*Suffolk County Vector Control and Wetlands Management Long Term Plan and Generic Environmental Impact Statement*

*For the:*

# Wertheim National Wildlife Refuge Open Marsh Water Management Demonstration Project Proposal

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New York State Department of Environmental Conservation

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## 1. Goal

Suffolk County has determined that the development of a Long-Term Plan (LTP) for its vector control and wetlands management program is in order. The most effective, economical, and potentially environmentally benign means of control for salt marsh mosquitoes is to manage their habitat so as to minimize breeding of larvae and the propagation of adults (CDC, 2001). Historically, this has been accomplished by constructing ditches so as to manipulate water levels on the marsh. Ditching is intended to minimize breeding opportunities by drying the marsh surface and so removing breeding sites. Ditching also provides some access to interior sections of the marsh for fish that consume mosquito larvae (Richards, 1938). Ditching, because it fundamentally alters the natural water regime of the wetlands, is believed to have some consequential environmental impacts (Taylor, 1998). Currently, ditch maintenance is under legal attack; and, along the south shore of the County, where tidal ranges are low and so ditching may not be as effective as in higher tidal amplitude environments, mosquito control requires larvicide applications, and sometime adulticide use.

Open Marsh Water Management (OMWM) is a guild of techniques that has been developed with the intention of controlling mosquito production but avoiding environmental impacts associated with ditching. OMWM is intended to enhance habitat for the fish that consume mosquito larvae and also increase access for this fish to potential breeding sites. OMWM is intended to at least partially restore water levels to pre-ditching variability. OMWM is therefore often classified as a means of salt marsh restoration (Wolfe, 1996).

There are a variety of implementations to achieve these goals. Adjoining states (such as New Jersey, Connecticut, and Massachusetts) rely on OMWM or OMWM-like methods as primary means of water management for mosquito control (Wolfe, 1996).

There have been several projects that have used OMWM principles or OMWM-like techniques in, such as the plugging of drainage ditches, certain wetlands on Long Island (see, for example, Lent et al., 1990). However, none of these projects have constituted a comprehensive demonstration project of standard OMWM, involving the excavation of fish reservoirs or establishment of shallow spur ditches, especially with the overt intention of demonstrating mosquito control feasibility.

Therefore, as part of the development of its LTP for vector control, Suffolk County would like to institute a wide-ranging, long-term, comprehensive demonstration project of several alternatives of OMWM. The US Fish and Wildlife Service (USFWS) has offered to allow portions of the Wertheim National Wildlife Refuge (WNWR) to be used for this purpose. The County has arranged for suitable technical assistance through its consultant contract for the LTP. The County believes that such a convergence of need, resources, and opportunities will not be available again in the foreseeable future.

The project goal, therefore is to:

> Determine the feasibility of using one or more OMWM techniques in south shore settings as a part of the development of a LTP for mosquito management in Suffolk County. "Feasibility" is a function of:
>
> - Impacts to mosquito populations
> - Stability of post-project vegetation regimes (i.e., the marsh continues to serve as an estuary-land buffer)
> - Acceptable post-project ecological functionality

Both of the proposed OMWM techniques (full ditch plugs and sill plugs) will be assessed in terms of the following objectives (which support the goal and the notion of feasibility, discussed above):

- No Larviciding following OMWM application
- All physical alterations stable
- Appropriate sedimentation rates maintained
- Biological diversity patterns maintained or enhanced
- OMWM maintenance effort equal to or less than that required for ditching

- Fish populations stable or enhanced similar to what Able documented in NJ
- Marsh productivity maintained
- Bird use increased
- River and creek water quality maintained
- Use as nursery grounds unaffected

## 2. Project Background

OMWM is not a particularly new or innovative means of controlling mosquitoes, although it has not been fully implemented on Long Island. The following very briefly discusses Long Island OMWM-like projects and presents some background information on implementations in other jurisdictions.

### *2.1. Relevant LI OMWMs*

#### 2.1.1. Seatuck

In the early 1980s, OMWM pilot studies were conducted at Seatuck NWR. After two years of pre-project monitoring, OMWM alterations were implemented on a test plot and monitored for an additional two years. The study determined that mosquito production was reduced, but not eliminated, without any significant adverse impacts on the marsh. As a result of this study, NYDEC produced a manual of methods for OMWM (Niedowski 2000). Subsequently, the USFWS constructed a tidal creek to further restore this wetland. Most of this marsh no longer breeds significant numbers of mosquitoes, but one section (known as IS-74) continues to require regular larvicide applications.

#### 2.1.2. Sayville

In 1998, ditches were plugged in the County-owned portion of the West Sayville salt marsh in a cooperative project involving Suffolk County, USFWS, DU and NYSDEC. Subsequent monitoring was largely limited to mosquito sampling by SCVC. Mosquito breeding continued, most likely because few spur ditches were constructed and fish reservoirs were limited to existing ditches.

#### 2.1.3 Fireplace Neck

In 1986, the State tidal wetland at Fireplace Neck, west of Mott Lane, was altered using the following OMWM techniques: ditch blockages, spur ditches, and culverts under Mott Lane to restore tidal flow. Pre-project vegetation and physiographic maps were prepared, and mosquito breeding and salinity were monitored by NYDEC for two years post project. In 1994, additional spur ditches and plugs were installed to further reduce breeding. It was apparent that there was no breeding in those portions of the marsh that were accessible to fish, but there remains some breeding in the marsh. Some new pannes were formed, but these stabilized after approximately two years. This project should be revisited as part of the Long Term Plan study, since it appears that the extent of *Phragmites australis* invasion in the marsh has been reduced.

#### 2.1.4 USGS/USFWS Wertheim demonstration projects

In 2001, the USGS/USFWS and the University of Rhode Island began a three-year project to determine impacts from OMWM at NWRs in the northeast US. The sites chosen included Wertheim NWR. The site at Wertheim NWR is located between Area 3 and Area 4. Two data reports have been released to date, but the data has not been analyzed nor have any formal reports on impacts been released (James-Pirri et al., 2001).

### *2.2 Other Jurisdictions*

#### 2.2.1 Connecticut

Paul Capotosto, Director of the Salt Marsh Restoration for the State of Connecticut, reported on Connecticut OMWM at a meeting on Long Island, December 12, 2003.

Connecticut has conducted OMWM for over 15 years as part of its mosquito control program, and also as a salt marsh restoration technique. The State reports that it has been an unalloyed success. Sites where OMWM has been implemented do not require larviciding, and no maintenance of the installed structures is necessary. Connecticut's preferred technique is a full ditch plug with a great deal of constructed open water spaces. Improvements in waterfowl habitat have been the most notable environmental impact.

Connecticut has a rigorous application process. It involves all stakeholders in a project, including those regulators and natural resource protection personnel who may have perceived conflicts (such as bird and marsh vegetation specialists, as gains in bird habitat often occur at the expense of wetlands plant acreage). Following a preliminary design of a project, at least one extensive site visit is made by all of the participants in the review process. The design is then altered, using consensus as the means to ensure optimization.

Many Connecticut OMWMs are made for wetlands reclamation or restoration purposes, rather than as mosquito source control. Other pertinent factors include the high tidal range associated with most of the Connecticut shoreline, and that there are fewer layers of involved government in Connecticut (many of the participants belong to one or another branch of State government; the remainder tend to be federal).

### 2.2.2 New Jersey

OMWM techniques were initially developed in New Jersey in the late 1960s (Ferrigno and Jobins, 1968). Three basic types of marsh alteration in New Jersey include the construction of tidal ditches, ponds, and pond radials. OMWM techniques used in New Jersey are confined to high marsh areas consisting of *S. patens* and *S. alterniflora* vegetation. The standard technique used in New Jersey involve open ditches (Wolfe, 1996).

