USDA
NATURAL RESOURCES
CONSERVATION SERVICE

MARYLAND CONSERVATION
PRACTICE STANDARD

SINKHOLE AND SINKHOLE AREA TREATMENT

CODE 725
(Reported by No.)

DEFINITION

A method of treating sinkhole areas to reduce contamination of ground water resources. (A sinkhole is a circular and funnel-shaped surface depression occurring in soluble bedrock areas and commonly develops as a result of surface soil moving downward into open bedrock fractures and solution cavities.)

PURPOSES

The primary purpose is to treat a source of ground water pollution by reducing the amount of contaminants or contaminated surface water entering sinkholes. A secondary benefit is improved safety due to the closing of sinkhole entries.

CONDITIONS WHERE PRACTICE APPLIES

On any land surface or existing conservation practice where a sinkhole has developed due to natural geologic conditions, and contaminated surface water and other contaminated materials have the opportunity to enter the sinkhole and pollute the ground water resource.

CONSIDERATIONS

General

Consider using a systems approach for solving the problem by treating both the sinkhole directly, and its drainage area (i.e., when possible, this practice should work in conjunction with existing or planned conservation systems, including practices that control sheet, rill and gully erosion, and practices that provide pest and nutrient management).

Consideration should be given to the following:

1. Land use;
2. Existing and planned land treatment;
3. Sinkhole drainage area;
4. Dimensions of sinkhole opening;
5. Safe outlet for diverted surface water;
6. Environmentally safe disposal site for sinkhole "clean out" material;
7. Availability and quality of inverted filter material;
8. Safety of equipment operators and laborers during practice installation.

Effects on Water Quality and Quantity

To improve ground water quality, consider methods for removing contaminated materials from sinkholes and reducing or eliminating direct inflow of contaminated surface water into sinkholes.

Consider using land treatment methods that will improve filtration and infiltration of surface water before it reaches the sinkhole. Consider that improved infiltration may provide some increase in soil moisture.

CRITERIA

The type of treatment selected shall be based on the size of the sinkhole drainage area and may include both direct sinkhole treatment along with surface water control measures and filter strips. The sinkhole treatment shall not result in surface water ponding or high soil moisture conditions over an extended period of time. How-

Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version of this standard, contact the Natural Resources Conservation Service.

ever, because percolation rates vary among different soils, ponding and soil moisture conditions may also vary.

The design for this treatment applies to sinkholes with excavated depths between 5 and 25 feet and with drainage areas up to 15 acres. (For most sinkholes, excavation up to 5 feet is sufficient to allow for filter installation.) For sinkholes requiring excavated depths greater than 25 feet or uncontrolled drainage areas greater than 15 acres, adjustments to the inverted filter and/or surface water control measure(s) may be required. In these cases, geologic and engineering assistance must be requested and a site specific design prepared.

Other Maryland conservation practice standards that may need to be implemented in conjunction with this practice include: Diversion (Code 362), Filter Strip (Code 393), Grassed Waterway (Code 412), Lined Waterway or Outlet (Code 468), and Terrace (Code 600).

Treatment for Sinkholes with Drainage Areas Less than 5 Acres

Treat the sinkhole using the Inverted Filter 1 specification in this standard.

Inspection of the treatment shall be made after periods of heavy precipitation, because some material may run further into sinkhole voids causing a surface depression. In this case, maintenance will include adding soil material at the surface.

The existing (or planned) land use or practice may exist over the treated sinkhole as long as the treatment is maintained.

Treatment for Sinkholes with Drainage Areas of 5 Acres or More, and a Safe Outlet

The following additional criteria are applicable to sinkholes with drainage areas of 5 acres or more, where a safe outlet can be provided for surface water that is diverted away from the sinkhole. A safe outlet is one that does not erode, divert surface water to another sinkhole, or cause flood damage to crops, property or buildings.

Inverted Filter - Treat the sinkhole using the Inverted Filter 1 specification in this standard.

Inspection of the treatment shall be made after periods of heavy precipitation, because some material may run further into sinkhole voids causing a surface depression. In this case, maintenance will include adding soil material at the surface.

The existing (or planned) land use or practice may exist over the treated sinkhole as long as the treatment is maintained.

Control of Surface Water - Install one or more surface water control measures to divert runoff away from the sinkhole to a safe outlet.

