FEMP-2600

FERNALD RESTORATION
ECOLOGISTS AND ENGINEERS INTEGRATE RESTORATION AND CLEANUP

BY
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July 2002

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Published in "Radwaste Solutions"
October 2002

Fluor Fernald, Inc. with the U.S. Department of Energy under Contract No. DE-AC24-01OH20115

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RADWASTE SOLUTIONS

Fernald Restoration

Ecologists and engineers integrate restoration and cleanup

Authors: Eric Woods, Restoration Manager
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As cleanup workers excavate pits and tear down buildings at the Fernald site in southwest Ohio, site ecologists are working side-by-side to create thriving wetlands and develop the early stages of forest, prairie, and savanna ecosystems to restore natural resources that were impacted by years of site operations.

In 1998, the U.S. Department of Energy-Fernald Office (DOE-FN) and its cleanup contractor, Fluor Fernald, Inc., initiated several ecological restoration projects in perimeter areas of the site (e.g., areas not used for or impacted by uranium processing or waste management). The projects are part of Fernald's final land use plan to restore natural resources over 904 acres of the 1,050-acre site. Pete Yerace, the DOE-FN Natural Resource Trustee representative is working with the Fernald Natural Resource Trustees in an oversight role to resolve the state of Ohio's 1986 claim against DOE for injuries to natural resources. Fluor Fernald, Inc., and DOE-FN developed the *Natural Resource Restoration Plan,* which outlines 15 major restoration projects for the site and will restore injured natural resources at the site. In general, Fernald's plan includes grading to maximize the formation of wetlands or expanded floodplain, amending soil where topsoil has been removed during excavation, and establishing native vegetation throughout the site.

Today, with cleanup over 35 percent complete and site closure targeted for 2006, Fernald is entering a new phase of restoration that involves heavily remediated areas. By working closely with engineers and cleanup crews, site ecologists can take advantage of remediation fieldwork (e.g., convert an excavated depression into a wetland) and avoid unnecessary costs and duplication. This collaboration has also created opportunities for relatively simple and inexpensive restoration of areas that were discovered during ongoing remediation.

To ensure the survival of the plant material in heavily disturbed soils, Fernald will use techniques such as large-scale soil amendment, drainage modifications, and specially designed plant mixes during restoration. While these techniques have helped ecologists manage the early phases of restoration at Fernald, they will be critical to the long-term success of restoring heavily remediated areas of the site.

Early Restoration

In 1998, Fernald initiated ecological restoration activities in undisturbed, perimeter areas of the site because they were immediately accessible, met cleanup standards governed by the U.S. and Ohio Environmental Protection Agencies (EPA), and did not impact site cleanup activities. By starting in undisturbed areas, Fernald ecologists could test restoration techniques, monitor growth patterns and gain valuable field experience prior to restoring more difficult remediated areas.

Wetlands

For site neighbors, the most visible restoration project is the 12-acre, 8-basin wetland that borders the northeast perimeter of the site (Photo #1). During its construction in 1999, Fernald workers planted 3,327 trees and shrubs and 30 species of grasses and wildflowers that are native to southwest Ohio. The project provides 7 of 16.5 acres of new wetlands to compensate for wetlands that were destroyed during cleanup.

For the last two years, Fernald has been monitoring the overall health of the wetland system to improve or enhance wetland functions and ensure the replacement acreage is met. Ecologists monitor water level and quality, woody and herbaceous species, soil, infrastructure and maintenance. They also observe weather conditions and wildlife patterns and develop a summary of findings, problems and lessons learned. Due to a severe drought in 1999, approximately 29 percent of the plant stock was lost. To maintain the 80 percent survival requirements for woody stock, Fernald re-planted trees and shrubs in 2000 and 2001, and installed herbaceous wetland plugs in two basins to address lack of cover. In general, ecologists have found that the wetland basins are exhibiting good water retention capabilities, and the water quality and prevalence of wildlife indicate a healthy, balanced ecosystem.

Site ecologists have discovered that the large quantities of clay in the soil and the numerous depressions that remain following soil excavation and building demolition present optimal conditions for wetland creation. As an example, ecologists and cleanup crews have worked together to create new wetlands in two areas of the site that were remediated.

Following a small soil remediation project in 2000, workers saw an opportunity to convert a 0.5 acre area into new wetlands (Photo #2). To retain water, workers installed a berm across the southern portion of the excavated area. The area was then reseeded with native grasses and forbs, and coir (i.e., coconut fiber) matting and willow cuttings were installed to control erosion at the outfall point. In spring 2002, workers planted approximately 2,100 shrubs across the area. Most of the plants were installed as dormant live cuttings, which Fernald will use as a source of live cuttings for future restoration projects.