### 2.2.3 Others

In Maryland, OMWM techniques were implemented on existing grid-ditched marshes. The methods chosen include open tidal OMWM systems, systems with restricted tidal exchange, and closed non-tidal systems. Two high marsh areas in the Chesapeake Bay area were treated with tidal (open), semi-tidal (sill), and non-tidal systems (closed). The closed system was reported to have had the least change in plant community structure when compared to open and semi-tidal systems. *Iva frutescens* invaded some of the sill and open systems of the marsh one year after the excavations (Wolfe, 1996).

In Delaware, more than 28 percent (4,200 acres) of the salt marsh mosquito breeding habitats have been eliminated from aerial chemical insecticide treatment as a result of OMWM activities (Wolfe, 1992). Practices used in Delaware include open tidal OMWM systems with restricted tidal exchange and closed nontidal systems. The type of technique installed on salt marshes is largely determined on the type of mosquito breeding being addressed and the concerns over long-term water quality within the OMWM ponds and ditches. In most of the OMWM techniques deployed in Delaware, physical alterations of the marsh include infrequently flooded or semi-tidal permanent bodies of water in high marsh vegetation. Open tidal ditches are used in a very limited capacity due to the undesirable effects on hydrology and vegetation that may result. Mosquito breeding areas found in large shallow pannes are treated with a sill outlet that removes surface sheetwater during ebb tides. This action eliminates mosquito breeding habitats while still maintaining the groundwater levels within the treatment area. Excavated spoil material is carefully managed to maintain existing vegetation. Excavated spoil material is deposited on site to fill adjacent mosquito breeding potholes, or is thinly spread across the marsh surface (Wolfe, 1996).

## 3. Project Description

### *3.1 Project Setting*

This project will take place at WNWR, a 2,550-acre site on the south shore of Long Island. The Carmans River, a state-designated Wild and Scenic River, enters from the north, meanders through the refuge and empties into the Great South Bay, at the southern end of WNWR. WNWR protects one of the last undeveloped estuaries on Long Island. The freshwater of the Carmans River mixes with the saltwater of the Great South Bay to form a critical area for wildlife. The environment supports a remarkable diversity and abundance of aquatic life**.** The project has been approved by, and will be undertaken with the support and assistance of, USFWS, under whose jurisdiction the refuge is operated.

The project locations are along the east bank of the Carmans River near its confluence with the bay. Generally, the marshes are ditched, and are comprised of nearly monotonic stands of *Spartina alterniflora* (low marsh) and *S. patens* (high marsh). Invasive *Phragmites australis* stands are found throughout the proposed project region. *Phragmites australis* stands are more widespread in Areas 1 and 4 (see below), and are found along some of the mosquito control ditches. However, they are also found in higher elevations of the marshes, especially along the upland interface, where they appear to be promoted by fresh water inflows.

Most of the mosquito control ditches were plugged at various times in the 1980s and 1990s. Many of the plugs have failed, either due to physical processes (erosion caused by tides or storms) or undermining by muskrats. However, some are still effectively retaining water within the marsh during tidal cycling. A three year monitoring project conducted between Areas 3 and 4 (and also including a treatment site on the west side of the River and a control at Smith Point County Park) has just been completed by James-Pirri et al. (2001) (part of a North-East US project covering 11 different sites (three of which are on Long Island), sponsored by USFWS and US Geological Survey [USGS]).

The marsh is an active breeding area for salt marsh mosquitoes, although some other species breed in the refuge as well. Suffolk County Vector Control and USFWS conduct weekly larval monitoring at selected locations. Increases in larval counts (the factors include larvae numbers and age class; past spray history; tide condition, marsh drying or flooding; and air temperature) result in aerial applications of larvicides (either methoprene or Bti). WNWR has also been included in one aerial adulticide application since 1999, intended to prevent West Nile virus infestations in the Bellport-Brookhaven-Mastic-Shirley area.

### *3.2 Proposed Treatments Vector Control*

A site design team reviewed aerial photography, mosquito breeding site maps, a topographic survey with elevations, and salinity data to propose the following alterations for these two areas at Wertheim. The proposed alterations to these marshes include the addition of sill plugs, full plugs, shallow spurs, and fish reservoirs. These alterations are recommended based on existing mosquito breeding sites and anticipated new sites that would develop once the marsh hydrology is restored. This combination of techniques will ensure a greater chance of project success resulting in reduced mosquito breeding and associated pesticide used on these marshes. This is a draft with the final design requiring fieldwork and input from all interested parties.

Please note the following:

- Spurs are designed to provide fish access to all potential breeding sites within the marsh while not significantly altering the height of the water table. They are the key design feature utilized for providing mosquito control. The use of the term "spur" refers to a very shallow ditch coming off the main ditch or coming off a fish reservoir, without significantly altering the water table within the marsh. When a spur emanates from a fish reservoir it is typically referred to as a radial ditch. The number of spurs will be noted in the panel alteration sections, though some come off the ditches directly.

Spurs will be approximately six inches deep and six inches in width. Although much shallower than traditional ditches, this depth is adequate to allow fish access and to prevent spurs from drying out. Spurs are to be constructed using rotary ditchers set to the appropriate depth, and will be on either semicircular or trapezoidal profile.

Spurs are never connected to each other or to another ditch; thereby avoiding complete drainage of a panel should a plug fail. It is expected that those existing ditches, which remain, will function as spurs;

- Sill and full plugs are to be constructed at a minimum of 75 feet in length. Their placement and width will be determined by field assessments that consider their optimum size in order to minimize erosion;

- Full plugs will be constructed with plywood added on its side facing the main water body, usually the Carmans River, facing west. The height of the plug is equal to the height of the *S. patens* marsh and this technique is featured in Area 2;

- Sill plugs will have pieces of plywood added to both ends to minimize erosion of the sill to a lower elevation than desired. The height of the sill is set by the height of the plywood. The height of the sills is expected to be 0.25 feet below the marsh surface, half the typical 0.5 feet used due to the low tidal amplitude. Surface elevations must be re-examined in order to finalize the height of sills. Sills are not expected to have a lot of vegetation associated with them due to their low elevation, therefore they will resemble existing ditches, only shallower;

- Fish reservoirs are recommended with a minimum of 200 square feet in surface area and 2 feet in depth (unless a narrower one is suggested in some ditches). This is in order to provide a refuge for fish during low tides and is considered too deep for predation by wading birds. There should be 10 feet of slope on at least one side, a 3/1 slope, with featheredges, and be irregularly shaped to take advantage of the immediate environment. These reservoirs are to be excavated primarily in *Phragmites australis* areas. Placement considerations include low-lying areas which are near actual and potential breeding sites. Reservoirs will be constructed by either widening existing ditches into adjacent *Phragmites australis* areas, by excavations in *Phragmites australis* where there is no ditch nearby or widening and deepening existing ditches if there are no *Phragmites australis* areas suitable for excavation;

- Use of each particular kind of equipment will hinge on minimizing movement of the equipment to transport excavated material. Most excavated material will be used to plug ditches. In some instances, excavated material can be spread in a thin layer over *Phragmites australis* areas if it is not needed elsewhere and if this will minimize damage due to transport of material;

- If any berms exist that, upon further investigation, represent barriers to fish passage, these berms will be broken through with a small spur.

Numbers have been assigned to each ditch and "panel" of marsh. The alterations can be organized by ditch number (plugs, sills, most fish reservoirs) and by panel (spurs, some fish reservoirs). An Arcview project is being prepared using digital orthophotography that shows the current situation and each alteration assigning attributes (numbering, descriptions) to each alteration. In final form, it will be possible to view the plan using Arcview and to click on each alteration for more information. The use of Arcview will also facilitate revision to the design.

