Guide to Common Construction Materials and Components

Aggregates

There can be no construction of any sort without aggregates. Aggregates are the stone and sand products found in concrete, asphalt paving, construction entrances, filters, infiltration trenches, sand filters, enhanced filters, etc. Examples and descriptions of the various aggregate products used in SWM facilities are reviewed below.

Types of Materials

Stone vs. Gravel - Throughout this manual and others there will be references to both "stone" and "gravel." Typically, "stone" refers to a manufactured product produced via crushing of larger material. A stone particle will have irregular, fractured, angular, rough faces. Gravel particles are typically naturally occurring material that has a rounded, smooth surface, created through the action of moving water and natural erosion of the particle's surface over time. A "stone" particle will have a much greater surface area than a similar size gravel particle due to the roughness and angularity of the particle surface. Stone particles will also "knit" together in a more stable fashion than gravel particles due to the propensity of the angular particles to interlock with each other. These properties also apply to smaller aggregates commonly referred to as "sand."

Sand - Sands may be produced through mechanical crushing like stone, or be naturally occurring like gravel. When sand has been specified as a filtering media, manufactured sand is prohibited due to the properties of angular particles noted above. Manufactured sand, due to the angular configuration, will knit together and significantly restrict flow of water through the media. Rounded, naturally occurring sand particles will maintain a consistent flow rate over time if not clogged by external materials. As noted above, "manufactured" sand is prohibited as a filtering media due to its physical properties.

Size Nomenclature

The size designations of various materials are described below. However, what makes a stone product that ranges in size from 1½ to 2½ inches in diameter a "#2" stone is determined by the materials standards as found in the American Society for Testing and Materials (ASTM) C33, "Standard Specification for Concrete Aggregates," or in the American Association of State Highway and Transportation Officials (AASHTO) M43 "Standard Specification for Sizes of Aggregate for Road and Bridge Construction." These standards provide the guidance for aggregate sizes in concrete mix design, and are based on the gradation requirement of the specification. For example, ASTM C33 defines "#2" stone as consisting of 1½ inch to 2½ inch particles with the following distribution within those limits: 90% - 100% passing the 2½-inch sieve, 35%-70% passing the 2-inch sieve, 0% to 15% passing the 1½-inch sieve, and 0% to 5% passing the ¾-inch sieve. In other cases (e.g., #57, #67), the size refers to a combination of aggregates. For example, #57 stone is a combination of #5 and #7 stone. Refer to the tables below for the specific size ranges of each material, as well as the size range for the combination. Also refer to ASTM C33 or AASHTO M43 for specifics.

AASHTO M43 Sizes of Coarse Aggregate															
Material Size	Nominal Size[1]	Amounts Finer Than Each Sieve (Square Openings) Percentage by Weight													
	inches	4	3-1/2	3	2-1/2	2	1-1/2	1	3/4	1/2	3/8	1/4	No. 4	No. 8	No. 16
	mm	100	90	75	63	50	37.5	25	19	12.5	9.5	6.3	4.75	2.36	1.18
1	3½ - 1½	100	90-100		25-60		0-15		0-5						
2	2½ - 1½			100	90-100	35-70	0-15		0-5						
24	3½ - 0½			100	90-100		25-60		0-10	0-5					
3	2 - 1				100	90-100	35-70	0-15		0-5					
357	2 - No. 4				100	95-100		35-70		10-30			0-5		
4	1½ - ¾					100	90-100	20-55	0-15		0-5				
467	1½- No. 4					100	95-100		35-70		10-30		0-5		
5	1 - ½						100	90-100	20-55	0-10	0-5				
56	1 - ?						100	90-100	40-75	15-35	0-15		0-5		
57	1 - No. 4						100	95-100		25-60			0-10	0-5	
6	¾ - ?							100	90-100	20-55	0-15		0-5		
67	¾ - No. 4							100	90-100		20-55		0-10	0-5	
68	¾ - No. 8							100	90-100		30-65		5-25	0-10	
7	½ - No. 4								100	90-100	40-70		0-15	0-5	
78	½ - No. 8								100	90-100	40-75		5-25	0-10	
8	? - No. 8									100	85-100		10-30	0-10	0-5

[1] Numbered Sieves are those of the United States Standard Sieve Series

This guidance speaks to approximate particle size and general physical properties used to identify the various materials in the field. Refer to the project material specifications for other criteria such as soundness, wear resistance, specific gravity, etc. The material producer/supplier will provide documentation that the product meets these other specifications.

