STRAWBERRY ISLAND PHASE III EROSION CONTROL AND WETLAND HABITAT RESTORATION: A CASE STUDY IN THE SUCCESSFUL APPLICATION OF IN-LIEU FEE MITIGATION

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Abstract: The New York State Department of Environmental Conservation (NYSDEC), together with the New York State Office of Parks, Recreation and Historic Preservation (NYSOPRHP) and New York State Department of Transportation (NYSDOT), is conducting a riverine wetland restoration project at Strawberry Island. Strawberry Island is located at the divergence of the Tonawanda and Chippawa Channels of the Niagara River, near the City of Buffalo, in western New York. The majority of the funding for the project comes from New York's 1996 Clean Water / Clean Air Bond Act, which was approved by voters and signed by Governor George E. Pataki. Additional funding was provided by NYSDOT as an in-lieu fee solution to unavoidable impacts to freshwater wetlands.

The island, which was once more than 200 acres in size, has been severely impacted by sand and gravel mining as well as natural erosive forces. By 1993 the island had been reduced to less than six acres. Critical water levels, existing bottom topography, weather-related impacts, and recreational and commercial boating along with utilization by fish and wildlife all need to be considered.

This paper describes the island history, design, regulatory approval process and construction activities utilized to protect /restore this ecologically sensitive site. Construction was completed in November 2001. Preliminary results suggest that erosion to the island has been halted and a flourishing wetland community is developing.

Strawberry Island is located at the divergence of the Tonawanda and Chippawa Channels of the Niagara River near Buffalo, New York. The island was first surveyed in 1814 and found to be approximately 100 acres in size. By 1912, the island had grown to over 200 acres, when dredged materials from the construction of the Erie Canal and Black Rock Lock were placed on the site. From 1926 until 1953, the island was mined for sand and gravel to construct roads and other infrastructure for the growing City of Buffalo. By the time the mining ceased, barely twenty-five acres of the original island remained. Archived maps and aerial photography suggest that portions of the island were once productive riverine wetlands. Since that time, erosion from high-water storm events, ice scour and boat traffic have reduced the island to approximately six acres (Leuchner 1998). In the spring of 1997 both Phase I and II were completed. An aquatic habitat restoration project was completed with funding from the New York State 1996 Clean Water/Clean Air Bond Act. Rip-rap breakwaters were constructed, and wetland soil was transported from a nearby freshwater wetland. Additional wetland plants were established to supplement natural revegetation of the wetland areas, totaling three acres. The goal of the Phase III project was to protect Strawberry Island from further erosion, and restore a small portion of wetlands that were once more abundant in the river corridor.

Major Events in Strawberry Island History

1814	Surveyor General of the State of New York, Simeon DeWitt, calculates the area of Strawberry Island as 100 acres and values it at $100.
1820+/-	The island's area begins growing when dredged material from the Erie Canal and Black Rock Locks is placed there.
1882	Records tell of a two-story resort hotel being located at the island. A small canal was constructed through the island so ladies could fish without risking the current of the main river.
1947-1950	The Lakeport Sand and Dredging Company reduces the island to 25 acres, creating the present horseshoe shape.
1960	The Town of Tonawanda purchases the island and locates municipal water intakes beneath it.
1970's	The Strawberry Island Coalition and Strawberry Island Preservation Group form. These groups lobby for restoration of the island.
1987	Strawberry Island and 400 acres of downstream shoals are designated a significant coastal fish and wildlife habitat by the New York State Department of State.
1989	Jurisdiction of the island is transferred to the New York State Office of Parks Recreation and Historic Preservation.

1993	High-water storm events cause a breach in the south end of the horseshoe, requiring repair. This work becomes Strawberry Island Phase I.
1996	New York State Department of Transportation funds Phase II, which includes some armoring of the eroding shoreline and conservation plantings.
June 1998	U.S. Army Corps of Engineers Experiment Station completes a Survey of Vegetation and Mussel Communities at Strawberry Island, Niagara River, NY.
October 1998	New York State Governor George E. Pataki awards $735,000 from the 1996 Clean Water/Clean Air Bond Act to Strawberry Island Phase III.
June 2001	Strawberry Island Phase III Erosion Control and Wetland Habitat Restoration project is complete.

