

Adelphia Gateway Project

Void Mitigation Plan for Karst Terrain and Underground Mining

May 2020

Prepared For:

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Adelphia Gateway Project

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ABBREVIATIONS AND ACRONYMS

Adelphia	Adelphia Gateway, LLC
EI	environmental inspector
Existing Mainline	84.2 miles of 18-inch outer diameter pipeline
IEC	Interstate Energy Company
Karst Plan	Void Mitigation Plan for Karst Terrain and Underground Mining
MLV	mainline valve
MP	milepost
NJR	New Jersey Resources Corporation
NV5	NV5, LLC
OD	outer diameter
PADCNR	Pennsylvania Department of Conservation and Natural Resources
PADEP	Pennsylvania Department of Environmental Protection
PASDA	Pennsylvania Spatial Data Access
Project	Adelphia Gateway Project

1.0 INTRODUCTION

Adelphia Gateway, LLC (Adelphia), an indirect wholly-owned subsidiary of New Jersey Resources Corporation (NJR), is proposing to construct and operate the Adelphia Gateway Project (Project) in Delaware and Pennsylvania. The Project uses and enhances an existing natural gas and oil pipeline system [formerly owned by Interstate Energy Company (IEC) and acquired by NJR] located in eastern Pennsylvania and also includes the construction of new facilities in Pennsylvania and Delaware.

The existing system includes 84.2 miles of 18-inch outer diameter (OD) pipeline (Existing Mainline), 4.5 miles of 20-inch OD pipeline, two meter stations along the Existing Mainline, and two meter stations along the existing 20-inch OD line.

The entire 20-inch OD pipeline and about 35 miles of the Existing Mainline would not require any modifications. The southern approximately 49-mile-long segment of the Existing Mainline would require installation of new facilities, including two compressor stations; two 16-inch OD pipeline laterals; multiple meter stations and blowdown assembly valves; two mainline valves (MLVs); and appurtenant facilities (e.g., pig launcher and receivers).

This *Void Mitigation Plan for Karst Terrain and Underground Mining* (Karst Plan) discusses underground voids that could be encountered along the Project, potential risks associated with these features, and measures that Adelphia would implement to prevent and/or mitigate potential associated adverse impacts.

2.0 EXISTING CONDITIONS

2.1 KARST IN THE PROJECT AREA

NV5, LLC (NV5) evaluated the United States Geological Survey's *Karst in the United States: A Digital Map Compilation and Database* and the Pennsylvania Department of Conservation and Natural Resources' (PADCNR) *Digital Dataset of Mapped Karst Features in Southcentral and Southeastern Pennsylvania* to identify areas of potential karst development and known karst features along the Project. Geologic features such as surface depressions (PASDA 2019) and soluble rock units (USGS 2014) that have the potential for karst features to develop occur along the Existing Mainline in the following approximate locations: milepost (MP) 18.0 to 20.0; MP 59.5 to MP 61.0; and MP 63.5 to MP 84.2 (USGS 2014, PASDA 2019). Figure 1 identifies potential karst areas near the Project.