Aggregate Sizing

So far, this guidance has referenced “stone,” “gravel” and “sand” under the topic of “aggregates.” Realistically, aggregates can cover materials from the largest boulders to the finest sand. A basic guide to aggregate sizing is included below:

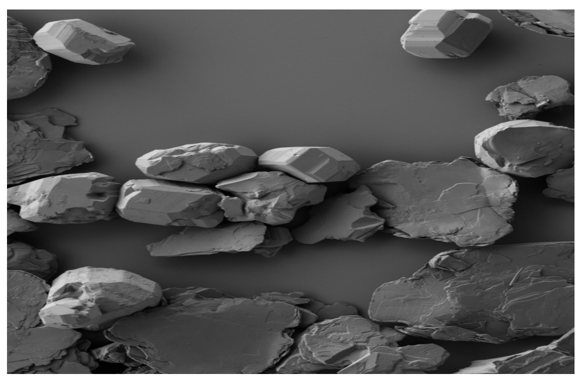
- **Riprap** - Large particles, typically used for inflow/outfall stabilization/armor. Sized in Maryland by “class”
  - Class “0”- particles are roughly 7 inches in diameter
  - Class “1”- particles are roughly 12 inches in diameter
  - Class ”2”- particles are roughly 20 inches in diameter
  - Class “3”- particles are roughly 28 inches in diameter
- **Gabion Stone** - Mid size particles roughly 4 to 7 inches in diameter. Typically used to construct “gabion baskets,” wire containment filled with gabion stone used to prevent erosion in specific applications, or placed loosely as armor.
- **#2 Stone** - small particles, typically ranging from 1½ inches to 2½ inches in diameter. #2 stone is most often seen utilized in stabilized construction entrances and in stone reservoirs.

- **#57 Stone** - smaller particles, typically between ⅜ and 1-inch in diameter. #57 stone is the most widely used aggregate in SWM construction, and is typically found in stone reservoirs, around underdrains, under permeable paving systems, and as a filter media over dry basin drawdown devices.
- **Pea Gravel** - rounded, naturally occurring particles of approximately ⅜-inch diameter.
- **Stone Dust/#10 screenings** - a matrix of crushed stone particles ranging from approximately ¼" in diameter down to fine dust. Typically used as a structural fill or as a traction aid in icy conditions. Not acceptable as a filter media.
- **ASTM C33/AASHTO M-6 Sand**- fine particles ranging from .0059 inches up to .187 inches. **<u>NOTE- if this product is to be used as a filter media, it must be from a naturally occurring source. Products produced as a result of crushing operations are unacceptable and prohibited in filter applications.</u>**

#2 Stone

#57 Stone

Natural, Rounded Sand Particles (Magnified)



Manufactured Sand Particles (Magnified)

Natural Pea Gravel (#8 or #9)

