

*Best Management Practices (BMP)
Maintenance Documents
for
Linkside Cove at the Riverfront
Suffolk, Virginia*

February 13, 2004

KHA Project No. 016050016

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Description of Facilities

Wet Pond

Wet Ponds contain a permanent pool of water much like a lake. The wet pond is designed to hold a permanent pool, above which stormwater runoff is temporarily stored and released at a controlled rate. The impounded water is discharged through an outlet that provides for prolonged release. Wet ponds can also serve as an aesthetic or recreational amenity as well as a habitat for some wildlife. The life expectancy of a well-maintained wet pond is 20-50 years.

Baysaver Unit

The Baysaver unit is a physical separation system that meets regulations for non-point source pollution control. The system operates using gravity flow and density differences to remove oils, suspended sediments, and floatables (trash and other floating debris) from stormwater runoff. The Baysaver provides many of the operations that the wet pond provides without using the valuable acreage necessary for the wet pond. The life expectancy of a well-maintained Baysaver Unit is indefinite. For more information about the Baysaver, see appendix E.

Outlet Protection

Outlet protection is structurally lined aprons or other acceptable energy dissipating devices placed at the outlets of pipes or paved channel sections. The purpose of outlet protection is to prevent scour at stormwater outlets, to protect the outlet structure and to minimize the potential for downstream erosion by reducing the velocity and energy of concentrated stormwater flows. The life expectancy of well-maintained outlet protection is 20-50 years.

Grassed Swale

Grassed swales are common devices for directing stormwater runoff, though not always designed to treat stormwater. Typically, grassed swales are concave, earthen conveyance systems designed to simply transfer runoff. As a water quality device, a grassed swale is constructed to allow stormwater to soak into the soil, and particles are trapped by the groundcover, usually turf grass. The life expectancy of a well-maintained grassed swale is indefinite.

Inspection Criteria

The following schedule sets forth the minimum frequency of inspections for the BMP:

Wet Pond:	Annually
Baysaver Unit:	Annually
Outlet Protection:	Annually
Grassed Swales:	Annually

For inspection checklists for the BMP devices, see appendices A-D.

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Maintenance Items

Wet Pond

- **Twice annually, minimum:**
 - Mow grass to a minimum height of 4", preferred height of 6-8"
- **Annually or as needed:**
 - Cleaning and removal of debris after major storm events
 - Harvest excess vegetation
 - Repair embankment and side slopes
 - Repair of outlet structure
- **5 to 10-year cycle:**
 - Removal of accumulated sediment from pond when 10% of the capacity has been lost due to sediment accumulation

Baysaver Unit

- **Annually, or as needed:**
 - Removal of accumulated trash and sediment from unit

Outlet Protection

- **Annually, or as needed:**
 - Replace any dislodged or washed out rip-rap
 - Regrade and stabilize any eroded soils with rip-rap or permanent seeding
 - Remove vegetation

Grassed Swale

- **Annually, or as needed:**
 - Mowing and litter and debris removal
 - Stabilization of eroded side slopes and bottom
 - Nutrient and pesticide use management
 - De-thatching swale bottom and removal of thatching
 - Disking or aeration of swale bottom
- **5-year cycle**
 - Scraping swale bottom, and removal of sediment to restore original cross section and infiltration rate
 - Seeding and sodding to restore ground cover (use proper erosion and sediment control)

Probable Cost

Wet Pond

- Maintenance of grassed side slopes of the wet pond should be included in landscaping services fees.
- Sediment removal costs potentially between \$4,000 and \$15,000 every 5 to 10 years.

Baysaver Unit

- Removal of water and sediment from unit, cleaning unit and disposal of sediment approximate cost \$2,000 per year.

Outlet Protection

- Maintenance of outlet protection and vegetation removal should be included in the landscaping services fees.

Grassed Swale

- Maintenance of grassed swale, including mowing and unwanted vegetation removal should be included in the landscaping services fees.