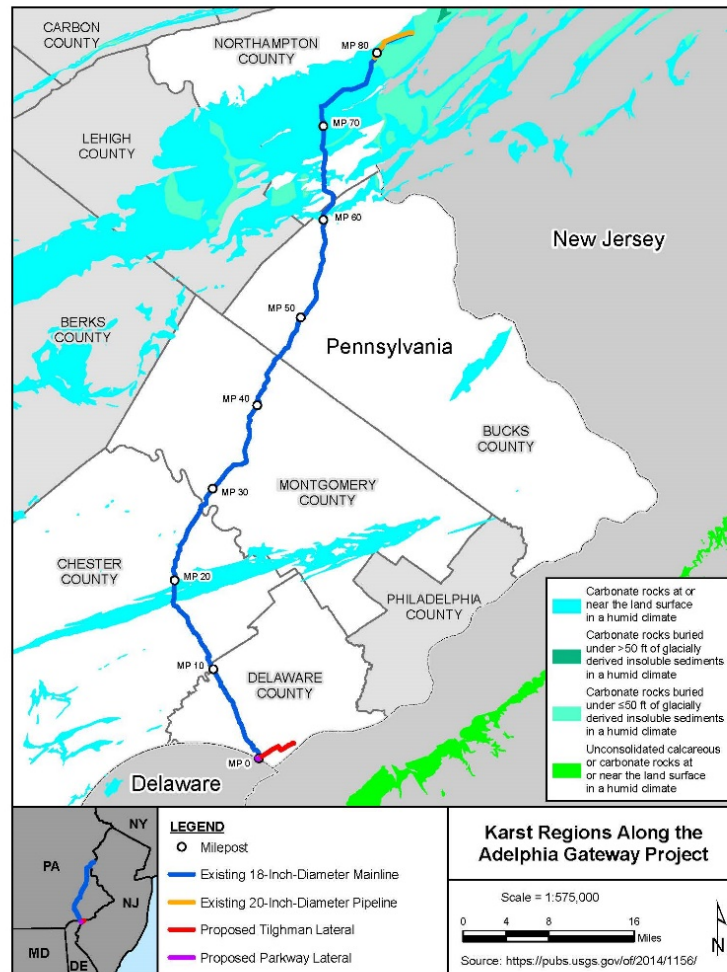
IEC conducted karst remediation at three areas along the Existing Mainline at approximate MP 70.2, MP 73.2, and MP 81.7. According to a 2018 IEC memo summarizing the remediation activities, two of the areas (MP 70.2 and 81.7) were problematic due to erosion (not issues related to karst terrain). The other area (MP 73.2) was successfully remediated by IEC in 2016 (Warfield 2018).

Martins Creek Station and MLV 2 are the only Project sites in which Project construction will occur near potential karst terrain. Both Project sites are along the Existing Mainline. Martins Creek Station is an existing active power station that was part of the IEC system acquired by Adelphia. It is located at the northern terminus of the Existing Mainline at MP 84.2. Construction activities at the Martins Creek Station would be limited to installation of a chain-link fence area within the station's existing paved/graveled footprint.

With the exception of a new temporary access road (which will not require modifications to existing conditions), construction of MLV 2 at MP 17.9 will take place within existing maintained pipeline right-of-way. Adelphia will clear, grade, and excavate, as necessary to access the existing pipeline. Adelphia would then cut out an approximately 20-foot-long section of the pipe and replace that section with a new valve assembly. Adelphia would then backfill the excavated area with the same material that was removed from

the trench and restore the areas to pre-construction conditions. Construction activities at both sites will not change stormwater flows or promote the development of new karst features.

Figure 1. Karst Regions along the Adelpia Gateway Project



2.2 UNDERGROUND MINING IN THE PROJECT AREA

NV5 obtained information regarding coal mining, oil and gas, and industrial mineral mining activities in the Project area in Pennsylvania from the Pennsylvania Geospatial Data Clearinghouse. No mining permits or active, inactive, or abandoned coal mines were identified within 0.25 mile of the Project. There are also no historical, current, or known planned non-fuel mineral resource operations, or oil and gas wells near the Project (PGDC 2018a,b,c,d)

3.0 MITIGATION MEASURES

3.1 KARST TERRAIN

Adelphia will include a discussion of karst terrain in its environmental training program. All Project personnel will be required to complete environmental training prior to working on the Project. Adelphia will provide additional training to its environmental inspectors (EI) on how to identify and monitor the Project alignment for evidence of subsidence, surface cracks, or depressions that could indicate karst formations. EIs will visually monitor the alignment for karst features daily during construction.

Adelphia will contract Advanced Geoservices Corporation, a company that specializes in karst terrain, to conduct a biennial survey in areas of known potential karst terrain (i.e., MP 18.0 to 20.0; MP 59.5 to MP 61.0; and MP 63.5 to MP 84.2) for the life of the Project. A typical post-construction karst inspection will consist of a site visit, a pedestrian survey of the area, visual observations, and reporting. Assuming that no indications of karst formations or subsurface mining are identified, post construction karst monitoring is expected to take one inspection staff approximately two days to complete.

