pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION
Bureau of Clean Water

Chapter 102 / NPDES Construction and Chapter 91 / Water Quality Management Permitting

Stormwater Drainage Wells as a Post-Construction Stormwater Management (PCSM) Best Management Practice (BMP)

Final, March 18, 2022
Version 1.0

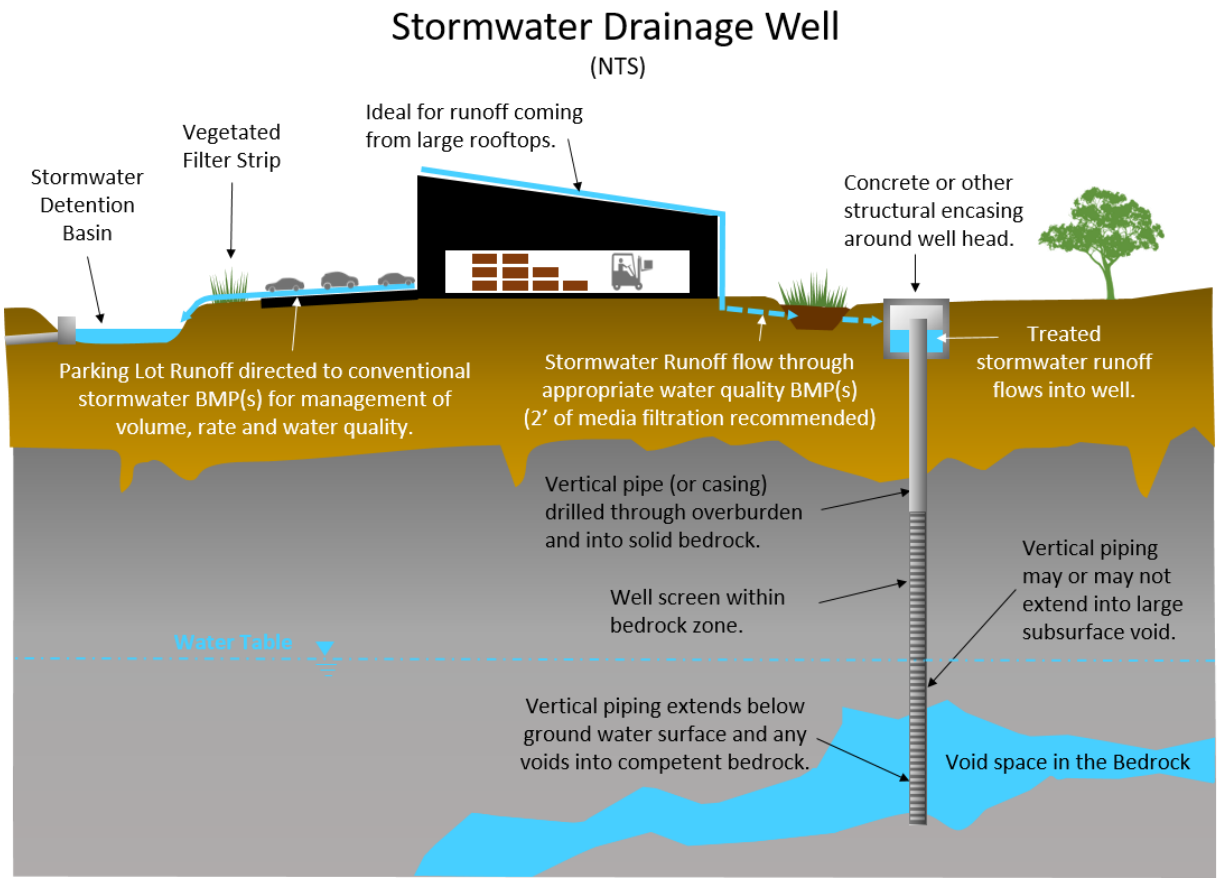
DEP maintains a list of Alternative PCSM BMPs on the Bureau of Clean Water Website. Stormwater Drainage Wells are an approvable alternative PCSM BMP when the guidelines herein are followed including prospective applicants discussing their project with DEP during a pre-application meeting.

I. INTRODUCTION:

Stormwater Drainage Wells (SDWs) are systems involving discharge of effectively treated stormwater to a receiving bedrock aquifer that addresses stormwater volume management. The use of SDWs as a Post-Construction Stormwater Management (PCSM) best management practice (BMP) can be a complex and costly alternative that may be impractical at many sites. Due to the required rigor of geologic investigations, engineering design, regulatory review and necessary monitoring, these practices require the involvement of a Pennsylvania-licensed Professional Geologist (P.G.) and a Pennsylvania-licensed Professional Engineer (P.E.) during planning, design, permitting, construction, and post-construction. When no lower maintenance-intensive solution to meeting volume management regulatory targets can be constructed due to existing site limitations, health and safety considerations, or environmental justifications, SDWs may be an appropriate alternative.