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Appendix A
Wet Pond Inspection Checklist

Operation and Maintenance Checklist

Page 1 of 3

	YES/NO	REPAIR	INVESTIGATE	Inspector Name: _____
				Inspection Date: _____
				Type of BMP: _____

Item				Comments
I. EMBANKMENT				
A. Crest				
1. Visual settlement				
2. Misalignment				
3. Cracking				
B. Upstream slope				
1. Erosion				
2. Adequate groundcover				
3. Trees, shrubs or other				
4. Cracks, settlements or bulges				
5. Rodent holes				
C. Downstream slope				
1. Erosion				
2. Adequate groundcover				
3. Trees, shrubs or other				
4. Cracks, settlements or bulges				
5. Rodent holes				
D. Abutments				
1. Erosion				
2. Seepage				
3. Cracks				

Operation and Maintenance Checklist

Page 2 of 3

	YES/NO	REPAIR	INVESTIGATE	Inspector Name: _____ Inspection Date: _____ Type of BMP: _____
E. Drainage, seepage control				
1. Internal drains flowing				
2. Seepage at toe				
II. EMERGENCY SPILLWAY				
1. Eroding or backcutting				
2. Obstructed				
3. Leaking				
4. Operational				
IV. PRINCIPAL SPILLWAY BARREL				
1. Seepage into conduit				
2. Debris present				
3. Displaced or offset joints				
V. OUTLET PROTECTION/ STILLING BASIN				
1. Obstructed				
2. Adequate riprap				
3. Undercutting at outlet				
4. Outlet channel scour				
VI. BASIN & UPLAND BUFFER AREA				
A. Low flow channel				
1. Erosion				
2. Adequate vegetation				
3. Obstructed				

Operation and Maintenance Checklist

	YES/NO	REPAIR	INVESTIGATE	Inspector Name: _____ Inspection Date: _____ Type of BMP: _____
B. Basin bottom & side slopes				
1. Erosion				
2. Adequate stabilization				
3. Sediment accumulation				
4. Floating debris				
5. High water marks				
6. Shoreline protection				
C. Inflow channels/pipes				
1. Erosion				
2. Adequate stabilization				
3. Undercutting				
D. Sediment forebay				
1. Sediment accumulation				
2. Stable overflow into basin				
E. Upland landscaping				
F. Aquatic landscaping				

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Appendix B
BaySaver Inspection Checklist

INSPECTION CHECKLIST FOR THE BAYSAVER SEPARATOR UNIT

	YES/NO	REPAIR	Inspector Name: _____ Inspection Date: _____
Item			Comments
I. Manhole Structures			
A. Manhole Covers			
B. Manhole Tops			
C. Manhole Steps			
D. Manhole Sides			
E. Inlet Pipe			
F. Trash/Debris Accumulation			
II. BaySaver Separator Unit			
A. Wier			
B. Two (2) 10" PVC Pipes			
C. 36" Corrugated Pipe			

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Appendix C
Outlet Protection Inspection Checklist

INSPECTION CHECKLIST FOR RIP-RAP OUTFALL

	YES/NO	REPAIR	Inspector Name: _____ Inspection Date: _____
Item			Comments
Grass			
Trash/debris/leaves			
Shrubs			
Trees			
Silt and/or sediment			
Bare spots			
Missing stone			
Erosion/scouring			

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Appendix D
Grassed Swale Inspection Checklist

INSPECTION CHECKLIST FOR GRASS SWALES

	YES/NO	REPAIR	Inspector Name: _____ Inspection Date: _____
Item			Comments
Grass height			
Trash/debris/leaves			
Shrubs			
Trees			
Silt and/or sediment			
Bare spots			
Erosion/scouring			

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Appendix E
BaySaver Separation System Technical
and Design Manual

BaySaver® Separation System
Technical and Design Manual

October, 2002

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Introduction

For years the BaySaver® team has been protecting lakes, streams, and waterways from environmental problems. One of BaySaver®'s most innovative products to control non-point source pollution is the BaySaver® Separation System¹. The system has been installed in commercial, industrial, and residential applications worldwide, and continues to be used in projects as varied as parking lots, gas stations, service stations, maintenance facilities, and highways. It is also used as pre-treatment for other types of stormwater technologies such as ponds, infiltration systems, etc.

The BaySaver® Separation System is a physical separation system that meets regulations for non-point source pollution control. The system operates using gravity flow and density differences to remove oils, suspended sediments, and floatables (trash and other floating debris) from stormwater runoff. Easy to specify, install, inspect, and maintain, the BaySaver® Separation System helps you avoid using the valuable acreage necessary for other types of best management practices (BMPs).