Physical Assessment

Geologic Conditions

Strawberry Island was formed when sediments carried by the Niagara River were deposited on an outcrop of Camillis shale bedrock (Sault et al. 1996). The sand and gravel layers appear to have been deposited during the draining of Lake Dana, during the recession of the last glaciers to cover western New York (Earth Dimensions 1998). Since the island was formed during a somewhat catastrophic outflow of early Lake Erie, it seems unlikely that such an event will soon occur to deposit additional material at the island. In fact, there are several reports of record that suggest the future of the island will be shaped by erosion rather than deposition (Bossert 1973).

At this time, the island serves to split the flow between the Tonawanda Channel on the east and the Chippawa Channel, which runs to the west of Grand Island. Approximately 600 feet to the west of the island is the internationally recognized border with the Canada. Both the United States and Canada are sensitive to activities which may alter water levels or flow patterns within the Niagara River. In 1948, the International Joint Commission warned of a danger of polluted water, from the industrialized east channel, being diverted to the west channel if it were not for Strawberry Island. Of equal importance is the fact that both countries use water from the river for hydroelectric power generation. Therefore, both countries have a stake in the island remaining where it is so that river flow patterns continue unchanged.

Weather and Erosion

The normal littoral movement of water past the island would be considered a primary cause of erosion. Velocity measurements ranging from 1.5 to 2.0 feet per second are strong enough to erode particles up to one millimeter in size. Sieve analysis shows a small percentage of this sized material near the island, which suggests that finer particles have been eroded already. In this case larger particles are left to stabilize the island from normal erosive current forces (Acres International 1988). Consequently, the majority of the erosion that now takes place at the island is due to high-water storm events, usually emanating from the west or northwest. A storm fetch of over one mile increases the likelihood that large waves will reach Strawberry Island. It is not uncommon to see waves and storm surges exceeding six feet. When this occurs, the island is almost entirely under water, which contributes to the erosion of both downstream arms. Water levels in Lake Erie are lower now than in the past several years and forecasts suggest that this trend will continue. It was favorable to construct a restoration project when water levels were at their lowest.

The Niagara River is prone to ice jams emanating from Lake Erie. These ice jams affect downstream hydropower plants. In 1964, the New York Power Authority began installing a log ice boom at the mouth of Lake Erie. When the boom is in place, large chunks of ice are prevented from traveling down the river. Smaller pieces of ice, which form in the quiet sections upstream of Strawberry Island, still impact considerably on the vulnerable shores of the island, especially on the southwest corner. This effect is somewhat diminished by recent stabilization projects (Phase I and Phase II), which armored the south end of the island with rock rip-rap.

Vegetation

For the purposes of this project, the authors chose to ignore upland and shoreline vegetation since it was not impacted. To implement this restoration project, it was important that productive offshore areas were not degraded in the name of restoring habitat. The majority of the proposed construction areas were devoid of vegetation due to shallow water and faster currents. Lush beds of aquatic vegetation can be found downstream of the island. One reason this project was proposed was to protect these vegetation beds from erosion. It is hypothesized that the shoal areas downstream, along with their associated vegetation,

would be quickly eroded if Strawberry Island were to disappear. In 1987, the New York State Department of Transportation designated this downstream area (approximately 400 acres) as a Significant Coastal Fish and Wildlife Habitat. The shoals act as foraging and resting habitat for migratory waterfowl and shorebirds as well as being one of the premiere nursery areas for muskellunge in the Niagara River. Using the U.S. Army Corps of Engineers (USACE) Waterways Experiment Station study, titled *Survey of Vegetation and Mussel Communities at Strawberry Island, Niagara River, NY* (1998), several species of aquatic plants were identified in the construction area. Table 1 shows species which occur in or adjacent to the area of construction. Recent restoration efforts utilized aerial photography, field inspections and the USACE vegetation study to ensure that minimal impacts would occur to the existing vegetation beds.

Table 1
Species observed adjacent to the area of construction

Potamogeton pectinatus	Potamogeton richardsonii	Potamogeton crispus
Potamogeton pusillus	Elodea canadensis	Vallisneria americana
Zannichellia palustris		

Recreation

In 1989, ownership of Strawberry Island was transferred to the People of the State of New York, NYSOPRHP. The island is treated as parkland associated with nearby Beaver Island State Park. Since the island is home to several species of waterfowl and colonial nesting birds, access is restricted to a beach on the south end of the island. Several waterfowl hunting blinds are available for daily use during the hunting season, through a lottery system conducted by NYSOPRHP. The island is also used for boating recreation purposes and has become a convenient, yet unwanted, picnic area and restroom. The downstream shoals and lagoon are popular for fishing and waterskiing. There was some concern that boat or personal watercraft traffic through the vegetated shoals would have a detrimental impact on that ecological community. Aerial observations of the shoal areas show heavy scarring of the sandy bottom. Much of this damage is accidental, as boaters race across the river at high speeds only to find themselves running aground in depths of approximately 18 inches. Other damage is purposeful, as boaters sneak across the shoals as a shortcut to area boat launches or marinas. Finally, the island and offshore areas are popular with birders who access the area for passive recreation or to take part in annual bird counts. Due in part to the use of the island area for such a wide array of recreational uses, there was strong support from the public for this project.

