Restoring a Natural Resource Treasure in Northern Virginia

The Central Wetland Area at Huntley Meadows Park

Aerial view of project, October 2013.

Background and Project Goals

The central wetland area at Huntley Meadows Park in Alexandria, Virginia (approximately 46 acres in size and the largest non-tidal wetland in Northern Virginia) was created as a result of the arrival of beavers in the late 70s, which, from their damming activities, created a swamp/flooded forested wetland area. The marsh system's hydrology was controlled by a beaver dam with a length of ±225 feet and elevation ±2 feet above the

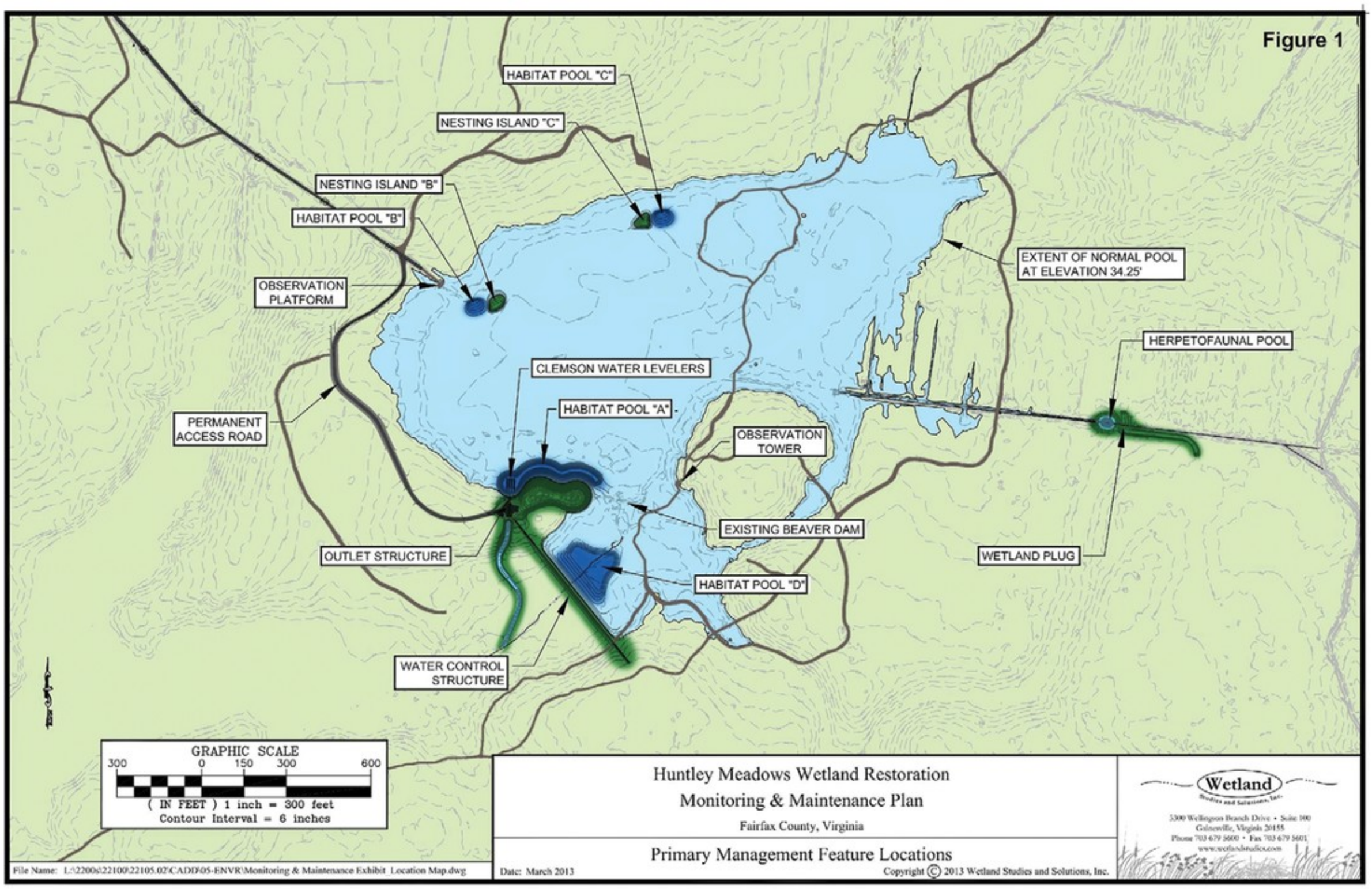
deepest marsh area.