While removing contaminated debris from a 2-acre area on site during early 2001, workers took advantage of another opportunity to create new wetlands (Photo #3). To maximize water retention following debris removal, they graded the resulting basin and placed a large brush pile in the center of the shallow basin. They then seeded the area with native wetland grasses and forbs. To stabilize the banks along Paddys Run, the adjacent stream where additional debris was removed, workers applied erosion control measures, such as using live cuttings in conjunction with riprap.

Although these projects were not planned as wetland restoration projects, cleanup workers and ecologists responded quickly to opportunities in the field, creating new wetland environments with minimal funding and without disrupting cleanup work.

Forest Ecosystems

A second major restoration project is the Demonstration Forest Project, which completes 18 acres of the 904 acres DOE has committed to restore (Photo #4). In 2000, Fernald converted 18 acres of former pasture along the northwest perimeter of the site into native Ohio forests, planting over 2,000 trees and shrubs. Workers also constructed several ponds and wetlands, including a vernal pool that is designed to stay wet and provide amphibian habitat in the spring and dry up in the summer. In addition, about two acres of the project were converted to tallgrass savanna, using native grasses and forbs.

After the second full growing season, monitoring results and field observations indicate that seeded areas are progressing as planned. Woody plants achieved 80 percent survival; however, workers replanted 90 plants in 2002 due to deer impacts in several areas. To determine herbaceous cover, Fernald established random sampling quadrants. Fourteen of the 16 quadrants met the 90 percent cover criterion. Several invasive species are present, but ongoing maintenance of the restored area is gradually reducing the impact of invasive species. Fernald is required to monitor the area for three years, through 2003, to ensure the growth and progression of the new forest.

In a 70-acre area of the site that once contained rows of white and Austrian pines to shield site operations during the production years, Fernald will plant new trees and shrubs creating the early stages of a forest ecosystem. The first step of this restoration project was to remove 19 acres of diseased and overcrowded trees from the area. Workers chipped the trees and stockpiled the woodchips for later use as soil amendment and mulch in other on-site restoration activities. Now that the trees are cleared, Fernald workers will install and mulch 2,970 saplings, 1,656 shrubs, and 7,200 seedlings, and will seed the 50 acre project area with native grasses. The restoration design also contains two open areas to support excavation of vernal pools and installation of prairie grass. Where possible, workers will modify the drainage to create wetlands and additional vernal pools.

Bioengineering Bank Stabilization

During construction of the Fernald site in the early 1950s, alterations to site drainage patterns and straightening Paddys Run Stream channel that flows along the western perimeter of the site resulted in stream bank erosion. In some places, banks were cut as deep as 50 feet into glacial overburden, reducing the stream's floodplain and riparian buffer. The erosion also threatened a sediment basin on site.

To repair one portion of the eroding banks, Fernald implemented a project in 1998 using bioengineering, a technical discipline that merges engineering concepts with biological knowledge to design solutions for erosion and land stability problems (Photo #5). Fernald workers regraded the eroded slopes to restore the gently sloping floodplain, and placed coir logs at the toe of the banks to provide stability. They then placed coir fabric along the length of the regraded bank, seeded the soil under the matting with a native prairie grass mixture, and inserted willow cuttings through the coir fabric into the ground to stake the fabric in place. These bioengineering techniques allow the stream banks to accommodate its intermittent high flow without eroding the banks. As the coir fabric decomposes, the native plants continue to grow and spread creating natural bank stabilization. Presently, all vegetation is established and the bank is stable.

Ecological Research

Under an agreement with the U.S. EPA to settle a dispute resolution for missing enforceable milestones associated with one of Fernald's cleanup projects, DOE agreed to implement supplemental ecological restoration and research projects.

To educate the communities about site ecological restoration and satisfy the dispute resolution agreement, Fernald developed a 1 acre park along the western boundary of the site. The Fernald Ecological Restoration Park is open to the public from dawn to dusk and includes a small parking lot, short trail, interpretative signs and two overlook platforms. Fernald workers planted native trees, shrubs, grasses and wild flowers, resulting in new habitats, including tallgrass prairie, old field, hardwood forest, upland forest and wetland vegetation. Educators and students have used the park for field trips to study ecology and restoration techniques.

In 1999, DOE implemented the following pilot-scale ecological research projects of possible site restoration strategies:

- Evaluating various approaches to forest restoration using different plant sizes and densities;
- Evaluating the optimal strategy for re-vegetating prairie grasses on areas where topsoil has been excavated;
- Re-establishing a population of blight-resistant American chestnut trees;
- Identifying invasive plant species and evaluating control methods to use during restoration;
- Developing an ecological restoration literature source for ecologists, scientists and students.

From the data, ecologists have learned about invasive species control, the rate of volunteer recruitment and optimal planting densities, and the approach for prairie creation in remediated areas, and have refined final site restoration plans.