Biological Assessment

Strawberry Island divides the Niagara River's current into the east and west channels. This creates a quiescent area roughly 400 acres in size, located immediately downstream of the island. This area is rich in aquatic vegetation, which provides food and protective cover for myriad fish and avian species. Strawberry Island is the hallmark for this neighboring shoal area known as Strawberry Island/Motor Island Shallows, designated a Significant Coastal Fish and Wildlife Habitat in 1987. The "Shallows" is the largest riverine littoral zone in the Niagara River, with water depths ranging from eighteen inches to five feet. Strawberry Island/Motor Island Shallows is part of one of the most important waterfowl wintering areas in the northeastern United States, especially for diving ducks. During the fall and spring migration, many species of waterfowl, such as common merganser (*Mergus merganser*), red-breasted merganser (*Mergus serrator*), common goldeneye (*Bucephala clangula*), canvasback (*Aythya valisineria*), lesser scaup (*Aythya affinis*), black duck (*Anas rubripes*), mallard (*Anas platyrhynchos*), bufflehead (*Bucephala albeola*) and long-tailed duck (*Clangula hyemalis*) can be observed foraging in the lagoon and quiet downstream waters of the island (Steck, Poole and Wilkinson 1995; Barrows, Leuchner and Steck 1996). The island is also home to several thousand pairs of ring-billed gulls (*Larus delawarensis*) as well as lesser numbers of Canada geese (*Branta canadensis*) and double-crested cormorants (*Phalacrocorax auritus*). Areas such as this are rare in the Great Lakes Plain ecological region and are extremely valuable fish and wildlife habitat.

Design Criteria

Previous Efforts

In 1988, Acres International Corporation, performed a review of conditions which existed at Strawberry Island and made several recommendations for remediation. They considered current, flow patterns, ice and use patterns to develop several potential remedies to the erosion problems that affected Strawberry Island. One recommendation was to incorporate offshore breakwaters to deflect the current and ice. These breakwaters were to be located on the south end of the island, knowing that most of the erosion impacts were occurring there. In 1993, a series of large storms created a breach at the southwest corner of the island. The problem was exacerbated by small watercraft using the breach as a shortcut to the lagoon. In the fall of that year,

Strawberry Island Phase I began. Almost $350,000 was spent to fill in the breach and armor the shoreline. Additional funds were spent to establish willow species and other vegetation in an effort to further strengthen the breached area against erosion. In 1996, mitigation funds provided by NYSDOT were used to add additional armoring to the island, as well as to plant additional shrub species. The rip-rap armoring and shrubs provide excellent protection against the erosive forces of the river.

It appeared the only way to protect the island from erosion was to encase it in stone. The 1988 Acres International Corporation report recommended using offshore breakwaters. However, NYSDEC has had some success in establishing wetlands in the protected areas behind breakwaters and agency biologists felt wetland establishment at Strawberry Island would be an essential part of the long-term stability of the island and its habitats. Since only the downstream arms were left unprotected, it was possible to incorporate both ideas. The proposed project would use similar types of breakwaters as were recommended by Acres International but would incorporate wetlands into the design. This would be an excellent alternative to armoring the entire shoreline of the island. It was decided this type of restoration be attempted at Strawberry. The wetlands would serve two purposes. First, they would dissipate energy generated by waves overtopping the breakwaters prior to those waves reaching the fragile shores. Second, the wetlands would serve as additional foraging, resting and escape habitat for fish and wildlife that frequent the area.

