Delaware Department of Natural Resources and Environmental Control
Delaware Coastal Management Program

Initial Review: ________
Updated On: ________
Complete: ________
Official Use Only

Coastal Zone Management Act Federal Consistency Form

This document provides the Delaware Coastal Management Program (DCMP) with a Federal Consistency Determination or Certification for activities regulated under the Coastal Zone Management Act of 1972, as amended, and NOAA's Federal Consistency Regulations, 15 C.F.R. Part 930. Federal agencies and other applicants for federal consistency are not required to use this form; it is provided to applicants to facilitate the submission of a Consistency Determination or Consistency Certification. In addition, federal agencies and applicants are only required to provide the information required by NOAA's Federal Consistency Regulations.

Project/Activity Name:	Open Marsh Water Management

I. Federal Agency or Non-Federal Applicant Contact Information:

Contact Name/Title: William H. Meredith / Program Administrator

Federal Agency Contractor Name (if applicable): ______________________

Federal Agency: United States Army Corps of Engineers
(either the federal agency proposing an action or the federal agency issuing a federal license/permit or financial assistance to a non-federal applicant)

Mailing Address: 89 Kings Highway

City: Dover State: DE Zip Code: 19901

E-mail: William.Meredith@delaware.gov Telephone #: (302) 739 -9096

II. Federal Consistency Category:

○ Federal Activity or Development Project (15 C.F.R. Part 930, Subpart C)

○ Outer Continental Shelf Activity (15 C.F.R. Part 930, Subpart E)

○ Federal Financial Assistance (15 C.F.R. Part 930, Subpart F)

◉ Federal License or Permit Activity (15 C.F.R. Part 930, Subpart D)

○ Federal License or Permit Activity which occurs wholly in another state (interstate consistency activities identified in DCMP's Policy document)

III. Detailed Project Description (attach additional sheets if necessary):

Open Marsh Water Management - Please see attached for project details.

IV. General Analysis of Coastal Effects (attach additional sheets if necessary):

V. Detailed Analysis of Consistency with DCMP Enforceable Policies (attach additional sheets if necessary):

Policy 5.1: Wetlands Management

Please see attached.

Policy 5.2: Beach Management

Policy 5.3: Coastal Waters Management (includes wells, water supply, and stormwater management. Attach additional sheets if necessary)

Please see attached.

Policy 5.4: Subaqueous Land and Coastal Strip Management

Policy 5.5: Public Lands Management

Policy 5.6: Natural Lands Management

Policy 5.7: Flood Hazard Areas Management

Policy 5.8: Port of Wilmington

Policy 5.9: Woodlands and Agricultural Lands Management

Policy 5.10: Historic and Cultural Areas Management

Policy 5.11: Living Resources

Please see attached.

Policy 5.12 Mineral Resources Management

Policy 5.13: State Owned Coastal Recreation and Conservation

Policy 5.14: Public Trust Doctrine

Policy 5.15: Energy Facilities

Policy 5.16: Public Investment

Policy 5.17: Recreation and Tourism

Policy 5.18: National Defense and Aerospace Facilities

Policy 5.19: Transportation Facilities

Policy 5.20: Air Quality Management

Policy 5.21: Water Supply Management

Policy 5.22: Waste Disposal Management

Policy 5.23: Development

Policy 5.24: Pollution Prevention

Policy 5.25: Coastal Management Coordination

VI. JPP and RAS Review (Check all that apply):

Has the project been reviewed in a monthly Joint Permit Processing and/or Regulatory Advisory Service meeting?

☐ JPP ☐ RAS ☒ None

*If yes, provide the date of the meeting(s): ______________________________

VII. Statement of Certification/Determination and Signature (Check one and sign below):

☐ **FEDERAL AGENCY CONSISTENCY DETERMINATION.** Based upon the information, data, and analysis included herein, the federal agency, or its contracted agent, listed in (I) above, finds that this proposed activity is consistent to the maximum extent practicable with the enforceable policies of the Delaware Coastal Management Program.

OR

☐ **FEDERAL AGENCY NEGATIVE DETERMINATION.** Based upon the information, data, and analysis included herein, the federal agency, or its contracted agent, listed in (I) above, finds that this proposed activity will not have any reasonably foreseeable effects on Delaware's coastal uses or resources (Negative Determination) and is therefore consistent with the enforceable policies of the Delaware Coastal Management Program.

OR

■ **NON-FEDERAL APPLICANT'S CONSISTENCY CERTIFICATION.** Based upon the information, data, and analysis included herein, the non-federal applicant for a federal license or permit, or state or local government agency applying for federal funding, listed in (I) above, finds that this proposed activity complies with the enforceable policies of the Delaware Coastal Management Program and will be conducted in a manner consistent with such program.

Signature:	William H. Meredith		
Printed Name:	William H. Meredith	Date:	01/12/2023

Pursuant to 15 C.F.R. Part 930, the Delaware Coastal Management Program must provide its concurrence with or objection to this consistency determination or consistency certification in accordance with the deadlines listed below. Concurrence will be presumed if the state's response is not received within the allowable timeframe.

Federal Consistency Review Deadlines:

Federal Activity or Development Project (15 C.F.R. Part 930, Subpart C)	60 days with option to extend an additional 15 days or stay review (15 C.F.R. § 930.41)
Federal License or Permit (15 C.F.R. Part 930, Subpart D)	Six months, with a status letter at three months. The six month review period can be stayed by mutual agreement. (15 C.F.R. § 930.63)
Outer Continental Shelf Activity (15 C.F.R. Part 930, Subpart E)	Six months, with a status letter at three months. If three month status letter not issued, then concurrence presumed. The six month review period can be stayed by mutual agreement. (15 C.F.R. § 930.78)
Federal Financial Assistance to State or Local Governments (15 C.F.R. Part 930, Subpart F)	State Clearinghouse schedule

OFFICIAL USE ONLY:

Reviewed By:	Fed Con ID:	Date Received:
Public notice dates: to	Comments Received: ☐ NO ☐ YES *[attach comments]*	
Decision type: *(objections or conditions attach details)*	Decision Date:	

STATE OF DELAWARE
DEPARTMENT OF NATURAL RESOURCES AND ENVIRONMENTAL CONTROL
DIVISION OF FISH & WILDLIFE
RICHARDSON & ROBBINS BUILDING
89 KINGS HIGHWAY
DOVER, DELAWARE 19901

MOSQUITO CONTROL SECTION

PHONE
(302) 739-9917

January 11, 2023

Kimberly Cole, Administrator
Delaware Coastal Management Program
100 West Water Street, Suite 7B
Dover, DE 19904

Re: Request for a CZM Consistency Certification for Open Marsh Water Management Activities used for Mosquito Control in Delaware

Dear Mrs. Cole:

The Delaware Department of Natural Resources and Environmental Control, Division of Fish and Wildlife, Mosquito Control Section will be applying to the U.S. Army Corps of Engineers for an "individual permit" to allow the State of Delaware to continue using the technique of Open Marsh Water Management (OMWM) as the primary form of saltmarsh larval mosquito control. The Corps wishes for the Mosquito Control Section to first have a CZM Consistency Certification from your Office prior to their issuing a COE Individual Permit.

By way of this letter, the Mosquito Control Section is requesting a Coastal Zone Management "Consistency Certification" for Open Marsh Water Management activities as used in Delaware. Please be aware that the proposed activity complies with Delaware's approved coastal management program and will be conducted in a manner consistent with such program.

OMWM methodology involves the selective installation of small, shallow ponds and/or inter-connecting ditches superimposed on known mosquito-breeding saltmarsh habitats, in an effort to manage water conditions on saltmarshes to the extent that mosquito breeding habitats are eliminated. Newly created permanent water habitats formed by OMWM ponds and ditches are unattractive for mosquito egg deposition, while simultaneously improving habitats for mosquito-eating larvivorous fishes. It should be recognized that the techniques of OMWM are designed to create permanent water bodies on saltmarshes and, as such, is significantly different from the past mosquito-control marsh management strategies of grid-ditching which advocated drainage of surface and sub-surface water from saltmarshes.

The goals of OMWM are as follows: 1) control of saltmarsh mosquitoes, 2) reduce overall volume and frequency of insecticide applications, and 3) create habitat for saltmarsh fisheries and wildlife. Efforts made towards achieving these applaudable goals must be made in a manner that does not have negative or secondary impacts to other saltmarsh resources. Of particular concern is that OMWM must not alter or adversely affect saltmarsh vegetation communities by significantly lowering subsurface marsh water levels or by depositing excavated marsh spoil too high. Be aware that the Mosquito Control Section has a long history of successfully installing OMWM on saltmarshes and doing so without initiating any significant environmental damage. Virtually all of this OMWM work has been installed according to the guidance provided by the attached document, "Guidelines for Open Marsh Water Management in Delaware's Saltmarshes – Objectives, System Designs and Installation Procedures", Meredith et.al 1985. The Mosquito Control Section will continue to perform OMWM using this document as guidance.

OMWM is a mosquito control technique that has been successfully used in Delaware since 1979 and is supported by the Delaware Coastal Management Plan as the ideal means of mosquito control. Part II of this Plan's Final Environmental Impact Statement, Section 5.C.3 states that "mosquito and other pest controls shall use techniques of marsh management which reduce the application of chemicals and …substitute biological control (through fish predation)."

To further aid evaluation of this Consistency Certification request, we have identified several specific sections applicable to OMWM activities within the DCMP Federal Consistency Policy Document. Specifically, these sections are "Wetlands Management", "Coastal Waters" and "Fish & Wildlife". Further, specific "orders" pertinent to this application and within each chapter have been identified and addressed within this document.

Wetlands Management: Order 2: *Activities in or adjacent to wetlands shall be conducted so as to minimize wetlands destruction or degradation, to preserve the natural and beneficial values of wetlands, and to protect the public interest therein.*

RESPONSE: The primary goal of OMWM activities is to control saltmarsh mosquito populations without the repetitive application of mosquito-killing chemicals. When designed and installed correctly, OMWM, as compared to chemical treatment, is a more effective and more cost-efficient form of mosquito control. Secondary benefits of OMWM include 1) create saltmarsh wildlife and fisheries habitat, 2) restore saltmarsh hydrology patterns to pre-1930 grid ditch conditions, and 3) minimize concerns of mosquito control chemical concerns on non-target organisms. Towards this very applaudable effort, while designing and installing OMWM, great care must also be taken to ensure that alterations do not adversely affect saltmarsh resource functions or established vegetation patterns. Of particular concern is the alteration of pre-OMWM vegetation communities by significantly changing relative sub-surface water level. Saltmarsh vegetation communities are zoned by water availability – low areas of the saltmarsh receiving daily tidal exchange and possessing a relatively high sub-surface water level are dominated by *Spartina alterniflora* while slightly higher areas of the marsh that receive limited tidal exchange and possesses a lower sub-surface water level are dominated by *Spartina patens*. Even higher areas of the saltmarsh that, save storm tides, receive very little tidal exchange and have a lower relative ground water level are dominated by woody bushes, pine trees and *Phragmites australis*. OMWM must be done in a manner that does not significantly contribute to vegetation changes. Towards this end, spoil management is of paramount concern. Excavated materials are deposited on site. Some of this material is used to fill adjacent mosquito breeding potholes while the remainder is spread in a thin veneer across the saltmarsh. Spoil deposited to an initial depth of 4" and finally settling to 2" does not cause vegetation changes on typical salt marshes. Spoil deposited at depths greater than this amount may lead to a lower "relative" water table and drier surface soils which in turn may lead to vegetation changes towards those species such as *Phragmites australis* and *Baccharis/ Iva* water bushes. In addition to spoil deposition, physical removal of subsurface water through a network of created tidal ditches would also likely change vegetation communities and often times more significantly and over a larger area than spoil deposition can alone. As such, use of tidal ditches in OMWM is very judicious and only used in *S. alterniflora* areas of the salt marsh. It should be recognized that a single tidal ditch transversing a *S. alterniflora* salt marsh will have no-expected effect on vegetation communities and will actually increase productivity of native communities through increased nutrient cycling while a network of tidal ditches through a *S. patens* marsh will very likely contribute to vegetation changes.