Borrow Area

A primary component of Fernald's cleanup plan is the construction of a seven-cell engineered waste disposal facility that is designed to hold up to 2.5 million cubic yards of low-level contaminated demolition debris and soil. To construct the earthen layers of the cells, Fernald is excavating large portions of soil, clay and rock from a nearby on-site area, resulting in deep depressions near the main access road to the site (Photo #6). As part of the 904 acres of required restoration, the 190-acre Borrow Area and the perimeter of the On-Site Disposal Facility, will be seeded with native prairie grass. They will also plant 165 saplings and 1,530 shrubs in select areas, and establish wetland plant plugs near the edge of open water areas. To control erosion, workers will install coir matting or jute matting down gradient of drainage features and dormant willow cuttings in matting adjacent to stream channels. Fernald will restore the borrow area in phases throughout construction of the disposal cells.

Restoring Remediated Areas

This year, Fernald has started restoring a 26-acre area called the Southern Waste Units – the first major restoration project in a remediated area (Photo #7). During uranium metal production, Fernald dumped contaminated construction debris, boiler plant flyash and soil in the isolated area south of the site to make room for new structures. Fernald's Security officers also used an adjacent area for fitness training and target practice. In November 2001, workers completed excavation and disposition of over 400,000 cubic yards of contaminated soil and debris from the Southern Waste Units, eliminating a source of contamination to the underlying Great Miami Aquifer.

Using existing excavations made during remediation of the Southern Waste Units, Fernald will create additional floodplain with wetland features along Paddys Run Stream and expand the wooded corridor near the stream. Workers will amend the remaining subsoil with composted woodchips and stockpiled topsoil, install and mulch 2,805 saplings, 1,564 shrubs and 6,800 seedlings, and plant and seed native grasses and wildflowers. Fernald will complete restoration of the Southern Waste Units area in 2003.

Fernald's greatest restoration challenges lie ahead, following remediation of nearly 200 acres in the most contaminated areas of the site. This includes: the 136-acre former production area, where workers produced uranium metal products for the nation's defense program during the Cold War; the 37-acre waste pit area, which contains 1 million tons of solid and liquid waste in six pits; and the 10-acre area surrounding four concrete silos, three of which contain low-level radioactive wastes. The cleanup plan for each project involves excavating contaminated soil below the facility, pit or silo to remove any material that exceeds regulatory limits. This extensive excavation will leave behind deep, sloping depressions – many 20 to 30 feet deep – with extremely poor soil conditions (e.g., very hard clay, sand and gravel).

To avoid disrupting cleanup, Fernald has integrated ecological restoration plans with ongoing remediation projects. In 2006, Fernald will initiate the Production Area/Waste Pit Area Restoration Project and the Silos Area Restoration Project. The first project will cover approximately 190 acres in the central part of the site. Workers will install 825 saplings, 2,081 shrubs and 2,000 seedlings. The restoration design for the Silos Area Restoration Project involves grading and seeding the disturbed area with native prairie grass, and planting 825 saplings, 450 shrubs and 2,000 seedlings over 5 acres. Workers will grade the area and shape drainages to create deep depressions, with slopes at 5:1 ratio for safety and stability. To create a diverse wetland system, workers will also integrate shallow depressions and swales into the final topography.

Monitoring

To ensure site restoration projects are healthy and flourish during the critical early development years, Fernald will monitor all restored areas annually for a predetermined period of time. The monitoring occurs in two phases: implementation phase monitoring and functional phase monitoring. Workers conduct implementation phase monitoring for two years to ensure the restoration projects are completed pursuant to the *Fernald Natural Resource Restoration Plan* design plans. During negotiations with the Trustees, DOE agreed that Fernald must achieve 80 percent survival of all planted vegetation, and 90 percent cover of seeded areas. To determine vegetation survival, Fernald conducts mortality counts for two growing seasons and assigns one of three categories to vegetation: alive, resprout, or dead.

For wetland projects, Fernald must monitor and evaluate growth for three to five growing seasons. Depending on the project, specific design plans may impose additional implementation phase monitoring requirements for such factors as water levels and the formation of hydric soils.

During functional phase monitoring, workers review each project's system-specific contributions to the site's ecological communities. Rather than a pass/fail determination like implementation phase monitoring, functional phase monitoring evaluates the progress of the restored community against pre-restoration baseline conditions and an ideal reference site. Functional phase monitoring focuses on three broad community types: wetlands/open water; prairie; and forest. Using a Floristic Quality Assessment Index (FQAI), as well as several other vegetation and wildlife indices, Fernald will evaluate each of these community types on a rotating annual schedule until the last restoration project is complete.

