George Wuerch, Mayor

Anchorage Storm Water Treatment in Wetlands: 2002 Guidance

Document No. **WMP CPg02003**

MUNICIPALITY OF ANCHORAGE
WATERSHED MANAGEMENT PROGRAM

NOVEMBER 2002

WATERSHED MANAGEMENT

Office of Planning, Development & Public Works

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WATERSHED MANAGEMENT

Office of Planning, Development & Public Works

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Acronyms

BMP	Best Management Practice
cfs	cubic feet per second
DCM	Design Criteria Manual
DPW	Department of Public Works
MOA	Municipality of Anchorage
NPDES	National Pollution Discharge Elimination System
OPDPW	Office of Planning, Development, and Public Works
PM&E	Project Management and Engineering
WMS	Watershed Management Section

Summary

Guidance Purpose

The WMS is required to provide guidance in the design of controls for the discharge of storm water to wetlands. Current WMS guidance is focused on two primary goals:

1. Identification of simple pretreatment best management practices (BMPs) to mitigate the impacts of storm water discharges on wetlands, and
2. Development of planning-level tools for use in identifying and designing suitable storm water pretreatment for specific Anchorage wetlands.

Obviously, a complete guidance must also address the *suitability* of a wetland to receive storm water. However, current guidance only generally addresses approaches that might be applied to this task. The suitability of a specific wetland for receiving storm water can be based in part on a technical estimation of the ecologic and hydrologic character of the wetlands. However, suitability is also a function of the more subjectively determined social value of the wetlands (based on *all* its available possible uses including storm water mitigation). Determination of the suitability of any Anchorage freshwater wetland for any use (including receiving storm water) is in part in place in the MOA's Wetland Management Plan, though guidance in these determinations continue to be refined as the MOA maps and assesses wetlands under ongoing programs. In any event, the user should be aware that the suitability of a specific wetland to receive storm water runoff from developed basins is only generally addressed in the current guidance. Ultimately the suitability of specific wetlands for receiving storm water discharges will be determined through the appropriate permitting process for the wetlands in question.

Hydraulic Modeling and Wetland Performance

Wetlands can benefit by receiving storm water discharge as a result of the rehydration that is otherwise lost to these features as urbanization reduces overall infiltration. However, practices for discharging storm water to wetlands must protect against inundation and the development of integrated flow across the wetland surface and must result in a net social benefit. The model developed for this guidance addresses both hydraulic design and cost benefit analyses. The simple spreadsheet-driven model described in the guidance allows planners and designers to estimate the hydraulic response of specific Anchorage wetlands to any storm water discharge hydrograph. Based on this analysis a designer can estimate threshold detention and bypass pretreatment controls that are most likely to allow discharge to and rehydration of the wetland without incurring significant hydraulic damage to the wetland feature. The model also approximates the value of the service the wetland provides by estimating costs to construct a man-made basin with a detention capacity equivalent to the wetland.

The hydraulic routing part of the model is based on the assumption that just a few surface characteristics of Anchorage wetlands determine the predominant hydraulic response of a wetland to surface water flow. These characteristics include vegetation, soil and slope. Model performance proved most sensitive to the first level vegetation classes in Viereck's Alaska Vegetation Classification. The applicability of a simplified vegetation classification is useful as it also makes mapping tasks required for design relatively simple. The model is much less sensitive to soils. This was expected as moisture retention in all wetland soils is high and available soil void space is typically limited except near the surface. Finally, the model is quite sensitive to very flat slopes and steeper slopes. At slopes less than 0.05% ponding may locally overwhelm flow and the model may underestimate detention. At slopes much greater than 25% integration of surface flows reduces the effective detention capacity of the wetland and the model may overestimate wetland detention.

The cost model is designed to estimate the service value of a natural wetland in providing storm water detention. This module designs and estimates costs for a pond sized to meet current MOA Design Criteria, with an active pool capacity equivalent to the hydraulic detention provided by the wetland.

The hydraulic and cost models were applied to four Anchorage wetlands to test the performance of the model and to provide an estimate of the possible range of storm water detention service available from low-sloping Anchorage wetlands. Hydraulic model results suggest that the tested Anchorage wetlands have a capacity to store 60 to 90 percent of the MOA 2-year 6-hour water quality design storm, and would reduce the peak 5-minute flow by 90 to 95 percent. Similar model runs for these wetlands using flows from a 100-year rainfall event show reductions remain significant, with 5-minute peak reduction still at 80 to 90 percent. Obviously these results will depend on the relative size of the wetland and its contributing storm water basin. However, observation of the response of a number of Anchorage wetlands to recent, unusually high rainfall suggests the model may be conservative (i.e., underestimate storm water detention and transport capacity of the wetlands). Specifically, the model does not address interflow as a water transport mechanism, a process that can lead to rapid recovery of wetland detention storage with time. This process appears to be significant in those Anchorage wetlands that have a predominant vegetation type other than aquatic herbaceous.

Analysis of the test wetlands using the cost model suggests the wetlands also have a good cost performance compared to constructed detention facilities. Analysis of the selected wetlands using the cost model indicates that equivalent detention ponds built to replace the services provided by the natural wetlands would require a footprint of 16 to 37 percent of the effective wetland area (the area actually participating in storm water treatment), and capital costs of $500,000 to 1,980,000.

Pretreatment BMP Recommendations

Pretreatment BMPs for use in discharging storm water to wetlands are described in some detail in the national literature. Applicability of specific BMPs to Anchorage conditions focuses on the pollutants peculiar to our area. Based on current understanding of Anchorage conditions, these include seasonally increased particulate and chloride loading. As for urban runoff nationwide, Anchorage BMPs must also address means to prevent elevated runoff peaks from overwhelming natural wetlands through prolonged inundation, or development of high energy, integrated flow paths (hydraulicking). Recommended pretreatment management practices for storm water discharge to wetlands in this guidance focus on these issues. Recommendations are briefly summarized below.

