BEFORE THE ENVIRONMENTAL APPEALS BOARD
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C.

In re:	)	
GENERAL ELECTRIC COMPANY	)	**RCRA Appeal No. 16-01**
Modification of RCRA Corrective Action Permit No. MAD002084093	)	

GENERAL ELECTRIC COMPANY'S REPLY TO EPA REGION 1'S RESPONSE TO GENERAL ELECTRIC'S PETITION FOR REVIEW

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Dated: March 24, 2017

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GLOSSARY OF TERMS

ACEC	Area of Critical Environmental Concern
A.R.	Administrative Record
ARAR	Applicable or Relevant and Appropriate Requirement
CD	Consent Decree in *United States et al. v. General Electric Company*, Civil Action No. 99-30225-MAP *et seq*. (Oct. 27, 2000)
CD-Permit	Reissued RCRA Permit (reissued by EPA in October 2001 and again effective Dec. 7, 2007), incorporated into Consent Decree
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
Comp/Analysis	EPA's Comparative Analysis of Remedial Alternatives for the Rest of River (May 2014)
EPA	U.S. Environmental Protection Agency
EPA.Resp.	EPA Region 1's Response to General Electric Company's Petition for Review (Feb. 14, 2017)
EPA Resp. to Mun.Com	EPA Region 1's Response to Petition of the Housatonic Rest of River Municipal Committee for Review (Feb. 14, 2017)
GE	General Electric Company
GE Comments	Comments of General Electric Company on Draft Permit Modification and Statement of Basis (Oct. 27, 2014)
GE.Pet.	Petition of General Electric Company for Review of Final Modification of RCRA Corrective Action Permit Issued by EPA Region 1 (Nov. 23, 2016)
GHG	Greenhouse gas
mg/kg	milligrams per kilogram (equivalent to parts per million)
NCP	National Contingency Plan
O&M	Operation and maintenance
OPCA	On-Plant Consolidation Area
PCBs	Polychlorinated biphenyls

RCMS	Revised Corrective Measures Study (submitted by GE, Oct. 2010)
RCRA	Resource Conservation and Recovery Act
RTC	EPA’s Response to Comments (Oct. 2016)
SOP	Statement of Position
SOW	Rest of River Statement of Work
Stmt/Basis	EPA’s Statement of Basis for Proposed Rest of River Remedial Action (June 2014)
TSCA	Toxic Substances Control Act

INTRODUCTION

General Electric Company ("GE") submits this reply to EPA's Response ("EPA.Resp.") to GE's Petition for Review of Final Modification of RCRA Corrective Action Permit Issued by EPA Region 1 ("GE.Pet.").[1] Nothing in EPA's response changes the overarching fact that its dispute with GE is governed – in both substance and procedure – by a court-approved and binding Consent Decree ("CD"), including a Permit ("CD-Permit"). This document defines the parties' rights and obligations here and, insofar as the present dispute concerns its interpretation, EPA is not entitled to the type of "deference" that applies to its technical and scientific judgments. Instead, the Board must interpret the CD according to its plain terms in order to honor the manifest intent of the parties and the court. Under this standard, EPA's interpretations of the governing instrument are untenable. For example, in choosing between two remedies EPA has conceded are both fully effective and protective, and in selecting the one that costs at least $160 million more to achieve analogous results, EPA relies on improper factors not expressed in the CD and CD-Permit. EPA also asserts authority that exceeds the contractual boundaries of its discretion. In doing so, its decision here crosses the threshold that separates reasoned from arbitrary agency action.

In addition, with respect to several issues that do not turn on an interpretation of the CD, EPA nevertheless has committed clear error by failing to consider pertinent aspects of the problems before it, by offering rationales that are inconsistent with the evidence, and by reaching conclusions that cannot be attributed to the application of agency expertise.

[1] Relevant provisions of key documents referenced herein have been provided in Attachments to GE's Petition or EPA's Response. There are two new attachments hereto. *See* List of Attachments.

ARGUMENT

I. EPA Is Not Entitled to Deference on the Interpretation of the CD and CD-Permit.

At least three issues raised by GE turn on the intent, scope, and meaning of the CD or CD-Permit – (1) the out-of-state disposal requirement; (2) the Downstream Transport and Biota Performance Standards, insofar EPA would rely on them to demand additional remedial action long after the remedy under review has been completed; and (3) the so-called "Future Work" requirements, pertaining to potential, as-yet unspecified, response actions in connection with future river and floodplain projects. Importantly, because the CD is a contract, it must be interpreted according to principles of contract law, which in turn do not give EPA's views the deference that a reviewing body may give to the Agency's scientific and technical judgments. *See* GE.Pet. at 8. Rather, as the federal District Court held in another proceeding under the same CD, when the issues involve the parties' intent and the scope of their agreement, "EPA's construction of the Consent Decree is not entitled to any particular deference." *United States v. GE*, 986 F.Supp.2d 79, 86 (D.Mass. 2013).

Nothing EPA says in its Response makes that established legal principle inapplicable here. First, there is no merit to EPA's contention that GE waived this argument by failing to make it during the public comment period on the draft Permit. EPA.Resp. at 13. The regulations cited by EPA do not support this proposition. They merely required GE to show that "each issue being raised in the petition was raised during the public comment period," or that an issue about which it did not comment was "not required to be raised during the public comment period." 40 C.F.R. §124.19(a)(4)(ii). GE satisfied this obligation by raising each of the substantive issues argued in its Petition. *See, e.g.*, GE.Pet. at nn.6, 29, 32. However, GE was not required to anticipate the occurrence of a formal dispute over every possible issue it raised and to predict what the standard of review would be for hypothetical disagreements in the future or in subsequent appeals, and then foreshadow that standard of review in its comments.

Second, the Board should reject EPA's suggestion that it "need not hear" GE's arguments about three Permit conditions (the Downstream Transport and Biota Performance Standards and two other conditions challenged by GE). EPA does not deny that GE raised these issues in comments and that EPA addressed them in its Response to Comments ("RTC"). Instead, EPA argues that the Board need not hear them ***because*** they were addressed in the RTC. *See* EPA.Resp. at 26 (Woods Pond), 32 (restoration), 45 (Downstream Transport and Biota Performance Standards). This is a Catch-22: Under EPA's argument, on the one hand, the Board would lack jurisdiction over arguments that GE did not raise in comments, and on the other hand, it need not hear arguments raised in comments and addressed in the RTC. If that were true, then there would effectively be nothing for this Board to review, and the CD's provisions for administrative and judicial review would be nullified.

The only authority EPA cites for this position does not support it. In *In re City of Pittsfield*, NPDES Appeal No. 08-19 (EAB Mar. 4, 2009), the Board denied review of a petition that consisted of a single paragraph and made no substantive argument except by vague reference to previous submissions. *Id.* at 10. Here, on the other hand, GE's Petition discussed all three issues in detail. Moreover, unlike the petition in *Pittsfield* – and contrary to EPA's claim, EPA.Resp. at 32 – GE's Petition identified and explained the flaws in EPA's RTC on each issue. *See, e.g.*, GE.Pet. at 26-28, 30 (regarding Woods Pond); 34-36, 38-40 (regarding restoration); 49-50 (regarding Downstream Transport and Biota Performance Standards).

Third, EPA is incorrect when it accuses GE of (i) failing to "identify which issues concerning the Permit it is claiming do not deserve deference," EPA.Resp. at 13, and (ii) "labor[ing] to convert this matter into a contractual dispute governed by common law." *Id.* at 2. According to EPA, "the matters to be decided are self-evidently scientific and technical in nature…." *Id.* at 14. This characterization, however, is at odds with the substance of both GE's Petition and EPA's own Response. GE clearly identified the contractual bases of particular arguments, *see* GE.Pet. at 8, 20, 24-25, 44-47, 48-51; and EPA responded to each of those arguments in contract-interpretation terms and with reference to contract-interpretation case law. *See* EPA.Resp. at 21 & 25, 45-49, and 52-54. In addition, EPA devoted its entire "Standard of Review" section to a discussion of the standards that supposedly apply "[t]o the extent the Board's process of reviewing the Permit … requires interpretation of any ambiguous terms of the Decree itself.…" EPA.Resp. at 11-12. In other words, EPA's own treatment of these issues makes clear that they are fundamentally contractual.

The Board should note, moreover, that even as EPA tacitly acknowledges the contractual essence of these issues, it misstates the applicable legal standard. It cites a District Court's decision (in a billing dispute under the Housatonic CD) for the seemingly-relaxed proposition that:

> "while courts generally construe commercial-litigation consent decrees like contracts, 'programmatic decrees entered into in public law litigation will often warrant a more flexible approach.'… Such judicial discretion in public law litigation may be crucial for the court to secure complex legal goals."

EPA.Resp. at 12, quoting *United States v. GE*, 986 F.Supp.2d at 86. EPA's response omits the fact that the District Court went on to say, with respect to this very CD, that:

> "[because] the issues before the court involve the parties' original intent and scope of their agreement,…***EPA's construction of the Consent Decree is not entitled to any particular deference.***"

Id. (emphasis added). The Board should follow the District Court's instruction here.

II. The Board Should Reject EPA's Erroneous Interpretations of the CD and CD-Permit.

GE's argument against Modified Permit Condition II.B.5 – which requires it to transport and dispose of removed sediments and soils at an out-of-state facility – rests on two grounds.[2] First, because out-of-state disposal would be hundreds of millions of dollars more expensive than on-site disposal, EPA's selection of the much higher-priced remedy is inconsistent with the CD and CD-Permit, particularly given EPA's admissions that both alternatives would be protective and effective in terms of the remedy-selection criteria enumerated in the CD-Permit. *See* GE.Pet. at 12-13. Second, when EPA disregarded cost and opted for out-of-state disposal, it improperly relied on factors beyond the enumerated remedy-selection criteria. These fundamental errors constitute arbitrary decision-making.

A. EPA Effectively Ignored Cost in Dismissing a Protective and Effective Remedy for an Alternative Costing $160-245 Million More.

EPA admitted during the remedy-selection process that both on-site and out-of-state disposal "would provide high levels of protection to human health and the environment," EPA Statement of Basis ("Stmt/Basis") at 35 (in Att. 5 to GE.Pet.), and would "provide protection of human health and the environment." EPA Comparative Analysis ("Comp/Analysis") at 60, 61 (in Att. 10 to EPA.Resp.) EPA does not dispute, moreover, that its preferred remedy will cost at least $160 million, and possibly as much as $245 million, more than the on-site alternative. RTC at 267. EPA therefore erred when it selected out-of-state disposal because, as GE has already

[2] EPA continues to insist that Condition II.B.5 mandates only "off-site" disposal, implying that it does not necessarily require out-of-state disposal. The response submitted by Massachusetts exposes this as a fiction by admitting that no qualified disposal facilities exist in the Commonwealth. Massachusetts Response to GE's Petition at 15 n.5.

argued, cost is an express criterion under the CD-Permit and cost-effectiveness is a fundamental principle of reasoned agency decision-making. *See* GE.Pet. at 12.

In its Response, EPA says that "cost-effective does not necessarily imply least costly," and contends that, "[w]hile costlier than GE's favored approach, off-site disposal is less costly than two other alternatives considered and rejected by EPA." EPA.Resp. at 15. However, just as "cost-effective does not necessarily imply least costly," neither does "less costly than two other alternatives" necessarily imply cost-effectiveness. Out-of-state disposal may have been the third-most expensive alternative EPA considered, but it was the most expensive option that could actually work on the Rest of River. EPA rejected the two priciest disposal options (known as "TD-4" and "TD-5") because those alternatives had not been shown to be effective and reliable for this site. Stmt/Basis at 35 (TD-4 "may not be able to effectively treat PCB contamination from the site"), 37 (noting "uncertainty regarding the adequacy and reliability" of TD-5) (in Att. 5 to GE.Pet.). In reality, the choice was binary: out-of-state disposal or on-site disposal, with a cost differential of up to $245 million, to do the same job. EPA erroneously chose the more expensive, but no more effective, option.

B. EPA Relied on Criteria that the CD-Permit Did Not Authorize It to Consider.

1. EPA improperly relied on state and local opposition to on-site disposal.

When trying to justify its extraordinary selection of costly out-of-state disposal, EPA has consistently cited what it has called "public and state opposition," EPA Statement of Position ("SOP") at 44, and described, in detail, as "persistent and vigorous opposition" by local communities and governments. RTC at 264. *See also* EPA.Resp. at 21-24. That opposition has undeniably played a critical role in EPA's selection of a disposal remedy, and it is therefore a critical element of this Board's assessment. If state and local opposition to on-site disposal is not a legitimate remedy-selection criterion, as GE contends, then EPA has relied on an "improper factor" and its decision is arbitrary and capricious. *See Associated Fisheries of Maine, Inc. v. Daley*, 127 F.3d 104, 109 (1st Cir. 1997). Whether EPA was entitled to consider such opposition is a matter of interpretation of the CD-Permit; EPA's own response implicitly concedes as much. *See* EPA.Resp. at 21-25. Thus, with respect to this issue, the Board owes EPA no deference.

Recognizing this vulnerability, EPA states at the outset that it "did not consider 'state and community acceptance' as an independent criterion in its analysis of disposal options. *Id*. at 21. EPA thus tacitly acknowledges that it could not take public opinion "independent[ly]" into account because – as the Agency says elsewhere – "the CD-Permit does not explicitly list community and state acceptance as stand-alone remedy selection criteria." *Id.* at 24. Instead, it contorts its position to nevertheless rely on this opposition through a back door by asserting that: (i) public opinion should be read into the instrument because it is "squarely within the plain meaning of the term 'implementability,'" *id.* at 21, and because it fits into the category of "other relevant information in the Administrative Record," *id.* at 23; and (ii) EPA can base its remedy selection on public opinion regardless of the CD-Permit's provisions because "RCRA and CERCLA guidance and regulations call for EPA to consider the public's views as part of its remedy selection and permit decisions." *Id.* at 24. All of this is wrong.

Implementability. "Implementability" is a Selection Decision Factor under the CD-Permit, but local opposition to a remedial alternative does not "fit squarely within the plain meaning of the term," as EPA says. EPA.Resp. at 21. Indeed, it does not fit at all. EPA's argument disregards the regulatory background from which the parties derived their agreed-upon enumeration of remedy-selection criteria. As GE has already explained, GE.Pet. at 21, "implementability" is drawn from the National Contingency Plan ("NCP"), and under the NCP, "implementability" and "state and community acceptance" are defined separately, 40 C.F.R. §300.430(e)(9)(iii)(F),(H),(I), and enumerated as distinct remedy-selection criteria, with implementability listed as a "primary balancing" criterion, *id.* at §300.430(f)(1)(i)(B), and state and community acceptance as tertiary "modifying criteria." *Id.* at §300.430(f)(1)(i)(C). If public opposition to a remedial alternative is "squarely within the plain meaning" of "implementability," as EPA claims, then it had no reason to include "state acceptance" and "community acceptance" as separate remedy-selection factors in the NCP.

EPA's reliance on several sub-criteria of "implementability" is equally ineffective. With respect to both "coordination with other agencies" and "regulatory and zoning restrictions," EPA fails to explain how state and local opponents could undermine the implementation of on-site disposal when both CERCLA and the CD exempt on-site remedial actions from the need to obtain state and local permits and approvals. *See* GE.Pet. at 22. Nor has EPA responded to the decisions, cited in GE's Petition, which hold that local zoning ordinances are preempted by CERCLA insofar as they might otherwise apply to on-site remedies. *Id.*

EPA's Response does not address the relevant statutory and contractual terms and adverse case law. Instead of tackling these obstacles, EPA says that, "[e]ven if CERCLA may preempt such restrictions, the State or local concerns or public views underlying those regulations or zoning restrictions ***must*** be factored into the CD-Permit evaluation." EPA.Resp. at 22 (emphasis added). But EPA never says why those concerns and views "must be factored" in when the plain language of the CD and the CD-Permit do not authorize it, and when attempting to take into account the local concerns underlying zoning restrictions would undermine the very purpose of preemption.

As for the “suitability” sub-criterion, EPA argues, without support, that “[r]eviewing a facility’s suitability would not be successful without consideration of ***whatever factors*** affect the success of a facility.” EPA.Resp. at 23 (emphasis added). If this were true, then the parties engaged in an empty exercise when they negotiated and delineated a set of specific remedy-selection criteria for the CD-Permit because, according to EPA, it has the authority to consider “whatever factors” it deems appropriate under the rubric of “suitability.” Even if EPA’s interpretation of the CD were entitled to deference – which it is not – that would be an untenable construction.

“**Other relevant information.”** EPA has said nothing new about this issue that GE did not address in its Petition. *See* GE.Pet. at 22-23. Briefly, EPA’s argument that it could consider state and local opposition as “other relevant information” is erroneous for two reasons.

First, it misconstrues the terms of the CD-Permit. The CD-Permit does not authorize EPA to base its remedy-selection decision on substantive considerations other than the criteria enumerated separately in Condition II.G. It does say that EPA can select a remedy “[b]ased on the information that [GE] submits pursuant to this Permit and any other relevant information in the Administrative Record.” CD-Permit Condition II.J. However, that condition describes the sources – not the substance – of the information that EPA may consult when selecting a remedy. If it loosened the restraints on EPA, it did so only insofar as it allowed the Agency to consider relevant information submitted by parties other than GE, but subject to the substantive constraints in the earlier Condition.

Second, even if the “other relevant information” clause could be construed to authorize EPA to consider some information apart from the nine enumerated criteria, it cannot be stretched to authorize consideration of factors (“state acceptance” and “community acceptance”) that the parties deliberately excluded from the contractual equation. As GE has already set forth, an unstated term can be read into a contract only when "it is absolutely necessary to introduce the term to effectuate the intentions of the parties." 23 Williston on Contracts §63:21 (4th ed. May 2016 Update). That is not the case here. To the contrary, reading "state and community acceptance" into the CD-Permit would defeat the intention of the parties by giving the Commonwealth veto power over an equally effective, and far more cost-effective, remedial option.

Relevant guidance and regulations. The same defect mars EPA's argument that, even though "the CD-Permit does not explicitly list community and state acceptance as stand-alone remedy-selection criteria," RCRA and CERCLA "guidance and regulations call for EPA to consider the public's views as part of its remedy selection and permit decisions." EPA.Resp. at 24. EPA does not mention, much less account for the implications of, the CERCLA regulations incorporated in the NCP. Like the CD-Permit, which specifies the criteria for selecting the Rest-of-River remedy, the NCP enumerates the criteria on which EPA can and must base a remedy-selection decision under CERCLA. *Cf.* CD-Permit Condition II.G and 40 C.F.R. §300.430(f)(i). Unlike the CD-Permit, however, the NCP explicitly lists community and state acceptance as stand-alone remedy-selection criteria. *Id.* at §300.430(f)(i)(C).

EPA's argument here, then, does nothing to fill the gap in its position. When they agreed to the terms of the CD, the parties negotiated the conditions for a remedy that was to be ***performed*** under CERCLA, CD ¶22.w, but ***selected*** according to the criteria enumerated in Condition II.G of the CD-Permit. Knowing that the NCP explicitly authorized consideration of both state and community acceptance for remedies selected under CERCLA, the parties omitted those elements from the parallel, but distinct, contractual enumeration of criteria for selecting a remedy under the CD. According to settled rules of interpretation, on which EPA's position deserves no deference, only one inference is possible: When the parties excluded "state and community acceptance" from the CD-Permit's list of criteria, they excluded public opinion from EPA's selection of the Rest-of-River remedy. *See Smart v. Gillette Co. Long-Term Disability Plan*, 70 F.3d 173, 179 (1st Cir. 1995) ("when the parties list specific items in a document, any item not so listed is typically thought to be excluded").

2. EPA's reliance on control of sources of releases, protectiveness, and compliance with ARARs is misplaced.

Finally, EPA cannot justify its decision on the basis of the enumerated CD-Permit criteria under the circumstances here. The CD-Permit lists eight criteria in addition to cost. Condition II.G. EPA cites only three of the eight criteria to support its choice of out-of-state disposal: Control of Sources of Releases, Overall Protection of Human Health and the Environment, and Compliance with ARARs. Its attempt to justify out-of-state disposal on the basis of these three criteria, however, does not stand on its own merits and cannot overcome the massive cost disparity between on-site and out-of-state disposal.

Control of sources of releases. EPA contends (albeit in a single paragraph) that out-of-state disposal will better meet the criterion of Control of Sources of Releases. EPA.Resp. at 20-21. But EPA does not explain how disposal in an out-of-state facility will provide any better control over future releases than disposal in an on-site facility. Indeed, in its Statement of Basis, EPA admitted that "[a]ll the alternatives would control … sources of releases…." Stmt/Basis at 35 (in Att. 5 to GE.Pet.).

EPA suggests in a footnote that its reliance on this criterion is based more on local concerns than on efficacy: "if such a release occurs ***along the Housatonic***," it says, "the risks ***to***

the Rest of River are greater than if it occurred at a licensed off-site facility….” EPA.Resp. at 21 n.17 (emphases added). This is consistent with Massachusetts’ Response, which argues candidly that, “[a]fter all, if issues arise with off-site disposal, the Housatonic River watershed is unaffected, whereas the Housatonic River watershed will bear the negative impacts if issues arise with on-site disposal.” Massachusetts Response (“MA.Resp.”) at 23. This is not, however, consistent with the CD-Permit, which specifies “control of sources of releases,” not control of sources of releases to a particular location. And as GE has already demonstrated, state and local concerns are not valid remedy-selection criteria.

Overall protection of human health and the environment. Any argument that EPA makes about this criterion has to overcome a formidable obstacle of the Agency’s own making. As noted, EPA has repeatedly admitted during the remedy-selection process that both on-site and out-of-state disposal “would provide high levels of protection to human health and the environment,” Stmt/Basis at 35, would “provide protection of human health and the environment,” Comp/Analysis at 60, 61 (in Att. 10 to EPA.Resp.), and would be effective by “permanently isolat[ing] [the PCB-containing sediment/soil] from direct contact with human and ecological receptors.” *Id*. at 63.

Nothing EPA says here can explain or justify its pivot to the contradictory position that “off-site disposal is more protective of human health and the environment than on-site disposal.” EPA.Resp. at 16. For one thing, its arguments here, as elsewhere, continue to be tainted by the notion that a remedy is superior if it preferentially protects the Rest of River, even if it exposes people and nature to equal or greater impacts elsewhere. Thus, for example, even as it concedes that out-of-state disposal would have greater short-term impacts, EPA.Resp. at 15, EPA fails mention or account for the increased risks that would result – *e.g.*, the risk of releases during long-range transport of over a million cubic yards of contaminated sediment/soil to an out-of-state facility, and the substantially greater greenhouse gas ("GHG") emissions that would result from out-of-state rail transport. *See* GE Comments (in Att. 7 to GE.Pet.) at 21.

Likewise, with respect to its assertion that the on-site disposal locations identified by GE would not meet certain default siting criteria in EPA's Toxic Substances Control Act ("TSCA") regulations, 40 C.F.R. §761.75(b), EPA.Resp. at 16, EPA admits that the potential for future noncompliance with applicable requirements is "equally possible" for out-of-state and on-site facilities. EPA.Resp. at 19 n.16. EPA also has not refuted GE's showing that, at a minimum of three potential out-of-state disposal facilities, EPA has waived at least one of the TSCA siting criteria – namely, the specification that the bottom of the landfill liner system be at least 50 feet above the historical high groundwater table. See Att. 13 to GE.Pet.

If TSCA waivers are appropriate for out-of-state disposal facilities, then refusing to waive the same or similar requirements for an on-site facility is arbitrary and capricious unless the on-site and out-of-state facilities are so different (in relevant respects) that the Agency is not making a "patently inconsistent application[] of agency standards" by treating them differently. *South Shore Hospital, Inc. v. Thompson*, 308 F.3d 91, 103 (1st Cir. 2002). EPA has not even made the comparison needed to justify differential treatment. As to the proposed on-site facility, it has not responded to GE's demonstration that: (i) even if it is not located in "thick, relatively impermeable formations," an on-site disposal facility could meet the TSCA requirements for soil characteristics by using either soil with a high clay content in a "compacted soil liner" or a synthetic membrane liner (40 C.F.R. §761.75(b)(1)&(2)); and (ii) the few hydrogeological criteria that would not be met – that the bottom liner be at least 50 feet above the historical high water table and that the site avoid groundwater recharge areas and hydraulic connections to a surface water body – have been waived or avoided through risk-based approvals at numerous sites when equivalent protections are provided. GE.Pet. at 15-16.

On the out-of-state side of the equation, the record is devoid of any support for EPA's claims; indeed, as far as the record shows, EPA has not evaluated any out-of-state facilities against the TSCA default criteria that it says an on-site facility wouldn't meet. EPA asserts only that "it is more reasonable to favor an off-site disposal alternative that has been sited based on its suitability to accept PCB wastes," and that the out-of-state disposal facilities will be "fully licensed and regulated under federal law, and are generally constructed in areas best suited for that use considering soil and hydrology." EPA.Resp. at 16. Of course, the on-site facility would also be fully regulated by EPA and compliant with applicable federal and state law. While it would not need a license due to the on-site permit exception in CD ¶9.a and CERCLA §121(e)(1), EPA can't be suggesting it would allow such a facility to be less protective.

Finally, EPA does not refute GE's showing that EPA has previously recognized the protectiveness of on-site disposal by approving on-site disposal facilities at this and other sites. For example, EPA asserts that the on-site disposal facilities approved in the CD for this Site consisted of either an existing landfill (the Hill 78 On-Plant Consolidation Area [OPCA]) or a new landfill in an adjacent area (the Building 71 OPCA), whereas the disposal facility locations identified by GE for the Rest of River would be located in areas with "no known contamination." EPA.Resp. at 17. However, EPA does not explain how the presence or absence of "known contamination" in a particular place affects the protectiveness of a disposal facility located there.

Compliance with ARARs. EPA contends that out-of-state disposal would better comply with ARARs, asserting that "[t]here is no disagreement that the on-site disposal locations that GE proposes would not meet the requirements of ARARs, absent waivers." EPA.Resp. at 18. In fact, GE has disputed and disagrees with EPA's statement. To be clear, at least two of three identified on-site disposal locations would meet ARARs without waivers. The Rising Pond and Forest Street Sites are not located in the Upper Housatonic Area of Critical Environmental Concern ("ACEC"), so the State's prohibition on disposal sites within an ACEC would not apply. EPA says that the Rising Pond Site directly abuts priority habitat for the state-listed wood turtle, "potentially implicating" the Massachusetts Endangered Species Act, *id*. at 20; but this is a speculative concern made negligible by the fact that the boundaries of the Rising Pond Site were drawn to avoid any impacts to the priority habitat of the wood turtle. *See* GE.Pet. at 19-20. EPA also claims that the Forest Street Site "is within a regulated wetland area," EPA.Resp. at 19; but GE has shown that a disposal facility located at Forest Street would have minimal impacts on regulated wetland areas, and that the work could be conducted in accordance with the substantive requirements of the Massachusetts Wetlands Protection Act, avoiding the need for a waiver. GE Pet. at 19.

The Woods Pond Site is located within the boundaries of the ACEC, but the ACEC designation presents no legitimate impediment to the implementation of an on-site disposal remedy at that site. When it designated the ACEC in 2009 – almost a decade after the CD was executed, and after GE had already submitted its original CMS Report – Massachusetts gave specific assurances (i) to EPA and Connecticut, that "the ACEC designation should not be used to delay or preclude remediation, habitat protection, or restoration activities along the Rest of River," and (ii) to existing industrial business interests in the ACEC, that the designation "is not intended to impede development or redevelopment," and that the Commonwealth's decision to give the ACEC wide boundaries should not be construed as a determination that a particular parcel of land within those boundaries "has unique environmental resources," or that industrial development or redevelopment on any particular parcel "is in any way incompatible with the protection of the natural environment." Attachment 1 to this Reply at 17-18.

The Commonwealth's statements in 2009 belie its contention in 2017 that "prior or current property use is simply irrelevant to the applicability of MassDEP's regulations prohibiting a solid or hazardous waste disposal facility within an ACEC." MA.Resp. at 20. The same statements also refute EPA's current position because they show that: (i) the state regulatory prohibition on siting a disposal facility in an ACEC should not affect remediation along the Rest of River; (ii) the designation of this particular ACEC was not intended to impede appropriate industrial redevelopment within its boundaries; and (iii) the regulations at issue should not be applied to (or should be waived for) the proposed use of the Woods Pond Site because a disposal facility there would occupy an industrial area used as a sand and gravel quarry (*i.e.*, not an area with "unique environmental resources"), and because on-site disposal would not affect any of the resources of the ACEC and thus would not be "incompatible with the protection of the natural environment."[3]

C. EPA's Retention of Indefinite Authority to Order Additional Response Actions Because a Numerical Performance Standard Has Been Exceeded or a Third Party Has Decided to Do "Future Work" Along the River Conflicts with the CD.

In its Petition, GE also argued on contractual grounds for the exclusion of two groups of Modified Permit conditions – the Downstream Transport and Biota Performance Standards, and

[3] EPA also contends that construction of a facility at the Woods Pond Site would violate certain requirements of the Massachusetts hazardous waste regulations – *e.g.*, the requirement that a landfill not be located within 1000 feet of a private drinking water well – and may not meet other locational requirements of those regulations. EPA.Resp. at 20. However, apart from the ACEC prohibition, the state hazardous waste regulations exempt facilities that manage PCB waste in compliance with EPA's TSCA regulations, as the on-site facility here could do, as discussed above. 310 CMR 30.501(3)(a). Thus, the locational criteria of those regulations would not apply. *See* GE.Pet. at 18 n.12.

the "Future Work" provisions. *See* GE.Pet. at 43-47, 48-51. These conditions address different subjects but share a common flaw: They all violate the CD by allowing EPA to order GE to perform additional remedial actions far into the future (and long after the completion of the remedies selected in the Modified Permit and reviewed by this Board and the First Circuit).