Coastal Waters: Orders 1 – 4*: The development and utilization of the land and water resources of the state shall be regulated to ensure that water resources are employed for beneficial uses and not wasted, to protect beneficial uses of water resources, and to assure adequate water resources for the future; The water resources of the state shall be protected from pollution which may threaten the safety and health of the general public; The coastal water resources of the state shall be protected and conserved to assure continued availability for public recreational purposes and for the conservation of aquatic life and wildlife; It is the policy of the DNREC to maintain within its jurisdiction surface waters of the State of satisfactory quality consistent with public health and public recreation purposes, the propagation and protection of fish and aquatic life, and other beneficial uses of the water.*

RESPONSE:

In Delaware, mosquito control is performed through the multi-disciplinary techniques of Integrated Pest Management (IPM) that advocates and practices (in this preferential order): 1) *source reduction* (elimination of mosquito breeding sites), 2) *surveillance* (determining mosquito population sizes and in turn directing the need and specific areas for chemical control), 3) *larviciding* (controlling immature mosquitoes at the aquatic stages when they are highly susceptible using EPA-registered insecticides), and lastly 4) *adulticiding* (controlling adult mosquitoes using EPA- registered insecticides). Source reduction (removal of mosquito breeding sites) is the preferred method of mosquito control because of the long-term control efficacy, potential to improve habitat resources and reduced long-term mosquito control financial cost (as compared to chemical treatment). There are several forms of "source reduction" applicable to salt marshes but the only environmentally acceptable form is OMWM. OMWM benefits the State's water resources and aquatic wildlife by reducing the volume of 1) mosquito control larvicides applied directly to the salt marsh surface water which may arguably have some small impacts on some selected aquatic invertebrates and 2) mosquito control adulticides which are applied to the air column and some of which may eventually drift over and settle upon water bodies and may arguably have some small impact on aquatic invertebrates. As such, OMWM reduces chemical applications and reduces concerns that these chemicals may have upon some saltmarsh resources.

In and of itself, OMWM has no appreciable effect upon the State's water and/or water quality other than to increase the total area of surface water within salt marshes. Additionally, in these created water bodies, water quality must be maintained to the highest possible level since fish survival and resultant mosquito control is dependent upon high water quality. Without a healthy predatory fish population, excavated ponds and ditches can become mosquito-breeding habitat. As such, successful OMWM relies on regular water renewal to maintain water quality. This is particularly important during the summer months where high rates of biological decay leads to low dissolved oxygen and other factors lead to the rapid oxidation of sulfur leading to formation of sulfuric acid and pH as low as 3.0. Both conditions will kill saltmarsh fishes. As such, knowledge of local salt marsh hydrologic conditions and flooding cycles is necessary for designing a functional and productive OMWM system. To this end, OMWM systems found in close proximity to a medium or high energy tidal source are typically installed as non-tidal systems since tidally-borne estuarine water predictably crests the creek bank and floods the salt marsh at least once per month on lunar cycles. It is this flooding that rejuvenates water quality in closed OMWM systems. On the other hand, many marshes, or portions of larger marshes in Delaware are occluded from normal tidal exchange. These tidally limited marshes may be completely natural and other tidally-limited marshes are anthropogenically created or altered through road and canal construction or other means of habitat disruption. On these marshes, where surface marsh flooding cannot be predicted or expected, water quality in OMWM systems is ensured via semi-tidal ditch installation. A sill is installed which allows a limited amount of tidal exchange while still preserving stable water levels within the designed system.

Fish and Wildlife: ***Orders 1 and 3:*** *All forms of protected wildlife shall be managed and protected from negative impacts; Mosquito and other pest controls shall use techniques of marsh management which reduce the application of chemicals and which substitute biological controls.*

Response: Through the mosquito control techniques of OMWM, the primary advantage of such a program is found in the *biological control* of mosquitoes, significant reduction in chemical application and alleviated concerns by many interested parties of chemical application effects on non-target species. Towards these very applaudable efforts, while designing and installing OMWM, great care must also be taken to ensure that alterations do not adversely affect saltmarsh resource functions, established vegetation patterns and wildlife usage. Of particular concern is the alteration of pre-OMWM vegetation communities by significantly changing relative sub-surface water level. Salt marsh vegetation communities are zoned by water availability – low areas of the saltmarsh receiving daily tidal exchange and possessing a relatively high sub-surface water level are dominated by *Spartina alterniflora* while slightly higher areas of the marsh that receive limited tidal exchange and possesses a lower sub-surface water level are dominated by *Spartina patens*. Even higher areas of the saltmarsh that, save storm tides, receive very little tidal exchange and have a lower relative ground water level are dominated by woody bushes, pine trees and *Phragmites australis*. OMWM, regardless of its mosquito control effectiveness, must be done in a manner that does not significantly contribute to vegetation changes which frequently alters wildlife use. Towards this end, spoil management is of paramount concern. Excavated materials are deposited on site. Some of this material is used to fill adjacent mosquito breeding potholes while the remainder is spread in a thin veneer across the saltmarsh. Spoil deposited to an initial depth of 4" and finally settling to 2" does not cause vegetation changes on typical salt marshes. Spoil deposited at depths greater than this amount may lead to a lower relative water table and drier surface soils which in turn may lead to vegetation changes towards those species such as *Phragmites australis, Baccharis* and *Iva*. In addition to spoil deposition, physical removal of subsurface water through a network of created tidal ditches would also likely change vegetation communities and often times more significantly and over a larger area than spoil deposition can alone. As such, use of tidal ditches in OMWM is very judicious and only is used in *S. alterniflora* areas of the salt marsh. It should be recognized that a single tidal ditch transversing a *S. alterniflora* salt marsh will have no-expected effect on vegetation communities and will actually increase productivity of native communities through increased nutrient cycling while a network of tidal ditches through a *S. patens* marsh will very likely contribute to vegetation changes.

OMWM, by creating stable and shallow open bodies of water within salt marshes very often creates nesting and feeding habitat for many wildlife resources. As such, OMWM often mitigates for losses created by grid ditching. Grid ditching on Delaware's saltmarshes removed many of the non-tidal ponds that once "poke-a-doted" the landscape and provided a significant amount of wildlife habitat. These ponds provided protected feeding, resting and nesting habitats that could not be provided on the higher energy tidal creeks and rivers of Delaware nor along the Delaware Bay or Atlantic coast. The complete extent of these once-present protected water habitats will never be replaced, but the efforts of OMWM do provide some mitigation in replacing non-tidal and stable water saltmarsh habitats. As an added benefit to mosquito control, many of these shallow water ponds (and even ditches) are quickly colonized by widgeon grass, macro invertebrates and fishes, all of which are very attractive foods for waterfowl and waterbirds. OMWM habitats also provide ideal nesting for ducks and geese and lodging locations for fur- bearing mammals. This usage has been well documented in the scientific literature.

In summary, based upon the information provided within this document as well information provided in the attached Corps of Engineers Individual Application, the Mosquito Control Section is requesting a State Coastal Zone Consistency determination by your office for the activities of OMWM as implemented for mosquito control activities in Delaware. Thank-you in advance and please contact me at 739-9917 if you have any addition questions or need additional information.

Signature: William H. Meredith

William H. Meredith, Program Administrator, Mosquito Control Section

GUIDELINES FOR "OPEN MARSH WATER MANAGEMENT" IN DELAWARE'S SALT MARSHES - OBJECTIVES, SYSTEM DESIGNS, AND INSTALLATION PROCEDURES

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Abstract. Open Marsh Water Management (OMWM) is a method for controlling salt-marsh mosquitoes using physical alterations of marsh habitat. Ponds and ditches are selectively excavated in order to create unsuitable environs for mosquito eggs and larvae while creating suitable habitat for larvivorous fishes. Based on environmental effects observed at two experimental sites, plus operational experiences in Delaware and adjacent states, guidelines are presented for designing and installing OMWM systems in Delaware. These guidelines should be applicable to other salt marshes from New England to Florida that have similar environmental characteristics.

The guidelines are intended to produce OMWM systems that will control mosquitoes while minimizing long-term ecological disruptions of the marsh community. They emphasize the following topics, including the environmental or economic reasons for why particular approaches were chosen: 1) use and location of open tidal ditches; 2) interspersion of open tidal ditches with closed, non-tidal ponds and pond radial ditches; 3) use of semi-tidal sill ditches and ponds; 4) incorporation of OMWM systems into previously parallel-grid-ditched marshes; 5) permissible lowering of the water table elevation in relation to local marsh surface, as caused by spoil deposition on the marsh surface and/or drainage from open tidal ditching, but not to such an extent that the original vegetation is replaced by other species during vegetative recovery; 6) protocols for designing, demarcating and installing OMWM systems; 7) density, depth and surface areas of ponds; 8) geometric vs. naturalistic excavations; 9) habitat enhancement for waterfowl use; 10) water quality, fish kills and dependable mosquito control; 11) OMWM alterations under special situations, such as upland border marshes with excessive freshwater runoff or marshes with intensive muskrat burrowing activity; 12) blending of OMWM with other marsh management goals.

INTRODUCTION

Open Marsh Water Management (OMWM) is a method for controlling salt marsh mosquitoes using physical alterations of marsh habitat. OMWM alterations involve selective excavation of ponds and ditches which create unsuitable environs for mosquito egg deposition and larval maturation, while simultaneously providing stable habitats for larvivorous fishes (Ferrigno and Jobbins 1968; Ferrigno *et al*. 1975). As such, OMWM promotes and maximizes biological control through physical manipulations. The Delaware

Mosquito Control Section is proposing to use OMWM, where appropriate, as a primary means of salt-marsh mosquito control on much of Delaware's tidal wetlands. It has become obvious that a set of operational guidelines is necessary for OMWM system design and installation. Since water management practices, when incorrectly conceived or installed, have potential for adverse environmental impacts (Daiber 1982), it is essential that a protocol for design and installation be formulated in order to avoid detrimental effects.

Guidelines for OMWM have been written for New Jersey (Bruder 1980) and Maryland (Lesser 1982). These guidelines adequately define the local OMWM process for regulatory or permitting agencies, but do not fully address the reasons for many recommended procedures, nor do they account for OMWM use under unusual conditions (e.g. in atypical border marshes, in areas of snow goose feeding). Guidelines for OMWM in Massachusetts are being prepared by Hruby and Montgomery (ms. in prep.) which provide greater insights into the "why" of recommended procedures. The Delaware OMWM guidelines attempt to elaborate upon the reasons for recommended procedures. Our guidelines should be applicable to other mid-Atlantic regional marshes, and also to marshes of similar environmental characteristics (e.g. tide range, vegetation, soil type) in New England and along the southeast Atlantic coast. The Delaware OMWM protocol is partially based on the experiences and recommendations of OMWM programs in New Jersey and Maryland; it is strongly influenced by studies done by the Delaware Mosquito Control Section, sponsored by the Delaware Coastal Management Program (DCMP), of the environmental effects of prototype OMWM systems on marshes of the Bombay Hook and Prime Hook National Wildlife Refuges (Meredith et al. 1983); and it also relies on observations of operational OMWM systems in Delaware which were begun in 1980.