If a karst feature or other subsidence feature is identified during construction or operation, the person that identified the feature would report the feature to Adelphia's Project Manager, work would be stopped within 100 feet of the karst feature (if applicable), and sediment or stormwater management would be installed around the feature, as necessary. Sediment and stormwater best management practices may include sandbags, diversion berms, or other industry standard method(s) to divert stormwater flow away from or around the feature to prevent further development of the feature and to prevent construction stormwater from entering the karst system. If during construction flow cannot be diverted away from the feature, double row silt fence, hay bales, or similar best management practices would be installed to prevent sediment-laden water from entering the karst feature. Adelphia would obtain a geotechnical engineer or karst specialist to evaluate the karst feature identified during Project construction or operations to determine the most appropriate form of mitigation in accordance with Chapter 17 of the Pennsylvania Department of Environmental Protection's (PADEP) *Erosion and Sediment Manual* (see Attachment A) to ensure proper stabilization and mitigate any hazards posed to the pipeline.

3.2 UNDERGROUND MINING

Mine voids are not expected to occur along the Project or present potential associated risks (see Section 2.2). The PADEP's *Erosion and Sediment Manual* does not specify mitigation in regards to potential voids in relation to mining. Therefore, should a mine void of similar size to a karst void be identified in the Project area, it would be mitigated in the same manner as referenced in this report for karst voids. If a mine void is encountered indicating a potentially more complex problem, Adelphia will notify the PADEP within 48 hours of its observation. Because of differences between sinkholes and historical underground mines, mitigation would proceed with direct consultation of a professional geologist and/or professional geotechnical engineer.

4.0 REFERENCES

- Pennsylvania Spatial Data Access (PASDA). 2019. Digital Data Set of Mapped Karst Features in South-Central and Southeastern Pennsylvania. Pennsylvania Department of Conservation and Natural Resources. Available at: <http://www.pasda.psu.edu/uci/DataSummary.aspx?dataset=3073>. Accessed March 2019.
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Attachment A