- **Suitability:** Address general wetland suitability for receiving storm water discharges through existing permitting processes and through new mapping currently being performed staff of the Office of Planning, Development and Public Works.
- **Design:** Analyze wetland hydraulic capacity, using tools developed under this guidance, in order to identify threshold hydraulic capacity of wetlands and to appropriately size storm water bypass structures.
- **Grit Settlement:** Install grit settlement basins as pretreatment facilities at storm water outfalls prior to discharge to natural wetlands. Design settlement basins to remove 80% of particles greater than 100 microns in diameter from all MOA water quality design storm events.
- **Sorbent Booms:** For storm water basins that drain off-street paved parking exceeding five acres, or major or minor arterial streets exceeding 2 acres in area and comprising more than 25 percent of the total road area in the basin, install and maintain a sorbent boom or other surface oil trapping technology.
- **Flow Spreaders:** Install flow spreaders at all storm water discharge points to wetlands to promote non-integrated flow across the receiving wetlands.
- **Wetland Storm Bypass:** Install side discharge-type bypass weirs upstream from all pretreatment devices to divert flows exceeding the hydraulic threshold capacity of the receiving wetlands. Flows exceeding the hydraulic threshold capacity may not be discharged to the wetlands.

- **PreTreatment Storm Bypass:** Install a side discharge-type bypass structure around the grit settlement basin for flows that do not exceed the hydraulic threshold capacity of the receiving wetlands but that do exceed the design capacity of the grit settlement basin. These flows may be discharged to the wetlands through the flow spreader.
- **O&M Plan:** Document and implement an operations and maintenance plan for all pretreatment facilities that describes maintenance practices for the flow diversion weir(s), grit separator basin, sorbent boom and level (flow) spreader. Include schedules for cleaning the grit settlement basin, flow spreader and diversion weir(s), and for replacing the sorbent boom.

Introduction

Guidance described in this document was compiled by MWH under MOA Office of Planning, Development and Public Works (OPDPW) Watershed Management Section WMS Project No. 95003. Field investigations and model development were performed to meet project requirements defined in the Municipality's National Pollutant Discharge Elimination System (NPDES) storm water discharge permit (No. AKS05255-8). Part 3.1.3 of Appendix A of that permit requests guidance for the use of natural wetlands to treat of storm water discharged in Anchorage.

Background

The federal Clean Water Act established the NPDES program. Regulations for that program defines wetlands (40 Code of Federal Regulations 122.2) as: "Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas." Wetlands have all three of the following: 1) the presence of water, 2) a majority of plant species adapted to wet conditions, and 3) soil types that have developed due to groundwater. Approximately 11,292 acres of freshwater wetlands have been mapped throughout the entire Municipality (excluding military lands), as described in the MOA Wetlands Management Plan (MOA, 1996). The MOA OPDPW's Physical Planning Division and WMS continue to map and inventory wetlands within the MOA.

Wetlands are known for their ability to filter water and attenuate peak flows. Large portions of Anchorage were wetlands prior to development. These wetlands are frequently found to be fed by groundwater. Currently, wetlands are used for discharge of storm water in Anchorage and this practice is helping to preserve remnant wetland areas that have been isolated from their historic water sources. As development has occurred, and the areal extent of wetlands has decreased, discharge to creeks has increased. As development continues, it is expected that more wetland area will be reduced.

This document summarizes a procedure to characterize the hydraulic characteristics of wetlands and to evaluate the costs of replicating those characteristics with sedimentation basins.

It also recommends BMPs for storm water discharges into natural wetlands.

Intent and Objectives of Project

To establish guidelines for the applicability of discharging storm water to wetlands in Anchorage, the following must be determined:

- Suitability of wetlands to receive storm water through identifying wetland thresholds for physical, chemical, and biological processes affected by storm water inflow
- Performance of wetlands in treating physical and chemical impacts of storm water discharges
- Performance of wetlands in treating hydraulic impacts of storm water discharges

As stated in the first bullet, a complete guidance must also address the *suitability* of a wetland to receive storm water. However, current guidance only generally addresses approaches that might be applied to this task. The suitability of a specific wetland for receiving storm water can be based in part on a technical estimation of the ecologic and hydrologic character of the wetlands. However, suitability is also a function of the more subjectively determined social value of the wetlands (based on *all* its available possible uses including storm water mitigation). Determination of the suitability of any Anchorage freshwater wetland for any use (including receiving storm water) is in part in place in the MOA's Wetland Management Plan, though guidance in these determinations continue to be refined as the MOA maps and assesses wetlands under ongoing programs. In any event, the user should be aware that the suitability of a specific wetland to receive storm water runoff from developed basins is only generally addressed in the current guidance. Ultimately the suitability of specific wetlands for receiving storm water discharges will be determined through the appropriate permitting process for the wetlands in question.

The WMS is required to provide guidance in the design of controls for the discharge of storm water to wetlands. This WMS guidance is focused on the following two primary goals:

- Identification of simple pretreatment best management practices (BMPs) to mitigate the impacts of storm water discharges on wetlands, and
- Development of planning-level tools for use in identifying and designing suitable storm water pretreatment for specific Anchorage wetlands.

The planning-level tools developed here are focused on identifying the hydraulic performance of wetlands. In particular, this guidance identifies means for mitigating storm flows and serves as a planning level tool for quantifying the hydraulic impacts of storm water on wetlands. Specific objectives for developing these planning-level tools include the following:

- Acquiring wetlands data that can be used to describe the hydraulic characteristics of wetland types in Anchorage
- Developing a model to simulate the hydraulics of natural wetlands when subjected to 2-year and less frequent storm inflow hydrographs
- Testing the model using wetland data acquired
- Determining the cost of comparably sized sedimentation/detention basins

In addition, this guidance presents BMPs for diversion or treatment of storm water before or as it is discharged to wetlands.

Anchorage Wetland Hydrologic Characterization

Wetlands can benefit by receiving storm water discharge as a result of the rehydration that is otherwise lost to these features as urbanization reduces overall infiltration. However, practices for discharging storm water to wetlands must protect against inundation and the development of integrated flow across the wetland surface and must result in a net social benefit.

The model developed for this guidance addresses hydraulic functions of wetlands and to provide a tool to help determine hydraulic thresholds of existing Anchorage wetlands. The model also estimates costs to replace some of the hydraulic functions.

Wetland Characterization Overview

The wetland storage and hydraulic routing part of the model are based on the assumption that just a few surface characteristics of Anchorage wetlands determine the predominant hydraulic response of a wetland to surface water flow.