BaySaver® is the leading technology in stormwater pollution control. This manual is an introduction to the BaySaver® Separation System line of products and to the technical details that will help you meet your stormwater pollution control requirements both now and in the future.

The BaySaver® team thanks you for your interest in BaySaver® stormwater pollution control products and services. We are committed to providing you with stormwater treatment systems that make sense and with excellent customer service. If you have any questions about the information in this manual, please contact the BaySaver® team at 1-800-229-7283 (1-800-BaySaver) or by e-mail at TechQuestions@BaySaver.com.

¹ The BaySaver® Separation System is manufactured in Mount Airy, Maryland, by BaySaver, Inc., and is protected by one or more U.S. and international patents. Any infringement on these patents will be prosecuted to the fullest extent of the law. For detailed information on specifying, purchasing, or installing a BaySaver® Separation System, please contact BaySaver, Inc. or an authorized representative directly.

The BaySaver® Separation System

The BaySaver® Separation System is composed of two standard precast manholes and the BaySaver® Separator Unit. The two manholes allow the removal and storage of pollutants, while the separator unit directs the flow of water to provide the most efficient treatment possible. Figure 1 shows a cutaway view of the complete BaySaver® Separation System.

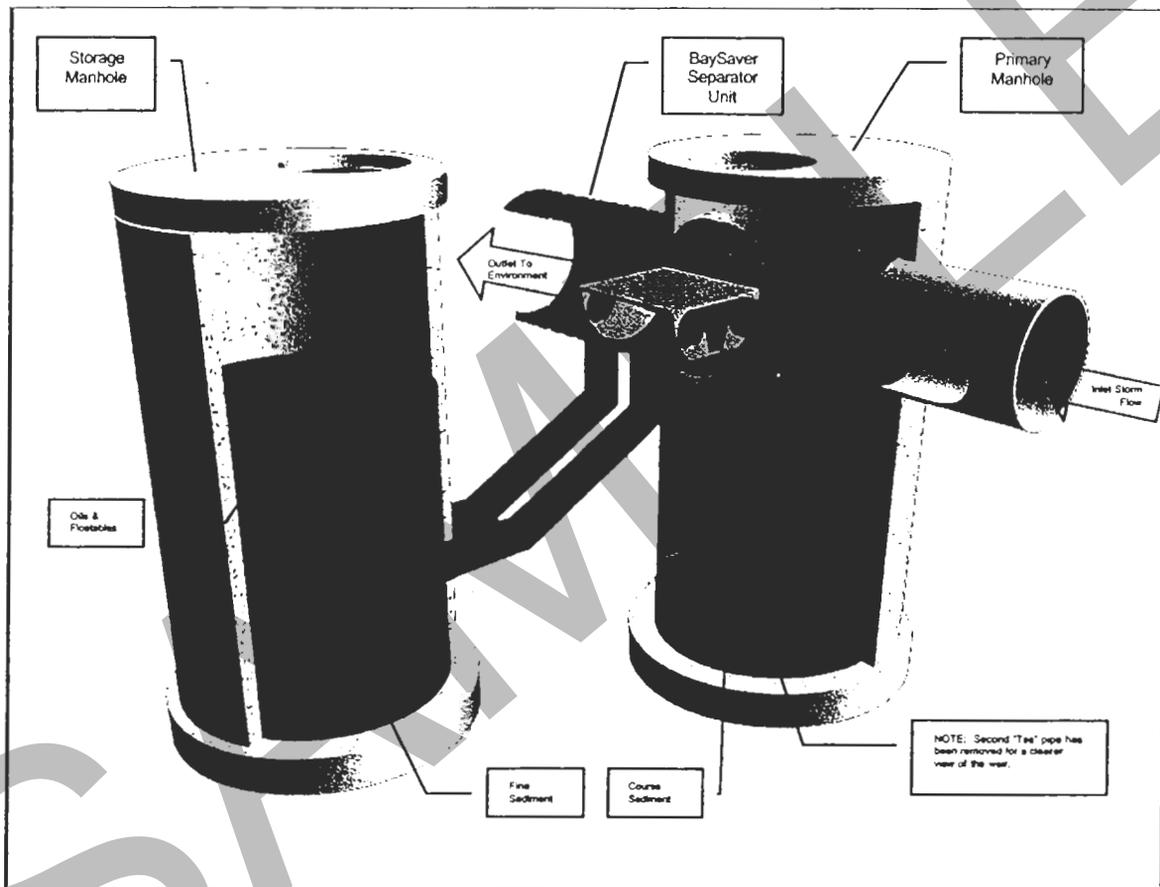


FIGURE 1: THE BAYSAVER® SEPARATION SYSTEM