Over time, this system transitioned into a hemi-marsh, which is known to have one of the highest levels of biodiversity and ecological function and is critical habitat for a diversity of birds along the Atlantic fly-way (the wetland was just recently listed as Virginia's "hidden gem" on Yahoo!'s Travel Page). As a result of the beavers continued damming activities, the hemi-marsh transitioned into a lake marsh system and has deteriorated over time due to consecutive droughts, siltation from upstream development, sporadic beaver activities, herbivorous feeding habits of Canada geese, and natural succession. These factors caused the wetland to transition from the lake marsh into a dry marsh/wet meadow comprised of large, monotypic stands of invasive species such as broad-leaved cattail (*Typha latifolia*) as a result of the uniform, shallow water levels. This more recent transition has greatly reduced the diversity of habitat and degraded the ecological function, leading to decreased wildlife diversity.

The primary objective of the Huntley Meadows Wetland Restoration Project was to replace the remnants of the existing beaver dam with a permanent water control structure that would provide Park Authority staff with some control over water surface elevations in the main wetland in order to recreate and sustain a hemi-marsh environment (a type of wetland system that contains roughly 50 percent open water and 50 percent vegetated wetland in the winter, with a summer draw down, along with a woody component).

Various design options to restore the central wetland area have been put forth over the years, particularly in 1993 and most recently in 2008. The issues with these previous efforts centered around the amount of disturbance that would be required to implement the more conventional stormwater management design solutions being proposed in this very sensitive and highly protected natural environment. Opposition to the designs came from various stakeholders, including from highly knowledgeable and influential citizen environmental groups, as well as from the Fairfax County Department of Public Works and Environmental Services (DPWES) that cited non-conformance with County dam safety requirements. Additionally, the size of the proposed dam would have required a permit from the Virginia Department of Conservation and Recreation's (DCR) Dam Safety Program, which was not desirable.

As a result of the previous failed attempts to develop an appropriate design solution, Wetland Studies and Solutions, Inc. (WSSI) was contracted by the Fairfax County Park Authority (FCPA) in 2011 to restore this unique ecosystem. The primary challenge was to provide an innovative engineering design that not only "fit" into this highly sensitive environment, but also would win over a skeptical contingent of involved stakeholders and was permittable



Basic restoration design elements.

by regulatory agencies.

Restoration Design Elements

To start, several pre-application meetings were held with staff from the FCPA (who were funding the project at an estimated cost of $3,000,000 after completion), the U.S. Army Corps of Engineers (COE), and the Virginia Department of Environmental Quality (DEQ) to discuss project history, purpose and need, studies required, concept plans, and the type of wetland permit that would be needed. It was determined by the COE and DEQ that the proposed project could be permitted with a Nationwide Permit #27 (Aquatic Habitat Restoration, Establishment, and Enhancement Activities) and conditional DEQ 401 Water Quality Certification.

WSSI (in close collaboration with the FCPA) developed a design that enables Park Authority staff to maintain the central wetland area as a hemi-marsh for the foreseeable future. The primary elements of the design included a water control structure and a concrete outlet structure with adjustable slide gates that enable Park Authority staff to raise, maintain, or lower the water level within the central wetland area based on time of year or observed conditions. In addition, an earthen "plug" was installed to the east of the site to prevent water from leaving the system through an old drainage ditch. A permanent access road was also constructed that enables Park Authority staff to access the water control structures. This road also serves as a means to facilitate the impoundment of higher water levels in the wetland. Additionally, several deep water habitat pools were excavated along with the construction of adjacent nesting islands within the central wetland area.

Several design alternatives were considered for raising and managing the water level (e.g., coarse woody debris dam (to mimic a beaver dam), concrete stem wall on sheet piles, imbricated stone, and sheet pile). Based on the practicability, feasibility, cost, and maintainability of each alternative, it was determined that a vinyl sheet pile wall (approximately 600 feet long and driven to a depth of approximately 20 feet) with a reinforced earth mix on either side (at a gentle 20:1 slope on the upstream side and 3:1 slope on the downstream side) was determined to be the most suitable design for the primary water control berm (i.e. the "dam), along with a concrete side-flow outlet structure with adjustable gates to enable seasonal manipulation of the wetland water surface elevation. As a result, the ability to manipulate the water surface elevation from 32 ft to 34.25 ft was achieved.

The selected design has allowed Park Authority staff to manipulate water surface elevations to create the desired hemi-marsh environment, while minimizing the impact to the park during construction, as well as in the long term. Only the top of the sheet pile wall is visible, flush with the ground, and is further masked by the dense and diverse planting of native shrubs and herbaceous plant species. The vinyl sheet-pile wall in combination with the earthen-dam allows large storm events to over-top the structure without degradation and eliminates the need for a separate emergency spillway, further reducing impacts to the surrounding forested areas.