Manufactured Stone Dust - #10 Screenings

C33/AASHTO M-6 Sand

Riprap, Various Sizes

Gabion Stone Baskets

Loose Gabion Stone

Unwashed #8 Stone

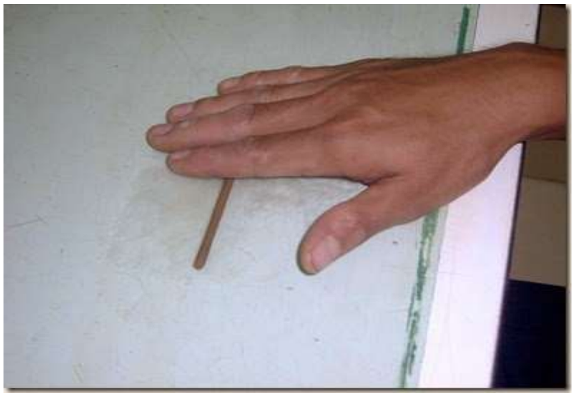
Residue/Dust from Unwashed Aggregate

Soil

As discussed, any SWM facility that utilizes an embankment to impound water must be constructed with an impervious core and cut-off trench composed of impervious material. Typically, this impervious material is composed of fine- grained clay soils. Clay soils are defined by their level of plasticity. Plasticity can be illustrated by the ability to roll a small sample of the soil into a thread of no greater than ⅛ inch. Soils of similar grain size that do not display the cohesive properties of clays are typically defined as silts. Silts generally cannot be rolled into a thread, although some elastic silts can demonstrate a degree of plasticity. Any material intended to be utilized in an embankment as an impervious core or cut-off trench must be fully classified by a soils laboratory under the direction of a geotechnical engineer. However, the inability of a field sample to be rolled into a thread is a good indication that the material may not meet the requirements of MD-378 for impervious material. Clays will also exhibit considerable strength when air dried, whereas silts of a similar grain size profile will not. Clays also tend to be more vividly colored than typical local soils, presenting in colors ranging from dark grey/purple to white.

Vein of Clay Being Excavated

Close Up of Clay Formation



Rolling Clay to Determine Plasticity

Rolling Clay in the Field to Estimate Plasticity

Geotextiles

Often referred to in the field as “filter cloth,” geotextiles are utilized in multiple applications in the construction of SWM facilities. Geotextiles are divided into two basic categories, woven, and non-woven. Woven geotextiles are produced by weaving individual strands of material into sheets, and can be recognized by the woven pattern in the material. Woven geotextiles also often have a shiny appearance. The most common example of a woven geotextile familiar to inspectors would be silt fence. Nonwoven geotextiles have the appearance of a “felt” product, and do not present the weave that a woven geotextile will. Geotextiles are most often utilized to separate aggregates from native soils or planting media. Geotextiles are also utilized in multiple sediment control BMPs as filtering media. Refer to the 2011 Maryland Standards and Specifications for Soil Erosion and Sediment Control and the Design Manual for specific applications of each type of material.

Woven Geotextile (note shiny appearance)

Detail of Woven Geotextile

Non-Woven Geotextile Roll

Detail of Non-Woven Geotextile

Control Structures

Control structures are the means to control the release of stormwater from any facility. In an above ground facility, they may take the form of a vertical structure or "riser," or take the form of a weir wall. The objective of a control structure is to slow down or limit the release of impounded water up to the volume that the BMP is designed to handle. Volumes that exceed the design volume of a BMP are released in an unmetered fashion, but still directed through the control structure. Vertical control structures can be constructed of metal, concrete, or even wood. Weir walls are typically constructed of concrete, but some wooden weirs do exist. The metered release of stormwater is typically controlled by a small orifice in a vertical control structure. Weir walls may use an orifice or a "notch" in a weir wall. These restricting components are typically referred to as the "low flow" orifice or weir. The orifice may take the form of a metal plate with a specifically sized hole to pass stormwater, or the orifice may be an opening cast into the concrete structure.

Concrete Weir
(Photo courtesy of SWM, LLC)

Wooden Weir with Orifice Plate
(Photo courtesy of Morton-Roberts Consulting Engineers)

Concrete Control Structure and Low-Flow Dewatering Device
(Photo courtesy of Gannett Fleming ,Inc.)

