ATTACHMENT 8
EXCERPTS FROM GENERAL ELECTRIC’S REVISED CORRECTIVE MEASURES STUDY REPORT, HOUSATONIC RIVER, REST OF RIVER (OCTOBER 2010) (RCMS)
(GE RESPONSE ONLY)

General Electric Company
Pittsfield, Massachusetts

Housatonic River – Rest of River
Revised Corrective Measures Study Report

October 2010

Acronyms

Executive Summary

5. Approach to and Considerations in Evaluating Adverse Impacts from Remedial Alternatives, Means To Avoid or Minimize Those Impacts, and Potential Restoration

The Permit requires evaluation of the long-term and short-term adverse impacts from implementation of each remedial alternative, as well as consideration of measures to mitigate such impacts. In addition, EPA's September 9, 2008 comments requested a discussion of the processes that GE would use under any alternative to identify current ecological functions and conditions of potentially affected habitats, evaluate methods to avoid or minimize the adverse impacts of the alternative on those habitats, evaluate and implement restoration methods, and establish performance standards to assess the success of any restoration efforts. This section provides an overview of GE's approach to these issues. Further, to reduce repetition in the sections on individual alternatives, this section includes a general discussion of potential methods to avoid or minimize adverse ecological impacts, the adverse impacts of remediation on the various types of habitats involved (even after incorporating measures to attempt to avoid or minimize those impacts), potential restoration methods for those habitats, and the constraints on restoration of those habitats and consequent likelihood of success of restoration efforts in re-establishing pre-remediation conditions and functions of those habitats. A more detailed application of these processes and assessments is illustrated by the evaluation, presented in the Supplement to Interim Response, of the six example areas identified by EPA to be representative of the ecology of the PSA. In addition, this section includes a discussion of the approach used to evaluate other types of adverse impacts from implementation of the remedial alternatives, including their carbon footprint and their impacts on local communities and on public and worker safety.

5.1 Process to Identify Existing Ecological Functions

This section describes the process that GE would follow, under the selected remedial alternatives, to identify and document the existing ecological conditions and functions in the areas that would be affected by the alternatives. Application of this process is illustrated by the descriptions of the existing conditions and functions of the six example areas presented in the Supplement to Interim Response.[96] However, unlike the example area descriptions, which were based on existing information together with visual observations, the identification of current ecological functions prior to implementation of the selected remedial alternatives would require the collection of additional, focused data to supplement existing information, as discussed further in Section 5.1.2.

---

[96] The six example areas together comprise 122 acres of the PSA, including most of the habitat types present in the PSA, and are generally representative of existing conditions and functions of the Housatonic River and its floodplain.

5.1.1 Review of Existing Information

The initial step in the process of identifying and documenting existing conditions would be to review and compile existing information. A considerable amount of work has already been performed that has documented the unique ecological resources of the Housatonic River and its floodplain and in particular those of the PSA. These include the following:

- The *Ecological Characterization of the Housatonic River*, prepared by Woodlot Alternatives, Inc. (2002) (now Stantec) for EPA. This document summarizes detailed field investigations performed over a three-year period (1998-2000) and associated research compiling the results of previous investigations of the ecological resources of the PSA. The 2002 Woodlot Ecological Characterization is a compilation of reported landscape/biophysical settings, natural community types, and biota (including macroinvertebrates, fish, amphibians, reptiles, birds, and mammals), including rare species information.

- The Designation of the Upper Housatonic River as an ACEC (Mass EOEEA, 2009), as well as the nomination prepared by the Upper Housatonic River ACEC Steering Committee (Save the Housatonic, 2008). These documents include a summary of ecological conditions within the Housatonic River and floodplain from the Confluence to Woods Pond Dam in the context of a broader area encompassing 12,280 acres of land surrounding the 13-mile corridor of the Housatonic River from southern Pittsfield to northern Lee.

- Data, mapping, and reports from the NHESP of the MDFW depicting Priority Habitats of Rare Species and Estimated Habitats of Rare Wildlife, as well as Biomap Core Habitats and Supporting Natural Landscapes within the PSA. These sources describe habitat conditions of state-wide significance and detail the state-listed rare species that have been documented within the Priority Habitat limits delineated.

- The evaluations of six example areas presented in GE's Supplement to Interim Response. Those evaluations contain considerable information on the existing ecological conditions and functions in the six example areas selected by EPA (which, as noted above, are representative of the river and floodplain ecology in the PSA), as well as the impacts of remedial alternatives on those conditions and functions.

- The results of NHESP's ongoing comprehensive survey of populations of state-listed rare species within the Upper Housatonic River Valley. NHESP has identified over 100 state-listed species within the areas surveyed. To date, this research has confirmed the presence of at least 49 state-listed species in the Housatonic River Valley between the Confluence and Rising Pond Dam (32 between the Confluence and Woods Pond Dam and 30 between Woods Pond and Rising Pond Dams, with many of these species found in both stretches), and has resulted in the preparation of updated Priority Habitat mapping for each of these species. These maps show Priority Habitat for 40 state-listed species within the lateral boundaries of the Rest of River (28 in the PSA and 23 in the 100-year floodplain between Woods Pond and Rising Pond Dams, with numerous species in both stretches). NHESP is also using a model developed by NHESP and Kevin McGarigal and others at the University of Massachusetts to delineate Critical Supporting Watersheds for the Housatonic River. Ultimately NHESP will develop a conservation plan for the Upper Housatonic River Valley. It is anticipated that all of the information being developed by NHESP will be available by the time that the initial restoration design step of identifying existing functions would be implemented.

- The assessments conducted by GE's ecological consultants of state-listed species documented to occur within the Rest of River area. Such assessments of state-listed species within the PSA were initially presented in Appendix B to GE's Interim Response, but have been updated, revised, and expanded to also include state-listed species documented to occur in riverine and/or floodplain areas between Woods Pond and Rising Pond Dams that are subject to remediation under one or more remedial alternatives. These revised and expanded assessments are presented in the "Revised Assessment of MESA Issues for Rare Species Under Remedial Alternatives," provided as Appendix L hereto. These assessments summarize the life cycles and habitat requirements of these species, indicate the presence of these species in the PSA and/or downstream areas subject to remediation, and evaluate the adverse impacts to these species that would result from implementation of the remedial alternatives. These assessments are discussed further in Section 5.4 below.

The existing information clearly documents the unique and extraordinary ecological value of the Housatonic River and its floodplain, including the PSA. This exceptional ecological value is a product of numerous biophysical factors (geology, hydrogeology, surface water hydrology), land use, and biological factors that function in concert. A brief overview of how these factors contribute to the ecological diversity of the PSA follows:

- <u>Regional landscape context and connectivity:</u> The Housatonic River and its floodplain communities between the Confluence and Woods Pond provide a contiguous, largely undisturbed riparian corridor along an extensive stretch (about 10 miles) of diverse riverine and wetland/floodplain habitats. The Housatonic River Valley includes undeveloped highlands to the east and west, making it a critical regional migratory and dispersal corridor for many wildlife and an essential element of the ecological complex that includes those flanking highlands.

- <u>Geologic and hydrogeologic setting:</u> Both bedrock and surficial geologic conditions of the region have a significant influence on the ecological resources of the PSA. The regionally unique calcareous bedrock formation (marble of the Stockbridge Formation) that underlies the valley is bordered by metamorphic rock (slates, schists and gneisses) of the adjacent highlands. Surficial geologic deposits from glaciation have filled the valley with variable material, including calcareous (i.e., alkaline) cobbles derived from the underlying marble. This condition produces a unique hydrogeologic environment of groundwater flow through these deposits and discharges to the surface. These interactions between groundwater and surface waters significantly affect the character of the natural communities in the area.

- <u>Hydrologic characteristics:</u> Surface water and groundwater hydrology, including floodwater dynamics and riverine flow, give rise to a wide array of wetland hydrologic regimes, remnant channel segments, complex and diverse soil profiles (including river sediment differences), riverbank variability, significant microtopographic relief, and diverse vegetative community types.

- <u>Habitat functions:</u> Exceptional habitat features have developed due to the cumulative effect of the factors discussed above. A high diversity of contiguous natural riparian community types juxtaposed with adjacent landscapes has given rise to an extensive, relatively unfragmented ecological resource. A distinguishing feature of this resource area is that it supports numerous state-listed species, including those for which Priority Habitat has been mapped by the NHESP and others that were identified by Woodlot (2002).