1. GE's arguments are ripe for review.

EPA contends that GE's arguments on these conditions are not ripe for review. EPA.Resp. at 45, 52. Since "no Future Work responsibilities have to date been placed on GE," EPA says, "a conflict has not presently occurred, and may not occur at all, so it is not presently ripe for adjudication." *Id.* at 52. *See also id.* at 45 (arguing that GE's objections to Downstream Transport and Biota Performance Standards "are based upon speculative concerns that may never arise").

EPA's ripeness argument fails because GE's only opportunity to challenge these provisions of the Modified Permit is through this proceeding (and any subsequent appeal to the First Circuit). The issue of ripeness turns on the "fitness of the issues for judicial decision and the hardship to the parties of withholding court consideration." *Pacific Gas & Electric Co. v. State Energy Resources Conserv. and Dev. Comm'n*, 461 U.S. 190, 201 (1983). Here, the issue of the correct interpretation of the CD is undeniably fit for review, and GE could suffer hardship if the issue is not resolved now. If GE waited to challenge these requirements until EPA implemented them, EPA would certainly argue that it would be too late to challenge those requirements themselves since the requirements would already be included in the Modified Permit. While EPA notes that the CD provides for administrative and judicial dispute resolution of disputes during remedy implementation, EPA.Resp. at 52 n.28, those provisions do not apply to "the modification of the Reissued RCRA Permit to select the Rest of the River Remedial Action in accordance with Paragraph 22….” CD ¶138.c. The Board should not heed EPA's request to effectively deny review of these conditions.

2. The Downstream Transport and Biota Performance Standards violate the Consent Decree and exceed EPA's authority.

EPA concedes that these Performance Standards will enable it to select and order the performance of additional corrective actions whenever the numerical benchmarks are exceeded for the specified duration. As GE anticipated in its Petition, EPA claims this open-ended authority by reference to several provisions in the CD, but it says nothing new about them, and nothing of substance that GE has not already refuted.

For example, although EPA repeatedly acknowledges that its ability to order additional remedial actions is limited by the CD, EPA.Resp. at 46 (conceding that EPA can order additional actions only "*in accordance with the Decree*") (emphasis in original), and that this power is contractually limited to "specific circumstances," *id.*, it continues to turn a blind eye to the text of the CD and the specific circumstances under which (and specific processes by which) EPA can ask for additional remedial work.

The CD could not be clearer. It draws a bright line between two kinds of Agency authority: (i) EPA's ability to ***modify*** the remedial actions specified in the Modified Permit, and (ii) the Agency's ability to seek GE's performance of ***additional*** remedial actions. EPA can require modifications of already-specified (and already-reviewed) remedial actions under Paragraph 39.a of the CD, on which EPA principally – but mistakenly – relies. EPA.Resp. at 47-48. Paragraph 39.a does not apply here, however, because it expressly limits modifications to those that are "consistent with the scope of the [originally selected] response action." By contrast, the Performance Standards at issue purport to give EPA the power to demand "additional actions," Modified Permit Sections II.B.1.a(2) and II.B.1.b(2), not just to modify the remedial actions specified in the Modified Permit.[4] Under the CD, EPA can "seek[] to compel" GE to "perform further response actions relating to the Site" only under the covenant "reopeners" in Paragraphs 162 and 163. These provisions allow EPA to act only in tightly-limited circumstances and only by instituting new proceedings or issuing a new administrative order. The Performance Standards at issue go far beyond that limited authority. GE has already explained why, GE.Pet. at 43-47, and nothing that EPA says here requires an additional reply.

Likewise, EPA continues to insist that GE's obligation to perform long-term Operation and Maintenance ("O&M") exposes it indefinitely to the kind of "additional work" requirements contemplated by the Performance Standards at issue. EPA.Resp. at 46. It is true that the CD requires GE to perform O&M, and that the Modified Permit requires O&M, too. GE has not objected to this requirement and stands ready to meet its legitimate O&M obligations.

The flaw in EPA's position, however, is that GE's O&M obligations are not stated in the Downstream Transport or Biota Performance Standards. The Modified Permit contains a separate condition devoted specifically to the subject of O&M. Modified Permit Section II.C. If the Performance Standards at issue had merely cross-referenced Section II.C – *i.e.*, if they had merely reiterated that GE must conduct O&M on the remedial measures it performed to achieve the Downstream Transport and Biota Performance Standards – then GE would not object. But the Performance Standards at issue go well beyond what Section II.C authorizes. They purport to

[4] EPA asserts that the additional work would be consistent with the scope of the Remedial Action because the Modified Permit gives EPA the authority to require such work. EPA.Resp. at 47 n.26. If that were correct, then EPA could include a provision in the Modified Permit that simply said, "GE shall undertake any future response actions that EPA deems protective of human health and the environment," and any such response action would be deemed consistent with the scope of the initial Remedial Action. That would render meaningless the "consistent" language in Paragraph 39.a.

authorize EPA to require "any additional actions" that the Agency deems necessary to achieve and maintain the Performance Standards. Modified Permit Sections II.B.1.a(2) and II.B.1.b(2). "Any additional actions" is on its face a broader category than "Operation and Maintenance," since the purpose of O&M is to maintain the effectiveness of response actions that have already been selected and implemented, not to serve as a vehicle for requiring new response actions.[5] Indeed, the only reason to include distinct "additional action" requirements in the Performance Standards would be to give EPA an authority it does not already have under Section II.C. The existence of GE's O&M obligation, therefore, is irrelevant to the present issue.

It is not true, then, that the Downstream Transport and Biota Performance Standards are "no different than any of the other Performance Standards included in the Decree and the Permit," and that in challenging them, GE is unfairly arguing that "virtually all future actions to be required of GE must … be included in the Permit." EPA.Resp. at 45. These Performance Standards are very different from the others, whose achievement is ascertainable by doing specified work (*e.g.*, actions to remove and cap sediments to achieve an average PCB concentration of 1 mg/kg). The Downstream Transport and Biota Performance Standards, in contrast, are numerical standards that could require significant additional, unspecified response actions to achieve far into the future. GE's position in challenging them is not that EPA must necessarily specify all future response actions now. Instead, EPA must comply with the CD, which provides two avenues for requiring response actions by GE: (i) EPA can specify them now, as provided in CD ¶22.n and CD-Permit Condition II.J and subject to EPA's modification rights in CD ¶39.a; or (ii) if EPA believes that additional response actions are required later, it

[5] The reference in Section II.C to "other response actions," relied on by EPA (EPA.Resp. at 46), must therefore be read as referring to response actions that are necessary to maintain the implemented remedy, not brand-new ones.

can follow the reopener process specified in CD ¶¶162 and 163. Any other later requirements are barred by the covenants in ¶161 themselves.

3. The "Future Work" requirements violate the Consent Decree and exceed EPA's authority thereunder.

GE made a similar argument in its challenge to the "Future Work" requirements in the Modified Permit, under which GE would have to conduct "response actions to be protective" of any future project or work in the river or floodplain implemented by a third party in Massachusetts, and certain such projects or work in Connecticut. As with the Downstream Transport and Biota Performance Standards, EPA exceeded its authority under the CD when it imposed permit conditions that empower EPA to require GE to perform additional response actions years into the future. EPA contends that this power exists without having to invoke the reopeners, without evaluating its selection under the CD-Permit criteria, and without giving this Board or the First Circuit any present basis on which to review the Agency's decision. GE.Pet. at 48-51.

This issue, then, also turns on an interpretation of the CD. *See* EPA.Resp. at 52-53 (arguing that CD authorizes these "potential actions"). It is not a technical issue, as EPA alternatively, but wrongly, maintains. EPA.Resp. at 50, 53-54. Again, moreover, GE is not demanding absolute certainty or seeking a "free pass on its responsibility" for addressing PCBs in the Rest of River, EPA.Resp. at 51, but simply insisting on its contractual due – *i.e.*, the CD requirement that EPA either specify the response actions now or, if it cannot and believes that additional response actions are required later, follow the covenant reopener process specified in Paragraphs 162 and 163. Invalidating the Future Work requirements would not necessarily insulate GE from future liability to third parties who might undertake such work. If they have claims against GE, they would assert and – if necessary – litigate them in the context of the specific facts. The Future Work requirements, on the other hand, prejudge and adjudicate GE's liability to such hypothetical future plaintiffs before their claims gestate, effectively declaring now-for-then that GE is 100% responsible, regardless of the circumstances.

Finally, EPA argues that these Future Work provisions essentially constitute Conditional Solution requirements, which GE agreed to in the CD, even for the Rest of River. EPA.Resp. at 52-53. However, as GE has shown, it did not agree to conduct unspecified response actions anywhere in the Rest of River; indeed, the CD's Conditional Solution requirements do not apply to river projects at all. GE.Pet. at 49-50.[6] All of EPA's arguments ignore the language of the CD to gut its purpose.

III. The Other Challenged Elements of the Modified Permit Are Clearly Erroneous.

The remaining issues raised by GE's Petition may not turn directly on the interpretation of the CD, but EPA cannot rescue the other challenged aspects of the Modified Permit through a blanket appeal to "deference." Under the CD, this Board's review is one step in a process that may lead to review by the First Circuit under Section 7006(b) of RCRA. CD ¶22.q. Under established law, EPA's action will be deemed arbitrary and capricious if it relied on improper factors, failed to consider an important aspect of the problem, or offered a rationale contradicting the evidence before it. *Motor Vehicle Mfrs. Ass'n v. State Farm Mut. Auto. Ins. Co.*, 463 U.S. 29,

[6] EPA points to a clause in the introduction to CD ¶34 stating that the Performance Standards for Conditional Solutions shall include requirements "that may be identified as Performance Standards for a Conditional Solution in the Rest of River SOW…." That reference, however, does not reflect an agreement by GE to implement Conditional Solutions in the Rest of River. The CD provisions that actually require GE to implement Conditional Solutions apply ***only*** to defined areas upstream of the Rest of River. CD ¶¶25.d(vi)&(vii), 26.h. 29.b, and 30.a(ii). Further, all of the substantive requirements of Paragraph 34 pertain to the implementation of Conditional Solutions at those areas and refer to the Performance Standards established for those areas. CD ¶34.b,c,d. Besides, Conditional Solutions apply only to upland areas, not the River.

43 (1983). *See also Michigan v. Environmental Protection Agency*, 135 S.Ct. 2699, 2707 (2015). Each of the following elements of the Modified Permit is arbitrary and capricious and thus clearly erroneous for one or more of those reasons.[7]

A. The Remedy Selected for Woods Pond Conflicts with the CD and Is Clearly Erroneous.

GE argued in its Petition that EPA's deep-dredging remedy for Woods Pond is arbitrary and capricious because it is disproportionately costly and disruptive compared to a remedy that would involve much less removal yet be equally effective. Aside from its claim that the issue is moot because GE raised it in its Comments and EPA addressed it in its RTC, *see* Section I above, EPA's primary contention is that it weighed all of the relevant remedy-selection criteria and determined that its selected approach was best. By responding at this level of generality, EPA has evaded GE's specific argument – that EPA's selection of the deep-dredging remedy was arbitrary, clearly erroneous, and contrary to the remedy-selection criteria because it required vastly more sediment removal from Woods Pond, at greater cost and with more short-term adverse effects, than is needed to achieve protectiveness.

Thus, EPA does not (and cannot) dispute that, according to its own model, its deep-dredging remedy will achieve no greater reduction in PCB concentrations in fish or in direct contact or ecological risks than a remedy that requires GE to cap the Pond after conducting much less removal. EPA.Resp. at 27. EPA instead attempts to justify its remedy on the ground that it is "precautionary," *i.e.*, that a cap might one day be compromised by a flood, a dam breach or failure, or a cap breach. *Id*. at 27-28.

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[7] GE discusses three of these other challenged elements in this Reply. For the remaining provisions it contests, GE relies on its Petition.

Speculative benefits cannot support an undeniably more costly and intrusive remedy, especially where, as here, EPA resorts to guesswork about the potential benefits of its preferred remedy. During the long period of model development and application, if EPA believed that a breach or failure was a real risk at Woods Pond, it should have required GE to model that scenario, so that the impacts could be scientifically evaluated, rather than relying on an unsubstantiated supposition to justify what therefore amounts to an arbitrary decision. In fact, EPA has no concrete reason to be concerned about an engineered cap in Woods Pond. Under EPA's stringent cap design standards, the cap at Woods Pond would be designed to withstand large flood events (e.g., 100-year or 500-year flow events, Modified Permit at 34), and the risk of a breach will be negated by GE's ownership of the Woods Pond Dam, which means that GE itself will conduct the monitoring, maintenance, and repairs needed to prevent a dam failure. *See* GE.Pet. at 29.

EPA also postulates that, even if the PCB trapping efficiency of a deeper Pond (reducing downstream PCB transport) would be only marginally greater than that of a less extensive remedy, it could consider that marginal benefit to justify its remedy. EPA.Resp. at 29. But the potential benefit isn't just marginal here, it is negligible: According to model projections, the minor differences in trapping efficiency would make no difference in whether the Downstream Transport Performance Standard is attained, and would not translate to any reduction in risks due to fish consumption, direct contact, or ecological impacts.

B. The Remedy Selected for Rising Pond Conflicts with the CD and Is Clearly Erroneous.

GE's challenge to EPA's remedy for Rising Pond pointed out that there, too, the selected remedy would have no greater risk-based benefits than a less extensive, less costly removal-and-capping remedy. EPA cannot refute this; it has already admitted that such a remedy would achieve similar reductions in fish PCB concentrations, ecological exposures, and downstream PCB transport. RTC at 185. Its response focuses instead on the fact that the thickness of the cap is not currently known and will depend on the design. EPA.Resp. at 30-31. That is beside the point. GE's example of a less extensive remedy may have assumed a six-inch cap, but its argument was broader. Even with a somewhat thicker cap, a remedy that involves less removal, followed by capping of the entire Pond, would still (i) be less expensive and disruptive than EPA's remedy, (ii) be comparably protective, and (iii) not impact flood storage capacity or cause an increase in flood stage on the River because the backwater effects in Rising Pond are controlled by the dam, and the extra caps would be placed only in areas that are already over three feet deep. GE.Pet. at 31.

EPA also asserts that a breach of the dam has already occurred once (in 1992) and could occur again. EPA.Resp. at 31. As GE has shown, GE.Pet. at 29 n.19, the previous event was not a breach of the dam, but rather a release of PCBs that occurred when the then-owner drew down water in the Pond to repair the dam without taking steps to contain the PCB-containing sediments. Such a mistake will not recur now that GE owns the dam, and would not be consequential even if it did happen once a cap has been placed over the entire Pond.

C. EPA Improperly Relied on Unsubstantiated Assumptions that Unspecified "Restoration" Measures Will Mitigate the Remedy's Adverse Impacts on the Rest-of-River Ecosystem.

In its Petition, GE argued that EPA improperly discounted the adverse impacts of the selected remedy as short-term issues that will be mitigated by "restoration." GE.Pet. at 34. There is no foundation for this rosy assurance: EPA has not identified measures that would achieve the promised restoration, or even assessed the possibility that restoration could succeed in the Rest-of-River area; it has simply assumed that some kind of "restoration" would return that ecosystem to its pre-remediation condition.[8]

EPA responds that the record contains "many studies" by GE or EPA regarding restoration measures and their likelihood of success, and that restoration at other riverine sites has been successful. EPA.Resp. at 32-33. But those "many studies" boil down to: (i) GE's Revised Corrective Measures Study ("RCMS"), which concluded that, for many affected habitats, restoration is ***unlikely*** to re-establish existing conditions and functions for many decades, if at all;[9] and (ii) the information presented in EPA's 2011 workshops and contained in its Comparative Analysis, which does not demonstrate the likely success of site-specific restoration measures in the Rest of River. *See* GE Comments at 34-36 and Att. D (in Att. 7 to GE.Pet.). The other sites listed by EPA consist of sites in Maine and Montana, as well as the Upper ½ Mile and 1½ Miles of the Housatonic. EPA.Resp. at 33-37. GE has already shown that the upper two miles of the Housatonic are very different from the Rest of River, where the challenges to successful restoration are far more extreme, GE.Pet. at 38-39; and the Maine and Montana sites are likewise so different from the Rest-of-River ecosystem that their experiences with restoration provide no support for an assumption that restoration is likely to succeed here. *See* Att. D to GE Comments at 19-20.

EPA also claims that the selection of the actual restoration measures to be implemented should be left to design. EPA.Resp. at 39-40. But GE is not suggesting that EPA should have prescribed the actual restoration methods that GE must use. While that step can be taken in

[8] Indeed, EPA now concedes, contrary to past assertions (Comp/Analysis at 29; in Att. 10 to EPA.Resp.), that restoration will ***not*** return the ecosystem to its pre-remediation condition, but will create a "novel ecosystem." EPA.Resp. at 38.

[9] *E.g.*, RCMS at 5-27 – 5-28, 5-37, 5-61, 5-89 (included in Attachment 2 to this Reply).

design, EPA cannot postpone its obligation to assess the selected remedy under the enumerated criteria, *i.e.*, to identify potential restoration measures and to assess their site-specific likelihood of success in the Rest-of-River habitats where they would apply. The Agency cannot simply rely (as it does here) on GE's RCMS or its Evaluation of Example Areas (*id*.), because, as noted, GE concluded that, in many habitats, the restoration techniques it assessed were unlikely to successfully mitigate long-term impacts.[10]

CONCLUSION

For the foregoing reasons and those set forth in GE's Petition, GE reiterates its request for the relief requested in its Petition.

STATEMENT OF COMPLIANCE WITH WORD LIMITATION

In accordance with 40 C.F.R § 124.19(d)(1)(iv), undersigned counsel certifies that the foregoing Reply to EPA Region 1's Response to GE's Petition contains 8,494 words, as counted by a word processing system, including headings, footnotes, quotations, and citations in the count, but not including the cover, Table of Contents, Table of Authorities, Table of Attachments, Glossary of Terms, Statement of Compliance with Word Limitation, signatories, or Attachments; and thus this Reply meets the 8,500-word limitation approved by this Board's order dated November 8, 2016.

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[10] EPA also cites two attachments to its Comparative Analysis as identifying methods for riverbank and stream restoration. EPA.Resp. at 39. But those attachments discuss the techniques in general, not as applied to Rest-of-River habitats, and do not assess their likelihood of success as applied to specific portions of the Rest of River.

Respectfully submitted,

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Dated: March 24, 2017

Attachment 1

Excerpt from Designation of the Upper Housatonic River Area of Critical Environmental Concern by Massachusetts Secretary of Energy and Environmental Affairs (March 30, 2009)

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DESIGNATION of the

UPPER HOUSATONIC RIVER

AREA OF CRITICAL ENVIRONMENTAL CONCERN

located in portions of the

MUNICIPALITIES OF LEE, LENOX, PITTSFIELD AND WASHINGTON

WITH SUPPORTING FINDINGS

Following an extensive formal review required by the regulations of the Executive Office of Energy and Environmental Affairs (301 CMR 12.00) including nomination, review, on-site visits, research, public information meetings, a public hearing and written comment period, and evaluation of all public comment and assembled data, I, the Secretary of Energy and Environmental Affairs, hereby designate the Upper Housatonic River, located in portions of the municipalities of Lee, Lenox, Pittsfield and Washington, as an Area of Critical Environmental Concern (ACEC). I take this action pursuant to the authority granted me under Mass. Gen. L. ch. 21A, § 2(7).

I also hereby find that the wetland resource areas included in the Upper Housatonic River ACEC are significant to the protection of groundwater supply and public water supply, the prevention of pollution, flood control, the prevention of storm damage, the protection of fisheries, and the protection of wildlife habitat - all of which are public interests defined in the Wetlands Protection Act and regulations promulgated thereunder.

I. Procedures Leading to ACEC Designation

On September 2, 2008 I received a letter of nomination from 43 Massachusetts citizens, including State Representatives Denis Guyer, Smitty Pignatelli, and Christopher Speranzo, and State Senator Ben Downing, pursuant to the ACEC Regulations at 301 CMR 12.05. In a letter dated September 29, 2008 I accepted the Upper Housatonic River ACEC nomination for full review. In this letter I outlined the ACEC nomination review process including the initial public information meetings to be held in October of 2008. Notice of these public information meetings was included in the October 8, 2008 issue of The Environmental Monitor, published by the Massachusetts Executive Office of Energy and Environmental Affairs (EEA); in an September 30, 2008 press release, issued by EEA; in an article published in the Berkshire Eagle on October 4, 2008; and in an update posted on the ACEC Program website.

III. Boundary of the Upper Housatonic River ACEC

Upon review of the boundary as recommended in the nomination letter, oral testimony presented at the public hearing, correspondence submitted to the Secretary, and information gathered in the course of EEA agency review, I hereby designate the final boundary of the ACEC as the same boundary proposed in the nomination. Other than technical clarifications (such as of road names and of 200-foot Riverfront Areas and 100-foot wetland Buffer Zones), the final boundary is identical to the one nominated.

According to GIS data, the final designated Upper Housatonic River Watershed ACEC boundary includes approximately 12,276 acres. (According to GIS data provided by DFW for the nomination, the originally nominated boundary included approximately 12,280 acres.) The approximate acreage located in each municipality is as follows:

Lee	1,614 acres
Lenox	3,517 acres
Pittsfield	3,166 acres
Washington	3,978 acres

Discussion of Final ACEC Boundary

The environmental information available for the review of the nomination, summarized above in the Description of the Resources of the Upper Housatonic River ACEC, supports the basic approach for delineating the boundary described in the nomination. The flow of ground and surface water throughout and within the Upper Housatonic River watershed is essential to the health and integrity of the ecosystem of river, wetlands, floodplain, tributaries, steep slopes and the rare species habitats located throughout the designated area. The use of roads as a boundary is a reasonable approximation of the subwatersheds and the central resource features of the Upper Housatonic River area in most cases. However, in specific areas, especially where roads do not exist or to be inclusive of certain resources within subwatersheds, railroads, 100-foot wetlands Buffer Zone, 200-foot Riverfront Area, and municipal boundary lines are used to delineate the boundary.

Proposals to change the boundary

Several proposals to change the nominated ACEC boundary were submitted during the course of the public review or were provided as public testimony at the public hearing. Requests were made to exclude the northernmost Lee Industrial Zone or individual properties within it, several industrial properties in Lenox, and several municipal properties in Pittsfield. There were also requests to exclude October Mountain State Forest. Finally, there was a request to expand the boundary to add a conservation/residential zone in Lee.

In its letter, the United State Environmental Protection Agency (EPA) notes that the proposed ACEC includes an area that has been contaminated by the release of PCB's from the General Electric plant in Pittsfield. Pursuant to a consent decree signed by EPA, GE, the Commonwealth, the State of Connecticut, and the City of Pittsfield, GE is analyzing various remedial options for this area, known as the "Rest of River." EPA expresses a concern that "certain challenges would accompany the designation of an ACEC for an area covered by the cleanup process" and states that the ACEC designation should not "be used to delay or even preclude remediation, habitat protection, or restoration activities that we determine [are] necessary to protect human health and the environment." (The State of Connecticut articulates a similar concern in its comment letter).

At the same time, however, EPA also states that "if the designation goes forward, we will work closely with the Commonwealth and the community to address such challenges."

I agree fully with the EPA and Connecticut that the ACEC designation should not be used to delay or preclude remediation, habitat protection, or restoration activities along the Rest of the River. In my view, the ACEC designation is fully consistent with these objectives, in fact furthers them by highlighting the important ecological value of this stretch of the river and ensuring that this ecological value is considered in the remediation decision. I also agree with EPA that to the extent there is any conflict between the ACEC designation and the remediation (and I am not aware of any such conflict at this time), EEA and its agencies will work with EPA, Connecticut, and others to resolve such conflicts in a good faith, reasonable manner.

EPA also requests that in the ACEC designation, I either exempt the remediation activities from any restrictions imposed by the ACEC designation, or clarify that certain types of activities are allowable under various regulations that are triggered by the ACEC designation. I believe that it is premature to act upon this request, as no remedy has been selected, and indeed GE and other stakeholders are still analyzing the benefits and detriments of a wide variety of approaches. I also believe that it is unnecessary in light of the level of cooperation and broad agreement on goals that has characterized the remediation process thus far.

Requests to exclude industrial properties

The Town of Lee Board of Selectmen and Planning Board wrote to offer "qualified support" of the ACEC from Woods Pond to the north, requesting that the Town's Industrial Zone with manufacturing and a gravel and asphalt plant within the nominated ACEC be excluded. Although the Lee Community Development Corporation first opposed the ACEC, they later submitted a written letter supporting the Lee boards' qualified support. Lane Construction Corporation submitted a letter requesting that the section of the Housatonic River adjacent to Crystal Street, including any property owned by Lane, be excluded from the proposed ACEC. In response to other comments in Lane Construction's letter, I wish to make clear there are no prohibitions on renewing water withdrawal permits within ACECs, however, higher scrutiny may be used in reviewing the hydraulic effect on any wetlands when reviewing a permit renewal application; there are no zoning changes associated with ACEC designation; and there are no restrictions on the "current allowable uses" of their properties based upon ACEC designation.

Several existing industrial business interests in Lenox requested that their properties be excluded from the ACEC. I do not believe that any of these businesses will be restricted from continuing to conduct their existing businesses based upon the effects of ACEC designation.

I find that the resources contained within these areas in Lee and Lenox that border the Housatonic River itself, or are located within the adjacent floodplain, Riverfront Area, and contributing subwatersheds, are important to the central integrity of the ACEC. Thus I must respectfully decline all of these requests for property exclusions. The ACEC is not intended to impede development or redevelopment, and I find that the challenge of balancing environmental protection of critical resources with the support of economic improvements to the region through appropriate and sustainable development is worthy of our concerted efforts. The designation is intended to encourage sensitively designed development within the ACEC that incorporates Low Impact Development (LID) techniques and best practices to minimize impacts to the important ecological and cultural resources of the Upper Housatonic River.

I also received a request from Interstate Biofuels, LLC. This company intends to purchase a 5.5 acre parcel in Lenox to build a biofuel production facility, but expresses strong concern that the

ACEC designation will interfere with the permitting of this facility. This facility will produce approximately 15 million gallons per year of a clean, biofuel product that can be used for vehicles with diesel engines and in residential and commercial furnaces using heating oil. I believe that the development of facilities to manufacture clean and non-fossil based fuel are manifestly in the public interest, as such facilities will lower greenhouse gas emissions and help make Massachusetts a center of clean energy technology. Facilities such as this one are also needed to enable Massachusetts to meet the requirements of the Clean Energy Biofuels Act, which Governor Patrick signed into law in 2008.

I also believe that this is a promising location for this facility, as the site is a discontinued paper mill and therefore represents a creative re-use of property. Also, the property is located in Lenox's industrial zone, and is contiguous to an active railroad line, which allows the organic materials and the biofuel byproduct to be shipped by rail, thereby further reducing the greenhouse gas emissions that would otherwise be associated with the project.

I have decided not to exclude this property from the ACEC designation, just as I have rejected excluding other industrial properties. My decision should not be construed as a determination that this five acre parcel has unique environmental resources or that this proposed biofuel facility at this location is in any way incompatible with the protection of the natural environment.

In response to the general concerns expressed by Interstate Biofuels, I would like to state clearly that the inclusion of this parcel is not intended to place additional burdens upon this project, or in any way suggest that the project should be denied by state or local permitting agencies. For example, should EEA's MEPA Office review an Environmental Notification Form ("ENF") under MEPA and 301 CMR 11.00 for this project, and should it exceed **only** the ACEC threshold at 301 CMR 11.03(11), a rebuttable presumption will exist that the project will not require the preparation of an Environmental Impact Report ("EIR").

Requests to exclude municipal properties

The Mayor and the Pittsfield Department of Community Development submitted comments indicating endorsement of the ACEC if the City-owned wastewater treatment plant and Farnham Reservoir with "associated city owned lands in [Washington]" were excluded.

I find that the Farnham Reservoir, a municipal public water supply, and its surrounding protected watershed lands are important resources worthy of protection under the ACEC Regulations and therefore are not excluded. The City's wastewater treatment plant is located in a central area of the ACEC with adjacent resources of floodplain, wetlands, potential vernal pool, river, coldwater fisheries, and rare species and wildlife habitat and is also vital to the integrity of the ACEC and is therefore not excluded.

However, it is not the intention of the ACEC designation to prohibit or complicate future permitting for either of these important public service industries for drinking water supply and for wastewater treatment should they need to upgrade, renovate, or expand their operations. Furthermore, I note the public health interests served by both of these facilities.

Requests to exclude October Mountain State Forest

Two off-road vehicle organizations submitted comments requesting that October Mountain State Forest be excluded from the ACEC boundary to avoid potential closure of the Forest to off-road vehicle use currently permitted on this DCR property. I understand that DCR has conducted a multi-year public review of Off-Highway Vehicle (OHV) use of public DCR properties resulting in criteria for the sustainable practice of this recreational use on DCR properties as concluded in

Attachment 2

Excerpt from GE's Revised Corrective Measures Study Report (October 2010)

ARCADIS
Infrastructure, environment, buildings

ANCHOR QEA

AECOM

General Electric Company
Pittsfield, Massachusetts

Housatonic River – Rest of River
Revised Corrective Measures Study Report

October 2010

occur, and the appropriate BMPs would be selected for implementation during that work in an effort to reduce direct and indirect impacts. In addition, an evaluation would be performed to determine the availability of necessary proper construction equipment, materials, and qualified labor.