PADEP Erosion and Sedimentation Manual

Chapter 17

CHAPTER 17 - AREAS OF SPECIAL CONCERN

SINKHOLE REPAIR



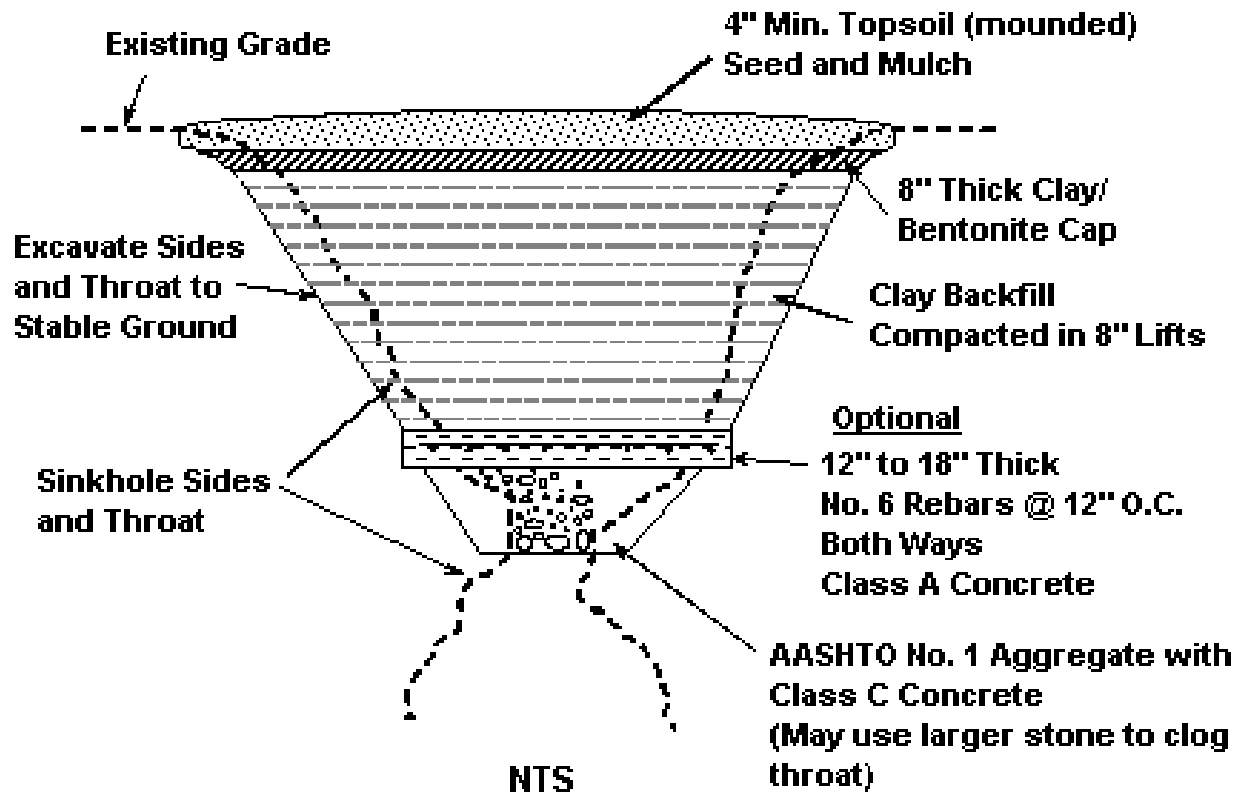
Source Unknown

Sinkholes vary greatly in size and nature. Therefore, specific methods of repairing sinkholes will depend on site conditions including but not necessarily limited to:

- Sinkhole diameter and depth
- Surface slope
- Presence or absence of surface runoff
- Soil type
- Connectivity to public or private water supplies
- Proximity of surface waters
- Ease of access by construction equipment
- Potential danger to the public or damage to structures

Due to the variable nature of sinkholes, they should be repaired under the direct observation and supervision of a professional geologist or licensed geotechnical engineer. Figures 17.1 through 17.4 are provided as general guidelines for the repair of sinkholes. They may be modified as necessary to accommodate specific site conditions. Site specific sinkhole repair plans will be reviewed on a case-by-case basis.