Restoration Techniques

One of Fernald's challenges has been controlling the impacts of the Whitetail Deer on the newly planted trees and shrubs. Deer browsing and rubbing have severely damaged and destroyed planted vegetation. To deter deer rubbing, Fernald installed tree tubes on all planted saplings at the site, and applied deer repellant on all trees and shrubs susceptible to browsing. This two-pronged approach has resulted in some success at reducing damage. However, there are still occasions when deer rip the tubing off the trees or snap limbs above the tubing, significantly reducing survival (Photo #8). Fernald has acquired a deer consultant to assist with techniques to reduce deer damage in future restoration projects.

Another challenge has been eliminating or controlling invasive species. Fernald workers have conducted an "invasives sweep" across restored areas several times during 2000 and 2001 to search for amur honeysuckle, multiflora rose and other invasive species. Workers either mechanically remove or spray the plants with herbicide in the spring and fall of each year. To apply herbicide, workers have used several methods, including direct spray onto foliage, injection using an EZ-Ject Lance, and the "lop and squirt" technique, where herbicide is immediately applied to the stump, following mechanical removal. Fernald will continue to evaluate the most effective means of controlling invasive species.

Early coordination between ecologists and civil engineers has resulted in significant time and cost savings by maximizing the benefits of final grading following remediation. In many instances, remediation activities will leave large depressions and altered drainage patterns. Instead of backfilling and grading to drain, Fernald is converting the post-remediation topography to a "restoration grade," where possible. With slight alterations, construction pits and sedimentation basins become open water, emergent wetlands, and vernal pools.

Another problem that occurs following soil excavation is the removal of all topsoil, which exposes compacted clay, sand and gravel that are practically devoid of organic matter and macronutrients. Ecologists are using several techniques to amend the soil and make it conducive for growing vegetation. The techniques include composting woodchips from the site and incorporating the chips, stockpiled topsoil or imported compost into the existing subsoil prior to restoration. In addition, workers inoculate all trees and shrubs with appropriate mycorrhizal fungi prior to installation to increase the plant's ability to uptake water and required nutrients.

Seeding efforts across the site have evolved to a point where native grasses and forbs are used almost exclusively. Ecologists have realized that the subsoil conditions following remediation actually benefit the establishment of prairie species, since weed growth is often suppressed. Native species are slower growing, but slope protection and erosion control is managed through the use of cover crops.

After Cleanup and Closure

DOE and Fluor Fernald are on target to complete cleanup and site closure by late 2006, and natural resource restoration by 2007 (Photo #9). In anticipation of site closure, DOE, Fluor Fernald, regulators and stakeholders have been exploring key issues that will impact the site's future since the early 1990's, and have developed consensus-based decisions on final land use and public use/access.

Following DOE's approval of the final land use plan in 1999, the next step was to consider whether stakeholders should be allowed to use the property; and if so, what access was compliant with the site's land use. Stakeholders expressed a strong interest in using the site for multiple purposes (primarily educational and recreational) following cleanup and closure.

Earlier this year, regulators and stakeholders accepted DOE's proposed future public use plan for the Fernald site. The plan will allow limited public access for educational purposes, a fundamental component of the site's long-term stewardship plan. To showcase completed remediation areas and restoration projects, DOE and Fluor Fernald will construct a series of walking trails, overlooks and interpretive signs that provide information about the site's role during the Cold War as well as cultural and ecological points of interest. Visitors will be able to observe Native American reburial areas and Fernald's Cold War Garden, a memorial to workers, local residents and others who made significant contributions to the site during its uranium production and cleanup missions.

In late 2002, DOE will issue a draft Comprehensive Stewardship Plan for public review. The Comprehensive Stewardship Plan will identify monitoring and maintenance requirements for the On-Site Disposal Facility, public use amenities and restored areas, and will outline the roles and responsibilities of the site steward, the entity that will manage the site after closure. DOE has received overwhelming public support to construct a regional, multi-purpose educational facility on site. The Comprehensive Stewardship Plan will also identify requirements for managing and maintaining such a facility, if approved. Community groups are currently evaluating potential funding options, uses, space requirements and designs for such a facility, and will issue recommendations to DOE for consideration.

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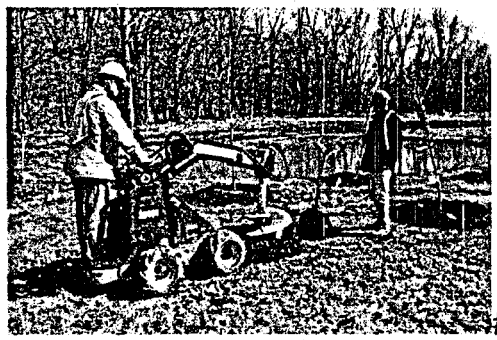
Photos and Captions:

