

ENGINEERING APPROACHES TO ECOSYSTEM RESTORATION

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STREAM AND WETLAND RESTORATION *Restoring a high value trout stream following the removal of contaminated sediments*

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Abstract

As part of environmental restoration activities subject to the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) at the former Loring Air Force Base (LAFB) in northeastern Maine, contaminated sediments from a high-value brook trout (*Salvelinus fontinalis*) stream and floodplain are being removed. In 1997, 50,387 cubic meters of contaminated sediments was removed from the East Branch of Greenlaw Brook (EBGB) and one of its tributaries, the Flight Line Drainage Ditch (FLDD). In 1998, another 46,000 cubic meters of sediment is expected to be removed from the EBGB. In total, approximately 2,500 linear meters of stream and 10 hectares of bordering floodplain wetland will be restored. This paper describes the process and methods used to develop and implement restoration.

Introduction

The former LAFB is situated on about 3,600 hectares in northeastern Maine, approximately eight kilometers west of New Brunswick, Canada. The base, which was constructed between 1946 and 1953, was officially closed in 1994. As part of the Air Force Installation Restoration Program, contaminated sediments identified through a base-wide investigation of streams and wetlands are being removed. This paper describes stream and wetland restoration activities following the removal of contaminants in the upstream portion of the EBGB and the FLDD Wetland. Greenlaw Brook is a cold-water stream fed by two main

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tributaries, the east and west branches of Greenlaw Brook. Approximately 70 percent of the base runoff (based on land area) flows into Greenlaw Brook. Greenlaw Brook drains into Little Madawaska River, a historical Atlantic Salmon (*Salmo salar*) river.

From 1988 to 1996, the U.S. Air Force (USAF) characterized surface water and sediment in the FLDD, FLDD Wetland, and EBGB. Contamination was documented primarily in the sediment. Much sediment had been deposited behind beaver dams, which occurred throughout the stream system. Recognizing that environmental restoration efforts at the base would impact wetlands, the USAF, in conjunction with the U.S. Environmental Protection Agency (USEPA), U.S. Fish and Wildlife Service (USFWS), and Maine Department of Environmental Protection (MEDEP), developed a wetland Mitigation Process Plan. This plan outlined the methods to be used during remedial investigations and remedial actions to ensure that impacts to wetlands were avoided and minimized to the maximum extent possible. The development of the plan was a highly interactive process and participation by all team members was critical to its success. Team collaboration also has been extremely important during the stream and wetland restoration effort. This project is one of the largest of its type in the Northeast and successful implementation has been achieved with a concerted collaborative effort by the USAF, USEPA, USFWS, and MEDEP.

In the spring of 1997, intensive sampling using analytical screening methods was performed in the FLDD Wetland and EBGB to determine the limits of excavation based on (1) remedial goals (RGs) primarily for pesticides, PCBs (polychlorinated biphenyls) and lead; and (2) potential for any residual contaminants to enter the aquatic system, either through flooding or stream erosion. The limits of excavation were marked with grade stakes, surveyed with Global Positioning Satellite (GPS) equipment, and incorporated into site plans. Once the limits of excavation were identified, approximately 2,500 linear meters of stream and 10 hectares of floodplain wetland were targeted for remediation. Because of the extensive and intrusive nature of the proposed remediation, and the need to meet the intent of state and federal wetland regulations, a detailed restoration plan was required. There are three components to the stream-restoration plan: characterizing existing conditions, preparing proposed conditions plans and narratives, and constructing the proposed conditions.

I. Existing Conditions Survey

The existing conditions survey was performed to characterize stream and floodplain wetland functions and values to serve as a guide for restoration actions. The first phase of the existing conditions survey was to establish a baseline throughout the remedial area. Perpendicular transects extending to the edge of the remedial area also were established along the baseline every 15.2 meters. A detailed 40-scale topographic map and cross-sections then were produced. Using topographic base maps, a wetland scientist surveyed the stream and floodplain wetland and produced detailed existing conditions plans. These plans

showed the location of pools and riffles; water depths; substrate textures (i.e., cobble, gravel, and silt/muck); in-stream structures (i.e., logs, large rocks, boulders, cobble bars, and gravel bars); and plant community types (i.e., forested, scrub-shrub, and emergent wetland). The locations of active or abandoned beaver dams also were mapped. Photographs of the stream and floodplain were taken approximately every 30 meters, and the location and direction of the photographs were marked on the field map. The existing conditions field maps were produced, then overlaid onto topographic maps in AutoCAD®. A videotape of the stream and floodplain also was prepared prior to site clearing and grubbing.