FIGURE 17.1
Sinkhole Repair with a Bentonite Cap

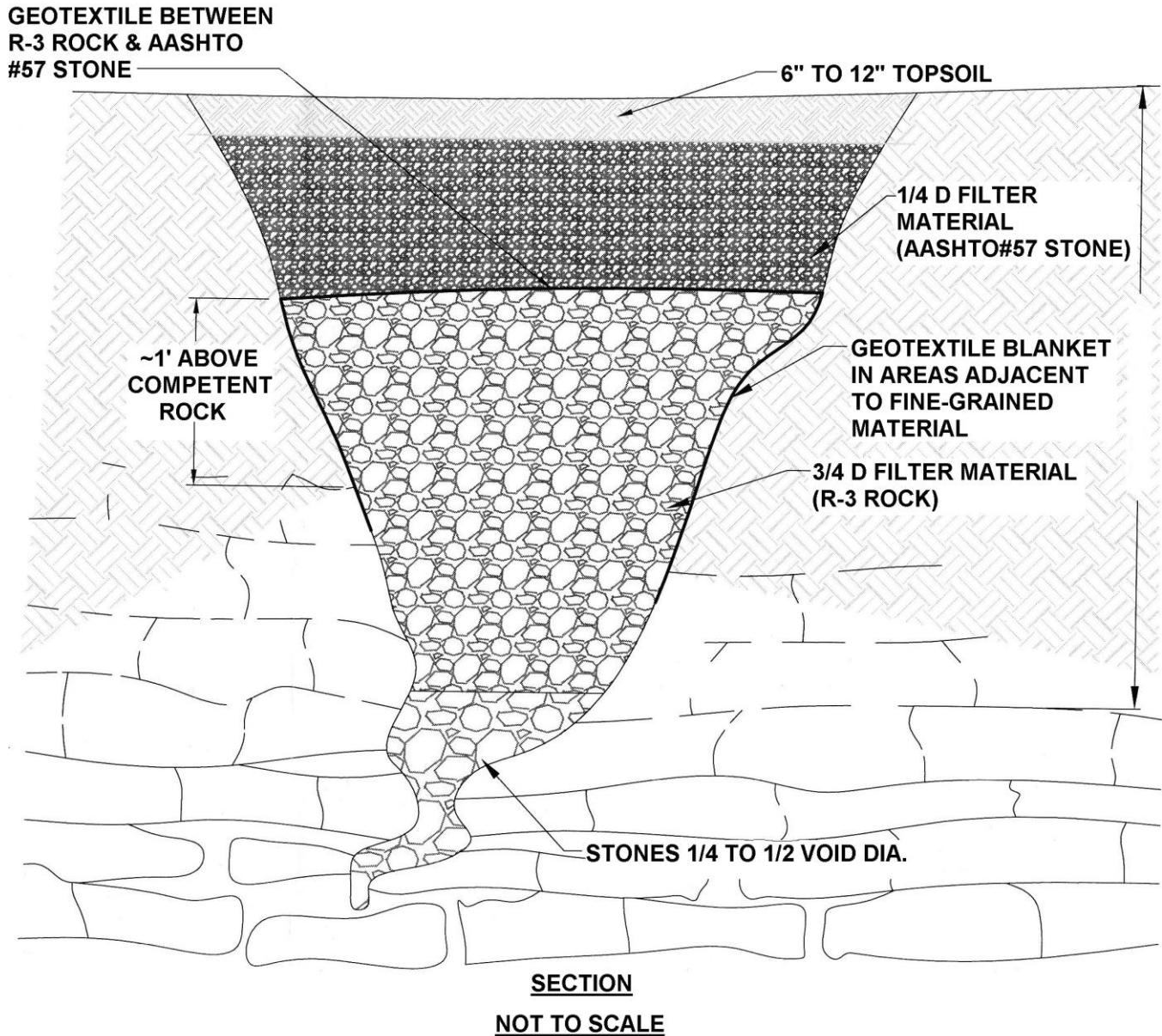


PA DEP

Loose material shall be excavated from the sinkhole and expose solution void(s) if possible. Enlarge sinkhole if necessary to allow for installation of filter materials. Occupational Safety and Health Administration (OSHA) regulations must be followed at all times during excavation.

Stones used for the "bridge" and filters shall have a moderately hard rock strength and be resistant to abrasion and degradation. Shale and similar soft and/or non-durable rock are not acceptable.