5.1.2 Obtaining Additional Information

The next step in the process of identifying and documenting existing conditions and functions of the habitats affected by the selected remedial alternatives would be to collect additional, focused information, as necessary, to supplement the existing information. Several methods are available to collect such additional information, as described below.

One approach that is based on accepted processes and methodologies is to use a standardized form to record site characteristics, using existing information supplemented with additional field measurements. Numerous sources describing recognized habitat assessment procedures are available for the development of such a form, including:

- *Massachusetts Wildlife Habitat Protection Guidance for Inland Wetlands* (MDEP, 2006);

- *Rosgen Stream Classification System* (Rosgen and Silvey, 1996);

- *Nutrient Criteria Technical Guidance Manual: Wetlands* (EPA, 2008);

- *The Highway Methodology Workbook Supplement* (USACE, 1995);

- *Estimating Wildlife Habitat Variables* (U.S. Fish & Wildlife Service, 1981);
- *Ecological Census Techniques: A Handbook* (Sutherland (ed.), 1996);
- *Wildlife-Habitat Relationships: Concepts and Applications* (Morrison et al., 1998);
- *Research & Management Techniques for Wildlife and Habitats* (Wildlife Society, 1996);
- *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish* (Barbour et al., 1999);
- *Measuring and Monitoring Biological Diversity: Standard Methods for Amphibians* (Heyer et al., 1994); and
- *Measuring and Monitoring Biological Diversity: Standard Methods for Mammals* (Wilson et al., 1996).

In addition, specific inventories and measurements may be appropriate for specific habitats. For example, within aquatic riverine habitats, baseline inventories may include: mesohabitat assessment, which involves the dimensions and location of pools, riffles and runs; substrate evaluation, which includes the types and positions of major sediment types (silt, coarse and fine sand, coarse and fine gravel, cobble, ledge or boulder); and a woody debris survey. Use of the Rosgen Stream Classification System may be appropriate to further document river characteristics based on river geomorphology principles.

As another example, data collected to document existing conditions and functions of vernal pools could include the size and geographical extent of the pools, resident plant and animal species, source of hydrology, typical annual water levels and duration of wetness, basic water chemistry data, soil conditions (including potential permeability tests), in-pool physical features, relationship (or networking) to other vernal pools in the area, usage of adjacent habitats by vernal pool animals, and composition of the predator community. In addition, as micro-topography and elevations within a given depression can be an important factor influencing requisite vernal pool water levels, a detailed pre-construction topographic survey is typically performed in efforts to restore a vernal pool.

Additional field investigations or data collection may be conducted to address specific requirements of procedures referenced above. For example, the Corps of Engineers' Highway Methodology (USACE, 1995) lists a series of criteria or conditions to address for each evaluation area that describe the prevailing conditions of the area, which ultimately affect functional capacity. Other methods, including models, are also available that could potentially be used to document the existing conditions in the Rest of River area.

5.1.3 Approach to Evaluation of Existing Functions

The specific method or methods used to assess existing conditions would be based primarily upon the collection of data on measurable and observable structural parameters that are known to give rise to the functions of the relevant habitats. This approach recognizes that identifiable geographical, physical, biological and chemical characteristics of wetland/floodplain, riparian, and riverine communities perform specific processes which result in various ecological functions. Environmental classifications are often based on measurable attributes of physical structure or pattern. Structure, in turn, is usually the result of physical processes, and thus structurally based classification categories are often related to natural processes or functions. Structural parameters are less variable and more reliably measured than most functions themselves and are more amenable to being designed, controlled, and managed as part of a restoration program (although often even these parameters cannot be completely controlled or managed).

5.2 Options To Avoid or Minimize Adverse Impacts

As discussed in the Interim Response and the Supplement to Interim Response, the implementation of remedial actions within the Rest of River area would inevitably have adverse impacts on the unique and extraordinary ecological resources in the Upper Housatonic River and floodplain, especially in the PSA. GE has considered a number of potential options to attempt to avoid or minimize those adverse impacts. These options include: (1) alternate riverbank stabilization techniques to lessen the adverse impacts from such stabilization; (2) modification of the locations of access roads and staging areas in an effort to avoid or minimize their adverse effects, including on sensitive habitats (as well as on local communities); (3) potential adjustments to the timing (i.e., season) or sequencing of the work in an effort to avoid or minimize negative effects on certain species (especially state-listed species); and (4) use of best management practices (BMPs) in the performance of the work.

5.2.1 Evaluation of Alternate Riverbank Stabilization Techniques

As discussed in Section 3.1.4, GE has conducted a detailed re-evaluation of the riverbank stabilization techniques described for SED 3 through SED 8 in the CMS Report and discussed further in the Interim Response. That evaluation has also included SED 9 and SED 10, as described in the 2009 Work Plan. The objective of this evaluation was to identify, in conceptual terms, potential bank stabilization techniques that could be applied to the various riverbank areas subject to stabilization to stabilize the banks and reduce the erosion of PCB-containing bank soil while also reducing the adverse ecological impacts of the bank stabilization where practical. This evaluation considered a variety of bioengineering techniques, as well as traditional bank hardening methods, as described in Section 3.1.4 and Appendix G; and it identified a combination of those techniques for use in Reaches 5A and 5B under SED 3 through SED 9, as well as SED 10 (which calls for stabilization of only selected banks in these reaches), in an effort to reduce ecological impacts where practicable consistent with effectively stabilizing the banks. The bank stabilization techniques identified for these alternatives are presented in Appendix G and summarized in Section 3.1.4.

In considering bank stabilization, it is important to recognize, as discussed further below, that any stabilization of the riverbanks would be intended, by design, to prevent significant bank soil erosion and lateral channel migration, which are two of the key hydrologic processes in the upper reaches of the PSA that are responsible for the diversity of stream, floodplain, and wetland features that are important to the plants and wildlife of the region. Thus, if successful, the stabilization would reduce the current important heterogeneous mix of riverbank types, including vertical riverbanks. For this and other reasons (discussed in Section 5.3.2 below), while efforts can be made to reduce ecological impacts, any bank stabilization technique, including bioengineering techniques, would have long-term adverse ecological consequences.

5.2.2 Siting Options for Access Roads and Staging Areas

For any remedial alternative involving sediment or soil removal and/or capping or backfilling, the locations of that remediation are fixed by the alternative and not subject to revision based on the extent of impacts. As a result, there are no alternate siting options that would avoid or minimize the effects of these activities.

However, the locations of temporary access roads and staging areas can be modified to some degree, where practical, to avoid or minimize adverse impacts. Thus, GE has undertaken an assessment of the locations of access roads and staging areas for each sediment and floodplain alternative, as well as for the combinations of alternatives identified in Section 1.8, in an effort to site those facilities so as to avoid or minimize adverse impacts. In this assessment, GE has considered and balanced both the potential ecological impacts of the access roads and staging areas and their potential impacts on local communities, especially residential areas.

In this assessment, GE has considered use of existing infrastructure to gain access to remediation areas, where practicable, taking into account impacts to current users of such infrastructure, especially in heavily populated areas. For example, existing utility line easements may afford access that limits impacts to previously disturbed plant community types. For much of the PSA, however, existing infrastructure is very limited. Access for most sediment, riverbank, and floodplain remedial alternatives, therefore, would require significant spans of temporary access roads that would unavoidably have to be sited in wetlands and floodplains simply to get to the targeted remediation areas. In areas that are currently devoid of existing access infrastructure, GE has considered the shortest available routes, road configurations that could avoid forested areas and other sensitive habitats in non-target areas (as well as steep slopes leading from existing roads into the floodplain) to the extent practical, and measures to avoid inundated or saturated soils in non-target areas where feasible. Similarly, in evaluating potential locations for temporary staging areas, GE has considered locations that would avoid sensitive habitats where feasible, but the need for those areas to be relatively close to the removal locations requires siting many of those areas in or near wetlands, since most of the floodplain in the PSA (approximately 85%) consists of wetland community types.[97]

In addition to attempting to situate the access roads and staging areas in locations that would best avoid or minimize adverse impacts on sensitive ecological habitats, GE has also made efforts, in the siting of those facilities, to avoid or minimize travel through densely populated areas and impacts to residential neighborhoods where doing so would be practical.