A second innovative technique employed in the project was the use of Clemson Beaver Pond Levelers, installed in deep habitat pool (habitat pool "A" located immediately adjacent to the concrete outlet structure). This device allows baseflow to discharge through submerged pipes, thereby eliminating the noise from surface flows that would attract beavers. This technique will allow the continued habitation of beavers with minimal impacts to the outlet

Clemson Water Levelers. Inset: Aqua-Dam in place.

structure from damming activities.

AECOM (formerly URS Corporation) provided the structural and geotechnical design of the side flow discharge structure as well as the vinyl sheet pile within the earthen water control structure. This included the required length and depth of the wall, as well as the design of the soil and rock materials placed on the downstream side to provide the necessary stability under high flow conditions. WSSI performed the necessary hydraulic analyses to determine the size of the weirs, outlet culvert, and slide gates.

Final design plans were completed by the end of 2012 and were approved by Fairfax County in early January 2013. Clean Water Act Section 404/401 wetlands permits for the project were obtained in early February 2013. The size of the water control structure was designed such that no dam safety permits were required.

Construction

Construction commenced in May 2013. Fort Meyers Construction Group, Inc. served as the general contractor for the project and WSSI staff provided construction oversight. The project team was very fortunate that Northern Virginia was experiencing dryer-than-normal conditions during the summer of 2013, which made construction much easier, minimized impacts to wetland wildlife, and allowed the project to stay on schedule. Construction was broken up into three phases to allow working in "dry" conditions as much as possible and to work around sensitive wildlife breeding within the wetland.

Phase I included construction of the access road and installation of the concrete outlet structure. After installation of the erosion and sediment controls, the first step was to remove trees within the limits of clearing. All trees removed as part of the project were used in some fashion to enhance habitat in the wetland and upland areas. The largest hardwood trees (oaks and hickories) were removed intact (root wad and all) and piled up for use in the wetland as basking logs and woody habitat, which has been absent from the wetland for approximately 20 years. Smaller trees were used to create habitat brush piles both in the wetland and upland areas along the new access road. The outlet structure and outfall box culvert was installed at this time so it could serve as a water bypass during Phase III work. This concluded Phase I of the project, which was completed on schedule around mid-June.

Phase II included excavating the side discharge outfall channel and the largest habitat pool (Pool A). Pool A is the deepest of the four habitat pools and was excavated to the lowest elevation in the wetland to ensure sufficient drawdown could be achieved when the gates were lowered. An Aqua Dam (comprised of a hollow tube about 6 feet in diameter that is filled with water) was installed around the area which would ultimately be Pool A to enable it to be excavated "in the dry". All excavated top soil and clay was stockpiled. The clay was used as an impermeable core in the access road (as it also serves as a berm to contain very high water levels). After the excavation of Pool A was completed, the Clemson Water Levelers were installed. When complete (end of July), water was diverted through the outlet structure and side outfall channel to ready the construction of the water control berm. (Phase III).

Phase III commenced in early August and consisted primarily of the installation of the water control berm, excavation of the remaining habitat pools, and installation of the wetland plug in the ditch east of the main wetland area. Although water was being diverted through the concrete outlet structure, another Aqua-Dam was installed to ensure the work area for the water control berm and habitat Pool D (located immediately upstream of the water control berm) remained dry. The construction areas for Pools B and C (located in the north western portion of the main wetland area) were dry enough in the summer of 2013 to excavate without use of an Aqua-Dam.

The installation of the vinyl sheet piling used as the impermeable core of the water control structure berm was performed by McGee Mobile Crane Inc. Installation was performed using a crane with a hydraulic, vibratory hammer. Due to the sensitive nature of the site, vegetable oil was used instead of hydraulic fluid in case a leak or rupture occurred in the lines during construction. The sheet piles were driven 20 ft into the ground to ensure no water would

leak or discharge out of the wetland under the sheet piling due to the alluvial nature of the soils under the 5-10 ft deep layer of clay on which the wetland was perched. A rocky bed mix of Class IA rip-rap, cobble, sand and topsoil was used behind the sheet piling to provide additional support as well as erosion control during flooding events that over-top the berm while allowing vegetation to grow on the substrate. Once all the sheet piling was installed to the proper depth it was cut off at the desired elevation of 34.5 ft above sea level. The construction portion of Phase III was completed in November 2013.

As each phase of construction was completed, the stockpiled top soil was redistributed on all disturbed areas, seeded with a native seed mix, and covered with straw to promote native vegetation establishment. Park Authority staff was given a DCR grant of $25,000 for establishing native plants in the project area. Staff used $10,000 of this grant money to hire a local non-profit native plant nursery known as Earth Sangha, to collect seed from the park and grow local genome plants at their nursery for use in the restoration efforts once the project was completed. The project was too big for the nursery to handle all of the restoration plants; therefore, seed sources for plants were also collected within 200 miles of the park (the distance estimated for pollen to travel and migratory birds to carry seeds). Only species common to the park were included in the planting plan.