The purpose of this Best Management Practice (BMP) document is to:

- define SDWs when utilized as a PCSM BMP in Pennsylvania;
- discuss the applicability and suitability for using SDWs as a PCSM BMP;
- provide an overview of federal and state regulatory considerations;
- propose stormwater management criteria;
- provide guidance on site investigation and evaluation recommendations;
- establish general design guidelines and recommendations; and
- provide a list of permits/authorizations that may be required.



SDWs may be referred to by other names, including (but not limited to):

- Class V wells
- Injection wells
- Gravity drains
- Bored wells

Selecting the appropriate nomenclature is important. The names listed above have been used interchangeably, which can be misleading. With respect to this document, it is important to note that the term "Stormwater Drainage Wells" is defined in the Underground Injection Control (UIC) regulations (40 CFR 144.3) as:

> *A bored, drilled, or driven shaft whose depth is greater than the largest surface dimension; or, dug hole whose depth is greater than the largest surface dimension.*

A. Key Considerations:

- This document covers activities meeting the definition of a SDW which discharge directly into competent bedrock. See Section VII (General Design Guidelines and Recommendations).
- This document does not cover "improved sinkholes". See Section II (Applicability and Suitability) and the "Stormwater Discharges to Improved Sinkholes" document.

- If the source of runoff discharging to the SDW is only from roof areas, then the project would only need to be covered under an Individual Chapter 102 NPDES Permit. If the discharge includes sources of runoff other than roof area, then the project will also require a Water Quality Management (WQM) Permit. See Section VIII (Permits/Authorizations) for more details.
- The use of SDWs in Pennsylvania may require early coordination with United States (US) Environmental Protection Agency (EPA) Region 3. See discussion in Section III (Federal Regulatory Basis) and EPA clarification on stormwater management systems, including those with piping to enhance infiltration capabilities, which likely do not fall under the jurisdiction of a Class V well or a SDW. Also see EPA's Fact Sheet on their Underground Injection Control (UIC) Program.
- Prior to permit submittals, project proponents proposing to use SDWs should contact DEP's Regional Permit Coordination Office (RPCO) for a pre-application meeting. (RA-EPREGIONALPERMIT@pa.gov)

