

DEP Permitting Related to Stormwater Discharges to Improved Sinkholes

Final, March 18, 2022

Version 1.0

The Department of Environmental Protection (DEP) maintains a list of [Alternative PCSM BMPs](#) on the Bureau of Clean Water Website which includes alternatives in areas of karst topography. As noted in Section II of this document, Improved Sinkholes are not a PCSM BMP in their own right; however they can be effective when paired with other appropriate on-site PCSM BMPs and when the recommendations herein are followed including prospective applicants discussing their project with DEP during a pre-application meeting.

I. Introduction

In general, runoff from land development activities should not be intentionally directed to a sinkhole for the purpose of Post-Construction Stormwater Management (PCSM) in Pennsylvania. However, it is recognized that there are many existing sinkholes, and other karst features across the Commonwealth, that receive runoff under existing site conditions. This document has been prepared by DEP to provide recommendations specifically for “improved sinkholes” in areas of karst topography where new land development activities are taking place.

This document defines an “improved sinkhole” as a modified sinkhole which receives stormwater runoff. The act of directing increased volumes of stormwater runoff from developed land into a sinkhole or other karst feature constitutes a “modification”.

The U.S. Environmental Protection Agency (EPA) definition of a Class V injection well includes improved sinkholes; however DEP has made the decision to explicitly exclude improved sinkholes from the [Stormwater Drainage Wells \(SDWs\) PCSM document](#) because, in most situations, improved sinkholes are both physically and functionally different than SDWs as shown in the diagram below.

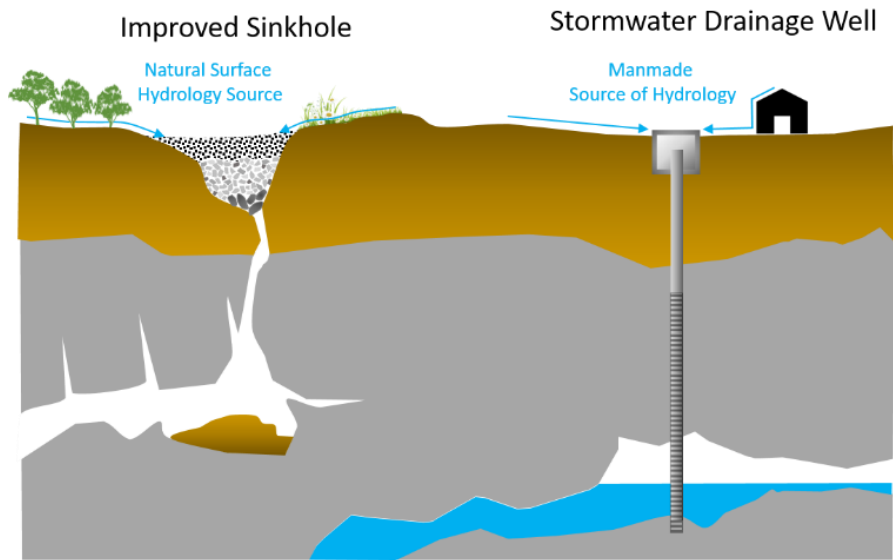


Figure 1 – Stormwater Drainage Well vs. Improved Sinkhole

As previously noted, there are many existing sinkholes in Pennsylvania which are intricately connected to surface water hydrology and which receive runoff. Sinkholes are concentrated in areas with karst topography – predominantly in Central/Southcentral PA, Southeast PA and in the Lehigh Valley – as shown in the solid blue areas on the map below. More general information on sinkholes in Pennsylvania is available on the [DCNR](http://www.dcnr.state.pa.us) website.