1. # 7476-250 - "Aerial view (looking northwest) of 12-acre wetland mitigation project completed in 1999 located in northeast corner of Fernald site."
2. #7800-D0015 – "Wetland created after remediation a 0.5 acre area near the center of Fernald in 2000."
3. #7800-D0030 – "Wetland created after remediation of a 2.0 acre area in northern portion of Fernald in 2001."
4. #7321-d24 – "Planting work in process in 2000 in 18 acre restoration project in Northwest corner of Fernald"
5. #6690-D0138 – "Bioengineering work in process in 1998 to stabilize erosion problems along a portion of Paddys Run Stream"
6. #6319-D3522 – "Soil removal from Borrow Area in 2002 to support construction of the On-Site Disposal Facility"
7. #7800-D0001 – "Restoration grading and seeding in process in the Southern Waste Units in 2002"
8. #7321-D0130 – "Tree damage resulting from a deer rub in Demonstration Forest Project"
9. #7792-84 – "Aerial view (looking northwest) of Fernald in 2002 showing site remediation in process"

1. *Wetland Aerial Image* # 7476-250 – To compensate for wetlands destroyed during cleanup, workers created a 12-acre, 8-basin wetland near the northeast border of the site. The wetland includes over 3,000 trees and shrubs and 30 species of grasses and wildflowers.

2. 7800-D0015 #7800-D0015 - The large quantity of clay in the soil and the deep depressions from soil excavation present optimal conditions for new wetlands. Workers created this wetland after remediating a 0.5-acre area.

3. 7800-D0030 #7800-D0030 - The large quantity of clay in the soil and the deep depressions from soil excavation present optimal conditions for new wetlands. Workers created this wetland after remediating a 2.0-acre area.

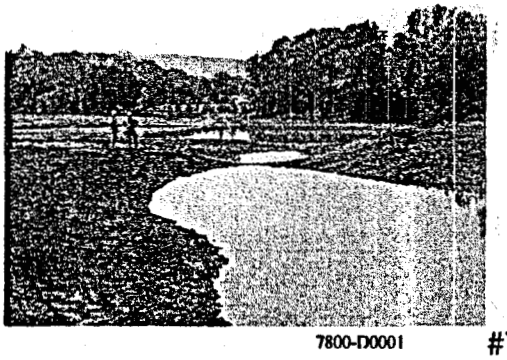


4. #7321-D24 - Fernald converted 18 acres of former pasture along the northwest perimeter of the site into native Ohio forests.

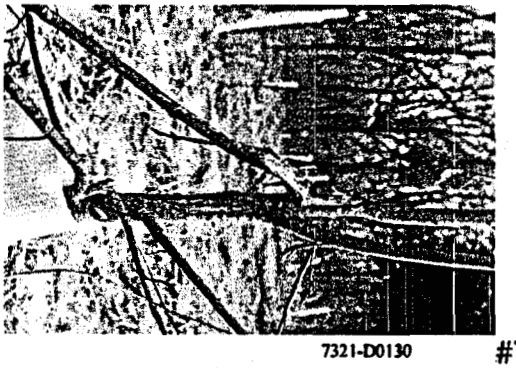
Workers planted over 2,000 trees and shrubs and constructed ponds, wetlands and a vernal pool.

5. 6690-D0138 #6690-D138 - Workers use bioengineering techniques to stabilize erosion and land stability problems along a nearby stream.

6. 6319-D3522 #6319-D3522 – To construct the earthen layers of the seven-cell On-Site Disposal Facility, workers excavate soil, rock and clay from a "Borrow Area" on site. Fernald will restore the Borrow Area after construction of the cells.

7. 

#7800-D1 – Fernald is grading and seeding a 26-acre area called the Southern Waste Units, the first major restoration project in a remediated area.

8. 

#7321-D0130 - Deer browsing and rubbing have severely damaged and destroyed new-planted vegetation. To deter deer rubbing, Fernald is installing tree tubes and applying deer repellant.

9. *Site Aerial Image* #7792-84 - DOE and Fluor Fernald plan to complete site remediation and closure in late 2006, and natural resource restoration in 2007. Today, site cleanup is over 35 percent complete.

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Wetlands

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While removing contaminated debris from a two-acre area on site during early 2001, workers took advantage of another opportunity to create new wetlands (Photo #7800-D30). To maximize water retention following debris removal, they graded the resulting basin and placed a large brush pile in the center of the shallow basin. They then seeded the area with native wetland grasses and forbs. To stabilize the banks along Paddys Run, the adjacent stream where additional debris was removed, workers applied erosion control measures, such as using live cuttings in conjunction with riprap.

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Ecological Research

Under an agreement with the U.S. EPA to settle a dispute resolution for missing enforceable milestones associated with one of Fernald's cleanup projects, DOE agreed to implement supplemental ecological restoration and research projects.