Although use of these BMPs, where applicable and appropriate, would help to control the impacts of the construction activities to some degree, they would not prevent the adverse impacts of the remediation, as discussed further in Section 5.3 below.

5.2.5 Modification of Remedial Alternatives

Each of the sediment and floodplain remedial alternatives, as well as the combinations of alternatives identified in Section 1.8, has been modified to incorporate the measures identified to avoid or minimize adverse impacts (where practical), as discussed above. Specifically, the sediment/riverbank remedial alternatives that involve active remediation will be assumed to include the use of revised bank stabilization measures as discussed in Sections 3.1.4 and 5.2.1; all alternatives have been modified to incorporate the revised access road and staging area locations discussed in Section 5.2.2; all alternatives will include consideration of any timing or sequencing options that may help to reduce impacts to state-listed and sensitive species (if feasible); and all alternatives will be assumed to use appropriate BMPs.

5.3 Description of Affected Habitats, Adverse Ecological Impacts, Restoration Methods, and Post-Restoration Conditions

As discussed in Section 5.1, the riverine, riparian, and floodplain system within the Rest or River, particularly the PSA, possesses exceptional natural resource characteristics that provide numerous significant ecological functions. Most of the remedial alternatives would involve substantial disturbances of that system. As discussed in Section 5.2, there is no feasible way to avoid or significantly reduce the adverse impacts to the PSA ecosystem that would result from those disturbances. Accordingly, it is critical to consider whether and to what extent this unique system can be restored to its pre-remediation condition and level of function.

Ecological restoration is a relatively new discipline. As defined by the Society of Ecological Restoration International (SERI, 2004), "ecological restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed." Because the natural resource variables that give rise to ecological characteristics are complex, and the means of restoring those characteristics are still being developed and do not have a long track record, the ability to accurately predict the outcome of restoration efforts has significant limitations. However, generally speaking, restoration of a small area involving one or a limited number of natural resources is more likely to succeed than the restoration of a large, complex, multi-resource riverine, riparian, and floodplain system like that of the PSA. This is true because, among other reasons, the habitats of the PSA do not exist in isolation. They are functionally interdependent and together comprise the large, contiguous corridor of the PSA. For example, aquatic riverine habitat cannot be considered separately from the banks and floodplain, and the life cycles of many aquatic species have aerial/terrestrial periods or are dependent upon terrestrial processes (e.g., food inputs). Therefore, the prospect of in-stream restoration success cannot be evaluated without also considering the adverse impacts of related activities (e.g., bank remediation, floodplain remediation, construction of access roads and staging areas) on adjacent wetland/terrestrial habitat, which in many instances is essential to the survival of species associated with the river.

This section provides a general discussion of these issues for each of the main categories of habitats that could be affected by the remedial alternatives. Those habitat types are: (1) aquatic riverine (in-stream) habitat; (2) riverbanks; (3) impoundments; (4) forested floodplain habitats; (5) shrub and shallow emergent wetlands; (6) backwaters and deep marshes; (7) vernal pools; and (8) upland habitats. The discussions of these habitat types focus primarily on the PSA, although the discussion of impoundments includes the impoundments in Reaches 7 and 8 and the discussions of the floodplain habitats include notes relating to the extent of such habitats in Reach 7. For each of these habitat types, this section presents: (a) a description of the habitat type; (b) a general discussion of the adverse impacts of sediment, riverbank, and/or floodplain remediation work (as relevant) on the habitat; (c) a description of the methods that could be used for restoration; and (d) an assessment of the constraints on restoration and consequent likelihood of success of restoration efforts in re-establishing the pre-remediation conditions and functions of the resources. These issues were illustrated in the Supplement to Interim Response for the six example areas discussed in detail in that Supplement.[98]

For purposes of the evaluations in this Revised CMS Report, it is assumed that the remedial alternatives would include restoration using methods such as those described in this section. However, as noted in Section 1.2 and discussed in Section 2.1.3 above, GE has concluded that certain federal and state requirements that relate to restoration of affected resources and might apply to other construction projects but do not address on-site hazardous substances or the media containing them do not constitute ARARs for the Rest of River remedial action. Moreover, such requirements would exceed EPA's remedial authority under CERCLA and would amount to actions to address natural resource damages, for which GE has a full covenant not to sue under the CD in this case. Accordingly, the discussion of restoration methods in this Revised CMS Report and the assumption that the alternatives would include

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[98] Although this section focuses on the impacts of sediment, floodplain, and riverbank remediation on these habitats and the restoration of the habitats affected by such remediation, the same concepts also apply to any impacts from the treatment/disposition alternatives on those habitats and the associated restoration of habitats affected by those alternatives. See Section 9 of this Revised CMS Report.

them should not be regarded as a proposal or commitment by GE to implement those methods or any other restoration methods.

5.3.1 Aquatic Riverine Habitat

5.3.1.1 Description of Habitat

Habitat Types Within the Riverine Environment

The Housatonic River between the Confluence and Woods Pond includes two primary flowing water habitat designations (as defined by NHESP, Swain and Kearsley 2000): Medium Gradient Stream (MGS) and Low Gradient Stream (LGS). In this stretch of the river, there are 9 acres of MGS, running from the Confluence to approximately the Holmes Road Bridge, and 117 acres of LGS, from approximately Holmes Road to Woods Pond, although the boundary between these two habitats is not well defined. Two other aquatic habitats are distinguished from the stream itself by NHESP (Swain and Kearsley 2000) – riverine point bars and mud flats. Riverine point bars include deposits of coarse material near the edge of the river, typically at an inner bend, and are spread throughout Reaches 5A and 5B. Mud flats are composed of finer material deposits, usually of higher organic content, also along the river edge. The extent of mud flats has not been quantified within the PSA, but they are noted as a seasonally available habitat, associated with low late summer and early autumn water levels, entirely in association with LGS in Reach 5C.

Physical Features

The Housatonic River within the PSA transitions from moderate to low channel slope. Elevational gradient along the river length within the PSA is a primary factor in establishing the features of the riverine environment and the associated habitat types. Water velocity, channel depth, river width, substrate, and bank slope are all affected by stream gradient. In the upstream MGS area, water velocities are at least moderate and substrate is dominated by coarse sand to gravel or even cobble, with some boulders present and very little silt. Maximum water depth is typically 1.5 to 5 feet in the main channel, with some pools and riffles but mostly run habitat (moderate to rapid non-turbulent flow with little exposed substrate). Banks are high in most MGS area, but there are sufficient cuts in the bank to provide functional linkage with the adjacent floodplain.

Stream gradient declines downstream of Holmes Road, and a transition to LGS occurs. For purposes of classification in this response, the transition zone has been included with LGS in the characterization of habitat areas, but the change is actually quite gradual.

Riverine point bar habitat is formed at points where higher water velocities transition to lower velocities as a function of channel changes, usually on the inside of a river bend, but where velocities are rarely high enough to wash away accumulated sediment. Typically, point bars have a gentle slope and are often submerged during flood events and periods of high water. These river features accumulate downed woody material and other debris during times of high water levels, and are important for the emergence of insect larvae and for providing access between terrestrial and aquatic habitats for a variety of wildlife. These conditions are relatively uncommon in the PSA, and riverine point bar habitat occupies only an acre of the overall riverine habitat.

Progressing downstream in the river channel, the substrate becomes dominated by silts, organic muck, and fine sand in the LGS area. Some gravel, cobble, or boulders may be present, particularly along the margins, but are not a major component of the submerged substrate. Mud flats may form as water levels decline during prolonged periods of low flow. Maximum water depth can be 10 feet in the main channel, but is more typically 6 to 7 feet in the PSA. LGS area occupies the valley floor and contains considerable meanders, providing much more river length per mile than the actual linear distance between two points a mile apart. Water levels fluctuate seasonally, as with a lake, but are subject to more rapid rises in response to storms, and are usually highly connected to the floodplain, allowing high flows to spread laterally into adjacent wetlands. Woods Pond Dam accentuates the LGS attributes, backing up water during high flow events and potentially altering the location and extent of the transition zone from MGS to LGS.

Dead trees and branches that fall into the river create habitat features that are very important to physical structure, localized flow pattern, substrate features, and overall habitat value for many species. Such large woody debris is a dominant visual aspect of MGS and much of the transition zone to LGS. Woody debris is present but often submerged in LGS. While such debris may not be visible, it adds considerable structure and affects depositional patterns within the LGS. Woody debris creates variation in habitat over space and time in the river; old debris eventually decays, crumbles, and moves downstream, while newer debris replaces it, although not at a uniform rate and often not in the same locations.

In the PSA, MGS and the transition to LGS occur in Reach 5A, while Reaches 5B and 5C are entirely LGS. The riverine point bar habitat occurs in Reaches 5A and 5B; velocity changes in Reach 5C are generally not suitable for riverine point bar formation, despite the presence of many riverbends. Mud flats are associated with LGS in Reach 5C.

<u>Biological Communities</u>

Upstream areas (e.g., Reach 5A) host only sparse aquatic vegetation due to the sand and gravel substrate and high water velocity. Aquatic vegetation is more abundant in downstream areas (e.g., Reach 5C), but is still not a dominant structural feature of the river. The primary aquatic plant species in the Housatonic River are Eurasian watermilfoil, curly-leaf pondweed, narrow-leaf burreed, giant burreed, flatstem pondweed, Canada waterweed, and duckweed.

The watermilfoil and curly-leaf pondweed are invasive species and are prevalent in many aquatic areas in Reach 5. Shading by shoreline trees and shrubs occurs, restricting light and limiting temperature rise, further controlling aquatic plant growth. Aquatic vegetation is limited to small patches in sandy areas in Reach 5A and much of Reach 5B. Cover and overall habitat structure are more often associated with woody debris in those reaches. Dense patches of aquatic vegetation occur in Reach 5C, particularly peripherally, and submergent coverage may be substantially greater than is obvious from the river surface.

A wide range of aquatic invertebrates utilizes the Housatonic River within the PSA (Woodlot, 2002; Mass EOEEA, 2009), including a number of state-listed species. The state-listed species include six species of dragonflies (brook snaketail, riffle snaketail, arrow clubtail, rapids clubtail, spine-crowned clubtail, and zebra clubtail) and the triangle floater (a freshwater mussel). The snaketails and triangle floater are restricted to MGS habitat and the transition zone to LGS within the PSA, preferring gravelly substrates. The clubtail dragonflies can be found throughout the PSA in sandy or silty sediments. Other invertebrates commonly found in the PSA include other dragonfly species, damselflies, a variety of true bugs (*Hemiptera*), beetles, caddisflies, a wide range of true flies (*Diptera*), freshwater shrimp (*Amphipoda*), two native species of crayfish, and two other species of mussels (Eastern floater and Eastern elliptio). All but a few of these species live in the river in a larval form, morphing into a flying adult stage during spring and/or summer, although with long-lived larval stages or multiple generations in a year, the river is never without invertebrates. A few species, like mussels and some true bugs and beetles, never leave the stream in any life form. The adult stages of many aquatic invertebrates utilize the adjacent riverbanks and floodplain, as do many terrestrial insects.

Fish in the PSA are mostly warmwater species, with 25 species detected in surveys from 1998-2000, including sunfish species, perch, various minnow species, suckers, bass, pickerel, pike, bullheads, goldfish, and carp. Three coldwater trout species have been found in surveys since 1998, but are not abundant and only one (brook trout) is native. In 2000, the most abundant fish species in the upstream portion of the PSA (Reach 5A) was the white sucker, at 65% of the biomass, but other commonly occurring species included largemouth and rock bass, yellow perch, and various minnow species (*Cyprinidae*) (Woodlot 2002). In Reaches 5B and 5C, white sucker was again most abundant, at about 41% of the biomass, followed by largemouth bass, yellow perch, rock bass, and common carp (Woodlot 2002).

The point bars provide access between the river and floodplain for wading birds and small and large mammals. They also serve as emergence habitat for amphibian and invertebrate larvae, including some dragonflies. The higher, more gravelly portions of the point bars provide potential nesting habitat for the state-listed wood turtle.

The Housatonic River is the major migration and dispersal corridor in the PSA. It provides opportunity for aquatic and semi-aquatic organisms, including numerous fish species, wood turtles, beaver, and muskrat, to seek out and navigate into suitable habitat. It also allows for transport of nutrients, sediment, and food items from upstream terrestrial and aquatic communities to downstream areas.

There are 15 state-listed plant and animal species that have NHESP-mapped Priority Habitat within the River in the PSA and that could be found in the aquatic riverine habitat in the PSA. These species are listed in the following table.

Table 5-2 – State-Listed Species Associated with the Aquatic Riverine Habitats of the PSA

Common Name	Scientific Name	State Status
Arrow clubtail (dragonfly)	*Stylurus spiniceps*	Threatened
Rapids clubtail (dragonfly)	*Gomphus quadricolor*	Threatened
Spine-crowned clubtail (dragonfly)	*Gomphus abbreviates*	Endangered
Brook snaketail (dragonfly)	*Ophiogomphus asperses*	Special Concern
Riffle snaketail (dragonfly)	*Ophiogomphus carolus*	Threatened
Zebra clubtail (dragonfly)	*Stylurus scudderi*	Special Concern
Triangle floater (mussel)	*Alasmidonta undulate*	Special Concern
Wood turtle	*Glyptemys insculpta*	Special Concern
Water shrew	*Sorex palustris*	Special Concern
Bald eagle	*Haliaeetus leucocephalus*	Endangered
American bittern	*Botaurus lentiginosus*	Endangered
Common moorhen	*Gallinula chloropus*	Special Concern
Intermediate spike-sedge	*Eleocharis intermedia*	Threatened
Straight-leaved pondweed	*Potamogeton strictifolius*	Endangered
Wapato	*Sagittaria cuneata*	Threatened

5.3.1.2 Impacts of Remediation

This section provides a general description of the negative impacts of the various sediment remedial technologies on the aquatic riverine habitat. This section focuses on immediate and near-term impacts. The longer-term impacts of these technologies are discussed in Section 5.3.1.4. The specific long-term and short-term impacts of the individual sediment remedial alternatives on this habitat type are described in the evaluations of those alternatives in Section 6.

In-Stream Sediment Removal

Excavation of sediment in the river channel would be followed by either installation of a cap or backfilling. The actual removal of sediment would involve either excavation in the dry, after dewatering of a section of stream to facilitate such excavation, or removal in the wet using either mechanical or hydraulic dredging techniques.

With dewatering, disruption of the aquatic riverine habitat would be complete; no aquatic organisms remaining in the work area would survive. Most non-aquatic animal species able to flee would be chased away by construction activities. With mechanical or hydraulic dredging in the wet, mobile organisms such as fish would be able to vacate the work area, but immobile or less mobile species (most invertebrates, all plants) would be destroyed.

Removal of sediment would cause removal of viable propagules (the organisms and their eggs, seeds, or regenerative tissue of any kind) within those sediments, even with the shallowest planned excavation (1 foot). Following the excavation, backfilling or capping at depths of at least a foot and up to 4 feet would bury any remaining aquatic invertebrates and aquatic plants present in the remediation work area. These removal and capping activities, together with the riverbank remediation, over long stretches of the River would disrupt existing benthic communities and their habitats and, by extension, other elements of the riverine ecosystem (e.g., insect predators, fish, piscivorous birds and mammals).

In addition, woody debris, which is a major component of the riverine habitat of the PSA, would be removed as part of any excavation or capping. This would have multiple adverse impacts as woody debris is direct habitat for many species and also affects localized flow patterns to create habitat for still more species. Thus, the loss of woody debris would drastically and negatively affect the character of the in-stream habitat.

Further, invasion by non-native species, which are already a major threat to the unique plants and animals of this region, is highly likely following excavation and capping or backfilling. Invasive species, such as Eurasian watermilfoil and curly-leaf pondweed (already present in the PSA) and others not yet able to establish populations under current conditions, are likely to immigrate and dominate within the areas where sediment has been removed and new material put in place. Intensive invasive species control programs are not practical in the flowing water environment for the reasons discussed below in Section 5.3.1.4.

Some invertebrates would recolonize areas in which remediation work occurs, but different species would be expected to dominate, at least initially, as a result of changed substrate.

The pace and nature of recolonization would be determined by (among other factors) the scale, timing, and sequencing of the remedial alternative implemented. In the meantime, the species dependent on the benthic organisms would be adversely affected. Moreover, there could be a complete loss of state-listed species (such as the larvae of the state-listed dragonfly species and the triangle floater mussel), particularly if the remediation adversely impacts a significant portion of the local population, as discussed further in Appendix L.

Finally, due to the change in substrate and burying of aquatic macroinvertebrates and aquatic plants, a change in the fish community would be expected. While fish would move into the remediated areas, they would be challenged by the changed food resources and would likely have an altered species composition, at least initially. Bottom-feeding species which root around in soft organic sediments to obtain food would be replaced by more centrarchids (sunfish and bass), as the substrate would be more favorable to them for foraging. White sucker could still be the primary fish in the PSA, as they tolerate the greatest range of substrate conditions, but loss of cover may make these and other species more vulnerable to predation. In addition, there may be some reduction in the number of fish for several years, which could also affect piscivorous predators (e.g., kingfisher, mink, otter).

Habitat alterations of primary concern for in-stream excavation and related backfilling or capping undertaken as part of the sediment alternatives can be summarized as:

- Dewatering impacts on organisms and resting stages (eggs, seeds, overwintering forms);
- Removal of any organisms present in the sediments subject to excavation or dredging;
- Generation of turbidity and downstream movement of suspended sediment from areas not dewatered;
- Removal of woody debris, rocks, and other structural habitat elements;
- Changed substrate type that would not support some previously resident species of invertebrates, fish, and other wildlife;
- Loss of any state-listed species present; and
- Colonization by invasive species.

Capping Without Removal

Engineered capping without prior removal would involve the placement of a one-foot layer of sand and a one-foot (or, in some cases, 6-inch) layer of armor stone on top of existing sediments. The impacts of engineered capping on existing aquatic biota would be the same as with sediment removal followed by backfilling or capping. That is, this remedial technique would be expected to cause complete destruction of any non-mobile organisms in the remediation work area, as well as the other impacts discussed above for sediment removal with backfilling or capping.

In addition, the placement of a cap on top of the existing substrate would change the substrate type and elevation of the river bottom. In certain areas with relatively shallow water, such as along the shoreline, if consolidation of the underlying sediment does not occur, the increase in substrate elevation due to the cap could change the vegetative characteristics of those riverine fringing wetlands and the types of benthic invertebrates and other biota dependent on them. Indeed, in areas where the thickness of the cap (18-24 inches) (or the cap plus any subsequently deposited sediments) exceeds the depth of water and consolidation does not occur, the existing riverine wetland habitat would be lost and the emergent wetlands vegetation would be replaced by species tolerant of less frequently inundated or drier conditions.

Thin-Layer Capping

A thin-layer cap would be applied in riverine areas under some of the sediment remedial alternatives. The effects of a thin-layer cap would depend on the material type, the thickness of the cap, and the method and rate of placement. For purposes of assessing the impacts of this activity, it has been assumed that the thin-layer cap would consist of a 6-inch layer of sand placed at one time. The placement of such a cap would adversely impact many species inhabiting the riverine habitats, including the state-listed dragonflies in such areas. Most, if not all, of the organisms in the remediation work area, including plants and invertebrates, would perish by being smothered by the cap material. Only the hardiest plants (including invasive species) and invertebrates could regrow or make their way through the cap material, which is not desirable for maintaining biological diversity. Further, any plants that did survive would undoubtedly become stressed due to increased substrate depth over their roots.

The thin-layer cap would change the existing substrate type (which, in areas that would be subject to such a cap, is dominated by fine-grained silt) to one composed of sand. This would lead to colonization by a different aquatic plant and benthic invertebrate community, more compatible with that sandy substrate type, at least until deposition of silty sediments from upstream occurs (as discussed further in Section 5.3.1.4). In the meantime, the species dependent on the missing invertebrates and plants would be adversely affected.

Further, recolonization by invasive plant species is typical in such circumstances; and both Eurasian watermilfoil and curly-leaf pondweed, which are present already, could dominate the post-remediation plant community. As with areas subject to removal and capping or engineered capping alone, fish would move into the area, but would likely have altered species composition. There may also be a reduction in fish numbers for several years.

In addition, similar to the situation with an engineered cap, in areas where the water depth is less than 12 inches deep, which may occur along the shorelines, if consolidation of the underlying sediment does not occur, the increase in substrate elevation due to the thin-layer cap could change the vegetative characteristics of these riverine fringing wetlands and the biota dependent on them. Indeed, in areas where the thin-layer cap (or the cap plus any subsequently deposited sediments) exceeds the depth of water and consolidation does not occur, the emergent wetlands vegetation would be replaced by species tolerant of less frequently inundated or drier conditions.

Other Impacts

Any alteration of the stream bottom using any of these remedial approaches has the potential to alter patterns of groundwater discharge into the stream from the surrounding floodplain and uplands. Changes in flow volume, locations of spring seeps, and substrate particle size will likely affect how these hydrologic contributions contribute to base flow.

In addition to work in the River, riverbank and floodplain remediation activities and the construction of access and staging areas are also expected to affect the River. Vegetation clearing on the riverbanks or near the River would alter shading and food inputs (e.g., leaves, associated insects). Further, the life cycles of many aquatic species have aerial/terrestrial periods or are dependent upon terrestrial processes (e.g., food inputs), and thus the impacts of floodplain activities (e.g., access roads, staging areas, floodplain soil removals) on adjacent terrestrial habitat would in many instances affect processes that are essential to survival of species associated with the River.

Summary

Where sediment remediation is required, there is no way to avoid the direct effects of that remediation on the aquatic riverine habitat, and at least some indirect impacts are unavoidable as well. Wherever excavation is involved, the habitat would be altered and all in-situ aquatic organisms would be destroyed. Where engineered capping is applied, the habitat would be completely disrupted as well and existing populations would be eliminated. Thin-layer capping, as described above, would also result in the destruction of most, if not all, of the benthic invertebrates and aquatic plants in the areas subject to that technique.

5.3.1.3 Restoration Methods

A number of restoration procedures could be used in an effort to address the impacts described above and to restore the affected aquatic riverine habitat. Those restoration procedures are described in this section. However, there are significant constraints on the ability of these procedures to re-establish the pre-existing conditions and functions of this habitat type. Those constraints and the resulting long-term prognosis for recovery of this habitat type are discussed in the next section.

The first step in a restoration effort for aquatic riverine habitat would be to collect data on the existing conditions and functions of the riverine habitat to be restored. This would include a detailed baseline assessment that should include identification of representative water depths and velocities, substrate types, and important physical habitat features within the river corridor, including large woody debris, pools, undercut banks, and large rocks/boulders, if any. It would also include an identification of the biota present or expected to be present in this habitat (including any state-listed species). Using these data, design plans would be developed, which would likely include specifications on elevations of the stream bed, characteristics of the materials to be used for caps or backfill, location and specifications for woody debris or other natural physical structures (if any) to be replaced in the River in areas where they currently exist, any measures designed to replace specific habitat features used by state-listed species (e.g., wood turtle hibernacula), and protective measures for the surrounding habitat.

Restoration of affected aquatic riverine habitat would likely include the following steps, which would be coordinated with the various phases of the remediation process, as indicated below: These steps would be tailored as necessary depending on the type of remediation (removal/capping, engineered capping without removal, thin-layer capping) and the particular riverine area involved.

<u>Site Preparation Phase</u>

1. Conduct any necessary investigations of state-listed species, such as surveys for wood turtles, triangle floater mussels, and any other state-listed aquatic species with Priority Habitat within the area subject to remediation.

2. Identify any specific habitat features to be avoided and preserved consistent with the remediation plan (e.g., certain large trees along access routes) and review procedures to afford their protection during clearing activities for construction of access roads and staging areas.

Excavation Phase (if applicable)

1. Evaluate cut trees for preservation and subsequent re-use as habitat features; set aside selected material (if any) separately from woody debris to be removed from the site.

2. Identify large in-stream woody debris or other features present in the channel, if any, that may be replaced after excavation.

3. Perform surveys to assess the need to remove and re-locate any visible triangle floater mussels in the work area.

Capping/Backfilling and Grading Phase

1. Following excavation (where applicable), obtain and place capping or backfill material to re-establish pre-remediation stream bed topography (within a reasonable tolerance) to the extent practicable (except where the remedial alternative specifies otherwise).

2. For capping or thin-layer capping without prior excavation, place cap material in accordance with design.

Replacement of Woody Debris and Other Habitat Features (if any)

1. Replace existing large woody debris and/or boulders (if any) in the stream channel after excavation and/or capping in areas where such features are currently present and where doing so would not compromise the integrity of the cap and is consistent with the restoration design.

2. Install any specific habitat features (if any) designed to replace features used by state-listed species.

It is assumed that this restoration program would not include active planting of native aquatic vegetation. Rather, it is assumed that natural recolonization of plants from upstream would occur as suitable substrate conditions develop over time. However, given the presence of invasive species within the watershed, it is likely that recolonization in many vegetated areas would include the establishment of invasive species, which are likely to impede and dominate the growth of native vegetation and which are impractical to control in flowing water.

Following implementation of the above-listed restoration measures, post-restoration monitoring would be conducted in accordance with a post-restoration monitoring plan, typically for a period of five years. Monitoring programs for stream restoration can involve a stream-specific suite of physical, chemical, and/or biological variables through a combination of quantitative and qualitative methods. It is anticipated that this program would include visual observations of the restored aquatic habitat within the River to assess substrate features and any structures replaced in the River. See also Section 3.7.1 above. The details of the monitoring and maintenance program would be determined during design.

5.3.1.4 Evaluation of Restoration Constraints and Post-Restoration Conditions

Despite the implementation of the restoration procedures described in Section 5.3.1.3, there are significant constraints on the ability to restore aquatic riverine habitat. As a result, implementation of these restoration procedures would not necessarily result in returning the aquatic riverine habitat to its pre-remediation condition or level of function. This section describes those constraints and their associated effects on the likelihood of returning this habitat type to its pre-remediation state and the timing in which this might occur.

Loss of State-Listed Rare Species. The remediation of in-stream habitat would cause the loss of a number of state-listed species that use those habitats, as discussed in Appendix L. Many state-listed species tend to be so listed in part because they are highly sensitive to habitat quality that thus effective restoration of their habitat may be very difficult, if not impossible. Thus, the loss of these species constitutes a serious constraint on restoration in that such species may not ever recolonize the adversely impacted areas in the PSA, as discussed further below.

Change in Substrate Type. In riverine areas subject to removal followed by capping or subject to engineered capping alone, placement of the cap material would change the surficial substrate from its current condition to one consisting of armor stone. This change would be more extreme in the more downstream areas of the PSA, where the substrate is currently dominated by silts and fine sand, than in the more upstream areas, where the substrate is dominated by sand, gravel, and even cobbles. Backfilling with sand and gravel in removal areas that would not be capped would also cause some change in substrate but to a lesser degree. Placement of a thin-layer cap consisting of sand in areas dominated by silty sediments would also change the substrate type. These changes in surficial substrate type would result in a change in the organisms present in the sediments. Over time, deposition of natural sediments on top of the cap or backfill materials would be expected to naturally change the substrate back to a condition approximating its prior condition, with sand in the upper portion of the PSA and finer sediments downstream. But this could take years, during which other species, some invasive, may become dominant. This process would be lengthened to the extent that areas upstream of the particular area in question are subject to sediment remediation and/or bank stabilization, since those activities would diminish the amount of soil and sediment available to be transported into the area in question and thus delay the re-establishment of the pre-remediation substrate type.

Loss of Continuing Source of Woody Debris and Shade. As previously noted, woody debris is a major component of habitat in the riverine environment of the PSA and would be removed as part of any excavation or capping. Replacement of such debris in stream restoration efforts typically involves embedding or anchoring the debris in the substrate (see FISRWG, 1998; Saldi-Caromile et al., 2004), but this generally cannot be done without disturbing any capping material in place. Thus, while successful restoration depends on the presence of woody debris, it is constrained by the fact that the anchoring of such debris could be a threat to the continued integrity of any cap if not accounted for properly during design. In any case, it is not practicable to continue to supply such woody debris artificially over the long term.

In addition, remediation/stabilization activities on the banks of the river would eliminate the mature overhanging trees that exist on those banks (as discussed further in Section 5.3.2 below). While some vegetation would be planted on the banks and other vegetation would begin to grow back, that vegetation would consist of shrubs and herbaceous plants because of the long-term control efforts that would be necessary to restrict the growth of trees that could cause destabilization of the banks (see Section 5.3.2 below). As a result, there would be a long-term loss of continuing natural sources of woody debris from trees along the banks, altering habitat in the riverine environment. The loss of trees along the riverbanks would also result in greater exposure to wind and sun. This increased exposure would be expected to increase evaporation from the water surface as well as increase water temperature.