Quantitative stream and floodplain characteristic data were collected using standardized protocol developed by the Maine Natural Areas Program. Data were recorded for community types, soils, slope, aspect, tree basal area, stand age, canopy height, deadwood characteristics, total vegetative cover per strata (i.e., tree, sapling/tall shrub, shrub, herb, and bryoid), physiognomy, phenology, and history (e.g., fire, wind, cutting, agriculture, and impoundment). Seven transects for quantitative plots were located in the stream and floodplain wetland perpendicular to the baseline. At each transect, four to six plots were established, each 11.3 meters in diameter.

Soil and hydrology data also were collected to determine whether backfilling needed to occur following the removal of 0.6 meters of contaminated sediments. Hydric soil features and wetland hydrologic characteristics were noted every 30 meters along the perpendicular transects to estimate characteristics of the soil that would remain on-site following remediation. This was important for reestablishment of a wetland plant community. Similarly, site-specific hydrology data were needed to ensure that the proper hydrologic regime would exist following contaminated-soil removal to support the proposed post-restoration wetland community types.

II. Proposed Conditions Plan Preparation

The primary project objectives were to restore the stream to support a self sustaining, uncontaminated brook trout population, and restore the floodplain wetland so that forested, scrub-shrub, and emergent plant communities could redevelop. A literature review was performed to identify similar projects that involved stream and floodplain restoration. Interviews were conducted with fishery and wetland scientists to solicit information applicable to this project. Results from the literature review and interviews were compiled, analyzed, and reviewed with the LAFB team. Stream restoration techniques that were used widely and that were applicable to the size and hydrologic characteristics of this project were selected. The primary in-stream structures chosen were log deflectors and boulders because they would mimic naturally occurring conditions, provide lodging space for fish, and are designed to work with the action of water to scour out pools in the stream.

Wetland restoration plans (called backfill plans) were developed for each section of stream and floodplain. These plans contained existing conditions maps, proposed conditions maps, cross-sections for existing and proposed conditions, a stream profile for proposed conditions, and a narrative describing the proposed restoration. Whenever possible, in-stream features, such as pools and riffles, were replaced on-site and in-kind. Where opportunities existed, habitat enhancement was proposed (e.g., restoring a braided, shallow stream channel back to a single channel).

Coincident with the development of proposed conditions maps was the identification of materials for reconstructing the streambed and floodplain. In 1997, approximately 11,850 cubic meters of gravel (similar to that removed) was needed to reconstruct the streambed. Gravel from an active pit on-base was analyzed using a standard sieve analysis and compared to stream sediments. Gravel-pit soils proved suitable for use and were available in sufficient quantities. Cobbles needed for cobble-bar restoration also were available at the gravel pit and were similar to cobbles naturally found in the stream. Boulders needed for stream structures also were located on-base. There was also an ample supply of large trees for use in building log deflectors. Material availability was the key to the successful implementation of the plan because it significantly reduced costs and the impact to local roads from repeated use by heavy trucks.

Each backfill plan went through an internal review process, was revised and then issued to the regulatory agencies and the construction team. During development and implementation of each plan, there were extensive on-site negotiations and collaboration with state and federal agencies concerning stream reconstruction, erosion control, materials, and field changes. Issues that developed during the 1997 field season were resolved successfully without delaying construction. This was critical because of the size of the project, which required numerous personnel and equipment.

III. Plan Implementation

Preparing the site for construction involved clearing and constructing access roads and lay-down areas, stream-diversion ditches, and sediment and erosion controls. Clearing was accomplished with chainsaws and skidders. Trees greater than 15 centimeters in diameter were stockpiled for later use as log deflectors and woody debris. Access roads, haul roads, and lay-down areas were constructed to avoid and minimize impacts to wetlands. To the maximum extent possible, existing paths and roads were used.

Prior to dewatering the stream and beginning construction, two rounds of electrofishing were conducted to remove brook trout and other fish from the work area. Fish passage was blocked by installing a stone-check dam and screens over road culverts near the downstream end of the project, below which the captured trout were released.