OBJECTIVES FOR OMWM IN DELAWARE

The objectives of OMWM in Delaware are as follows:

1) Control of Pestiferous Salt-Marsh Mosquitoes

The primary objective is to provide a water management technique that will control the dominant species of Delaware salt-marsh mosquitoes: *Aedes sollicitans*, *Aedes cantator*, *Aedes taeniorhynchus*, *Culex salinarius*, and *Anopheles bradleyi* (Lake 1973).

2) Reduction in Use of Chemical Insecticides

If the primary objective is achieved, then the current reliance on chemical insecticides will be reduced. Successful control via OMWM will be considered achieved if the frequency of insecticide spraying on a given marsh is at least 80% less after OMWM than before OMWM.

3) Minimize Adverse Secondary Impacts on the Marsh Community

The application of OMWM should not adversely impact other existing marsh resources or functions. A primary gross environmental alteration to be avoided when using OMWM is promotion of higher elevation plants through increasing the marsh surface elevation due to spoil deposition and/or excessive lowering of the water table elevation due to drainage. Since the ecological consequences of altering marsh vegetation patterns are not fully understood, it is both responsive and prudent to install OMWM systems that will not grossly alter existing vegetation. With minimal alterations to extant vegetation, other components of the marsh community (e.g. surface invertebrates, edaphic alge, detritus production and export) will not be radically changed.

4) Habitat Enhancement for Waterbirds

As a result of the creation of mosquito-control OMWM ponds, habitat may be created that is also beneficial to waterfowl, shore birds, and wading birds (Meredith *et al*. 1984). OMWM pond creation may help to mitigate the loss of high marsh ponds that historically were abundant on Delaware's salt marshes, but were drained by the old mosquito control method of parallel-grid ditching.

5) Cost-Effective Mosquito Control

The use of OMWM is potentially more cost effective than the use of insecticides. According to economic analyses conducted in New Jersey (Hansen *et al*. 1976; Shisler *et al*. 1979; Shisler and Schulze 1985), properly installed OMWM systems will be less expensive than continual treatment with chemical insecticides.

PROTOCOLS FOR OMWM IMPLEMENTATION

1) Marsh Breeding Habitats Where OMWM Could Be Used

The environmental requirements necessary for breeding of salt-marsh mosquitoes are usually delineated by vegetation zones. In Delaware, the most severe breeding habitats are on the highest marshes (i.e. marshland that is only flooded by spring or storm tides, and which often goes dry between rainfalls or surface inundations). Plant species characteristically associated with the high marsh are the salt hay grasses, *Spartina patens* and *Distichlis spicata*, and the short-form of the cordgrass, *Spartina alterniflora*. Short-form *S. alterniflora* in the high marsh may be found in extensive stands, or may be confined to shallow depressions surrounded by salt hay that hold water long enough for a mosquito brood to progress to adult emergence; in either case, zones of short-form *S. alterniflora* can produce severe broods, but usually not at the frequency of salt hay habitat. The salt hay contains two types of breeding sites: 1) discrete, relatively deep potholes; 2) "tussocky" areas that hold surface water at the base of grass clumps. Both of these salt hay sites are major problem habitats. Mosquito breeding can also occur near the upland fringe in salt hay zones which are in association with marsh elder (*Iva frutescens*), groundselbush (*Baccharis halimifolia*), marsh hibiscus (*Hibiscus* spp.), marsh mallow (*Kosteletzkya virginica*), or panic grasses (*Panicum* spp.). Depending upon locality within the State, the short-form *S. alterniflora* found in shallow, mosquito-breeding depressions surrounded by salt hay may be replaced by three-squares (*Scirpus* spp.) or black needlerush (*Juncus roemerianus*), both which can form mosquito-producing habitat under such conditions. A final type of salt-marsh mosquito breeding habitat in Delaware can be found in potholes or depressions in zones of common reed, *Phragmites australis*.

Any of the above described breeding habitats are candidates for OMWM treatment. These marsh breeding habitats are found in extensive, open salt marshes extending landward from tidal rivers and coastal embayments; in small pocket or finger marshes along the upland fringe; in the more brackish marshes near headwaters of tidal creeks; and in swales behind coastal dunes.

OMWM will not be used in marshes or marsh zones subject to an average of at least one high tide per day, since such areas usually do not produce mosquitoes. Non-breeding marshes or marsh zones in Delaware are typically vegetated by tall- or intermediate-form S. alterniflora. Also, extensive stands of cattails (Typha) spp. or three-squares (Scirpus spp.) are not candidates for OMWM. Permanent ponds on the marsh surface (which are relatively large and deep) do not serve as breeding habitat and will not be drained.

2) Factors Considered in OMWM Site Selection and System Design

OMWM alterations must directly affect potential mosquito breeding sites within known breeding marshes. The determination of which marshes breed, and are thus candidates for OMWM, will be based on historical aerial spray records and/or historical larval inspection records for specific marshes. Potential breeding sites within a candidate OMWM marsh will be identified by staff biologists and/or mosquito control supervisors via on-site evaluations of: 1) vegetative cover, 2) tidal flooding and runoff patterns, 3) physical characteristics of surface depressions, 4) potential for access and survival of larvivorous fishes, and 5) when practical, direct observation and quantification of mosquito larvae. To aid in design of the OMWM systems, other environmental factors may be considered on a site-specific basis. Such factors could include local topographic relief, soil characteristics (particularly peat vs. mineral content), depth of mean water table below local marsh surface, and proximity to critical or unique wildlife habitats. Which factors will be examined for a specific tract, and how they will be integrated to assist in the OMWM system design, will vary from site-to-site. Staff biologists will use this information to aid in formulating regional OMWM design concepts specific to geographic areas.

3) Field Demarcation of OMWM Systems and Alterations

Prior to any excavations, all breeding sites and their specific methods of OMWM treatment will be demarcated with surface stakes. If there is to be an on-site, regulatory review of the proposed alterations, the post-staking stage is the most logical point to have such a review. It is important that a uniform, consistent system for indicating alterations be designed and used by all parties. Since the field lay-out of OMWM systems will be done under supervision of staff biologists and/or mosquito control supervisors, but the actual machine excavations supervised by foremen or machine operators, it is mandatory that excavation personnel be able to interpret and understand the staked designs.

The staking system should clearly indicate pond borders; island locations; location of deeper reservoirs in ponds; the beginning and termination of primary ditches, pond radial ditches, and lateral spurs; where a semi-tidal ditch's shallow sill outlet begins and terminates; and whether or not a ditch approaching a tidal source will be connected at full depth to daily tidal flow. Stake tips can be color coded to indicate various features, and various combinations of stakes used to further discriminate features.

The staked OMWM design should be drawn on a map which also indicates major natural features. Such maps will be used by the equipment operators and could also be valuable to regulatory agencies. The maps could be of particular value in indicating to which side(s) of an excavation spoil should be directed or placed. This is especially important if spoil is to fill breeding depressions that are not staked for ditching. The amount of excavation planned will be the minimum required to satisfy the OMWM objectives.

4) Excavation Equipment Used in OMWM

Whenever feasible, excavations in OMWM are to be made with a rotary excavator (either amphibious or land-limited). The rotary cutting head broadcasts spoil as a crude slurry, thinly covering the marsh surface for distances up to 15 m from an excavation. Other heavy machinery (e.g. dragline, backhoe, front-end loader) can be used in OMWM as long as the OMWM objectives are met, particularly in regard to satisfactory deposition of spoil. Spoil from non-rotary excavations may be used to fill breeding depressions or old ditches, or can be deposited in small mounds and then spread to a depth less than 10 cm over the marsh surface. Care must be taken during spreading and compaction not to pack the overburden of spoil too densely to permit vegetation recovery. Also, the creation of ruts by the machinery during the spreading process should be avoided. The most likely use for non-rotary equipment in OMWM is to excavate ponds in soils with high mineral content.

5) Removal of Shrubs Impeding Spoil Broadcasting

In some instances, it may be necessary to cut down wetland fringe vegetation, especially shrubs (e.g. *Iva*, *Baccharis*), in order to permit unimpeded broadcasting of rotary spoil. Care should be taken to leave at least a 1.5 m wide band of shrubs along the marsh's upland edge. This will help preserve the natural wetland-upland transition.

6) Location and Ranking of Candidate OMWM Marshes

Of Delaware's 34,500 ha of tidal wetlands, about 6000 ha have been identified as severe salt-marsh mosquito-breeding habitat and are thus candidates for OMWM treatment. Marshes to be treated with OMWM are ranked for work priority according to degrees of breeding severity in relation to human population centers, in terms of both nuisance problems and disease potential. This ranking of work areas may then be modified by factors of landowner cooperation, efficient deployment and transport of heavy equipment, and impact on reduction of aerial spraying.

DESCRIPTION OF OMWM ALTERATIONS

1) Terminology and Types of Alterations

Three types of alteration systems are used in Delaware OMWM: 1) Full-depth tidal ditches (45-90 cm deep), with relatively deep tidal outlets (e.g. 75 cm below marsh surface), plus associated lateral spur ditches, creating a system that has daily tidal exchange; 2) Semi-tidal systems consisting of full-depth ditches (e.g. 75 cm) with a shallow tidal outlet or sill (e.g. 10-20 cm deep - see Fig. 1), plus associated lateral spur ditches landward of the shallow outlet, creating a system that has more tidal exchange than if no ditching was done, but not as much as full-depth tidal

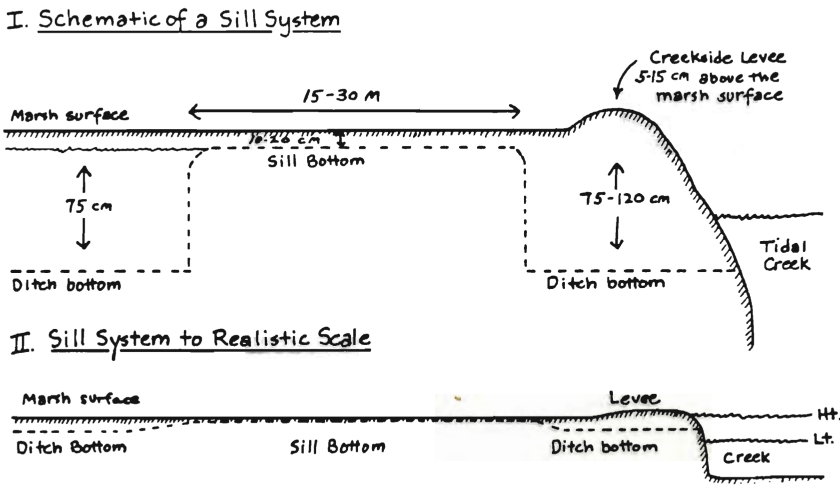

Figure 1. Side-view diagram of a sill (semi-tidal) OMWM system, with emphasis on the sill's shallow outlet.

ditches; 3) Shallow ponds of 50-1000 square meter surface area (averaging 30 cm deep), with deeper reservoirs (75-90 cm deep), plus associated pond radial ditches of full-depth (e.g. 75 cm), with both ponds and radial ditches lacking any tidal outlets, creating a system that has tidal exchange during only spring or storm tides.

The full-depth tidal ditches with deep outlets are often referred to as "open" systems; when these systems are made semi-tidal via shallow outlets, then these modified systems are known as "sill" systems; the essentially non-tidal systems of ponds and pond radials are often called "closed" systems. The word "Open" in Open Marsh Water Management refers to the fact that OMWM systems do not contain elevated structures above marsh surface to prohibit tidal exchange (e.g. no impoundments, dykes, or sluice gates). OMWM systems may have various combinations of tidal, semi-tidal, and non-tidal systems (i.e. open, sill, and closed systems - see Fig. 2).

When digging open ditches, deeper ditches are preferable since they will not fill-in as rapidly with tidally-borne sediment and will have a longer functional life. Open ditches can be connected to tidal sources at more than one point in order to promote circulation.

