Drainfield rock distribution media

Standards and guidance document version #2

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Introduction

The purpose of this Standards and Guidance document is to identify specifications and other requirements for drainfield rock distribution media to ensure it is suitable for use in soil treatment and dispersal systems. This document also identifies quality control measures and best management practices used to ensure drainfield rock stays 'clean' when stored, transported, stockpiled and handled prior to system construction.

This document was written to provide technical information regarding the quality and use of what is commonly called 'drainfield rock' in the Subsurface Sewage Treatment System (SSTS) industry. Drainfield rock is a type of distribution media used in soil treatment systems, including trenches, beds (seepage beds and pressure beds), at-grades, mounds, sand filters and other treatment and dispersal systems. Public domain drainfield rock distribution media is the material addressed in these standards. The Standards and Guidance contained in this document were developed for statewide application, with input from the Technical Advisory Panel and other practitioners.

Public domain distribution technologies are products developed without a patent. Drainfield rock is a public domain distribution technology [Minn. R. 7083.4000, subp. 1(B)(3)]. Another example of a public domain material is the specified sand filter media used in mounds and sand filters.

The purpose of drainfield rock is to temporarily store and convey wastewater to the soil's infiltrative surface (absorption area) in soil treatment and dispersal systems. The infiltrative surface is the interface where effluent moves through the distribution media and into the treatment media or native soil (Decentralized Wastewater Glossary, 2009).

General background

Drainfield rock is a natural material obtained from different aggregate sources. The rock can be produced by crushing, screening, grading and washing to meet the desired specifications. In some regions of Minnesota, sand and aggregate deposits are common; other areas lack significant suitable deposits. Proper washing of the rock is critical to remove fine particles, such as silt and clay. If the aggregate washing process is inadequate, fine particles on the rock could 'wash-off' the rock surface when the system is loaded with effluent. This could cause a layer of fines to accumulate along the infiltrative surface, potentially reducing its ability to transmit wastewater into the native soil or sand media.

Distribution media can also include proprietary distribution products that can be produced from recycled or synthetic materials. A list of registered proprietary distribution media products ("List of Registered Distribution Media Products" or the "At A Glance Listing of Proprietary Distribution Media Products") can be found on the Minnesota Pollution Control Agency (MPCA) website at: www.pca.state.mn.us/www.pca.state.mn.us/programs/ists/productregistration.html. For each of the listed registered distribution media products, MPCA's website contains the registration letter that was mailed to the manufacturer, along with a link to the manufacturer's website.

Performance standards

This section provides the standards for drainfield rock distribution media and the recommended quality control assurance that certified or licensed designers, installers and local governmental units (LGUs) use when drainfield rock is the selected distribution media in trenches, beds, at-grades, mounds and sand filters.

Drainfield rock must meet minimum specifications when used in soil treatment and dispersal systems. The MPCA does not require that each gravel pit owner 'register' drainfield rock when used in soil treatment and dispersal systems. However, drainfield rock must meet minimum requirements.

Drainfield rock shall be clean, sound and durable. If not clean, drainfield rock will typically need to be properly washed to remove the fine silt and clay particles that can contribute to soil clogging. Uniform rock size is preferred to obtain the maximum void space for the temporary storage of effluent. Rock durability or hardness of the rock is also important. For limestone aggregate, durability of the rock has been an issue of concern in some parts of southern Minnesota. Drainfield rock must not break down during transport or when used in sewage treatment and dispersal systems.

Ultimately, the MPCA licensed installer is responsible to ensure that suitable materials, including suitable drainfield rock, are used in the construction of soil treatment and dispersal systems [Minn. R. 7083.0760, subp. 2(D) and (G)].