Metal Low-Flow Orifice (Partially Clogged)

Metal Control Structure with Trash Rack

Metal Control Structure with Wooden Inserts

Control Structure in a Bioretention Filter

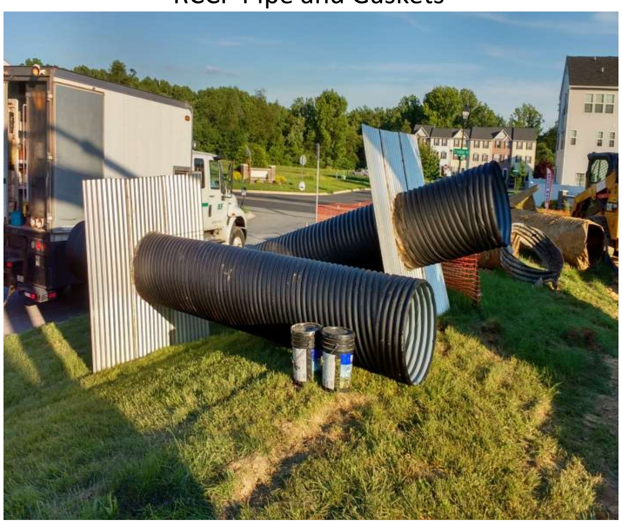
Control Structure in a Micro-Bioretention Filter

Pipe

Stormwater BMPs can contain a variety of pipe configurations and materials. High Density Polyethylene (HDPE) plastic (black), Polyvinyl Chloride (PVC) plastic (white), aluminum coated corrugated metal (ALCCMP), bituminous coated corrugated metal (BCCMP), and reinforced concrete (RCCP). Principal spillway pipe may be HDPE, ALCCMP, BCCMP, or RCCP. Conveyance pipe may be any of the above materials. Underdrain pipe is typically perforated or slotted, and may be PVC or HDPE.

RCCP Pipe and Gaskets

ALCCMP Pipe and Anti-Seep Collar



BCCMP Pipe and Uncoated Anti-Seep Collars

Non-Perforated HDPE Pipe

Perforated HDPE Underdrain Pipe

Perforated and Solid PVC Pipe

Slotted Sch. 40 PVC Pipe

Drain Pipe and Fittings

Trash Racks

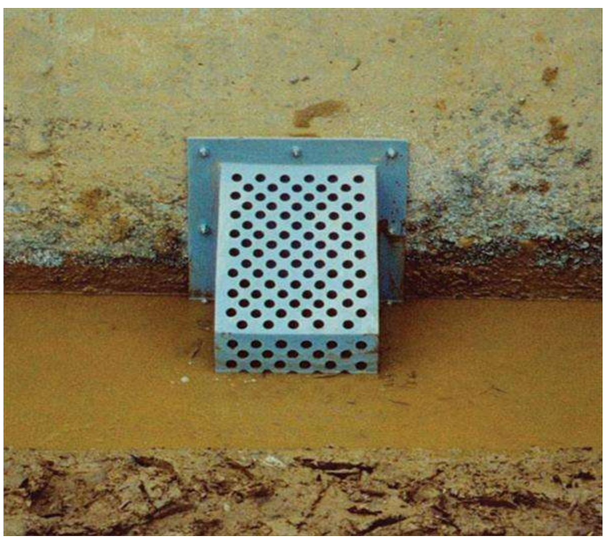
Trash racks are typically metal or plastic guards designed to prevent large items from entering or clogging the control structure either via the low-flow orifice or the main outlet. Trash racks can be found in a wide variety of configurations, depending on the control structure design. Below are some examples of commonly seen trash racks in a variety of applications, from large impoundments to low-flow orifice protection.

Large Trash Rack on Control Structure
(courtesy SWM, LLC.)

Welded Galvanized Steel Trash Rack (Top Mount)

Welded Reinforcing Steel Trash Rack
w/Anti-Vortex Baffle
(Photo courtesy of HydroCAD Software Solutions, LLC)

Side Mounted Trash Racks



Low-Flow Orifice Trash Rack

Cast Iron Surface Inlet Trash Rack ("Beehive")