The results of this assessment of potential locations of access roads and staging areas are presented on figures in the subsequent evaluation sections (Section 6 for the individual sediment alternatives, Section 7 for the individual floodplain alternatives, and Section 8 for the selected combinations of sediment and floodplain alternatives). A more detailed assessment of siting for access roads and staging areas to avoid or minimize adverse impacts would be conducted during design once a specific remedy has been selected.

5.2.3 Timing/Sequencing Options

Seasonal Adjustments

In addition to siting options, an evaluation has been made of the extent to which construction activities could be timed to avoid or minimize impacts. Seasonal and climatic factors such as the following have been considered:

- Growing season, leaf-out, and fruiting periods of resident plant communities;
- Typical breeding, spawning, and/or and nesting seasons of resident wildlife;
- Life history attributes of resident species, including state-listed species;
- Seasonal high water or flooding conditions; and
- Low-flow conditions.

---

[97] Note that it has not been possible to site access roads and staging areas in locations that would avoid the habitats of state-listed species, since the overall NHESP-designated Priority Habitats for the state-listed species in the area between the Confluence and Woods Pond cover virtually the entire PSA, as shown on Figure 1 in the Introduction to Appendix L.

However, given the numerous animal and plant species that would be affected, with different life cycles and growing seasons, there is no way that remedial construction work could be timed to prevent adverse impacts to all species. For example, sediment removal and/or capping would result in the removal or burial of aquatic animals and plants present in the river in the area subject to such removal or capping. While an effort could be made to avoid doing work in the river in that area during the breeding or emergence season for one generation of animals, such as dragonflies, mayflies, and possibly spawning fish (typically late spring and summer), this approach would not avoid adverse effects to these animals because the impacts of the remediation work would last well beyond the immediate construction season, affecting breeding and emergence in subsequent seasons. Similarly, for animals with high site fidelity, remediation work within their habitat, even if occurring during periods of the year when they are not present, would adversely impact that habitat for multiple years, disrupting their life cycles. Thus, even if it were possible to avoid direct impacts to plants and animals from remedial construction activities (which would affect the current generation of each species), future generations of such species may be eliminated entirely, resulting in loss of this component of the species gene pool or severe curtailment of their populations, with subsequent negative impacts to food webs within the ecosystem.

Moreover, some remedial activities would inherently have permanent or long-lasting effects, as discussed further in Section 5.3 below. For example, riverbank stabilization would result in the permanent elimination of mature overhanging trees from the stabilized banks (since large trees could destabilize the banks) and the permanent reduction or elimination of vertical and/or undercut banks. This stabilization would adversely affect the animals that rely on these bank features regardless of the season in which the stabilization activities occur. Similarly, as also discussed below, the impacts from clearing mature floodplain trees would last at least many decades, as it would take at least 50 to 100 years for mature forests to be re-established (if that occurs at all), and the impacts from remediation within the large number of vernal pools or other sensitive wetlands that would be affected by most of the floodplain removal alternatives would be permanent or very long-lasting. As a result, in these areas, adjusting the timing of remediation work would not avoid or significantly minimize the adverse impacts of that work.

State-listed species have been specifically considered. With specific reference to state-listed plant species, there is no time of year that would avoid adverse impacts, since removal activities would affect both the plants themselves and their seed banks. Thus, even for plants that do not bloom in winter, construction activities at any time of year would remove the seed banks of these plants. With respect to state-listed animal species, Figures 5-1, 5-2, and 5-3 present timing graphs for those species with Priority Habitats in Reaches 5A, 5B, and 5C, respectively, with separate graphs for work in floodplain habitats and work in riverine habitats. These graphs show, for each species (based on its life history cycle), the periods of the year when construction is most likely to directly impact the species and when construction impacts on the species might be minimized. As can be seen, work in the floodplain would generally have the least direct impact to these species during the winter, but even work during this time period would not avoid impacts to some species. For example, while mustard white butterflies emerge in up to three broods in spring and summer, they overwinter as pupae, and thus direct effects would be unavoidable during most of the year. Additionally, any impacts on these butterflies' host plant species or the seed banks of those species would affect the continued presence of mustard whites in the affected area. Further, assuming that the floodplain remediation work is coordinated with the riverine and riverbank remediation work, conducting the latter work in the winter would adversely affect the state-listed species that often hibernate in the river bottom or bank, such as the wood turtle or any larvae of the rare dragonflies (i.e., the listed clubtails and snaketails) buried in the substrate. Moreover, for a species such as the triangle floater mussel which is immobile and constrained to a certain type of habitat (sand and gravel substrate), there is no timing option which is suitable for avoiding construction impacts.. Finally, as noted above, even for species that may not be present in the winter but have high site fidelity, such as the American bittern, the adverse impacts from work conducted in their habitat in the winter would extend beyond that period and disrupt their life cycles.

In short, there would be no time of the year in which remedial construction activities would not cause adverse impacts to at least some of the state-listed species. Although a few temporal strategies could reduce the harm to some degree, any significant avoidance and minimization of adverse impacts must come from greatly reducing the spatial extent of impacts within the PSA.

Sequencing of Work

The effects of sequencing the remediation work over many years have also been considered. Since the removal alternatives would have implementation durations ranging from 5 to over 50 years, the remediation work would be spread out over multiple years. It might be argued that this would allow some portions of the system to begin recovery while work is ongoing in more downstream sections. In fact, however, sequencing would not prevent adverse impacts of the remediation work, both because the work in a given season would itself produce substantial harm to the habitat and associated wildlife in the affected area (regardless of sequencing) and because, as noted above, the impacts of the work would last far longer than the construction season and, in some cases, would be permanent.

5.2.4 Use of Best Management Practices

Numerous material and process-oriented BMPs are available for multi-habitat remediation projects involving riverine and floodplain/wetland habitats. Many of these may be appropriate to use during implementation of the selected sediment, riverbank, and floodplain remedial alternatives. These BMPs include the following:

- Minimizing width of access roads for construction vehicles;
- Use of timber mats, poled fords, or alternative matting (e.g., AlturnaMats, plywood sheets for smaller vehicles) to cross wetlands or temporarily bridge small streams;
- Use of vehicles with rubberized tracks or wide tires, light-weight or smaller vehicles, and low-pressure construction equipment to minimize soil compaction and limit soil scarification;
- Use of long-reach excavators to avoid driving in sensitive areas and to limit soil compaction and scarification within wetlands, where doing so is feasible and consistent with the required remediation;
- Use of straw-based materials (e.g., hay bales, straw bales, straw wattles) and/or silt fencing for erosion control;
- Other stormwater management measures as necessary to meet the Massachusetts Stormwater Management Standards (310 CMR 10.05(6)(k); 314 CMR 9.06(6)(a)) – including the requirement to provide a setback from receiving waters and wetlands where it is practicable;
- Use of sheetpiling, coffer dams, and/or silt curtains for in-water activities and siltation control;
- Use of erosion control blankets for slope stabilization;
- Use of temporary swales and basins to control stormwater and/or to dewater excavation areas;
- Use of coffer dams and other means to temporarily circumvent flows around excavation areas;
- Use of water bars and check dams to control water velocities in temporary stormwater swales; and
- Blocking off certain swales that convey water from the river to wetlands, backwaters, or vernal pools subject to remediation to help avoid accidental wash-outs and erosion during remediation and restoration work.

The typical applicability of these BMPs and their limitations are listed in Table 5-1. These and other BMPs would be carefully evaluated based on the planned activities and the nature of sensitive habitats encountered at each area of the PSA in which remediation work would 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

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 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:

Site Preparation Phase

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.

Clearing and Grubbing and Site Access Phase

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

- *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.

---

[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.

<u>Placement of Woody Debris and Other Habitat Features</u>

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.

<u>Seeding and Planting</u>

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.

---

[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

Table 6-1. Summary of volume calculations, removal depths and areas by subreach for all SED alternatives.