FIGURE 17.2
Sinkhole Repair with a Pervious Cover

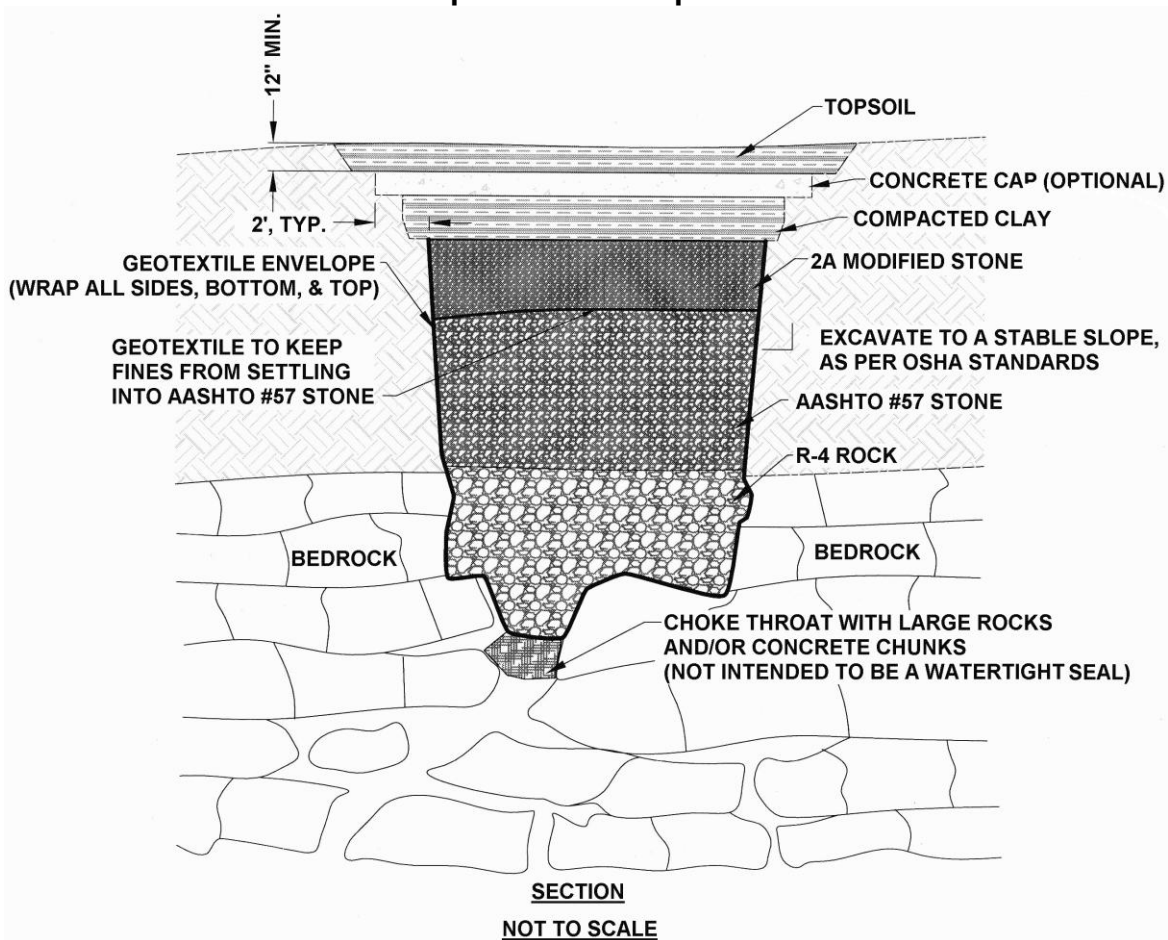


Adapted from USDA NRCS

Loose material shall be excavated from the sinkhole and expose solution void(s) if possible. Enlarge sinkhole if necessary to allow for installation of filter materials. OSHA regulations must be followed at all times during excavation.

Stones used for the "bridge" and filters shall have a moderately hard rock strength and be resistant to abrasion and degradation. Shale and similar soft and/or non-durable rock are not acceptable.

FIGURE 17.3
Sinkhole Repair with an Impervious Cover



Adapted from USDA NRCS

Loose material shall be excavated from the sinkhole and expose solution void(s) if possible. Enlarge sinkhole if necessary to allow for installation of filter materials. OSHA regulations must be followed at all times during excavation.

Geotextile shall be non-woven with a burst strength between 100 and 200 psi.

Select field stone(s) about 1.5 times larger than solution void(s) to form “bridge.” Place rock(s) so no large openings exist along the sides. Stones used for the “bridge” and filters shall have a moderately hard rock strength and be resistant to abrasion and degradation. Shale and similar soft and/or non-durable rock are not acceptable.