<u>Rate of Recolonization by Native Organisms</u>. As discussed above, aquatic habitat remediation would destroy most, if not all, non-mobile organisms present in the remediation work area. For any area subject to excavation with backfilling or capping, engineered capping alone, or thin-layer capping, biological recovery would depend on the nature and rate of recolonization from outside the area, and the nature and rate of recolonization would be determined by many factors, including the scale, timing, and sequencing of the remedial alternative. In general, the larger the area affected, the more uncertain the nature and rate of any recovery of the species currently present, particularly the state-listed species.

Recolonization of remediated riverine areas in the PSA is expected to be largely a function of transport of organisms and sediment from upstream. Initially, with sand, gravel, or cobble as the surficial sediment in remediated areas, certain groups of aquatic plants and invertebrates can be expected to recolonize from similar upstream aquatic habitats, although plant recolonization may be slower with less growth due to coarser substrates. As discussed above, the nature and rate of recolonization would depend, in part, on the extent of remediation upstream of the area in question (i.e., the extent of unremediated patches that could supply organisms to downstream areas), as well as how far the recolonizers have to move to reach the remediated areas.

For aquatic vegetation, it is expected that, as conditions resembling the previous substrate return, areas that were previously vegetated with aquatic plants would become vegetated again. However, the rate of such colonization is uncertain and would be slowed by upstream riverbed and riverbank remediation; and (as discussed further below) the recolonized plant community would likely be dominated by invasive species, which are already present in many areas in Reach 5. Moreover, as indicated above, in areas that are subject to an engineered or thin-layer cap without prior removal and where the cap thickness is close to the depth of the water, the change in substrate elevation could change the vegetative characteristics of these areas – or, in cases where the cap exceeds the depth of water, cause the emergent wetlands vegetation to be replaced by species tolerant of less frequently inundated or drier conditions.

For the benthic macroinvertebrates, while recolonization would occur as the substrate reverts to prior conditions, it is expected that the recolonized community would be dominated for some period of time by macroinvertebrate taxa that are more tolerant of stress, and that the more sensitive taxa would be severely reduced and may not have an opportunity to become established. Over time, continued accumulation of sediments would increase the diversity of habitat, resulting in a more complex and sustainable macroinvertebrate community, but that community is still unlikely to match the pre-remediation macroinvertebrate community in terms of composition, species diversity and richness, and relative abundance of species, at least for many years. In particular, sensitive species that are eliminated and are not represented further upstream, including some state-listed species like the triangle floater mussel, are unlikely to recolonize at all.

For fish, the gradual re-establishment of a healthy macroinvertebrate community would support a more robust fish community. However, individual species abundance would vary depending on the specific riverbed and riverbank conditions that develop over time, and the post-restoration fish community may not match the pre-remediation community for many years until the prevailing soft sands and silts have re-established conditions similar to those currently prevailing.

In summary, over time, in the upper portion of the PSA, as observed in the remediated 1½ Mile Reach, sand would become the dominant substrate. In that case, a gradual establishment of a biological community consistent with those conditions would be expected, although the length of time for that to occur and the abundance of organisms and richness of the mix of species in that community are all uncertain. Further, the return of certain specialized species such as any state-listed species whose local populations were adversely affected by the remediation is doubtful, and additional opportunistic or invasive species that take advantage of open space and available resources are highly likely.

Further downstream, if the remediation affects the LGS habitat dominated by finer sediments prior to remediation, there would be an initial change to surficial sediments dominated by gravel, sand, and/or cobble. A natural progression to finer surficial sediments would ensue as a natural riverine process. Again, a gradual establishment of a biological community consistent with those conditions would be expected, but the length of time for that to occur, the types and numbers of organisms that may be present, and the presence of any specialized species are all uncertain. As with upstream areas, loss of state-listed species whose local populations were adversely affected, as well as increased abundance of invasive species adapted to open or disturbed areas, is likely. The rate and extent of recolonization in these areas would depend, among other things, on the extent to which the remedial alternative would leave upstream areas undisturbed to supply organisms for recolonization.

High Potential for Colonization by Invasive Species: As previously noted, the species best adapted to colonize open areas may not be those that were there previously, when physical features were different. Rather, it is invasive species such as Eurasian watermilfoil and curly-leaf pondweed (already present in the PSA) and others not yet able to establish populations under current conditions that are likely to immigrate and dominate within the areas where sediment has been removed and new material put in place. Once established, these invasive species are likely to impede the growth of native species.

A sufficiently intensive invasive species control program would not be practical and may not even be possible in the aquatic riverine environment. A sufficient level of early detection would require multiple intrusive inspections through the area, and standard sampling protocols (aquatic rake tosses) would disrupt native vegetation and possibly fragment the invasive milfoil expected as a primary invasive in this area. With flowing water, use of herbicides would not be practical. Control would have to be by hand-pulling, which is effective only at low densities, would be logistically difficult, and would itself represent a disturbance that has a risk of damage to desirable species and also of introducing invasive species by carrying plant propagules inadvertently into the area.

Conclusion/Long-Term Outlook

Over time, following the remediation and restoration of aquatic riverine habitat, the physical substrate type in the river would be expected to approximate its prior condition, and a biotic community consistent with that substrate type would be expected to be present. However, the length of time for that to occur and the abundance of organisms and richness of the mix of species in a given area are uncertain and depend, in part, on the extent of upstream remediation. Further, the return of certain specialized species, such as state-listed species whose local populations were adversely affected, is doubtful; and colonization by invasive species is highly probable.

We have found no precedent for a stream restoration project on the scale that would be involved in most of the sediment alternatives (SED 3 through SED 9). A number of publications (Gore, 1985; Petersen, 1986; Cairns, 1995; Federal Interagency Stream Restoration Working Group, 1998; Saldi-Caromile et al., 2004) describe stream restoration case histories and extract recommendations and lessons for future efforts. Examples focus heavily on watershed management to limit inputs associated with adverse impacts (e.g., contaminants, sediment) and structural alteration to enhance habitat (e.g., pool creation, cover provision). No cases were found in peer-reviewed literature or textbooks involving restoration of a river like the Housatonic River in the PSA, which winds for 10 miles in a sinuous manner through a biologically rich and environmentally sensitive ecosystem.

5.3.2 Riverbank Habitat

5.3.2.1 Description of Habitat

Physical Description

The riverbanks of the Housatonic River between the Confluence and Woods Pond Dam have substantial variability in physical appearance and function. The slope and height of these riverbanks vary, with height generally decreasing from the Confluence to Woods Pond.

Riverbanks in Reach 5A, the upper portion of the PSA, generally range in height from 2 to 5 feet, with areas of high vertical banks ranging from 8 to 12 feet. Banks consist of silts and sands with a range of physical attributes, including sloped and vegetated banks, vertical and exposed banks, erosional banks with slumping, and erosional but vegetated banks. Vertical and exposed banks lack vegetative cover but provide important habitat functions discussed in more detail below. Undercut banks are an important habitat component of the riverbanks in Reach 5A and are more prevalent in Reach 5A than anywhere else in the PSA. Mature trees overhanging the river and dense herbaceous and shrub communities are also prevalent on the banks in Reach 5A and provide shading to the river and foraging opportunities for wildlife.

Riverbanks in Reaches 5B and 5C are markedly different from those in Reach 5A. Consisting of fine sands and silts, these riverbanks generally range in height from 2 to 4 feet and are well vegetated. Vertical banks are present on the outside bends of the river, while inside bends tend to be gently sloped. Undercut banks are present in Reach 5B but are less prevalent than in Reach 5A. Mature overhanging trees are present in most of Reach 5B but decrease in abundance near the downstream boundary. Riverbanks in Reach 5C consist of fine silts and are almost entirely low and gently sloped. Vertical and undercut banks are not present in this portion of the river.

Biological Communities

Vegetation along the riverbanks grades from mostly trees in Reach 5A and most of Reach 5B to a shrub-dominated mix with some trees and herbaceous growths in Reach 5C. Silver maple, red maple, eastern cottonwood, and box elder form much of the canopy in the upstream area, while the subcanopy, shrub and herbaceous layers are minimized by light limitation. Further downstream, the canopy tends to be sparse and includes mainly red and silver maple, black willow and gray birch. A variety of shrubs are abundant there, including silky and red osier dogwoods, silky and pussy willows, winterberry, speckled alder, meadowsweet, buttonbush, blueberry and northern arrowwood. Herbaceous species in lighted areas include various ferns, grasses, aster, goldenrod and the invasive purple loosestrife.

The riverbanks within Reach 5A are unique and an integral part of the overall riverine habitat. These banks provide a variety of functions for a range of wildlife species. Exposed vertical banks in Reach 5A provide suitable nesting habitat for two species of bank nesting birds, the belted kingfisher and the bank swallow. The vertical banks also provide potential nesting sites for several turtle species, including the state-listed wood turtle. The riverbanks in Reach 5A provide lodging habitat and slides for beaver and muskrat and foraging habitats for birds and mammals, including mink and raccoons. In particular, beaver activity along the banks is common in many places, with frequently occurring burrows evident. Undercut banks and woody accumulations offer hibernacula sites for wood turtles to overwinter. Large overhanging trees in this area provide shaded microhabitats and variability in water temperature within the river for fish, invertebrates, and shade-tolerant plant species, as well as foraging and perching sites for piscivorous and insectivorous birds.

The riverbanks in Reaches 5B and 5C also perform a variety of wildlife functions. Although exposed vertical banks and undercut banks are less prevalent in Reach 5B than in Reach 5A, they are present in Reach 5B, where they provide similar wildlife functions to described above for Reach 5A. Similarly, mature overhanging trees are present in portions of Reach 5B, particularly in the upstream portions; and where present, they offer shaded microhabitats within the river and foraging and perching sites for piscivorous and insectivorous birds. In the downstream portions of Reach 5B and in Reach 5C, where the banks are well vegetated with a shrub-dominated mix with some trees and herbaceous growth, those banks provide foraging habitat for a variety of birds and mammals.

A total of 20 state-listed plant and animal species have NHESP-mapped Priority Habitat that encompass the riverbanks in the PSA and are likely to be found in those bank habitats. These species are listed in the following table.

Table 5-3 – State-Listed Species Associated with the Riverbank Habitats of the PSA

Common Name	Scientific Name	State Status
Arrow clubtail (dragonfly)	*Stylurus spiniceps*	Threatened
Brook snaketail (dragonfly)	*Ophiogomphus aspersus*	Special Concern
Rapids clubtail (dragonfly)	*Gomphus quadricolor*	Threatened

Common Name	Scientific Name	State Status
Riffle snaketail (dragonfly)	*Ophiogomphus carolus*	Threatened
Spine-crowned clubtail (dragonfly)	*Gomphus abbreviatus*	Endangered
Zebra clubtail (dragonfly)	*Stylurus scudderi*	Special Concern
Wood turtle	*Glyptemys insculpta*	Special Concern
Water shrew	*Sorex palustris*	Special Concern
American bittern	*Botaurus lentiginosus*	Endangered
Common moorhen	*Gallinula chloropus*	Special Concern
Mustard white (butterfly)	*Pieris oleracea*	Threatened
Narrow-leaved spring beauty	*Claytonia virginica*	Endangered
Crooked-stem aster	*Symphyotrichum prenanthoides*	Threatened
Intermediate spike-sedge	*Eleocharis intermedia*	Threatened
Bristly buttercup	*Ranunculus pensylvanicus*	Special Concern
Bur oak	*Quercus macrocarpa*	Special Concern
Foxtail sedge	*Carex alopecoidea*	Threatened
Gray's sedge	*Carex grayi*	Threatened
Hairy wild rye	*Elymus villosus*	Endangered
Wapato	*Sagittaria cuneata*	Threatened

5.3.2.2 Impacts of Remediation/Stabilization

Under all sediment alternatives except SED 1 and SED 2, some or all of the riverbanks in Reaches 5A and 5B would be subject to bank stabilization, with removal of bank soil where necessary as part of the stabilization. SED 3 through SED 9 would involve such remediation on all riverbanks in Reaches 5A and 5B, and SED 10 would involve such remediation on a portion (approximately 12%) of the riverbanks in those subreaches. The bank stabilization activities that are part of these alternatives are described in Section 3.1.4, with details in Appendix G. These activities, particularly under SED 3 through SED 9, would cause numerous significant adverse impacts on the riverbank habitat in these subreaches. This section focuses on the immediate and near-term impacts of these activities. The longer-term impacts of bank stabilization activities are discussed in Section 5.3.2.4.

The bank stabilization activities would involve removal of riverbank vegetation and woody debris from the riverbanks, as well as the cutting back and reshaping of banks and removal of bank soil in many locations. This would result in the loss of large mature trees alongside, overhanging, and adjacent to the river in the areas subject to stabilization, leading to an open canopy, sparsely vegetated terrestrial community along and immediately adjacent to the river. The nearest mature trees would be located roughly 30 feet from the river, since such trees would be removed from the banks to facilitate implementation of the remediation/stabilization and to avoid subsequent destabilization of the banks. These conditions would result in a loss of shading and wind protection and increased water temperature in the river, as well as decreased large woody debris and overall organic material. They would also produce a corresponding reduction in the piscivorous and insectivorous birds that currently use these large trees as perching or cavity nesting sites (such as wood ducks, woodpeckers, kingfishers, and owls and other raptors), the dragonflies (including state-listed clubtail dragonfly species) that use these trees for perching and resting during their adult stage, and the reptiles and mammals that use the living and dead woody vegetation for shelter, resting, and basking (e.g., the state-listed wood turtle, salamanders, frogs and toads, and several rodent species such as mice and shrews).

The stabilization of the riverbanks would also, by design, have a direct and material impact on two of the current geomorphic processes that have allowed for the existing heterogeneous mix of riverbank types, including vertical and cut banks. These processes are bank erosion and lateral channel migration. As indicated in Section 3.1.4, the bank stabilization measures are intended to prevent significant bank erosion over the long term. To do so, the stabilization measures would be designed to basically lock the existing channel in a stable state or geometry. Thus, if successful, these measures would prevent the processes of significant bank erosion and lateral channel migration from continuing, leading to the loss of the vertical and undercut banks. This would result in the direct elimination of habitat for a number of riparian species that utilize the banks. Of particular concern is the loss of nesting sites for belted kingfishers and bank swallows, which build nest burrows in the vertical banks that are formed in the PSA. These species are known to return to these nest burrows over multiple years, demonstrating very strong site fidelities, but would find the stabilized banks no longer suitable for nesting. Similarly, the state-listed wood turtle uses overhanging banks for cover and overwintering, and also has strong site fidelity to specific riverbanks. This species would lose critical habitats for those activities.

The implementation of bank stabilization techniques would cause other adverse impacts on the local wildlife as well. For example, slides, burrows, and dens of mammals such as muskrat and beaver would be removed from the banks. The changes in riverbank slope, composition, and vegetation that would be part of bank stabilization would impede safe movement in some areas between the terrestrial and aquatic habitats required by a number of amphibian, reptile, and mammal species (such as leopard frogs, wood turtles, snapping turtles, beaver, and mink), as well as large mammals (such as deer and black bear) trying to drink from or cross the river during low water periods. The long-term prognosis for return of these bank functions is discussed in Section 5.3.2.4.

The bank remediation would also curtail or eliminate dispersal corridors in Reaches 5A and 5B for resident and migratory species that use the banks for those purposes. With long reaches of riparian banks altered, species moving either along the riverbank edge or through the riparian cover at the tops of banks would lose travel and migratory corridors. For example, neotropical migrant songbirds such as blackpoll warblers and water thrushes might not use these corridors any longer, which could lower their population numbers in the Rest of River. Overall, having long sections of stabilized banks would force species into suboptimal habitat (where they would be subject to increased predation) or eliminate these sections as dispersal and migratory corridors.

Finally, connectivity between aquatic habitats and adjacent upland areas would be disrupted, affecting virtually every species that uses the upstream two-thirds of the PSA river corridor in its current state.

In short, regardless of the bank stabilization techniques selected (including bioengineering techniques), implementation of bank remediation and stabilization activities throughout Reaches 5A and 5B would change the character of the banks and have major negative impacts on the riverine and riverbank habitats throughout these subreaches.

5.3.2.3 Restoration Methods

In an effort to address these impacts, bank restoration procedures could be applied in combination with the bank stabilization measures. Those restoration procedures are described in this section. However, as indicated above, there are significant constraints on these procedures that would prevent them from re-establishing the pre-existing conditions and functions of the riverbanks. Those constraints and the resulting long-term impacts of stabilization on the riverbanks are discussed further in the next section.

The first step in a restoration effort for the riverbanks would be to collect data on the existing conditions and functions of the riverbanks involved. This would be performed in conjunction with data collection on the aquatic riverine habitat, since physical processes occurring in the river greatly influence riverbank processes. The data relevant to the riverbanks would include data on the existing slope, substrate type, erodibility and sheer stress, geomorphological factors affecting the area (e.g., channel geometry and velocity, sediment transport, hydrodynamics), bankfull elevation (i.e., the elevation of the flow that transports the majority of a stream's sediment load over time and thereby forms and maintains the channel), presence and type of vegetation, and physical structures, as well as an identification of the plants and animals present or likely to use the bank (including any state-listed species). It would also be important to obtain information on the river-riverbank interface, since many species move between the river and the riverbank on a daily or a seasonal basis, and the nature and quality of the interface, including slope and cover, determine the suitability of that interface for those species.

Following collection of the data, detailed design plans would be developed, which would include specifications on bank reconstruction methods, bioengineering techniques, structure locations and elevations, and detailed planting plans. The restoration design would be coordinated and consistent with the design of the riverbank stabilization techniques and would build on those stabilization techniques. In fact, as previously discussed, the riverbank stabilization techniques would be selected with the objectives of not only effectively minimizing bank soil erosion, but also facilitating restoration to the extent feasible through implementation of bioengineering methods (e.g., the use of natural materials and the encouragement of the growth of riparian vegetation that is not inconsistent with the objective of stabilization) where practical. The design would also include, where appropriate and feasible, specifications for replacing state-listed plant species or habitat features used by state-listed animal species on the banks.

The general procedures for restoration of riverbanks would likely include the following steps, which would be coordinated with the various phases of the remediation process, as indicated below:

<u>Site Preparation Phase</u>

1. Conduct any necessary investigations for state-listed species or other special habitat surveys, such as surveys for wood turtles and kingfisher nest sites.

2. Identify any specific habitat features to be avoided and preserved consistent with the remediation plan and review procedures to afford their protection.

3. Identify trees and vegetation (if any) to be preserved or set aside for use as log vanes, root wads, or other riverbank bioengineering features.

<u>Clearing and Grubbing and Site Access Phase</u>

1. Evaluate cut trees and vegetation (if any) for re-use as log vanes, root wads, or other bioengineering features; set aside selected material separately from woody debris to be removed from site.

2. Stockpile stone, coir matting, and other bioengineering materials.

Bank Reconstruction and Grading Phase

1. Reconstruct point bars on the inside of meander bends, as identified in design plans.

2. Construct bankfull benches as identified in design plans.

3. Reshape or reconstruct banks as identified in design plans.

4. Install appropriate erosion controls to protect the new bank features, where necessary, until those features are established.

Installation of Flow Controls and Other Bioengineering Structures

1. Reevaluate bioengineering structures placement for minor modification of locations of vanes and other structures based on reconstructed bank conditions.

2. Install/implement flow controls and other bioengineering structures.

3. Install any other specific habitat features designed to replace features used by state-listed animal species on the banks.

Seeding and Planting

1. Apply appropriate native seed mix to the disturbed banks within the restoration area.

2. Plant live stakes and other herbaceous and shrub plantings as detailed in the final planting plans approved for the site. These plans would include, to the extent feasible, replanting any state-listed plant species that would be impacted.

3. Manage the new plantings according to final detailed specifications.

4. Implement an invasive species control plan immediately after planting.

Following implementation of these restoration measures, post-restoration monitoring would be conducted in accordance with a post-restoration monitoring plan, typically for a period of five years. It is anticipated that this program would include: (a) visual observations of the restored riverbanks to monitor for potential erosion and riverbank stability; (b) quantitative and/or qualitative monitoring of plantings on the banks to assess planting survival, areal coverage by herbaceous species, and the presence and extent of any invasive species; and (c) appropriate maintenance requirements, including an invasive species control program. See also Section 3.7.1 above. For stabilized riverbanks, this program would also be expected to include a long-term tree management plan to prevent trees from growing on those banks, because such trees would be subject to windthrow and overtopping from storm events, which could destabilize the banks, and thus their presence would be incompatible with the objective of bank stabilization. The details of the monitoring and maintenance program would be determined during design.

5.3.2.4 Evaluation of Restoration Constraints and Post-Restoration Conditions

Despite the implementation of the stabilization measures described in Section 3.1.4 and the restoration procedures described in Section 5.3.2.3, there are significant constraints on the ability to restore the riverbanks. Regardless of the stabilization and restoration techniques used, those measures would not result in re-establishing the pre-remediation conditions and functions of the riverbanks. This section describes those constraints and their associated effects on the likelihood of returning the riverbanks to their pre-remediation conditions and level of function.

Changes in Geomorphic Processes and Associated Loss in Bank Nesting Habitat: As previously discussed, the stabilization of riverbanks would be developed to prevent significant bank erosion over the long term and thus, if successful, would prevent or permanently curtail the continuation of the current geomorphic processes of bank erosion and lateral channel migration, which have allowed for the existing heterogeneous mix of riverbank types. This would result in the permanent elimination of vertical and/or undercut banks in the stabilized areas. In consequence, animals that depend on such banks would lose critical habitat. For example, bird species such as the kingfisher and bank swallow and several turtle species, including the state-listed wood turtle, that currently utilize the exposed and/or undercut vertical banks would lose nesting or overwintering habitats. Although wood turtle habitat requirements would be factored into final restoration design, some of the bank stabilization techniques that would be used, such as riprap and bioengineered wall-type construction techniques (e.g., geogrids), would not be conducive to future wood turtle use.

In addition, riverbank habitat within stabilized areas would lose some functionality as suitable nesting habitat for bird species that depend on sandy banks for nesting. While shrub plantings in certain areas would over time provide some nesting, resting, and feeding habitat for species such as passerine birds as well as cover for small mammals, potential nesting areas would be reduced.

Changes in Bank Vegetative Characteristics and Associated Loss in Overhanging Tree/Tree Canopy Habitat: In many locations, the riverbanks in Reaches 5A and 5B contain mature trees overhanging the river. In these areas, as discussed above, the implementation of bank stabilization/restoration techniques would result in a dramatic change from their current condition of mature overhanging wooded growth to conditions ranging from open, sparsely vegetated banks to those which over time would provide dense shrub growth. While shrub thickets can be developed in the stretches that have lower shear stress, the return of mature trees on the banks is incompatible with the objective of bank stabilization, as discussed above; and hence long-term management to prevent large trees from establishing in these portions of the riverbank would be needed. The long-term effect on the riverbank habitat is that the current wooded environment, characterized by a combination of mature overhanging trees and dense bushy shrub growth, would never be fully re-established. While tree species planted at the top of the bank (more than 30 feet farther away from the river than the current tree line) would eventually provide mature tree specimens (in approximately 50 to 100 years or more, as discussed in Section 5.3.4.4 below), these would not replicate the current condition of mature trees overhanging the river from the bank slopes.

This reduction in the extent of large, mature, overhanging trees and woody debris snags on the riverbanks would produce a corresponding reduction in the birds that currently use these features as perching or nesting sites, the dragonflies (including state-listed dragonfly species) that use these trees for perching during their adult stage, and reptiles and mammals that use these features as shelter or resting/basking sites. The plantings installed on the riverbanks as part of restoration, as well as the woody debris placed along the armored banks, would provide such functions to some degree, particularly after numerous years of growth for the new plantings. However, these functions would not return to pre-remediation levels.

Loss of Slide and Burrow Habitat: As noted above, slides and burrows of muskrat and beaver would be removed as part of the bank stabilization. However, areas that would require stabilization with riprap or geogrids would, by design, not be conducive to animal burrows. Areas for potential beaver slides may be included in the final design of certain bioengineered portions of the stabilized riverbanks; but generally construction by local wildlife of new habitat features in banks that have been stabilized by techniques such as riprap or geogrids is unlikely. Thus, there is likely to be an overall long-term reduction in such burrows and slides in portions of Reaches 5A and 5B.

Reduction in Wildlife Access Routes and Movement to and from the River: As also noted above, the bank stabilization techniques would reduce access between the terrestrial and aquatic habitats required by some amphibian, reptile, and piscivorous mammal species, as well as large mammals trying to drink from or cross the river. For example, deer, black bears, and mink that currently access the river at certain points may alter their access routes based on new riverbank slopes and construction materials. Within 5 to 10 years of restoration, these larger species may adapt to the post-restoration riverbank conditions, regardless of the bank stabilization technique employed. The movement of smaller and less mobile species such as wood turtles, snapping turtles, and leopard frogs, which move between the river and other wetland habitats within the currently forested floodplain, particularly in the spring and summer months, would be substantially constrained by riverbanks stabilized with hard-engineered methods (e.g., riprap or concrete mat revetments). However, areas consisting of vegetated mats and coir fabric would be easier for these species to negotiate. Thus, by about 5 to 10 years or more after restoration, it is expected that in such bioengineered areas, while there would be some changes in the locations of access points, the movement of these smaller species between the river and the adjacent terrestrial habitats would likely approach pre-remediation conditions as vegetation matures in these areas and the species adapt to the modified conditions.

Reduction in Species Richness and Diversity: In terms of species richness and diversity, there would be a number of trade-offs linked to the changed riverbanks. As discussed above, there would be a loss of habitat for species that depend on undercut or exposed vertical banks or on mature overhanging trees. On the other hand, there may be an increase in utilization by certain birds and mammals that prefer an open, early successional habitat as opposed to a mature forest. Overall, although the total number of species (species richness) might increase with the addition of early successional habitats, those that use mature trees and cut banks, many of which are species of concern, would be reduced, resulting in impoverished biodiversity from pre-remediation levels.

Increased Potential for Colonization by Invasive Species: As plantings would not cover all remediated areas, colonization would bring additional plant species to the riverbanks in some areas. At least some of these are expected to be invasive plant forms, some of which are present already and many of which are known to dominate other disturbed areas in the Housatonic Valley. Preventing proliferation of Japanese knotweed, purple loosestrife, and similar invasive species with minimal habitat value would require an invasive species control program of early detection and eradication with mechanical and herbicide treatments, but such a program could not adequately prevent the proliferation of these species without significantly disturbing the newly planted remediated banks. For example, Japanese knotweed, which is currently established along portions of the riverbank within Reaches 5A and 5B, would be extremely difficult to eradicate or to control from spreading along the riverbanks. Given the extensive lengths of riverbank that would be remediated under SED 3 through SED 9, applying a labor-intensive control program would not be practical over the long term.

Conclusion/Long-Term Outlook

The use of the bank stabilization/restoration measures described above, including bioengineering techniques, would promote the re-establishment of some aspects of current bank conditions by encouraging the growth of riparian vegetation and providing habitat or access routes for some wildlife. However, since the bank stabilization measures would be intentionally designed to prevent the current geomorphic processes of continued bank erosion and lateral channel migration that are critical to some species, and since steps would be taken to avoid the re-establishment of trees on the banks, the riverbanks subject to stabilization would not ever return to their current condition and level of function, with negative consequences to the existing biota.

5.3.3 Impoundment Habitat

This section addresses six impoundments in the Rest of River area in Massachusetts within the reaches being considered for remediation: Woods Pond in Reach 6; Columbia Mill Dam Impoundment, the former Eagle Mill Dam Impoundment, Willow Mill Dam Impoundment, and Glendale Dam Impoundment in Reach 7; and Rising Pond in Reach 8.

5.3.3.1 Description of Habitat

The primary habitat type associated with these impoundments is characterized as moderately alkaline pond (Woodlot, 2002), although as impoundments they are influenced by riverine flows to a greater extent than many moderately alkaline ponds in this region that are not on the mainstem of the Housatonic River.

Physical Features

The six impoundments addressed here (Woods Pond, Columbia Mill Dam Impoundment, former Eagle Mill Dam Impoundment, Willow Mill Dam Impoundment, Glendale Dam Impoundment, and Rising Pond) have approximate areas of 60 acres, 10 acres, 8 acres, 8 acres, 10 acres, and 41 acres, respectively. The four impoundments in Reach 7 are more linear than Woods Pond and Rising Pond.

Based on bathymetric survey data collected by GE in 1997 and 2005 (and bathymetric data collected by EPA [CR Environmental] in 1998 in Woods Pond and Rising Pond), estimated average water depths in these impoundments are approximately 5 feet in Woods Pond, 3 feet in the Columbia Mill Dam Impoundment, 2 feet in the former Eagle Mill Dam Impoundment, 5 feet in the Willow Mill Dam Impoundment, 8 feet in the Glendale Dam Impoundment, and 5 feet in Rising Pond. Woods Pond has a maximum depth of approximately 15 feet in a relatively deep hole located in the southeastern portion of the pond. The other impoundments tend to have their deepest points near their respective dams. Rising Pond also has a maximum depth of 15 feet, while the Columbia Mill Dam Impoundment has a maximum depth of approximately 7 feet, and the Willow Mill and Glendale Dam Impoundments have maximum depth of approximately 10 feet and 17 feet, respectively. As the former Eagle Mill dam was breached, it has a considerably lower maximum depth of approximately 3 feet.

Moderately alkaline ponds such as these have gently sloped shores and soft substrate bottoms with upper horizons composed of organic sediment over silt and fine sand.