3.2.1 Area 1 (sill ditches)

1. Area 1 has a dryer marsh surface than Area 2. In spring, this area floods with approximately 2 feet of water on the marsh;

2. Area 1 has more fresh water input than Area 2 and as a result has greater coverage of *Phragmites australis* than for Area 2.

3. It is important for the pannes at low tide to be either dried out or to have fish access.

4. Depth of the spurs should be below the top of the sill.

5. See Ditch 8 below. For a recommended activity out of the study area which is bounded by the "easterly tidal creek";

6. In Area 1, the possibility of excavating a ditch along the *Phragmites australis* edge to the immediate east of the upper ditches was not recommended based on a high maintenance requirement and the probable lack of salt marsh mosquito production in this area.

3.2.1.1 Area 1 Ditch Alterations

<u>Ditch</u>

| | | |
|---|---|---|
| 1 | *NOW* | The sill plug is 80 feet from mouth and in good condition. Looking from end of ditch, filled in with *Scirpus americanus* and *Phragmites australis* on edges. Water level at high tide was 10 inches below top of plug. Distinct end of ditch is 50 feet from tree line. |
| | *ACT* | Remove plywood from the sill plug to prevent freshwater buildup. |
| 1a | *NOW* | Ditch runs north-south. Sill plug is 5 feet wide with no distinct ditch visible. Entire area is heavy with *Phragmites australis*. |
| | *ACT* | No alterations recommended. |

| | | |
|---|---|---|
| 2 | *NOW* | Mouth is 6 feet wide with heavy *Phragmites australis* on edges. Sill plug is in poor condition with *Phragmites australis* on it. Ditch is 4 feet wide at intersection with Ditch 1a. Ditch ends 100 feet east of this intersection with no distinct end and trailing off into *Phragmites australis* stand. |
| | *ACT* | Remove plywood. |
| 3 | *NOW* | Sill plug is approximately ½ the way up the length of the ditch. Ditch is filled with dead *Phragmites australis.* Water flows easterly. Terminus is in heavy *Phragmites australis* area. Area beyond the easterly plug is totally overgrown with the ditch choked off. |
| | *ACT* | Ditch alterations begin here. Locate and reinforce sill plug inland approximately 75 feet east from where the widened open ditch ends coming off of the Carmans River. One fish reservoir is recommended on easterly side of the ditch in low-lying area. |
| 4 | *NOW* | Soil plug exists 30 feet from mouth. Thinner *Phragmites australis* with low vigor surrounds the middle of the ditch along with *S. patens* and *Distichlis spicata* in a low-lying area. During the falling tide, water flows westerly. The terminus, located in *Phragmites australis,* is approximately 70 feet from tree line. |
| | *ACT* | Rebuild existing plug as a sill plug. The one fish reservoir, is recommended in middle of ditch to allow fish access through light Phragmites *australis* area and then into *S. patens* area. |
| 5 | *NOW* | Mouth is approximately 12-15 feet wide with *Phragmites australis* and *Iva frutescens* on banks and also in mid section of ditch, 60 feet from the mouth. No plug is visible at the mouth, where *Iva frutescens* and light *Phragmites australis* is growing in the center of the ditch. Ditch is approximately 4 feet wide. There may be a berm along this ditch. Tide is visibly running west. Distinct |

terminus trails off into heavy *Phragmites australis* and *Iva frutescens*, 300 feet west of the tree line.

*ACT* Relocate sill plug east of where the widened open ditch ends. Recommend one fish reservoir located in the low vigor *Phragmites australis* area at the east end of the ditch.

6 *NOW* Mouth is 6-7 feet wide in heavy *Phragmites australis*. The sill plug is in good condition located 30 feet from mouth with *Phragmites australis* and *Iva frutescens* growing behind it. Water is flowing westerly. 120 feet east of mouth has low banks with a ditch width of 2-3 feet, and with light *Phragmites australis*, Iva *frutescens*, and *S. patens*. The terminus of the ditch trails off into *Phragmites australis* and *Scirpus americanus*.

*ACT* Sill plug does not need much work. Two fish reservoirs are required due to the length of the ditch into heavy areas of *S. patens* in both panels 6 and 7.

7 *NOW* Mouth is 4-5 feet wide with banks lined with heavy *Phragmites australis*. Sill plug is in moderate condition 60 feet from mouth, approximately 3.5 feet wide, and covered with *Phragmites australis*. Only one area, from fish station D-8 to 70 feet west of mouth is devoid of *Phragmites australis* in which *Scirpus americanus, S. patens, S. alterniflora*, and *Distichlis spicata* exist. Terminus of ditch is in an area of *Phragmites australis*, S. *patens*, and *Scirpus americanus.* Water is flowing westerly.

*ACT* Reinforce existing plug. Two fish reservoirs are required due to the length of the ditch and access into low-lying *S. patens* areas.

8 *NOW* Ditch is 10 feet wide at mouth surrounded by heavy *Phragmites australis.* The sill plug, located 50 feet east of mouth, is in poor condition. *Phragmites australis* is growing behind this plug in an area with muskrat activity. At mid-length of ditch, with low banks, is a large amount of *Scirpus americanus* on the north side of the

ditch and a moderate amount of *Phragmites australis* otherwise. At the terminus, which is 3-4 feet wide, is a heavy *Phragmites australis* growth. Water is flowing westerly.

*ACT* Relocate westerly sill plug further up ditch since ditch has widened. One fish reservoir is located on easterly side in low area to service *S. patens* in the panels north and south of this ditch, but vegetation needs to be further assessed on easterly side to make sure *Scirpus americanus* is not evident, therefore not warranting fish access into this kind of vegetation. Also, need to observe the water flow on easterly side near "easterly tidal creek" to determine need for additional sills, one possibly east of study area and a second one south off the easterly portion of the ditch into the beginnings of this tidal creek or what looks like an outline of a ditch.

9 *NOW* Mouth is 2 feet wide. Water is finding its way around the westerly sill plug with erosion occurring. Sill plug with board and soil is 100 feet west of Carmans River. Ditch is very narrow at less than 1 foot wide in spots. Terminus is approximately 500 feet from the tree line choked with *Phragmites australis*. Water flow is visible, flowing westerly with tide.

*ACT* Relocate westerly sill plug easterly due to poor conditions northwest of ditch going into panel 9. Locate one fish reservoir near the center of the ditch to provide fish access into low-lying *S. patens* area.

10 *NOW* Light *Phragmites australis* with *S. patens and S. alterniflora* exists 300 feet from the sill plug going easterly, where ditch narrows to 2-3 feet wide. There is remnant of sill plug on easterly side in poor condition, moderately holding water 60 feet from junction with small pool 10 feet in diameter. Dry area exists around easterly end of ditch.

*ACT* Reinforce westerly sill plug. Relocate easterly sill plug to west of current one, with fish reservoir excavated immediately adjacent, on the west side of this newly created sill plug.

11 *NOW* Sill plug is 25 yards from mouth with the ditch 3 feet wide. 300 yards from Carmans River a berm begins on the northern side of the ditch. Approximately 300 yards west of the tidal creek a large stand of *Phragmites australis* is on south side of ditch with a small berm; a smaller amount of *Phragmites australis* exists on the north side of the ditch. The easterly sill plug is 25 yards from the easterly tidal creek at about 8 feet in length.

*ACT* Reinforce the westerly sill plug and relocate the easterly sill plug closer to tidal creek. Recommend one fish reservoir to be constructed in *Phragmites australis* area. To prevent leakage from panel areas, create two short full plugs going south into panel 12.

3.2.1.2 Area 1 Panel Alterations

For more in depth current condition of these panels, refer to the current ditch information above, noting that each panel's area is set by a ditch above and below it.

<u>Panel</u>

1 *NOW* There is a short ditch, approximately 50 feet long, with one plug half way up this panel. Probably no breeding of salt marsh mosquitoes, based on the heavy *Phragmites australis* vegetation.

