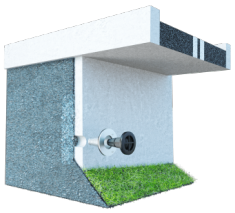
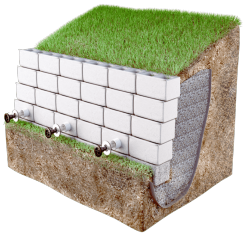
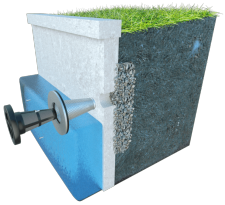
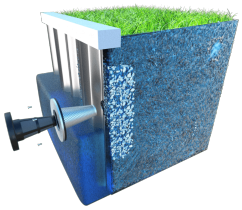
Maintainable Weep Hole System

Providing Geotextile Drainage & Erosion Control

Frequently Asked Questions

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What are Jet Filters?

The Jet Filter addresses the challenges of traditional drainage systems. Poor drainage is by far the most common cause of poor performance of earth retaining structures. Poor drainage leads to burdensome maintenance and repair costs and can lead to outright wall failure.

There are many variables that interact to determine the long-term success of a retaining wall and its drainage system. These include such things as the site's soil hydrology, backfill material, wall & drainage design.

Experience has shown that overtime, many drainage systems will experience reduced flow rates as it becomes clogged or blinded. As the drainage systems' performance decreases, pressurized water will seek new exit paths. These exit paths take the water around the wall, under the wall, through seams and/or exert enough pressure to move or crack the wall. As it does, voids are created by water carrying backfill material out the new exit paths.

Fixing a failing drainage system often requires expensive excavation to repair. Accessing the failing drainage system from behind the wall often requires demolition and rebuilding of other structures such as roads, walks, retaining walls, landscaped areas, etc. Repairing a failing drainage system or a collapsed wall can be cost prohibitive.

Jet Filters provide a quick and inexpensive solution to create a new drainage path that also controls erosion. The Jet Filter is a cone shaped cartridge that inserts a geotextile filter fabric into the front of an earth retaining structure through a new or existing weep hole. It is designed so the geotextile filter fabric can be removed, cleaned and reinstalled.

The maintainable weep hole filter cartridge contains Mirafi's FW300 woven geotextile drainage & erosion control fabric. The filters are designed to be installed and maintained from the front of any new or existing structure. Therefore, excavation is not required to install or to maintain the drainage system.

JET Filter Benefits:

- **Relieves hydrostatic water pressure**
- **Stops erosion through drainage systems**
- **Fits into new or existing weep holes**
- **Contains a removable cartridge, making it easy to maintain**
- **Provides faster drawdown than a similar sized weep hole**
- **Low installation & maintenance cost**
- **Used as a primary or a secondary drainage**
- **Installs in new or existing walls**

Why were Jet Filters invented?

Jet Filters were originally invented as a solution to preserve sea walls that were failing from inadequate or failed drainage systems. Poor drainage systems create significant hydrostatic pressure behind the wall that would result in a compromised wall. A wall, that without help, would fail.

This 21st century idea has had great success in seawalls and has now expanded the Jet Filter's use far beyond seawalls to include all earth retaining structures.

Where are Jet Filter products used?

Jet Filter products are used in many different markets around the world where earth retaining structures experience hydrostatic pressure. A lack of adequate drainage or impermeability of the backflow materials can cause significant forces which, over-time, result in structural failures. Thus, filtration and drainage are critical for earth retaining structures, including, bridge abutments, wing walls, retaining walls, MSE walls, seawalls, spillways and even underground structures like parking garages or culverts. Jet Filters can be used on concrete, all types of sheet pile, MSE walls, and, wooden bulkheads.

When are Jet Filter products needed?

Walls are designed to retain the lateral force of the soil, but when the soil holds water, as it always does, the hydrostatic pressure can significantly increase the force on the wall. Design criteria generally provide for methods of removing this pressure by draining the water away from the back of the wall or even through weep holes strategically placed in the wall. However, over time, these drainage systems can fail. They are prone to clogging as the soil clogs the filtration system installed behind the wall. Or, soil penetrates through the filtration system causing erosion of the soil.

If no action is taken the wall will eventually fail early in its design life and need to be completely replaced. The traditional early action solution is to excavate behind the wall to replace or repair the drainage system. Excavation is expensive and could cost up to ~70% of what a new wall would cost. ***The alternative solution for existing walls would be to install Jet Filters through the front face of the wall, thereby relieving hydrostatic pressure and preserving design life. For new construction Jet Filters can be a reliable investment as primary or secondary drainage solution.***

How do Jet Filters work?