To educate the communities about site ecological restoration and satisfy the dispute resolution agreement, Fernald developed a 1-acre park along the western boundary of the site. The Fernald Ecological Restoration Park is open to the public from dawn to dusk and includes a small parking lot, short trail, interpretative signs and two overlook platforms. Fernald workers planted native trees, shrubs, grasses and wild flowers, resulting in new habitats, including tallgrass prairie, old field, hardwood forest, upland forest and wetland vegetation. Educators and students have used the park for field trips to study ecology and restoration techniques.

In 1999, DOE implemented the following pilot-scale ecological research projects of possible site restoration strategies:

- Evaluating various approaches to forest restoration using different plant sizes and densities;
- Evaluating the optimal strategy for re-vegetating prairie grasses on areas where topsoil has been excavated;
- Re-establishing a population of blight-resistant American chestnut trees;
- Identifying invasive plant species and evaluating control methods to use during restoration;
- Developing an ecological restoration literature source for ecologists, scientists and students.

From the data, ecologists have learned about invasive species control, the rate of volunteer recruitment and optimal planting densities, and the approach for prairie creation in remediated areas, and have refined final site restoration plans to incorporate lessons learned.

Borrow Area

A primary component of Fernald's cleanup plan is the construction of a seven-cell engineered waste disposal facility that is designed to hold up to 2.5 million cubic yards of low-level contaminated demolition debris and soil. To construct the earthen layers of the cells, Fernald is excavating large portions of soil, clay and rock from a nearby on-site area, resulting in deep depressions near the main access road to the site (Photo #6319-D3522). As part of the 904 acres of required restoration, the 190-acre Borrow Area and the perimeter of the On-Site Disposal Facility, will be seeded with native prairie grass. They will also plant 165 saplings and 1,530 shrubs in select areas, and establish wetland plant plugs near the edge of open water areas. To control erosion, workers will install coir matting or jute matting down gradient of drainage features and dormant willow cuttings in matting adjacent to stream channels. Fernald will restore the borrow area in phases throughout construction of the disposal cells.

Restoring Remediated Areas

This year, Fernald has started restoring a 26-acre area called the Southern Waste Units – the first major restoration project in a remediated area (Photo #7800-D1). During uranium metal production, Fernald dumped contaminated construction debris, boiler plant flyash and soil in the isolated area south of the site to make room for new structures. Fernald's Security officers also used an adjacent area for fitness training and target practice. In November 2001, workers completed excavation and disposition of over 400,000 cubic yards of contaminated soil and debris from the Southern Waste Units, eliminating a source of contamination to the underlying Great Miami Aquifer.

Using existing excavations made during remediation of the Southern Waste Units, Fernald will create additional floodplain with wetland features along Paddys Run Stream and expand the wooded corridor near the stream. Workers will amend the remaining subsoil with composted woodchips and stockpiled topsoil, install and mulch 2,805 saplings, 1,564 shrubs and 6,800 seedlings, and plant and seed native grasses and wildflowers. Fernald will complete restoration of the Southern Waste Units area in 2003.

Fernald's greatest restoration challenges lie ahead, following remediation of nearly 200 acres in the most contaminated areas of the site. This includes: the 136-acre former production area, where workers produced uranium metal products for the nation's defense program during the Cold War; the 37-acre waste pit area, which contains 1 million tons of solid and liquid waste in six pits; and the 10-acre area surrounding four concrete silos, three of which contain low-level radioactive wastes. The cleanup plan for each project involves excavating contaminated soil below the facility, pit or silo to remove any material that exceeds regulatory limits. "Our biggest restoration challenges will be the deep, sloping depressions that will remain after the excavation work is complete," said Yerace. "Many of the depressions will be 20 to 30 feet deep, with extremely poor soil conditions. By working with the project managers early in the planning process, we can integrate restoration plans with ongoing remediation work and develop solutions that might not have been possible if we'd waited."

In 2006, Fernald will initiate the Production Area/Waste Pit Area Restoration Project and the Silos Area Restoration Project. The first project will cover approximately 190 acres in the central part of the site. Workers will install 825 saplings, 2,081 shrubs and 2,000 seedlings. The restoration design for the Silos Area Restoration Project involves grading and seeding the disturbed area with native prairie grass, and planting 825 saplings, 450 shrubs and 2,000 seedlings over 5 acres. Workers will grade the area and shape drainages to create deep depressions, with slopes at 5-1 ratio for safety and stability. To create a diverse wetland system, workers will also integrate shallow depressions and swales into the final topography.