*ACT* No alteration.

1a *NOW* Probably no breeding of salt marsh mosquitoes, based on the heavy *Phragmites australis* vegetation.

*ACT* No alteration.

2 *NOW* Probably no breeding of salt marsh mosquitoes, based on the heavy *Phragmites australis* vegetation.

*ACT* No alteration.

3 *NOW* Heavy *Phragmites australis* vegetation. Muskrat mound exists in panel.

*ACT* Panel alterations begin here. Connect spur 3S1 to open ditch west of plug on Ditch 3 in order to provide fish access to low areas not suitable for plugging. 3S2 is a long spur connecting the low area to the one fish reservoir that comes off of Ditch 3. Recommend no fish reservoir within panel and a total of two spurs.

4 *NOW* Low area with *S. patens* throughout panel especially on the easterly side.

*ACT* Two spurs (4S1 and 4S2) off Ditch 3 on easterly side utilize low area for fish access into panel. Construct one fish reservoir within the western part of the panel to provide fish for low areas and spurs 4S3 and 4S4 into *S. patens* area. Spurs 4S5 and 4S6 provide access for fish from ditch into low areas. Recommend a total of six spurs.

5 *NOW* Heavy *Phragmites australis* on the westerly side with *S. patens* one-quarter of way into entire panel and continuing throughout the rest of the panel going west.

*ACT* Have spur from fish reservoir off of Ditch 5 cut through *Phragmites australis* area to allow fish into *S. patens* area. Spur 5S2 allow fish access from ditch into panel. Spurs 5S3 and 5S4 allow access from fish reservoir off of Ditch 5. This panel has fish reservoirs coming off of the Ditch to its north (Ditch 4) and from its south (Ditch 5). Recommend a total of four spurs.

6 *NOW* Heavy *Phragmites australis* east of Carmans River and extending half way up both Ditch 5 and 6, filling out with *S. patens*.

*ACT* Place one fish reservoir approximately 60 feet from Carmans River with spur 6S3 from fish reservoir cutting into mosquito breeding and low-lying areas. Spread excavated material over *Phragmites* *australis* in area if not need for sill plugs. Spurs 6S 1, 2, 4 and 5 allows fish into low areas utilizing existing depressions. Recommend a total of five spurs.

7 *NOW* *Phragmites australis* stand exists next to breeding locations on westerly section of this panel. "Pot holes" exist throughout this panel.

*ACT* Recommend one fish reservoir placed on the *Phragmites australis* stand next to breeding locations on westerly side of panel. Spurs 7S4 and 7S5 from the fish reservoir are connected to these breeding areas. Recommend a total of ten spurs, some going into the "pot holes".

8 *NOW* Heavy *Phragmites australis* vegetation east of Carmans River extending along Ditch 8. Heavy breeding areas throughout panel are illustrated in completed GPS of this panel. Have shallow pannes on upper portion of panel.

*ACT* Recommend one fish reservoir constructed in *Phragmites australis* area in western part of panel with spurs into low-lying areas. Recommend a total of nine spurs.

9 *NOW* On westerly side, Carmans River is making inroads into this panel. There is heavy *Phragmites australis* vegetation in this low-lying area due east of Carmans river and along more than half of Ditch 8.

*ACT* Recommend one fish reservoir situated just east of this Carmans River finger in *Phragmites australis* area, with spurs going into *S. patens* area. Northerly spurs from Ditch 8 to be cut through low-lying depressions in this panel. Recommend a total of nine spurs.

10 *NOW* Heavy *Phragmites australis* east of Carmans River and up along Ditch 9. *S. patens* dominate this panel.

*ACT* In western portion of panel, create three spurs emanating to patens areas from the one fish reservoir. Recommend a total of ten spurs, all going into low-lying *S. patens* areas.

11 *NOW* First time see less of *Phragmites australis* east of Carmans River and instead takes up solid portion of easterly side of panel and going west along Ditch 11.

*ACT* Westerly fish reservoir due east of Carmans River in *Phragmites australis* stand with four spurs into mosquito breeding and low-lying areas with the second fish reservoir in the eastern section. Its twelve spurs are cut low areas.

12 *NOW* In this narrow panel, *S. patens* east of Carmans River exist and then *Phragmites australis* takes over.

*ACT* Recommend two short plugs.

3.2.2 Area 2 (full ditch plugs)

1. Area 2 has greater coverage of *S. patens* than Area 1. There exists a greater coverage of *Scirpus americanus* and *Iva frutescens*. Some *Pluchea purpurascens* is also apparent around Ditch 2.

2. From the terminus of Ditch 1 going south, the easterly side of this area is bounded by a tidal creek.

3. An outline of an old, filled in ditch exists between ditches 4 and 5 below, and runs parallel to Ditch 2.

4. Minimum of two plugs per ditch.

5. Recommend that the length of some of the easterly plugs be longer than 75 feet due to both a large proportion of soft *S. patens* nearby and proximity to the tidal creek.

6. The height of the plug is equal to the height of the marsh surface.

7. Recommend fewer fish reservoirs in this area as opposed to Area 1.

3.2.2.1 Area 2 Ditch Alterations

<u>Ditch</u>

1 *NOW* Failed plug 10 yards east of mouth. Ditch width is 18-24 in with clumps of *S. patens* vegetation. Three berms exist. The easterly plug is approximately 25 feet in length, large, in good condition, and 100 feet from terminus. *Phragmites australis* exists on east end of ditch for 30 yards then for 40 yards going west, on the south side only. On the northern side for these 40 yards are *Scirpus americanus* and *S. patens*. Going west 35 yards from the *Scirpus americanus* edge, the vegetation turns to *S. patens* with the *Phragmites australis* thinning out. Some *Iva frutescens* is present. *Phragmites australis* ends on both sides but *Scirpus americanus* appears 20 yards west of mouth on the north side and 40 yards from the mouth on the south becomes mostly *S. patens*. Terminus at tidal creek is 50 feet in diameter. 100 yards west of tidal creek, ditch opens up to 30 feet long, 10 feet wide pool.

*ACT* Recommend the easterly plug's reinforcement to 100 feet in length because it is in a soft patens area and also near the tidal creek. Reinforce westerly plug. Recommend two fish reservoirs, one approximately 25 yards east of mouth and the second one located where ditch opens up into pool.

2 *NOW* Very large mouth where *Phragmites australis* exists on south side

and tall form *S. alterniflora* is on the north side, then leading into *Phragmites australis*. The westerly plug is in good condition and is 30 yards east of mouth, where *Phragmites australis* ends, and both sides are taken up by *Pluchea purpurascens*, *S. alterniflora*, and *S. patens*. Berm is on the north side. Ditch flows at both ends and is wide in spots. *Phragmites australis* chokes off ditch west of eastern plug. The easterly plug is 30 yards from tidal creek in area of *S. alterniflora*, *Scirpus americanus*, and *Iva frutescens*.

*ACT* Recommend cleaning out ditch by making deeper with one narrow fish reservoir in middle of ditch. Recommend the reinforcement of the easterly plug to 100 feet length because it is in a soft *S. patens* area and just west of a tidal creek. Reinforce westerly plug.

3 *NOW* Water flows from east to west. The westerly plug is 30 yards from Carmans River and is moderately working. Ditch opens up to a pool on the north and south side surrounded by *Phragmites australis* 10 yards west of the plug. Easterly plug is 20 yards from tidal creek. *S. patens* and *S. alterniflora* runs from plug to tidal creek. Going 30 yards west of this plug, *Phragmites australis* is on both sides of the ditch for 20 yards. Berms on south side 100 yards from the *Phragmites australis* area heading west.