Jet Filters provide a solution to remove the water from behind the wall without excavation. Weep holes are cored into the front of the wall. Then, Jet Filters are inserted into the cored holes through the front of the wall. This provides a path for water behind the wall to flow out. Once installed, Jet Filters allow water to flow through a geotextile filter fabric that prevents soil erosion. A series of Jet Filters mounted low on a wall will reduce the hydrostatic pressure behind the wall extending its life. To achieve the full benefit of the Jet Filters, failing walls must be fixed. For example, if water is currently flowing out of cracks in the wall, the cracks must be filled so that the water will flow through the filter instead.

The Jet Filter's cone shaped design gives the geotextile a greater surface area than the surface area of a similarly sized weep hole. The greater surface area gives the Jet Filter the ability to drain more water. When fully penetrating the backfill material, greater flows were observed for the six-inch drains (~2.3x), numerical models confirm this and show similar effects for the four-inch drains.

Why do Jet Filters use the Mirafi FW300 geotextile filter fabric?

Geotextile filter fabrics provide drainage & erosion control. Geotextile filter fabrics fall in to two categories, woven & nonwoven. Typically, when selecting a geotextile, different technical specifications are considered (e.g. permeability, flow rate, strength, etc.). Unlike other geotextile uses, the Jet Filter is also designed for maintainability. And, historically, geotextiles have never been used in a maintainable manner.

Jet Filter System selected TenCate's woven geotextile - Mirafi FW300. The FW300 gives the right balance between drainage, erosion control and maintainability.

Technical Specifications – Mirafi FW300

Mechanical Properties	Test Method	Unit	Minimum Average Roll Value	
			MD	CD
Grab Tensile Strength	ASTM D4632	lbs (N)	400 (1780)	335 (1491)
Grab Tensile Elongation	ASTM D4632	%	20	15
Trapezoid Tear Strength	ASTM D4533	lbs (N)	145 (645)	125 (556)
CBR Puncture Strength	ASTM D6241	lbs (N)	1250 (5563)	
			Minimum Roll Value	
Percent Open Area	COE-02215	%	8	
Permittivity	ASTM D4491	sec^{-1}	1.5	
Flow Rate	ASTM D4491	$gal/min/ft^2$ ($l/min/m^2$)	115 (4685)	
			Maximum Opening Size	
Apparent Opening Size (AOS)	ASTM D4751	U.S. Sieve (mm)	30 (0.60)	
			Minimum Test Value	
UV Resistance (at 500 hours)	ASTM D4355	% strength retained	90	

If specifications require a different geotextile, the Jet Filter can be special ordered with another woven or a nonwoven fabric such as TenCate's N140.

What is the difference between "Open-end" and "Closed-end" filters?

The Jet Filter comes in two different models. Open-end & Closed-end.

Open-end

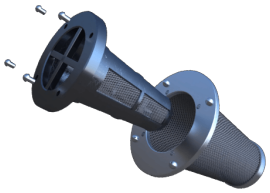
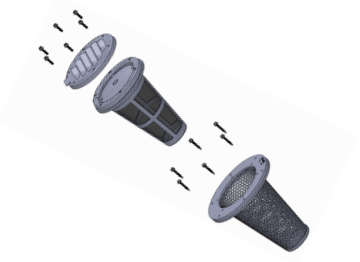
The open-end model allows water to exit the filter when the hydrostatic pressure behind the wall is greater than on the front of the wall. The open-end filters come with an optional louver vent faceplate which helps with vermin control. The open-end units are ideal for areas that do not experience high tides or storm surge.

When the open-end model is used in coastal, lake or river environments water can enter back through the filter. Depending on the backflow material, this water can help to flush the filter and keep it cleaner thus requiring less frequent maintenance.

Closed-end

Our closed-end models come with a one-way backflow preventer. The backflow preventer allows water out of the filter when hydrostatic pressure is greater behind the wall than in front of the wall. During high tides and storm surge, the backflow preventer does not allow water to penetrate the filter and get back behind the wall.

The closed-end unit comes with a louver faceplate to protect the filter. The backflow preventer helps to inhibit marine growth while louver vent acts as a shield from debris and vermin control.

Models	Description	Diameter & Material
 **Open-End**	The Open-End models: • Are used in many inland and coastal applications. • The 4" & 6" dia. sizes come with an optional stainless- steel louver cover plate. • The optional louver cover plate provides vermin control and protection from floating debris.	• ABS 2 ½" • 316 Stainless 2 ½", 4" & 6" • Powder Coated 2 ½", 4" & 6"
 **Closed-End with backflow prevention**	The Closed-End models are designed with a one-way valve. The Closed-End model: • Prevents high tides, storm surge and other water from entering the land side through the filter. • Includes a stainless steel louvered faceplate to protect the valve. • Inhibits marine life, provides vermin control and protection from floating debris.	• 316 Stainless 4" & 6" • Powder Coated 4" & 6"

What diameter Jet Filter should I consider?