The measure(s) shall be located to reduce the internal drainage area around the sinkhole to less than 5 acres.

The selected measure(s) shall be based on specific site conditions, and the appropriate Maryland conservation practice standards shall be followed.

Treatment for Sinkholes with Drainage Areas from 5 to 15 Acres, and No Safe Outlet

The following additional criteria are applicable to sinkholes with drainage areas from 5 to 15 acres, where a safe outlet for surface water is not feasible.

Inverted Filter - Treat sinkhole using the Inverted Filter 2 specification in this standard.

Inspection of the treatment shall be made after periods of heavy precipitation, because some material may run further into sinkhole voids causing a surface depression. In this case, maintenance will include adding filter material at the surface.

The treated sinkhole will remain as unused land.

Grassed Filter Area - Install a grassed filter area around the sinkhole to improve water quality by filtration and adsorption of contaminants. The grassed filter area shall be installed within the sinkhole drainage area and shall begin at the treated sinkhole.

The minimum width (in feet) of the grassed filter area shall be determined by multiplying the sinkhole drainage area (in acres) by seven. Because surface runoff may be temporarily stored before reaching the treated sinkhole, this width should provide beneficial filtering for some distance outside the sinkhole.

Follow the Maryland conservation practice standard for Critical Area Planting (Code 342) to determine the appropriate vegetation to be planted and maintained in the grassed filter area.

Establishment of Vegetation

On disturbed areas and/or sinkholes (as applicable), determine the appropriate vegetation to be established based on site conditions and planned land use. Follow the Maryland conservation practice standards for Critical Area Planting (Code 342), Conservation Cover (Code 327), or Pasture and Hay Planting (Code 512), as appropriate.

When a grassed filter area is required around a sinkhole, follow the Maryland conservation practice standard for Critical Area Planting (Code 342) to determine the appropriate vegetation for the filter area.

Do not use plants listed on the Maryland noxious weed list. Schedule construction so that completion occurs during periods suitable for the establishment of vegetation.

Materials

Geotextile – Geotextile must be non-woven with minimum burst strength of 100 psi. It must meet the requirements of Maryland Department of Transportation, State Highway Administration, Standard Specifications for Construction and Materials, Section 921.09, Class SE.

Aggregates - Fine aggregates, gravel, and rock riprap must meet the requirements of Maryland Department of Transportation, State Highway Administration, Standard Specifications for Construction and Materials, Sections 901.01 and 901.02 respectively, or the American Association of State Highway and Transportation Officials (AASHTO) Standard Specifications for Construction Materials, as specified.

SPECIFICATIONS

Prepare plans and specifications for treating sinkholes and sinkhole areas in accordance with the Considerations, Criteria, and Operation and Maintenance described in this standard. Describe the requirements for applying the practice to achieve its intended use.

Inverted Filter 1

Use the following procedure for installing an inverted filter to treat sinkholes with drainage areas of less than 5 acres:

1. Remove and properly dispose of materials dumped in and around the sinkhole;

2. Excavate loose material from the sinkhole and try to expose the solution void(s) in the bottom. Enlarge the sinkhole, as necessary, to allow for installation of the filter materials;

3. Select a field stone(s) that is about 1.5 times larger than the solution void(s). Place the stone(s) into the void(s) forming a secure "bridge";

4. Place a layer of filter material over the "bridge" at a minimum thickness of 18 inches. About 30 percent of the material should be larger than the opening between the bridge and the void(s). (A well placed "bridge" should not have large openings around it.) In most cases, this material can be MSHA gabion stone;

5. Place a layer of smaller size filter material over the previous layer at a minimum thickness of 9 inches. The size should be 1/4 to 1/2 the size of the previous layer. In most cases, this material can be No. 57 stone;

6. Place a layer of sand size filter material over the previous layer at a minimum thickness of 9 inches. The sand has to be compatible in size with the previous layer to prevent piping. In most cases, this material can be MSHA fine aggregate - underdrain;

7. A non-woven geotextile with minimum burst strength of 100 psi can be substituted for the stone and sand filter materials discussed in 5 and 6;

8. Stone used for the "bridge" and the filters should have a rock strength at least equal to moderately hard (i.e., resistant to abrasion or cutting by a knife blade but can be easily dented or broken by light blows with a hammer). Shale or similar soft and non-durable rock is not acceptable;

9. Backfill over the last filter layer (or geotextile) with soil material to the surface. Overfill by about 5 percent to allow for settlement. The material should be mineral soil with at least 12 percent fines. The reuse of any soil material excavated from the sinkhole should be considered and any available topsoil should be placed on the surface;

10. Establish vegetation on the treated sinkhole and other disturbed areas in accordance with the criteria provided in this standard for "Establishment of Vegetation."