Included with this manual is a disk containing AutoCAD details and other information to make it easy for you to specify the BaySaver® Separation System. This manual and the AutoCAD details are also available at the BaySaver® web site at www.BaySaver.com. If you need clarification of any of the information provided, please contact BaySaver® technical support at 1-800-229-7283 (1-800-BaySaver).

The primary manhole, shown in Figure 2, is a standard precast structure used to remove coarse sediments. **This manhole is generally installed in-line with the storm drain and can be used as a multiple inlet structure.** The precast manholes can be purchased from local concrete distributors to reduce freight costs, ensure the structures meet local regulations, and enable contractors to shop for the best price. Manhole sizing guidelines can be found in Table 3 on page 12.

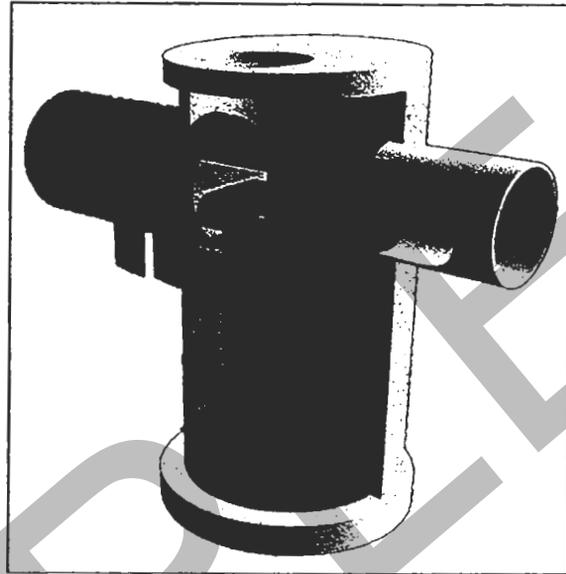


FIGURE 2: THE PRIMARY MANHOLE

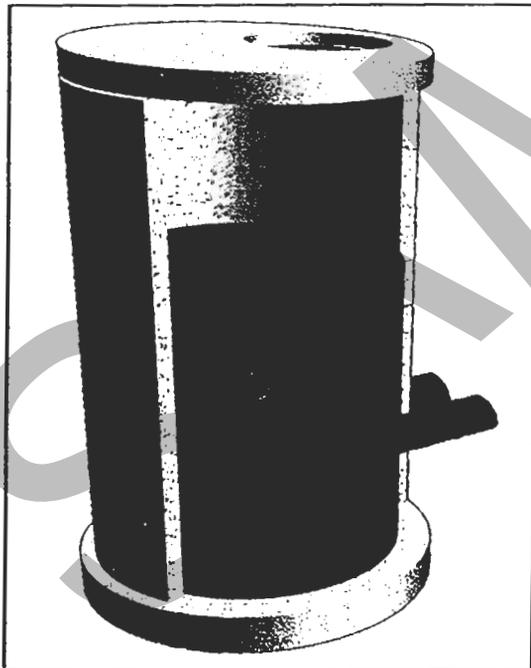


FIGURE 3: THE STORAGE MANHOLE

Shown in Figure 3, the storage manhole acts as a secondary treatment device for the collection of oils, fine sediments and floatables. It is a standard precast manhole that can also be purchased locally. The storage manhole is a key component that sets the BaySaver® Separation System apart from other less effective systems. **The BaySaver® Separation System stores the pollutants offline to prevent resuspension.** BaySaver® benefits are further discussed in the operation section beginning on page 5.

Figure 4 is a picture of the heart of the BaySaver® Separation System, the Separator Unit. The Bay-Saver® Separator Unit is the device that controls the influent flow through the two manholes. This device is manufactured at BaySaver®'s facilities and can be purchased directly from BaySaver, Inc., or through a local BaySaver® technical sales representative (contact BaySaver, Inc. for additional sales information).