Monitoring

To ensure site restoration projects are healthy and flourish during the critical early development years, Fernald will monitor all restored areas annually for a predetermined period of time. The monitoring occurs in two phases: implementation phase monitoring and functional phase monitoring. Workers conduct implementation phase monitoring for two years to ensure the restoration projects are completed pursuant to the *Fernald Natural Resource Restoration Plan* design plans. During negotiations with the Natural Resource Trustees, DOE agreed that Fernald must achieve 80 percent survival of all planted vegetation, and 90 percent cover of

seeded areas. To determine vegetation survival, Fernald conducts mortality counts for two growing seasons and assigns one of three categories to vegetation: alive, resprout, or dead.

For wetland projects, Fernald must monitor and evaluate growth for three to five growing seasons. Depending on the project, specific design plans may impose additional implementation phase monitoring requirements for such factors as water levels and the formation of hydric soils.

During functional phase monitoring, workers review each project's system-specific contributions to the site's ecological communities. Rather than a pass/fail determination like implementation phase monitoring, functional phase monitoring evaluates the progress of the restored community against prerestoration baseline conditions and an ideal reference site. Functional phase monitoring focuses on three broad community types: wetlands/open water; prairie; and forest. Using a Floristic Quality Assessment Index (FQAI), as well as several other vegetation and wildlife indices, Fernald will evaluate each of these community types on a rotating annual schedule until the last restoration project is complete.

Restoration Techniques

One of Fernald's challenges has been controlling the impacts of the white-tailed deer on the newly planted trees and shrubs. Deer browsing and rubbing have severely damaged and destroyed planted vegetation. To deter deer rubbing, Fernald installed tree tubes on all planted saplings at the site, and applied deer repellant on all trees and shrubs susceptible to browsing. This two-pronged approach has resulted in some success at reducing damage. However, there are still occasions when deer rip the tubing off the trees or snap limbs above the tubing, significantly reducing survival (Photo #7321-D130). Fernald has acquired a deer specialist to assist with techniques to reduce deer damage in future restoration projects.

Another challenge has been eliminating or controlling invasive species. Fernald workers have conducted an "invasives sweep" across restored areas several times during 2000 and 2001 to search for amur honeysuckle, multiflora rose and other invasive species. Workers either mechanically remove or spray the plants with herbicide in the spring and fall of each year. To apply herbicide, workers have used several methods, including direct spray onto foliage, injection using an EZ-Ject Lance, and the "lop and squirt" technique, where herbicide is immediately applied to the stump following mechanical removal. Fernald will continue to evaluate the most effective means of controlling invasive species.

Early coordination between ecologists and civil engineers has resulted in significant time and cost savings by maximizing the benefits of final grading following remediation. In many instances, remediation activities will leave large depressions and altered drainage patterns. Instead of backfilling and grading to drain, Fernald is converting the post-remediation topography to a "restoration grade," where possible. With slight alterations, construction pits and sedimentation basins become open water, emergent wetlands, and vernal pools.

Another problem that occurs following soil excavation is the removal of all topsoil, which exposes compacted clay, sand and gravel that are practically devoid of organic matter and macronutrients. Ecologists are using several techniques to amend the soil and make it conducive for growing vegetation. The techniques include composting woodchips from the site and incorporating the chips, stockpiled topsoil or imported compost into the existing subsoil prior to restoration. In addition, workers inoculate all trees and shrubs with appropriate mycorrhizal fungi prior to installation to increase the plant's ability to uptake water and required nutrients.

Seeding efforts across the site have evolved to a point where native grasses and forbs are used almost exclusively. Ecologists have realized that the subsoil conditions following remediation actually benefit the establishment of prairie species, since weed growth is often suppressed. Native species are slower growing, but slope protection and erosion control is managed through the use of cover crops.

After Cleanup and Closure

DOE and Fluor Fernald are on target to complete cleanup and site closure by late 2006, and natural resource restoration by 2007 (Photo #7792-84). In anticipation of site closure, DOE, Fluor Fernald, regulators and stakeholders have been exploring key issues that will impact the site's future since the early 1990's, and have developed consensus-based decisions on final land use and public use/access.

Following DOE's approval of the final land use plan in 1999, the next step was to consider whether stakeholders should be allowed to use the property; and if so, what access was compliant with the site's land use. Stakeholders expressed a strong interest in using the site for multiple purposes (primarily educational and recreational) following cleanup and closure.

Earlier this year, regulators and stakeholders accepted DOE's proposed future public use plan for the Fernald site. The plan will allow limited public access for educational purposes, a fundamental component of the site's long-term stewardship plan. To showcase completed remediation areas and restoration projects, DOE and Fluor Fernald will construct a series of walking trails, overlooks and interpretive signs that provide information about the site's role during the Cold War as well as cultural and ecological points of interest. Visitors will be able to observe Native American reburial areas and Fernald's Cold War Garden, a memorial to workers, local residents and others who made significant contributions to the site during its uranium production and cleanup missions.