Inverted Filter 2

Use the following procedure for installing an inverted filter to treat sinkholes with drainage areas from 5 to 15 acres:

1. Remove and properly dispose of materials dumped in and around the sinkhole;

2. Excavate loose material from the sinkhole;

3. Place a layer of filter material into the sinkhole, allowing the stone to fill the void(s) below the bottom of excavated sinkhole. The size should be 1/4 to 1/2 the size of the void(s). In most cases, this material can be MSHA gabion stone;

4. Place a layer of the same size filter material at a thickness of about 3/4 D (D = total depth) above the sinkhole bottom;

5. Place a layer of smaller size filter material over the previous layer at a thickness of about 1/4 D. Bring this layer to the surface. The size should be 1/4 to 1/2 the size of the previous layer. In most cases, this material can be No. 57 stone;

6. Stone used for the filters should have a rock strength at least equal to moderately hard (i.e., resistant to abrasion or cutting by a knife blade but can be easily dented or broken by light blows with a hammer). Shale or similar soft and non-durable rock is not acceptable.

7. Establish vegetation on disturbed areas in accordance with the criteria provided in this standard for "Establishment of Vegetation."

OPERATION AND MAINTENANCE

The owner/operator shall be responsible for maintaining the treated sinkhole and sinkhole area according to the plan and design provided.

At a minimum, the following items shall be included in the O&M plan, as applicable:

1. Mow herbaceous plantings as necessary to promote vigorous growth;

2. Inspect practices at least once a year and after major storms. Fill in and reseed any damaged areas.

SUPPORTING DATA AND DOCUMENTATION

Field Data and Survey Notes

The following is a list of the minimum data needed:

1. Drainage area of sinkhole;
2. Availability of safe outlet for surface water, if applicable;
3. Estimated depth and volume of sinkhole.

Design Data

Record on appropriate engineering paper. For guidance on the preparation of engineering plans, see Chapter 5 of the Engineering Field Handbook, Part 650. The following is a list of the minimum required design data:

1. Plan view showing sinkhole and, if applicable, any associated surface water control measures(s) and filter strip;
2. Drawing of inverted filter showing thickness of each filter material;
3. Determine the quantity of each filter material selected;
4. Planting plan. This must meet the criteria, specifications, and documentation requirements of the Maryland conservation practice standard for Critical Area Planting (Code 342). Show on plan.