Special Considerations

Many factors were taken into consideration when deciding on the design for this restoration project. Ecological, social, aesthetic and economic concerns were addressed. Particular issues pertaining to this design are identified below:

- A municipal water intake structure is located approximately 200 yards south of the island. It was very important this structure not be disturbed during construction.
- Water levels and flow patterns shall not be adversely affected. Article III of the 1909 Boundary Waters Treaty between the United States and Great Britain restricts obstructions that affect level or flow in boundary waters.
- The integrity of the island as parkland should be maintained. However, during periods of construction, certain areas were off limits to the public. This was to protect visitors and workers from any dangers associated with construction equipment and/or boat traffic.
- It was essential that the downstream shoals be awarded whatever protection that was possible. Under these circumstances, the breakwater design should not adversely affect the shoal areas. To this end, breakwaters and wetlands were located in areas devoid of vegetation that offered lesser ecological value.
- Marine contracting is expensive. The cost of materials nearly doubles when they are transported by barge and placed by vehicles that normally operate on dry land. In this case, the scope of the project was limited due to the higher costs of implementation.

This project was put out for public bid. NYSDEC and NYSOPRHP were able to take advantage of an existing term contract with Acres International, Inc., for design services. The actual construction contract was awarded in late 2000. Contractors were asked to provide evidence of experience in marine contracting and wetland restoration.

Mitigation

The policy of New York State, per the Freshwater Wetlands Act, is to preserve and protect the benefits that wetlands provide — flood control, surface and groundwater protection, wildlife habitat, open space, water resources, recreation, education and research and aesthetic enjoyment (NYSDEC Freshwater Wetlands Program Manual, 7/96). Thus, one goal of NYSDEC when dealing with freshwater wetlands and development projects is to achieve no net loss of wetland acreage and function. Compensatory mitigation is one way to achieve this goal.

Mitigation is an attempt to counteract the adverse effects of a development or construction project by replacing lost acreage and function. In freshwater wetlands cases, a permit is issued when an applicant (the individual or company) demonstrates that impacts to a wetland cannot be entirely avoided, losses to the form and function have been minimized and compensation for losses will occur (NYSDEC 1997).

Mitigation may take two forms: on-site, or "in-kind," which must involve the affected wetland and the replacement of the same type of wetland, or off-site, which occurs at a wetland removed from the project in question. On-site mitigation is preferred, as it ensures the size and integrity of the affected wetland are maintained. However, on-site mitigation is not always possible or desirable, and regulatory agencies must turn to the next alternative, off-site mitigation.

Off-site mitigation is not done within or necessarily contiguous to the impacted wetland. The mitigation area may be within the project site boundaries, on adjacent property, elsewhere in the watershed or within some larger political, ecological or geographic area (NYSDEC 1997).

Other mitigation alternatives currently used in the U.S. include mitigation banking, consolidated mitigation projects and in-lieu fee mitigation. Mitigation banking means creating or restoring a large wetland in advance of specific projects requiring permits and mitigation (NYSDEC 1997) and is not a form of compensatory mitigation supported by NYSDEC.

Consolidated mitigation projects combine efforts of a number of separate and distinct, but geographically proximate projects. In-lieu fee mitigation is not a formally accepted alternative for compensatory mitigation in New York State. Presently, it is only allowed to occur between government agencies and is accepted on a case-by-case basis after review by the permitting agencies.

In-lieu fee mitigation occurs when funds are transferred to a natural resource agency from an entity unavoidably impacting wetland resources as compensatory mitigation for those wetland impacts. The in-lieu fee manager uses the cumulative funds to create or restore wetland resources on a current habitat enhancement project (VADEQ 2003).

In 2001, NYSDOT had an ongoing capital improvement project which required compensatory mitigation be completed for 0.87 acre of federal wetland impact. No space was available for on-site mitigation. Concurrently, NYSDEC and NYSOPRHP were in the midst of the Phase III Erosion Control and Wetland Habitat Restoration project at Strawberry Island. Funding for the Strawberry Island Restoration project was limited; it was anticipated that only 75 percent of the needed work could be completed, with the other 25 percent to be completed at a later date when the capital became available.

The remaining 25 percent would leave the eastern arm of the island exposed and unprotected. Already severely eroded, concerns arose about how much longer the eastern arm would remain. The western arm was a priority to stabilize because securing the western arm would add some protection for the eastern arm.

The USACE determined that it would be suitable in-lieu mitigation for NYSDOT to provide funding toward the completion of Phase III project at Strawberry Island. NYSDOT provided $282,700 toward a $1 million project. This insured the protection and stabilization of the eastern arm. Without the additional funds, the existence of the eastern arm would depend solely on the western arm. In-lieu fee funding made it possible for the contractor to complete the entire project at one time. Approximately $500,000 in additional expenses was saved in transporting equipment alone.

The success of in lieu-fee mitigation, in this circumstance, was a direct result of cooperation, partnership and teamwork between the involved state agencies.