*ACT* Reinforce both plugs. Recommend placement of one narrow fish reservoir in low-lying area on the easterly side of ditch beyond *S. alterniflora* and some *Scirpus americanus* into an area of *Phragmites australis*. Recommend second fish reservoir approximately 0.4 of the total distance of the ditch from the mouth of the ditch.

4 *NOW* The moderately working western plug is 30 yards from mouth, a mouth which is 10 yards wide. A 10 inch diameter pool is 5 yards west of plug. Two small pools are 50 yards east of mouth and 5 feet in diameter. Seventy-five yards east of mouth, ditch opens up to 5 feet diameter pool. Monotypic *Phragmites australis* stand

continues until 175 yards east of mouth. Fifty yards going east of the end of this *Phragmites australis* stand is the middle plug. The working easterly plug is 15 yards west of tidal creek in *Phragmites australis* stand. Berm on south side.

*ACT* Reinforce all three plugs. Recommend one narrow fish reservoir on the easterly site of ditch and second plug located approximately 1/3 of the total distance of the ditch east of the mouth.

5 *NOW* The mouth is 25 yards wide. The westerly plug has failed. The failed easterly plug is 18 yards from tidal creek and is 4 feet x 4 feet. The west side of this plug opens up to a small pool. The easterly end of this ditch is in *S. patens* area with evidence of muskrat damage. Monoculture of short form of *S. alterniflora* is 50 yards west of this plug. Then there is a *S. alterniflora* and *S. patens* mix 150 yards west of this plug. The working middle plug is approximately 200 yards from easterly plug. At this plug, the water flows easterly, west to east but 100 yards west of this middle plug, the water flows in the opposite direction, east to west towards the Carmans River. At this juncture, the north edge of ditch becomes a *Scirpus americanus* and *S. alterniflora* mix into *Phragmites australis*. Approximately 135 yards west of the middle plug, *Phragmites australis* dominates both sides of the ditch heading west.

*ACT* Reinforce easterly plug at 100 feet in length and reinforce the other two plugs. Recommend one narrow fish reservoir in small pool that is on the west side of the easterly plug and a second fish reservoir located just east of the westerly plug.

6 *NOW* Four plugs in this ditch. The mouth is 15 yards wide. The working westerly plug is 45 yards east of mouth. Starting at the mouth, there is *S. alterniflora* on the north and south sides of ditch. Approximately 25 yards east of mouth, short form *S. alterniflora* is on the south side and tall and short form S. alterniflora with *Iva*

| | | |
|---|---|---|
| | | *frutescens* is on the north side of the ditch. The second plug, 125 yards east of mouth, is okay. At this point, there are S. patens on north side of ditch for 30 yards. Approximately 220 yards east of mouth, there's small *Phragmites australis* stand with *Scirpus americanus*, *S. patens*, and short form *S. alterniflora*. The third plug is 240 yards east of mouth. The working easterly plug is 270 yards east of mouth and 20 yards west of the tidal creek. Water flow is west to east. There's evidence of muskrat damage on easterly side. |
| | *ACT* | Reinforce three plugs, possible elimination of one of the plugs. Recommend one fish reservoir north of *Phragmites australis* area, approximately half way between the third and the fourth plugs. |
| 7 | *NOW* | The remaining ditches are much narrower than the ones north of Ditch 7. There are only two plugs here with the westerly one 15 yards from the mouth of the ditch. Mouth is 10 feet wide. Water flows from west to east. The easterly plug is 6 feet wide, 10 feet long and covered with *Iva frutescens*. There is evidence of muskrat damage. Ten yards west of tidal creek is *Iva frutescens* on north side and *Phragmites australis* on south side. Forty yards west of tidal creek is short form *S. alterniflora* and *S. patens* mix on both sides. Eighty yards west of tidal creek is a 15 yard stand of *Phragmites australis*, followed by 20 yards of S. patens going west and then 20 yards of *Phragmites australis* west of *S. patens.* |
| | *ACT* | Recommend one fish reservoir little more than half way along the ditch from the mouth of the ditch. Reinforce both plugs. |
| 8 | *NOW* | Mouth of ditch is 7 yards wide. The working western plug is 20 yards east of mouth. *S. patens* and *S. alterniflora* mix exists on both sides of the ditch 50 yards east of plug. The easterly plug is 3 yards west of tidal creek, 8 feet long and 24 inches wide. |
| | *ACT* | Reinforce both plugs. Recommend spur off ditch to break berm and use existing ditch as fish reservoir. |

9 *NOW* Western plug is 15 yards from mouth. There is short form *S. alterniflora* and *S. patens* mix on both sides of ditch. Narrow ditch is 30 inches wide. The easterly plug is 5 yards from tidal creek and blends into marsh surface.

*ACT* Reinforce both plugs. Recommend use of existing ditch as fish reservoir.

10 *NOW* Mouth is 8 feet wide. Western plug is 10 yards east of mouth. *S. patens* and *S. alterniflora* exist on the north and south sides of ditch. The easterly plug is 25 yards west of tidal creek and 4 feet long by 5 feet wide.

*ACT* Need to check condition of plugs and existence of berms before decide on plan of action but doubt fish reservoir will be needed.

11 *NOW* Mouth is 11 feet wide and western plug is 20 yards west of eastern plug, which in turn is 5 yards west of tidal creek and 5 feet long by 3 inches wide. There is short form *S. alterniflora* and *S. patens* mix on both sides of the ditch.

*ACT* Need to check condition of plugs and existence of berms before decide on plan of action but doubt fish reservoir will be needed.

3.2.2.2 Area 2 Panel Alterations

For more in depth current condition of these panels, refer to the current ditch information above, noting that each panel's area is set by a ditch above and below it.

<u>Panel</u>

1 *NOW* Easterly side is an area of soft *S. patens*.

*ACT* Recommend one fish reservoir approximately 45 feet east of the tidal creek which separates Area 1 from Area 2 in a large *Phragmites australis* stand. Recommend seven spurs.

2 *NOW* Narrow panel area with soft *S. patens*.

*ACT* Recommend five spurs and no fish reservoir.

| | | |
|---|---|---|
| 3 | *NOW* | Low-lying depressions. |
| | *ACT* | Recommend no fish reservoir and 14 spurs. |
| 4 | *NOW* | On westerly side next to Carmans River have large *Phragmites australis* stand. |
| | *ACT* | Recommend one fish reservoir located at easterly edge of *Phragmites australis* stand and 18 spurs. |
| 5 | *NOW* | Remnant of old ditch within panel. |
| | *ACT* | Recommend one fish reservoir and upon inspection of the old ditch, spurs into this ditch to allow fish access if warranted, and a total of 20 spurs. |
| 6 | *NOW* | Soft *S. patens* on easterly side. |
| | *ACT* | Recommend many spurs off Ditch 6 into easterly side of panel with a total of 12 spurs and no fish reservoir. |
| 7 | *NOW* | Some *Phragmites australis* in middle of panel around Ditch 7. Starting with this panel going south, a branch of the Carmans River is featured prominently on the easterly side of the panels. |
| | *ACT* | Recommend no fish reservoir and a total of five spurs. |
| 8 | *NOW* | Some *Phragmites australis* in northerly part of panel around Ditch 7. |
| | *ACT* | Recommend no fish reservoir and a total of three spurs. |
| 9 | *NOW* | Small area. |
| | *ACT* | Recommend no fish reservoir and a total of one spur. |
| 10 | *NOW* | Small area. |
| | *ACT* | Need to check condition of plugs in Ditch 10 and existence of berms before decide on plan of action. At the moment, cannot recommend a fish reservoir or a spur. |
| 11 | *NOW* | Small area. |
| | *ACT* | Need to check condition of plugs in Ditches 10 and 11 and existence of berms before decide on plan of action. At the moment, cannot recommend a fish reservoir or a spur. |

### 3.2.3 Control Sites

Area 3 and Area 4 will not be altered, but will serve as control sites.