Construction Check Data/As-Built

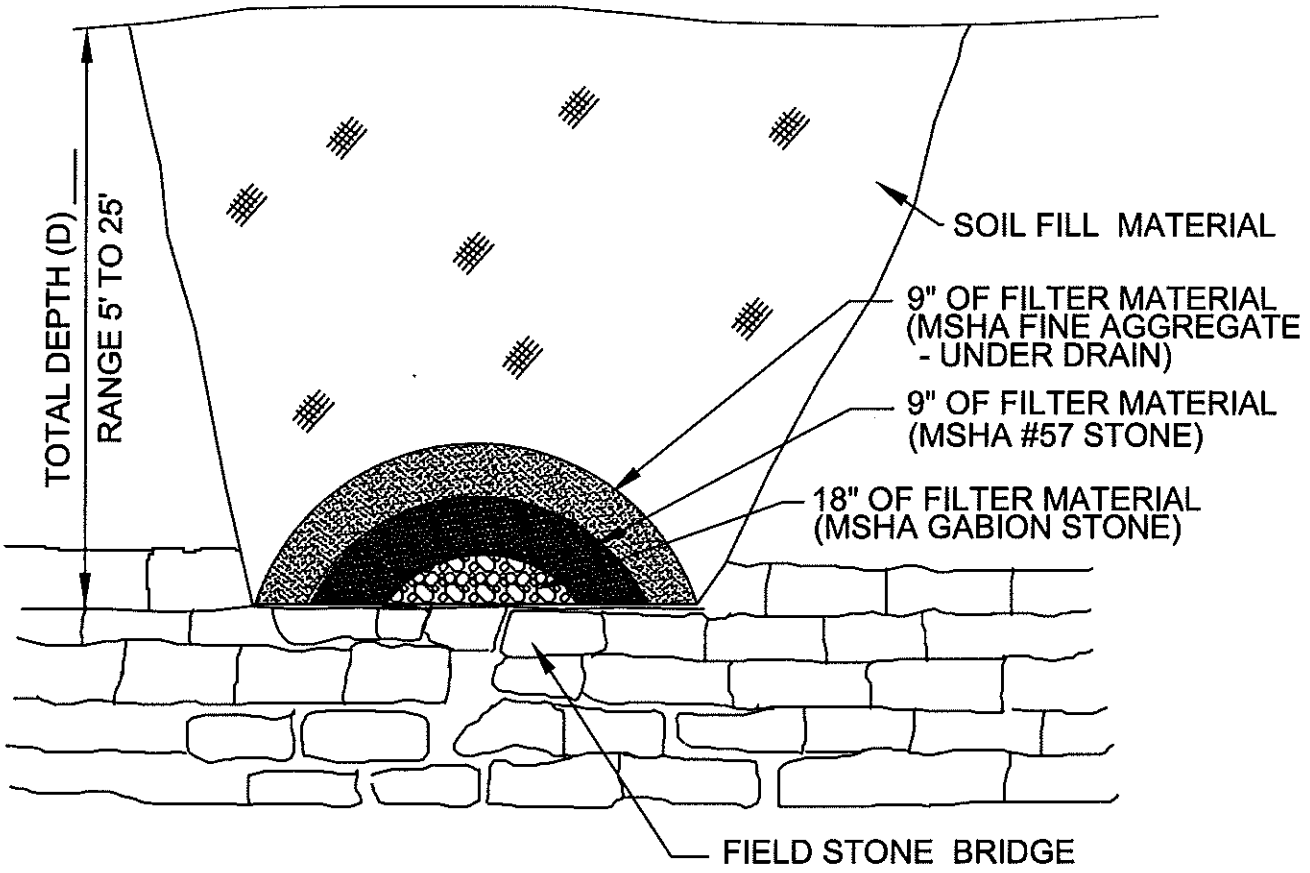
Record on survey notepaper, SCS-ENG-28, or other appropriate engineering paper. Survey data will be plotted on plans in red. The following is a list of minimum data needed for As-builts:

1. Documentation of site visits on CPA-6. Include the date, who performed the inspection, specifics as to what was inspected, all alternatives discussed, and decisions made and by whom;
2. Check notes recorded during or after completion of construction showing width and depth;
3. Seeding performed;
4. Written operation and maintenance plan;
5. Final quantities and documentation for quantity changes, and materials certification;
6. Sign and date checknotes and plans by a person with the appropriate approval authority. Include a statement that the practice meets or exceeds NRCS practice standards.

REFERENCES

1. Koerner, R.M., 1985. *Designing With Geosynthetics.* Prentice-Hall, Englewood Cliffs, NJ.
2. Maryland Department of Transportation, State Highway Administration, January 2001. *Standard Specifications for Construction and Materials, "Section 901 - Aggregates."*
3. National Crushed Stone Association, June 1978. *Graded Riprap Stone, Quarried Stone for Erosion and Sediment Control.*
4. USDA, Natural Resources Conservation Service. *Conservation Practice Standards.* Maryland Field Office Technical Guide, Section IV.
5. USDA, Natural Resources Conservation Service, August 1989. *Engineering Field Handbook, Chapter 2, "Estimating Runoff and Peak Discharges."*
6. USDA, Natural Resources Conservation Service, 1978. *National Engineering Handbook, Section 8, Engineering Geology, Chapter 1.*
7. USDA, Natural Resources Conservation Service, June 1986. *Technical Release 55, Urban Hydrology for Small Watersheds.*

MARYLAND STANDARDS FOR AGRICULTURAL BMPS
DETAIL 725-A - SINKHOLE TREATMENT



NOTE:
A NONWOVEN GEOTEXTILE MEETING MSHA CLASS SE MAY BE SUBSTITUTED FOR THE MSHA #57 STONE AND MSHA FINE AGGREGATE.