Anchorage wetlands can be characterized hydraulically by defining the areas of a wetland that store and transmit water and field-assessing whether these areas are similar with similar vegetation types. The applicability of a simplified vegetation classification is useful because it makes mapping tasks required for design relatively simple. A field investigation was conducted to assess whether wetland hydraulic parameter can be predicted based on association with particular wetland vegetation types. Details of the field investigation are provided in Appendix A.

Within a wetland, areas that can store water significant for storm water processes include the following:

- Soil pore space, or soil capacity
- Interdepressional storage, which includes storage between humps, tussocks, or irregularities in the land surface

These storage parameters were investigated for their correlation with vegetation type. In addition, sheet flow across a wetland naturally attenuates, causing a certain amount of storage, due the following processes:

- Roughness, or flow resistance
- Slope of the flow surface

These characteristics were also investigated for correlation with vegetation type.

Vegetation Classification

Evaluation of the Alaska Vegetation Classification System (Viereck, et al., 1992) and MOA's credit-debit system indicate the following three gross wetland vegetation categories:

- Forested wetlands - defined as having 10 percent or more tree canopy at 10 feet or taller
- Shrub wetlands - defined as having trees less than 10 feet tall and 25 percent or more shrub canopy
- Herbaceous wetlands - defined as less than 25 percent shrub canopy and dominated by grasses, forbs (herbs, ferns, horsetails), bryophytes (mosses, lichens) or aquatic plants (sedges, rushes, and other aquatic plants)

Eighteen wetlands were visited for this study: six that can generally be characterized as forested, five as shrub, and seven as herbaceous. The locations of these wetlands are shown in Figure 1.

Soil pore space, interdepressional storage, and roughness were all found to be grossly categorized by vegetation type. Slope was not.

Wetland Storm Routing Model

The wetland storm routing model is based on the following:

- Assumed regularity and predictability in terms of gross hydraulic characteristics, as described in this section
- Prescribed simple single-event driven storage and flow resistance for routing water

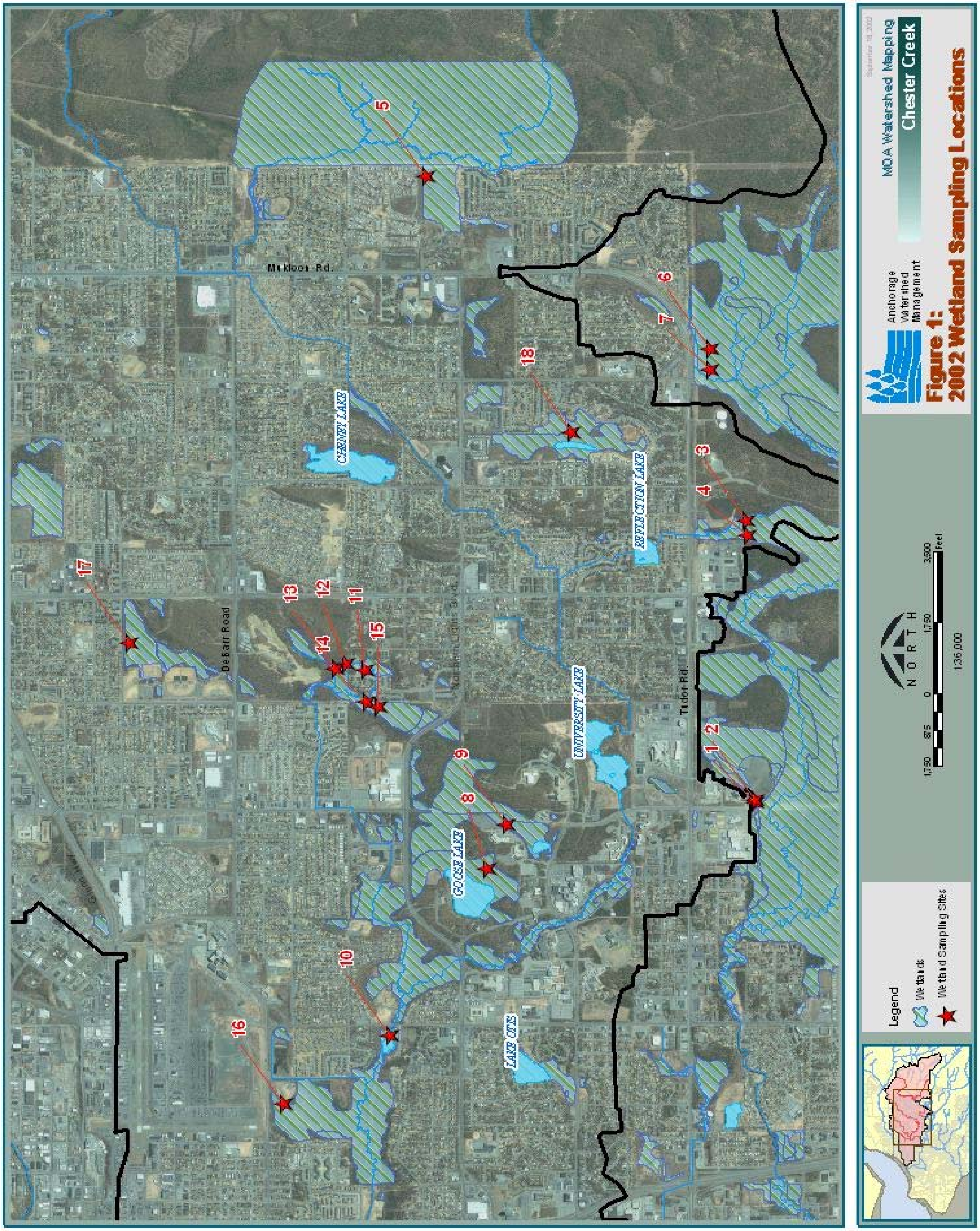
Field collection of data supporting the values in this section are described in Appendix A; derivation of these factors is described in Appendix B.

For purposes of this document, wetland attributes that helped describe wetland hydraulics under storm loadings were evaluated. Values for hydraulic parameters were needed as model input. These parameters can be divided into two general categories of hydraulic processes: storage and flow. These hydraulic parameters, and their relationship to wetland attributes, are described in this section.

STORAGE CAPACITY PARAMETERS

Soil storage, interdepressional depth, and percent of an area that is interdepressional vary based on field study by vegetation classification.