## 4. Pre-project Monitoring Program

The project team (Suffolk County Department of Health Services, Suffolk County Vector Control, Ducks Unlimited, WNWR staff, and Cashin Associates) have established a rigorous pre-project sampling regime. This approach is intended to establish many baseline metrics from which impacts of the treatments can be determined. The initial data report for 2003 has recently been completed (CA-CE, 2004). In addition, USFWS and USGS have recently completed a three year monitoring effort, also intended to determine impacts of OMWM on ditched marshes (James-Pirri et al. 2001). Although the latter program is not as rigorous or comprehensive as the project team effort, it is expected that certain similarities in monitoring techniques and the geographical closeness of the two efforts will allow USFWS/USGS data to be usable for this project.

### *4.1 LTP Monitoring Efforts*

Table 4-1 lists the monitoring approach adopted by the project team. Some of the pertinent details on the effort are given immediately below, but a full account is found in CA-CE (2004).

Transects were identified across each Area, using the USFWS/USGS protocols. Twenty-four stations were established in each of Areas 1 and 2, and 20 stations were established in Areas 3 and 4, for a total of 88 marsh surface stations. In addition, 10 ditch sampling points ("fish stations") were established, again using the USFWS/USGS protocols. Suffolk County Department of Health Services also established six permanent Carmans River water quality monitoring stations (one associated with each Area). Figures 4-1 – 4-4 show station locations.

#### 4.1.1 Biological Sampling

Mosquito Breeding Concentration Areas

Mosquito breeding concentration areas were identified throughout the four areas of the marsh in September. For a period of four weeks, the areas were visually inspected five times for small pools of stagnant water that might contain mosquito larvae. A selection of the pools was sampled with a mosquito dipper. The larvae collected in the dipper were counted and recorded. Each location containing mosquito larvae was flagged and the GPS coordinates were documented. The data were used to define locations of concentrated mosquito breeding.

Mosquito Dip Transects

Mosquito larvae were sampled during a period of six weeks in September and October. Larvae were sampled every 15-20 m along each transect in all four marsh areas using a mosquito dipper. At each sampling location, the nearest standing water within a 3 m radius was noted. If standing water was present within a 3 m radius, the edges of the standing water were sampled with the mosquito dipper. If a full dipper of water was not possible, the volume increments inside the mosquito dipper were used to estimate the water volume collected. The larvae collected in the mosquito dipper were then counted and recorded.

Vegetation Quadrats

In order to detect differences in the vegetative community composition and abundance, vegetation quadrats were placed at 88 stations in all four areas of the marsh, following USFWS/USGS protocols. The vegetation was sampled once toward the end of the growing season in October, when plants were easily identifiable. The total number of times each species was recorded was tallied for each quadrat. All vegetation quadrats were sampled within one to two weeks and during a period when the marsh surface was not flooded.

Vegetation Biomass

Vegetation biomass sampling was also conducted. Half of the stations were sampled for above-ground vegetation mass, and a quarter was sampled for above-ground and below-ground mass. The samples were selected randomly (stratified by area).

A 10 cm ring was placed at each above-ground biomass station to determine the vegetation plot to be sampled. The live vegetation within the plot was clipped at ground level and bagged separately from any dead vegetation. The samples were dried and the weight of the non-refractory material determined.

Soil biomass samples were collected using a 5 cm core sampler. Live vegetation above the plot at ground level was clipped. The core sampler was driven into the marsh surface to a depth of 30 cm below ground surface. The soil was extracted from the core and placed in individual labeled bags. The samples were dried, and the non-refractory mass determined.

Nekton Sampling

Nekton sampling was conducted at all fish stations located throughout the four marsh areas in October, following USFWS/USGS protocols. A total of 40 samples were collected using a ditch net. Any nekton caught were identified, counted and measured.

Invertebrates

Invertebrates are commonly used as a measure of overall habitat function and health. Invertebrate samples were collected from three different areas: marsh surface; mosquito ditches (water column samples); and mosquito ditch sediments (benthic samples).

Twenty-six marsh surface samples were collected at randomly selected stations in October 2003 (the stations were stratified by area, and then again by vegetation type: *Phragmites australis*, low marsh, high marsh, with one *Phragmites australis* and two samples each from high marsh and low marsh taken from Areas 2 and 3, and two *Phragmites australis* and three samples each from high and low marsh taken in Areas 1 and 4). Sessile and motile organisms from the shallow soil layer and the standing vegetation were sampled. All specimens caught were preserved in 91% alcohol for later identification.

The water column was sampled at 28 fish stations in November (seven randomly selected stations in each area). Samples were collected by net (500 micron mesh). Twelve net-sweeps were performed along a one-meter length segment above the benthos at each sampling station. The contents of the net were emptied individually into five-gallon buckets and transported to a lab where they were processed in sorting trays. The invertebrates that were captured were stored in 91% alcohol for later identification.

Benthic samples were collected from the same 28 fish stations in early December. A screened dipper, 10 cm in diameter (0.5 mm mesh), was used to collect samples at the top 5 cm of benthos. Three replicate samples were taken from every station and stored in individual plastic bags. The samples were taken to a lab where they were processed. All invertebrates observed were removed and preserved in 91% alcohol for later identification.

Invertebrate Analysis

Specimens collected from each invertebrate sample (marsh surface, water column, and benthos) were identified by a taxonomist with the use of a dissecting microscope and magnifying glass. Each invertebrate was identified to the family level using standard reference guides (Weiss, 1995; Borror and White 1970; Emerton, 1961). Six specimen were identified by Robert Cerrato and his laboratory, Marine Sciences Research Center, Stony Brook University.

Marsh Composition

Those intimately familiar with the wetlands through field work will use large-scale aerial photographs of the Areas and delineate the extent of low marsh, low-marsh-high marsh mixed vegetation, high marsh, and *Phragmites australis*. The areas associated with the *Phragmites australis* mapping will be compared to an analysis of *Phragmites australis* conducted at WNWR in 2001 (Batcher, 2003). The areas mapped for each of these four vegetation groups will be calculated.

Bird Observations

The bird fauna within the refuge have been continuously observed and documented. The marsh lies along migration corridors used by shorebirds, raptors and songbirds. In addition, the refuge supports nine federal and/or New York State designated endangered/threatened avian species. Through anecdotal observations, approximately 22 species of birds have been observed in the marsh. The most abundant species observed include black duck and a variety of shore and wading birds. Tree and barn swallows are very common during migrating season. During September and October, swallows were observed in flocks of hundreds. An immature bald eagle has wintered at the Refuge the past several years.

### 4.1.2 Physical Sampling

Ditch Qualities

There are 43 delineated mosquito ditches within the four Areas. The ditches vary in width, but are constructed uniformly east to west in all areas, except in Area 4 which contains a crisscross ditch network. A visual inspection of all the mosquito ditches was performed in late fall, and general characteristics of the ditches were recorded. These included accounts of the plugs, which were classified as "working" (retaining water), "moderate," or "failed." Major features were recorded by GPS coordinates. This survey of the ditches was augmented in the early winter, when a complete photographic log of the ditches was completed.

It should be noted that most of the plugs in Area 4 were determined to have failed; most of the plugs in Area 1 were characterized as moderate; and most of the plugs in Area 2 and 3 were listed as working.

Water Flows

Ditches are constructed to carry water from the marsh to the estuary. However, it cannot be assumed that flows actually follow the shortest path to the River. Therefore, a variant of drift cards was used in an attempt to determine general flow patterns in the ditches, but icing of the ditches prevented completion of the experiment at this time. The attempt will be repeated in warmer weather. In addition, those ditches that mostly empty at low tide will be assessed to determine the nature of the residual water remaining in the ditch, as a check on fresh water inflow sources.