Performance criteria

Distribution media used in subsurface sewage treatment systems shall meet four basic criteria (Minn. R. 7083.4070):

- be non decaying and non-deteriorating and does not leach unacceptable chemicals when exposed to sewage and soil
- provides adequate void space for the passage and temporary storage of effluent while maintaining a stable density throughout the life of the system
- supports the distribution pipe, provides for suitable effluent distribution and presents an interface with the infiltrative surface for absorption of the wastewater
- maintains the integrity of the excavation, supports soil backfill and cover material and weight of equipment used in backfilling

Application standards

General conditions

Drainfield rock distribution media may be used in all subsurface sewage treatment systems. Drainfield rock distribution media may incorporate any combination of the following design elements:

- gravity flow distribution
- pressure distribution
- timed dosing
- zoned or alternating systems

Permitting

Permitting of systems using drainfield rock distribution media are subject to state and local requirements.

- name, mailing address, and telephone number
- property identification number and address or other description of property location
- site evaluation report as described in Minn. R. 7080.1730
- design report as described in Minn. R. 7080.2430
- management plan as described in Minn. R. 7082.0600

Other items normally required by the local governmental unit jurisdiction will also be included in the construction permit.

Influent wastewater characteristics

Wastewater from residential sources must receive primary treatment at least equal to that provided by a properly sized septic tank before final discharge into the drainfield rock distribution media (constituents are typically less than 170 mg/L BOD_5, 60 mg/L TSS and 25 mg/L oil and grease). Wastewater from non-residential sources, or high-strength wastewater from residential sources, must receive pre-treatment sufficient to lower the waste-strength to the level commonly found in domestic residential septic tank effluent. This will help ensure that proper organic loading rates to the soil are achieved before discharging effluent into the drainfield rock distribution media.

Specifications for drainfield rock distribution media

Drainfield rock must be clean, durable, broken or crushed stones, or screened gravel, meeting the quality requirements of Minnesota Department of Transportation (Mn/DOT) Specification 3137. The drainfield rock shall meet the gradation requirements for coarse aggregate shown in Table 1 and the limestone testing requirements for 'hardness' shown in Table 2.

Drainfield rock shall be meet the requirements of Mn/DOT Specification 3137 for silt, lumps of clay, mud, dirt, organic material, wood, other deleterious substances and fines. Drainfield rock shall not contain more than one percent fines (passing the #200 sieve).

Table 1. Drainfield rock size requirements

Sieve size	Percent passing (by weight)
2-1/2 inch	100
1-1/2 inch	85 - 100
¾ inch	5 - 35
#4	0 - 5
#200	0 - 1

Limestone and other potentially soft rocks cannot decay or deteriorate when exposed to sewage and soil. Currently, there are two specified tests to determine this suitability: 1) loss of abrasion and 2) loss of soundness. The purpose of these two tests, as suggested by the Aggregate Ready-Mix Association of Minnesota (Aggregate Ready-Mix Association of Minnesota, 2008 and 2009), is to help ensure that limestone and other potentially soft rock does not break down when transported and used in sewage treatment systems. Thus, drainfield rock shall: 1) have a loss of abrasion of not more than 40 percent using AASHTO Method T 96 (Los Angeles Rattler Test), LAR and 2) not have a loss of soundness using magnesium sulfate of more than 15 percent at the end of five cycles for any coarse fraction using AASHTO Method T 104.

At the pit, sufficient material must be produced and stockpiled to permit proper sampling and testing of the material, as specified in Mn/DOT Specification 3137. The material from the pit shall be tested to ensure the material meets the required specifications.