Figure 1 2002 Wetland Sampling Locations



STORAGE CAPACITY PARAMETERS

The field data indicate a relationship of interdepressional storage and soil capacity to wetland vegetation type, as summarized in Table 1.

Table 1 Interdepressional Storage and Soil Capacity Related to Vegetation Type

	Interdepressional Storage		Soil	Soil
	Depth	Percent of Area	Depth	Capacity
Vegetation Type	feet	%	feet	%
Forested	0.7	60	1.54	14
Shrub	0.3	50	2.58	13
Herbaceous	0.3	58	1.67	14

FLOW ROUTING PARAMETERS

Wetland characteristics that affect how storm flows are routed through them are tabulated in Table 2. This table indicates whether each characteristic has been assumed to be site-specific or whether it is related to wetland vegetation type.

Table 2 Flow Routing Parameters

Characteristic	Association
Flow path width	Site-specific; obtain from site survey or topographic mapping
Flow path length	Site-specific; obtain from site survey or topographic mapping
Slope	Site-specific; obtain from site survey or topographic mapping
Roughness coefficient	Related to vegetation type (in Anchorage)

Table 3 presents the estimated values of roughness based on the results of the field investigation. The roughness parameter was based on Manning's equation and was derived from observations of vegetation density and height.

Table 3 Roughness Related to Vegetation Type

Vegetation Type	Roughness "n"
Forested	0.15
Shrub	0.19
Herbaceous	0.2

Pond Size/Cost Model

The cost model is designed to estimate the service value of a natural wetland in providing storm water detention. This module designs and estimates costs for a pond sized to meet current MOA Design Criteria, with an active pool capacity equivalent to the hydraulic detention provided by the wetland.

This pond is generically designed for a capacity equivalent to that of the wetlands for runoff from the 2-year 6-hour. The design includes features that account for scour velocity and flood storage as outlined in the MOA DCM. Details of sedimentation basin sizing and cost model limitations and assumptions are described in Appendix C.

Model Performance

Wetland characteristics of vegetation, soil and slope were used to assign values to model parameters. Model performance proved most sensitive to the first level vegetation classes in Viereck's Alaska Vegetation Classification. The model is much less sensitive to soils. This was expected as moisture retention in all wetland soils is high and available soil void space is typically limited except near the surface. Finally, the model is quite sensitive to very flat slopes and steeper slopes. At slopes less than 0.05% ponding may locally overwhelm flow and the model may underestimate detention. At slopes much greater than 25% integration of surface flows reduces the effective detention capacity of the wetland and the model may overestimate wetland detention.

Wetland Storm Routing Model Guidance for Developers

The wetland storm routing model was developed to simulate wetland response to storm flow events as measured by wetland storage volume and outflow hydrographs. The model uses wetland parameters outlined above in a step-wise routing model to predict outflows from a given inflow hydrograph.

Storm Routing Model Purpose

The purpose of the storm routing model include the following:

- Estimating the modification of a basin's storm water discharge hydrograph as a result of detention and storage in natural wetland features
- Estimating detention service provided by wetlands as a percent of flood detention required by MOA

The spreadsheet-driven model allows planners and designers to estimate the hydraulic response of specific Anchorage wetlands to a single-event storm water discharge hydrograph, up to six hours in length. Based on this analysis a designer can estimate threshold detention and bypass pretreatment controls that are most likely to allow discharge to and rehydration of the wetland without incurring significant hydraulic damage to the wetland feature. The model also approximates the value of the service the wetland provides by estimating costs to construct a man-made basin with a detention capacity equivalent to the wetland.

Use of the Wetland Storm Routing Model

Wetland model computations are carried out in an Excel workbook on seven work sheets, titled as follows:

- Input – provides a place for user input
- Output – displays output hydrographs, wetland parameters, and pond size and cost
- 2-year 6-hour – calculates storage and outflow from a 2-year 6-hour inflow hydrograph
- 100-year 3-hour – calculates storage and outflow from a 100-year 3-hour inflow hydrograph
- Lookup Values – provides values for Manning's "n," interdepressional storage, and soil capacity based on wetland type

- Pond Size – calculates pond size and construction quantities for a pond that would provide equivalent capacity and meet DCM settling requirements
- Pond Cost – calculates the pond cost based on pond construction quantities and 2001 unit costs

The user provides input on the "Input" worksheet; output is displayed on the "Output" worksheet. Other worksheets are used for calculations.

OPENING THE SPREADSHEET

When the spreadsheet is opened, the user is queried about enabling macros. Macros should be enabled since these are used for numerical solutions.

INPUT VALUES

The user input sheet is shown in Table 4. The user may provide descriptors of the modeled wetland and tributary area in cells B3 through B7. These are not required for model operation but are useful in identifying model output. The user must provide inflow hydrographs and wetland parameters.

Wetland Parameters

- Wetland length along fall line, in feet (Cell B8)
- Wetland width is the average width of entire wetland, in feet (Cell B9)
- Wetland Slope in feet per feet (Cell B10). This can be obtained from topographic mapping or a site survey. Values no less than 0.0005 feet per foot (0.05%) should be used.
- Percent of wetland represented in each of the following three vegetation classes: forested, shrub, and herbaceous (Cells B13 through B15, respectively). The sum of these three values must equal 1. These values should be obtained by field survey and reference to the Alaska Vegetation Classification System (Viereck, 1992). The proportional wetland type values should be representative of the effective area of the wetland, which is calculated by the model when a wetland length and width are given (see Model Output).

Inflow Hydrographs

The use must provide two inflow hydrographs, one for the 2-year 6-hour storm and one for the 100-year 3-hour storm, both described in Chapter 2 of the MOA DCM (MOA DPW, 1988). The hydrograph should have the following form:

- Cumulative time step – Cells A19 through A171
- 2-year 6-hour storm flow - Cells B19 through B171
- 100-year 3-hour storm flow – Cells C19 through C163

Flow units should be cubic feet per second (cfs) and corresponding cumulative time units should be hours. The model was developed using 5-minute (0.083 hours) time steps. The model is unstable if the time steps are not uniform over the storm duration.

The inflow hydrograph should be developed using the Storm Water Management Model (SWMM) (Huber, 1988) or equivalent MOA-approved storm hydrograph model for the tributary basin and rainfall hyetograph specified in the MOA DCM (MOA DPW, 1988).