Alternative		River Reach																	
		5A	**5B**	**5A/B Banks**	**5C (Upper Section)**	**5C (Lower Section)**	**5 Backwaters (Small)**	**5 Backwaters (Large)**	**Woods Pond (Shallow)**	**Woods Pond (Deep Hole)**	**7A, D, F, H (Reach 7 Channel)**	**7B (Columbia Mill Dam Imp.)**	**7C (Former Eagle Mill Dam Imp.)**	**7E (Willow Mill Dam Imp.)**	**7G (Glendale Dam Imp.)**	**Rising Pond (Shallow)**	**Rising Pond (Deep)**	**9 to 17**	**Total**
SED 1	**Approach**	No action	No action	No action	No action	No action	No action	No action	No action	No action	No action	No action	No action	No action	No action	No action	No action	No action	
	Criteria	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	
	Removal depth	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	
	Removal volume (cy)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	**---**
	Replacement engr. cap (acres)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	**---**
	Replacement backfill (acres)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	**---**
	Engineered Cap only area (acres)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	**---**
	Thin Layer Cap only area (acres)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	**---**
	MNR (acres)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	**---**
SED 2	**Approach**	MNR	MNR	MNR	MNR	MNR	MNR	MNR	MNR	MNR	MNR	MNR	MNR	MNR	MNR	MNR	MNR	MNR	
	Criteria	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	
	Removal depth	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	
	Removal volume (cy)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	**---**
	Replacement engr. cap (acres)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	**---**
	Replacement backfill (acres)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	**---**
	Engineered Cap only area (acres)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	**---**
	Thin Layer Cap only area (acres)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	**---**
	MNR (acres)	42	27	---	20	37	18	68	37	23	164	10	8	8	12	19	22	---	**515**
SED 3	**Approach**	Removal	MNR	Stabilization	MNR	TLC Only	MNR	MNR	TLC Only	TLC Only	MNR	MNR	MNR	MNR	MNR	MNR	MNR	MNR	
	Criteria	Full reach	---	Operational	---	Full reach	---	---	Full reach	Full reach	---	---	---	---	---	---	---	---	
	Removal depth	2-ft	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	
	Removal volume (cy)	134,000	---	35,000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	**169,000**
	Replacement engr. cap (acres)	42	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	**42**
	Replacement backfill (acres)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	**---**
	Engineered Cap only area (acres)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	**---**
	Thin Layer Cap only area (acres)	---	---	---	---	37	---	---	37	23	---	---	---	---	---	---	---	---	**97**
	MNR (acres)	---	27	---	20	---	18	68	---	---	164	10	8	8	12	19	22	---	**376**
SED 4	**Approach**	Removal	Removal/TLC Only	Stabilization	TLC Only	EC Only	TLC Only/MNR	TLC Only/MNR	Removal	TLC Only	MNR	MNR	MNR	MNR	MNR	MNR	MNR	MNR	
	Criteria	Full reach	Velocity/depth	Operational	Full reach	Full reach	PCBs: 15 ppm [1]	PCBs: 15 ppm [1]	Full reach	Full reach	---	---	---	---	---	---	---	---	
	Removal depth	2-ft	2-ft	---	---	---	---	---	1.5-ft	---	---	---	---	---	---	---	---	---	
	Removal volume (cy)	134,000	39,000	35,000	---	---	---	---	89,000	---	---	---	---	---	---	---	---	---	**297,000**
	Replacement engr. cap (acres)	42	12	---	---	---	---	---	37	---	---	---	---	---	---	---	---	---	**91**
	Replacement backfill (acres)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	**---**
	Engineered Cap only area (acres)	---	---	---	---	37	---	---	---	---	---	---	---	---	---	---	---	---	**37**
	Thin Layer Cap only area (acres)	---	15	---	20	---	7	54	---	23	---	---	---	---	---	---	---	---	**119**
	MNR (acres)	---	---	---	---	---	11	14	---	---	164	10	8	8	12	19	22	---	**268**
SED 5	**Approach**	Removal	Removal	Stabilization	Removal	EC Only	TLC Only/MNR	TLC Only/MNR	Removal	EC Only	MNR	MNR	MNR	MNR	MNR	TLC Only	TLC Only	MNR	
	Criteria	Full reach	Full reach	Operational	Full reach	Full reach	PCBs: 15 ppm [1]	PCBs: 15 ppm [1]	Full reach	Full reach	---	---	---	---	---	Full reach	Full reach	---	
	Removal depth	2-ft	2-ft	---	2-ft	---	---	---	1.5-ft	---	---	---	---	---	---	---	---	---	
	Removal volume (cy)	134,000	88,000	35,000	66,000	---	---	---	89,000	---	---	---	---	---	---	---	---	---	**412,000**
	Replacement engr. cap (acres)	42	27	---	20	---	---	---	37	---	---	---	---	---	---	---	---	---	**126**
	Replacement backfill (acres)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	**---**
	Engineered Cap only area (acres)	---	---	---	---	37	---	---	---	23	---	---	---	---	---	---	---	---	**60**
	Thin Layer Cap only area (acres)	---	---	---	---	---	7	54	---	---	---	---	---	---	---	19	22	---	**102**
	MNR (acres)	---	---	---	---	---	11	14	---	---	164	10	8	8	12	---	---	---	**227**
SED 6	**Approach**	Removal	Removal	Stabilization	Removal	Removal	Removal/TLC Only	Removal/TLC Only	Removal	EC Only	MNR	TLC Only	TLC Only	TLC Only	TLC Only	TLC Only	EC Only	MNR	
	Criteria	Full reach	Full reach	Operational	Full reach	Full reach	PCBs: 50 ppm / 1 ppm [2]	PCBs: 50 ppm / 1 ppm [2]	Full reach	Full reach	---	Full reach	Full reach	Full reach	Full reach	Full reach	Full reach	---	
	Removal depth	2-ft	2-ft	---	2-ft	2-ft	1-ft	1-ft	1.5-ft	---	---	---	---	---	---	---	---	---	
	Removal volume (cy)	134,000	88,000	35,000	66,000	120,000	1,000	23,000	89,000	---	---	---	---	---	---	---	---	---	**556,000**
	Replacement engr. cap (acres)	42	27	---	20	37	1	14	37	---	---	---	---	---	---	---	---	---	**178**
	Replacement backfill (acres)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	**---**
	Engineered Cap only area (acres)	---	---	---	---	---	---	---	---	23	---	---	---	---	---	---	22	---	**45**
	Thin Layer Cap only area (acres)	---	---	---	---	---	14	41	---	---	---	10	8	8	12	19	---	---	**112**
	MNR (acres)	---	---	---	---	---	3	13	---	---	164	---	---	---	---	---	---	---	**180**
SED 7	**Approach**	Removal	Removal	Stabilization	Removal	Removal	Removal/TLC Only	Removal/TLC Only	Removal	EC Only	MNR	Removal/TLC Only	Removal/TLC Only	Removal/TLC Only	Removal/TLC Only	Removal/TLC Only	EC Only	MNR	
	Criteria	Full reach	Full reach	Operational	Full reach	Full reach	PCBs: 10 ppm / 1 ppm [3]	PCBs: 10 ppm / 1 ppm [3]	Full reach	Full reach	---	PCBs: 3 ppm [4]	PCBs: 3 ppm [4]	PCBs: 3 ppm [4]	PCBs: 3 ppm [4]	PCBs: 3 ppm [4]	Full reach	---	
	Removal depth	3 to 3.5-ft	2.5-ft	---	2-ft	2-ft	1-ft	1-ft	2.5-ft	---	---	1.5-ft	1.5-ft	1.5-ft	1.5-ft	1.5-ft	---	---	
	Removal volume (cy)	218,000	109,000	35,000	66,000	120,000	5,000	46,000	148,000	---	---	12,000	7,000	9,000	15,000	15,000	---	---	**805,000**
	Replacement engr. cap (acres)	---	---	---	20	37	3	29	37	---	---	5	3	4	6	6	---	---	**150**
	Replacement backfill (acres)	42	27	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	**69**
	Engineered Cap only area (acres)	---	---	---	---	---	---	---	---	23	---	---	---	---	---	---	22	---	**45**
	Thin Layer Cap only area (acres)	---	---	---	---	---	12	27	---	---	---	5	5	4	6	13	---	---	**72**
	MNR (acres)	---	---	---	---	---	3	12	---	---	164	---	---	---	---	---	---	---	**179**
SED 8	**Approach**	Removal	Removal	Stabilization	Removal	Removal	Removal	Removal	Removal	Removal	MNR	Removal	Removal	Removal	Removal	Removal	Removal	MNR	
	Criteria	Full reach, to 1 ppm horizon	Full reach, to 1 ppm horizon	Operational	Full reach, to 1 ppm horizon	Full reach, to 1 ppm horizon	Full reach, to 1 ppm horizon	Full reach, to 1 ppm horizon	Full reach, to 1 ppm horizon	Full reach, to 1 ppm horizon	---	Full reach, to 1 ppm horizon	Full reach, to 1 ppm horizon	Full reach, to 1 ppm horizon	Full reach, to 1 ppm horizon	Full reach, to 1 ppm horizon	Full reach, to 1 ppm horizon	---	
	Removal depth	4-ft	3.5-ft	---	3-ft	3-ft	2-ft	3-ft	6-ft	6-ft	---	2-ft	2-ft	2-ft	2-ft	7-ft	7-ft	---	
	Removal volume (cy)	268,000	153,000	35,000	99,000	180,000	57,000	331,000	355,000	220,000	---	32,000	25,000	25,000	39,000	217,000	251,000	---	**2,287,000**
	Replacement engr. cap (acres)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	**---**
	Replacement backfill (acres)	42	27	---	20	37	18	68	37	23	---	10	8	8	12	19	22	---	**351**
	Engineered Cap only area (acres)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	**---**
	Thin Layer Cap only area (acres)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	**---**
	MNR (acres)	---	---	---	---	---	---	---	---	---	164	---	---	---	---	---	---	---	**164**

Table 6-1. Summary of volume calculations, removal depths and areas by subreach for all SED alternatives.