The shallow outlets for sill systems should be at least 30 m long in peaty soils and at least 15 m long in mineralogical soils. These lengths will help promote sill longevity in areas where the sill might erode to deeper depths, since the maximum rates of erosion occur at the sill ends. Past the tidal end of the sill, the outlet should slope gradually toward the tidal source in order to minimize undercutting by ebbing water. The shallow sill should not go through any creekside levee since it is along the creekside where sedimentation rates are highest, and where sill longevity would be least. An extra wide (e.g. 150 cm), extra deep (e.g. 120 cm) ditch is constructed at the seaward end of the shallow sill, cutting through the creekside levee. This larger ditch will serve as a "catch basin" for tidally-transported sediments and debris on flooding tides, prolonging the functional longevity of the more landward sill. A correctly designed and installed sill system will remove very shallow, standing surface water from tussocky mosquito-breeding areas while still maintaining a high subsurface water table at low tides. It will also enhance tidal exchange (since the creekside levee has been broached), promoting good water quality to the benefit of larvivorous fishes. Because of the shallow nature of the sill's outlet, breeding depressions greater than 5 cm deep or more than a few meters away from a sill ditch will not be drained; these deeper or more remote breeding depressions should be directly treated with sill ditch lateral spurs.

Closed ponds are excavated in areas of concentrated breeding depressions. Ponds should have a uniform depth of about 30 cm over most of their surface area. Slate (1978) found this depth to be the average depth of potholes containing widgeongrass (Ruppia maritima), a valuable waterfowl food. To insure fish survival during droughts, reservoir ditches from 75-90 cm deep should be dug along one or two sides of the pond. Natural or OMWM ponds with several full-depth pond radial ditches (e.g. 75 cm deep) extending outward from the main pond body may not need ditch reservoirs within the pond. Islands should be left in ponds when feasible to provide

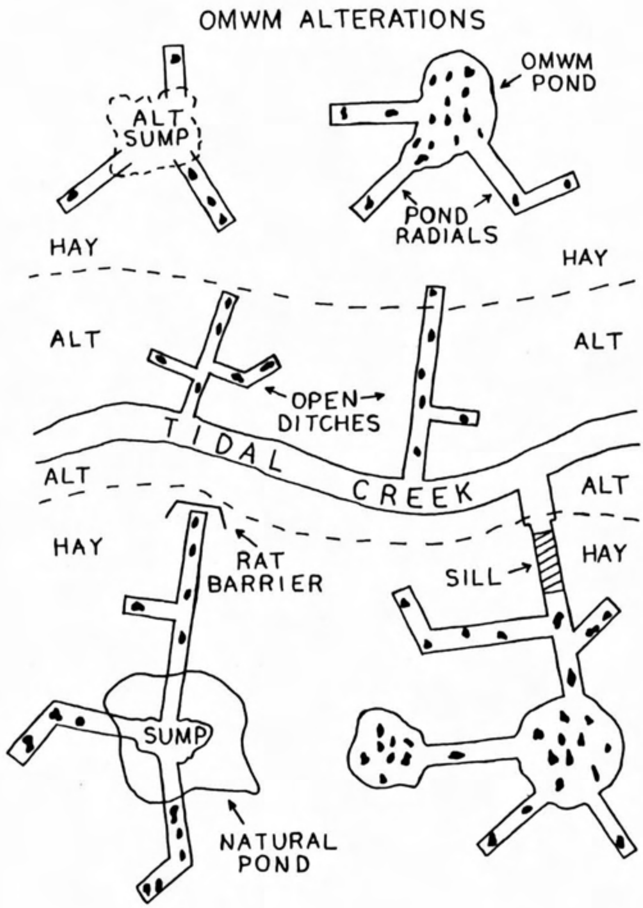

Figure 2. Various marsh excavations and alterations used in the OMWM technique. The darkened spots represent former mosquito-breeding depressions.

protected areas for bird nesting plus additional edge habitat, while reducing spoil volume around pond perimeters.

2) Interfacing the Old, Parallel-Grid Ditch System with OMWM Alterations

The open tidal ditches of the old parallel-grid ditch network slowly fill with tidally-borne sediment. In the past, these ditches have been cleaned of deposits, restoring the ditch network to its original design and function. This routine cleaning of parallel-grid ditches is a questionable procedure, since many ditches were placed in marshes or sections of marsh that did not require mosquito control, and in some areas these open ditches caused drainage of waterfowl ponds (Clarke *et al.* 1984) plus excessive depression of the subsurface water table. Routine, wholesale cleaning of the parallel-grid ditch system is not part of Delaware OMWM. Parallel-grid ditches that are filling will not be reexcavated if the cleaned ditches fail to met all of the objectives and specifications for OMWM alterations.

Parallel-grid ditches may be cleaned and restored to open tidal flow in zones of short-form cordgrass where mosquito breeding is evident. Lateral spurs may be dug from these cleaned ditches, treating breeding depressions that might exist between parallel-grid ditches in zones of short-form cordgrass. However, restoring the parallel-grid ditches in salt hay zones to open tidal flow will usually not be done.

Since the installation of sill and closed systems in salt hay areas of the high marsh requires limited or no direct tidal exchange, and since many areas of the high marsh have been treated with parallel-grid ditches, it may be necessary to block, or at least not clean, these high marsh grid ditches. A desirable location for ditch blockage would be at the transition from predominantly short-form cordgrass zones to predominantly salt hay zones. The parallel-grid ditches seaward from this transition edge, in short-form cordgrass zones, could be cleaned and spur ditched if breeding occurs in the lower marsh. Landward from ditch blockages, parallel-grid ditches could be cleaned in order to deepen them for inclusion in sill or closed systems in the high marsh.

If a parallel-grid ditch in the high marsh area has not silted enough to have a short segment of the ditch serve as blockage for a sill or closed system, then spoil "plugs" may be used to achieve blockage. These plugs should fill the parallel-grid ditch to marsh surface level and be at least 8 m long in marshes with mineralogical soil to at least 15 m long in marshes with peaty soils. The plugs should be installed on the salt hay side of a cordgrass-salt hay interface, taking advantage of the more consolidated soils in salt hay zones.

In summation, the basic strategy for managing parallel-grid ditches in Delaware OMWM is to "break-up" the grid network: 1) clean only those ditches that directly contribute to mosquito control; 2) allow other non-breeding ditches to fill naturally; 3) prohibit excessive tidal flow and drainage in the high salt marsh via plugs, thereby restoring standing surface water to the upper marsh with sill and closed systems (see Fig. 3 for an example of OMWM superimposed over a parallel-grid ditch system).

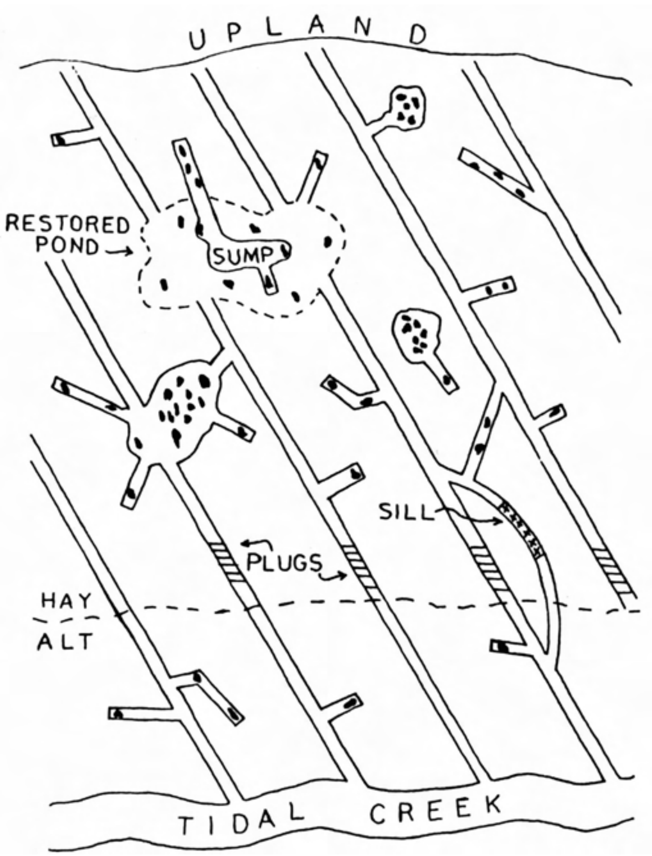

Figure 3. An OMWM system superimposed over a previously parallel-grid ditched marsh. The darkened spots represent former mosquito-breeding depressions.

TAILORING OMWM ALTERATIONS TO MEET OMWM OBJECTIVES

1) Maintenance of a High Subsurface Water Table

A basic management goal is to insure that no OMWM alteration causes the mean subsurface water table to drop more than 15 cm below local marsh surface elevation. The OMWM studies sponsored by the Delaware Coastal Management Program (DCMP) have found that the mean water table in study site zones of *Iva*, *Baccharis*, and robust *Phragmites* is 15 cm or more below local marsh surface, creating a soil condition that is drier and more aerated than soils in salt hay or short-form cordgrass zones (Meredith *et al*. 1983). In order to discourage conditions that may cause establishment and growth of marsh shrubs and common reed, excessive subsurface drainage and/or excessive spoil deposition, which either separately or in combination may establish a greater than 15 cm average distance between marsh surface and mean water table, should be avoided. While the correlation between vegetation cover type and depth to mean water table may be somewhat variable from site-to-site (especially for *Phragmites*, which may grow in areas of considerable tidal flooding), the avoidance of creating a mean distance between the marsh surface and water table greater than 15 cm provides an initial management criterion for maintaining existing vegetation patterns.

Spoil from ditches and ponds should be spread over the marsh surface at initial depths no greater than 10 cm (after a period for spoil settling, any permanent increase in surface elevation should be less than 5 cm).

Generally, open tidal systems should not be put in areas of salt hay. However, breeding depressions in salt hay within 3 m of an existing tidal feature (natural or man-made) may be treated with open spur ditches. This will permit operational treatment of isolated potholes near tidal features without having to extend closed or sill ditches close to these tidal sources, thereby minimizing the risk of non-tidal systems becoming directly connected to tidal sources (e.g. via muskrat burrowing).

Sill systems in salt hay zones may have their shallow outlets from 10-20 cm deep, depending on local tidal amplitude and soil composition. The DCMP-sponsored studies suggest that deeper sill depths (e.g. 20 cm) can be installed in areas of high tidal amplitude and peaty soil, whereas shallower depth sills (e.g. 10 cm) should be used in areas of low tidal amplitude and mineralogical soils.

An exception to avoiding creation of a water table elevation which averages a distance of 15 cm or more below local marsh surface could be made for low elevation areas that are subject to enough tidal surface flooding to retard colonization and/or growth of high elevation plants (e.g. in short *S. alterniflora* zones near tidal sources). In such areas, a 15 cm or greater water table displacement would be allowed, but only if created by open ditch drainage, not by spoil deposition on the marsh surface. Excessive deposition of spoil could raise surface elevations above heights where high marsh plants would no longer be suppressed by tidal flooding.

2) Efficient Dispersion and Use of Spoil

A second basic management goal is efficient use of spoil to fill breeding depressions. Effort should be made in all OMWM systems designs to take advantage of spoil for beneficial filling of breeding depressions. Breeding areas filled with spoil will not require further modification. Precautions to take are not to fill depressions to heights above marsh surface and not to compact the fill too densely to prevent future plant growth.

3) Creating Natural-Looking OMWM Systems

A third basic management goal is creation of systems which look natural. Until the marsh surface is substantially revegetated following spoil deposition, a period of time usually taking one or two growing seasons, portions of the marsh will have an unavoidable muddy and/or barren look. After the vegetation has recovered, the positioning and configuration of the excavations will have the greatest impact on marsh aesthetics. The principal, long-term considerations for designing natural looking systems are to construct, whenever practical, irregular pond edges, islands in ponds, and curvilinear ditches. Geometric ponds (e.g. square or rectangular ponds) and long, straight ditches should be avoided.