Table 2. Limestone testing requirements for 'hardness'

Description	Method	Results required
Abrasion determines if rock breaks down when moved around	AASHTO Method T 96 (Los Angeles Abrasion Test)	Not more than 40 percent loss
Soundness determines if rock breaks down over time	AASHTO Method T 104 (magnesium sulfate)	Not more than 15 percent loss at end of five cycles

Design and installation

When drainfield rock is used, the following practices apply:

- For trenches using gravity distribution, the bottom absorption area (infiltrative surface) in a one-foot long by three-foot wide trench is equal to three square feet. Most trenches typically contain six-inches to 11 inches of drainfield rock below the distribution pipe. Drainfield rock also needs to completely encase the top and sides of the distribution pipe to a depth of at least two inches above the distribution pipe. The total thickness of rock filled trenches cannot exceed 30 inches.
- For trenches using gravity distribution, the bottom absorption area may be reduced by the following percentages when designing a trench system loaded with septic tank effluent:
  - no reduction for loading six to 11 inches of trench sidewall absorption below the distribution pipe
  - twenty percent reduction for loading 12 to 17 inches of trench sidewall absorption below the distribution pipe
  - thirty four percent reduction for loading 18 to 23 inches of trench sidewall absorption below the distribution pipe
  - forty percent reduction for 24 inches of trench sidewall absorption below the distribution pipe

- For trenches using pressure distribution, the bottom absorption area (infiltrative surface) in a one-foot long by three-foot wide trench is equal to three square feet. The trenches must contain a minimum depth of six inches of drainfield rock below the pressure distribution pipe. Drainfield rock needs to completely encase the top and sides of the pressure distribution pipe to a depth of at least two inches above the pressure distribution pipe.
- For beds (seepage beds and pressure beds), the bottom absorption area (infiltrative surface) is equal to one square foot per square foot of rockbed. For example, a ten-foot wide and 50-foot long bed contains 500 square feet of bottom absorption area. Beds using pressure distribution would require 500 square feet of bottom area; beds using gravity distribution would require 750 square feet of bottom area [Minn. R. 7080.2210, subp.3 (A)].
- For trenches and beds (seepage beds and pressure beds), the minimum sidewall absorption height is six inches; at least six inches of drainfield rock distribution media is required below the distribution pipe [Minn. R. 7080.2210, subp. 3(B)]. Drainfield rock needs to completely encase the top and sides of the distribution pipe to a depth of at least two inches above the distribution pipe. Natural, undisturbed soil must exist between multiple trenches and beds; a minimum three feet spacing between trenches is recommended to facilitate oxygen diffusion. A four-inch vertical inspection pipe is required in the distribution rock at the 'end' of each trench and bed [Minn. R. 7080.2210, subp.4 (B)].
- For at-grades, the bottom absorption area (infiltrative surface) is equal to one square foot per square foot of rockbed. Proper scarification of the entire absorption area is required before placement of drainfield rock. There shall be a minimum of six inches of drainfield rock below the pressure distribution pipe. Drainfield rock needs to completely encase the top and sides of the pressure distribution pipe to a depth of at least two inches above the pressure distribution pipe. A four-inch diameter inspection pipe must be installed vertically from the soil interface to a point above final grade along the down slope bed [Minn. R. 7080.2230, subp. 3(G)].
- For mounds, the bottom absorption area (infiltrative surface) is equal to one square foot per square foot of rockbed. Proper scarification of the entire absorption area is required before placement of clean sand. There shall be a minimum of six inches of drainfield rock below the pressure distribution pipe. Drainfield rock needs to completely encase the top and sides of the pressure distribution pipe to a depth of at least two inches above the pressure distribution pipe. The sidewall of the rock bed must be as vertical as practical and not intentionally sloped. A four-inch vertical inspection pipe must be installed at the drainfield rock and sand interface [Minn. R. 7080.2220 subp. 3(O)].
- For single pass sand filters, drainfield rock specifications for distribution and underdrain media are either contained in this document or in the most current version of the MPCA Recommended Standards and Guidance Document for Single Pass Sand Filters (MPCA, 2012).
- For recirculating sand filters, drainfield rock specifications for distribution and underdrain media are either contained in this document or in the most current version of the MPCA Recommended Standards and Guidance Document for Recirculating Sand Filters (MPCA, 2012).
- For all systems, the following items apply:
  - Any excavation into the absorption area must be in a manner that maintains soil structure in an un-smeared and un-compacted condition. Excavation and placement of drainfield rock is allowed when; 1) the soil moisture is less than the plastic limit and 2) the soil is not frozen or freezing [Minn. R. 7080.2150, subp. 3(G)]. Placement of drainfield shall be performed in a manner that minimizes the embedment of drainfield rock into the underlying soil.