Alternative		River Reach																	
		5A	5B	5A/B Banks	5C (Upper Section)	5C (Lower Section)	5 Backwaters (Small)	5 Backwaters (Large)	Woods Pond (Shallow)	Woods Pond (Deep Hole)	7A, D, F, H (Reach 7 Channel)	7B (Columbia Mill Dam Imp.)	7C (Former Eagle Mill Dam Imp.)	7E (Willow Mill Dam Imp.)	7G (Glendale Dam Imp.)	Rising Pond (Shallow)	Rising Pond (Deep)	9 to 17	Total
SED 9	**Approach**	Removal	Removal	Stabilization	Removal	Removal	Removal/EC Only[5]	Removal/EC Only[5]	Removal[5]	Removal[5]	MNR	Removal[5]	Removal[5]	Removal[5]	Removal[5]	Removal[5]		MNR	
	Criteria	Full reach	Full reach	Operational	Full reach	Full reach	PCBs: 1 ppm / water depth[6]	PCBs: 1 ppm / water depth[6]	Full reach	Full reach	---	Full reach / shear stress[7]	Full reach / shear stress[7]	Full reach / shear stress[7]	Full reach / shear stress[7]	Full reach / shear stress[7]		---	
	Removal depth	2-ft	2-ft	---	2-ft	1.5-ft	1-ft	3-ft	3.5-ft	1-ft	---	1 to 1.5-ft	1 to 1.5-ft	1 to 1.5-ft	1 to 1.5-ft	1 to 1.5-ft		---	
	Removal volume (cy)	134,000	88,000	35,000	66,000	90,000	23,000	86,000	207,000	37,000	---	22,000	19,000	19,000	24,000	71,000		---	**921,000**
	Replacement engr. cap (acres)	42	27	---	20	37	14	54	37	23	---	10	8	8	12	41		---	**333**
	Replacement backfill (acres)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---		---	**---**
	Engineered Cap only area (acres)	---	---	---	---	---	1	2	---	---	---	---	---	---	---	---		---	**3**
	Thin Layer Cap only area (acres)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---		---	**---**
	MNR (acres)	---	---	---	---	---	3	12	---	---	164	---	---	---	---	---		---	**179**
SED 10	**Approach**	Removal	MNR	Stabilization	MNR	MNR	MNR	MNR	Removal		MNR	MNR	MNR	MNR	MNR	MNR	MNR	MNR	
	Criteria	Minimize ecological harm[8]	---	Minimize ecological harm[8]	---	---	---	---	PCBs: generally >13 ppm		---	---	---	---	---	---	---	---	
	Removal depth	2-ft	---	---	---	---	---	---	2.5-ft		---	---	---	---	---	---	---	---	
	Removal volume (cy)	66,000	---	6,700	---	---	---	---	169,000		---	---	---	---	---	---	---	---	**241,700**
	Replacement engr. cap (acres)	20	---	---	---	---	---	---	---		---	---	---	---	---	---	---	---	**20**
	Replacement backfill (acres)	---	---	---	---	---	---	---	---		---	---	---	---	---	---	---	---	**---**
	Engineered Cap only area (acres)	---	---	---	---	---	---	---	---		---	---	---	---	---	---	---	---	**---**
	Thin Layer Cap only area (acres)	---	---	---	---	---	---	---	---		---	---	---	---	---	---	---	---	**---**
	MNR (acres)	---	27	---	20	37	18	68	---		164	10	8	8	12	19	22	---	**413**

Notes:

[1] For backwaters in SED 4 and SED 5, thin layer capping occurs for entire backwaters with average PCBs > 15 ppm; delineation based on model-predicted 0-6" sediment PCBs at the end of validation.

[2] For backwaters in SED 6, removal occurs in areas > 50 ppm, TLC only in areas <50 and >1 ppm; delineation based on 0-12" Theissen Polygons; volumes and areas are approximate due to limited data coverage.

[3] For backwaters in SED 7, removal occurs in areas > 10 ppm, TLC only in areas <10 and >1 ppm; delineation based on 0-12" Theissen Polygons; volumes and areas are approximate due to limited data coverage.

[4] For Reach 7 impoundments and Rising Pond shallow area in SED 7, removal occurs in areas > 3 ppm, with TLC only in the rest; delineation based on 0-12" Theissen Polygons; volumes and areas are approximate due to limited data coverage.

[5] Engineered cap in backwaters and replacement cap in Woods Pond, Reach 7 impoundments, and Rising Pond for SED 9 contains an active or sorptive layer.

[6] For backwaters in SED 9, removal occurs in areas with PCBs > 1 ppm and water depth less than 4 feet, and EC only occurs in areas with PCBs > 1 ppm water depths greater than 4 feet; delineation based on 0-12" Theissen Polygons; volumes and areas are approximate due to limited data coverage.

[7] For the Reach 7 impoundments and Reach 8 in SED 9, 1-ft removal occurs in areas of low shear stress, and 1.5-ft removal occurs in areas of high shear stress (see Appendix F for analysis and delineation of high and low shear stress areas).

[8] Criteria for selection of sediment remediation areas in Reach 5A and bank stabilization areas in Reaches 5A & 5B for SED 10 are described in Section 6.10.1 and Figure 6-29.

Abbreviations: Monitored Natural Recovery (MNR); Thin-layer Cap (TLC); Engineered Cap (EC) compliance with ARARs. For that reason, the evaluation of whether TD 3 would be protective of human health and the environment is presented at the end of Section 9.3 so that it can take account of the evaluations under those other criteria.

9.3.3 Control of Sources of Releases

Placement of PCB-containing sediments and soils into an Upland Disposal Facility located outside the 500-year floodplain would effectively and permanently isolate those materials from being released into the environment and transported within the River or onto the floodplain. The components of the facility described in Section 9.3.1, including the double base liner system, the double leachate collection system, and the cover system, would be designed to prevent releases from the Upland Disposal Facility to the surrounding environment; and the facility would be operated and would be monitored and maintained (both during and after operation) to ensure that it continues to isolate the PCB-containing materials within the landfill.

9.3.4 Compliance with Federal and State ARARs

The potential ARARs identified by GE for TD 3 in accordance with directions from EPA are listed in tables in Appendix C. As directed by EPA, separate tables have been prepared for the Woods Pond Site (Tables T-3.a through T-3.c), the Forest Street Site (Tables T-3.d through T-3.f), and the Rising Pond Site (Tables T-3.g through T-3.i). No chemical-specific ARARs have been identified for TD 3, although several guidances to be considered are listed in Tables T-3.a, T-3.d, and T-3.g.

Review of the potential location-specific and action-specific ARARs listed in these tables indicates that implementation of TD 3 at any of the identified locations would achieve certain of those ARARs, but that there are some potential ARARs that would or may require a specific EPA approval or finding or that would or may not be met.[499] Those potential ARARs are discussed below.

TSCA Requirements

EPA's regulations under TSCA establish certain technical requirements for chemical waste landfills used for disposal of PCBs, including siting, design, operation, and monitoring requirements (40 CFR § 761.75(b)). Any of these requirements may be waived by EPA

---

[499] For the reasons discussed in Section 2.1.3, a number of these regulatory requirements do not constitute ARARs for the Rest of River remedial action, but are listed in these tables as potential ARARs per EPA's direction.

based on a finding that that requirement is not necessary to protect against an unreasonable risk of injury to health or the environment (40 CFR § 761.75(c)(4)). In addition, the regulations allow EPA to provide a risk-based approval of an alternate method of disposal of PCB remediation waste if EPA finds that such method will not pose an unreasonable risk of injury to health or the environment (40 CFR § 761.61(c)).