MAP 15
DCNR

LIMESTONE AND DOLOMITE DISTRIBUTION IN PENNSYLVANIA

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF
CONSERVATION AND NATURAL RESOURCES
BUREAU OF TOPOGRAPHIC AND GEOLOGIC SURVEY
www.dcnr.state.pa.us/topogeo

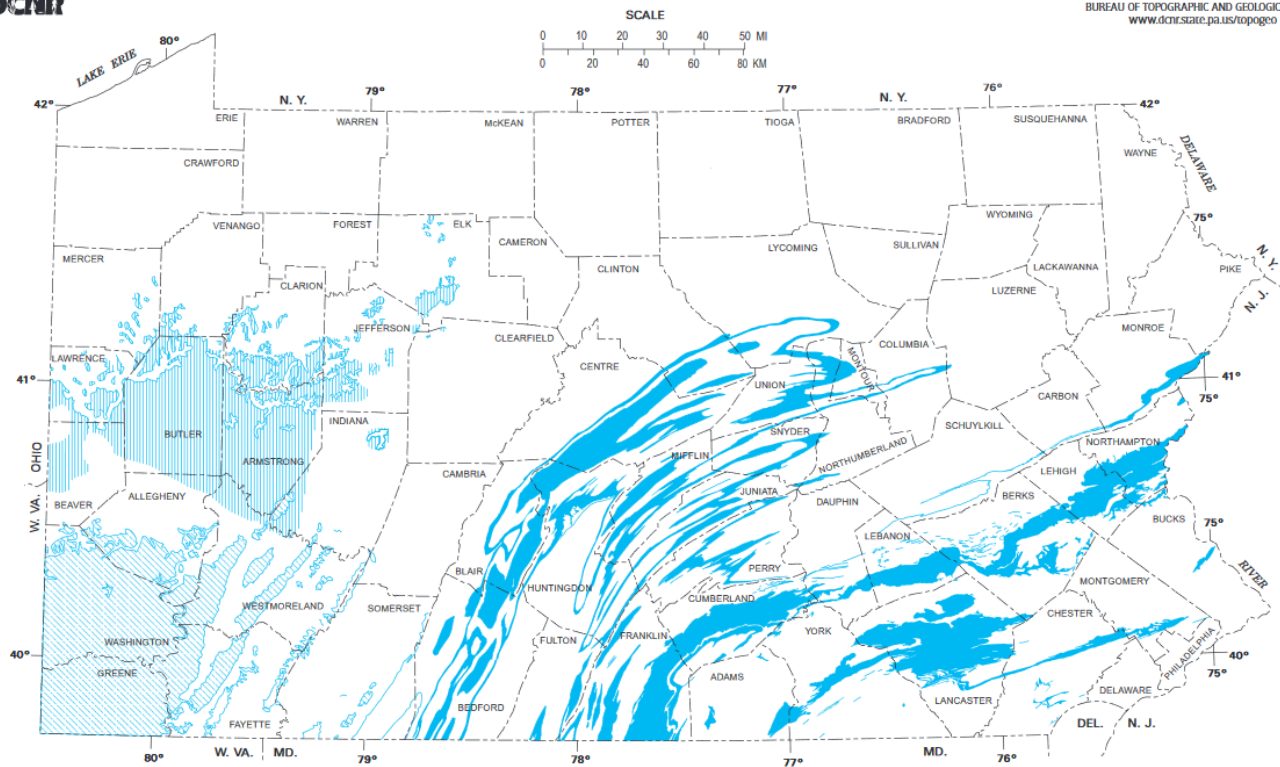


Figure 2 - PA Karst Map
Source: PA DCNR

II. Applicability and Suitability

Sinkholes, including improved sinkholes, do not treat stormwater runoff – rather they provide conveyance to the underlying aquifer, which is a protected water of the Commonwealth under the [Clean Streams Law](#). This is particularly true for sinkholes that form along watercourses or drainageways that receive concentrated sources of runoff (example provided in diagram below). Site development normally leads to modification of the stormwater hydrology. In areas with karst topography, the stormwater hydrology often interacts with sinkholes and other karst features. Runoff from site development that eventually feeds existing sinkhole(s) should be appropriately handled on-site prior to discharging to the receiving water. Therefore, when proposed land development changes the surface hydrology, the rate, volume, and water quality of runoff should be managed on-site and through acceptable BMPs, prior to discharge to either a receiving stream, an abandoned quarry¹, or a sinkhole. (see Section IV for more details)