When selecting a diameter for the Jet Filter, many factors should be considered. For example, how tall is the wall? What is the wall composed of? How thick is the wall? What type of backfill material is behind the wall?

2 ½" ABS: The 2 ½" ABS (Acrylonitrile Butadiene Styrene) is made of a strong, UV protected plastic. Our 2 ½" ABS unit is designed for vinyl sheet pile. If you are designing a vinyl wall, you should choose the 2 ½" ABS unit. This units come in 4 color options: Slate, Gray, Brown & Clay.

2 ½" Steel: The 2 ½" steel unit is used primarily in low profile, sheet pile walls, such as steel, composite, aluminum, etc. When used on a sheet pile wall, the 2 ½" unit will penetrate the backfill to achieve maximum drainage.

4" Steel: The 4" unit is the most commonly used size. The 4" unit can be used on any type of wall. It is recommended for concrete walls and sheet pile walls. The 4" units can provide faster drawdown of the hydrostatic pressure or can be placed further apart to achieve the same drawdown as the 2 ½". The 4" unit comes in both the open-end and closed-end versions.

6" Steel: The 6" unit is typically used for large concrete retaining structures that experience significant hydrostatic pressure and need constant, fast pressure relief. The 6" is usually used in large coastal structures and very tall retaining walls. The 6" can be used in steel sheet pile walls that allow the 8" flange to secure flush to the wall. The 6" comes in both the open-end and closed-end versions.

How many Jet Filters do I need to preserve my wall?

There is no exact answer to this question, as walls and soils vary in each application. It will also depend on which Jet Filter is selected (2.5", 4", 6"). A Civil Engineer should be consulted for each unique application. When making the spacing decision, it should be noted that the hydrostatic pressure behind the wall will be lowest "in-line" with the filter. Pressure will be highest between the filters. Therefore, the closer together the Jet Filters are, the lower the overall pressure will be. The following chart shows the recommended spacing based on wall height and filter size.

Filter Spacing Based on Filter Size & Wall Height			
Filter spacing	Filter Size	Wall Height	
		Less than 6'	Between 6' & 10'*
	2.5"	6'	4'
	4"	8'	6'
	6"	10'	8'
	*** A second row should be considered for walls higher than 10'. Filters on the first and second rows should be staggered.**		

Speed to drain is another consideration. In areas that experience significant rain events, water may need to be drained quickly. Placing the filters closer together will provide quicker hydrostatic pressure relief.

When should I choose Stainless-Steel or Powder Coated Steel?

Powder Coated Steel

Our powder coated steel (PC) units are designed for non-corrosive environments such as inland lakes, rivers and retaining walls. The PC models come in 2 ½" dia., 4" dia., and 6" dia. Our PC models have all the same physical specifications as our stainless-steel units.

Stainless-steel

Jet Filters' stainless-steel (SS) models use 316 SS and are designed for corrosive environments such as marine environments or areas with heavy salt runoff. Our SS models come in 2 ½" dia., 4" dia., and 6" dia. Our SS models have all the same physical specifications as our powder coated steel units.

Where should the Jet Filters be installed in the wall?

The hydrostatic pressure will be reduced to a height equal to the Jet Filter. For example, installing a Jet Filter halfway down a wall will only reduce pressure halfway down the wall. It is recommended that the filters be installed so that the center of the filter is 4" to 6" above the mean water line or soil line.

Other considerations should include the seams. Seams are the weakest points. Therefore, some engineers/contractors prefer to install the filter at the seam. This way the seam will experience the least amount of hydrostatic pressure.

What equipment is required to install Jet Filters? *

Jet Filter installation is fairly straight forward. An installer will need the following tools:

- chalk line, level, tape measure to mark filter locations on the wall.
- coring drill and coring drill bit to core drill the appropriate sized hole.
- drill with bit (3/16" concrete or 7/16" sheet piling) to install the mounting flange to the wall.
- epoxy sealant to seal any gaps between the flange and wall.
- 3/8" wrench and rubber mallet.

* See installation instructions for a complete list of tasks and tools.

What knowledge level is required to install Jet Filters? ★★☆☆☆

Fundamental knowledge of tool use is required as well as some experience in measuring, leveling and alignment. The largest obstacle in installing Jet Filters would be the coring. Usage and safety knowledge of the coring drilling is important for a clean installation, but most importantly for safety. No electrical or pipe fitting certifications are needed. Persons experienced in maintenance or contracting positions should not find installation of Jet Filters difficult.

