



Natural Resources Conservation Service
CONSERVATION PRACTICE STANDARD
SINKHOLE TREATMENT
CODE 527

(no)

DEFINITION

A treatment of karst or pseudokarst sinkholes or sinkhole areas on agricultural land.

PURPOSE

This practice is used to accomplish one or more of the following purposes:

- Improve groundwater and surface water quality
- Reduce soil erosion

CONDITIONS WHERE PRACTICE APPLIES

This practice may be applied as part of a conservation management system on any land surface or existing practice where the soils and geologic conditions have led to the development of sinkholes.

This practice does not apply to—

- Erosional or collapse features caused by failure or leakage of underground pipes or constructed surface drainage features (e.g., canals), piping of unstable soil materials, or poorly compacted or constructed features.
- Subsidence pits associated with mining activities. Use NRCS Conservation Practice Standard (CPS) Mine Shaft and Adit Closing (457).
- Sinkholes that may appear in or beneath structures, or in flowing streams.
- Sinkholes that open into caves.

CRITERIA

General Criteria Applicable to All Purposes

Install and operate sinkhole and sinkhole area treatments in compliance with all applicable Federal, State, and local laws, rules, and regulations. Notify landowner and/or contractor of their responsibility to locate all buried utilities in the project area, including drainage tile and other structural measures. The landowner is also required to obtain all necessary permits for project

NRCS reviews and periodically updates conservation practice standards. To obtain the current version of this standard, contact your Natural Resources Conservation Service State office or visit the Field Office Technical Guide online by going to the NRCS website at <https://www.nrcs.usda.gov/> and type FOTG in the search field.

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installation prior to construction.

Conduct a geologic investigation of the potential impact of the treatment on groundwater, surface water influent, and geomorphology in accordance with NRCS National Engineering Manual (Title 210), Part 531, "Geology." If conditions are complex and uncertain, use additional expertise to evaluate and provide recommendations on the suitability of the site for treatment.

Remove refuse and all other unsuitable material from the sinkhole and the established buffer area and dispose of it in an environmentally sound manner.

Use appropriate erosion and sediment control measures to reduce the amount of sediment entering sinkhole openings during the establishment of the treatment.

If necessary for safety reasons, install a gate for a sinkhole that opens into a cave. Design the gate so that it does not impede movement or negatively impact wildlife species such as bats. Refer to "Agency Guide to Cave and Mine Gates" (2009) for gate designs.

Changes to the volume of surface water entering a sinkhole may affect the underground hydrology. Maintain surface water flow to the sinkhole at historic (predevelopment) volumes if possible. Minimal alterations should be made while stabilizing preexisting concentrated channels flowing into the sinkhole.

Document the location of the sinkhole on a plan map so that the structures and other systems that could be adversely impacted by the sinkhole or vice versa can be avoided.

Vegetative treatment

If a sinkhole does not present a safety hazard and is not actively eroding, use a vegetative buffer for treatment. Use NRCS Conservation Practice Standards (CPSs) Riparian Forest Buffer (Code 391), Riparian Herbaceous Cover (Code 390), or Filter Strip (Code 393), or equivalent for the buffer. If an exclusion fence is needed, use CPS Fence (Code 382).

Design the fenced buffer at least 25-feet wide as measured from the estimated point of collapse or estimated stable angle of repose for vertical slopes. Do not apply nutrients, herbicides, pesticides, or animal waste within the buffer area. Use only mechanical treatments to control weeds in the buffer area.

Fill Treatments

If a sinkhole presents a safety hazard or is actively eroding and enlarging, consult with an experienced geologist to evaluate and provide recommendations on the suitable fill treatment for the site. Typical treatments include an inverted filter, rock, geosynthetics, gabions, or other appropriate methods.

Design inverted filters per NRCS National Engineering Handbook (Title 210), Part 633, Chapter 26, "Gradation Design of Sand and Gravel Filters." If larger rock is needed to bridge crevices or voids, size the rock to effectively support the openings, or as a bed layer under a graded inverted filter.

If the sinkhole needs to be plugged (sealed) due to contaminated surface runoff, acceptable sealing materials are provided in ASTM D5299, "Standard Guide for Decommissioning of Groundwater Wells, Vadose Zone Monitoring Devices, Boreholes, and Other Devices for Environmental Activities," Part 6.4; and Department of the Army, U.S. Army Corps of Engineers, EM 1110-2-3506, "Engineering and Design of Grouting Technology."

CONSIDERATIONS

Consider current and planned land use so that the sinkhole does not impact structures or vice versa. Consider establishing a conservation easement for the sinkhole area.

The sinkhole treatment should not result in excessive surface water ponding or high soil-moisture conditions over an extended period of time.

Consider mounding fill materials on top of the treatment for future settlement. Additional fill may be required as treatment ages.

Fill treatments of sinkholes may impact the hydrology of the sinkhole and surrounding area. Surface water may find other preferential pathways into the bedrock and reopen the fracture or adjacent fractures.

PLANS AND SPECIFICATIONS

Prepare plans and specifications that describe the requirements for applying this practice to achieve its intended purpose.

As a minimum the documentation must include—

- A plan view delineating the sinkhole and sinkhole area, including topographic information and photographs.
- Factual geologic information, including *depth from ground surface to bedrock*, cross section or profile drawings, as needed to support treatment design and facilitate construction.
- Details of planned treatment measures.
- Special safety requirements, as appropriate.
- Additional site-specific considerations.
- Material and construction specifications.

OPERATION AND MAINTENANCE

Provide an operation and maintenance plan that describes specific instructions for maintaining the sinkhole and sinkhole area treatment, including—

- Periodic inspections of -
 - settlement of fill,
 - erosion, and
 - new settlement areas.
- Prompt repair and as needed, replacement of damaged components.

REFERENCES

American Cave Conservation Association, Bat Conservation International, Missouri Department of Conservation (2009). Agency Guide to Cave and Mine Gates 2009. <http://www.batcon.org/pdfs/AgencyGuideCaveMineGating2009.pdf>

ASTM D5299. Standard Guide for Decommissioning of Groundwater Wells, Vadose Zone Monitoring Devices, Boreholes, and Other Devices for Environmental Activities. ASTM International, West Conshohocken, PA. Latest Edition. <https://www.astm.org/>

Department of the Army, U.S. Army Corps of Engineers (2017). EM1110-2-3506, Engineering and Design Grouting Technology 3/31/17.

National Speleological Society, State Cave Protection Laws,
<https://caves.org/conservation/pdf/StateCaveProtectionLaws.pdf>

USDA NRCS. 2019. National Engineering Manual (Title 210), Part 531, Geology. Washington, D.C. <https://directives.sc.egov.usda.gov>

USDA NRCS. 2017. National Engineering Handbook (Title 210), Part 633, Chapter 26, Gradation Design of Sand and Gravel Filters. Washington, D.C.
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Van Beyen, P.E. (2011). Karst Management. Springer Publishing, New York.

White, W.B. (1988). Geomorphology and Hydrology of Karst Terrains. Oxford University Press, New York.