Biological Communities

Many species of submerged and floating-leaved aquatic species may be present in shallow areas of this habitat type (Woodlot, 2002). Aquatic plant growths can become very dense, affecting ecology and human uses. Some of the more commonly found plants are coontail, naiad, Canada waterweed, water celery, long-beaked water crowfoot, and various species of pondweed. Moderately alkaline pond communities are highly susceptible to some of the more invasive aquatic plant species, such as water chestnut, Eurasian watermilfoil, and curly-leaf pondweed. All of these invasive species are found in at least Woods Pond and water chestnut is prevalent there.

The aquatic macroinvertebrate community associated with the impoundments of the Housatonic River is extensive (Woodlot, 2002). Mussels such as eastern floaters and eastern elliptio are found in most impoundments and lakes along the river. A substantial number of dragonfly and damselfly species are typically found in these impoundments. Other typical invertebrates include a variety of true bugs (*Hemiptera*), beetles, caddisflies, a wide range of true flies (*Diptera*), and fresh water shrimp (*Amphipoda*).

Many species of fish utilize these impoundments. Woods and Rising Ponds were surveyed in 1997 and 1998 and were shown to contain landlocked alewife, common carp, spottail shiner, golden shiner, white perch, largemouth and smallmouth bass, bullhead catfish, and several species of sunfish (Woodlot, 2002). Bluegill sunfish, pumpkinseed sunfish, yellow perch, chain pickerel, and brown bullhead are also common in moderately alkaline pond habitats (Swain and Kearsley, 2000), and were recorded in Woods Pond (Woodlot, 2002).

Reptiles associated with this habitat include snapping and painted turtles (Woodlot, 2002). They are largely associated with soft aquatic sediments. Northern water snakes are known to occur in lakes and have been observed in Woods Pond. Amphibians such as green frogs and bullfrogs are expected in these impoundments (Woodlot, 2002). Pickerel frogs, northern leopard frogs, and American toads are also likely to be found. Red-spotted newts are common throughout the eastern United States and are abundant in permanent pools associated with the river and are expected to be found in the impoundments.

Numerous avian species utilize this habitat type and have been observed or would be expected in these impoundments. These include several species of swallows, including tree swallows, bank swallows, barn swallows, and northern rough-winged swallows, which feed on insects over such ponds. They also include wading birds, such as great blue herons, green herons, and American bitterns (a state-listed species), which hunt for food in this habitat type. Several species of swans, geese, and ducks, including wood ducks, mallards, and Canada geese, have been observed at one or more impoundments during the nesting period, and other species of waterfowl are expected during migration. In addition, various raptor species utilize such impoundment habitat for feeding, including osprey and bald eagle (a state-listed species), both of which nest near water and feed on fish.

Long-tail weasels, minks, river otter, raccoons, and beaver commonly use this habitat type (Woodlot, 2002). Little brown bats, which feed over open water, are very likely to occur. Silver-haired bats, which feed above watercourses, are uncommon to the Northeast, but were found to be present in the Housatonic River area. Northern myotis are uncommon but also forage above waterways in forested areas.

There are 10 state-listed plant and animal species that have NHESP-mapped Priority Habitat within or on the banks of one or more of these impoundments. These species and the impoundments where their Priority Habitats occur are shown in Table 5-4.

Table 5-4 – State-Listed Species Associated with Impoundments

Common Name	Scientific Name	State Status	Impoundment(s)
Arrow clubtail (dragonfly)	*Stylurus spiniceps*	Threatened	Willow Mill
Zebra clubtail (dragonfly)	*Stylurus scudderi*	Special Concern	Willow Mill, Glendale Dam
Skillet clubtail (dragonfly)	*Gomphus ventricosus*	Special Concern	Glendale Dam
Stygian shadowdragon (dragonfly)	*Neurocordulia yamaskanensis*	Special Concern	Glendale Dam
Triangle floater (mussel)	*Alasmidonta undulate*	Special Concern	Willow Mill
Creeper (mussel)	*Strophitus undulatus*	Special Concern	Willow Mill
Wood turtle	*Glyptemys insculpta*	Special Concern	Willow Mill, Glendale Dam, Rising Pond
Common moorhen	*Gallinula chloropus*	Special Concern	Woods Pond
Bur oak	*Quercus macrocarpa*	Special Concern	Woods Pond *
Wapato	*Sagittaria cuneata*	Threatened	Woods Pond

* The Priority Habitat for this species occurs around the periphery of Woods Pond.

5.3.3.2 Impacts of Remediation

This section provides a general description of the impacts of the various remedial technologies that may be part of the sediment alternatives on the impoundment habitat. This section focuses on immediate and near-term impacts. The longer-term impacts of these technologies are discussed in Section 5.3.3.4. The specific long-term and short-term impacts of the individual sediment remedial alternatives on the impoundment habitat (where affected) are described in the evaluations of those alternatives in Section 6.

Sediment Removal

As discussed in Section 3.1.2, excavation of sediments in the impoundments is expected to involve removal "in the wet," using mechanical or hydraulic dredging techniques. With such dredging, mobile organisms such as fish would be able to vacate the work area, but immobile or less mobile species (most invertebrates, all plants) would be destroyed.

Removal of sediment would cause removal of viable propagules (the organisms and their eggs, seeds, or regenerative tissue of any kind) in those sediments, even with the shallowest planned excavation (1 foot). Where removal is followed by capping or backfilling, the substrate would be changed from organic sediment over silt and fine sand to a substrate composed of the capping or backfill material. Over time, as discussed above respecting the aquatic riverine habitat, some invertebrates and aquatic plants would recolonize the impoundments, although different species would be expected to dominate, at least initially, due to the changed substrate.

Where the sediment removal in an impoundment is not following by capping or backfilling, the post-removal substrate would be expected to be generally similar to pre-remediation conditions, which may facilitate more rapid recolonization of this habitat. The rate of recolonization would depend on the overall dredging depth during remediation and the presence of upstream source populations.

In addition, following sediment removal (with or without subsequent capping), there is a high probability of invasion by non-native species – such as water chestnut (already prevalent in Woods Pond), as well as Eurasian watermilfoil, curly-leaf pondweed, and potentially others not yet able to establish populations under current conditions – in areas within the photic zone. Such species are likely to immigrate and dominate, unless an active control program is sustained indefinitely or permanently, which would be impractical, as noted in Section 5.3.3.4 below.

The impacts of dredging and (where conducted) capping or backfilling in the impoundments on the fish community would be similar to those discussed in Section 5.3.1.2 respecting aquatic riverine habitat. The fish would be disrupted and move away during construction activities, but at least some would return. For some years after remediation, the fish species composition would likely be changed and the number of fish may be reduced. If no capping occurs after excavation, the fish community may return to pre-remediation composition more rapidly because the substrate types would be similar to pre-remediation conditions. However, the lack of food in these areas immediately following remediation would limit the usefulness of these areas as foraging grounds. In any case, it is anticipated that the fish community in the impoundment would eventually resemble a typical pond community, as discussed further in Section 5.3.3.4.

Habitat alterations of primary concern for excavation and related capping or backfilling (where conducted) in the impoundments can be summarized as:

- Removal of any organisms present in the sediments;
- Removal of woody debris, rocks, and other structural habitat elements;
- Where capping or backfilling is performed, alteration of substrate type and features that may not support previously resident species of invertebrates, fish, and other wildlife;
- Disruption and displacement of fish and of birds and mammals that eat fish; and
- Colonization by invasive species.

Capping Without Removal

The addition of capping material involves spreading suitable material over the surface of target areas. Engineered capping without prior removal in the impoundments would involve the placement of layers of one foot of sand and one foot (or, in some cases, 6 inches) of armor stone on top of existing sediments. (Thin-layer capping is addressed separately below.) Engineered capping would have similar impacts on existing aquatic biota as discussed above for sediment removal with backfilling or capping, except that the impacts would come from burial rather than removal of the aquatic vegetation, benthic invertebrates, and other non-mobile organisms in the sediments.

In addition, the placement of a cap on top of the existing substrate would change the elevation of the impoundment bottom. In certain areas with relatively shallow water, such as along the shorelines of an impoundment, if consolidation of the underlying sediment does not occur, the increase in substrate elevation due to the cap could change the vegetative characteristics of those areas. Indeed, in such areas where the thickness of the cap (18-24 inches) (or the cap plus any subsequently deposited sediments) exceeds the depth of water, the elevation change could cause the emergent vegetation to be replaced by species tolerant of less frequently inundated or drier conditions.

Thin-Layer Capping

Under alternatives involving placement of a thin-layer cap in impoundment areas, the effects of the thin-layer cap would depend on the material type, the thickness of the cap, and the method and rate of placement. For purposes of assessing the effects of such a cap, it has been assumed that the thin-layer cap would consist of a 6-inch layer of sand placed at one time. In such a case, most, if not all, the aquatic plants and invertebrates in the remediation work area would be covered and destroyed by the cap material. Only the hardiest plants (including invasive species) and invertebrates could regrow or make their way through the cap material, which is not desirable for maintaining biological diversity; and any plants that did survive would become stressed due to increased substrate depth over their roots.

As discussed with respect to thin-layer capping in aquatic riverine habitats, the thin-layer cap would change the existing substrate type in the impoundments to one composed of sand. This would lead to colonization by different aquatic plant and benthic invertebrate communities, more compatible with that sandy substrate type, at least for some period of time; and the species dependent on the missing invertebrates would be adversely affected. Further, recolonization by invasive plant species is typical in such circumstances; and invasive species such as water chestnut (currently prevalent in Woods Pond), as well as Eurasian watermilfoil and curly-leaf pondweed (currently present in at least some of the impoundments), would likely dominate the post-remediation plant community. In addition, fish would move back into the impoundments, but would likely have altered species composition as a result of changed substrate. For example, more centrarchids (sunfish and bass) are likely as the substrate would be more favorable to them than to carp, goldfish, and other bottom feeders.

Again, too, in areas where the water depth is less than 12 inches deep, which may occur along the shorelines, if consolidation of the underlying sediment does not occur, the increase in substrate elevation due to the thin-layer cap could change the vegetative characteristics of these areas – and, in areas where the thin-layer cap (or the cap plus any subsequently deposited sediments) exceeds the depth of water, could cause the emergent wetlands vegetation to be replaced by species tolerant of less frequently inundated or drier conditions.

5.3.3.3 Restoration Methods

For impoundments, the restoration procedures that could be used in an effort to address the impacts described above are limited. Those restoration procedures are described in this section. However, there are significant constraints on the ability of these procedures to re-establish the pre-existing conditions and functions of this habitat type. Those constraints and the resulting long-term prognosis for recovery of this habitat type are discussed in the next section.

The development of restoration plans for impoundments would begin with pre-design investigations of baseline conditions, including water depths and velocity (where relevant), substrate types, important physical habitat features (if any) especially along shorelines, and an identification of the biota present or expected to be present (including any state-listed species). Using these data, design plans would be developed. The implementation of the restoration work would likely include the following steps, which would be coordinated with the various phases of the remediation process, as indicated below: These steps would be tailored as necessary depending on the type of remediation (e.g., removal/capping, engineered capping without removal, thin-layer capping, removal without capping) and the particular impoundment involved.

Site Preparation Phase

1. Conduct any necessary investigations of state-listed species, such as surveys for wood turtles and any other state-listed species with Priority Habitat within the area subject to remediation.

2. Identify any specific habitat features to be avoided and preserved consistent with the remediation plan (e.g., certain large trees along access routes) and review procedures to afford their protection during clearing activities for construction of access roads and staging areas.

Excavation and Capping/Backfilling Phases (if applicable)

1. Evaluate cut trees for preservation and subsequent re-use as habitat features; set aside selected material (if any) separately from woody debris to be removed from the site.

2. Identify large woody debris or other features (if any) present in the impoundment, especially along the shorelines, that may be replaced after excavation.

3. Following excavation, obtain and place capping or backfill material (where called for by the alternative in question) to the elevation specified in the design.

4. For capping or thin-layer capping without prior excavation, place cap material in accordance with the design.

Replacement of Woody Debris and Other Habitat Features (if any)

1. Replace existing large woody debris and/or other features (if any) in the impoundment, especially along shorelines, after excavation and/or capping in areas where such features are currently present and where doing so would not compromise the integrity of the cap and is consistent with the restoration design.

2. Install any specific habitat features (if any) designed to replace features used by state-listed species.

As with aquatic riverine habitat, it is assumed that this restoration program would not include active planting of native aquatic vegetation. Rather, it is assumed that restoration would rely on natural recolonization of plants from upstream as suitable substrate conditions develop over time. Moreover, given the current presence of invasive species within the impoundments, it is likely that recolonization in vegetated areas would include the establishment of invasive species.

Following implementation of these restoration measures, a monitoring program would be conducted, typically for a period of five years. In this case, it is anticipated that the monitoring program would involve annual surveys of the impoundments to document the condition of backfill and caps (where placed) and well as any other restoration measures. Preventing the establishment of invasive species in the impoundments on a long-term or permanent basis would be impractical. Widespread controls would involve either mechanical disturbance (e.g., excavation, harvesting) or chemical controls (i.e., herbicides, pesticides), each of which represents a major disturbance and risk to multiple non-target species.

5.3.3.4 Evaluation of Restoration Constraints and Post-Restoration Conditions

There are a number of constraints on the ability to re-establish the habitat in impoundments. As noted above, where capping, backfilling, or thin-later capping of an impoundment is part of the sediment alternative, the substrate would be changed from silty organic sediments to a substrate composed of the capping or backfill material. Over time, as natural sediments from upstream areas are deposited in the impoundment, the substrate would begin to return to a condition comparable to its current condition. However, the length of time for that to occur is uncertain and would depend on the extent to which such materials are available in upstream areas for transport into the impoundment. The latter, in turn, would depend, at least in part, on the extent to which the upstream sediment areas have been subject to similar remediation.

The primary biological constraints on the restoration of impoundments are the rate of recolonization by desired species and the potential elimination of affected species during the remediation process. Since impoundment remediation would destroy most organisms and displace the rest, at least temporarily, biological recovery would depend on colonization from outside the impoundments. Commonly occurring macroinvertebrates from upstream areas would be expected to recolonize the impoundments, as would aquatic plants, with such plants or their propagules arriving with flow into the impoundments. Initially, the species composition of these invertebrates and plants would differ from those currently present due to the change in substrate. Similarly, as noted above, while fish would move back into the remediated impoundments, the composition and relative abundance of fish are likely to be different, at least initially.

Eventually, as sand and organic sediments are deposited from upstream, a biological community in the impoundments that is consistent with those conditions would be expected to develop (with possible changes in the type of vegetation present along shorelines and associated biota due to elevation changes from placement of a cap or thin-layer cap that approaches or exceeds the depth of water). However, the length of time for such a community to develop, the number of organisms that may be present, and the presence of any specialized species are all uncertain. The extent and rate of such recolonization would depend, in part, on the extent of remediation in areas upstream of the impoundment – i.e., the extent to which upstream areas are disturbed rather than being left alone to provide organisms to the impoundments. In particular, if the upstream remediation should cause the loss of a significant portion of the local population of a state-listed species, then the sources of that species to the impoundment would be eliminated or reduced.

In addition, as noted above, there is a high probability that invasive species would colonize the disturbed impoundments and dominate over native species, particularly given the presence of such species in at least some impoundments under existing conditions; and implementation of a sustained active control program on a long-term or permanent basis would be impractical.

In summary, following remediation and restoration of the impoundments, it is anticipated that a biological community typical of such impoundments would eventually develop, with the rate unknown and influenced by the extent of upstream remediation, except that the community may include some changes in the mix of native species, may not include certain specialized native species (including state-listed species), and would likely be dominated by invasive species such as those currently present.

5.3.4 Floodplain Forest Habitats

5.3.4.1 Description of Habitats

Nearly 400 acres of floodplain forest habitats occur within the PSA. In this Revised CMS Report, floodplain forests (or forested floodplains) refer to wetland areas that are forested; non-wetland forest types are included in the category of upland forests, described in Section 5.3.8 below, even if parts of them are physically located within the Housatonic River floodplain. These wetland forests of the floodplain are distinguished from upland forests by their classification as palustrine habitats (Swain and Kearsley, 2001; Cowardin, 1979). Four different natural community types are represented within these floodplain forest areas, including black ash-red maple-tamarack calcareous seepage swamp (referred to herein as calcareous seepage swamp), red maple swamp, transitional floodplain forest, and high terrace floodplain forest. The acreage of these community types is summarized in Table 5-5.[99]

Table 5-5 – Breakout of Floodplain Forest Natural Communities within the PSA

Forested Natural Community Type	Acreage within the PSA
Calcareous Seepage Swamp	79
Red Maple Swamp	102
Transitional Floodplain Forest	199
High Terrace Floodplain Forest	11
TOTAL	**391 acres**

Black Ash-Red Maple–Tamarack Calcareous Seepage Swamp

This forested floodplain type occupies about 79 acres within the PSA. These are mixed deciduous-coniferous forested swamps occurring in areas where there is calcareous groundwater seepage, which are rare in Massachusetts. The species-rich herbaceous layer is characterized by calciphilic (calcium-loving) species. A variable mixture of deciduous and coniferous trees forms the canopy of this natural community, but black ash, tamarack, and red maple are most common. Numerous other tree species are found in association with those dominant species. The shrub layer can be dense, and the herbaceous layer is diverse with many calciphilic species mixed in with other common wetland plants. Parts of calcareous seepage swamps can function as vernal pool habitat if water remains standing for two to three months and they lack fish.

Red Maple Swamp

This forested floodplain type occupies approximately 102 acres within the PSA. Red maple swamps occur in a variety of physical settings. Golet at al. (1993) describe three basic types: hillside seeps and upland drainageways fed primarily by groundwater seepage and overland flow; seasonally flooded basin swamps in undrained basins; and alluvial swamps. Depending on the physical setting, red maple swamps receive water through surface runoff, groundwater inputs, or stream overflow. The hydrogeologic setting is the primary determinant of water regime and the plant community structure and composition. Soils have shallow to thick organic layers overlying mineral sands/silts. Red maple is usually strongly dominant in the

[99] In addition, limited floodplain areas downstream of Woods Pond in Reach 7 consist of forested floodplain (wetland) habitat. Based on review of files from MassGIS (providing land use and wetlands information) and 2005 aerial photographs, the Reach 7 floodplain contains approximately 1.5 acres of this habitat type.

overstory, and often provides more than 90% of the canopy cover. A variable mixture of tree species co-occurs with red maple. The shrub layer of red maple swamps is often dense and well-developed, generally with over 50% cover, but it can be variable. The herbaceous layer is highly variable, but ferns are usually abundant. Parts of red maple swamps that have two or three months of ponding and lack fish can function as vernal pools.

Transitional Floodplain Forest

This forested floodplain type occupies approximately 199 acres within the PSA. Transitional floodplain forests generally experience annual flooding. The severity of flooding, soil texture, and soil drainage of transitional floodplain forests are intermediate between major-river and small-river floodplain forests. Soils are either silt loams or very fine sandy loams, and soil mottling is generally present within 60 cm (2 feet) of soil surface. A surface organic layer is typically absent. Silver maple is dominant in the canopy, but unlike in major-river forests, cottonwood is typically absent. Similar to small-river forests, green ash and American elm are present. A shrub layer is generally lacking; however, saplings of overstory trees are common. Vines are abundant; and the herbaceous layer is typically an even mixture of wood-nettle, ostrich fern, sensitive fern, and false nettle. Transitional floodplain forests often contain meander scars or sloughs that can function as vernal pools.

High Terrace Floodplain Forest

This forested community type occupies approximately 11 acres within the PSA. High-terrace floodplain forests occur on raised banks adjacent to rivers and streams, on steep banks bordering high-gradient rivers, on high alluvial terraces, and on raised areas within floodplain forests. They are river-influenced and mesic (i.e., characterized by organic-rich moist soils), but they typically are not flooded annually, as indicated by the presence of a distinct surface soil organic layer. Soils are typically silt loams. The canopy is a mixture of floodplain taxa, such as red and silver maple and mesic deciduous hardwoods. The shrub layer varies from sparse to well-developed, and the herbaceous layer is a mixture of the characteristic floodplain forest ferns. High-terrace floodplain forests can contain low wet depressions that function as vernal pools.

Floodplain Forest Functions

The forested floodplains within the PSA provide a number of important functions. These include the provision of physical habitat for resident birds, amphibians, reptiles, mammals, and invertebrates; important temporal habitat for certain migratory bird species that use such forested floodplains for periods during their migrations; habitat for state-listed plant and animal species; vital shade which helps control surface water, soil and air temperatures, and evaporative losses of the floodplain forests and river channel; and a significant yearly infusion of biomass – fallen leaves and decaying coarse woody material – which, in conjunction with sunlight, provide the foundation of the food chain of these forested ecosystems. They also provide the following additional functions:

- Groundwater recharge/discharge. This function involves interactions between ground and surface waters. Overbank flooding that is stored in the floodplain is at least partially infiltrated to the shallow groundwater table and moves laterally to discharge in the river. At other times, groundwater flow from the adjacent highlands may intersect the land surface within the floodplain and discharge to the surface, contributing to base flow. The Housatonic River is a reflection of the regional groundwater table, and groundwater discharge to it provides base flow which is critical for fish and other aquatic life.

- Flood flow alteration. This function includes not only the general provision of flood storage capacity, but also the function of providing temporary attenuation of the floodwaters, followed by a delayed and gradual release of the floodwaters draining back into the river. The characteristics within the floodplain forests that contribute to the latter flood flow alteration function include the surface topography and varied microtopographic surface features, the sinuous surface flow paths, the presence of dense herbaceous cover and shrubs in some pockets, and the dense mature woody vegetation that produces coarse woody debris. For example, vegetation impedes surface water flow and reduces the energy of storm runoff, causing water to deposit sediment and debris. Heavy vegetation, including dense areas of herbaceous and shrub species and especially mixed age classes of trees, slows flow and provides areas of slack water, allowing more water to seep down through soil and be stored as groundwater. Microtopographic complexity increases the tortuosity of flow pathways, reduces average velocity, and increases the gradient of moisture conditions. This increases the diversity of biogeochemical processes occurring in the wetland and the presence of abundant and varied microhabitats. Coarse woody debris, derived from large trees, blocks flows and modifies flow patterns. These characteristics create naturally produced roughness, which significantly increases flow resistance on the floodplain. This flow resistance, in turn, enhances retention of floodwaters, reduces erosion, increases groundwater infiltration, increases retention of inorganic sediments and organic particulates, and diversifies both moisture gradients and microhabitats for animals and plants.

- Water quality maintenance, nutrient processing, and production export. These separate but related functions are generally related to the cumulative effects of hydrology, sediment transport and deposition, and plant productivity. Sediment is transported into and through the floodplain from upstream sources, and bank erosion contributes further to this sediment load. When overbank or backwater flooding occurs from the main stem of the Housatonic River into the adjacent floodplains, inorganic sediment carried by the river is deposited within the floodplain, and adsorbed constituents (such as nutrients) settle out with the sediment; some sediment also settles within the quiescent pools of the river itself. This function maintains surface water quality by removing sediments, nutrients, and other pollutants from the water column. In addition, nutrients are processed within the floodplain as primary plant productivity converts inorganic forms into organic forms of nutrients. The floodplain then serves as a source of organic forms of nutrients back to the river, either during further flood flows or by direct deposition of leaves and related vegetative parts, and these contribute to sustaining the base food chain in the river and ultimately the entire biotic community. This is the production export function.

This section focuses on the floodplain forest habitats generally; vernal pools are discussed separately in Section 5.3.7 below.

There are 29 state-listed plant and animal species that have NHESP-mapped Priority Habitat within the floodplain forest habitats in the PSA and that could be found in those habitats. These species are listed in the following table.

Table 5-6 – State-Listed Species Associated with Floodplain Forests in the PSA

Common Name	Scientific Name	State Status
Wood turtle	*Glyptemys insculpta*	Special Concern
Jefferson salamander	*Ambystoma jeffersonianum*	Special Concern
American bittern	*Botaurus lentiginosus*	Endangered
Bald eagle	*Haliaeetus leucocephalus*	Endangered
Common moorhen	*Gallinula chloropus*	Special Concern
Water shrew	*Sorex palustris*	Special Concern
Arrow clubtail (dragonfly)	*Stylurus spiniceps*	Threatened
Brook snaketail (dragonfly)	*Ophiogomphus aspersus*	Special Concern
Rapids clubtail (dragonfly)	*Gomphus quadricolor*	Threatened
Riffle snaketail (dragonfly)	*Ophiogomphus carolus*	Threatened
Spine-crowned clubtail (dragonfly)	*Gomphus abbreviatus*	Endangered
Zebra clubtail (dragonfly)	*Stylurus scudderi*	Special Concern
Mustard white (butterfly)	*Pieris oleracea*	Threatened
Ostrich fern borer moth	*Papaipema sp. 2 nr. pterisii*	Special Concern
Bristly buttercup	*Ranunculus pensylvanicus*	Special Concern
Bur oak	*Quercus macrocarpa*	Special Concern

Common Name	Scientific Name	State Status
Black maple	*Acer nigrum*	Special Concern
Crooked-stem aster	*Symphyotrichum prenanthoides*	Threatened
Culver's root	*Veronicastrum virginicum*	Threatened
Fen cuckoo flower	*Cardamine pratensis* var. *palustris*	Threatened
Foxtail sedge	*Carex alopecoidea*	Threatened
Gray's sedge	*Carex grayi*	Threatened
Hemlock parsley	*Conioselinum chinense*	Special Concern
Hairy wild rye	*Elymus villosus*	Endangered
Long-styled sanicle	*Saniula odorata*	Threatened
Intermediate spike-sedge	*Eleocharis intermedia*	Threatened
Narrow-leaved spring beauty	*Claytonia virginica*	Endangered
Tuckerman's sedge	*Carex tuckermanii*	Endangered
White adder's-mouth	*Malaxis monophyllos var. brachypoda*	Endangered

5.3.4.2 Impacts of Remediation

This section provides a general description of the impacts of the principal remedial technology of the floodplain alternatives (soil removal and backfilling), as well as associated access roads and staging areas, on the forested floodplain habitats. This section focuses on immediate and near-term impacts. The longer-term impacts of these activities are discussed in Section 5.3.4.4. The specific long-term and short-term impacts of the individual floodplain remedial alternatives on this habitat type are described in the evaluations of those alternatives in Section 7.

<u>Impacts from Soil Removal Activities</u>

Soil removal activities in the floodplain forest would cause direct impacts to the forested floodplain habitats through cutting of trees and shrubs, as well as the grubbing of tree stumps and roots, and through soil excavation, replacement, and grading. All living trees in the soil removal areas, including all associated biomass such as limbs, stumps, and root systems, would be removed, as would all shrubs and herbaceous vegetation within these remediation areas. The loss of vegetation in these areas would result in a reduction of hard and soft mast used by several wildlife species such as white-tailed deer and turkey, perching and nesting sites for birds, and areal vegetative cover required for virtually all species. In addition to the removal of all living biomass, all snags and downed woody debris in these areas would be removed. The reduction of dead standing woody material would reduce the habitat value of the remediation work area for both primary excavators, such as the pileated woodpecker, and secondary cavity users, which range from large mammals like black bears and raccoons to small birds like the tufted titmouse and black-capped chickadee. The reduction of downed woody debris would result in the loss of habitat for small mammals, mink, and amphibians. Further, the removal of surface soils and leaf litter at the ground surface in these wooded areas would harm the many animal species that use these areas for forage, cover, aestivation, and/or hibernation. The losses of animals and plants in these habitats would include the state-listed species that use these forested habitats, as identified above.

Native soil material, which has accumulated due to countless years of flood deposits and other pedogenic (soil-forming) processes, would be removed from the areas in question and replaced with soil material from external sources. The suitability of these new soil materials to support typical floodplain microbial communities and to provide other habitat functions is unpredictable. The surface temperature and solar exposure patterns on the forest floor would be altered due to the removal of the vegetation, and the seed bank for the native species which currently occupy the removal areas would be removed during the excavation activities. The soil disturbances would increase the likelihood of encroachment by invasive species into the disturbed areas. In addition, the use of heavy machinery in these forested areas would probably cause direct mortalities to small and slower-moving animals, and at a minimum, would disrupt important elements of their life cycles. It would also cause compaction of the soils, with consequent effects on the permeability of the soils

These removal activities would also reduce the floodplain roughness that produces flow resistance and thus contributes to the important flood flow alteration function of the floodplain. It would do so by removing coarse woody debris and vegetation and altering microtopography in the disturbed areas, as these are the principal factors creating flow resistance. Reduction in roughness cannot be countered by applying BMPs because the vegetative cover would become less dense due to floodplain clearing activities. Excavation of floodplain soils would alter topographic variability and create areas of bare soil. In these areas, these conditions would result in faster flows during flood events, more erosion, and less infiltration.

Additional Effects from Access Roads and Staging Areas

In addition to the impacts in the soil removal areas themselves, remedial construction activities would have additional effects on the forested floodplains through removal of vegetation and soil disturbance in adjacent areas not targeted for soil remediation. These additional impacts would include:

- *Vegetation cutting*: Cutting of trees and shrubs would be needed for the construction of access roads and staging areas, and to provide ample space beyond the actual work area to install sedimentation and erosion controls (e.g., hay bales and silt fence). Much of this impact would occur to portions of the floodplain which are currently undisturbed mature forest and not within the geographical limits of the required soil removal areas.

- *Root zone removal (grubbing)*: Grubbing of tree stumps and roots would be required in adjacent floodplain forests for access road and staging area construction.