SINKHOLE TREATMENT

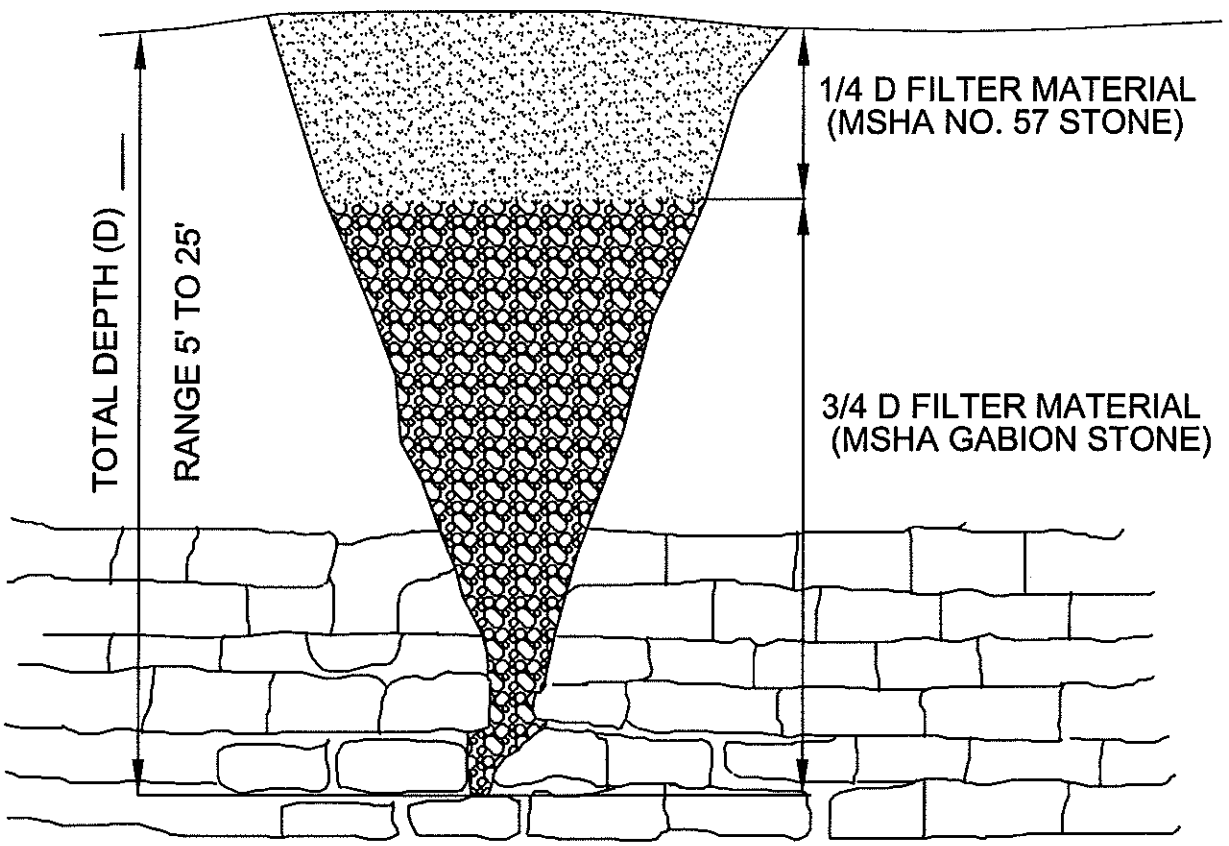
(DRAINAGE AREA LESS THAN 5 ACRES)

725-A-INV FILTER.DWG

NTS

U.S.DEPARTMENT OF AGRICULTURE NATURAL RESOURCES CONSERVATION SERVICE MARYLAND	725-A-INV FILTER.DWG 6/03	MARYLAND DEPARTMENT OF AGRICULTURE MARYLAND SOIL CONSERVATION DISTRICTS

MARYLAND STANDARDS FOR AGRICULTURAL BMPS
DETAIL 725-B - SINKHOLE TREATMENT



SINKHOLE TREATMENT

(DRAINAGE AREA 5-15 ACRES)

725-B - INV FILTER.DWG

NTS

U.S.DEPARTMENT OF AGRICULTURE NATURAL RESOURCES CONSERVATION SERVICE MARYLAND	725-B-INV FILTER.DWG 6/03	MARYLAND DEPARTMENT OF AGRICULTURE MARYLAND SOIL CONSERVATION DISTRICTS