INTERFACING OMWM WITH OTHER MARSH MANAGEMENT GOALS

The Delaware Division of Fish and Wildlife has embarked on a comprehensive marsh management program known as Integrated Marsh Management (IMM). . The purpose of IMM is to make sure that individual marsh management projects are not working at contradictory purposes and that projects with the potential to augment each other do so. Marsh management goals identified by the Division encompass environmentally-compatible mosquito control; waterfowl habitat enhancement, including selective creation or restoration of marsh ponds and optimum management of existing impoundments; *Phragmites* control; habitat conservation for fish spawning and nursery areas; habitat management for muskrat production and deer utilization; and integration of goals of the non-game and endangered species program (e.g. osprey production, protection of colonial waterbird nesting colonies and heronries, peregrine falcon hacking towers, etc.).

When the Mosquito Control Section performs OMWM, it has the potential to impact several of these other projects. Excessive spoil deposition or lowering of the subsurface water table could promote *Phragmites* growth, which must be avoided. OMWM activities detrimental to nesting sites of colonial waterbirds or raptors must be minimized. The creation of standing water on the marsh surface with OMWM (via sill and closed systems) can enhance habitat for waterfowl, wading birds, shorebirds, and muskrats. However, it must be understood that OMWM is first and foremost a mosquito control technique.

OMWM SYSTEM LONGEVITY

1) "Routine" Maintenance

Based on projections from New Jersey OMWM programs (Hansen *et al.* 1976), it is anticipated that "cleaning" (re-excavation) of most OMWM features will not have to be done more frequently than once every 15 to 20 years. Open tidal ditches may require more frequent cleaning than sill or closed systems, since sediment loads are deposited in the open ditches twice per day. The shallow outlets of sill systems may also require more frequent maintenance (e.g. once every five years), but this cleaning could be rapidly and inexpensively accomplished because of the small areas and spoil volumes associated with sill outlets.

2) Corrective Actions and Preventive Measures

It mav sometimes be necessarv to return to a recentlv treated area in order to make corrections in either OMWM system design or installation. The two most likely problems to correct would be: 1) satisfactory mosquito reduction has not been achieved because of flaws in the site-specific OMWM design - additional, more intensive excavation is needed; 2) OMWM systems have been altered (e.g. surface ponds have drained) due to design flaws or animal damage - restoration of these systems must be done.

The most likely damage by animals is from snow goose grazing or muskrat burrowing. Snow goose creveys ("eat-outs") which produce mosquitoes should eventually be retreated with OMWM excavations. Muskrat burrowing damage can be lessened by terminating all sill or closed excavations no closer than 15 m from a tidal source in peaty soil and no closer than 8 m in mineral soil. To further prevent muskrat burrowing damage, or to repair drainage damage already done, barriers impervious to muskrat penetration (e.g. heavy-gauge fencing wire or plywood sheets) can be installed below the marsh surface between the end of a sill or closed system feature and an open tidal source (see Fig. 2). The barriers should extend one meter or deeper below marsh surface and extend laterally at least two meters to either side of a line between the end of the OMWM feature and the tidal source.

ACKNOWLEDGEMENTS

Financial support for environmental studies of OMWM's impacts was provided by the Delaware Coastal Management Program (CMP), through funding from NOAA's Office of Ocean and Coastal Resources Management, pursuant to Section 306 of the Coastal Zone Management Act of 1972 (as amended). We thank D. S. Hugg III, CMP Manager, for his leadership and guidance. A draft of the guidelines was distributed in November, 1983 to the U.S. Army Corps of Engineers, the U.S. Fish and Wildlife Service, the U.S. Environmental Protection Agency, and the National Marine Fisheries Service. We thank the following personnel in the Delaware Department of Natural Resources and Environmental Control for their reviews and comments: W. C. Wagner II, R. L. Graham, C. A. Lesser, A. J. Florio, W. Moyer, D. Hardin, R. G. Neumann, W. M. King, and R. V. Cole. Additionally, discussions with the following individuals were influential in formulating the guidelines: Delaware - F. C. Daiber, J. L. Gallagher, R. L. Lake, R. G. Weber, V. A. Lotrich, M. H. Taylor, N. Wilder, L. Fleming; New Jersey - J. K. Shisler, F. Ferrigno, F. H. Lesser, J. A. Hansen, P. Slavin, T. Candeletti, R. Candeletti, C. Roman; Maryland - C. R. Lesser, R. Berry, D. Schofield, D. F. Whigham; North Carolina - N. H. Newton, A. Anderson; Florida - W. R. Opp, D. Carlson; Massachusetts - T. Hruby, B. Harrington, R. Lent; U.S. Fish and Wildlife Service - G. Ruddy, P. Daly, D. Perkuchin, G. O'Shea, G. Gavutis, G. Haas, R. Andrews, R. Rudolph; U.S. Army Corps of Engineers - J. Steen, R. Hassel, R. Walker; National Marine Fisheries Service - T.

Goodger; U.S. Environmental Protection Agency - W. Muir. Finally, we thank P. J. Short for typing the document.

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U.S. Army Corps of Engineers (USACE) **APPLICATION FOR DEPARTMENT OF THE ARMY PERMIT** 33 CFR 325. The proponent agency is CECW-CO-R.	***Form Approved - OMB No. 0710-0003 Expires: 01-08-2018***

The public reporting burden for this collection of information, OMB Control Number 0710-0003, is estimated to average 11 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding the burden estimate or burden reduction suggestions to the Department of Defense, Washington Headquarters Services, at whs.mc-alex.esd.mbx.dd-dod-information-collections@mail.mil. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. PLEASE DO NOT RETURN YOUR APPLICATION TO THE ABOVE EMAIL.

PRIVACY ACT STATEMENT

Authorities: Rivers and Harbors Act, Section 10, 33 USC 403; Clean Water Act, Section 404, 33 USC 1344; Marine Protection, Research, and Sanctuaries Act, Section 103, 33 USC 1413; Regulatory Programs of the Corps of Engineers; Final Rule 33 CFR 320-332. Principal Purpose: Information provided on this form will be used in evaluating the application for a permit. Routine Uses: This information may be shared with the Department of Justice and other federal, state, and local government agencies, and the public and may be made available as part of a public notice as required by Federal law. Submission of requested information is voluntary, however, if information is not provided the permit application cannot be evaluated nor can a permit be issued. One set of original drawings or good reproducible copies which show the location and character of the proposed activity must be attached to this application (see sample drawings and/or instructions) and be submitted to the District Engineer having jurisdiction over the location of the proposed activity. An application that is not completed in full will be returned. System of Record Notice (SORN). The information received is entered into our permit tracking database and a SORN has been completed (SORN #A1145b) and may be accessed at the following website: http://dpcld.defense.gov/Privacy/SORNsIndex/DOD-wide-SORN-Article-View/Article/570115/a1145b-ce.aspx

(ITEMS 1 THRU 4 TO BE FILLED BY THE CORPS)

1. APPLICATION NO.	2. FIELD OFFICE CODE	3. DATE RECEIVED	4. DATE APPLICATION COMPLETE

(ITEMS BELOW TO BE FILLED BY APPLICANT)

5. APPLICANT'S NAME	8. AUTHORIZED AGENT'S NAME AND TITLE (agent is not required)
First - William Middle - H. Last - Meredith	First - Middle - Last -
Company - DE-DNREC, F&W, Mosquito Control Section	Company -
E-mail Address - William.Meredith@delaware.gov	E-mail Address -
6. APPLICANT'S ADDRESS:	9. AGENT'S ADDRESS:
Address- 89 Kings Highway	Address-
City - Dover State - DE Zip - 19901 Country - USA	City - State - Zip - Country -
7. APPLICANT'S PHONE NOs. w/AREA CODE	10. AGENTS PHONE NOs. w/AREA CODE
a. Residence b. Business (302) 739-9917 c. Fax (302) 739-6157	a. Residence b. Business c. Fax

STATEMENT OF AUTHORIZATION

11. I hereby authorize, ________________________ to act in my behalf as my agent in the processing of this application and to furnish, upon request, supplemental information in support of this permit application.

______________________________ SIGNATURE OF APPLICANT ____________ DATE

NAME, LOCATION, AND DESCRIPTION OF PROJECT OR ACTIVITY

12. PROJECT NAME OR TITLE (see instructions)
Open Marsh Water Management in tidal salt marshes in the State of Delaware

13. NAME OF WATERBODY, IF KNOWN (if applicable) Delaware, Rehoboth, Indian River and Assawoman Bays	14. PROJECT STREET ADDRESS (if applicable) Address N/A
15. LOCATION OF PROJECT Latitude: ◦N N/A Longitude: ◦W N/A	City - State- Zip-

16. OTHER LOCATION DESCRIPTIONS, IF KNOWN (see instructions)

State Tax Parcel ID N/A Municipality N/A

Section - Township - Range - New Castle, Kent and Sussex Counties

17. DIRECTIONS TO THE SITE
N/A

18. Nature of Activity (Description of project, include all features)
Continuation of the conducting of Open Marsh Water Management in tidal salt marshes in Delaware as outlined in "Guidlines for Open Water Marsh Management in Delaware Salt Marshes - Objectives, System Design and Installation Procedures" W.H. Meredith et.al., in order to provide mosquito control by altering the topography and hydrology of salt marshes to the extent that permanent water bodies are created to provide fisheries habitat and fisheries access to mosquito breeding areas. Please see attached document for detailed guidelines on OMWM excavations.

19. Project Purpose (Describe the reason or purpose of the project, see instructions)
To conduct Open Marsh Water Management in tidal salt marshes in Delaware to control saltmarsh mosquito populations in order to protect human and domestic animal health and ensure human quality of life as often compromised by uncontrolled mosquito populations. The work will be conducted within the permitted time frame.

USE BLOCKS 20-23 IF DREDGED AND/OR FILL MATERIAL IS TO BE DISCHARGED

20. Reason(s) for Discharge
The material excavated from the salt marsh surface in OMWM excavation is spread as a thin veneer across the marsh surface in order to fill mosquito larval "pothole" habitat adjacent areas not directly addressed by the excavated features. The way the materials are deposited "on-site" across the marsh surface promote a quick re-vegetation by saltmarsh grasses local to each site.

21. Type(s) of Material Being Discharged and the Amount of Each Type in Cubic Yards:

Type Amount in Cubic Yards	Type Amount in Cubic Yards	Type Amount in Cubic Yards
TBD	TBD	TBD

22. Surface Area in Acres of Wetlands or Other Waters Filled (see instructions)

Acres N/A
or
Linear Feet N/A

23. Description of Avoidance, Minimization, and Compensation (see instructions)
OMWM activities, by their nature of their implementation on the vegetated marsh surface, cause minimal impacts to waters of the United States.

24. Is Any Portion of the Work Already Complete? ☐ Yes ☒ No IF YES, DESCRIBE THE COMPLETED WORK

25. Addresses of Adjoining Property Owners, Lessees, Etc., Whose Property Adjoins the Waterbody (if more than can be entered here, please attach a supplemental list).

a. Address- N/A. This application is for a 10-year blanket permit and will cover many OMWM projects within this time period.

City - State - Zip -

b. Address-

City - State - Zip -

c. Address-

City - State - Zip -

d. Address-

City - State - Zip -

e. Address-

City - State - Zip -

26. List of Other Certificates or Approvals/Denials received from other Federal, State, or Local Agencies for Work Described in This Application.