The BaySaver® Separator Unit is fabricated entirely of high density polyethylene (HDPE) infused with UV-resistant carbon-black. HDPE is a non-brittle, chemically inert material known for its corrosion-resistant properties. It is commonly used in applications that expose it to harsh conditions (landfills and chemical plants, for example) and is used in storm drains throughout the world.

The separator unit itself is constructed using state-of-the-art technology and the best materials available to ensure the quality of your BaySaver® system. Extrusion welding ensures that the entire system is well designed to take the abuse associated with construction applications. The separator unit is light, easy to install, and delivered with the connecting pipes, couplers, and seals needed to install the unit to the manholes.

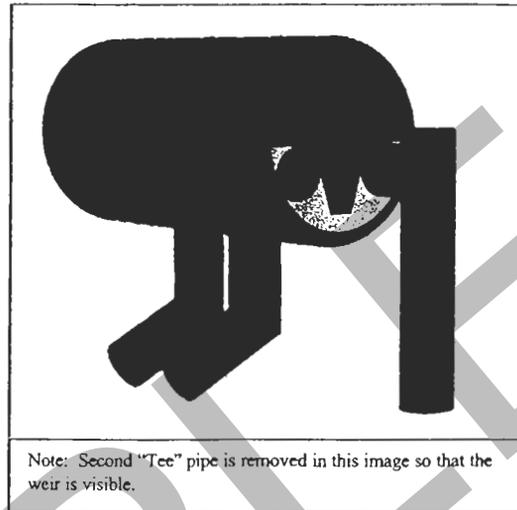


FIGURE 4: THE BAYSAVER SEPARATOR UNIT

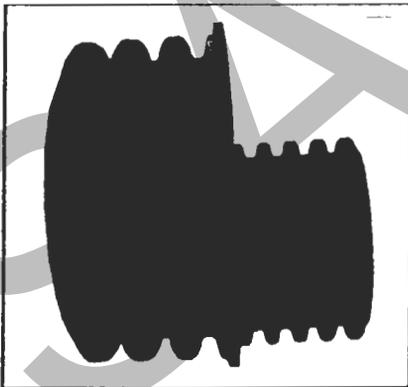


FIGURE 5: THE BAYSAVER REDUCER/ADAPTOR

The reducer/adapter in Figure 5 is used to adapt the outlet of the BaySaver® Separator Unit to your pipe configuration. It also allows the BaySaver® Separator Unit to be attached to any type of outlet pipe (concrete, metal, HDPE, etc.).

The reducer/adapter is custom manufactured from HDPE for each project. When you specify your outlet pipe diameter, the reducer/adapter will be shipped with your unit along with the proper fittings for your pipe.

BaySaver® Separation System Operation

When rain begins to fall on an impervious surface, the runoff carries with it the oils, total suspended solids (TSS), and floatables that have built up since the last storm. In the past it was thought that the majority of these pollutants are mobilized during the first 20 to 30 minutes of precipitation. This phenomenon is referred to as the "first flush." Because of this theory, many BMPs have been designed around treating only the low flows associated with this first flush. New studies² indicate that when designing a treatment system to treat only the first flush, it is likely the amount of pollutants captured will not meet stormwater regulations. Even before these studies began, the BaySaver® Separation System was designed to treat throughout the storm.

During a storm event, rainfall intensity can vary significantly. Peaks in the rainfall intensity result in higher runoff flows at various frequencies during the storm. These higher intensity precipitation flows result in additional flushes of contaminants. The subsequent flushes need to be treated to prevent the discharge of pollutants. While competing systems are designed to treat only the first flush and bypass these flows, the **BaySaver® Separation System was designed, from its inception, to operate throughout the entire storm, and when properly sized will treat all flows of an average storm for any given geographic area.**

The BaySaver® Separation System is designed with three distinct flow paths to convey and treat stormwater runoff. During low flows, the most common level of operation, the path of influent water is through both manholes in series. During higher flows, all influent water is treated in the primary manhole, and a portion of the water, containing oils, sediments, and floatables, is diverted to the storage manhole for secondary treatment. During extreme flows, the influent is directed through the system to avoid resuspension of materials that have already been collected and to prevent flooding upstream in the system. This section describes the flow paths and removal mechanisms for each level of treatment.