How are the Jet Filters maintained and how frequently do they need maintenance?

To ensure continuous drainage, Jet Filters should be periodically cleaned. Maintaining the Jet Filter is a simple process. It takes about 5-7 minutes per filter. It requires a wrench, a soft bristle brush (i.e. toothbrush) and a bucket of water. Steps:

1. Remove the geotextile filter cartridge by removing the 4 cartridge bolts
2. Slide the cartridge out
3. Use the brush and water to brush off any soil material clogging the filter

4. Slide the cartridge back in
5. Secure with the 4 cartridge bolts.
6. If the filter's geotextile fabric is ripped or damaged, a new cartridge can be installed.

The frequency of maintenance will be driven by factors that are unique to each location's soil type, soil hydrology, backfill material, rainfall and other factors. In sandy locations with a good flowing backfill, the filters may only need maintenance ever 5+ years. In clay soils with no backflow material behind the wall, cleaning may need to be performed more frequently.

Soil Type	First Maintenance Check	Subsequent maintenance schedule*
Sandy	1 Year	5+ years
Silty	1 Year	3-5 years
Clay	1 Year	1-2 years
*Since each location's soil hydrology is different, the actual maintenance schedule should be customize based on the findings during maintenance. Filters should be inspected if they are not "weeping" nor flowing after a rain event.		

How do I know if my wall has hydrostatic pressure issues?

All walls should be inspected regularly to insure the wall's integrity. A few critical areas need inspected to evaluate the effectiveness of the current drainage system. These are signs of water leakage and signs of eroded soil.

- Is there a current drainage system?
  If not, then hydrostatic pressure will become an issue and will need to be relieved.
- Is water/moisture present at the current drainage outlet?
  If moisture is present at the drain outlet or water is flowing out of the current drainage system after rain events, the drainage system is still working. If it is not performing as well as it should, one or more of the following may be experienced:
- Are there wet areas on the wall face?
  Wet areas on the wall face indicate that that water is being pushed through the wall instead of being drained out the drainage system.
- Are there cracks in the wall?
  This indicates that there has been wall movement most likely from hydrostatic pressure not being relieved. This means the drainage system may not be working as well as it should.
- Are the cracks or seams wet?
  Wet cracks & seams indicate that the wall and the seams are no longer water tight and that the drainage system is no longer functioning.
- Is vegetation growing in cracks or seams?
  Grass and other weeds sometimes grow out of seams and cracks. In order to grow, they need moisture. Typically, that moisture is coming through the crack or seam from the back of the wall. This indicates the drainage system is possibly failing.

- Is the wall buckling or bowing?
  Walls that buckle or bow are doing so because the hydrostatic pressure is not being relieved. The drainage system is, most likely, not working at all.
- Is the wall leaning?

  If the wall is leaning, hydrostatic pressure is pushing on the wall. This is a clear indication that the drainage system is failing.
- Is there soil piling up at the end of or below the current drainage outlet?
  A clear sign that soil is eroding from behind the wall is visible deposits of soil in or around the current drainage outlet. If lose backfill material is inside or around the drainage system, the filter fabric has failed and sink holes may develop.
- Is backflow material present below seams & cracks?
  If soil is present outside of the wall below seams and cracks, then soil is being carried out from behind the wall when the pressurized water is pushed out.
- Are sinkholes forming on the land side of the wall?

  Sinkholes form when voids are created in the backfill soil material. Once there are enough voids the sinkhole will form. Sinkholes are a clear indication that the filter fabric has failed.

The above signs typically indicate that the current drainage system is not able to handle the hydrostatic pressure and/or the lateral earth pressure. ***Installing Jet Filter's maintainable weep hole system is the most cost effective and quickest way to relieve the pressure without excavation.***

If I seal my wall or repair seams/cracks do I need Jet Filters?

Yes. Walls are often repaired by filling cracks and sealing the wall. The fact that cracks existed implies that the current drainage system was not working correctly. Whenever cracks are filled or a wall is sealed, the water that had been exiting through the cracks/wall is now held captive behind the wall. Without providing drainage, the water will begin to break through at the weakest points (e.g. the repaired seams & cracks). Or perhaps the water will travel under the wall creating a more significant problem.

After I fix sinkholes, should I consider installing Jet Filters?

Yes. Sinkholes appear when surface soil collapses due to voids in the soil below. Voids are created whenever moving water picks up soil particles and carries them outside the wall. This is also referred to as "erosion". In a working drainage & erosion control system soil voids would not be created.

Many times, soils are stabilized by injecting the voids with pressurized grout. Afterward, water will again be seeking the easiest path forward. Regardless of how voids & sinkholes are fixed, it is prudent to ensure that the easiest path for water is through the Jet Filter.