Design Selection

The selected design called for breakwaters to be constructed using two sizes of rip-rap. Fine stone fill was used as a core. Medium stone fill serves as armor stone. A sacrificial "shelf" was incorporated to eliminate the need to "toe in." Since the breakwater is entirely made of stone, all material was transported from the mainland by barge. Normal construction equipment was utilized in order to construct the breakwaters; this reduced cost. This design provided protection against erosion, enabled restoration of wetlands, was constructable and was cost efficient. For these reasons, this design was selected.

The selected design called for three offshore breakwaters and approximately three acres of emergent wetlands to be constructed. Two of the breakwaters are located along the west side of the island and one is located along the east arm. Construction began at the west side of the island once in-stream work restriction dates passed. A temporary staging area consisting of light stone fill rip-rap was constructed first. The staging area also incorporated steel or wooden piles for which to secure work barges. Once access to the island, was provided through limited dredging and the staging area was complete, breakwater construction began. The breakwaters were constructed in two phases. First, a base of fine stone fill was placed up to the mean summertime water mark in the river, or approximately 565.0' $IGLD_{55}$. This base served as a travelway for

subsequent construction activities. The next step was to construct temporary rock groins. The groins allowed rock and wetland soil to be placed in areas otherwise out of reach of the long-reach hoe. Wetland soil was transported from Buckhorn Island State Marsh, which is located approximately ten miles away by truck. The material was offloaded onto a barge and transported to the island. The wetland soil was placed at the island so that it resembles a naturally graded bottom. Finally, the top portion of the breakwaters was constructed using medium stone fill as armoring. Once construction of the breakwater was completed, erosion control fabric was placed on top of the wetland soil. The fabric helped to contain the wetland soils until plants become established. It also served to prevent catastrophic washouts in the event of a large storm. When construction of the first breakwater was complete, the whole process began again until all three wetland areas were constructed. The following spring supplemental plantings, numbering about 5,000 plants, were manually placed in the constructed wetlands. The wetland plants were in the form of dormant rhizomes or rooted cuttings. Workers penetrated the erosion control fabric and placed plantings four to six inches deep within the soil. It was expected that natural regeneration of wetland plants will occur at the island. For this reason, only the shallow portions of the wetlands were planted. Plants begin to colonize the deeper waters, once the wetland becomes established.

Design Components

This section further describes the five individual components of the restoration design, which are:

1) Breakwaters
2) Temporary groins and rock barriers
3) Geotextiles
4) Marsh soils and wetland plants
5) Erosion Control

Breakwaters

The breakwater was constructed using a two-tiered design. Fine stone fill was placed on a layer of geotextile fabric and acted as a core for the breakwater. Medium stone fill was placed on top of the lighter fill and acts as armoring for the entire system. Table 2 shows NYSDOT Specification 620-1 for stone sizes as described above.

Table 2
NYSDOT Specification 620-1 for stone sizes

Stone Filling Item	Stone Size	Percent of Total by Weight
Fine	Smaller than 8 ins. Larger than 3 ins. Smaller than No. 10 Sieve	90-100 50-100 0-10
Light	Lighter than 100 lbs. Larger than 6 ins. Smaller than ½ in.	90-100 50-100 0-10
Medium	Heavier than 100 lbs. Smaller that 4 ins.	50-100 0-10
Heavy	Heavier than 600 lbs Smaller than 6 ins.	50-100 0-10

A four-foot horizontal shelf was utilized to help dissipate normal wave energy by causing waves to break prior to reaching the wall. Secondary functions of the shelf were to deflect ice and to act as a sacrificial portion of breakwater. It is customary to key in the toe where large storm surges and currents exist. This prevents the toe from being undermined, leading to the eventual failure of the breakwater. In this case, a fragile bottom environment, turbidity concerns and added cost did not allow for the toe to by keyed in. As an alternative, the sacrificial portion eliminated the need to key in the toe of slope. Geotextile fabric was incorporated as a base for the breakwater as well as a transition layer between the breakwater and the wetland soils. The fine stone fill allowed for easy trafficking by tracked or wheeled vehicles and acted as a cushion so the geotextile fabric was not punctured by larger rock. The medium stone armoring was chinked with smaller stone to reduce pore space between individual stones, which should minimize “blow through” of wave energy.