- *Access road construction*: Temporary access roads would likely be constructed of a combination of geotextile fabric, or potentially timber mats, overlain by coarse gravel. These roads are assumed to be 20 feet wide. In addition, increased road widths would be required in certain areas to provide for pull-offs in order to allow construction vehicles to pass each other. These access roads would remove substantial additional portions of the floodplain forest habitats.

- *Truck and excavation equipment traffic*: Construction traffic on the access roads and remediation areas would produce air quality and noise impacts, which would disrupt forest animals in their terrestrial stages. The volume of traffic over extended periods of time would also likely result in mortality of slow-moving, smaller animals (e.g., salamanders, snakes, frogs, toads, invertebrates).

5.3.4.3 Restoration Methods

A number of restoration procedures are available that would attempt to address the impacts described above and to restore the affected floodplain forest habitats. Those restoration procedures are described in this section. However, there are significant constraints on the ability of these procedures to re-establish the pre-existing conditions and functions of this habitat type. Those constraints and the resulting long-term prognosis for recovery of this habitat type are discussed in the next section.

As with other habitat types, the first step in a restoration effort for forested floodplain habitats is to collect data on the existing conditions and functions of the habitats involved. This data collection would include a detailed baseline assessment that may include identification and evaluation of the geographical extent of the affected habitats, expected resident plant and animal species (including any state-listed species), "important" micro-habitats within the overall system, structural features of the tree components, sources of hydrology, typical annual water levels and duration of wetness, relationship to nearby habitats, importance of predation, composition of predator community, and soil characteristics. Following baseline data collection, design plans would be developed, which would likely include specifications on elevations, backfill and topsoil characteristics, planting plans, water levels, methods to reduce impacts to state-listed species (if feasible), and natural physical structures to be placed in the forested floodplains to serve as structural wildlife habitat or to replace features used by state-listed species.

The implementation of the work related to restoration of the forested floodplain habitats would likely include the following steps, which would be coordinated with the various phases of the remediation process, as indicated below:

Site Preparation Phase

1. Conduct any necessary investigations for state-listed species, such as surveys for wood turtles, the mustard white (butterfly), and state-listed plant species with Priority Habitat within the forested floodplain in the area subject to remediation.

2. Identify soil stockpile locations and any nearby invasive plant stands so that measures can be implemented to attempt to prevent contamination of soils by weed seeds.

3. Identify any specific habitat features that are to be avoided and preserved consistent with the remediation plan (e.g., wolf trees,[100] downed woody debris, or standing dead trees) and review procedures to do so.

Clearing, Grubbing, and Site Access Phase

1. Evaluate cut above-ground woody debris for preservation and subsequent re-use as habitat features; set aside selected material (if any) separately from woody debris to be removed from the site.

2. Implement any necessary construction-phase monitoring for state-listed species (e.g., monitoring for wood turtles).

3. Ensure preservation of any specific habitat features that have been designated to be avoided and preserved consistent with the remediation plan.

Backfilling and Grading Phase

1. Layer soils in lifts to re-establish existing zonation or otherwise approximate existing conditions to the extent practicable. Use low ground pressure machinery, as necessary, to reduce compaction in the distribution of soils.

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[100] Wolf trees are large broad-branched trees that are usually larger and older than the surrounding forest. These trees are important nest and perch sites, and add diversity to the area. These trees often have hollow cavities that may be used by songbirds, owls, flying squirrels, porcupines, and raccoons.

2. Use grade stakes and pre-remediation topographic mapping and data to re-establish the pre-remediation topography to the extent practicable. In this regard, make efforts to establish the original configuration of depressional areas and swales in forested areas that contribute to flood storage, surface water conveyance through the floodplain, soil moisture, and habitat conditions.

3. Promote microtopographic variability by embedding some organic debris within the replacement soils.

4. Scarify the soil surfaces and then implement stabilization measures that may include seeding and other measures such as netting in areas more prone to floodwater conveyance.

5. If, at the time of final grading, soil temperature and site conditions are not appropriate for transplantation and seed germination, stabilize the remediation area with appropriate erosion controls, to be followed by planting at a later time.

Placement of Woody Debris and Other Habitat Features

1. Distribute dead woody debris over and into the ground surface as appropriate depending on pre-remediation coverage by such debris.

2. Consider placement of other habitat features such as boulders, slash piles, or specific features used by state-listed species, as appropriate based upon final pre-remediation inventory and specifications.

Seeding and Planting

1. Apply an appropriate seed mix to the disturbed portions of the restoration area.

2. Plant trees, shrubs, and herbaceous species as detailed on final planting plans approved for the site. These plans would include, to the extent feasible, replanting any state-listed plant species that would be impacted and/or any affected plant species that is relied upon by state-listed animal species.[101]

3. Manage the new plantings according to final detailed specifications.

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[101] It should be noted, as discussed further below, that implementation of a standard planting plan for a forested community, in which all replacement trees are planted at one time, would not replicate the current structure and composition of the existing floodplain forest, which reflects a complex successional trajectory and has uneven size/age classes.

4. Implement an invasive species control plan immediately after planting.

Following the construction phase of restoration, a monitoring program would be established, typically for a period of five years after restoration. The details of this program would be determined during design, but would likely involve semi-annual or annual inspections of the forested floodplains in each growing season during the monitoring period (as well as after flooding events), with quantitative and/or qualitative assessments of the plant community and hydrologic features. See also Section 4.5 above. It would also include an invasive species monitoring and control plan.

5.3.4.4 Evaluation of Restoration Constraints and Post-Restoration Conditions

Despite the implementation of the restoration procedures described in Section 5.3.4.3, there are significant constraints on the ability to restore floodplain forest habitat. As a result, implementation of these restoration procedures would not result in re-establishment of the floodplain forest for 50 to 100 years, if at all. This section describes those constraints and their associated effects on the likelihood of returning this habitat type to its pre-remediation conditions and level of function and the timing in which this might occur.

Loss of Mature Trees. The most significant constraint on restoration of forested floodplain areas is the unavoidable loss of trees that would be necessary to implement the floodplain and sediment removal alternatives. These alternatives would require clearing and removal of mature trees in the floodplain and along the banks of the river, in order to remove soils in the remediation work areas and to build the necessary access roads and staging areas to conduct the river, riverbank, and floodplain remediation. Based on the size of the trees, the forests found within the floodplain in Reaches 5A and 5B are probably on the order of 50 to 75 years in age, and the mature forests bordering Reach 5C and around Woods Pond are most likely 75 to 100 years old or older.

As a general rule, given replanting in these forested areas, the plant community succession in these areas is expected to progress, at best, to the sapling/shrub stage during the first 5 to 15 years after restoration, to the young forest stage after 20 to 25 years, and later to a mature forest. The full progression to a mature forest stage would take at least 50 years to 100 years, as the time necessary for a replanted forested community to resemble its current condition is generally commensurate with the age of the current community. However, this vegetative progression depends on the extent of the cleared areas and assumes that events such as floods, colonization by invasive species, or browsing by deer or beaver do not impede the progression. As the extent of the cleared area increases, the path and rate of the vegetative succession would likely take longer and would be less reliable due to the greater proportion of floodplain habitat altered and the consequent increase in cumulative stresses from changes in microclimate, hydrology, and invasive species. Any openings in the forested areas would become prime opportunities for the colonization by invasive species, particularly along access roads and the edges of staging areas; and the presence of several such species within portions of the floodplain forest in the PSA makes it likely that such species would affect the progression of vegetation succession in all floodplain habitats. Similarly, the erosive effects of overbank flooding (discussed further below), particularly in the early years, could further slow or suspend the vegetative succession.

During the lengthy period until the mature forest is re-established (if that occurs), the tree canopy in the cleared areas would be reduced from its current condition, the areas would be more subject to sunlight and wind impacts, and there would be a reduction in large woody debris. Depending on the areal extent of these long-lasting openings, they could alter the suitability of the forest to support a diverse interior forest wildlife community over a comparable period. The decrease in availability of mature trees and forested habitat would reduce the capacity of the floodplain forest to support species dependent on such habitat, such as pileated woodpeckers, thrushes, a variety of warblers and owls, and mammals such as the fisher and bobcat. As the replanted forest develops, it goes through stages of supporting different communities until such time as it reaches maturity. Younger, developing plant communities support a different wildlife community that is characteristic of early and mid-level successional habitats.

It should also be noted that implementation of a standard planting plan is unlikely to replicate the structure and composition of the existing floodplain forest. Although it is feasible to replace emergent and shrub species within a few years with direct planting, replacing forested habitat is much more complex, as the successional trajectory for a forest is much different than that for emergent, herbaceous, or shrub communities. Through competition, forests go through a reduction in numbers of stems from seedlings (up to 3 feet tall, 5,000-10,000+ stems/acre) to saplings (3-10 feet tall, < 5 inches in diameter, 1,000-3,000 stems/acre) to pole stage after about 20-30 years (5-11 inches in diameter, 500-1,000 stems/acre) to mature trees (>11 inches in diameter, 100-200 stems/acre), usually occurring at more than 50 years after planting (Stoddard 1978). Moreover, forests often have uneven size/age classes, as does the forested floodplain in the PSA. Planting replacement trees in a cleared area all at the same time under a standard planting plan could not reproduce these characteristics. Thus, even under optimum conditions (i.e., with invasive species kept under control, which is highly unlikely over large areas), the developing forest would be an even-aged community for more than 25 years with minimal structural profile diversity and associated significant reduction in overall wildlife diversity.

Loss of Coarse Woody Debris and Annual Leaf Litter. The removal of trees would also result in the loss of woody debris that is used as structural wildlife habitat – i.e., for perching, basking, denning, nesting, cover, or escape habitat. While it is assumed that some of the coarse debris left over from cut tree trunks could be re-used in the remediated floodplain for that purpose, conditions would not be the same as under pre-remediation conditions. Similarly, while some of this material could also be chipped and left on site as an organic amendment to the imported topsoil, it would not be a soil amendment that could mimic the natural and beneficial carbon:nitrogen ratio afforded by leaf litter. In addition, the tree removal would cause the loss of yearly leaf litter that is generated by the mature deciduous trees that populate the floodplain. Leaf litter on the floor of the floodplain forest is important as part of the food chain by affecting soil permeability, providing cover habitat for amphibians, reptiles, small mammals and invertebrates, and regulating soil temperatures and relative humidity. The loss of woody debris and leaf litter would place a severe constraint on efforts to restore forested floodplains, at least within the decades after remediation.

Changes in Hydrology. An additional constraint on restoration efforts would be the impacts of the remediation on the hydrology of the floodplain forests. There are multiple sources of water that feed these systems (e.g., groundwater slope seepage, groundwater discharge from seasonally high water tables in the floodplain, and overbank flooding of the river). While efforts would be made to reconstruct the pre-existing swale systems to approximate current drainage patterns, the potential is high for larger overbank floods to cause erosion and destabilization in recently restored areas of the floodplain. Additionally, as discussed in Section 5.3.4.2, the loss of woody vegetation, reduction of coarse woody debris, presence of a sparsely vegetated area, and altered microtopography in the remediated areas would result in an increase in flood flow velocities, with more erosion and less infiltration, in those areas. Taken together, these alterations in flooding and flood flow distribution could substantially alter the hydrologic conditions in the affected portions of the floodplain, at least on a localized basis. These changes could result in wetter conditions, such as from the loss of evapo-transpiration due to tree removal or from soil compaction resulting in greater perching of surface waters, or drier conditions, such as from the use of sandier topsoils or from changes in overbank flooding and grading that result in decreased flood flows onto the floodplain.

Fragmentation of Forested Floodplain. Significant habitat alteration over widespread areas of the forested floodplain would result in fragmentation of the connections among forested habitats and between those and other habitats in the PSA. Habitat connectivity is important to the viability and sustainability of populations of most floodplain-dependent amphibians, reptiles, small mammals, and non-flying invertebrates, as these animals do not have the capability to disperse or migrate if corridors are obstructed or highly disturbed or fragmented. Moreover, wildlife such as neotropical migratory song birds and some carnivores like the fisher and bobcat rely on the forested nature of the floodplain to facilitate access and movement in the currently largely unfragmented forested riparian corridor. The fragmentation of the existing largely undisturbed contiguous forested floodplain would disrupt the dispersal and migratory movements of many of these wildlife species, at least for the prolonged period until those forested areas are re-established. This loss of connectivity thus places a severe constraint on the potential for successful restoration of this habitat, which would significantly affect both resident and migratory species, with possible elimination of multiple generations of individuals from each species population.

Impacts to Multiple State-Listed Species with Different Life Cycles. As noted above, 29 different state-listed plant and animal species have Priority Habitat within the forested floodplain in the PSA, and thus would be subject to adverse effects from remedial construction activities in those floodplain areas. Restoration efforts are complicated by the fact that the optimal construction windows in which to minimize impacts to these species are not all the same. As discussed in Section 5.2.3, for the state-listed species within the forested floodplain of the PSA, there would be no time during the year in which remedial construction work would not have adverse impacts on at least some of them; and their subsequent return is doubtful, because other, adjacent habitats would be occupied, so the disturbed portions of these populations would be eliminated. For some state-listed species, this may mean the elimination of an entire subpopulation.

Changes in Soil Composition and Chemistry. Although an effort would be made to secure replacement soil for backfill that is as similar as possible to existing soil, there is a limit on the ability of commercially available soil to match existing conditions. The existing soil has been created as a result of countless flood events depositing sands and silts across the floodplain, with organic content increasing commensurate with the extent of biological activity and moisture regimes. In these forested areas in particular, horizontal root growth in the surface soil greatly affects lateral water movement and associated moisture conditions. These existing soils also contain the viable seeds and other propagules from native floodplain plants. It would be impossible to recreate exactly these soil conditions over the remediation work areas. Replacement soils would likely come from upland settings; such soil would be variable in silt, sand, and organic matter composition, would lack native plant propagules, and would have altered soil chemistry (e.g., pH, nutrients). Such changes in soil composition and chemistry would likely create shifts in micro-organism and fungal composition and affect the local plant and animal communities. In addition, the annual loss of the major source of leaf litter (trees) would affect soil chemistry, and reduce the floodplain's production export functionality. All these factors would thus further impede the re-establishment of the existing forested communities.

Changes in Soil Stratigraphy. Not only would soil disturbance have an immediate direct impact on forested floodplain plant and animal species, but the heavy equipment required to undertake the remediation and restoration would also result in a long-term impact to soils in the form of compaction. Heavy, mechanized equipment, such as land-clearing machines, skidders, excavators, haul trucks, and bulldozers, would be required to clear vegetation, to excavate, remove, and grade the floodplain soils, and to place backfill. This would make soils less friable and conducive to the formation of the necessary subterranean burrows required by certain animals for overwintering, and hinder or prolong the reestablishment of the plant community. While the final grades of soils in the affected forested wetlands could be scarified by construction equipment (to limit compaction), this would not prevent compaction altogether.

Proliferation of Invasive Plant Species. A risk that is always present when structurally intact ecosystems exist – especially forested ones with a mostly enclosed canopy and little understory plant community – is the introduction of and/or spread of invasive plant species as a result of disturbances. Disturbances to any of these forested areas represent a prime opportunity for expansion of the extent of invasive species, as removing a mature, forested (stable) system creates primary successional conditions. The plant communities in primary successional systems are generally dynamic, and it is under these conditions that aggressive and exotic species readily take hold. This is a very real risk to the overall success of restoration activities, as the plant community is one of the foundations of the overall ecosystem. If non-native species out-compete native ones, the animals that depend on the native plants may be lost as well.

It should be noted that invasive plant species proliferation would be very difficult to prevent, even under a very rigorous control program, particularly if the cleared areas are large. Hand-pulling weeds during the first or second year following restoration is feasible at small sites (i.e., those well below an acre in size) but practically impossible at large sites – which generally necessitates the use of herbicides or execution of controlled burns. Many species are resistant to herbicides and mechanical removal methods; and if the methods used to control invasives are severe, they can cause harm to native species and/or make the environmental conditions unsuitable for recolonization by native species.

Proliferation of New Predatory Animal Species. In addition to controlling invasive plant species, it is important to control the influx of new predatory animal species. Following construction, it is possible that the temporal losses in habitat or other factors could create changes in the current predator-prey structure in the forested floodplains. Opportunistic predators may expand into areas where they did not previously exist, and prey on the resident species. For example, increases in the populations of medium-size predators such as raccoons and skunks should be expected from large habitat disturbances. These predators could affect the success of the restoration efforts.

Impacts on Other Floodplain Functions. Depending on the extent of the disturbance, the implementation of remediation activities could also have a long-term impact on the other floodplain functions described in Section 5.3.4.1. For example, the removal of surface soils in the floodplain would alter soil moisture levels, soil infiltration rates, and groundwater flow. These changes, together with the removal of sediments in the River (which controls the rate and level of groundwater flow in the valley), would alter the groundwater recharge/discharge function of the affected floodplain areas. This function should return as flood deposition restores soil conditions and the disturbed areas become vegetated and root systems stabilize the floodplain soils, but such a return could take decades and would be dependent upon unpredictable flood dynamics, which themselves would be affected by alterations to the river channel and/or banks.

In addition, as discussed above, the remedial construction activities would reduce the floodplain roughness that produces flow resistance and thus contributes to the important flood flow alteration function of the floodplain. It would do so by removing coarse woody debris and vegetation and altering microtopography in the disturbed areas. These conditions could last for decades in the affected portions of the floodplain, during which time the floodplain's capacity to moderate flood flows would be reduced. The extent of these impacts and the time for recovery would depend on the extent of the clearing of the floodplain forest.

The related functions of water quality maintenance, nutrient processing, and production export are a product of the cumulative effects of hydrology, sediment transport and deposition, and plant productivity. The duration of the impacts of remediation on these functions and the prospects for their restoration are largely dependent on the success of the riverbank stabilization/restoration measures in replicating existing overbank flooding patterns (which is uncertain) and on the extent of the loss of the floodplain plant community (which would remove the capacity for primary production), as well as the rate and successional progression of regrowth of that community, which would take decades and could be adversely affected by flood events, invasive species proliferation, and biotic factors such as beaver activity.

Conclusion/Long-Term Outlook

We have found no precedent in the Northeast for a riparian forest restoration project of the size and duration that would be involved under the more intrusive floodplain removal alternatives (i.e., FP 3 through FP 8). The effects of the significant loss of extensive acreages of mature floodplain trees and need to locate a comparable, clean source of soil to mimic current conditions make the proposition of restoring this large system extremely vulnerable to the constraints described above. Overall, despite the implementation of the most up-to-date restoration methods and the sequencing of restoration over a number of years, it is likely that re-establishment of affected forested floodplain communities in the PSA would take at least 50 to 100 years and, in areas with extensive clearing, would take longer and may not occur at all.

5.3.5 Shrub and Shallow Emergent Wetlands

5.3.5.1 Description of Habitats

We have included in the category of shrub and shallow emergent wetlands the natural communities of shrub swamp, shallow emergent marsh, and wet meadow. Within the PSA, these community types occupy approximately 153, 58, and 43 acres, respectively, for a total of 279 acres.[102] Each of these natural community types is described below. Shrub and shallow emergent wetlands have been combined here due to the similarity of these two habitats in hydrology and soil types, and thus in potential restoration measures, constraints, and success. (Deep emergent and submergent marshes are discussed separately along with backwaters in Section 5.3.6.)

Shrub Swamp

This wetland type is extensive within the PSA, occupying approximately 153 acres. Shrub swamps are generally quite variable. They may be co-dominated by a mixture of species or be a near-monoculture of a single dominant shrub species. Shrub swamps may represent a successional stage leading to forested wetland, or they may be relatively stable communities. Shrub swamps are usually characteristic of wetland areas that are experiencing environmental change, and are early to mid-successional in species complement and structure. This community is seasonally flooded and often saturated near the surface when not flooded. Soils are generally mineral soils with features indicative of the water table under a layer of well-decomposed organic mucks. Shrub swamps within the PSA are dominated by broadleaf deciduous plants such as silky dogwood, winterberry, speckled alder, meadowsweet, buttonbush, northern arrowwood, silky willow, and pussy willow. Shrub swamps are located throughout the PSA but the majority of them occur within Reach 5C.

Shallow Emergent Marshes

This wetland type occupies approximately 58 acres within the PSA, most commonly in Reaches 5B and 5C. Shallow emergent marshes are grass-, sedge-, and/or rush-dominated wetlands on mucky mineral soils that are seasonally inundated and permanently saturated. No canopy is present within this habitat and the shrub layer is usually sparse and intermixed, though dense shrub colonies can occur in patches. Based on species composition alone, it can be difficult to differentiate shallow emergent marshes and wet meadows, but they occur in different physical settings and hydrologic regimes. In the PSA, dominant plant species within this natural community include false water-pepper, woolgrass, dotted smartweed, cuckoo-flower, common arrowhead, purple loosestrife, water parsnip, and northern water-plaintain.

Wet Meadows

This wetland type occupies approximately 43 acres within the PSA. Wet meadows are wetlands which often resemble grasslands and are typically drier than other marshes except during periods of seasonal high water. For most of the year, wet meadows are devoid of

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[102] In addition, based on review of land use and wetlands information from MassGIS and 2005 aerial photographs, the Reach 7 floodplain contains approximately 11.8 acres of this habitat type.

standing water, though a high water table allows the soil to remain saturated. The wetland substrate consists of mineral soils with features indicative of the water table, sometimes with a surface layer of well decomposed organic material. A variety of water-loving grasses, sedges, rushes, and wetland wildflowers proliferate in the highly fertile soil of wet meadows. In the PSA, dominant plant species within this natural community include reed canary grass (an invasive species), spotted touch-me-knot, Canada blue-joint, lakeside sedge, spotted joe-pye weed, swamp and common milkweed, and stinging nettle. Wet meadows are located throughout the PSA but the majority are associated with agricultural fields in Reach 5B.

Shrub/Emergent Wetland Functions

The shrub and emergent wetlands within the PSA provide a number of wetland functions. These include wildlife habitat, including habitat for state-listed plant and animal species. They also include the same additional functions described for the floodplain forest – i.e., groundwater recharge/discharge, flood flow alteration, and water quality maintenance, nutrient processing, and production export (all defined in Section 5.3.4.1). All of these wetland types often contain habitat which functions as vernal pools in areas that exhibit extended periods of ponding and a lack of an adult fish population. However, this section focuses on shrub and emergent wetlands generally; vernal pools are discussed separately in Section 5.3.7 below).

There are 18 state-listed plant and animal species that have NHESP-mapped Priority Habitat within the shrub and shallow emergent wetlands of the PSA and that could be found in those habitats. These species are listed in the following table.

Table 5-7 – State-Listed Species Associated with the Shrub and Shallow Emergent Wetlands of the PSA

Common Name	Scientific Name	State Status
Wood turtle	*Glyptemys insculpta*	Special Concern
Jefferson salamander	*Ambystoma jeffersonianum*	Special Concern
American bittern	*Botaurus lentiginosus*	Endangered
Common moorhen	*Gallinula chloropus*	Special Concern
Water shrew	*Sorex palustris*	Special Concern
Mustard white	*Pieris oleracea*	Threatened
Bristly buttercup	*Ranunculus pensylvanicus*	Special Concern
Crooked-stem aster	*Symphyotrichum prenanthoides*	Threatened

Common Name	Scientific Name	State Status
Culver's root	*Veronicastrum virginicum*	Threatened
Fen cuckoo flower	*Cardamine pratensis var. palustris*	Threatened
Fen sedge	*Carex tetanica*	Special Concern
Foxtail sedge	*Carex alopecoidea*	Threatened
Hemlock parsley	*Conioselinum chinense*	Special Concern
Intermediate spike-sedge	*Eleocharis intermedia*	Threatened
Narrow-leaved spring beauty	*Claytonia virginica*	Endangered
Tuckerman's sedge	*Carex tuckermanii*	Endangered
Wapato	*Sagittaria cuneata*	Threatened
White adder's-mouth	*Malaxis monophyllos var. brachypoda*	Endangered

5.3.5.2 Impacts of Remediation

This section provides a general description of the impacts of floodplain soil removal and backfilling, as well as construction of associated access roads and staging areas, on the shrub and shallow emergent wetlands. This section focuses on immediate and near-term impacts. The longer-term impacts of these activities are discussed in Section 5.3.5.4. The specific long-term and short-term impacts of the individual floodplain remedial alternatives on this habitat type are described in the evaluations of those alternatives in Section 7.

Impacts from Soil Removal Activities

The main direct effect to shrub and shallow emergent wetlands from floodplain soil remediation would be from vegetation and soil removal. Vegetation clearing would cause substantial direct effects, as these wetlands provide: (1) nesting, burrowing, and/or escape habitat and food for birds, amphibians, reptiles, mammals, and invertebrates, including important nesting habitat for migratory neo-tropical songbirds and, in the emergent areas, nesting habitat for two state-listed bird species (American bittern and common moorhen); (2) vital shade which helps control surface water, soil and air temperatures, and evaporative losses; (3) a significant yearly infusion of biomass, consisting of fallen leaves, decaying herbaceous plants, and woody material, which make up a significant component of the underlying organic layer and are part of the foundation of the food chain of these ecosystems; (4) a system whereby large volumes of surface water and the dissolved constituents within it are removed and seasonally pumped into the living tissue of the shrubs and herbaceous vegetation, substantially affecting the local hydrology and attendant wetland functions; and (5) a complex physical structure that helps to attenuate flood flows and prevent storm damage.

Soil disturbance would also produce direct impacts with significant implications. The removal of root zone soils would negatively affect sediment and shoreline stabilization. In many areas of the floodplain, root systems are critical to binding soils in place. The losses of vegetative cover and soils in the floodplain would also create a substantial risk of erosion and associated receiving water impacts. Additional impacts would result from the removal of surface soils and organic litter in these wetlands, since many animal species use these areas as forage, cover, aestivation, and/or hibernation habitat. Further, the soil disturbances would increase the likelihood of encroachment by invasive species into the disturbed areas.

In addition, the use of heavy machinery in these areas would likely cause direct mortalities to small and slower-moving animals, and at a minimum, would disrupt important elements of their life cycles. It would also cause soil compaction; and this would affect the permeability of these soils, which influences plant colonization (e.g., slows the process of recolonization by native species and makes surface soils more susceptible to proliferation of invasive species), as well as affecting the groundwater recharge/discharge and flood flow alteration functions of the floodplain. Soil compaction is particularly problematic for expansive earthwork in shallow emergent marshes. These wetland types contain deep, organic soils that are extremely difficult to work in with heavy machinery when wet – which is most, if not all, of the time – and very difficult to keep dewatered during construction.

<u>Additional Effects from Access Roads and Staging Areas</u>

All the remedial alternatives involving removal, including both the sediment and floodplain alternatives, would have additional effects on non-target shrub and shallow emergent wetlands through related construction activities. These additional impacts are essentially the same as those discussed for forested floodplains in Section 5.3.4.2 and include:

- Cutting of trees and shrubs for the construction of access roads and staging areas and installation of sedimentation and erosion controls;
- Grubbing of stumps and roots in adjacent floodplain wetlands for access road and staging area construction;
- Construction of temporary access roads in or adjacent to non-target wetlands; and
- Air quality and noise impacts resulting from truck and excavation equipment traffic and disrupting animals which utilize the wetland habitats.

5.3.5.3 *Restoration Methods*

A number of restoration procedures are available to attempt to address the impacts described above and to restore the affected shrub and shallow emergent wetlands. Those restoration procedures are described in this section. However, there are significant constraints on the ability of these procedures to re-establish the pre-existing conditions and functions of this habitat type. Those constraints and the resulting long-term prognosis for recovery of this habitat type are discussed in the next section.

The development of restoration plans for shrub and shallow emergent wetlands would begin with pre-design investigations and development of design plans similar to those described above for the forested floodplain areas. The implementation of the work related to restoration of these wetlands would likely include the following steps, which would coordinated with the various phases of the remediation process, as indicated below:

Site Preparation Phase

1. Conduct any necessary investigations for state-listed species, such as surveys for wood turtles, nests of common moorhen or American bittern, or state-listed plants (as listed above).

2. Identify any specific habitat features that are to be avoided and preserved consistent with the remediation plan (e.g., downed woody debris) and review procedures to do so.

Clearing, Grubbing, and Site Access Phase

1. Implement any necessary construction-phase monitoring for state-listed species (e.g., monitoring for wood turtles).

2. Ensure preservation of any specific habitat features that have been designated to be avoided and preserved consistent with the remediation plan.

Backfilling and Grading Phase

1. Layer soils in lifts to re-establish existing zonation to the extent practicable. Use low ground pressure machinery and/or other management measures such as timber mats, as necessary, to minimize compaction of soils.

2. Use grade stakes and pre-remediation topographic mapping and data to re-establish the pre-remediation topography to the extent practicable. In this regard, make efforts to establish the original configuration of depressional areas and swales in the shrub and emergent wetland areas.

3. Promote microtopographic variability by embedding some organic debris within the replacement soils.

4. Scarify surface soil surfaces and then implement stabilization measures that may include seeding and other measures such as netting in areas more prone to floodwater conveyance.

5. If, at the time of final grading, soil temperature and site conditions are not appropriate for transplantation and seed germination, stabilize the remediation area with appropriate erosion controls, to be followed by planting at a later time.

Placement of Woody Debris and Other Habitat Features

1. Distribute dead woody debris over and into the ground surface as appropriate depending on pre-remediation coverage by such debris.

2. Consider placement of other habitat features such as boulders, slash piles, or specific features used by state-listed species, as appropriate based upon final pre-remediation inventory and specifications.