Construction and operation of an Upland Disposal Facility at any of the above-identified locations would meet all the siting, design, and operation requirements of § 761.75, with a few qualifications or exceptions. First, while the existing soils at each of these locations would not meet requirements in § 761.75(b)(1) regarding the permeability and characteristics of the existing soil, the facility would be constructed with a synthetic membrane liner with equivalent low permeability, as allowed under § 761.75(b)(2) (with EPA approval) in places where the existing soil does not have the characteristics specified in § 761.75(b)(1). Second, all of these sites would likely not meet one or more of the requirements of § 761.75(b)(3) relating to hydrologic conditions (e.g., that the bottom of the liner must be at least 50 feet from the historical high water table, that groundwater recharge areas should be avoided, and that there be no hydraulic connection between the site and a surface waterbody). These hydrological issues would be investigated during design. However, even if those requirements were not met, the Upland Disposal Facility would have a double liner and leachate collection system (as discussed further below) to prevent impacts to groundwater (and ultimately to surface water), as well as a groundwater monitoring network to ensure that groundwater is not impacted during or after operations. In addition, construction of an Upland Disposal Facility at the Forest Street Site would not meet the requirement of § 761.75(b)(5) that a landfill be located in an area of low to moderate relief to minimize erosion and landslides or slumping. However, the facility would have engineered measures in place to reduce the potential for occurrence of these conditions. Such measures would, as necessary, include slope benching or terracing, berm buttressing and intermittent erosion breaks/sediment traps.

Under the TSCA regulations, even if one or more of these specific requirements in § 761.75(b) were not met, the Upland Disposal Facility would comply with the TSCA regulations through an EPA determination that the facility meets the substantive criteria for a waiver of those requirement(s) under § 761.75(c)(4) or for a risk-based approval of the facility location and design under § 761.61(c) – i.e., that the facility would not pose an unreasonable risk of injury to health or the environment. For the Building 71 On-Plant Consolidation Area (OPCA) at the GE Facility (which was authorized to receive TSCA-regulated materials), EPA specifically determined in the CD, pursuant to § 761.61(c), that use of that landfill would not pose an unreasonable risk of injury to health or the environment (CD Appendix D). Moreover, in other cases involving on-site landfills, EPA has waived specific locational requirements of § 761.75(b) such as those identified above, pursuant to § 761.75(c)(4), based upon a determination that, even without meeting them, the landfill would not present an unreasonable risk of injury to health or the environment.[500] Given the safeguards to be built into the Upland Disposal Facility, such a finding would be warranted here.

Requirements Relating to Wetlands, Waterbodies, and Priority Habitat

As discussed in Section 9.3.1, all of the identified sites for an Upland Disposal Facility are located outside the floodplain of the Housatonic River, and the identified configurations for such a facility at all these sites would not contain or affect any regulated waterbodies, wetlands, or other resource areas under the Massachusetts Wetlands Protection Act with the following exceptions:

(1) The maximum (but not minimum) operational footprint for an Upland Disposal Facility at the Woods Pond Site contains the small (0.4 acre) shrub swamp, which may or may not meet the jurisdictional prerequisites for a regulated wetland under federal or state law (an issue that would be investigated during design).

(2) The maximum operational footprint for an Upland Disposal Facility at the Forest Street Site would require construction of an access road that would involve building a new crossing of a small stream in the southern portion of the site (Goose Pond Brook); and it would also be located within the 100-foot buffer zone of that stream. In addition, portions of both the minimum and maximum operational footprints would be within the 200-foot Riverfront Area of Goose Pond Brook (a jurisdictional resource area under the Massachusetts Wetland Protection Act).

(3) The maximum (but not minimum) operational footprint for an Upland Disposal Facility at the Rising Pond Site would impact a small (0.5-acre) forested wetland which may or may not meet the jurisdictional prerequisites for a regulated wetland under federal or state law. Further, should the adjacent section of Rising Pond be determined to constitute a river under the Massachusetts Wetlands Protection Act, a portion of the 200-foot Riverfront Area would be impacted by the maximum (but not the minimum) operational footprint.

---

[500] See, e.g., Record of Decision (ROD) for the Field Brook Site, Operable Unit IV, in Ashtabula, Ohio (EPA, 1997b); ROD for Paoli Rail Yard (EPA, 1992b); ROD for the King Highway Landfill – Operable Unit 3 of the Allied Paper/Portage Creek/Kalamazoo River Site (EPA, 1998b); ROD Amendment for Norwood PCB Site (EPA, 1996b); ROD for Berkley Products Company Dump Site (EPA, 1996c); ROD for Picillo Farm Site (EPA, 1985). See also OU-13 ROD for the Oak Ridge Reservation (U.S. Department of Energy [USDOE], 1999; concurred in by EPA).

exempt from those regulations under the above-described MCP exemption unless the MDEP determines that compliance with those regulations is required (310 CMR 40.0033(5)). In the unlikely event that some materials did constitute such hazardous waste and the MCP exemption did not apply, the Upland Disposal Facility at each of the potential locations identified above would meet the substantive requirements of the regulations for a hazardous waste landfill, including the location, design, operating, groundwater protection, closure, and post-closure requirements for such a landfill, with a few potential exceptions relating to the location of the facility, as described below.

The state hazardous waste regulations provide that a hazardous waste landfill may not be located within 1000 feet of an existing private drinking water well or within the groundwater flow path of such a well, or within the flow path of groundwater supplying a "potential private underground drinking water source," or on land overlying or within the flow path of a "potential public underground drinking water source" (310 CMR 30.704, 703(4) 30.010).[508] Review of available information indicates that, at the Woods Pond Site, the disposal facility would be within 1000 feet of an existing drinking water well in an adjacent campground and would potentially not meet some of the other locational requirements mentioned above – issues that would be investigated during design. For the Rising Pond and Forest Street Sites, it is unknown at this time whether a landfill would meet all of the above-mentioned requirements relating to actual or potential private or public underground drinking water sources – which are matters that would be investigated during design. To the extent that any of these hazardous waste requirements were found to apply and could not be met at the selected landfill location, GE would seek a waiver of such requirement(s) from EPA on the ground of technical impracticability.[509]

---

[508] A "potential private underground drinking water source" is defined as a groundwater source that is capable of sustaining a yield of between 2 and 100 gallons per minute [gpm] of drinking water and has less than 10,000 mg/L of TDS, unless it is economically or technologically impractical to render that water fit for human consumption. A "potential public underground drinking water source" is defined as a groundwater source that is capable of sustaining a yield of 100 gpm or more of drinking water and has less than 10,000 mg/L of TDS, unless it is economically or technologically impractical to render that water fit for human consumption.

[509] It should be noted that the Massachusetts site assignment regulations for solid waste facilities (310 CMR 16.00) and solid waste management regulations (310 CMR 19.00) would not apply to the Upland Disposal Facility because 310 CMR 19.013(2) exempts from those regulations remedial actions conducted pursuant to the MCP and, as noted above, the Rest of River remedial action would constitute a remedial action under the MCP by virtue of the MCP's "adequately regulated" provisions (310 CMR 40.0111).

Regulatory Requirements: Implementation of TD 3 would be an "on-site" activity for purposes of the permit exemption set forth in Section 121(e) of CERCLA and Paragraph 9.a of the CD. As such, no federal, state, or local permits or approvals would be required. However, this alternative would be required to meet the substantive requirements of applicable regulations that are designated as ARARs (unless waived). An evaluation of compliance with potential ARARs for construction and operation of an Upland Disposal Facility at the three potential locations is included in Tables T-3.a though T-3.i in Appendix C and was summarized in Section 9.3.4.

Access: GE is the current owner of the Rising Pond Site and has the right to acquire the Woods Pond and Forest Street sites. Thus, GE has or can obtain the right to permanent access to each site to construct and operate an Upland Disposal Facility. Upon site approval, it would be necessary for GE work with utility companies and other easement holders to ensure the appropriate site access to construct and operate the facility.

Coordination with Agencies: Both prior to and during implementation of TD 3 at any of the three potential locations, GE would need to coordinate with EPA, as well as state and local agencies to provide support with public/community outreach programs.