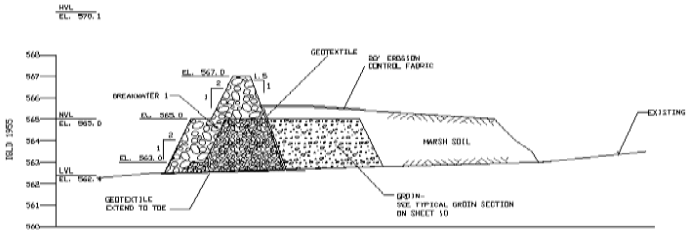

Fig. 1. A typical cross-section through the breakwater.

The design used fine stone fill as the core for the breakwater. The reasons for this were two-fold. First, the fine stone fill was less expensive to purchase and place than larger fill material. Second, fine stone fill allowed for rubber tired machinery to travel on top of the stone core. In past restoration projects, low pressure rubber tired vehicles were allowed to travel on light and even medium stone fill. Problems with deflation and puncture of tires required haul roads to be topped with fine stone fill material. By incorporating fine stone fill at the earliest stages of road construction, we hoped to alleviate work slow-downs and the expense of tire repair. The rock fill groin was incorporated to allow marsh soil to be reached in the furthest sections of the engineered wetlands. Long reach trackhoes with 40-foot booms placed soil in the wetland areas from the relative comfort and safety of the groin. This practice reduced the threat of turbidity as well as the possibility of getting vehicles stuck. Once soil placement was completed, the groins were covered with soil and incorporated into the wetland. In this way, the wetland areas were partitioned and thereby less susceptible to catastrophic events, which might otherwise have caused total destruction of the project.

In non-adjacent areas of the island, low-level rock barriers were used to contain wetland soil. The elevation of the rock barriers was 564.0' $IGLD_{55}$. This allowed the soil to be contained, allowed flow through the wetlands and were not a hazard to boats. Open areas were strategically placed in the barrier system to allow for fish passage and to prevent stagnant conditions.

Geotextiles

Geotextile materials played an important role in Phase III restoration. Woven geotextile such as AMOCO Type 2016 or an equivalent, were used as the base for the breakwaters. Since the river bottom in the area of construction is composed of approximately one foot of sand over silt, the potential for appreciable settling existed. The geotextile helped dissipate the loading of the rockfill and minimized settling. This issue was made even more important when vehicles were trafficking on top of the breakwaters. Geotextile was also used as a transition layer between the breakwaters and the wetland areas. This minimized current forces washing through the stone fill and impacting the wetlands.

Marsh Soils

When conducting wetland efforts of this type, the key is hydrology. It was theorized that some wetland plants would colonize the quiescent areas behind the breakwalls if left to natural regeneration. It is more likely that exotics, such as purple loosestrife (*Lythrum salicaria*) and common reed (*Phragmites australis*), would quickly establish within disturbed areas, especially since both species are currently found at Strawberry Island. Unfortunately time is working against the island. Acreage is being lost each year to erosion. Therefore, it was decided the wetlands restoration project should receive a boost. In other words, the applicants diligently attempted to speed up the process of establishing wetland hydrology and colonization by native wetland species. This was accomplished by transporting wetland soil from a functioning wetland to the island. There was a restoration project located at nearby Buckhorn Island State Park Marsh. At that site, changes in river levels have contributed to the wetland reverting to a monotypic cattail (*Typha spp.*) marsh. Open water channels were excavated to increase edge and provide habitat diversity. Spoil material had been stockpiled for use in future restoration projects. To date, three projects using this spoil material have been completed with good success. The material, owned by the State of New York, was available to contractors free of charge for use at Strawberry Island. The only cost incurred was for transport and placement of this material.

The soils at Buckhorn Island are classified as ponded Haplaquolls, the most prevalent soil type of freshwater wetlands in western New York (Soil Survey of Erie County, New York 1990). In these soils, cattail, rushes, grasses and other water-tolerant herbaceous vegetation are the dominant plants. The spoil material, rich in seeds, propagules and rhizomes, has shown the ability to quickly revegetate, as witnessed by the colonization

of wetland plants in the stockpiles. The high silt content of the spoil made it difficult to transport and place. The material needed to be de-watered prior to transport. When placing the material in the river, great care was exercised to reduce turbid conditions. Special handling techniques were incorporated so material was gently placed rather than dropped from an appreciable height into the river.

Supplemental Wetland Plants

To advance colonization of the newly established wetlands, supplemental plantings were incorporated. Species selection was determined by researching historical records and aerial surveys. The most useful resource was titled A Biological Survey of the Erie-Niagara System (New York State Conservation Department 1929). This book was the oldest available resource that specifically described vegetation found at Strawberry Island. Most of the wetland species found at the island in 1929 are commercially available today. Table 3 shows type and quantity of supplemental plantings used for Phase III restoration.