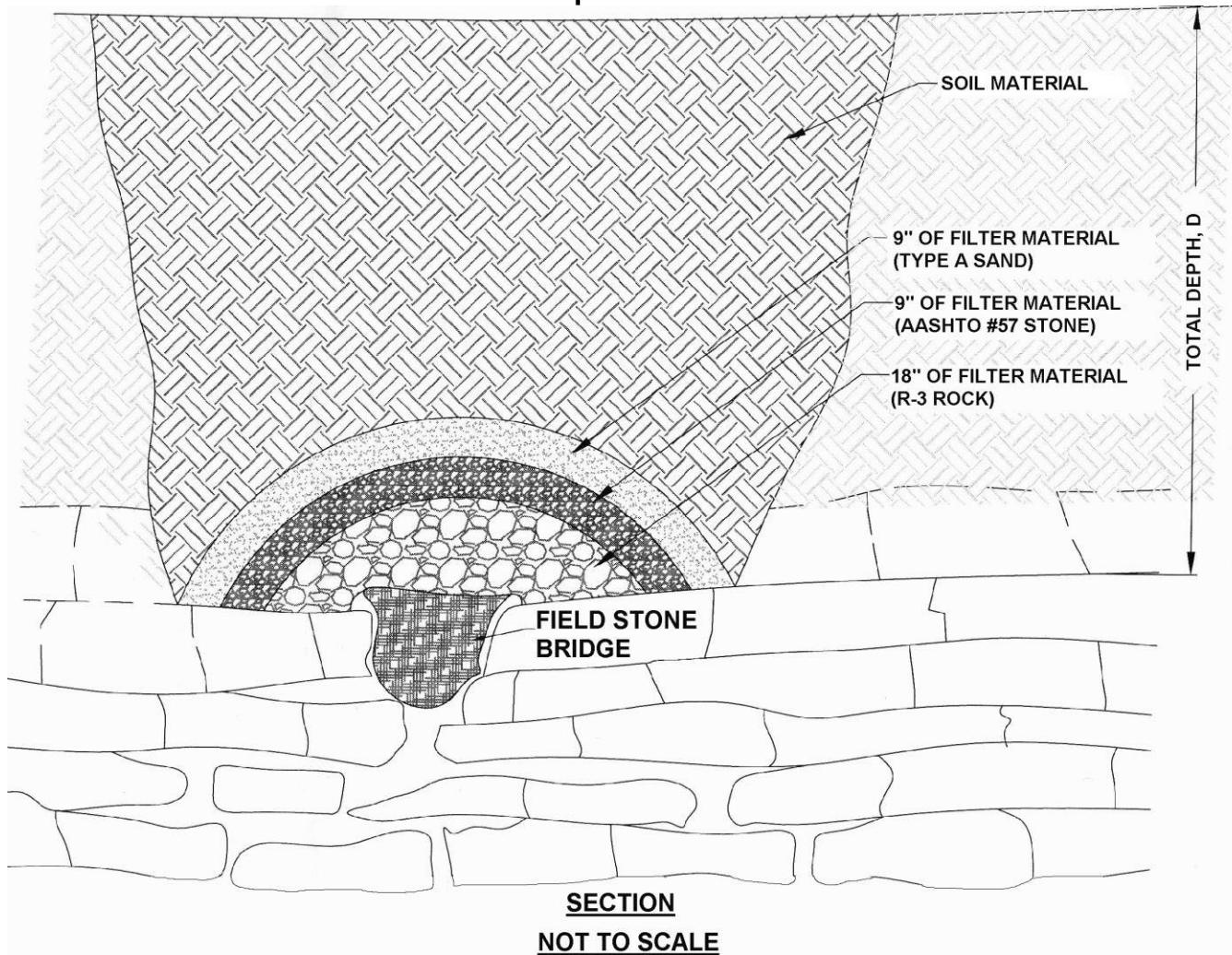
Minimum thickness of R-4 rock is 18.” AASHTO #57 stone thickness shall be ¼ to ½ that of the R-4 rock. Minimum thickness of 2A modified crushed stone shall be 9”. AASHTO #57 stone and 2A modified crushed stone shall be compacted after each placement.

Compacted clay seal shall be a minimum of 12” thick. Clay shall be placed in 6” to 9” lifts and thoroughly compacted.

Concrete cap, which is optional, shall be a minimum of 8” thick. Use 4,000 psi concrete with 6” X 6” - 6 gauge welded wire fabric, or # 3 rebar on 18” O.C. both ways.

Topsoil shall be a minimum of 12” thick. Grade for positive drainage away from sinkhole area.

FIGURE 17.4
Sinkhole Repair with Soil Cover



Adapted from USDA NRCS

Loose material shall be excavated from the sinkhole and expose solution void(s) if possible. Enlarge sinkhole if necessary to allow for installation of filter materials. OSHA regulations must be followed at all times during excavation.

Select field stone(s) about 1.5 times larger than solution void(s) to form "bridge." Place rock(s) so no large openings exist along the sides. Stones used for the "bridge" and filters shall have a moderately hard rock strength and be resistant to abrasion and degradation. Shale and similar soft and/or non-durable rock are not acceptable.

Minimum thickness of R-3 rock is 18." AASHTO #57 stone thickness shall be a minimum of 9" thick. Minimum thickness of type A sand shall be 9". NOTE: A non-woven geotextile with a burst strength between 100 and 200 psi may be substituted for the AASHTO#57 stone and type A sand.

Soil shall be mineral soil with at least 12 % fines and overfilled by 5% to allow for settlement. Suitable soil from the excavation may be used. Any available topsoil shall be placed on top surface.