In late 2002, DOE will issue a draft Comprehensive Stewardship Plan for public review. The Comprehensive Stewardship Plan will identify monitoring and maintenance requirements for the On-Site Disposal Facility, public use amenities and restored areas, and will outline the roles and responsibilities of the site steward, the entity that will manage the site after closure. DOE has received overwhelming public support to construct a regional, multi-purpose educational facility on site. The Comprehensive Stewardship Plan will also identify requirements for managing and maintaining such a facility, if approved. Community groups are currently evaluating potential funding options, uses, space requirements and designs for such a facility, and will issue recommendations to DOE for consideration.

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Photos and Captions:

7476-250 – To compensate for wetlands destroyed during cleanup, workers created a 12-acre, 8-basin wetland near the northeast corner of the site. The wetland includes over 3,000 trees and shrubs and 30 species of grasses and wildflowers.

#7800-D15 - The large quantity of clay in the soil and the depressions from soil excavation present optimal conditions for new wetlands. John Homer, Fluor Fernald restoration ecologist, surveys a wetland that workers created after remediating a .5-acre area.

#7800-D30 - Strategic placement of soil berms and seeding with native plant species are key components of wetland creation. Workers created this wetland after remediating a 2-acre area.

#7321-D24 – Fernald converted 18-acres of former pasture along the northwest perimeter of the site into the early stages of a forest community. Mark Fritts, operator and Shaw Wert, laborer are a few of the Fluor Fernald workers who planted over 2,000 trees and shrubs and constructed ponds, wetlands and a vernal pool.

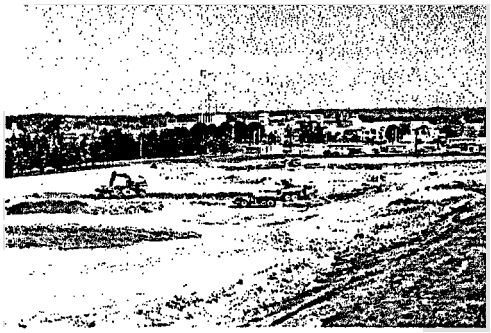
#6690-D121 - Herb Chaffin, Fluor Fernald laborer, employs bioengineering techniques to control erosion and to correct creek bank stability problems along a stream that runs through the Fernald property.

#6319-D3522 – To construct the earthen layers of the seven-cell On-Site Disposal Facility, workers excavate soil, rock and clay from a "Borrow Area" on site. Fernald will restore the Borrow Area after construction of the cells.

#7800-D1 – John Homer, Fluor Fernald restoration ecologist and Sonny Youngblood, Wise construction supervisor, evaluate an area that laborers are grading and seeding. The 26-acre area called the Southern Waste Units is the first major restoration project in a remediated area.

#7321-D0130 - Deer browsing and rubbing can severely damage and destroy newly planted vegetation. To deter deer rubbing, workers are installing tree tubes and applying deer repellant.

#7792-84 - DOE and Fluor Fernald plan to complete site remediation and closure in late 2006, and natural resource restoration in 2007. Today, site cleanup is over 35 percent complete.



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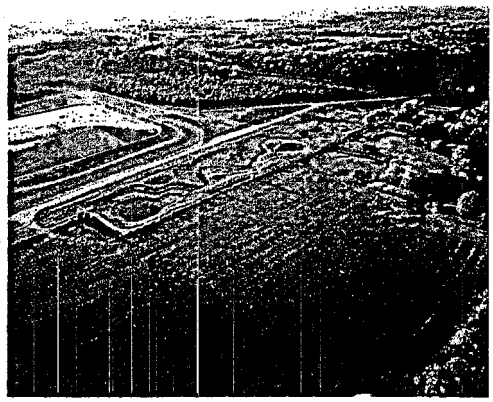

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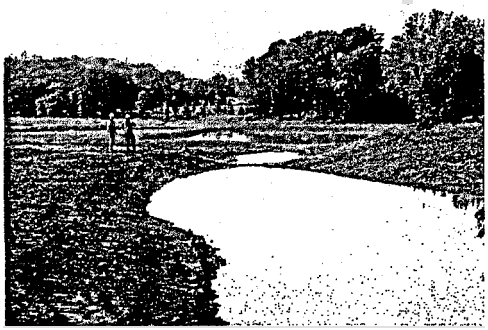

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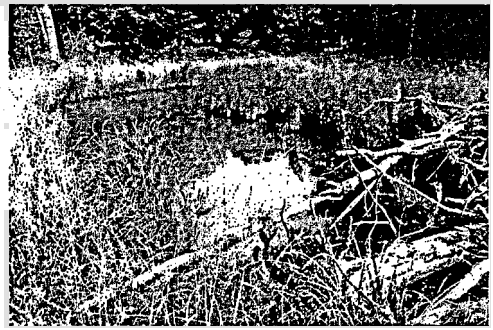

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