- Drainfield rock shall completely encase the top and sides of the distribution pipe to a depth of at least two inches above the distribution pipe.
- Durable non-woven geotextile fabric must be used to cover the entire drainfield rock distribution media. The fabric must be of sufficient strength to undergo installation without rupture. The fabric must permit the passage of water without passage of overlying soil material into the drainfield rock medium [Minn. R. 7080.2150, subp. 3(F)].
- The top and bottom of the drainfield rock distribution media must be level along the contour. Sidewalls must be as vertical as practical and not intentionally sloped [Minn. R. 7080.2210, subp. 4(C)].
- The minimum depth of soil cover, including topsoil borrow over the drainfield rock distribution media, is 12 inches [Minn. R. 7080.2210, subp. 4(D)]. At least six inches of topsoil is required on trenches, beds (seepage beds and pressure beds), at-grades and mounds.

Quality control considerations

When placing drainfield rock into an excavation, the licensed installer shall ensure the rock is of suitable quality and placed into the excavation in a fashion that maintains the soils infiltrative surface. The licensed installer shall verify the quality of drainfield rock when it is delivered to the construction site to ensure it meets the required specifications before using in the soil treatment system.

If the quality of the aggregate washing process is poor, the silt and clay particles remaining on the surface of the drain rock will likely wash off when the system is loaded with effluent. This can result in a layer of fines to accumulate along the infiltrative surface, thereby reducing the soil's infiltrative capacity. Furthermore, if drainfield rock is 'mishandled' on site, it can become contaminated with grass, soil and other materials and debris as the rock is moved with heavy equipment.

The pit or quarry operator and the licensed installer can follow some simple Best Management Practices (BMP)s when loading and moving drainfield rock around so it remains clean and will not become contaminated.

The following techniques can be used to help determine the suitability of drainfield rock:

- Test Results from the Plant. This would include the sieve analyses, soundness test and abrasion test (if limestone) that the aggregate meets quality Mn/DOT Specifications 3137 and the size requirements contained in this document. This is the best technique, using actual test results.
- Collect independent samples. Properly collect drainfield rock samples, and test at a materials testing laboratory.
- Use of Field Screening Techniques. Screening tools do not replace the testing performed by qualified laboratories. However, screening tools can help both the licensed installer and inspector to 'verify' the general suitability of drainfield rock.

Field screening tool for fines – Jar Test

A tool known as the 'jar test' can be used to evaluate the relative fines content in a load of drainfield rock delivered to a construction site. This tool has also been used by licensed installers and local inspectors to help evaluate fines in mound sand and single pass sand filters. For drainfield rock, the procedure can be used as a 'quick check' on fines in a load of drainfield rock.

Field screening tool for rock hardness – Mohs Test

Another field tool that can be used to help evaluate the suitability of drainfield rock is the Mohs Test (Mohs Hardness, 2008). Drainfield rock would typically have a hardness of three or more on the Mohs Scale of Hardness. Hardness is a measure of a rock's resistance to abrasion and is measured against a standard scale called the Mohs Scale of Hardness. The scale consists of ten fairly common minerals of known hardness, which are numerically ordered from the softest rock (1) to the hardest rock (10), as follows:

1. Talc (H=1)	2. Gypsum (H=2	3. Calcite (H=3)	4. Fluorite (H=4	5. Apatite (H=5)
6. Orthoclase (H=6)	7. Quartz (H=7)	8. Topaz (H=8)	9. Corundum (H=9)	10. Diamond (H=10)

The Mohs Scale of Hardness is based on the fact that a harder material will scratch a softer one. By using a simple scratch test, you can determine the relative hardness of drainfield rock. Please be advised this simple test is not suitable for all rock types. For example, chert and shale, which would 'pass' using this field tool would, in fact, break down using the AASHTO Methods for loss of abrasion and soundness tests because of the structure of the rocks.