Fresh Water Sources

In addition to the salinity surveys discussed below, all ditches will be observed at low tides. Those with residual flows will be tracked to determine if upland fresh water sources are the cause.

Sedimentation

To quantify surface deposition on the marsh surface, marker horizons were established. Feldspar clay was chosen for the marker in this project because it is easily distinguishable from the surrounding sediment and forms a cohesive layer once wetted.

In October, marker horizons were placed at the 88 stations on the marsh surface. The marker horizons were positioned 2 m southeast from the monitoring well at each station. This location relative to the wells was chosen because it was generally away from station-to-station pathways, and yet close enough to a defined point that the horizon should be recoverable in the future. All marker horizon locations were documented and recorded using GPS.

Water Table Height

Water table measurements have been collected using the 88 temporary groundwater monitoring wells in all four marsh Areas, following USFWS/USGS protocols. The monitoring wells are constructed of 4 cm PVC pipes, 70 cm in length (60 cm installed below the marsh surface). Holes were drilled into the pipe to allow water to percolate into the well. The top 10 cm of the pipe was left intact to prevent surface water from entering the well. The wells were capped with PVC caps.

The height of the water table was measured by meter stick (by contact with the water in the well). Measurements made included the distance to water and the amount of well extending above the marsh surface. Relative distances to the water table and, if the height of the well casing is assumed to be constant, absolute water table heights can be calculated.

Water Table Height – relative fresh water inputs

Suffolk County Department of Health Services has installed five standard water table wells, using standard installation techniques. A cluster of wells (one shallow 12 ft water table well, a 110 ft and 150 ft deep Upper Glacial aquifer wells), have been installed along the marsh perimeter access road adjacent to Area 4. Additionally, an 80ft well was installed across the service road opposite the cluster wells. Adjacent to Area 1, a 70 ft Upper Glacial aquifer well has been installed. A 12 ft water table well will be installed northeast of Area 1 along Smith Road. Two additional water wells will be affixed along the marsh perimeter of Area 1 and 4.

### 4.1.3 Chemical Sampling

Carman's River Water Quality

In July, Suffolk County Department of Health Services collected two rounds of samples at the four stations on the River. Field parameters were collected (temperature, depth, secchi disk depth, dissolved oxygen, specific conductivity, salinity and flow) and the water samples were analyzed for the Department's full parameter suite (water quality indicators, nutrients, and organic compounds including VOCs, SVOCs, and pesticides and metabolites). A third round from all six stations (including two stations on Big Fish Creek) was collected in November, as part of a quarterly monitoring schedule.

Water Quality Monitoring in Ditches

At each of the fish stations, beginning in October, hand-held YSI multi-parameter and pH meters were used to collect salinity, temperature, conductivity, pH, and dissolved oxygen concentrations measurements. Data have been collected bi-weekly.

Ditch Salinity Surveys

Salinity was measured along the mosquito ditches in November using a YSI meter. Measurements were taken every 30 to 50 m, depending on the length of the ditch. The survey will be repeated at intervals throughout the pre-implementation period.

Water Table/Pore Water Salinity

Soil water salinity was measured at all 88 stations every 10-14 days in September, October and November, following the USFWS/USGS protocol. A soil probe was used to extract water from 15 cm below the marsh surface, and salinity measured by refractometer.

### 4.1.4 Extensions of Current Sampling Program

Continuous Measurement of Ditch Water Quality

Suffolk County Department of Health Services will monitor any deep ditch locations, created as part of the fish habitat improvements of the OMWM installation, using continuous recording water quality sondes. It is anticipated that the sondes would be deployed through a two-week tidal cycle at each such identified location. Parameters recorded by the sondes would include salinity, temperature, conductivity, pH, and dissolved oxygen concentrations. Such measurements are not possible in undisturbed ditches, as the depths are not sufficient and continuous to allow use of the equipment.

Larvicide presence/time series

It is intended that a special sampling run would be made to determine pre-manipulation persistence of larvicide on the marsh and in nearby ditches. In each Area, a pool of standing water and a nearby fish station has been identified. Samples from the pool (taken by mosquito dipper) and from the ditch (taken using USGS techniques to concentrate the sample from the surface film layer) will be taken immediately prior to a larvicide application, immediately after one, and two days following the application. The samples would be analyzed by the Suffolk County Public Environmental and Health Laboratory for pesticides (including Methoprene). It was not possible to conduct this sampling in 2003, but it is intended for 2004.

### *4.2 USFWS/USGS NE US Project Applicability*

James-Pirri, working with USFWS and USGS, is conducting an 11-site assessment of OMWM effects. The project includes three Long Island locations, including a treatment site located between Areas 3 and 4, another on the west bank of the Carmans River at WNWR, and a control site in Smith Point County Park. This project has collected data over a three year period on water table heights, pore water salinity, vegetation composition, fish presence in ditches, mosquito larvae presence, and waterfowl use of the areas. Data from the first two years of the project have been published. The WNWR data should prove to be useful for this project.

### *4.3 Other Data Sources*

USFWS has been collecting mosquito larvae sampling data for approximately ten years from a variety of sampling points throughout WNWR. USFWS has also conducted a variety of sampling efforts, including some invertebrate sampling, that will augment the current project. Cashin Associates recently completed an

Environmental Assessment of the Carmans River for Suffolk County, which can be used to put conditions determined during the project into a long-term context.

## 5. Post Implementation Monitoring Program

### *5.1 Time frame*

The project will be assessed through the end of 2005 under the auspices of the LTP development. Following the completion of the LTP and GEIS processes, the County expects that continued monitoring will occur through the use of "Quarter-percent" funding (set-asides for environmental restoration purposes from the County sales tax, which was used to fund the initial monitoring effort). The non-County monitoring organizations may change following completion of the LTP, depending on legal opinions and County procurement necessities.

It may be that some of the analyses will not be made annually in order to conserve funds. It seems likely, given the "measures of Success" discussed below, that the four-year anniversary of project initiation will be well-monitored in terms of the physical alterations made for the project. Important biological components of the "measures of Success" may be sampled/sub-sampled at five year intervals in order to determine long-term impacts of the project. The physical changes at the site are likely to receive more frequent attention from both USFWS and SCVC as part of workaday needs.

### *5.2 Means of analyses*

The data collected in the project will be available in both raw and processed forms. Data processing will include several means of comparisons. It is most probable that individual parameter variability across time, within-Area stations, and across Areas will be analyzed for trends. Stations may also be analyzed in terms of vegetation types, pore water salinity, distance from ditches or plugs, etc. Comparisons will be made to pre-implementation conditions and to relative changes compared to the control sites.

Appropriate statistical measures will be made, including (as available) measures of significance (using $p<0.05$). It is quite likely that aggregated analysis means will be used for invertebrate analysis, similar to those employed by the RIBS program, for example. Multi-variate statistical analyses seem likely to be fruitful, especially those that generate cluster or factor analyses. These may enable groups of variables to be analyzed together, and to determine if there have been changes in the variables in relation to individual stations, vegetation types, etc., and relate independent variables to dependent variables across treatments.

## 6. Measures of Success

As discussed just above, the effects of the treatments can only be determined in relation to standards of comparison. There appear to be five appropriate grounds for making comparisons:

1. to a maintained ditched marsh;
2. to an unmaintained ditched marsh;
3. in absolute terms;
4. WNWR pre-installation conditions, as determined and measured by both the current project, but also the James-Pirri project and other USFWS research initiatives, as discussed above; and,
5. generally, comparing the treatment areas to the control areas.

What will be tested are the objectives, as outlined above in Section 1.