Table 4 Wetland Storm Routing Input Format

Column:	A	B	C
Row:			
1	Input Worksheet		
2			
3	BASIN ID	69	
4	BASIN Description	Eastridge condo outfall	
5	FID	119	
6	Wetland ID	227	
7	Tributary area	26	ac
8	Reach length	510	ft
9	Wetland Width	200	ft
10	Slope along fall line	0.05	ft/ft
11			
12	Percent Wetland Type		
13	Forested	1	
14	Shrub	0	
15	Herbaceous	0	
16			
17		2-year 6-hour	100-year 3-hour
18	Cumulative time	inflow	inflow
19	hours	cfs	cfs
20	0.1	0	0
21	0.2	0	0.317
22	0.3	0	0.778
22	0.3	0.009	1.061
…			
171	0.5	0.164	

Note: Shaded cells indicate user input.

There may be up to 152 discrete flow-cumulative time pairs for the 2-year 6-hour storm and 145 pairs for the 100-year 3-hour storm, allowing runoff for up to 12 hours. If the hydrograph period is shorter than 12 hours, flow for the remaining time steps should be set to 0.

The pond size/cost model is linked to the wetland routing model; no separate input is required for this model.

OUTPUT

An outflow hydrograph, wetland storage, and depth of water in the wetland are displayed on the "Output" worksheet. Calculated wetland parameters, outflow volumes and peak flows, and equivalent pond size and cost are also included on the output page. The pond size/cost model quantifies the size and cost of a replacement sedimentation/detention basin. Examples of the model output are included in Appendix D.

Hydrologic Role of Four Anchorage Wetlands

The hydraulic and cost model was applied to four Anchorage wetlands to test the performance of the model and to provide an estimate of the possible range of storm water detention service available from low-sloping Anchorage wetlands.

The locations of the four tributary-wetland areas used in this example are shown in Figure 2. Table 5 summarizes the parameters calculated by the storm water routing and pond sizing/costing modules of the model. Output from the models for these four wetland/tributary areas is included in Appendix D.

Three of the four modeled tributary areas are residential; one is primarily commercial/ industrial (Merrill Field). The 2-year 6-hour and 100-year 3-hour storm runoff hydrographs were generated using a SWMM (Huber, 1988) model developed for Anchorage outfall basins. Tributary areas ranged from 26 to 271 acres; peak 5-minute flow from these basins for the 2-year 6-hour storm ranged from 11 to 83 cfs.

The four wetland areas ranged in area from 2.3 to 29 acres and the calculated effective area (the area across which storm flows disperse) ranged from 1.6 to 22 acres. Estimated storage capacity of the wetlands ranged from 0.8 to 10 acre-feet.

Hydraulic model results suggest that the tested Anchorage wetlands have a capacity to store 60 to 90 percent of the MOA 2-year 6-hour water quality design storm, and would reduce the peak 5-minute flow by 90 to 95 percent. Similar model runs for these wetlands using flows from a 100-year rainfall event show reductions remain significant, with 5-minute peak reduction still at 80 to 90 percent. Obviously these results will depend on the relative size of the wetland and its contributing storm water basin. However, observation of the response of a number of Anchorage wetlands to recent, unusually high rainfall suggests the model may be conservative (i.e., underestimate storm water detention and transport capacity of the wetlands). Specifically, the model does not address interflow as a water transport mechanism, a process that can lead to rapid recovery of wetland detention storage with time. This process appears to be significant in those Anchorage wetlands that have a predominant vegetation type other than aquatic herbaceous.

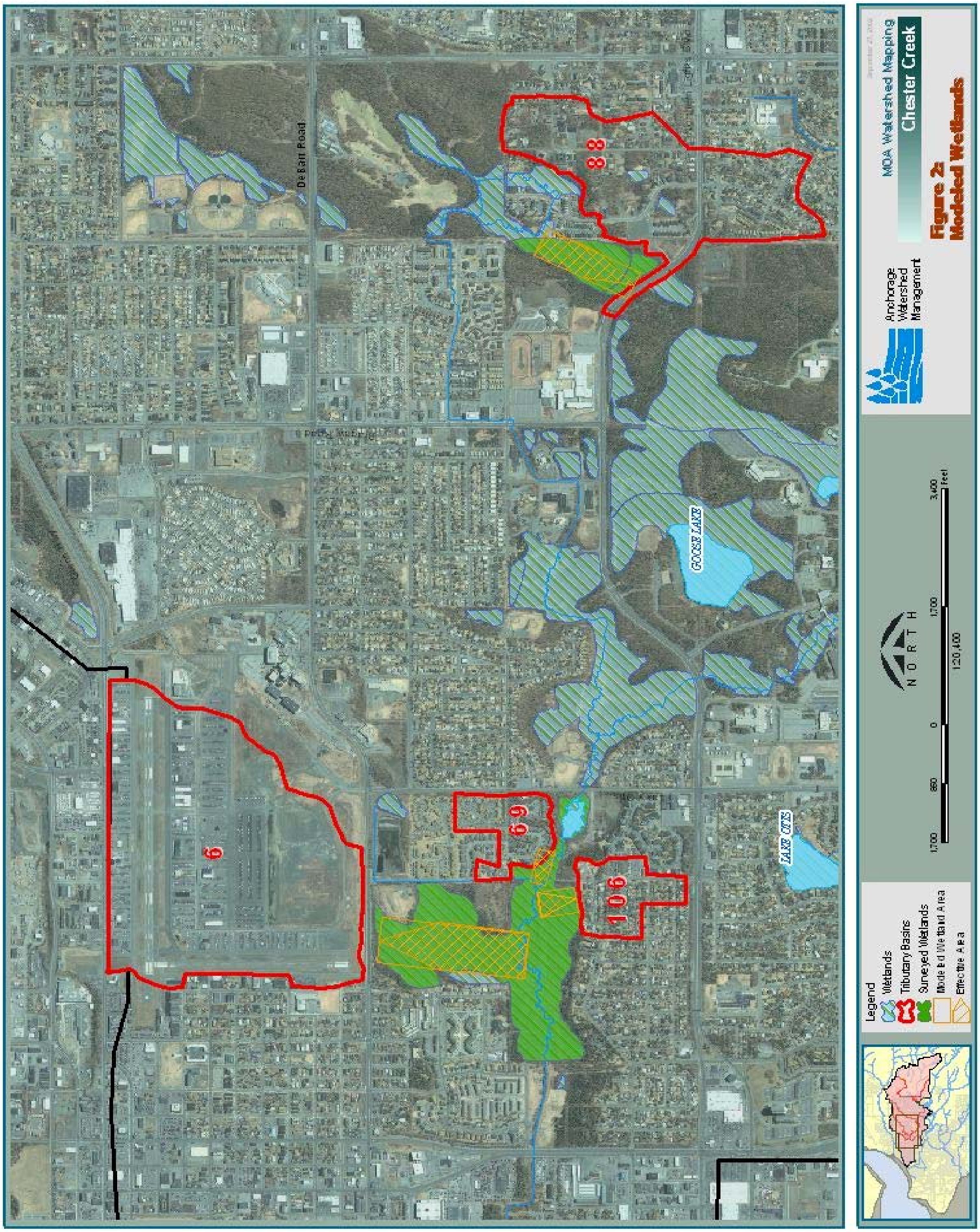
Analysis of the test wetlands using the cost model suggests the wetlands also have a good cost performance compared to constructed detention facilities. Analysis of the selected wetlands using the cost model indicates that equivalent detention ponds built to replace the services provided by the natural wetlands would require a footprint of 16 to 37 percent of the effective wetland area (the area actually participating in storm water treatment), and capital costs of $500,000 to 1,980,000.