Stream-diversion ditches and detention basins were constructed according to a water-management plan developed by the project team to address stormwater runoff, groundwater recharge, and construction wastewater management. The water-management system was designed to handle a 10-year, 24-hour storm event. Construction of the diversion ditches and detention basins effectively limited water in the stream. Construction sediment barriers consisting of soil, hay bales, silt fences, or stone-check dams were installed throughout the FLDD, FLDD Wetland, and EBGB. The sediment barriers were constructed in accordance with Best Management Practices to minimize sediments carried downstream during construction.

After dewatering the site, constructing erosion controls, and installing sediment barriers, contaminated sediments were bulldozed into piles, allowed to drain, and sampled. If contaminant levels were acceptable, the sediments were loaded into closed-bed trucks and hauled to a landfill on base. Following excavation of contaminated soils, the baseline was reestablished to provide vertical and horizontal control in the work area. At the same time, a wetland scientist reviewed hydrology in the floodplain to determine how much backfilling was necessary to establish the desired wetland communities. As-built surveys were performed every 15.2 meters along the reestablished baseline and cross-sections were drawn. As-built cross-sections were compared with proposed conditions cross-sections, the stream profile, and plan sheets to identify any necessary changes to proposed grading plans.

Two important issues were identified: the need to maintain the desired stream features and relationships (i.e., pools and riffles), and the need to minimize backfilling in the floodplain. It was decided that backfilling was not needed in the floodplain because the desired hydrologic characteristics were present following contaminated-soil removal and the remaining soils were primarily mucky silts, similar to those removed. The remaining soils also contained a wetland seed bank that would help in restoration efforts. Therefore it was not necessary or desirable to backfill over these soils. Conditions were different in the stream channel, where as-built elevations were different than expected because more sediment had been excavated.

Using modified plans and the reestablished baseline, the stream restoration subcontractor marked proposed elevations using grade stakes. Stakes also were used to mark the stream bottom, stream edge, cobble bars, and stream banks. Stream restoration work began at the upstream limits of work and proceeded downstream.

Prior to working in each section of stream, groundwater discharge in the stream was removed using pumps and irrigation piping to transport water to the diversion ditch.

Once this water was removed, gravel was spread in the stream to meet base grades by a D-6 bulldozer. Cobbles, large rocks, and boulders were positioned using an excavator. Approximately 30 meters of stream was reconstructed each day. At the end of each day, a brief on-site meeting was held to discuss work performed, resolve issues, and plan ahead.

Following the placement and grading of stream restoration materials, speckled alders (*Alnus incana*) were installed adjacent to the stream in two staggered rows 1.8 meters apart. In each row, alders were spaced approximately 3 meters apart. The remainder of the site will be planted in the spring and fall of 1998 by transplanting trees and shrubs from other parts of the base and by limited purchasing of nursery stock. The availability of planting stock on-site will not only reduce project costs, but is expected to increase the quality and hardiness of the stock. Areas proposed as forested wetlands will be planted primarily with tamarack (*Larix laricina*), northern white cedar (*Thuja occidentalis*), and balsam poplar (*Populus balsamifera*). Proposed scrub-shrub wetlands will be planted largely with speckled alder. Approximately 700 trees and shrubs will be installed per acre.

When the floodplain froze in 1997, some of the stockpiled trees were placed in the floodplain to provide micro-habitat and to add structure to the ground surface. Other trees were installed upright to serve as perches, feeding sites, and future nesting cavities.

Continuation of the remediation and restoration activities downstream and monitoring the success of the completed restoration will begin in 1998. Monitoring will continue for five years, or until success is established. Hydrology will be monitored with shallow piezometers installed throughout the wetland system. Vegetation monitoring will measure survivorship of planted stock and the establishment of volunteer plants. The details of wildlife and fisheries monitoring have yet to be finalized.

As of this writing, the project is approximately half complete. Some plants have rooted in the restored areas, and wildlife is already returning. The success of the project to date is attributable to the initial planning document (i.e., the Mitigation Process Plan), the detailed restoration plans, and the hard work and hands-on collaboration of the USAF, USEPA, USFWS, MEDEP, and construction contractor.