Seeding and Planting

1. Apply an appropriate seed mix to the disturbed portions of the restoration area.

2. Plant shrubs and herbaceous species as detailed on final planting plans approved for the site. These plans would include, to the extent feasible, replanting any state-listed plant species that would be impacted and/or any affected plant species that are relied upon by state-listed animal species.

3. Manage the new plantings according to final detailed specifications.

4. Implement an invasive species control plan immediately after planting.

Following the construction phase of restoration, a monitoring program would be established, typically for a period of five years after restoration. The details of this program would be determined during design, but would likely have similar components to those discussed above for forested wetlands.

5.3.5.4 Evaluation of Restoration Constraints and Post-Restoration Conditions

In general, restoration of shrub and shallow emergent wetland communities is expected to be more straightforward than restoring forested floodplain communities. However, it is still subject to numerous constraints that could result in affecting or delaying recovery of these wetland communities. This section describes those constraints and their associated effects on the likelihood of returning this habitat type to its pre-remediation conditions and level of function and the timing in which this might occur.

Changes in Soil Stratigraphy. As noted above, the heavy mechanized equipment required to clear vegetation, excavate and grade floodplain soils, and place backfill would result in compaction of the soils. This would make soils less friable and conducive to the formation of the necessary subterranean burrows required by certain animals for overwintering, hinder the re-establishment of a native plant community, and facilitate proliferation of invasive plant species. While scarification of the soils after placement of backfill or removal of the access roads would reduce the adverse effects from compaction, it would not eliminate such effects, which could last for a considerable period of time. In addition to compaction, final graded soils could subside more than expected, affecting water levels in a fashion that limits successful use by certain plant or animal populations (e.g. breeding amphibians).

Changes in Soil Composition and Chemistry. The shrub and shallow emergent wetlands contain high organic content soils (typically silty muck or organic soils) that have formed over many decades. It is unlikely that sufficient volumes of comparable organic soils could be found for use in the restoration efforts, and attempts to manufacture such soils are not reliable, since the soil chemistry and seed bank of the on-site soils are specific to the existing Housatonic River floodplain system. At a minimum, imported soils would have different microbial communities and other physical properties that affect plant growth and hydraulic conductivity. Pre-existing soil conditions would not return until the natural pattern of flooding has deposited enough silt and organic material over the backfilled areas to approximate their prior condition. This would be a slow process that depends on the frequency and extent of sufficiently large depositional flood events, which are irregular and unpredictable. It could take a decade or more for organic matter to build up to a point at which soil conditions comparable to current conditions would be common in these remediated wetlands. As a result, the changes in soil composition and properties could significantly affect the extent and type of plant growth and hydraulic conductivity in the affected areas (both lateral and vertical) for many years.

Changes in Hydrology. An additional important constraint on the ability to restore the shrub and shallow emergent wetlands would be presented by the impacts of the remediation activities on the hydrology in the area. As with the forested floodplains, this is a complex issue since there are multiple sources of water that feed these systems. In addition, since most of the acreage of these wetlands in the PSA is located within the lower portion of floodplain nearer the river, these areas are susceptible to dynamic changes in surface water levels, erosion, and deposition. Even with success in re-establishing pre-existing elevations, micro-topography, and ground contours, changes to the topography of the overall floodplain upstream or downstream may alter the discrete flood flows that dictate the recovery of the individual shrub and emergent wetland communities and their distribution within the floodplain. In short, after a restoration attempt, the geographic distribution and acreage of shrub and shallow emergent wetlands are quite likely to change, even if the basic restoration elements succeed.

Change in Vegetative Characteristics. Due to the changes in soil composition and chemistry and in hydrological conditions (as described above), the vegetation currently present in the shrub and shallow emergent wetlands is likely to change. Species that can tolerate a broader range of conditions are likely to be more abundant than those species which require specific habitat conditions within shrub and shallow emergent wetlands. For example, invasive purple loosestrife might replace native buttonbush. These changes in vegetation would last until such time as soil and hydrological conditions comparable to pre-remediation conditions return to these wetlands so as to support a vegetative community similar to the pre-remediation community. Given the unpredictable and likely slow rate of organic soil accumulation, it could take a decade or more to reach conditions that would support shrub or emergent plant communities comparable to current communities; and it is uncertain whether certain sensitive species, such as the state-listed species, would return.

Moreover, the ability to successfully restore these wetlands is further constrained by the potential introduction and/or spread of invasive herbaceous species. Portions of the shrub and emergent wetlands in the PSA targeted for restoration exhibit some degree of invasive plant species (e.g., purple loosestrife), while most portions do not. As is the case with forested floodplain, disturbances of these areas represent a prime opportunity for expansion of the extent of invasive species, since removing a mature, stable system creates primary successional conditions under which invasive species readily take hold. Further, as previously noted, invasive plant species proliferation may be difficult to prevent even under a very rigorous control program.

Recovery of Wildlife Community. The return of wildlife communities comparable to the pre-remediation communities in these shrub and emergent wetlands would depend on the return of soil, hydrological, and vegetative conditions. As discussed above, the time for that to occur is uncertain, but could be a decade or more. During this period, many common game and non-game avian species, as well as state-listed species (e.g., American bittern, common moorhen, wood turtle), would be lost from these wetlands, and the return of the state-listed species is doubtful.

Loss of Connectivity to the Nearby Wetland Communities. With any significant habitat alteration over widespread areas of the floodplain, the connections among shrub/emergent wetlands and their landscape settings in a forested habitat matrix would be degraded or lost entirely. This places another constraint on the ability to successfully restore these wetlands, since most wetland-dependent amphibians, reptiles, small mammals, and non-flying invertebrates are unable to disperse or migrate if corridors are obstructed or highly disturbed. The value of these habitats as part of a regionally important dispersal and migratory corridor would be lost, which would likely interfere with movements of those species that use them, thus resulting in higher mortality rates and elimination of some subpopulations.

Impacts on Other Floodplain Functions. Depending on the extent of the disturbances, the implementation of remediation activities in these wetlands could also have a long-term impact on the floodplain functions of groundwater recharge/discharge, flood flow alteration, and water quality maintenance, nutrient processing, and production export, for similar reasons to those discussed in Section 5.3.4.4.

Conclusion/Long-Term Outlook

Where shrub and shallow emergent wetlands are disturbed by floodplain soil removal or ancillary facilities (access roads and staging areas), it is expected that restoration efforts would result in re-establishment of most pre-remediation functions of these wetlands over time. However, give the constraints described above, this recovery time is uncertain and could take a decade or more. In addition, there is a serious risk of additional invasive species expansion into these areas. Moreover, depending on the extent of the disturbances and the length of time over which they last, some of the pre-remediation functions of these wetlands, such as providing habitat for state-listed species, may not return for a much longer period, if ever, in some of the affected wetland areas.

5.3.6 Backwater and Deep Marsh Habitat

5.3.6.1 Description of Habitats

In this Revised CMS Report, deep marshes and backwaters are considered in the same general category from a habitat standpoint, although remediation of backwaters is generally addressed by the sediment remedial alternatives while the areas designated as deep marshes are generally addressed by the floodplain alternatives.

Deep marshes are wetlands occurring on saturated, mucky mineral soils that are seasonally inundated and permanently saturated. The substrate is flooded by waters that are not subject to violent wave action, with water depths ranging from six inches to six feet. Water levels may fluctuate seasonally, but the substrate is rarely dry, and there is usually standing water throughout the year. The vegetation in deep marshes is quite variable. It may be co-dominated by a mixture of species or have a single dominant species. In the PSA, dominant plant species within the deep marshes include broad-leaved cattail, common reed, giant burreed, pickerel weed, tuckahoe, common arrowhead, and the invasive purple loosestrife. The PSA contains approximately 49 acres of areas designated as deep marshes.[103]

Backwaters refer more to a hydrologic condition than a distinct habitat type, and they encompass both riverine and floodplain natural community types. For remediation purposes, as noted above, backwaters are generally addressed by the sediment (rather than floodplain) remedial alternatives, reflecting the fact that they generally have a direct surface water connection to the river. However, from the perspective of habitat and restoration, the backwaters are predominantly deep marshes with either shallow (e.g., less than 6 feet deep) open water and/or floating and/or submerged aquatic vegetation. The PSA contains approximately 86 acres of backwaters. These backwaters are generally closely associated with the designated deep marshes in the PSA.

The presence of fish in backwaters and deep marshes varies within the PSA. The key feature of backwaters and deep emergent marshes that drives the wildlife function of these habitats is the hydrologic connection to the Housatonic River. During periods of high water when these areas are connected to the Housatonic River, fish can migrate between the backwater habitat and mainstem of the river. In smaller backwater areas, as the high water recedes, fish would be expected to return to the river, although some may be trapped within the backwaters. Larger backwater areas in the vicinity of Woods Pond contain open water year round and provide suitable habitat for fish, including brown bullhead, common carp, goldfish, bluegill, largemouth bass, yellow perch, and white sucker.

Backwater areas and deep emergent marshes are also utilized by a range of bird, mammal, amphibian, and reptile species that rely on these areas for foraging, shelter, and breeding. Large backwater and marsh habitats are important for nesting and foraging for a variety of bird species, including the state-listed American bittern, the state-listed common moorhen, wood duck, mallard duck, blue heron, green heron, marsh wren, and red-winged blackbird. Wading birds prefer these backwater and emergent marsh areas of open water with minimal current for foraging. Species presence may vary between years depending upon the hydrologic conditions of the backwater and marsh habitats. Amphibian and reptile species also use these habitats for foraging, breeding, and thermal regulation, including northern leopard frog, green frog, snapping turtle, spotted turtle, eastern painted turtle, eastern garter snake, northern water snake, and the state-listed wood turtle. In addition, during years when standing water exists through the amphibian breeding season, obligate vernal pool species such as wood frog and spotted salamander use portions of these areas for breeding. Although other amphibian species will often prey on obligate vernal pool species, the large size and diversity of micro-habitats within certain backwaters may allow for some co-

[103] In addition, based on review of land use and wetlands information from MassGIS and 2005 aerial photographs, the Reach 7 floodplain contains approximately 5.4 acres of deep marsh habitat.

existence between obligate species and those that normally prey on these species – e.g., by providing secluded areas in dense vegetation and organic debris for egg masses and developing larvae of the obligate species.

There are 22 state-listed plant and animal species that have NHESP-mapped Priority Habitat within the backwater and deep marsh areas of the PSA and that could be found in those habitats. These species are listed in the following table.

Table 5-8 – State-Listed Species Associated with the Backwater and Deep Marsh Habitats of the PSA

Common Name	Scientific Name	State Status
Bald eagle	*Haliaeetus leucocephalus*	Endangered
Wood turtle	*Glyptemys insculpta*	Special Concern
Water shrew	*Sorex palustris*	Special Concern
American bittern	*Botaurus lentiginosus*	Endangered
Common moorhen	*Gallinula chloropus*	Special Concern
Arrow clubtail (dragonfly) (adults)	*Stylurus spiniceps*	Threatened
Zebra clubtail (dragonfly) (adults)	*Stylurus scudderi*	Special Concern
Rapids clubtail (dragonfly)	*Gomphus quadricolor*	Threatened
Riffle snaketail (dragonfly) (adults)	*Ophiogomphus carolus*	Threatened
Spine-crowned clubtail (dragonfly)	*Gomphus abbreviatus*	Endangered
Mustard white (butterfly)	*Pieris oleracea*	Threatened
Dion skipper (butterfly)	*Euphyes dion*	Endangered
Intermediate spike-sedge	*Eleocharis intermedia*	Threatened
Bristly buttercup	*Ranunculus pensylvanicus*	Special Concern
Bur oak	*Quercus macrocarpa*	Special Concern
Culver's root	*Veronicastrum virginicum*	Threatened
Foxtail sedge	*Carex alopecoidea*	Threatened
Gray's sedge	*Carex grayi*	Threatened
Hairy wild rye	*Elymus villosus*	Endangered
Long-styled sanicle	*Saniula odorata*	Threatened

Common Name	Scientific Name	State Status
Wapato	*Sagittaria cuneata*	Threatened
White adder's-mouth	*Malaxis monophyllos var. brachypoda*	Endangered

5.3.6.2 Impacts of Remediation

This section provides a general description of the impacts of the remedial technologies that would be used in the backwaters and deep marshes in the River of River area under the sediment alternatives (for the backwaters) and floodplain alternatives (for the other deep marshes). Those technologies consist of sediment or soil removal followed by backfilling or capping and, for the backwaters under some alternatives, thin-layer capping. This section focuses on immediate and near-term impacts of these technologies. The longer-term impacts are discussed in Section 5.3.6.4. The specific long-term and short-term impacts of the individual sediment and floodplain remedial alternatives on the backwaters and deep marshes are described in the evaluations of those alternatives in Sections 6 and 7.

Sediment/Soil Removal

The excavation of sediments or soils from backwaters and deep marshes would generally be followed by the placement of a cap or backfill. These activities would have similar impacts to those discussed for removal of sediments from aquatic riverine habitats (Section 5.3.1.2), impoundments (Section 5.3.3.2), and shallow emergent marshes (Section 5.3.5.2). These immediate and near-terms impacts would occur regardless of whether the excavated areas are replaced with backfill, a sand cap, or a cap consisting of an active (sorptive) layer covered with a habitat/bioturbation layer. Impacts of primary concern for excavation and related backfilling or capping of backwaters and deep marshes include:

- Dewatering impacts on organisms and resting stages (eggs, seeds, overwintering forms) in any backwaters or deep marshes that would be dewatered;
- Removal of any organisms present in the sediments;
- Removal of woody debris, rocks, and other structural habitat elements;
- Clearing of any vegetation present in the remediation area, with consequent impacts on the water birds and other wildlife that rely on such vegetation;
- Change in substrate type from silts and mucky organic material to sand, a mixture of sand and gravel, or imported soil, which would not support some of the previously

resident species of invertebrates, fish, amphibians, reptiles, waterfowl, and other wildlife using the backwater or marsh;

- Change in hydrology of the backwater or deep marsh;
- Loss of any state-listed species present; and
- Colonization by invasive species.

Thin-Layer Capping

The impacts of thin-layer capping on the backwaters would be similar to those described for thin-layer capping for aquatic riverine habitats (Section 5.3.1.2) and impoundments (Section 5.3.3.2). Impacts of primary concern include:

- Burial of most, if not all, of the non-mobile organisms present in the sediments;
- Raising the elevation of the substrate, which would modify the hydrology of the backwater (making it drier, at least in part) and could change the vegetative characteristics of areas where the depth of the thin-layer cap approaches the water depth or, in areas where the thin-layer cap exceeds the water depth of water, cause the emergent wetlands vegetation to be replaced by species tolerant of less frequently inundated or drier conditions.
- Changing the silty/mucky organic substrate type to sand, resulting in a change in the aquatic vegetation, benthic invertebrates, fish, and other wildlife using the backwater;
- Loss of any state-listed species present; and
- Colonization by invasive species.

5.3.6.3 Restoration Methods

The restoration procedures available for use in the backwater and deep marsh areas are similar in several respects to those described in Section 5.3.5.3 for shrub and shallow emergent wetland areas, but would require certain modifications of those procedures. Some of the modifications are related to the different remedial measures that would be applied to some backwaters. For example, backwaters that would be subject to thin-layer capping would not require the same procedures for examining pre-remediation soil conditions as described above for shrub and shallow emergent wetlands, because no clearing, grubbing, excavation, or backfilling would occur.

In addition, no seeding of the soil surfaces would be warranted in the backwater/deep marsh areas because these areas would be permanently inundated once the dewatering or other water level controls implemented during the remediation process are removed. Vegetation selected for planting in the deep marsh/backwater areas where vegetation was previously present would consist of more aquatic species (submergent and floating-leaved species), rather than the emergent species for the shallow emergent wetlands.

Similar monitoring measures would apply for the backwater/deep marsh areas as described above for the forested floodplains and for the shrub and shallow emergent wetlands.

5.3.6.4 Evaluation of Restoration Constraints and Post-Restoration Conditions

There are a number of significant constraints on the restoration of backwater and deep marsh habitats that would affect the ability of the restoration methods to re-establish the pre-remediation conditions and functions of these habitats. Those constraints are generally similar to those discussed in Section 5.3.5.4 for shrub and shallow emergent wetlands, although they apply somewhat differently to the backwaters and deep marshes. Those constraints include the following:

<u>Changes in Substrate Composition and Chemistry.</u> As noted above, the remediation would result in changing the substrate of the affected backwaters and deep marshes from one that contains several feet of silts or mucky organic material to one consisting of sand, a mixture of sand and gravel, or imported soil backfill. This would result in alteration of the associated plant and animal community and would create difficulties in attempting to restore both the vegetation and hydrology of these areas. These changed conditions would last until enough silt and organic material from surrounding areas have been deposited in the backwater or marsh through flood events to approximate current conditions. The timeframe for this recovery is uncertain, but could be a decade or more.

<u>Changes in Hydrology.</u> The hydrology of the backwaters and deep marshes in the PSA is complex as it is governed by the swales that frequently connect these habitats to the Housatonic River and by the topographic features of the floodplain in the vicinity of these habitats. The removal and backfilling or capping of a backwater or deep marsh or the placement of a thin-layer cap in a backwater would alter the hydrology of the area. While efforts would be made to reconstruct the existing swale systems to replicate current flow patterns, the potential is high for changes to surface grades and substrate conditions that would affect the flow of waters through these features. Even minor changes in the surface elevations at control points where surface water is conveyed into and through the swales could significantly alter the quantity of flow to the backwater or deep marsh. In addition, changes in topography resulting from remediation or access road construction in the adjacent floodplain areas may further affect the hydrology of the backwater or deep marsh, through either altered infiltration features or transformed flow pathways. The ability to replace all

these features in a way that would re-establish the pre-existing hydrology of the affected backwater or deep marsh, and the length of time for that to occur, are uncertain.

Changes in Vegetative Characteristics. Given the above-described changes in soil composition and chemistry and in hydrological conditions, the aquatic vegetation currently present in the backwaters or deep marshes would change as well. Vegetation that requires mucky organic substrate, including the state-listed intermediate spike-sedge and wapato, would no longer be able to survive in the sandy substrate and would be replaced by plants that are more tolerant of low nutrient sandy conditions. Over time, as organic materials are deposited in the backwaters or deep marshes, emergent vegetation consistent with that substrate would likely return, but the length of time for that to occur, as well as the return of state-listed plant species, are uncertain. Moreover, in backwater areas subject to a thin-layer cap, if the cap depth approaches or exceeds the water depth, the change in elevation could permanently change the vegetative characteristics of those areas. Further, as with the other vegetated habitats in the floodplain subject to remedial actions, invasive species proliferation is likely in remediated/restored backwaters and deep marshes. For example, invasive species that are currently present in small pockets (e.g., purple loosestrife, Japanese knotweed) would be able to rapidly expand into disturbed areas. All of these factors add considerable uncertainty to the long-term recovery process, and suggest that the backwater and deep marsh habitats a decade or more after remediation would not match their pre-remediation condition.

Recovery of Wildlife Community. Where the remediation would involve extensive impacts within a backwater or deep marsh, most current wildlife species using that habitat would be initially eliminated; and the substrate, hydrology, and vegetation changes would dictate what species would return to that area. For example, wading birds may initially find the remediated backwater or deep marsh preferable for foraging due to the more open water (although success may be limited if fish and other aquatic prey are not available, which depends upon invertebrate colonization rates). However, as vegetation grows in and emergent vegetation dominance increases (as expected), suitability for most wading birds would decline. Conversely, habitat for ducks shortly after remediation would be poor due to lack of food and cover, but may improve over a period of several years as the ducks may prefer the protection offered by the emergent vegetation. Overall, given the uncertainties in the timing for return of soil, hydrological, and vegetative conditions, the timing for return of wildlife communities comparable to pre-remediation communities in these habitats is likewise uncertain.

Loss of Connectivity to Other Habitats. The extent of the disturbances not only within the backwaters and deep marshes but also through the floodplain would affect the connectivity between these habitats and other habitats used by the backwater/deep marsh wildlife. As previously discussed, any significant fragmentation of this connectivity would negatively impact the dispersal and migration movements of many species.

Conclusion/Long-Term Outlook

The remediation of backwater and deep marsh habitats would cause a change in the physical and biological conditions and resulting wildlife habitat of this area. It is expected that many of those conditions and functions would return to pre-remediation levels at some point, but the length of time for such recovery is uncertain. Moreover, in some respects, the biotic communities that are re-established in these areas may not match pre-remediation communities. For example, there would be a high potential for proliferation of invasive plants, and the return of certain sensitive species, such as state-listed wildlife species, is doubtful.[104]

5.3.7 Vernal Pools and Surrounding Habitat

5.3.7.1 Description of Habitat

The Massachusetts Wetlands Protection Act regulations define vernal pools as "confined basin depressions which, at least in most years, hold water for a minimum of two continuous months during the spring and/or summer, and which are free of adult fish populations, as well as the wetland area within 100 feet of the mean annual high water boundaries of such depressions" (310 CMR 10.04). Vernal pools supply essential breeding habitat for a number of amphibian and invertebrate species (often referred to as obligate vernal pool species), such as wood frog, spotted salamander, Jefferson salamander (a state-listed species), and fairy shrimp. They also provide foraging and resting habitat for numerous other amphibians and reptiles, including northern spring peeper, northern leopard frog, American toads, wood turtles, spotted turtles, snapping turtles, painted turtles, garter snakes, and ribbon snakes.. Pools also support migrating waterfowl and wading birds and serve as feeding oases for many small mammals and game species, including black bear, deer, and moose. The surge of biomass (amphibian adults and newly emerging young) migrating from pools to adjacent uplands provides energy for non-wetland dependent wildlife as well.

Vernal pools are not simply isolated depressions that are seasonally filled with water. In fact, they are not ecologically isolated at all. They constitute a unique habitat type because their presence and functionality during most years are reliant upon the co-occurrence of so many different variables, including spatial, chemical, physical, climatic, and biological factors . The right combination of the following characteristics is vital for a given basin to function during most years as viable vernal pool habitat:

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[104] In addition to the functions discussed in this section, some areas that constitute backwaters or deep marshes may provide breeding functions for obligate vernal pool species. The re-establishment of those functions has not been discussed in this section, but would be governed by considerations such as those discussed in the next section.

Topography. While vernal pool habitat can occur in large, multi-habitat wetlands, it is discrete depressions surrounded by forested habitat that typically provide the best habitat for the forest specialist species typically associated with vernal pools.

Hydrologic Regime and Water Depth. It is the lack of a *permanent* connection to open water systems such as lakes and rivers, proper water depths (not too shallow, but not too deep), and duration of flooding in vernal pool depressions, that generally keep them free of adult fish, which are more common in perennially aquatic systems and can be predators of amphibian eggs and larvae. The hydrology of a vernal pool can be influenced by many climatic and hydrological factors, including, but not limited to, direct precipitation, groundwater discharge, and overbank flooding. Each vernal pool is affected by a unique combination of these factors specific to that pool. Hydroperiod is strongly correlated with amphibian species richness and total number of metamorphosing larvae (i.e., reproductive success) (Pechmann et al., 1989; Babbitt and Tanner, 2000; Snodgrass et al., 2000a, b). The pools need to hold ice-free water to the proper depths and duration (usually around 2-3 months) in order for amphibians to breed, for eggs to develop, and for larvae to grow and successfully transform into juveniles which disperse into the surrounding terrestrial lands. If a pool dries too soon, significant or total mortality can occur to amphibian larvae, prohibiting those larvae from completing metamorphosis to terrestrial juvenile stages, which can result in complete reproductive failure (Pechmann et al., 1989; Skelly, 1996; Paton and Crouch, 2002). If the pool stays wet too long, it can become amenable to population by predatory fish and predatory green frog and bullfrog larvae. This is particularly true in floodplain settings where overbank flooding can allow fish to access the vernal pools.

Bottom Sediments/Soils Composition. The composition and structure of bottom sediments/soils in a vernal pool play an important role in the development of vernal pool amphibians. Significant leaf litter is generally common, and this material often provides the base for the food chain upon which amphibian larvae are a part. Wood frog larvae are omnivorous and may feed directly on algae attached to leaf litter, while salamander larvae are generally carnivorous and prey upon the smaller microorganisms that feed upon leaf litter and algae. In addition to being a potential food source, bottom sediments and soils in a vernal pool factor into the overall permeability of the depression – which may dictate how long and to what depths the pool holds surface water.

Water Chemistry and Temperature. Water temperature, pH, and dissolved oxygen are just a few factors than can dictate successful timing of amphibian breeding and larval development in a vernal pool. Water temperature and dissolved oxygen are significantly influenced by the shading effect of mature trees over the pool (Werner and Glennmeier, 1999), which can influence survivorship and growth rates of developing larvae (Seale, 1982).

In-Pool Physical Structure. In addition to leaf litter, fallen twigs or sticks, emergent plants, and coarse woody material play an important role in vernal pools, as these provide protective cover for larvae or the vital physical structure on which amphibians may attach egg masses (Gates and Thompson, 1981; Seale, 1982; Egan and Paton, 2004). These structures are essential to vernal pools with thriving vertebrate and invertebrate populations.

Surrounding Land Uses. One of the most important factors supporting a viable long-term population of vernal pool animals is not related to the pool itself, but the composition of the surrounding landscape. Many vernal pool amphibians, such as mole salamanders (including spotted, blue spotted, and Jefferson salamanders) and wood frogs, spend the majority of their annual life cycles in terrestrial lands beyond the vernal pool (McDonough and Paton, 2007; Rittenhouse and Semlitsch, 2007). A forested habitat is preferred in most cases, as it provides shade during warmer months that keeps air temperatures cooler and surface soils moist below the leaf litter, which prevents desiccation of the amphibians. Coarse woody material, deep leaf litter, and the burrows of small mammals (predominately shrews) are also important for protective cover and overwintering habitat for salamanders and wood frogs.

A mature forest surrounding a vernal pool depression provides the critical overhanging canopy that keeps the pool shaded and water temperatures within a tolerable range, and provides the leaf litter and woody debris that are the foundation of the detrital food web. A vernal pool with optimal breeding habitat will not support a successful population of amphibians without suitable terrestrial habitat to support amphibian migrations and other life history functions. Dispersal of juveniles is key for recolonization of local subpopulations and maintenance of regional populations, and this dispersal is largely influenced by the surrounding land uses.

For these reasons, management guidelines for habitat modification around vernal pools recognize that even small impacts to such adjacent non-breeding habitats materially reduce the value of these habitats for the vernal pool ecosystem (Calhoun and Klemens, 2002; Calhoun and deMaynadier, 2004). Thus, these guidelines recommend that impacts to non-breeding habitats within 100 feet of a vernal pool be avoided, and that impacts in critical terrestrial habitat from 100 to approximately 750 feet be substantially minimized – e.g., that in such areas, a development project should maintain a minimum of 75% of the zone in unfragmented forest with undisturbed ground cover (Calhoun and Klemens, 2002).

Relationship and Proximity to Other Vernal Pools. Vernal pools may function as singular aquatic systems, but often occur in clusters, allowing a meta-population of amphibians to disperse among the pools in search of suitable mates and habitat (Gibbs and Read, 2008) – i.e., when the carrying capacity of a pool for a given species is reached, or when the hydrologic or other factors of a given pool are not sufficient during a given year, but *are* adequate in a neighboring pool. It is the proximity of vernal pools with slightly differing, but suitable characteristics, which can provide the necessary network to keep the local population of a species intact. Vernal pool species display a high degree of fidelity to breeding sites as an evolutionary mechanism to ensure reproductive success (Berven and Grudzien, 1990).

Part of that success is predicated upon having opportunities for occasional exchange of genetic material among individuals from different subpopulations, especially individuals within the local meta-population (Gibbs and Read, 2008). This can occur when a cluster of suitable pools occur in proximity within an appropriate habitat matrix, which in the PSA is a contiguous area of mature forest. If the physical structures or hydrologic regimes of the pools are altered, or the habitat matrix shifts to a non-forest habitat type, then that meta-population is at risk to be displaced by a completely different community of organisms that can tolerate the altered conditions.

Vernal Pools in PSA. EPA, through Woodlot (2002), identified 66 vernal pools in the floodplain of the PSA. About two-thirds of these pools are located north of New Lenox Road, where there are numerous depressions in the forested floodplain that are seasonally filled with water due to overbank flooding of the Housatonic River, groundwater seepage, and/or a seasonally elevated water table. The remaining one-third of vernal pools in the PSA exist south of New Lenox Road, where the river has a lower gradient and the floodplain is broader and flatter.

Based on recent visual observations, it appears that some of the vernal pools identified by Woodlot (2002) now function as permanently inundated deep marshes or backwaters, rather than classic vernal pools that would meet the Massachusetts Wetlands Protection Act definition. However, these pools may still perform some vernal pool functions in certain places and times. For example, portions of these pools may contain physical structure (e.g., leaf litter, woody debris, aquatic emergent vegetation, and woody shrubs) that could provide refugia for developing larvae and thus make it possible for some of the more sensitive species to continue breeding in these pools despite current hydrologic conditions. Moreover, such longer hydroperiod ponds may provide critical breeding habitat for sensitive vernal pool species during periods of drought when nearby seasonally flooded vernal pools dry too soon, resulting in complete mortality of amphibian larvae in those pools. In any case, since these pools were identified as vernal pools by Woodlot and have been considered vernal pools in developing the remedial alternatives requiring vernal pool remediation, they are considered vernal pools in the evaluations presented herein.[105]

[105] In addition to the vernal pools within the PSA, there are 4 certified vernal pools (NHESP, January 2010) and 18 potential vernal pools (NHESP, December 2000) located within the 100-year floodplain in Reach 7. As discussed in Section 4.3.2, these NHESP data sets present vernal pools as individual points (not polygons); therefore, it is difficult to assess the actual size and shape of the pools within this reach. However, it appears that none of the floodplain alternatives would directly affect any of these vernal pools, but that soil removal activities under the largest floodplain alternative (FP 7) would occur within 100 feet of 3 of those pools and within 750 feet of 14 of those pools.