AGENCY	TYPE APPROVAL*	IDENTIFICATION NUMBER	DATE APPLIED	DATE APPROVED	DATE DENIED

* Would include but is not restricted to zoning, building, and flood plain permits

27. Application is hereby made for permit or permits to authorize the work described in this application. I certify that this information in this application is complete and accurate. I further certify that I possess the authority to undertake the work described herein or am acting as the duly authorized agent of the applicant.

William H. Meredith Digitally signed by William H. Meredith Date: 2022.05.23 11:22:25 -04'00' | 2022-05-23 | | 2021-12-21

SIGNATURE OF APPLICANT | DATE | SIGNATURE OF AGENT | DATE

The Application must be signed by the person who desires to undertake the proposed activity (applicant) or it may be signed by a duly authorized agent if the statement in block 11 has been filled out and signed.

18 U.S.C. Section 1001 provides that: Whoever, in any manner within the jurisdiction of any department or agency of the United States knowingly and willfully falsifies, conceals, or covers up any trick, scheme, or disguises a material fact or makes any false, fictitious or fraudulent statements or representations or makes or uses any false writing or document knowing same to contain any false, fictitious or fraudulent statements or entry, shall be fined not more than $10,000 or imprisoned not more than five years or both.

exeENVIRONMENTAL QUESTIONNAIRE
FOR CORPS OF ENGINEERS PERMIT APPLICATIONS
Philadelphia District, Corps of Engineers
Philadelphia, Pennsylvania 19107
CENAP-OP-R

INTRODUCTION AND INSTRUCTIONS

The District Engineer is required by law to assess the initial, cumulative, and long-term effects of any proposed permit on all aspects of the environment.

To speed the analysis of the probable impact of the proposed work, each applicant is required to submit appropriate environmental data as part of a permit application. We ask that you provide a thorough description of your proposed project and answer each question as it applies to the work and the results of that work. Complete and accurate answers will prevent unnecessary delays in processing your permit application

Parts I and II will be filled out by all applicants. Part I is self-explanatory. In Part II, the Environmental Impact Checklist, you should indicate the impacts of your project on all aspects of the environment that are listed. Use the space under “Qualifying Remarks” to indicate the specific impacts that your project will have. This may include types of plants or animals affected, specific adverse, beneficial, or mitigative effects, changes to existing conditions, etc. Although space for answers has been provided, you may wish to supply additional information on attached pages. If you do not anticipate an impact on a certain item, simply place a check in the “No” column.

Part III will be filled out by all applicants applying for a permit to perform dredging.

Part IV will be filled out by all applicants applying for a permit to perform filling operations. This includes activities such as filling behind bulkheads.

Refer any questions you may have concerning this supplemental form to the Regulatory Branch at (215) 656-6728.

PART I

I. PROJECT DESCRIPTION:

A. *General Site Location: Accurately locate the project site with respect to State, county, or other subdivision, and in relation to streams and rivers.*

This application, from the Delaware Division of Fish and Wildlife - Mosquito Control Section, is submitted to request renewal of a 10-year "blanket permit" which allows the Section to perform Open Marsh Water Management (OMWM) activities in New Castle, Kent and Sussex Counties, DE for the purposes of mosquito control. Given the nature and temporal/spatial scope of this application, it is not possible to predict or identify locations of all potential projects within this permit projected time period.

B. *Specific Site Locations: Completely locate the project site with respect to cove, creek, property owner, plot number, etc.*

N/A – This application requests a 10-year blanket permit and within this time frame numerous individual projects located on Federal, private, and State lands may be performed.

C. *Description of Proposed Action: Carefully describe the action proposed, including the method of construction, equipment, and materials to be used. Details in your description are important. Attach additional sheets if necessary.*

The Delaware Department of Natural Resources and Environmental Control (DNREC), Division of Fish and Wildlife, Mosquito Control Section proposes to continue performing Open Marsh Water Management (OMWM) within the tidal wetlands of New Castle, Kent and Sussex Counties, DE as the primary and preferred mosquito control technique. OMWM provides effective and permanent biological control of larval mosquito populations while significantly reducing the need to apply mosquitocide chemicals. The Delaware Mosquito Control Section has been successfully using OMWM to control mosquitoes in Delaware's tidal marshes since 1979.

OMWM will be installed in accordance with specifications presented in the attached document, "Guidelines for Open Marsh Water Management in Delaware's Salt Marshes – Objectives, System Designs and Installation Procedures", Meredith et.al 1985.

OMWM methodology involves the selective installation of small, shallow ponds and/or inter-connecting ditches superimposed on known mosquito-breeding habitats, in an effort to manage water conditions on salt marshes to the extent that mosquito breeding habitats are eliminated. Newly created permanent water habitats formed by OMWM ponds and ditches are unattractive for mosquito egg deposition while simultaneously improving habitats for mosquito-eating larvivorous fishes. It should be noted that only mosquito breeding areas of the salt marsh are candidates for OMWM and these areas are generally defined as depressional or "pothole" areas within tidal saltmarshes that have a 5-25 day "wet-dry-wet" cycle. This wet-dry cycle allows adult female mosquitoes to lay eggs on dry mud (an obligatory life cycle) and subsequently become flooded which allows eggs to hatch into the first of five aquatic developmental stages. The principal biological control agent in OMWM systems in Delaware and elsewhere in the Mid-Atlantic is the native saltmarsh killifish or mummichog (*Fundulus heteroclitus)*, which naturally quickly invades via tidal flooding any newly-created OMWM pond or ditch. In OMWM systems, scattered mosquito breeding depressions and sheet-water habitats are connected through pond and ditch excavations to allow unimpeded water flow and predatory fish movement, while isolated potholes are often filled with natural marsh soils to eliminate these smaller-sized breeding depressions.

The goals of OMWM are as follows: 1) control of saltmarsh mosquitoes, 2) reduces insecticide applications and 3) habitat enhancement for saltmarsh fisheries and wildlife. Efforts made towards achieving these applaudable goals must be made in a manner that does not have negative or secondary impacts to other saltmarsh resources. Of particular concern is that OMWM must not alter or adversely affect saltmarsh vegetation communities by significantly lowering subsurface marsh water levels or by depositing any excavated marsh spoil too high.

In light of the parameters described above, in virtually all cases OMWM systems in Delaware are installed in a manner that creates infrequently-flooded or semi-tidal permanent water bodies in the high marsh. The type of OMWM system installed is largely determined in consideration of two factors – type of mosquito breeding being addressed and concerns over long-term water quality within the OMWM ponds and ditches. Areas of the salt marsh possessing high densities of individual mosquito-breeding potholes are most effectively managed via OMWM systems that make extensive use of infrequently-flooded ponds and spur ditches. On the other hand, mosquito breeding found in areas of sheet-water, including large shallow "salt pannes" (large depressions up to a few acres in size with a rather uniform shallow depth of only a few inches) may be best treated with a "sill" outlet that creates a semi-tidal OMWM system, where a small 4"-6" tidal range is created within the OMWM ponds and ditches landward of the sill, in which ephemeral sheet water is removed from the marsh surface during ebb tides, thereby eliminating mosquito-rearing habitat but not lowering the subsurface water table to the extent that vegetation communities are significantly altered from pre-OMWM conditions.

Water quality concerns also dictate OMWM system designs, since *good water quality = good fish survival = good mosquito control*. Without a healthy predatory fish population, excavated OMWM ponds and ditches can sometimes become mosquito-breeding habitats. As such, successful OMWM systems rely upon periodic water renewal to maintain good water quality. In the high marsh, this might be only as infrequently as a few times per month in conjunction with tidal flooding near times of full or new moons which actually then mimics what happens in natural ponds and channels found in high marsh areas. This is particularly important during the summer months when high rates of biological decay can lead to low dissolved oxygen levels and other factors can lead to the oxidation of sulfur and formation of sulfuric acid, potentially causing pH as low as 3.0. Both such conditions can kill saltmarsh fishes and hence diminish good mosquito control. As such, knowledge of local saltmarsh hydrologic conditions, flooding cycles and surface elevations and topography are necessary for designing a functional and productive OMWM system. To this end, OMWM systems found in close proximity to a medium or high energy tidal source are typically installed as infrequently-flooded systems, since tidally-borne estuarine water predictably crests the creek banks and floods the saltmarsh at least a few times per month on lunar cycles. It is this flooding that rejuvenates water quality in such OMWM systems. On the other hand, many marshes (or portions of larger marshes) in Delaware are located in areas where even these infrequent tidal exchanges might not occur often enough to maintain good water quality. These tidally-limited marshes may be completely natural areas, whereas other tidally-limited marshes might be anthropogenically created or altered through road and canal construction or other means of habitat disruption. On marshes where at least some surface flooding cannot be predicted or reliably expected, water quality in OMWM systems can be ensured via installation of the semi-tidal sill outlets. The installed sills allow a limited amount of tidal exchange, while still maintaining a stable baseline water level within the designed system.

The primary mosquito species targets of OMWM are *Ochlerotatus sollicitans, Oc. cantator, Aedes taeniorhynchus, Culex salinarius and Anopheles bradleyi*. These species breed on tidal salt marshes and have a conservative flight range of 5-12 miles and as such have the ability to compromise human quality of life and local economies at locations very distant from wetlands. In addition, *Oc. sollicitans* is a primary vector species of Eastern Equine Encephalitis (EEE) – a mosquito-borne disease that fatally affects horses and humans. In addition, *Cx. salinarius* and the Culex genera are the primary vectors of West Nile Virus to humans and horses.

OMWM is a mosquito control technique that has been successfully used in Delaware since 1979 and is supported as the ideal means of mosquito control by the Delaware Coastal Management Plan. Part II of this Plan's Final Environmental Impact Statement, Section 5.C.3 states that "mosquito and other pest controls shall use techniques of marsh management which reduce the application of chemicals and …substitute biological control (through fish predation)."

D. <u>*Purpose of Proposed Action*</u>*: Define the purpose of the proposed structure or work. For example, the purpose of bulkheading may be to stabilize an eroding bank; whereas, the purpose for a pier may be for the mooring of a private boat, for access to a public or privatefacility, for a marina, or for another purpose.*

OMWM is installed for the primary purpose of mosquito control. And mosquito control is necessary for the residents, visitors and businesses within the State of Delaware. Lowered mosquito populations result in increased quality of life, decreased risk of contracting a mosquito-borne disease and enhanced economic gains.

E. *Submit color photographs of the site, with explanations of the views shown (prints only). Photographs help us to better understand your project. The more photographs you provide, the easier it is to understand and process your application.*

N/A – 10-year blanket permit covering numerous projects.

PART II – ENVIRONMENTAL IMPACT CHECKLIST			
ENVIRONMENTAL IMPACT	**YES**	**NO**	**QUALIFYING REMARKS**
A. Physical			
1. Topography	X		Slight alterations – 2-4”
2. Geological Elements and Leaching		X	
3. Air		X	
4. Transportation		X	
5. Handling of Hazardous Materials		X	
6. Spoil Disposal		X	
7. Sewage and Solid Wastes		X	
8. Water Resources			
a. Water Quality		X	
b. Hydrography, Circulation, Littoral Drift.	X		Positive effects
c. Ground Water		X	
B. Biological			
1. Vegetation			
a. Terrestrial		X	
b. Aquatic	X		Increases
2. Fish and Wildlife			
a. Mammals		X	
b. Birds		X	
c. Amphibians		X	
d. Reptiles		X	
e. Fish	X		Increases
f. Shellfish		X	
g. Invertebrates	X		Increases
3. Rare or Endangered Species		X	

ENVIRONMENTAL IMPACT	YES	NO	QUALIFYING REMARKS
C. Cultural			
1. Land Use		X	
2. Population Density and Trends		X	
3. Regional Development		X	
4. Historic Places		X	
5. Archaeological Sites		X	
6. Aesthetics		X	
7. Utilities		X	
8. Transportation Systems		X	
9. Recreation		X	
10. Public Health	X		Positive effects
D. Other Factors			
1. Secondary Effects		X	
2. Controversiality		X	
3. Is significant dredging involved?		X	
4. Is significant filling involved?		X	

Part III

Considerations of a Dredging Proposal:

A. *Describe characteristics and locations of the proposed dredged material disposal site. Providephotographs.*

There is no single "disposal site" of dredge material in OMWM activities. All excavated materials (spoil) from the salt marsh surface in the creation of OMWM ponds and ditches are thinly spread "on-site" and across the adjacent salt marsh surface. Research and 25-years of continued field observations have found that when spoil is thinly spread across the marsh surface (between 2 and 4", depending upon physical characteristics of each marsh) there is no resultant change in floral communities upon re-vegetation. Re-vegetation generally fully occurs within 6-18 months.