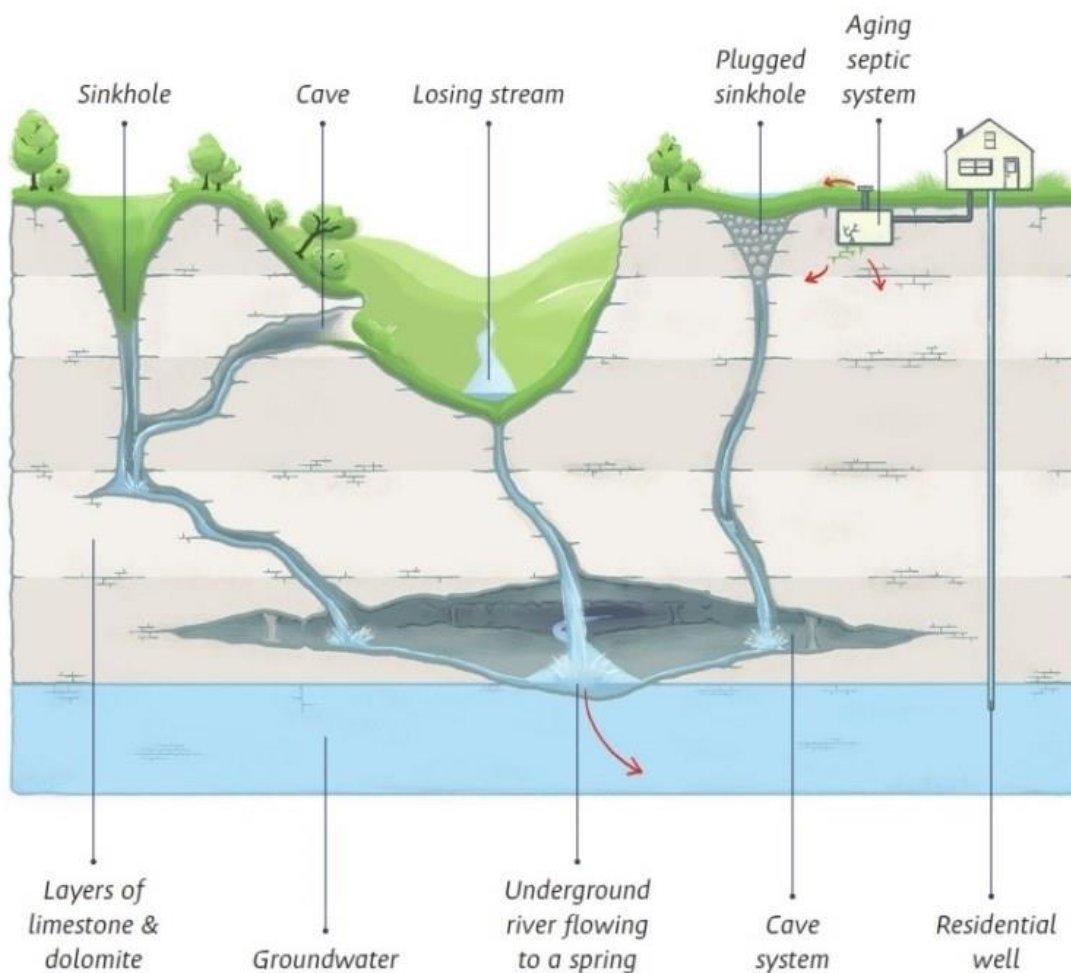


Figure 3 – Karst Diagram
Source: Watershed Committee of the Ozarks

¹ While this document does not specifically address stormwater discharge to abandoned quarries the process is the same as utilizing a sinkhole as a receiving water. Both sinkholes and water filled quarries act as direct conduits to groundwater. Stormwater rate, volume, and quality need to be addressed by on-site BMPs before discharging to these features.