9.3.9 Cost

Estimated total costs to implement TD 3 have been calculated for each potential location, based on a range of disposal volumes. These costs represent the range of estimated labor, equipment, and materials costs for the construction, operation, closure, and post-closure care of an Upland Disposal Facility for the minimum and maximum volume scenarios at each of the three identified sites. The low-end volume is based on the combination of SED 3 and FP 2 (combined 191,000 *in situ* cy) for all three potential locations. The high-end volumes vary for the three sites based on the largest Upland Disposal Facility that can be constructed at each site and thus are not comparable – i.e., Forest Street Site's capacity is approximately 1.0 million cy, Woods Pond Site's capacity is 2.0 million cy, and Rising Pond Site's capacity is 2.9 million cy (which is equivalent to the combined *in situ* volume for SED 8 and FP 7). The estimated costs differ for the three potential locations for an Upland Disposal Facility, as described below. In addition, for each location, total estimated present worth costs were developed using a discount factor of 7%, an assumed overall duration ranging from 10 years (the estimated duration for SED 3 and FP 2)[517] to 19, 29, or 52 years

---

[517] Note that the minimum duration for determining present worth costs (10 years) is different from the shortest possible duration for implementing sediment and floodplain alternatives (5 years, as discussed above), because the former is the estimated duration for the alternatives that involve the lowest removal volume and thus comprise the basis for the lower-bound cost estimate (SED 3 and FP 2).

itself would be decontaminated, dismantled, and transported off site. Any fill material brought onto the site to support the facilities would be removed, and surface soils would be restored by tilling and scarification. An appropriate grassland seed mix would be sown and established over the disturbed area.

Post-Treatment Monitoring and Maintenance: Following restoration of the disturbed areas, monitoring and maintenance of the restored areas would be conducted. For purposes of this Revised CMS Report, it is assumed that this monitoring and maintenance would be conducted for 5 years following completion of restoration.

9.4.1.2 Bench-Scale Treatability Study

Bench-scale testing was performed to further evaluate the potential for chemical extraction to be used as a treatment for sediments and soils from the Rest of River, as requested by EPA. The BioGenesis^{SM} Soil and Sediment Washing Process (BioGenesis process) was selected as the representative chemical extraction treatment technology, and a bench-scale study of this process was conducted in October and November 2007 in accordance with a work plan developed by BioGenesis and approved by EPA on July 31, 2007. A detailed description of the testing and results is included in the BioGenesis Report included as Appendix O. An additional analysis of the data from this study, including a more detailed analysis of the potential for reuse of material treated by this process as backfill in the River or floodplain, has been conducted and is presented in Appendix P. A summary of the bench-scale testing and the additional analysis is provided here, and key findings as they pertain to the CMS evaluation are discussed, where relevant, under the individual evaluation criteria in the following sections.

Bench-scale testing was performed using the BioGenesis^{SM} process on three types of representative materials from the River and floodplain:

- Coarse-grained sediment (TS-SED-A) – Sediment collected from the beginning of Reach 5A, with PCB concentrations ranging from 63 to 80 mg/kg. TS-SED-A contained 23% gravel, 72.8% sand, and 4.2% silt and clay.

- Fine-grained sediment (TS-SED-B) – Sediment collected from the eastern shore of the headwaters of Woods Pond (Reach 6), with PCB concentrations ranging from 110 to 180 mg/kg. TS-SED-B contained 0.2% gravel, 14.1% sand, 67.6% silt and 18.1% clay.

- Fine-grained soils (TS-SO-A) – Soils collected from the floodplain of the River south of New Lenox Road, with PCB concentrations ranging from 45 to 55 mg/kg. TS-SO-A contained 0.1% gravel, 24.0% sand, 55.1% silt, and 20.8% clay.

As part of the bench-scale study, BioGenesis performed jar tests and optimization tests on TS-SED-A, TS-SED-B, and TS-SO-A in accordance with the Work Plan. Certain process steps described in Section 9.4.1.1 above were omitted by BioGenesis for the TS-SED-B and TS-SO-A during the bench-scale study to better accommodate the various material types.

In general, each material was tested three times using the optimized proportions of reagents and conditions determined from their respective jar tests. However, for TS-SED-A, material greater than 425 microns was processed once through the system and for TS-SED-B and TS-SO-A material greater than 850 microns was screened out as a waste. After the first treatment cycle, treated solids from the Solid/Liquid Separation step were recombined and processed two additional times and analyzed, and the mass balance calculations were repeated to evaluate the extent of any reductions in PCB concentrations associated with multiple processing cycles. Samples were collected before and after various steps of the process. Samples of wastewater were also collected following treatment activities. Samples were analyzed for PCB Aroclors and certain samples were also analyzed for PCB congeners and dioxins and furans. Samples were also collected and analyzed for grain size, TOC, TSS, and total dissolved solids (TDS) to provide additional information on the process.

The results of the bench-scale testing are presented in Tables 4-1 through 4-3 of the BioGenesis Report (provided as Appendix O). In summary, they show the following:

- In the fine-grained sediment (TS-SED-B), initial concentrations ranged from 110 to 180 mg/kg. The treated sediment was sampled in two grain size fractions. PCB concentrations in those treated sediments after the first treatment cycle were in the range of 16 to 21 mg/kg and 9 to 60 mg/kg, respectively, with overall weighted averages of 12 to 48 mg/kg in the combined material. Somewhat lower concentrations were obtained after additional treatment cycles, with overall weighted average PCB concentrations after the third treatment cycle of 11 to 18 mg/kg.

- In the fine-grained floodplain soil (TS-SO-A), initial concentrations ranged from 45 to 55 mg/kg. The treated soil was sampled in two grain size fractions. PCB concentrations in those treated soils after the first treatment cycle were in the range of 5 to 7 mg/kg and 7 to 44 mg/kg, respectively, with overall weighted averages of 7 to 19 mg/kg in the combined material. Somewhat lower concentrations were obtained after additional treatment cycles, with overall weighted average PCB concentrations after the third treatment cycle of 4 to 8 mg/kg.

- In the coarse-grained sediment (TS-SED-A), initial concentrations ranged from 63 to 80 mg/kg. The treated sediment was sampled in five grain size fractions. PCB concentrations in the treated sediments after the first treatment cycle were lower in the larger grain-size material (< 1 mg/kg to 2.8 mg/kg in the two largest grain-size fractions [> 425 microns]), intermediate in the intermediate grain-size fraction (~ 40 to 50 mg/kg), and highest in the two smallest grain-size fractions (55 to 143 mg/kg); and the overall weighted averages in the combined material ranged from 13 to 30 mg/kg. Lower concentrations were obtained after additional treatment cycles, with the overall weighted average PCB concentrations after the third treatment cycle ranging from 5 to 22 mg/kg. The material greater than 425 microns was only treated once, but was included in the calculations of the weighted concentration of all the treated sediment for the second and third treatment cycles to provide a complete data set for the purposes of calculating a final weighted average concentration for each treatment cycle.

EPA collected split samples of untreated and treated materials for PCB Aroclor analysis. As noted in Appendix O, the EPA split sample data correlated fairly well with the original sample results.

Selected samples were also analyzed for PCB congeners as well as dioxins and furans. On a sample-by-sample basis, the concentrations of total PCB congeners were comparable to the total PCB Aroclor concentrations. The concentrations of dioxins/furans and PCBs were generally lower in treated materials than in untreated materials. These data suggest that the process does not create dioxins or furans; however, as noted below, insufficient data were collected to provide definitive mass balance information for these compounds.

An evaluation of the effectiveness of the BioGenesis process, and especially of multiple treatment cycles using that process, is complicated by the loss of solids observed during the bench-scale testing, which resulted in a failure to complete a mass balance. A total of 11% to 40% of the initial mass was unaccounted for following the first treatment cycle and 23% to 60% of the solids were unaccounted for after three treatment cycles. The inability to achieve closure to the mass balance makes it difficult to fully understand the mechanism for treatment and, therefore, to evaluate effectiveness. BioGenesis has stated that the poor mass balance is attributable to the batch sequence process used for bench-scale testing. The limitations of the bench-scale equipment with regard to completing mass balance constitute one of the concerns raised in available literature for bench-scale studies performed by BioGenesis at other sites (see Appendix P, Section 4). Significant amounts of aqueous mixture and fine-grained particulate material remained in the equipment and piping between each piece of equipment used in the bench-scale process. Subsequent cleaning and rinsing of the lines between each run effectively removed these materials and prevented cross-contamination between runs. Because this rinse water was not representative of the treatment process, it was not analyzed and was disposed of separately. Therefore, the amount of solids and the PCBs associated with those solids could not be determined at bench scale. This would not be expected at full scale, since equipment would be operated in a continuous mode rather than in batch mode.