Table 5 Indicators of Wetland Hydraulic Performance for Four Different Wetland/Tributary Areas

		Merrill Field East - Eastridge Condo Outfall	Merrill Field South of Chester Creek	North of Northern Lights and UAA	Merrill Field Wetlands
WETLAND DESCRIPTION					
Field identification number		119	25	7	166
Wetland number		227	227	251/267	227
Length	feet	510	540	1,400	1,970
Width	feet	200	350	420	640
Area, length times width	acre	2.3	4.3	14	29
Slope	percent	0.5%	0.264%	0.05%	0.433%
Vegetation type – forest	percent	100%	50%	0%	85%
Vegetation type – shrub	percent	0%	50%	100%	10%
Vegetation type – herbaceous	percent	0%	0%	0%	5%
TRIBUTARY BASIN INFORMATION					
Tributary basin identification		69	106	88	6
Tributary area	acres	26	28	135	271
5-minute peak flow, 2-year 6-hour storm	cfs	11	11	28	83
Volume, 2-year 6-hour storm	acre-feet	0.9	1.0	3.4	12.7
5-minute peak flow, 100-year 3-hour storm	cfs	28	28	80	230
Volume, 100-year 3-hour storm	acre-feet	1.4	1.6	5.5	19.1
STORM ROUTING MODEL OUTPUT					
Effective area	acres	1.6	2.2	10	22
Intrinsic storage	acre-feet	0.8	0.8	2.1	10
Storage capacity as percent of 2-year storm	percent	89%	74%	62%	76%
Storage Capacity as percent of-100 year storm	percent	56%	46%	38%	50%
5-minute peak outflow, 2-year storm	cfs	1	1	1	7
5-minute peak outflow, 100-year storm	cfs	4	5	6	35
Reduction in peak flow, 2-year storm	percent	95%	91%	95%	92%
Reduction in peak flow, 100-year storm	percent	84%	83%	92%	85%
POND MODEL OUTPUT					
Pond surface area	acres	0.5	0.5	1.6	8.0
Surface area as percent of tributary basin	percent	2.1%	2.0%	1.2%	3.0%
Surface area as percent of total wetland area	percent	23%	13%	12%	28%
Surface area as percent of effective wetland area	percent	33%	25%	16%	37%
Pond volume	acre-feet	2.2	2.2	9.1	61
Estimated construction cost	2002 $	$498,000	$499,000	$759,000	$1,984,000
INDICATORS					
Effective wetland area/tributary basin area	percent	6.2%	7.8%	7.7%	8.0%
Wetland storage/2-year storm volume	percent	89%	74%	62%	76%

cfs – cubic feet per second

Figure 2 Modeled Wetland Areas and Tributary Basins



Recommendations

This section presents guidance on considerations for discharge of storm water into wetlands in the Anchorage area.

Pretreatment BMPs for use in discharging storm water to wetlands are described in some detail in the national literature. Applicability of specific BMPs to Anchorage conditions focuses on the pollutants peculiar to our area. Based on current understanding of Anchorage conditions, these include seasonally increased particulate and chloride loading. As for urban runoff nationwide, Anchorage BMPs must also address means to prevent elevated runoff peaks from overwhelming natural wetlands through prolonged inundation, or development of high energy, integrated flow paths (hydraulicking). Recommended pretreatment management practices for storm water discharge to wetlands in this guidance focus on these issues. Recommendations are briefly summarized below.

- **Suitability:** Address general wetland suitability for receiving storm water discharges through existing permitting processes and through new mapping currently being performed staff of the Office of Planning, Development and Public Works.
- **Design:** Analyze wetland hydraulic capacity, using tools developed under this guidance, in order to identify threshold hydraulic capacity of wetlands and to appropriately size storm water bypass structures.
- **Grit Settlement:** Install grit settlement basins as pretreatment facilities at storm water outfalls prior to discharge to natural wetlands. Design settlement basins to remove 80% of plus-100μm particles from all MOA water quality design storm events.
- **Sorbent Booms:** For storm water basins that drain off-street paved parking exceeding five acres, or major or minor arterial streets exceeding 2 acres in area and comprising more than 25 percent of the total road area in the basin, install and maintain a sorbent boom or other surface oil trapping technology.
- **Flow Spreaders:** Install flow spreaders at all storm water discharge points to wetlands to promote non-integrated flow across the receiving wetlands.
- **Wetland Storm Bypass:** Install side discharge-type bypass weirs upstream from all pretreatment devices to divert flows exceeding the hydraulic threshold capacity of the receiving wetlands. Flows exceeding the hydraulic threshold capacity may not be discharged to the wetlands.

