUSE STATION
AUGUSTA, MAINE
04333-0022

JOHN ELIAS BALDACCI
GOVERNOR

PATRICK K. McGOWAN
COMMISSIONER

June 10, 2004

Maine Department of Inland Fisheries and Wildlife
Attn: Forrest Bonney
689 Farmington Road
Strong, Maine 04983

Subject: ADVISORY RULING AR 04-12, Rangeley Plantation, Franklin County

Dear Mr. Bonney:

Thank you for the information provided in your request for an Advisory Ruling. It is our understanding that the Maine Department of Inland Fisheries and Wildlife proposes to restore a reach of South Bog Stream in Rangeley Plantation to improve brook trout habitat. The stream has been degraded, presumably as a result of increased flows associated with timber harvesting in the area, resulting in bed load movement, channel over widening, and loss of pools. South Bog Stream was once the primary brook trout spawning tributary for Rangeley Lake. Rangeley Lake no longer supports a significant wild brook trout fishery. The decline of that fishery is attributed to habitat degradation within South Bog Stream. The stream still supports a reduced brook trout population and brook trout ascend the stream on spawning runs in the fall as confirmed by telemetry studies conducted in the fall of 2001. However, fish numbers are inadequate to provide a substantial fishery and egg survival is probably low due to bed load movement. The extent of degradation was documented in a detailed stream survey conducted in the summer of 2001.

The Maine Department of Inland Fisheries and Wildlife proposes to restore a 1,100-foot-long reach beginning approximately 200 feet upstream of the bridge and will include:

1. Realigning the channel upstream of the bridge to create a defined channel and a pool-riffle sequence and concentrate flow, reinforcing stream banks to reduce future erosion and bed load movement, and stabilizing eroding banks; and

2. Reconfiguring the channel downstream of the bridge to create a pool-riffle sequence and concentrate flow.

Work is scheduled for the summer of 2004 when water levels are low. Reconfiguration of the channel will require the use of heavy machinery in the channel. Measures will be taken to minimize siltation, banks will be sloped and stabilized, and disturbed areas will be promptly seeded.

Under provisions of Section 10.02(46) of the Commission's Land Use Districts and Standards, fishery management practices are activities engaged in for the exclusive purpose of management of freshwater and anadromous fish populations by manipulation of their environment for the benefit of

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one or more species. Such practices may include, but not be limited to, the construction of traps and weirs, barrier dams, stream improvement devices, fishways, and pond or stream reclamation, provided that any such activities are specifically controlled and designed for the purpose of managing such species and are conducted or authorized by appropriate state or federal fishery management agencies in compliance with the water quality standards contained in 38 M.R.S.A. § 465.

Under the provisions of Sections 10.23, L, 3, a (8) and 10.23, N, 3, a (12) of the Commission's Land Use Districts and Standards, fishery management practices do not require a permit from this agency within (P-SL) Shoreland Protection or (P-WL) Wetland Protection Subdistricts.

The Department's proposed stream restoration work meets the definition of a fishery management practice as defined in Section 10.02 (46) of the Commission's Land Use Districts and Standards, and are therefore do not require a permit pursuant to Sections 10.23, L, 3, a (8) and 10.23, N, 3, a (12) of those Standards. Although a LURC permit is not required for this project, because fill of what may be navigable water is involved, you should contact the U.S. Army Corps of Engineers in Manchester, Maine (207) 623-6072, to determine if a federal permit would be required.

Should you have any further questions, please contact me at (207) 287-2631.

Sincerely,

William J. Galbraith
Permitting and Compliance Division

xc: Geo File

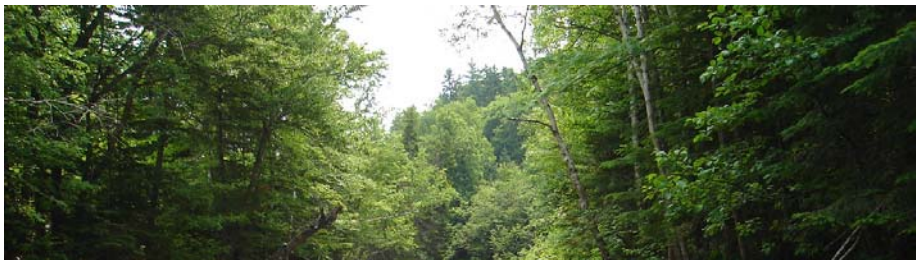
Appendix C
Photos of South Bog Stream transects

Transect 1 (Station 0) looking upstream, July 2005.

Transect 1 (Station 0) looking upstream, August 2006.

Transect 1 (Station 0) looking downstream, July 2005.