Table 3
Type and quantity of supplemental plantings

Species	Area ft^2	No. of Plants	Plant Type
Sparganium eurycarpum	1860	465	Bare root or dormant rhizome
Saggitaria latifolia	1720	430	Bare root or dormant rhizome
Typha latifolia	6420	1600	Bare root or dormant rhizome
Scirpus acutus	2480	620	Bare root or dormant rhizome
Scirpus americanus	2240	560	Bare root or dormant rhizome
Scirpus fluviatilis	6300	1575	Bare root or dormant rhizome

Wetland species were planted on a two-foot grid spacing approximately six inches deep within the soil. The range at which plants were placed was from 564.5' to 565.5' $IGLD_{55.}$ By planting on a gradient, some of the plants would establish regardless of local conditions. In western New York, NYSDEC has had little success when planting is performed in autumn. Therefore, all wetland planting were performed in the month of June following the completion of construction.

Erosion Control Fabric

To protect the establishing wetlands, it was necessary to incorporate some type of erosion control device. Since the crest height of the breakwaters is two feet above mean summertime water levels, waves often wash over them. This was not to be an issue once the wetland vegetation became established. Until wetland vegetation was established, however, the wetlands were in jeopardy of erosion. The applicants used erosion control products with the following properties:

- Dense and submersible
- Primarily made of natural materials
- PVC or nylon portions should biodegrade
- Should not allow entanglement by wildlife

A product containing all of the above properties was found. The erosion control fabric was laid on top of the wetlands and extended 20 feet inward from the breakwaters. The mostly natural fiber mat was easily penetrated by wetland plants and provided protection even after the mesh material had degraded. Since the island is frequented by shorebirds and waterfowl, there was some risk of entanglement. This risk was minimized by securing the mat below the water's surface with long staples.

Wildlife Depredation

Depredation by Canada geese is a problem in western New York. In recent years, more than $100,000 in wetland plants were eaten or otherwise destroyed by these waterfowl at area restoration projects. To mitigate this problem, the entire planted portion of the established Phase III wetlands was enclosed in temporary fencing. This was the only alternative, since products such as mylar tape and scare devices have little effect on the geese. Construction fencing such as Tensar Morrow GA-30260 or an equivalent was used. Temporary wooden stakes were driven into the river bottom for the season following construction. Once wetland plants became established, the fencing was removed. Two growing seasons were sufficient to effectively establish plants to the point where they were not affected by goose depredation.

A major component to the success of the restoration project depended on the propagation of the wetland plants and the maintenance of current vegetation on the upland part of the island. Vegetation is extremely important on Strawberry Island, as it serves as a natural erosion control. Gulls (*Larus sp.*) and double-crested cormorant (*Phalacrocorax auritus*) populations were managed for several years prior to the Phase III construction, in efforts to maintain existing vegetation. Several management techniques were used to limit avian impacts to existing and establishing vegetation.

In 1999, a 16,650-square-foot overhead grid was erected to discourage gulls from nesting and removing vegetation in a sensitive area of the island. In 1998, a depredation permit from the United States Fish and Wildlife Service (USFWS) was obtained to collect eggs and destroy gull nests, in an attempt to dissuade nesting in that area. From 1998 through 2002, egg collection was formed every two weeks during the nesting season, until attempts at re-nesting ceased. In 2003, significant numbers of gull nests were not present to warrant removal. In addition to managing gull nesting, approximately 60 Canada goose eggs were addled annually for the last two years.

On the southern end of the island, established poplar trees (*Populus sp.*) are dominant and serve as an "anchor" to the island. In 1998 double-crested cormorants started to establish a nesting colony in cottonwood trees. If allowed to establish and expand the breeding colony, cormorants could destroy the remaining poplar trees with the accumulation of their acidic feces. Again, a permit was obtained from USFWS to implement harassment and nest destruction techniques. After five years of using these procedures, double-crested cormorants no longer nest on Strawberry Island. They do continue to roost on the island. Presently, only one poplar tree of significant size has been adversely affected by the defecation of the cormorants.