B. *Is there a comprehensive plan for disposal sites that takes into account the accumulative effectover time and the decreasing amount of suitable sites for disposal?*

No. There is no disposal of dredge material in OMWM activities. All excavated materials are thinly spread on site and across the surface of the salt marsh.

C. *Describe the present land use of the disposal site.*

N/A. Please see "B" above.

D. *Describe characteristics of the material to be disposed, including:*

1. *Physical source of material (i.e. sand, silt, clay, etc.) Give percentages of the variousfractions if available.*

   Excavation materials are excavated from OMWM ponds and ditches and deposited on-site and in a thin veneer adjacent to the ponds and ditches. This material is used to fill mosquito-breeding depressions. As stated previously, this application is for a 10-year blanket permit to perform OMWM activities. As such, project sizes and materials to be excavated vary according to each site and site needs. It can be generally assumed that spoil resulting from OMWM excavations occurring within salt marshes along Delaware Bay will consist of primarily organic materials while those excavations from the Inland Coastal Bays will be primarily mineral (sand/clay) based.

2. *Chemical composition of material: Many areas, especially marinas, highly industrialized areas, etc., have sediments with high concentrations of pollutants (chemicals, organic material, etc.). These materials may be re-suspended or reintroduced into the water and result in serious environmental damage. If your proposed dredging is in an area such as described above, a chemical analysis of thematerial to be dredged should be provided.*

   N/A. OMWM excavations take place in salt marshes and in areas where high concentrations of industrial pollutants and other contaminants would not be expected to be found.

3. *Dewatering properties of the material to be disposed.*

   There is no actual disposal of any excavated materials, only removal of OMWM-excavated materials from one area and thinly spread in the immediately adjacent area. Water from the excavated material quickly re-assimilates back into the normal hydrological patterns of the salt marsh.

4. *Compactability of material and settling rates of material to be disposed.*

   As stated previously, this application is for a 10-year blanket permit to perform OMWM activities. Many projects at many locations will be performed during this time period and it is impossible to now characterize the materials that will eventually be found. It can be generally assumed that spoils resulting from OMWM excavations occurring within salt marshes along Delaware Bay will consist of primarily organic materials and have a low aquatic settling rate and high compactability while those excavations from the Inland Coastal Bays will be primarily mineral (sand/clay) based and have a higher aquatic settling rate and low compactability (realizing that "compactability" does not equate to "hardness").

5. *Dredging and disposal schedule to insure that operations do not degrade water qualityduring times of anadromous fish migration.*

   N/A. OMWM excavations occur in salt marshes and generally are not directly connected to tidal estuaries and as such, the ability of excavated materials to become suspended and negatively affect water quality where anadromous fishes are present is negligible.

E. *When the project involves land disposal, discuss the following:*

1. *Method of disposal to be utilized, i.e., pipeline discharge, barge, hopper (underway orstationary).*

   The majority of OMWM excavations occur with specialized wetland excavating equipment called a "pontoon excavator." This machine is similar to a typical hydraulic excavator found on any construction site but is structurally modified for use on salt marshes by the addition of two large water-tight tracking pontoons which not only makes the unit amphibious but also reduces the ground pressure to less than 2 psi. Pond and ditch excavation is realized through a snowblower-like, hydraulically-controlled "rotary" cutting head. The cutting head emulsifies soils with available water and shoots this mixture across the salt marsh in a thin veneer up to 70 feet from the site of excavation. Excavated materials are deposited and spread on-site in a thin veneer adjacent to the OMWM feature. This material is carefully managed, as previously described, in an effort to ensure that marsh elevation changes do not cause widespread, undesirable vegetation changes.

   Additionally, some OMWM excavations occur with a traditional tracked hydraulic excavator. In such cases, spoil is reduced and spread on-site with either the excavator or a specially modified low-ground pressure bulldozer or front-end loader.

2. *Describe method of dredged material containment (i.e. embankment, behind bulkhead, etc.)*

   There is no containment of excavated materials occurring from OMWM. Since spoil deposition is significantly low (elevation), placed on lands with no topographic relief and quickly re-vegetated – all indicating very minimal potential for erosion = no containment is needed.

3. *What type of leachates will be produced from the spoil material and what is plannedfor protection of the groundwater?*

   Through OMWM excavations, there is no anticipated discovery of leachates that would be of concern for groundwater contamination. All OMWM excavations take place in salt marshes where leachates and/or potential groundwater contamination would not be expected to be found. Additionally, all OMWM excavations occur with 36" of the marsh surface and 90% occur with 24" and as such, if any potential contamination were actually within the saltmarsh, leaching would have already naturally occurred within this upper layer of the marsh surface before OMWM installation.

4. *Methods to insure that spoil water does not adversely affect water quality, both duringconstruction and after completion of the project.*

   OMWM installation occurs at a relatively slow pace and the area of excavation at any one point in time is relatively small with the rate of actual excavation generally less than 3 acres per month/per site. In addition to the slow rate of excavation, OMWM excavations do not generate any significant amount of spoil water as compared to a "typical" dredge operation using large diesel engine powering a 100,000 gallon per hour pump and discharging through a 6-18" pipe. When excavations occur with the specialized amphibious excavating machinery, spoil is emulsified with water and the material is discharged over the marsh surface were natural grasses slow and trap surface discharge water and allows this water to filter back into groundwater. As previously discussed, excavations are generally not directly connected to tidal estuaries and as the ability of excavated materials and/or spoil water to enter a tidal estuary and have a negative effect on water quality is negligible.

5. *Provisions for monitoring during discharge: water quality, sediment transport, andprecautions to prevent "short-circuiting" dumping.*

   None. The volume of discharge water generated by OMWM is extremely small as compared to a typical dredge operation. Sediment transport is equally small and potential negative effect of this transport to off-target sites is of little concern as virtually all discharge water is immediately slowed and trapped by local emergent vegetation and re-assimilated back into ground water.

F. *Consider and discuss the following for water disposal:*

1. *Describe methods to be used for water disposal, including volumes and site selection.*

   None. OMWM generates a minimal amount of discharge water.

2. *Describe the existing water characteristics at the site, including chemical analysis forwater quality.*

   N/A. This application is for a 10-year blanket permit to allow performance of Open Marsh Water Management (OMWM) activities within the salt marshes of New Castle, Kent and Sussex Counties, DE for the primary purposes of mosquito control. As such, it is impossible to predict or identify locations of all potential projects within this projected time period nor is it possible to state the existing water quality or characteristics at all potential OMWM sites. It can be stated that surface water quality at the site of excavation would be typical of that found on salt marshes on a temporal-yearly basis.

G. *Discuss the frequency and amount of maintenance dredging which will be required; discussthe resulting impacts.*

The lifespan of OMWM is between 15 and 25 years – after this time period, many OMWM features have silted and filled to the extent of being non-functional. Higher rates of aging are discovered in OMWM systems installed in organic marshes and in marshes associated with estuaries carrying a high sediment load and which frequently flood the marsh surface.

H. *Alternatives.*

1. *Discuss all alternatives to the project, including the "no action" alternative.*

There exist several alternatives to the proposed action of using OMWM installation on salt marsh as a means of mosquito control. These include:

1. No action
2. Control all mosquito populations through adulticide chemical
3. Control larval mosquito populations through applications of bacterial stomach toxins (Bti and Bs chemical formulations)
4. Control larval mosquito populations through applications of growth regulator compounds (methoprene)
5. Re-establish a network of parallel grid-ditches
6. Re-establish a program of saltmarsh impoundment installation and dyke excavation on mosquito breeding marshes
7. Establish a biological control program of stocking mosquito breeding salt marshes with predatory fishes

In evaluating the practicality and suitability for mosquito control of each of these alternatives, the following minimum standards should be considered.

1) The alternative should reduce treated *Aedes* and *Ochleratus* mosquito populations by at least 90%. This level of mosquito control should be achieved over a wide range of environmental conditions and as typically found on Delaware's salt marshes in space and time.
2) The alternative should have a long-term mosquito control effect such that the application of repeated treatments is un-necessary.
3) The alternative should result in a substantial reduction in chemical insecticides applied by the State for mosquito control.
4) The initial cost of the alternative should be reasonably low.
5) The long-term cost of the alternative should be reasonably low.
6) The alternative should be compatible with the long-range salt marsh management plans of the State and other interested parties. This would include enhancing or improving saltmarsh resources such as waterfowl, shorebird, wading bird, fisheries and furbearing mammal habitat. Additionally, the chosen alternative should have the capability of restoring historic salt marsh function and resources altered by previous marsh management practices.
7) Non-target organisms should not be unacceptably and adversely affected by the mosquito control alternative.

Alternative 1 (no action) should be immediately dismissed as Delaware Code (Title 16, Sec. 1902 &1903) requires that the State provide mosquito control efforts for protecting public health and quality of life.

Alternative 2 (application of adulticides) is an effective form of mosquito control and often yields >90% mosquito reduction but has no long-term mosquito control effects and places a greater emphasis on chemical applications. The initial cost would be low ($3.75 – 4.00/treated acre) but would have no effect on improving saltmarsh resources. Effects on non-targets, on a large scale, ecosystem level would be none-minimal.

Alternative 3 (application of bacterial compounds for larval control) is often an ineffective form of mosquito control on salt marshes yielding sporadic results with a strong temporal correlation (i.e., bacterial larvicides are often very effective in the cooler months of April, May, June and October for saltmarsh mosquito control and significantly less effective in the warmers months of July, August and September). Saltmarsh mosquito reduction is often less than 90% in these warmer months of the mosquito season. There is no long term or residual mosquito control with this alternative. The initial cost of this option is relatively low ($8.50/treated acre) but has no effect on improving saltmarsh resources. Effects on non-targets, on a large scale, ecosystem level would be none-minimal.

Alternative 4 (application of growth regulating compounds for larval mosquito control) is often very effective for saltmarsh mosquito control with less temporal concerns than bacterial larvicides. There is no long term or residual mosquito control with this alternative. The initial cost of this option is relatively low ($9.00/treated acre) but this chemical application has no effect on improving saltmarsh resources. Effects on non-targets, on a large scale, ecosystem level would be none-minimal.

Alternative 5 (installation of parallel grid-ditches on salt marsh) as a means of mosquito control is a program started in the mid 1930's as an effort to improve natural resources and to provide a work initiative to remove the U.S. from economic depression. Ditches were indiscriminately dug at 100-150 ft intervals across all sections of the salt marsh regardless of the mosquito breeding potential. Ditches were tidal and designed to remove surface and sub-surface water with the intent of "no water = no mosquitoes". As a result of this water removal, significant and well documented changes in the saltmarsh floral and faunal communities resulted to a degree that would be grossly unacceptable by today's standards of environmental stewardship. In addition, grid ditching was only moderately effective as a mosquito-control agent often only yielding 50-70% mosquito reduction on treated marshes which is an unacceptable wetland management tool and would continue to require the State to rely on chemical treatment of target mosquito populations. For these reasons, the use of parallel grid ditches as a mosquito control agent on Delaware's salt marshes should be dismissed.