There are several simple tools that can be used in determining the relative hardness of drainfield rock. For example, your *fingernail* has a hardness of 2.5. If you can scratch the surface of a rock with it, its hardness is less than 2.5; slightly harder than gypsum (H=2) but softer than calcite (H=3). A *penny* has a hardness of 3.0. If you cannot scratch the rock with your fingernail (H=2.5), but can with a penny, the rock is at least as hard as calcite (H=3). The *steel blade* of the average knife commonly has a hardness of about 5.5. If a penny does not scratch your rock but the knife blade does, then it is harder than calcite (H=3) but softer than orthoclase (H=6).

If your drainfield rock	**Give it a hardness number**
Can be rubbed off on the fingers	1
Can be scratched with a fingernail	2
Can be scratched with a penny[1]	3
Can be scratched easily with a butter knife	4
Can be scratched with a steel nail but not glass	6
Can be used to scratch glass	7
Too hard to be tested in this scale	8 – 10

[1] Drainfield rock would typically have a hardness of three or more on the Mohs Scale of Hardness.

Best Management Practices

A few simple BMPs can be used to minimize contamination of drainfield rock with fines, dust, clods of silt and clay, woody materials and other undesirable materials. BMPs can be used by both equipment operators loading drainfield rock at the pit or quarry and by licensed installers moving rock around the construction site.

- Best Management Practices at the gravel pit or quarry
  - Leave a bottom layer of rock (six inches) when loading the truck. Do not scoop up all the rock on the ground because it will mix with the underlying soil and the load will become contaminated with soil and/or fines

- Don not let the rock get too dusty – it may need to be washed again due to excess fines. For example, if a stock pile sits in the pit for a number of years, it will likely be contaminated with fines because of dusty conditions found at these facilities.

- Best Management Practices at the construction site
  - Take rock directly from the truck to the soil treatment system, do not store or stockpile drainfield rock, just place it immediately.
  - If rock is stockpiled, use a clean, undisturbed area for temporary storage of drainfield rock. Consider covering stockpiled materials if conditions are excessively dusty.
  - If stockpiled, make sure different materials are kept separate (i.e. clean sand, pea rock and drainfield rock).
  - Make sure the bucket is clean before scooping up materials.
  - Take care not to mix any soil in with drainfield rock when moving it around.
  - Carefully place drainfield rock into the excavation; make sure soil is at the proper moisture content. Make sure the bottom and sides of the excavation are not smeared; minimize walking in the excavation. Carefully place drainfield rock into the excavation by minimizing drop distance into the excavation.

Operation, maintenance and abandonment

The owner of the residence or facility served by the subsurface soil treatment system is responsible for assuring proper operation and providing timely maintenance for all components of the system. The licensed designer, installer or inspector should instruct, or assure that instruction is provided to the owner of the residence or facility in the proper operation and maintenance of the system. The owner must be made aware of the system's Management Plan, its' purpose and the need for proper operation and maintenance. A below–grade management plan can be found at the University of Minnesota's website at: http://septic.umn.edu/formsandsheets/bytype/index.htm#plans.

Septic system owners can obtain additional information related to operation and maintenance at the University of Minnesota's website at: http://septic.umn.edu. The publication entitled *Septic System Owner's Guide* is available for purchase from the University of Minnesota.

System abandonment

Unused subsurface soil treatment systems must be properly abandoned (Minn. R. 7080.2500). The soil treatment system component filled with drainfield rock may be left in place. However, if drainfield rock is removed, proper disposal of the rock and other contaminated materials is required.

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