- **PreTreatment Storm Bypass:** Install a side discharge-type bypass structure around the grit settlement basin for flows that do not exceed the hydraulic threshold capacity of the receiving wetlands but that do exceed the design capacity of the grit settlement basin. These flows may be discharged to the wetlands through the flow spreader.
- **O&M Plan:** Document and implement an operations and maintenance plan for all pretreatment facilities that describes maintenance practices for the flow diversion weir(s), grit separator basin, sorbent boom and level (flow) spreader. Include schedules for cleaning the grit settlement basin, flow spreader and diversion weir(s), and for replacing the sorbent boom.

A schematic of the management of discharges from piped systems to wetlands is shown in Figure 3.

Bypasses of Peak Flows

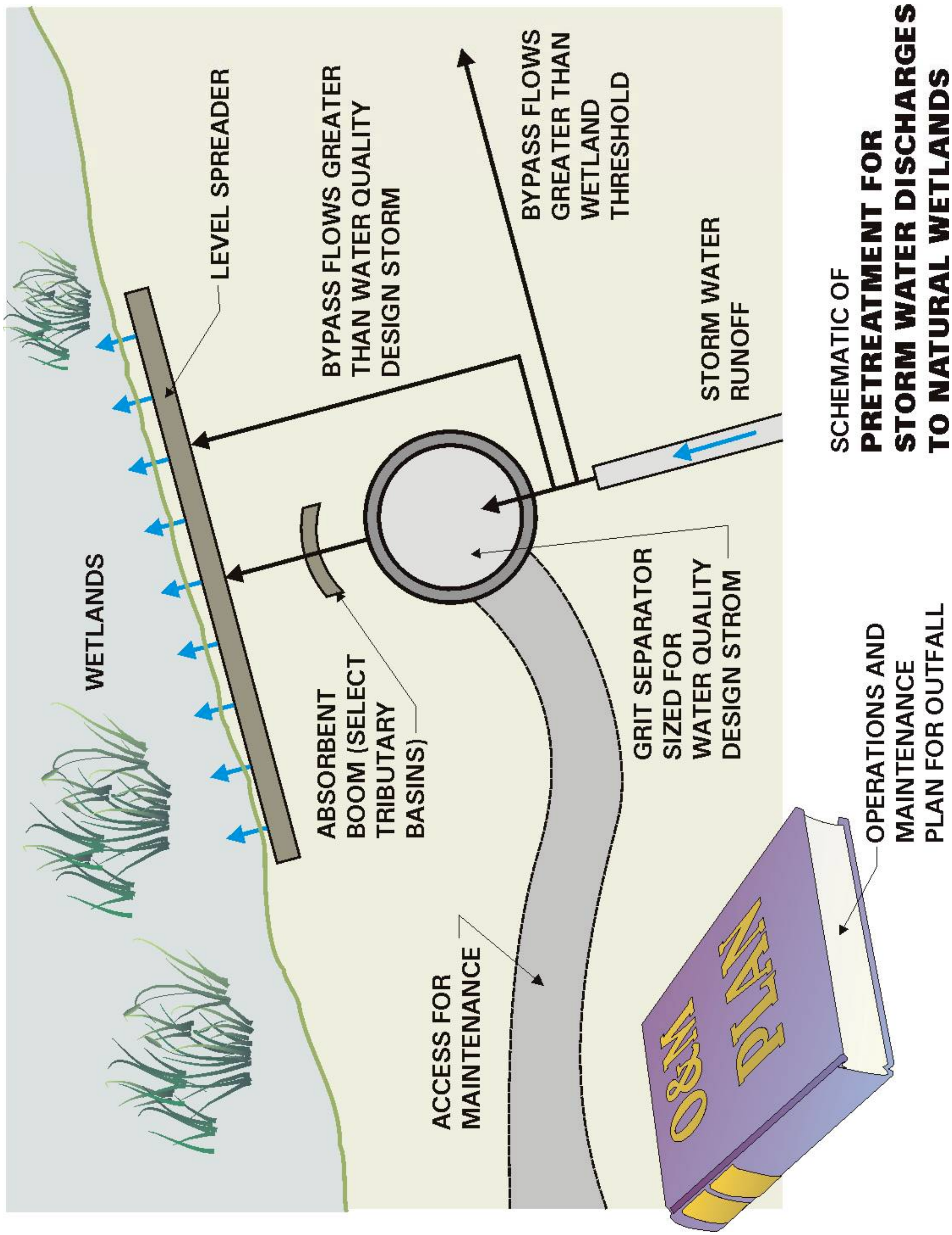
A wetlands threshold depth is determined by the storm routing model as 10 percent of the vegetation height, based on prorating vegetation heights according to the proportion of vegetation types present in the wetlands. For the three wetlands vegetation types, the threshold depth ranges from 0.008 to 0.025 feet deep.

A wetlands storage capacity is also determined by the storm routing model based on prorating vegetation-specific values for soil capacity and interdepressional storage according to the proportion of vegetation types present in the wetlands. For the three wetlands vegetation types, the storage capacity ranges from 0.06 to 0.49 acre-feet per acre.

If use of this wetland storm water routing model indicates that the wetland storage capacity or threshold depth is exceeded by either the 2-year 6-hour or the 100-year 3-hour storm, a peak flow bypass structure should be used. Flow exceeding the either of these two indicators must bypass the wetlands and be discharged elsewhere. This will reduce the impacts of flooding on wetland vegetation and soil structure.

A second discharge structure may be required if flows greater than the water quality design storm do not exceed the wetland storage capacity or threshold depth. In these cases, a bypass structure around the grit separation device is required. These flows, however, can be discharged to the wetlands as long as they do not exceed the wetland storage capacity or threshold depth.

Figure 3 Pretreatment for Storm Water Discharges to Natural Wetlands



Pre-Treatment

The following are recommended practices for discharge of storm water to wetlands:

- Grit Settlement
- Sorbent Booms
- Flow Spreaders

Each of these devices is described below.

Sediment traps and grit separators are installed to trap garbage and particulate matter. Install grit settlement basins as pretreatment facilities at storm water outfalls prior to discharge to natural wetlands. Design settlement basins to remove 80% of particles 100 microns in diameter or larger from all MOA water quality design storm events.