Transect 1, looking downstream, August 2006.



Transect 2 (Station 100, Upstream Control Area) looking upstream, July 2005.

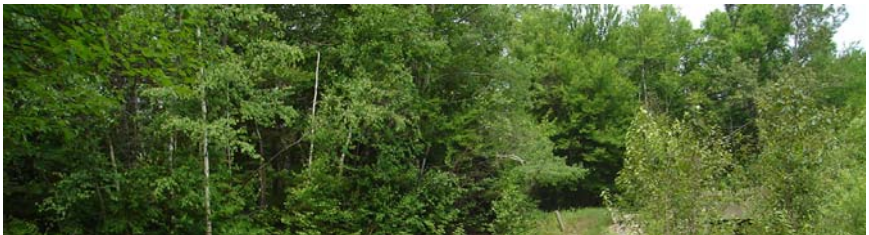
Transect 2 (Station 100, Upstream Control Area) looking upstream, August 2006.

Transect 2 (Station 100, Upstream Control Area) looking downstream, July 2005.

Transect 2 (Station 100, Upstream Control Area) looking downstream, August 2006.

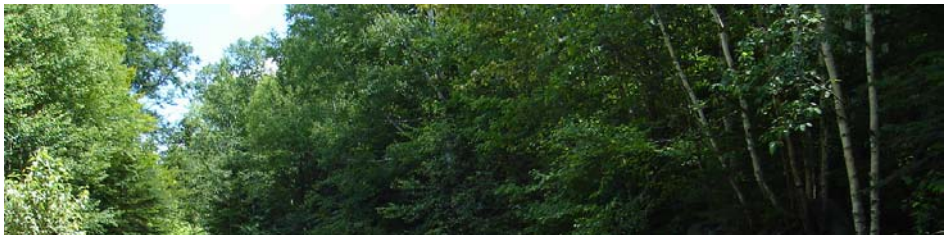
Transect 3 (Station 207, Project Area) looking upstream, July 2005, pre-construction.

Transect 3 (Station 207, Project Area) looking upstream, August 2006, post-construction. Pool in left-center has been deepened, and flow has been concentrated to right of photo.



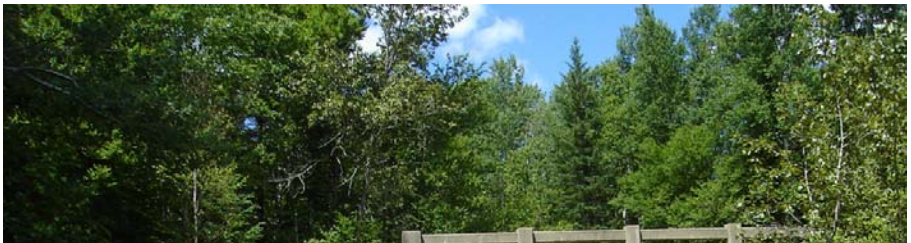
Transect 3 (Station 207, Project Area) looking downstream, July 2005, pre-construction (South Shore Drive Bridge is obscured by brush growing on flood plain).

Transect 3 (Station 207, Project Area) looking downstream toward South Shore Drive Bridge, August 2006, post-construction. Flow concentrated in newly-created step-pool channel to left of photo. Flow is spilling onto flood plain due to high flows.



Transect 4 (Station 270, Project Area) looking upstream, July 2005, pre-construction.

Transect 4 (Station 270, Project Area) looking upstream, August 2006, post-construction. Flow is concentrated in new channel at right of photo. Recently deepened pool is at top of photo.



Transect 4 (Station 270, Project Area) looking downstream at South Shore Drive Bridge, July 2005, pre-construction.

Transect 4 (Station 270, Project Area) looking downstream toward South Shore Drive Bridge, August 2006, post-construction.

Transect 5 (Station 468, Downstream Control Area) looking upstream toward South Shore Drive Bridge, July 2005, pre-project.

Transect 5 (Station 468, Downstream Control Area) looking upstream toward South Shore Drive Bridge, August 2006.

Transect 5 (Station 468, Downstream Control Area) looking downstream, July 2005.

Transect 5 (Station 468, Downstream Control Area) looking downstream, August 2006.

Appendix D

Upstream view from South Shore Drive Bridge prior to restoration, July 2005.[4]

Upstream view from South Shore Drive Bridge, immediately post-restoration, August 2005. Step-pool formation is evident in photograph.

[4] Photos this page by Chris Cummings, Parish Geomorphic Ltd.

Upstream view from South Shore Drive Bridge post-restoration, August 2006. Step-pool formation is still evident but much of riparian loam has been washed away by high flows.