Current Conditions

Approximately two years after construction, percent cover of vegetation on the breakwall number two increased from zero percent to sixty-three percent, and zero to fifty-nine percent on break wall number one. Purple Loosestrife consists of approximately five percent of vegetation on the western arm. On the eastern arm approximately ten percent of vegetation is purple loosestrife. Flora diversity has significantly increased. See Appendix A for a listing of plant species. Evidence of muskrat's feeding on cattails and rushes has been observed. Muskrat activity is being closely monitored to assure excessive negative impacts do not occur to establishing wetland vegetation.

Summary

Riverine wetland restoration was relatively new to western New York. There were several projects in NYSDEC Region 9 which were either underway or newly completed, with varying success. Upwards of ninety percent of the historically occurring riverine wetlands in the Niagara River Corridor have been lost due to changes in river levels and development. NYSDEC is committed to attempting wetland restoration when site conditions allow, and there is a reasonable expectation for success. Strawberry Island Phase III can be a model for how to successfully restore riverine wetlands in the larger rivers of New York State.

This project was not without risks. Invasive exotic vegetation will most certainly shape the future of wetland restoration in western New York. Purple loosestrife and common reed both pose a serious threat to native species richness. Depredation by wildlife is also a threat to project success. It seems unconscionable to consider harassing or even killing some of the very wildlife for which the project proposes to provide habitat. A solution needs to be found to enhance wetland plants to establish without the threat of depredation by wildlife.

Big changes are in store for Strawberry Island in the next few years. Hopefully erosion will be stemmed and three acres of emergent wetlands will flourish, providing additional foraging and resting habitat for area fish and wildlife. The final piece in this puzzle will be the completion of a Unit Management Plan which will be employed to determine future use and protection of the 400 acres of shoals and surrounding nesting islands. If this is the case, the future of Strawberry Island will be as exciting as its past, and a locally important area will be preserved for future generations of boaters, anglers and other recreational users.

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NYSOPRHP, Niagara Region
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Acres International Corporation, Inc.
Strawberry Island Preservation Group

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- Performing permit reviews and compliance activities related to stream protection and wetlands.
- Providing habitat information to consultants performing brownfields redevelopment.
- Assuring environmental compliance during activities related to utility crossings.
- Performing assessments for the State's Open Space Plan.
- Acting as project manager for several regional habitat restoration projects.
- Serving as liaison between New York State Department of Transportation, Region 5, and New York State Department of Environmental Conservation, Region 9.

Prior to beginning government service, he worked for ten years in the fields of civil engineering and land surveying. He is a 1995 graduate of the State University of New York College of Environmental Science and Forestry. He and his wife share their home with four Siberian huskies. They reside in the hamlet of Lawtons, where Tim serves as a lieutenant and president for the local volunteer fire company.

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APPENDIX A
VEGETATION FOUND IN WETLAND CREATION AREAS ON STRAWBERRY ISLAND, 8/20/03

Arrow arum(*Peltandra virginica*)
Arrowhead (*Sagittaria latifolia*)
Balsam poplar (*Abies balsamifera*)
Blue vervain (*Verbena hastata*)
Boneset (*Eupatorium perfoliatum*)
Common mullein (*Verbascum thapsus*)
Coontail (*Ceratophyllum demersum*)
Crown vetch (*Coronilla varia*)
Curled dock *(Rumex crispus*)
Dwarf bankers willow (*Saliz x cotteti*)
Elecampane (*Inula helenium*)
Enchanter's nightshade (*Circaea quadrisulcata*)
Fetterbush (*Leucothoe racemosa*)
Field bindweed (*Convolvulus arvensis*)
Flowering rush*(Butomus umbellatus*)
River bulrush (*Scirpus fluviatilis*)
Great bur-reed (*Sparganium eurycarpum*)
Hard-stemmed bulrush (*Scirpus acutus*)
Hedge mustard (*Sisymbrium officinale*)
Jewelweed (*Impatiens pallida*)
Joe-pye weed (*Eupatorium dubium*)
Narrow-leaved cattail (*Typha angustifolia*)
Pickerelweed *(Pontederia cordata*)
Purple loosestrife (*Lythrum salicaria*)
Queen Anne's lace (*Daucus carota*)
Small sundrop (*Oenothera perennis*)
Small water plantain (*Alisma subcordatum*)
Smartweed (*Polygonum hydropiper*)
St. Johnswort (*Hypericum perforatum)*
Streamco willow *(Salix purpurea*)
Teasel (*Dipsacus sylvestris*)
Thistle (*Cirsium vulgare*)
Water milfoil (*Myriophyllum humile*)
Wild mint (*Mentha arvensis*)
Wild celery *(Vallisneria americana*)