Alternative 6 (controlling saltmarsh mosquitoes through the installation of saltmarsh impoundments). At present, the State of Delaware actively owns and manages five impoundments and impoundment systems. These impoundments were originally installed for the purposes of mosquito control, which was achieved by keeping dyked wetlands continuously flooded and unsuitable for egg laying by most saltmarsh mosquitoes. In recent years, the value of these dyked wetlands to a variety of wildlife and fisheries species has been better appreciated and as a result, the management strategies of these resources have changed. Despite the change in management, the degree of mosquito breeding on these marshes has not appreciable increased. Unfortunately, despite being a valuable multi-objective wildlife/fisheries/mosquito control management tool, impoundment construction is not feasible primarily due to wetland permitting issues. In addition, impoundment installation tends to be very costly and typically does not provide the high level of mosquito control that the public has come to expect. As such, Alternative 6 should be dismissed.

Alternative 7 (stocking predatory mosquito fishes on breeding salt marshes to act as a biological control agent). It should be recognized that the shallow potholes, natural depressions and areas of sheet-water that breed mosquitoes on salt marshes are ephemerally wet and dry. This wet-dry cycle and is driven by precipitation, lunar tides, evaporation, and transpiration. It is this "wet-dry" cycle that is necessary for saltmarsh mosquitoes to complete its lifecycle. As such, large broods of mosquitoes are generally observed after a multi-day dry cycle followed by a wet cycle. Since fish would perish during the natural saltmarsh “dry cycle”, fish would have to be manually stocked on hundreds-thousands of individual potholes and mosquito breeding depression per acre of salt marsh on possibly a 2–3-week cycle, 6 months per year. Given the several thousand acres of mosquito breeding salt marshes in Delaware, this Alternative is logistically impossible and should be dismissed.

2. *Discuss alternative types and methods of dredging and disposal, such as pipelinedischarge, barging, or hopper method.*

   N/A. Only those methods of OMWM construction described above in E1 are environmentally acceptable forms of excavation.

3. *Discuss alternatives to dredging.*

   N/A. For OMWM to occur, excavations must occur.

4. *Discuss alternative areas of sites for spoil disposal.*

   N/A. OMWM spoils are used on-site to fill mosquito-breeding depressions. It would be impracticable and environmentally damaging to excessively transverse the salt marsh with heavy equipment to remove spoil from the site.

5. *Discuss impact of port docking patterns upon the demand for dredging. Can alternative patterns reduce the amount of dredging required to support port operations?*

   N/A. There is no port or vessel docking with OMWM. Land-based machinery is used in OMWM.

6. *Support alternative means of construction that would prevent or minimize water qualitydegradation using EPA standards for guidance.*

   N/A. OMWM excavations occur only in mosquito breeding areas.

7. *State in detail impacts resulting in alternative locations for the proposed project.*

   N/A. Again, OMWM excavations occur only in mosquito breeding areas.

Part IV

<u>CONSIDERATIONS OF A FILLING PROPOSAL:</u>

A. *Describe in detail the existing characteristics of the area proposed for filling (i.e. aquaticarea, marsh, mudflat, swamp, etc.). In your description, be sure to include the types of vegetation present and the types of animals that use the area. Provide photographs.*

This application, from the Delaware Division of Fish and Wildlife, Mosquito Control Section, is submitted to request renewal of a 10-year "blanket permit" which allows the Section to perform Open Marsh Water Management (OMWM) activities in New Castle, Kent and Sussex Counties, DE for the purposes of mosquito control. Given the nature and temporal/spatial scope of this application, it is not possible to predict or identify locations of all potential projects within this permit projected time period and as such, impossible to exactly characterize the conditions of the fill areas used in the OMWM technique. It should be recognized that OMWM occurs within salt marshes and the vegetation typical to salt marshes in DE includes *Spartina alterniflora, S. patens, Distichlis spicata, Juncus, Salicornia, Aster, Lythrum lineare, Iva/Baccharis,* and *Scirpus*. Animals present are those fauna typical of salt marshes. The Delaware Mosquito Control Section has a long and positive working history with an inter-governmental review committee, with representative members from the USFWS, ACOE, USEPA, Delaware Wetlands Section, Delaware Natural Heritage, National Marine Fisheries and Cultural Affairs (historical preservation). This review agency ensures that OMWM designs do not have any unseen potential negative impacts on salt marsh resources including rare and endangered species.

B. *Give the following information in regard to the project size:*

1. *Total area to be filled.*

   Cannot determine total as each project within the next 10 years will have differing sizes and differing fill areas. It should be noted that spoil excavated from OMWM features (ponds and ditches) is generally spread across the marsh surface in order to fill adjacent microtopography. Additionally, spoil is spread across the existing marsh surface in a thin veneer up to 4" deep upon initial deposition and after water removal settling to a final deposition of 2-4" above the previous marsh grade. This thin layer of spoil has been demonstrated in the scientific literature and by scientific observation to cause no significant change in floral composition.

2. *Size of underwater area to be filled.*

   None.

3. *Area of intertidal zone to be filled.*

   None. OMWM spoil is not spread in non-vegetated inter-tidal zones such as mud flats or river/creek banks.

4. *Area of wetlands to be filled.*

   At present, it is impossible to determine the percentage or area of OMWM spoil (fill) that will be deposited in wetland areas on future and still unplanned OMWM projects as this application is for a 10-year blanket permit.

5. *Proposed height of fill.*

Generally, OMWM spoil (fill) is placed only 2-4" above marsh grade on most projects.

6. *Volume of material that will be used in filling.*

The volume of fill material used will be determined by the size of the OMWM excavation as all spoil generated from excavations becomes on-site fill. OMWM ponds range in depth from 6-18" and generally vary in size from 0.05 to 1.0 acres with pond width rarely exceeding 100 ft. OMWM ditch excavations vary in length from just a few feet up to several thousand feet with an average uniform depth of 30".

C. Describe in detail the material to be used as fill including as follows:

1. *Type of fill to be used (sand, stone, rubble, etc.). If the material is a composite (i.e., rubble), list the types of materials it will contain.*

Fill material-type generated by OMWM is the material generated via saltmarsh excavations and as such the type of fill to be used is determined by the local salt marsh substrate. Salt marshes around the Inland Coastal Bays of the Atlantic coast often have a mineral sand base while those marshes along the Delaware Bay estuary are high in organic material.

2. *Give the specific location of the source of this material.*

From OMWM excavations.

3. *What types of leachates will be produced from the fill material and what is planned for protection of surface and groundwater?*

Through OMWM excavations, there is no anticipated discovery of leachates that would be of concern for groundwater contamination. All OMWM excavations take place in salt marshes and, as such, in areas where leachates and/or potential groundwater contamination would not be expected to be found. Additionally, all OMWM excavations occur within 36" of the marsh surface and 90% occur within 24" and, as such, IF any potential contamination were actually within the salt marsh, leaching would have already naturally occurred within this upper layer of the marsh surface.

D. Carefully describe the method of fill, including the following:

1. *Method of fill placement, including equipment used in deposition and grading.*

Fill material (spoil generated from OMWM excavation) is deposited on the marsh surface using a machine, specially designed for this type of mosquito control saltmarsh excavation, called a "pontoon excavator" with a "rotary'' cutting head. This machine digs OMWM features by emulsifying available water along with the marsh substrate, doing this emulsification with a high-speed cutting blade and then "shoots" this spoil slurry up to 70 ft away from the digging site. The spoil is deposited in a thin veneer as previously described and this spoil is used to fill shallow mosquito breeding depressions on the salt marsh. There is generally no grading employed when using the rotary ditcher.

In some cases, particularly when digging OMWM in hard substrates such as clays and sands, a low-ground pressure hydraulic excavator is used. The spoil is graded using either the excavator or a low-ground pressure bulldozer or front-end loader.

2. *Method of stabilization of banks from erosion, sloughing, wave action, boat wakes, etc.*

   N/A. OMWM spoil is deposited on the marsh surface and away from areas where erosion of spoil or natural wetland features would be of concern.

3. *Method of stabilization of the surface of the fill.*

   None. Over the course of 25 years of the State of Delaware performing OMWM techniques, no observation has been made to indicate that stabilization of discharged spoil on the saltmarsh surface is required to minimize erosion. The lack of erosion is attributable to several factors including: 1) flat topography – salt marshes have no topographical relief which is necessary for erosion, 2) spoil (fill) that is generated in OMWM is thinly spread across the marsh surface and is quickly re-vegetated by local marsh grasses, which minimizes any potential concern for erosion, and, 3) the relatively slow rate of OMWM progress and relatively quick rate of natural re-vegetation yields an acceptably low percentage of the entire marsh surface which is covered by new spoil.

4. *Length of time needed for completion of the project. State if filling will be continuous, intermittent, etc.*

   N/A. Within the 10-year permit period, many individual projects will be completed, all with varying sizes and time needed for completion. OMWM projects should be considered continuously operating.

5. *Method of controlling turbidity when filling an underwater area.*

   N/A.

E. Purpose of the Project:

1. *What is the intended use of the filled area?*

   There is no intended use of the fill area after OMWM is completed.

2. *What structures, if any, will be constructed on the fill?*

   None.

3. *What benefits would you gain from the proposed fill?*

   Generation of spoil (fill) is a necessary product of OMWM installation. OMWM is installed for the primary purpose of mosquito control, with the spoil being used in part to fill mosquito breeding depressions. And mosquito control is necessary for the residents, visitors and businesses within the State of Delaware. Lowered mosquito populations resulting in an increased quality of life, a decreased risk of contracting a mosquito-borne disease and an enhanced economic gain.

F. Alternatives

1. *Discuss the "no action" alternative and how this would affect your present and futureplans for the development of the area.*

   The "no action" alternative would mean that OMWM would no longer occur within the State of Delaware and would require the State Mosquito Control Section to abate mosquito populations through the repetitive applications of mosquitocides. The State could do this through the application of both larvicides and adulticides. OMWM is the preferred method of achieving mosquito control because: 1) Cost Effectiveness – OMWM systems last from 15-25 years while chemical control lasts only a few days. The high initial cost of OMWM installation is generally offset after 7 years of reduced/eliminated insecticide treatments, 2) Efficacy – OMWM is a more effective form of mosquito control, 3) Resource Enhancement – OMWM offers not only mosquito control benefits but also the ability to return a significant amount of open water and stable (non-tidal) bodies of water back to salt marshes similar to that which existed prior to grid-ditching practices. These bodies of water are beneficial to many wildlife species and, 4) Reduced Mosquitocide Applications - the application of mosquitocides is controversial as non-target impacts may have been purported.

2. *Discuss alternative locations for the proposed fill.*

   Spoil generated on-site from OMWM pond/ditch excavation has historically been deposited on-site and adjacent to the site of excavation. As previously discussed, this spoil is used to fill adjacent mosquito breeding sites and to promote the surface flow of water away from potential mosquito breeding areas. The alternative to on-site spreading is to carry spoil off-site (off the salt marsh) which would be accomplished via front-end loader and dump truck and ultimately depositing this material in an acceptable location. If this alternative was accepted, not only would all OMWM excavations be larger in scope and result in greater salt marsh topographical change, the additional mandated time and cost for OMWM installation would make OMWM as a mosquito control option prohibitive.

3. *Discuss the use of elevated structures (i.e. causeways, elevated platforms, etc.) in placeof the proposed fill.*

   N/A. Elevated structures are not part of, or needed in, OMWM techniques.

4. *Discuss any other alternatives you have considered prior to formulating the presentlysubmitted proposal.*

   See III(H)(1) above for a full description of the available OMWM alternatives.