5.3.7.2 *Impacts of Remediation*

This section provides a general description of the impacts of remediation work on the vernal pools, as well as on the non-breeding habitats surrounding the vernal pools. This section focuses on immediate and near-term impacts. The longer-term impacts of these excavation activities are discussed in Section 5.3.7.4. The specific long-term and short-term impacts of the individual floodplain alternatives on vernal pools are described in the evaluations of those alternatives in Section 7.

Vernal pool remediation would involve the removal of the surficial soil, together with the vegetative cover, tree stumps and roots, and woody debris, in all or a portion of the vernal pool. These soil disturbances would have a significant direct effect on vernal pool life. It would result in the mortality of any amphibian and/or invertebrate eggs, larvae, or adults in the pools (or affected portion thereof) at the time of remediation, which is probable throughout most of the year. It would also remove physical components of the vernal pools that are critical to vernal pool ecology – e.g., the highly organic soils, which provide a medium that supports the food chain, affects permeability so as to keep the pools from drying out too soon, and facilitates groundwater flow in groundwater-influenced vernal pools. Further, the remediation would alter the hydrology of the pools by changing the in-pool characteristics that determine the hydrology (e.g., sediment types and stratigraphy, microtopography, foliage cover), as well as affecting the surrounding landscape characteristics that affect the timing and quantity of surface water and groundwater inputs into the pool and conveyance of water out of the pool (e.g., their juxtaposition with fluvial swales that flood waters into the pools). As a result, important elements of the vernal pool animals' life cycles, including breeding for the obligate vernal pool species, would be disrupted.

Tree clearing within and immediately adjacent to the vernal pools would also produce substantial direct adverse effects, as these mature trees provide vital shade which helps control surface water, soil, and air temperatures, evaporative losses, and additionally provide a significant yearly infusion of biomass (fallen leaves) within the pools and surface litter and coarse woody material along the edges of the pools, all of which provide critical habitat cover from predators.

In addition, where the remediation would involve the removal of vegetation in the larger areas around the pools, especially the clearing of trees and shrubs in surrounding forested areas – either to facilitate remedial soil removal or to allow the construction of access roads – these activities would further exacerbate the adverse impacts on the vernal pool communities. As recognized by the management guidelines mentioned above, any such disturbances to the non-breeding habitats surrounding a vernal pool – especially within 100 feet of the pool but also within the 100- to 750-foot zone – would negatively impact the local amphibian subpopulations and could result in significant losses of amphibian breeders.

Other species reliant upon vernal pools in an intact forest riparian corridor would also be negatively impacted. For example, the vegetation cutting would negatively impact the wide-ranging wood turtles that forage in vernal pools, star-nosed moles that burrow and forage along moist edges, and migratory songbirds like the northern and Louisiana waterthrushes that forage along the pool edges under forest cover during both breeding and migratory seasons.

Further, the excavations within the vernal pools and the surrounding areas would result in the loss or fragmentation of landscape connectivity among networks of vernal pools or between vernal pools and associated non-breeding terrestrial habitat. Adult and emigrating juvenile amphibians have been shown to avoid clearcut areas adjacent to vernal pools (Patrick et al. 2006). This disruption of connectivity, along with loss of the critical features of the forest floor that provide protection, temperature and moisture regulation, foraging, and overwintering to obligate vernal pool species, would constrain subsequent colonization and recolonization of these vernal pools by target vernal pool species and/or promote use of those pools by other, more aggressive species such as green frogs or bullfrogs.

These impacts would be largely unavoidable. Working in the pools when the amphibians have left the pools for the season would avoid one set of impacts (i.e., to the breeding and larval stages), but would simply displace impacts to the terrestrial life stage of the vernal pool amphibians, as many vernal pool species spend a substantial portion of their annual life cycle in the surrounding woodlands. Even if the remediation work were to occur during the low-flow season and after the spring breeding and migration period, this would not avoid direct mortalities to vernal pool juveniles and adults living in the leaf litter or in shallow burrows. These are slow-moving organisms that are especially vulnerable to ground disturbance or soil compaction. Further, the impacts of remediation in a given pool would last multiple years beyond the season in which that remediation takes place, thereby adversely affecting the breeding potential of the local population. Because vernal pool amphibians have strong site fidelities, they would unsuccessfully attempt to return to disturbed vernal pools, even if the pools are no longer suitable for breeding.

While an effort has been made to site access roads away from vernal pools (as discussed in Section 5.2.2), this was not possible in connection with the alternatives requiring vernal pool remediation because of the access required adjacent to and in the vernal pools. Additionally, many of the access road alignments for the floodplain alternatives are constrained by severe topography, the river itself, and logical connection points to existing public roads that would be integral to the construction process. In any event, the adjustment of access road locations would not prevent the impacts that would unavoidably occur from soil removal and replacement within and near the vernal pools targeted for remediation.

5.3.7.3 *Restoration Methods*

A number of restoration procedures are available that would attempt to address the impacts described above and to restore the affected vernal pools. Those restoration procedures are described in this section. However, there are significant constraints on the ability of these procedures to re-establish the pre-existing conditions and functions of vernal pools. Those constraints and the resulting long-term prognosis for recovery of this habitat type are discussed in the next section.

The first step in the restoration effort for vernal pools would be to collect additional data on the existing conditions and functions of each vernal pool. Data collection would include a baseline functional assessment, which would include the size and geographical extent of the pools, resident plant and animal species (including any state-listed species), source of hydrology, typical annual water levels and duration of wetness, relationship to other vernal pools in the area or network, usage of adjacent habitats (including predominant migratory patterns) by vernal pool animals, and composition of the predator community. In addition, as micro-topography and elevations within a given depression can be the most important factor influencing requisite vernal pool water levels, a detailed pre-construction topographic survey is critical to the restoration of a vernal pool. Based on these data, design plans would be developed, which would likely include specifications for similar parameters to those discussed above for forested wetlands.

The implementation of the work related to vernal pool restoration would likely include the following steps, which would be coordinated with the various phases of the remediation process, as indicated below:

<u>Site Preparation Phase</u>

1. Conduct any necessary investigations for state-listed species, such as screening for wood turtles or Jefferson salamanders, as well as more complete investigations of the use of the pool by obligate vernal pool amphibian species and an assessment of the non-breeding habitat conditions surrounding the pool.

2. Identify any specific habitat features that are to be avoided and preserved consistent with the remediation plan (e.g., wolf trees, downed woody debris, or standing dead trees) and review procedures to afford their protection.

<u>Clearing, Grubbing, and Site Access Phase</u>

1. Evaluate cut woody debris for preservation and subsequent re-use as habitat features; set aside selected material separately from woody debris to be removed from the site.

2. Implement any necessary construction-phase monitoring for state-listed species (if any) and/or sensitive vernal pool species (e.g., monitoring for wood turtles and Jefferson salamanders).

3. Ensure preservation of any specific habitat features that have been designated to be avoided and preserved consistent with the remediation plan.

Backfilling and Grading Phase

1. Layer soils in lifts to re-establish existing zonation to the extent practicable. Use low ground pressure machinery, as necessary, to minimize compaction in the distribution of soils.

2. Use grade stakes and pre-remediation topographic mapping and data to re-establish the pre-remediation topography to the extent practicable. In this regard, make efforts to establish the original configuration of depressional areas and swales in proximity to the vernal pool that contribute to surface water conveyance to the pool, soil moisture, and overall habitat conditions.

3. Promote microtopographic variability, consistent with current conditions in the pool, by embedding some organic debris within the replacement soils.

4. Place at least a two-inch layer of mulch composed of leaf litter from trees characteristic of the nearby floodplain forest to the extent practicable.

Placement of Woody Debris and Other Habitat Features

1. Distribute dead woody debris over and into the ground surface as appropriate depending on pre-remediation coverage by such debris.

2. Consider placement of other habitat features, such as boulders or slash piles, outside of the pool to provide suitable cover, as appropriate, for vernal pool animals, based upon final pre-remediation inventory and specifications.

3. Install any specific habitat features designed to replace features used by state-listed species.

Seeding and Planting

1. Apply a wetland seed mix (or other acceptable mix) to the disturbed portions of the vernal pool.

2. Plant trees, shrubs, and herbaceous species as detailed on final planting plans approved for the site. These plans would include, to the extent feasible, replanting any state-listed plant species that would be impacted and/or any affected plant species that are relied upon by state-listed animal species.

3. Manage the new plantings according to final detailed specifications.

4. Implement an invasive species control plan immediately after planting.

Following the construction phase of restoration, a monitoring program would be established, typically for a period of five years after restoration. The details of this program would be determined during design, but would likely include semi-annual or annual inspections of the replanted vegetation during the growing season, as well as annual inspections of the vernal pools in the spring during the monitoring period. See also Section 4.5 above. The program would also include an invasive species monitoring and control plan.

5.3.7.4 Evaluation of Restoration Constraints and Post-Restoration Conditions

Despite the implementation of the restoration procedures described in Section 5.3.7.3, there are significant constraints on the ability to restore vernal pools. Restoration of a vernal pool would require, first and foremost, the re-establishment of the requisite hydrologic regime, which is, in turn, dependent on specific surface flow patterns through the floodplain as well as microtopographic and soil conditions that have developed within the floodplain depressions, each of which would be very difficult to reproduce for an isolated vernal pool, let alone a complex of such pools. In addition, it would require the re-establishment of the pre-existing soil composition of the vernal pool and the composition and structure of the native vegetation within and around the pool, each of which would also be very difficult to reproduce. These difficulties are reflected in literature describing vernal pool creation efforts that have not successfully produced the full range of vernal pool functions due to an inability to produce the correct hydrology or soil composition (Korfel et al., 2009; Gamble and Mitsch, 2009) and/or a situation in which sensitive vernal pool species, such as wood frogs, were driven out by more aggressive species such as green frogs (Vasconcelos and Calhoun, 2006). For these and other reasons, discussed further below, the ability to restore vernal pools is limited and highly susceptible to failure.[106]

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[106] In some example areas, as discussed in Section 5.3.7.1, certain pools that were identified by Woodlot (2002) as vernal pools in fact function like permanently inundated deep marshes or backwaters, although they may still perform some vernal pool functions. In these cases, the challenges in restoration are more akin to those discussed above in restoring deep marshes or backwaters, although there may be additional difficulties in re-establishing any vernal pool functions these areas may perform.

Change in Hydrology: The most important and distinguishing feature of vernal pools is their hydrologic regime. The depth and duration of flooding are what define these environments, provide the proper conditions for breeding by vernal pool species, and exclude other organisms that would prey on or otherwise exclude the obligate vernal pool species. As discussed above, vernal pool hydrology is determined by in-pool characteristics (e.g., sediment types and stratigraphy, microtopography, foliage cover) as well as surrounding drainage characteristics that convey surface water and groundwater into the pool and water out of the pool. Where several of these characteristics are disturbed, efforts to reproduce the full complement of these characteristics are unlikely to re-establish existing or comparable hydrologic regimes within the vernal pools. The reconstruction process necessary to re-create the vernal pools does not, in any way, mimic the processes by which they were formed. For example, for similar reasons to those discussed above for forested floodplain soils, it may not be possible to find and use replacement soils that have the same permeability as the current soils in the vernal pools, particularly given the complex interbedding of silt and mucky soil layers in the existing soils. Replacement soils with a different permeability would not retain comparable amounts of surface waters and may not allow for comparable flow of groundwater into or out of the pools. In addition, attempts to protect or reconstruct the swales that convey water into and out of the vernal pools and to re-establish riverbank conditions that would preserve the overbank flooding into the swales would not necessarily result in conditions that match current conditions. Minor changes in the surface elevations at control points where surface water is conveyed into and through the swales could significantly alter the quantity of flow to the vernal pools. In addition, loss of mature trees surrounding vernal pools would change rates of evapotranspiration, usually making the habitats wetter, and thus less suitable for obligate vernal pool species.

As a result of these factors, despite restoration efforts, the remediated vernal pools may be wetter than desirable, allowing predator species such as green frogs, bullfrogs, certain invertebrates, or even fish to colonize at the expense of existing vernal pool species; or the pools may dry faster than desirable, resulting in hydroperiods too short for vernal pool species to successfully reproduce. Also, degraded water quality (e.g., from unstable soils), extended hydroperiods, and temperature increases due to loss of mature tree canopy can cause adverse effects on the developing amphibians (e.g., reduction in oxygen to developing embryos due to silty soils settling on egg masses; Ranavirus associated with warmer water temperatures); and they can cause excessive growth of filamentous algae or aquatics such as duckweed, which may adversely affect the suitability of a pool for amphibian breeding.

Change in Vegetation: Restoration of within-pool vegetation and associated habitat functions is related to adequate re-establishment of microtopography, soils, and pool hydroperiod; if the resulting hydrologic conditions are too wet or too dry, as discussed above, they would result in completely different plant communities and succession. Establishing vegetative cover within the affected vernal pools, along with placement of other organic material such as leaf litter and coarse woody debris, would be part of the restoration effort for the vernal pools. However, the complex and mature organic vegetative composition (alive and dead) of these pools cannot be re-established in a predictable period of time, and numerous factors could derail the plant succession process and result in undesirable vegetative growth (e.g., invasive or other aggressive species). Under optimum conditions, and assuming that invasive species could be effectively controlled without damaging newly planted and naturally colonizing native species (which is, in fact, unlikely), growth rates of the types of shrub species that would be used in these vernal pools typically range from 1 to 2 feet per year (Dirr, 1998) following development of an established root system (i.e., usually 1 to 2 growing seasons). Under such conditions, as herbaceous and shrub layers develop within the pools and around the pool edges, some of the physical aspects and habitat functions associated with the loss of these vegetation strata could recover within 5 to 15 years following restoration. However, flooding may impede the success or timing of this recovery process. Moreover, other vegetation strata would take longer to recover. As discussed for the forested floodplain, the return of mature trees would take at least 50 to 100 years if not impeded by floods or invasive species encroachment.

Changes in Soil Composition, Chemistry, and Stratigraphy. As noted above, the composition and chemistry of the soils within vernal pools are important to the functioning of those pools. As with the forested floodplain and shrub/emergent wetlands discussed above, while an effort would be made to find comparable soils to use as replacement soils, it would be very difficult or impossible to find comparable soils from off-site sources, as the soil chemistry and seed bank of the on-site soils are unique to the existing Housatonic floodplain system. In addition, the surface structure of leaves and twigs on the pool bottoms would be extremely difficult, if not impossible, to sustain on a long-term basis, since this process occurs naturally under a forest canopy.

Moreover, the use of heavy equipment in the remediation and restoration would result in a long-term impact to soils in the form of compaction, as previously discussed in connection with forested floodplain and shrub/emergent wetlands. This could have a particularly serious effect on the formation of subterranean burrows by shrews and other small mammals in areas around the pools, which are needed by salamanders for overwintering (Montieth and Paton, 2006); and it would also directly impact wood frogs resting in shallow depressions beneath the leaf litter in the pools. In addition to compaction, final graded soils could subside more than expected, affecting water levels in the restored pool in a fashion that limits successful use by breeding amphibians.

Impacts on Surrounding Habitat. Another key constraint on successful vernal pool restoration is the impact of the remediation work on the forested habitat surrounding the pools. As previously discussed, even small impacts to the non-breeding habitats adjacent to vernal pools have the potential to reduce the value of this habitat for the vernal pool amphibians and thus to impact the functions required for a viable vernal pool ecosystem. In addition, the closer these impacts are to the vernal pool the more detrimental the effects will be. Consequently, as noted in Section 5.3.7.1, recognized management guidelines recommend that impacts to non-breeding habitats within 100 feet of a vernal pool should be completely avoided, and that impacts to non-breeding habitats between 100 feet and approximately 750 feet from the pools should be minimized to the extent practicable. Thus, disturbances of those surrounding zones would further undermine efforts to re-establish existing vernal pool communities.

Potential for Recolonization by Sensitive Vernal Pools Species. Following remediation and restoration, re-establishment of the obligate vernal pool species community in the affected vernal pools would depend on the site-specific re-establishment of the physical variables described above – i.e., the hydrologic conditions in those pools, the substrate and topography within the pool, the composition and structure of the vegetation within and adjacent to those pools, and the extent of unfragmented forested habitat in the non-breeding habitats around the pools. Where the remediation would affect most or substantially all of the vernal pools in a given area, as well as portions of the surrounding non-breeding habitat, it is highly unlikely that all the factors necessary to re-establish all these variables would coalesce to return all those pools to their pre-remediation function as vernal pools.

Further, even if the hydrology and soil structure and composition within the pools and the vegetation within and adjacent to these pools were eventually returned to their current condition, the interim loss or reduction of sensitive vernal pool species, such as wood frogs, and/or their displacement by more aggressive species during that time, would create a high potential that those sensitive species would not return or thrive. For example, wood frogs breed only one or two times over their 3-5 year life span, and thus a few years of eliminated or severely lowered recruitment levels can negatively impact a local subpopulation. Hence, if there are not sufficient wood frogs in the area to migrate into the vernal pools to breed after the new vegetation is established, those pools may no longer support wood frogs. Moreover, the disturbance of the vernal pools would increase the likelihood of colonization by more opportunistic amphibian species such as green frogs and bullfrogs, whose larvae are aggressive predators of wood frog and salamander eggs and larvae. Thus, there could be a long-term or permanent loss of wood frogs from these pools. Alternatively, if they did return, the pools could serve as an "ecological trap" for those frogs and for dispersing amphibians lured away from suitable breeding sites.

Loss of Connectivity to the Network. The restoration of vernal pools would be strongly influenced by the extent to which the connectivity among the various vernal pools in the floodplain and between the vernal pools and important non-vernal pool habitat for the vernal pool species is adversely affected. Most wetland-dependent amphibians do not have the capability to disperse or migrate if the matrix between habitat elements (breeding and non-breeding sites) is highly disturbed; therefore, habitat connectivity is key to the viability and sustainability of amphibian populations. Under floodplain alternatives involving significant habitat alteration over widespread areas of the floodplain, it is likely that the connections among some number of vernal pools, and between vernal pools and other related habitats, would be degraded or lost entirely.

Proliferation of Invasive Plant Species. An additional constraint on the ability to successfully restore vernal pools is the very real risk of introduction and/or spread of invasive plant species as a result of disturbances. As discussed above under forested floodplains, disturbances to the forested areas surrounding the vernal pools represent a prime opportunity for expansion of invasive species, such as cattail and purple loosestrife, as removing a mature forested system creates primary successional conditions and it is under these conditions that aggressive invasive species readily take hold. This could further undermine the overall success of vernal pool restoration activities, as the plant community within and near the vernal pools is critical to that habitat.

Proliferation of New Predatory Animal Species. Finally, the success of vernal pool restoration could be threatened by the introduction of new predatory animal species due to changes in habitat resulting from the remediation. Important predators (e.g., green frogs, bullfrogs) may be introduced to individual vernal pools where they did not previously breed, and these predators could affect the success of the restoration efforts.

Conclusion/Long-Term Outlook

Given the numerous constraints discussed above and the numerous variables that would be affected, it is highly likely that, under any remedial alternative that would affect a sizeable proportion of the vernal pool habitat in the PSA, the full complement of characteristics that contribute to vernal pool functions would not be re-established in at least many of those vernal pools despite the implementation of extensive restoration procedures. As a result, there would be a long-term or permanent loss of vernal pool functions and obligate species in the PSA.

5.3.8 Upland Habitats

5.3.8.1 Description of Habitats

Some of the floodplain alternatives would impact certain upland habitats. Within the PSA, these habitats include previously disturbed habitats such as cultural grasslands (~ 54 acres) and agricultural fields (~ 23 acres), and also include upland forest habitats such as northern hardwoods-hemlock-white pine forest, red oak-sugar maple transitional forest, and successional northern hardwoods forest (totaling ~ 87 acres).[107]

Cultural grasslands are open, upland fields dominated by grass-like herbs that are periodically disturbed, generally by mowing practices. Situated on relatively level ground, this community type lacks a canopy and subcanopy; however, it may include sparse patches of stunted shrubs that are often confined to dense colonies along the grassland edges. Typical shrubs found within this community include pussy willow, beaked willow, red-osier dogwood, and staghorn sumac. Herbaceous vegetation is usually dense and can include reed fescue, Timothy, Kentucky blue-grass, poverty grass, little bluestem, tall goldenrod, common milkweed, wild carrot, common evening primrose, spreading dogbane, common flat-topped goldenrod, and spotted knapweed.

Agricultural upland fields are open fields typically situated on level ground within floodplains of actively farmed areas and include crop cultivation and/or grazing. Because of their proximity to rivers and streams, agricultural fields typically contain fertile soils.

The upland forested areas generally comprise peripheral areas of the PSA. The northern hardwoods-hemlock-white pine upland forests are situated on relatively level to uneven ground vegetated with a mixture of broad-leaved and needle-leaved trees. Typically, the canopy layer is dominated by red oak, eastern hemlock, white pine, and sugar maple, and a poorly developed subcanopy is dominated by eastern hemlock and American beech. Shrub layer plants generally include hobblebush, striped maple, mountain maple, and Canada elder. The herbaceous layer, variable and dependant on canopy dominants, can include Christmas fern, shinning ground-fir, evergreen woodfern, Canada mayflower, bracken fern, Swan's sedge, wintergreen, southern running-pine, ground-pine, and partridge berry.

The red oak-sugar maple transition forests are relatively level to sloping upland forests dominated by larger canopy trees of red oak, white ash, sugar maple, American beech, eastern hemlock and cherry birch. This forest type typically includes a sparse subcanopy of American hornbeam as well as a sparse shrub layer of maple-leaved viburnum and witch-hazel. The herbaceous layer is generally dominated by New York fern, white wood aster, and will sarsaparilla.

Successional northern hardwoods forest are limited in the PSA to small areas mostly around borrow pits and other disturbed areas and near residential lots or abandoned fields. Typical species include quaking aspen, gray birch, and white pine. These forests tend to be younger and less developed in plant community structural diversity and organic composition.

[107] In addition, based on review of land use information from MassGIS and 2005 aerial photographs, the Reach 7 floodplain appears to contain approximately 59 acres of disturbed upland habitats (including cultural grassland, agricultural fields, and developed areas) and 20 acres of forested upland habitats.

There are 11 state-listed plant and animal species that have NHESP-mapped Priority Habitat within the upland habitats in the PSA and that could be found in those habitats. These species are listed in the following table.

Table 5-9 – State-Listed Species Associated with Upland Habitats in the PSA

Common Name	Scientific Name	State Status	Habitat Type
Wood turtle	*Glyptemys insculpta*	Special Concern	Deciduous forest, shrub thicket, open field and edges
Jefferson salamander	*Ambystoma jeffersonianum*	Special Concern	Deciduous forest
Arrow clubtail (dragonfly)	*Stylurus spiniceps*	Threatened	Forest (used by adults)
Brook snaketail (dragonfly)	*Ophiogomphus aspersus*	Special Concern	Forest (used by adults)
Rapids clubtail (dragonfly)	*Gomphus quadricolor*	Threatened	Forest (used by adults)
Riffle snaketail (dragonfly)	*Ophiogomphus carolus*	Threatened	Forest (used by adults)
Spine-crowned clubtail (dragonfly)	*Gomphus abbreviatus*	Endangered	Forest (used by adults)
Zebra clubtail (dragonfly)	*Stylurus scudderi*	Special Concern	Forest (used by adults)
Mustard white (butterfly)	*Pieris oleracea*	Threatened	Rich mesic forest (used by adults)
Hairy wild rye	*Elymus villosus*	Endangered	Rich mesic forest
Narrow-leaved spring beauty	*Claytonia virginica*	Endangered	Rich mesic deciduous forest and shrub thicket

5.3.8.2 Impacts of Remediation

This section presents a general description of the immediate and near-term impacts from floodplain remediation (including access roads and staging areas) on the above-described upland habitats. The longer-term impacts of these activities are discussed in Section 5.3.8.4. The specific long-term and short-term impacts of the individual floodplain remedial alternatives on these habitats type are described in the evaluations of those alternatives in Section 7.

The impacts from floodplain remediation on the disturbed upland habitats would include removal of the existing vegetation and topsoil in the remediation work areas and vegetation removal and soil compaction in the areas used for access roads and staging areas. These activities would thus change the vegetative and soil conditions in these areas. As these areas support altered or early successional plant communities that have more limited ecological value than other affected habitats in the PSA, the impacts would likewise be less significant to the overall ecosystem. However, some wildlife species use these disturbed habitats, particularly around the edges. For example, coyotes, raccoons, skunks, and whitetail deer are opportunists that utilize disturbed areas and edge habitat for foraging; and wood turtles may use the edges of these habitats for nesting. The remedial construction activities would further disrupt these species' use of these areas.

In the forested upland habitats, the impacts of remediation would include many of the same impacts described in Section 5.3.4.2 for floodplain forests. These would include removal of all live trees and other vegetation, as well as removal of all dead tree snags and downed woody debris, from the areas subject to soil removal or construction of access roads and staging areas. These activities would also produce changes in soil conditions due to replacement of existing soil with soil from external sources and compaction of the soil. As a result of these impacts, there would be a loss of habitat for the wildlife species that use these forested uplands, such as black bears, whitetail deer, opossum, mink, mice, voles, shrews, various snakes, salamanders, and birds. In addition, the removal of upland forest areas, which are part of the overall wooded riparian/floodplain corridor of the Housatonic River, would contribute to the overall loss and fragmentation of forested habitat in that corridor and the resulting effects on wildlife that depend on that corridor, as discussed above.

5.3.8.3 Restoration Methods

Available restoration procedures for previously disturbed upland habitats such as cultural grasslands and agricultural fields would consist mainly of re-grading and preparation of surface soils followed by seeding and/or replanting activities with an appropriate upland seed or plant mix.[108] For impacted upland forest habitats, restoration procedures would be similar to those described in Section 5.3.4.3 for floodplain forest habitats except that soil organic matter and organic amendments (e.g., mulch, coarse woody debris) are less important and invasive species control is generally less critical. For both disturbed upland habitats and upland forest habitats, planting plans would identify specific species and planting or seeding densities and would be based upon the composition of the impacted habitat, the surrounding habitat types, and any specific characteristics (e.g., use by state-listed species) of the affected upland community.

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[108] For areas that are used for dewatering or staging of excavated sediments or soils, more extensive activities may be required prior to regrading and seeding or replanting. Such post-use restoration activities for the temporary staging areas would be specified during design.

5.3.8.4 Evaluation of Restoration Constraints and Post-Restoration Conditions

The potential for successful restoration of impacted upland habitats would vary considerably among the various upland habitat types. Cultural grasslands and agricultural fields support altered or early successional plant communities. Restoration of these habitats should be readily accomplished with proper soil preparation and reseeding or replanting. Following reseeding or replanting, these habitats, if subsequently left alone, should return to a natural state; and no significant long-term impacts from the remediation would be expected.

Upland forest restoration, however, would be subject to many of the same constraints as floodplain forests, discussed in Section 5.3.4.4. These constraints relate to the time associated with the regrowth of a mature forested community, genetic stock of the plant material, and disruption in plant community succession from events such as adverse weather, predation by wildlife, and invasive plant species colonization. Despite restoration and replanting measures, long-term impacts would be expected in the cleared upland forested areas. The number of years before the impacted areas return to a condition approaching their pre-remediation condition would depend on the age of the vegetative community in the remediation work area, the extent of the disturbance (as larger impacted areas would take longer to re-vegetate), and the effects from invasive species or other disturbances. For example, where an upland forest consists of mature trees of 50-100 years old, the plant community succession would be similar to that described above for floodplain forest – i.e., under optimal conditions, 5 to 15 years to progress to the sapling/shrub stage, 20 to 25 years to reach the young forest stage, and at least 50 to 100 years to return to a mature forest. These timeframes assume that the vegetative progression is not impeded by colonization by invasive species. In general, although issues with invasive plant species are more likely in wetland and floodplain environments (Zedler and Kercher, 2004), a number of the invasive species recorded in and in proximity to the PSA, such as Japanese barberry, bush honeysuckle, common and glossy buckthorn, bishop's goutweed, oriental bittersweet, and garlic mustard, are capable of colonizing upland as well as wetland environments.

During the lengthy period until the affected upland forest habitats return to their prior condition, there would be a loss, displacement, or reduction in the wildlife species that use those habitats. As noted above, these would include black bears, whitetail deer, opossum, mink, mice, voles, shrews, various snakes, salamanders, and birds. They would also include a number of state-listed species, such as Jefferson salamander, mustard white, water shrew, wood turtle, and zebra clubtail. Further, the long-term alteration of the upland forest areas would contribute to the fragmentation of the overall wooded riparian/floodplain corridor of the Housatonic River, with the attendant long-term disruption of the dispersal and migratory movements of both resident and migratory wildlife species that rely on that corridor.

CERTIFICATE OF SERVICE

I hereby certify that on this 24th day of March, 2017, I served one copy of the foregoing General Electric Company's Reply to EPA Region 1's Response to General Electric's Petition for Review, with Attachments, on each of the following:

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