Examination of the data suggests that the effectiveness of the process may be largely a function of the removal of solids – specifically, how much of the higher-concentration, finer-grained material is removed from the material during successive treatment cycles – rather than dissolution-based removal of PCBs. If this is the case, additional treatment cycles would simply continue to remove more solids (which would be transferred to the wastewater), rather than reduce the PCB concentrations of the remaining solids. This possibility is consistent with the observation that the treated materials with the lowest concentrations (apart from the largest size fraction) did not show significant reductions in PCB concentrations between the second and third treatment cycles, indicating that additional treatment would not reduce concentrations further.

To allow treated materials to be reused as backfill, it is expected that the treatment process would have to reliably and consistently achieve PCB levels below 1 or 2 mg/kg in the materials, and even these concentrations may not be low enough to allow reuse in some areas, notably in the river bed. Indeed, to the best of our knowledge, EPA has not permitted the use of PCB-containing treated material as replacement fill for river sediments. Data from the bench-scale study show that the BioGenesis process will only treat material to certain plateau levels and that these plateau levels do not approach 2 mg/kg.

Based on the results discussed above, the BioGenesis^{SM} process did not reduce the PCB concentrations in the site-specific materials to an extent that would allow on-site reuse of the material. In general, the process was able to reduce the weighted average PCB concentrations in the combined treated solids materials to concentrations that ranged from 7 to 48 mg/kg after one treatment cycle. However, the individual results from the various outputs, and particularly the smaller grain-size fractions for the coarse-grained sediment, did not achieve these relatively low concentrations at bench scale. The disposal location(s) for treated materials from the BioGenesis^{SM} process that are not suitable for reuse following treatment would depend on a number of factors. For soils and sediments that contained initial PCB concentrations at or above 50 mg/kg prior to treatment, the ability to dispose of the treated material in a solid waste (non-TSCA-permitted) landfill would require an EPA determination that such disposal would satisfy the substantive requirements of EPA's TSCA regulations for a risk-based approval (40 CFR § 761.61(c)) (hereafter referred to as a "risk-based TSCA determination"). Given that the BioGenesis^{SM} process reduced the weighted average PCB concentrations in the combined solid materials to less than 50 mg/kg, it is possible that such a risk-based determination could be obtained for some or all of those materials. If such a determination is obtained, and assuming that the materials would not constitute hazardous waste under RCRA, the treated materials could be transported to a permitted solid waste disposal facility. One possible location for disposal of such chemically treated material from the Site could be Waste Management LLC's High Acres Landfill located in New York. Possible locations for disposal in Massachusetts, which would require prior approval by the MDEP and the disposal facility, could include the Fitchburg-Westminster, Southbridge, and Bourne Landfills. (Treated materials containing PCBs less than 2 mg/kg could be reused at these Massachusetts landfills per MDEP COMM-94-007 and COMM-97-001.) Other potential locations would be evaluated during design. Treated material for which such a risk-based determination is not obtained from EPA would be required to be disposed of at a TSCA-permitted landfill. One possible location for disposal of TSCA-regulated material could be Waste Management LLC's Model City Landfill located in New York. Other potential locations would be evaluated during design. For the purposes of this Revised CMS Report, it has been assumed that all the treated solid materials could be transported to and disposed of in an off-site non-TSCA solid waste landfill in accordance with a risk-based determination from EPA.

In addition to disposing of the treated material, it would be necessary to dispose of the PCB-containing sludge resulting from the wastewater treatment process described above. Since this PCB-containing sludge would most likely contain PCBs at concentrations over 50 mg/kg, it has been assumed that that material would need to be transported to and disposed of at a TSCA-permitted disposal facility.

9.4.2 Overall Protection of Human Health and the Environment – Introduction

As discussed in Section 9.1.2, the evaluation of whether a treatment/disposal alternative would provide overall human health and environmental protection relies heavily on the evaluations under several other Permit criteria – notably, long-term effectiveness and permanence (including long-term adverse impacts), short-term effectiveness, and compliance with ARARs. For that reason, the evaluation of whether TD 4 would be protective of human health and the environment is presented at the end of Section 9.4 so that it can take account of the evaluations under those other criteria.

9.4.3 Control of Sources of Releases

The chemical extraction process itself would not control sources of releases. However, as noted above, it is assumed that the treated PCB-containing sediments and soils would be transported to an off-site permitted landfill for disposal. Such disposal would effectively eliminate the potential for those PCB-containing materials to be released and transported within the River or onto the floodplain. Once placed in an off-site landfill and covered, the material would be permanently isolated from the environment. In the event that such material should be inadvertently released (e.g., from a spill during transport), it would have a lower PCB concentration that it would have if the material had not been treated.

11. Conclusions and Recommendations

Previous sections of this Revised CMS Report have presented detailed evaluations of each of the ten sediment remedial alternatives, nine floodplain soil remedial alternatives, seven selected combinations of sediment and floodplain alternatives, and five treatment/disposition alternatives under the three General Standards and six Selection Decision Factors specified in the Permit. This report has also considered the estimated combined costs of the sediment and floodplain alternatives when paired with the treatment/disposition alternatives. The Permit requires that GE "shall conclude the CMS Report with a recommendation as to which corrective measure or combination of corrective measures, in [GE's] opinion, is best suited to meet the [General Standards] in consideration of the [Selection Decision Factors], including a balancing of those factors against one another" (Special Condition II.G.3).

As noted in the Executive Summary of this Revised CMS Report, based on a critical analysis of the evidence regarding the potential human health and ecological effects of PCBs, as well as the severe ecological damage that would result from remedial construction activities in the River and floodplain, GE has concluded that continuing source control and remediation activities at and near the former GE plant site and monitoring the effect of those activities, along with the ongoing natural recovery processes in the Rest of River, constitute the best remedial alternative for the Rest of River. GE has reserved its rights (including its appeal rights under the CD and the Permit) on this issue and all other issues on which GE has presented its position to EPA during the process to date. Nevertheless, as required by the Permit, GE has conducted the evaluations presented in this Revised CMS Report taking into account EPA's HHRA and ERA and using assumptions, procedures, and other inputs that EPA directed GE to use.

In this context, GE concluded in Section 8 that, of the combinations of sediment and floodplain remedial alternatives under evaluation, the combination of SED 10/FP 9 would meet the General Standards of the Permit and would be "best suited" to meet those standards in light of the Selection Decision Factors, including a balancing of those factors against one another. In Section 9, GE concluded that, of the treatment/disposition alternatives, TD 3 is "best suited" to meet the General Standards of the Permit, based on consideration and balancing of the Selection Decision Factors, and would be the most cost-effective alternative.[558] Review of the combined cost information in Section 10 confirms those conclusions, including the conclusion that a combination of SED 10/FP 9 with TD 3

---

[558] As noted in Section 9, the extent to which TD 3 is better suited to meet the Permit criteria than TD 1 (off-site disposal) in light of these factors would increase with the volume of excavated materials to be disposed of and the duration of the implementation period, and is less pronounced with the volumes and durations at and near the lower end of the range, such as under SED 10/FP 9.

(estimated to cost $121 to $146 million, depending on the location of the Upland Disposal Facility) is the most cost-effective combination of alternatives. Accordingly, GE has concluded – taking into account EPA's HHRA and ERA and using EPA's directives for the Revised CMS, as required – that a combination of alternatives SED 10, FP 9, and TD 3 is best suited to meet the General Standards of the Permit, including protection of human health and the environment, in consideration of the Selection Decision Factors, including balancing of those factors against one another.

This combination of alternatives would constitute a major sediment and soil removal project. It would involve the removal of a total of approximately 268,000 cy of river sediments, bank soils, and floodplain soils over 76 acres of the River and floodplain, with disposition of the removed materials within a secure, engineered Upland Disposal Facility to be constructed in an area near the River but outside the 500-year floodplain. It is estimated that, following design and preparatory work, this combination of alternatives could be implemented within a 5-year period and, based on the cost estimates presented in Section 10, would cost approximately $121 to $146 million. However, given GE's reservations of rights noted above, this Report does not constitute a proposal to implement these alternatives.