² Studies by the University of Alabama; City of Portland, Oregon; City of Austin, Texas; University of Texas. For more information, please contact BaySaver, Inc.

Low Flows

During low flows, the BaySaver® Separation System treats all water twice. This flow situation occurs during small storms and during the beginning of more intense storms.

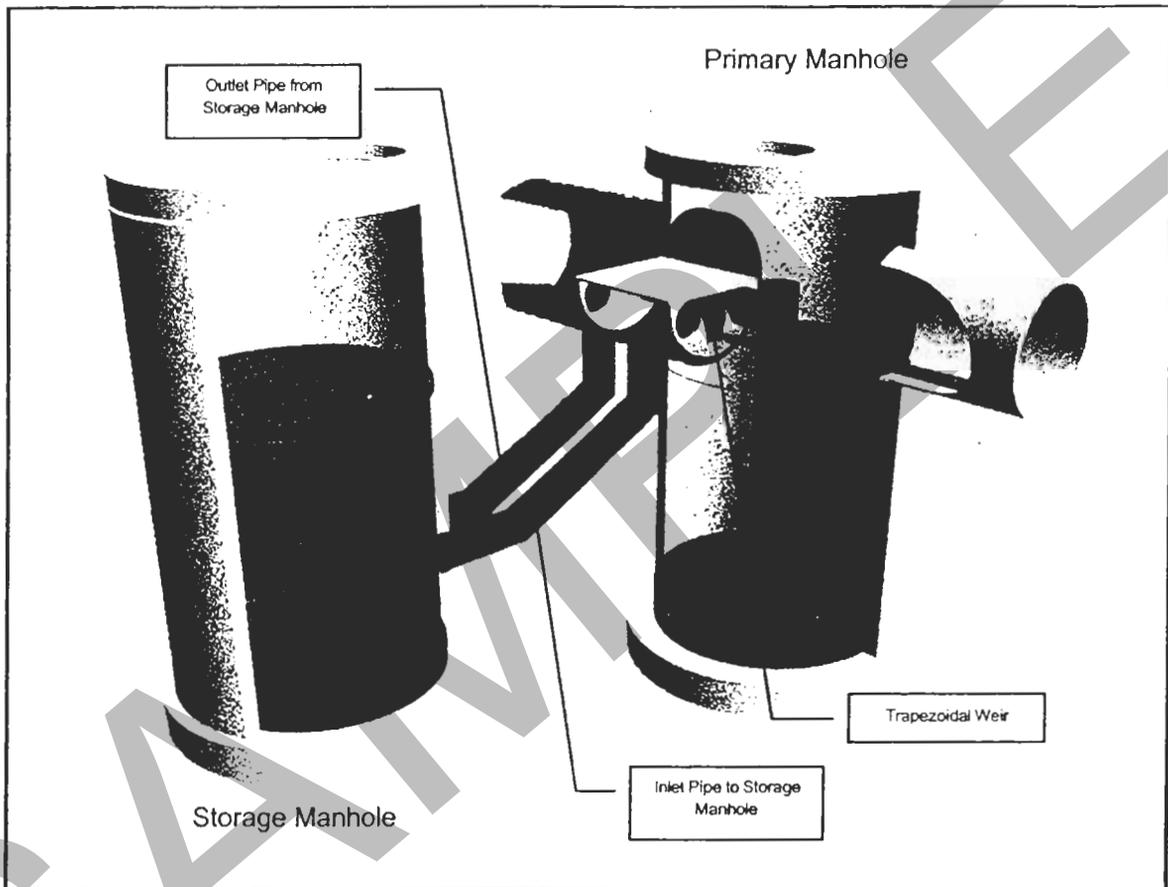


FIGURE 6: LOW FLOW OPERATION

As shown in Figure 6, water enters the BaySaver® Separation System's primary manhole through the inlet pipe shown on the right side of the figure. Coarse sediments (gravel and sand) immediately fall to the floor of the primary manhole. The influent water, carrying floatables and finer sediments, is skimmed off the surface by the trapezoidal weir and conveyed into the storage manhole (on the left). When water enters the storage manhole from the submerged inlet pipe, oils and other floatables rise to the surface, while sediments settle to the floor. These contaminants remain trapped off-line and are not resuspended during larger flows. The influent water displaces clean water from the center of the column, which is forced back up the return pipe to the system outfall. In this way, all of the water that reaches the system outfall has been treated in both the primary and storage manholes.