III. Pre-Development Site Characterization

Detailed geologic investigations should be conducted when the surface hydrology is modified in karst topographies, whereby various exploration and data gathering techniques are typically necessary:

1. **Preliminary Desktop Site Investigation:** Investigate the geology and hydrogeology through a review of existing mapping and other available records for the site and adjacent areas such as topographic mapping, karst features maps, geologic mapping, soil surveys, aerial photography, and any previous geotechnical or geologic reports covering the local area.
2. **Site Reconnaissance:** After completing the preliminary desktop investigation, field site reconnaissance is necessary to familiarize designers with specific karst features and issues. This may include:
 - a. **Soil Borings:** To collect information on soil and rock stratigraphy, soil strength and consistency, and location of voids within the overburden.
 - b. **Cone Penetration Testing (CPT)/ Hydraulic Profiling Tool (HPT):** An economical option to quickly collect similar information as the soil borings. HPT-CPT probes advanced via direct push drill rigs can quickly and efficiently provide soil and groundwater characteristics for the site.
 - c. **Groundwater Investigation:** The use of selectively placed piezometers or monitoring wells to collect groundwater elevation data and/or groundwater quality data.
 - d. **Geophysical Investigation:** Ground penetrating radar, electro-magnetic conductivity surveys, seismic surveys, and other methods can detect subsurface anomalies including subsurface voids.

The above methods can be utilized to evaluate the current karst conditions on the site. Regardless of the investigation methods, a geologist or geotechnical engineer licensed to practice in the Commonwealth and knowledgeable in local geology should be engaged while conducting the investigation.

IV. Sinkholes and Improved Sinkholes as a Receiving Water

Due to existing topography and hydrology, under some circumstances post-development stormwater will discharge into an existing sinkhole or other karst feature. This may occur where significant portions of a site are internally drained by karst loss and/or the majority of a site is underlain by karst. In other cases, it may be desirable to maintain pre-development flows to the existing sinkhole to maintain subsurface hydrology. In either case, the following recommendations apply:

- A. The improved sinkhole or karst feature receiving post-development stormwater runoff should be considered a Class V Injection Well and afforded the protection under EPA's definition.
 - i. The act of directing increased stormwater runoff (rate or volume) from developed land into a sinkhole or other karst feature constitutes a "modification" of this natural feature and as such, becomes a de facto improved sinkhole and qualifies that sinkhole as a Class V injection well requiring appropriate coordination with EPA who has Underground Injection Control (UIC) primacy in Pennsylvania. This may be true even when the improved sinkhole is downstream of stormwater treatment practices, either on-site or off-site.

- ii. When there are proposed discharges to improved sinkholes or other karst features with connections to groundwater, the project proponent should notify EPA Region 3 and obtain any necessary documentation/approval.
 - iii. Discharges to improved sinkholes on adjacent downstream properties may also require appropriate legal agreements with the property owners of the improved sinkhole. This is a civil matter handled outside of the permitting process, but proof of documentation may be requested by the permitting authority.
- B. The sinkhole or karst feature receiving post-development stormwater runoff should be fortified to protect against erosion of the feature. The volume of flow directed to the feature should be restricted to the pre-construction flow volumes for the 2-year/24-hour storm. The rate of flow directed to the feature should be managed to the pre-construction flow rates for storm events up to the 100-year/24-hour storm. Projects that are unable to achieve the pre-construction flow volumes and rates for discharges to a sinkhole may require a Water Quality Management (WQM) Permit. Note this document does not prescribe construction specifications for improving sinkholes. As noted in item A(iii) it is the responsibility of the project proponent to acquire any necessary approvals from adjacent landowners. DEP permits do not grant property rights (see item F for more details).
- C. The stormwater professional/engineer should conduct a complete and thorough survey for public or private drinking water wells with a 1/2 mile of their improved sinkhole, and submit data on any wells found to the UIC permit authority (EPA) and to DEP if NPDES construction stormwater permitting requirements under Chapter 102 are triggered.
- D. DEP permits related to new, or modified, discharges into a sinkhole may not be approved if the proposed land use or operation at the site is considered to pose a risk for groundwater pollution (see Attachment 1). Additional measures, including bypass systems and effective pretreatment, can be required to ensure protection of waters of the Commonwealth.
- E. The stormwater professional/engineer should prepare PCSM designs that manage both the quality and quantity of runoff on-site prior to discharge to an existing sinkhole (refer to additional information below).
 - i. It is good engineering practice to prevent increased runoff volumes from discharging from the site to the sinkhole up to the 2-year/24-hour storm; manage increases for all storms up to and including the 100-year/24-hour storm; and maintain the discharge of the pre-development runoff volumes so as to maintain groundwater recharge.
 - ii. Where increases in runoff volumes discharging from new land development and eventually into the sinkhole are unavoidable, applicants are directed to DEP's document on the Managed Release Concept (click [here](#) for more information). The downstream effect of any increase in storms up to and including the 100-year/24-hour storm must be fully investigated by an applicant. It is the responsibility of the project proponent to demonstrate that any proposed discharges to sinkholes from land development activities do not pose a threat to public health, safety, or the environment.
 - iii. Quality control will be conducted in accordance with existing guidance.
 - iv. When Chapter 102 NPDES construction stormwater permitting requirements are triggered, and where post-construction discharges to a sinkhole are proposed, the review and approval of on-site BMPs will be handled under an [Individual NPDES Permit](#) by the appropriate DEP regional office pursuant to the 25 Pa Code Chapter 102 Regulations.