- A sediment trap or forebay is an excavated pit or structures designed to slow storm water runoff and settle suspended solids (Figure 4). They are typical components of effective storm water detention and sedimentation ponds and constructed wetland designs. Their design should incorporate access and other features that allow vehicular access for sediment removal. They typically required more space than commercial grit separators (MaDEP, 1997).
- Grit separators are devices that separate particulates from water through settling or centrifugal separation. An example device is shown in Figure 5. Manufactured structures currently on the market are cylindrical in shape and are designed to fit into or adjacent to existing storm drainage systems or catch basins. Removal mechanisms include vortex-enhanced sedimentation, circular screening, and engineered designs of internal components for larger particulates and large oil droplets (WDOE, 2001). Some devices are designed to contain sorbent material for skimming oil. Contact PM&E for a list of approved commercial devices.

  Grit separators and sediment traps must be cleaned and maintained regularly.

Figure 4 Sediment Trap (MaDEP, 1997)

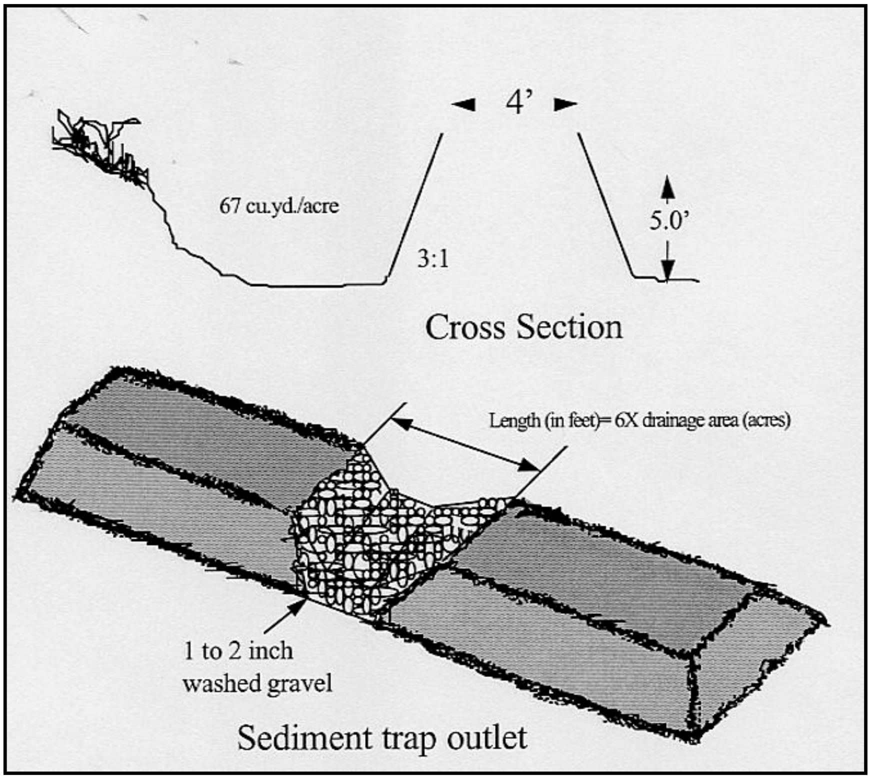


Figure 5 Grit Separator Device (CDS, 2002)

Sorbent booms absorb floating oils and grease. For storm water basins that drain off-street paved parking exceeding five acres, or major or minor arterial streets exceeding 2 acres in area and comprising more than 25 percent of the total road area in the basin, install and maintain a sorbent boom or other surface oil trapping technology. An example of a sorbent boom is shown in Figure 6.

Figure 6 Examples of Sorbent Boom

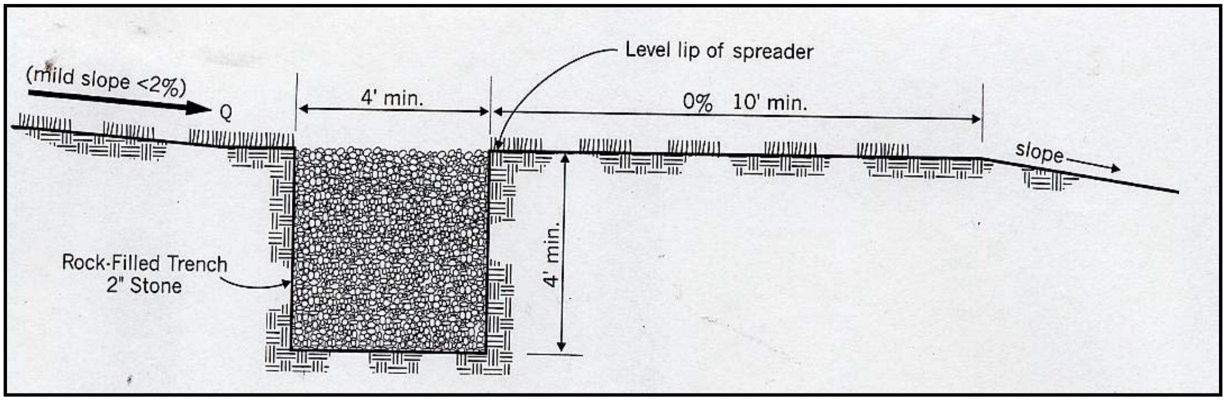
Flow spreaders reduce the depth and velocity of discharges from pipes. Install flow spreaders at all storm water discharge points to wetlands to promote non-integrated flow across the receiving wetlands.

- A flow spreader, or level spreader, is an outlet design to convert flow from a point source so that is dispersed uniformly across a slope to prevent erosion. One type of level spreader is a shallow trench filled with crushed stone (Figure 7). The lower level of the spreader must be level for the spreader to work properly to avoid formation of rilling or channeling. Erosion-resistant matting might be necessary across the outlet lip, depending on the velocities of the expected flows.

Operations and Maintenance Plan

Owners or operators of discharges to wetlands must have a written Operations and Maintenance Plan. The plan should identify owners, parties responsible for maintenance, an inspection and maintenance schedule, and a description of standard maintenance practices. It should include an inspection and maintenance schedule and a list of maintenance activities. Implementation of the plan must be assured, such as required filing of completed inspection and maintenance forms.

Figure 7 Flow Spreader (Prince George's County, 2000)



Treatment facilities, such as commercial grit separators, sediment traps, detention area forebays, and oil separators require routine and periodic maintenance, which includes the following:

- Sediment removal, at a minimum of two times per year
- Inspection for integrity and structural soundness, at a minimum of two times per year
- Structural repair or replacement when required

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