Sheet pile installation of water control berm.

Maintenance

Since completion, very little post-construction maintenance has been required.

Habitat Pool B - post construction.

After large rainfall events, basic clearing of storm debris and beaver placed mud and sticks have taken place from around the outlet structure, as well as from the water control berm. While the Clemson Water Leveler system should pass base flows, and on average handle smaller storm flows (depending on the level of the normal pool at the time of the storm), larger events that result in extended periods of flow through the surface weirs will attract beaver damming activities. Maintenance to remove materials placed by the beavers during these times is performed.

Annual maintenance will include lubrication and operation of all slide gates and valves in accordance with manufacture's recommendations. Annual mowing between September 15th and March 15th along the shoulders of the permanent access road, wetland-plug berm, upstream side of the water control structure, and the downstream face of the water control structure will be performed. After mowing, all water impounding facilities are inspected for erosion, woody plants, rodent damage, and other structural changes. Integrity inspections of the berm and permanent access road are also performed annually. Beaver fencing around planted habitat islands is inspected (and repaired if needed) once per week. After any 2-year storm event or greater (i.e., 3.2 inch rain event within a 24-hour period), the slide gates, valves, permanent access road, wetland-plug berm, water control structure, and outlet structure are also inspected.

Monitoring

Monitoring is required per the wetland permit obtained for the project, including monitoring of the central wetland area before and after construction activities were completed. Post-construction monitoring is also required for up to five years. The first year monitoring report included as-built plans, a summary of any changes to the permitted plans, pre-construction photographs, post-construction photographs, and vegetation plot monitoring data. In order for the site to be deemed successful by the COE and DEQ, the vegetation has to be comprised of at least 50% FAC, FACW, or OBL (i.e. wetland) species and not dominated by invasive plant species. The site successfully passed the first year growing requirements and is expected to easily pass future growing season requirements.

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In order to re-create and manage the Park as a hemi-marsh system, it will be necessary for Park Authority staff to monitor many aspects, including meteorological conditions and water levels, as well as the presence (or absence) of desirable wildlife and vegetation species. To assist Park Authority staff, a weather station was installed that records rainfall, humidity, temperature, wind speed and direction, water surface elevation in the wetland pool, and slide gate elevations. Park Authority staff also record the arrival and departure dates of the migrating wildlife target species, as well as nesting data to establish a correlation with the slide gate elevations and the resulting water regimes produced. To assist with documenting plant community changes within the central wetland area, natural color aerial photographs with 6-inch pixel clarity are taken every other year during the spring and fall seasons. The aerial photographs are used to provide a digitized vegetation cover analysis that is compared to the Existing Vegetation Map prepared prior to restoration activities. The results of the collected field data will provide Park Authority staff with the necessary information to be able to manipulate the water surface elevation as necessary to ensure a hemi-marsh system is maintained.

Conclusion

The benefits from the project are many. The variable water levels, the excavated deep water pools, and the larger wetland area with a variety of wetland habitats, will increase the diversity of plant/animal species and communities, provide habitat for target plant and animal species that were once present when it was functioning as a hemi-marsh system, prevent the dominance of invasive plant species, provide variation in the habitat quality for various animals, and will allow for annual restoration of forage to increase wildlife diversity. Successful completion of this project proved that engineering solutions can be successfully employed in highly sensitive areas to achieve project goals that are entirely based on environmental objectives.

Huntley Meadows Park is a highly prized and fiercely protected natural re-

source in a highly urbanized area. There is a long history of citizen activism to protect it from harm and restoration of the main wetland has been debated for decades. The Park receives approximately 200,000 visitors a year and conducts over 400 programs with 10,000 students every year. Along with the thousands of visitors, a non-profit organization (the Friends of Huntley Meadows Park) was created by individuals dedicated to the protection of the central wetland area (a place they refer to as "Fairfax County's premier wetland wildlife sanctuary"). The more than 400 member group represents an active and influential voice for the Park. The design was embraced by the Friends of Huntley Meadows and has received numerous positive reviews from regulatory agency representatives and County staff who have visited the site since construction was completed. The project also received a National Honor Award in the 2014 Engineering Excellence Awards competition by the American Council of Engineering Companies (ACEC), as well as the 2013 Fairfax County Tree Preservation Award and the 2013 Fairfax County Land Conservation Award: Best Protected Environmentally Site. **L&W**

Berm in 2015.

by Frank Graziano, PE, Director of Engineering at WSSI & Jennifer Van Houten, P.W.S., P.W.D., LEED® AP

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