Maximum Treatment Flow

During larger storms, as storm intensity increases, flow rates continue to increase. The BaySaver[®] Separation System was designed to treat these increased flows as well. During these larger storm events, the BaySaver[®] Separator Unit continues to divert low flows (containing the majority of suspended sediments, as well as the oils and other floatables) from the primary manhole to the storage manhole.



FIGURE 7: MAXIMUM TREATMENT FLOW

Additional flows associated with the larger storm are treated by separation in the primary manhole. As the pollutants are separated in the primary manhole, the influent water displaces treated water from the center of the column and forces it up the "Tee" pipes to the system outfall. **One of the advantages of the BaySaver[®] Separation System design is that it treats these larger storm flows in the same way that first flush flows were treated in the past.**

Inspection and Maintenance

Inspection

By removing the manhole covers, **the inspector or maintenance contractor can gain unobstructed access to the bottom of the manholes, making confined space entry unnecessary.** Site-specific inspection scheduling, coupled with maintenance that can be completed from above grade, results in more efficient maintenance at lower cost.

Beginning the day that construction is complete, periodic inspection determines the cleaning frequency. Most systems require yearly cleaning. In the first year, the system should be inspected quarterly to determine pollutant loading rates. Maintenance is needed when the sediment accumulation has reached a height of two feet from the floor in either manhole.

Maintenance

One of the advantages of BaySaver® Separation Systems is their ease of maintenance. Like any system that collects pollutants, the BaySaver® Separation System must be maintained for continued effectiveness. Maintenance is a simple procedure and is performed using a vacuum truck or similar equipment. Access to the contaminant storage is available through 30" manhole covers in each structure. Vacuum hoses can reach the entire floor area of both manholes, so all sediments can be evacuated.

The BaySaver® Separation System was designed to minimize the volume of water removed during routine maintenance, thus reducing disposal costs. The entire maintenance procedure typically takes from 2 to 4 hours, depending on the size of the system. The recommended maintenance procedure for the BaySaver® Separation System follows.

Maintenance Instructions

1. Remove the two manhole covers to provide access to the contaminant storage.
2. Remove all water, debris, oils, and sediment from the storage manhole using a vacuum truck or other equipment.
3. Using a high pressure hose, clean the storage manhole and remove the cleaning water using the vacuum truck.
4. Using a submersible pump, pump the bulk of the water from the primary manhole into the clean storage manhole. The pump intake must be kept below the water surface to avoid pumping surface oils, and pumping must be stopped when the water surface falls to a level one foot above the accumulated sediments.
5. Remove the remaining water and sediment from the primary manhole using a vacuum truck or other equipment.
6. Using a high pressure hose, clean the primary manhole and remove the cleaning water using the vacuum truck.
7. Fill the primary manhole with water to the invert of the BaySaver® Separator Unit. Fill the storage manhole with water to a depth of 8 feet.
8. Replace the two manhole covers.
9. Dispose of the contaminated water at an approved facility. Local regulations often prohibit discharge of this material to the sanitary sewer; the local sewer authority must authorize such a discharge.

This procedure is intended to remove all the collected pollutants from the system while minimizing the volume of water that must be disposed. Additional local regulations may apply to the maintenance procedure. Safe and legal disposal of pollutants is the responsibility of the maintenance contractor; therefore maintenance should be performed only by a qualified contractor.

BaySaver® can assist in coordinating a maintenance contractor in the installation area, or work directly with owners who wish to perform their own maintenance. Contact BaySaver® at 1-800-229-7283 (1-800-BaySaver) for more information.

System Costs and Availability

Material costs, installation costs, and maintenance costs vary significantly throughout the country. **The BaySaver® Separation System is your best value per treated CFS regardless of your geographic location.** For BaySaver® pricing in your area, please contact BaySaver® at 1-800-229-7283 (1-800-BaySaver) or an authorized representative directly.

The BaySaver® Separator Unit and materials can be shipped anywhere in the continental United States within two weeks or less. Custom systems may require additional time.

Reminder: The system's precast manholes need to be ordered locally to arrive in conjunction with the BaySaver® Separator Unit.