### *6.1 No Larviciding*

Currently, SCVC does not use solely quantitative means of determining the need for Larviciding. Rather, larvae counts are weighed in terms of larval development stages, spray history, weather, and tides to determine if there appears to be a need for larval control in a particular area. The species (or more than one species) involved is important, especially in terms of local land use (and the potential for impacts to people). Comparisons may be made in terms of historical patterns for a particular site, as when it is noted that in the past a sudden increase in a particular species or instar type has generally led to citizen complaints. The decision may be made in terms of data collected across sites (perhaps the numbers of larvae at a particular site changing in a fashion that is different from other locations in the County, suggesting a different process is controlling larval abundance). The presence or absence of disease threats at the site (or nearby) certainly factors into the decision. At Wertheim, a threshold larval abundance of 0.2 larvae per dip in a given area has been established for larviciding, based on experience at this particular marsh. Maintaining larval abundance below this threshold will be a primary method of determining success in larval control. Partial success would be a reduction in the number of weeks dip counts exceed this number, compared to the previous 5 years for which there is data.

The goal will be that larval abundances at the treated areas will be such that Larviciding will not be required following OMWM installation. Differences in larval counts are expected to occur in the first year, once temperatures rise to levels sufficient for fish to breed, since fish predation should commence once access to the breeding areas is achieved (it is assumed there is always a ready availability of mosquitovorous fish in the vicinity of a salt marsh).

### *6.2 Installed structures stable*

Within Areas 1 and 2, proposed treatments will include sill ditches (ditches plugged approximately 4 to 6 inches below the marsh surface), closed ditches (ditches plugged at the level of the marsh surface), radial channels, and fish reservoirs. It is expected that these features will be both persistent and will not expand.

Persistence for the plugs is defined as the continued failure to transmit water, meaning that breaches will not occur either because of biota or storms. Newly constructed radial channels and reservoirs should not require maintenance in the first two years due to siltation or excessive slumping. Ponds should not be colonized by terrestrial plants, although algal growth and SAV colonization may occur. The plugs should be fully vegetated; not requiring supplemental planting.

By the same token, the created ponds and radials should not be growing in size, either. The surface area of the irregular ponds should not increase by more than 25 percent over the first two years (suggesting that the size of major axes will not increase by more than 10 percent), and should not increase by more than 15 percent over the ensuing two years (years three and four) (axial growth less than 7 percent). The mean width of radials (measured at more than four randomly selected points) should not exceed 25 percent for the first two years, and 15 percent for the ensuing two years. While this means that the structures may increase in size, the increase is not very large, and is bounded in such a way as implies any change will be decreasing over time. However, should measurements of structural growth not exceed the limits above, but still suggest over four years that any growth is not decreasing with time, the County will confer with NYSDEC to determine if this is a fatal flaw.

### *6.3 Sedimentation rates*

It is important that overall sedimentation rates be comparable between the treatment and control areas. Marshes maintain themselves against sea-level rise through the accumulation of sediments. The new sediments may be largely allochthonous (minerals carried in by tides or run-off) in one area and autochthonous (peat derived from plant decay) in another. However, it is the overall rate that is important, given that the manipulation may change the general vegetation patterns at any one sampling point. Important variations in terms of general marsh geography need to be accounted for: interior marsh points at control and treatment sites should be behaving similarly, as should those sampling points closer to the edge of the marsh. It is important to account for changes that may be associated with decreases or increases in underlying peat density due to chemical changes resulting from different water regimes on the marsh, but certainly the maintenance of the marsh surface with general sea level rise must be a primary concern.

### *6.4 General biological diversity patterns maintained*

It is assumed there may be shifts in the species composition of fish, plants, and invertebrates due to the treatments. However, significant impacts will not be determined if general patterns of diversity/composition are maintained. For example, it seems quite likely that the treatment may shift the areas of the marsh comprised of high and low marsh; it is also hoped that the treatment may reverse invasion by *Phragmites australis*. However, the general diversity patterns of vegetation found in low and high marshes should be maintained, although the coverage areas may shift. Mosquitovorous fish are intended to become more abundant, but other species that are determined to use the marshes should not lose habitat access. It is expected that invertebrate assemblages may show a strong link to vegetation or other habitat determinants such as sediment type, and those may shift due to the treatment; but the measures used to appraise the invertebrate communities should not show losses in terms of diversity or overall quality.

### *6.5 Maintenance effort equal to or less than ditching*

It had been standard SCVC practice to maintain a South Shore ditch approximately every 3-5 years. Following installation of the OMWMs, SCVC expects the man-hours typically required for Wertheim under standard ditch maintenance will decrease (exclusive of project-related monitoring). In other jurisdictions, OMWM projects have required little or no maintenance for as long as 20 years.

### *6.6 Fish populations stable or increasing*

As discussed in Section 6.4, although it is expected that fish populations and biomass may change due to treatment, the variety of fishes using the ditches should be maintained. Sampling should indicate use of OMWM ditches by the same fish assemblages using the control ditches.

### *6.7 Productivity of similar vegetation regimes maintained*

Low marsh, high marsh, and *Phragmites australis* all have different levels of productivity at this site (and the levels of productivity may vary by Area due to changes in salinity). It is expected that, if the treatments do change pore-water salinity and overall water table heights, that there may be a shift in the current coverages of low and high marsh and *Phragmites australis*. This may change overall productivity of the marsh. However, if the general productivity of each type of plant regime (as determined for that particular Area) is unchanged, this shift will be deemed to be acceptable.

### *6.8 Bird counts increased*

Currently, anecdotal observations of the avian community are being recorded for Areas 1-4. Such data will continue to be collected throughout the pre-implementation phase of the project. Once the project is completed, the avian use of the site is expected to increase due to an increased diversity of available habitats. Post-implementation monitoring for the avian community could follow the protocol set forth by the USGS/USFWS OMWM study. The USGS/USFWS avian data could reasonably serve as the baseline data necessary to make an objective determination of success.

In addition, it is important that sharp-tailed and seaside sparrow populations be maintained at pre-project levels. This may be determined indirectly through comparisons of the high marsh habitat acreage (since the sparrows require high marsh).

### *6.9 River water quality maintained*

Salt marshes are thought to serve as filters for upland inputs to the estuary. The project will be deemed to have been successful in terms of maintenance of this function if nutrient and organics concentrations in the Carmans River and Big Fish Creek remain relatively stable (that is, in comparison to treatment sites, or in terms of historical data sets).

### *6.10 Use as nursery grounds unimpeded*

As discussed in Sections 6.4 and 6.6, the project is expected to increase the population of mosquitovorous fish in the ditches. However, the project must also maintain use patterns of the ditches by juvenile fish, especially those of commercial or recreational importance. Data from the USFWS/USGS project and from the control sites will be important to determine this, and will likely be assessed in terms of presence/absence rather than counts or biomass data (to avoid complications associated in weather and other more variable affects on the populations).

## 7. Reversibility

The project landowner (USFWS) believes quite strongly that these alterations cannot be "reversed" – that is, the environment need not be restored to a pre-project status. Reversing the project would essentially mean restoring its current grid-ditched condition.

However, Suffolk County is well aware of NYSDEC concerns regarding wetlands losses on Long Island. Likewise, USFWS has a tremendous stake in the perpetuation of salt marshes on its property. Therefore, these parties note that the success of the project, as enumerated above, will continue to be evaluated beyond the five year horizon discussed above. Every time the project is evaluated, NYSDEC will be consulted with and the import of available data discussed, data gaps assessed, and on-going monitoring protocols developed. Modifications to the original installations and/or the on-going maintenance of the installations will always be considered.

All of the involved parties agree that the wetlands in WNWR represent an irreplaceable resource. All of the parties agree that it is a primary goal of the project and on-going stewardship of the site to ensure the wetlands are managed so that they will be available to continue to provide the environmental services they provide at the current time. Therefore, all parties agree that necessary mitigations to the proposed project will be undertaken as needed.

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