- v. When there are proposed increases in runoff (rate and/or volume) from land development activities that discharge into the sinkhole, the project will also require a [WQM Permit](#) from DEP’s Bureau of Clean Water or the appropriate DEP regional office pursuant to the 25 Pa. Code Chapter 91 Regulations.
- F. The appropriate operation and maintenance of improved sinkholes will be addressed as conditions of the required Individual NPDES and (where necessary) WQM permits. Operation and maintenance may include short- and long-term monitoring of discharges directed to an improved sinkhole.
 - G. The sinkhole or karst feature receiving post-development stormwater runoff is not considered a Stormwater Drainage Well by DEP, which is the reason for this separate document.
 - H. When existing or new sinkholes are modified through the use of a bored, drilled, or driven shaft whose depth is greater than the largest surface dimension, or modified with a dug hole whose depth is greater than the largest surface dimension, then it will be treated as a [Stormwater Drainage Well](#). Individual NPDES Permits involving Stormwater Drainage Wells will be reviewed/approved by the Regional Permit Coordination Office.
 - I. When existing or new sinkholes are determined to require remediation, the person implementing the repair should use appropriate techniques related to the site and should follow guidance as outlined in DEP’s E&S Manual or other appropriate references. When sinkholes occur within stormwater BMPs, repairs may be conducted using the supplementary techniques described in the [Sinkhole Remediation in Stormwater Management Facilities](#).

V. REFERENCES

- Kochanov, W. E. (2015). *Sinkholes in Pennsylvania*. Educational Series, Pennsylvania Geological Survey, Harrisburg, 36.
- Pennsylvania Department of Environmental Protection (PA DEP). (2020). “eMAP.” *Pennsylvania Department of Environmental Protection*, <<https://www.dcnr.pa.gov:443/Geology/Pages/default.aspx>> (Jul. 13, 2020).
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- Pennsylvania Department of Conservation & Natural Resources (PA DCNR). (2020b). “GIS Map.” *Pennsylvania Department of Conservation & Natural Resources*, <<http://www.gis.dcnr.state.pa.us/maps/index.html?geology=true>> (Jul. 13, 2020).
- United States Environmental Protection Agency (USEPA). (2002). *A Lexicon of Cave and Karst Terminology with Special Reference to Environmental Karst Hydrology (2002 Edition)*. USEPA Office of Research and Development, National Center for Environmental Assessment, Washington Office, Washington, DC, EPA/600/R-02/003, 2002.

Attachment 1

[Operations that Should Not Utilize Groundwater Discharge for Stormwater Management](#)