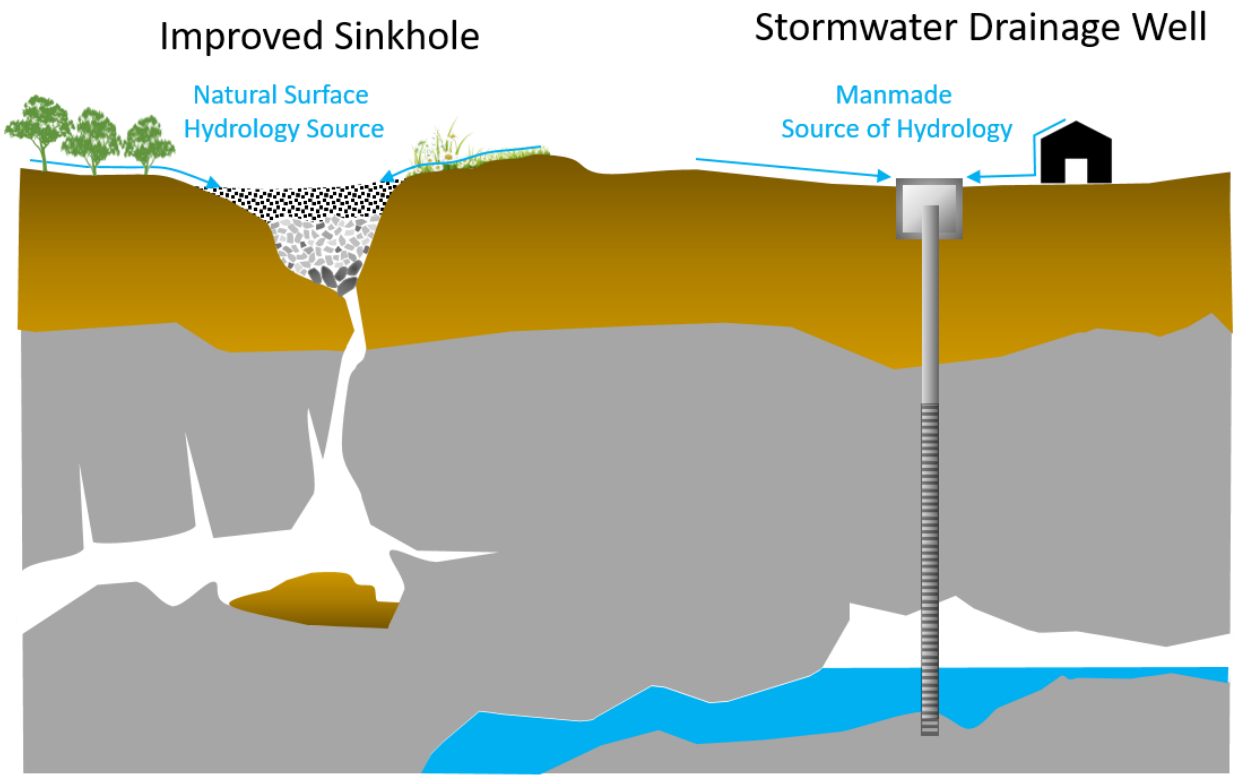
II. APPLICABILITY

Prior to discussing the applicability of discharging stormwater into a SDW, it is important to define what will be covered and what will not be covered in this document.

EPA performed a comprehensive study looking nationwide at 22 types of Class V Injection Wells – of which only one type dealt with **stormwater drainage wells**.

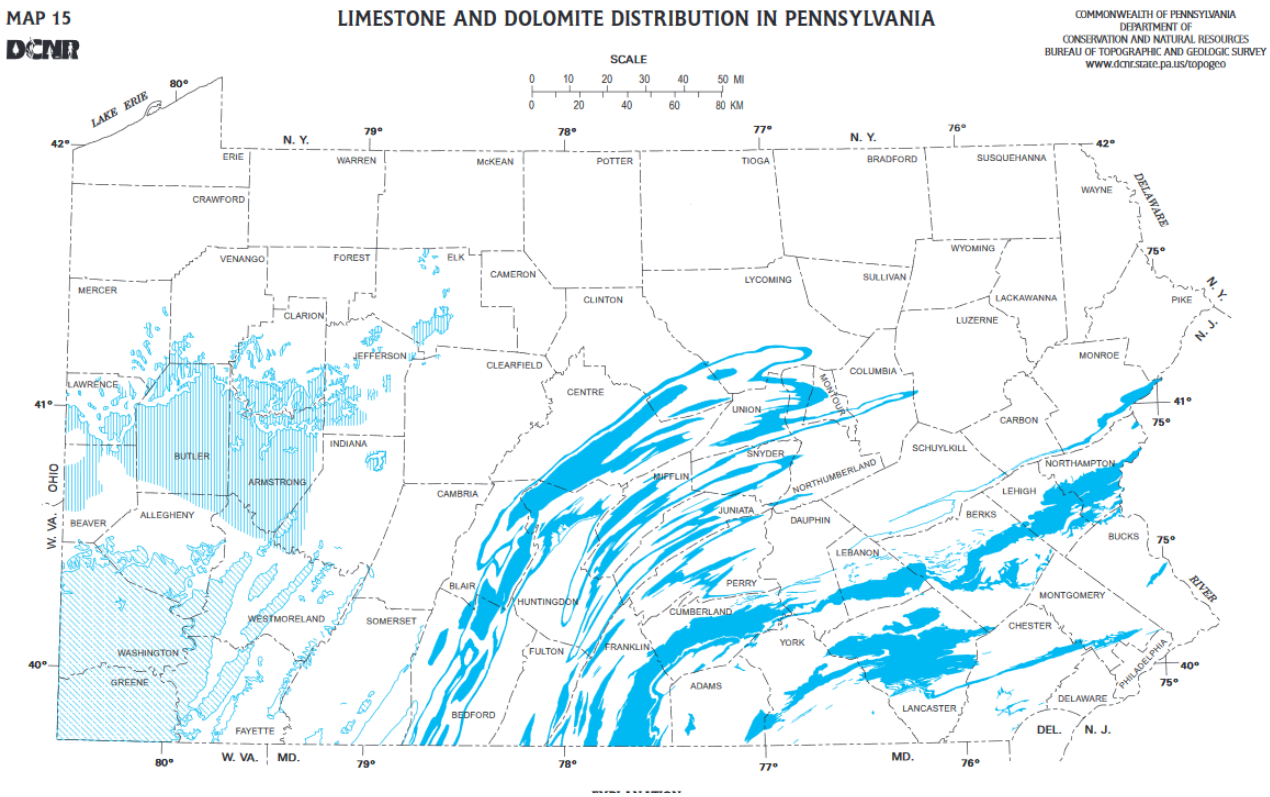
> **NOTE 1:** This study resulted in several study volumes – each addressing a particular well type. Volume 3: Stormwater Drainage Wells covers *shallow injection wells designed for the disposal of rainwater and melted snow*.

This document does not cover those other types of Class V wells. Also, despite the federal definition of a Class V injection well, improved sinkholes are not included herein unless they are physically modified into a stormwater drainage well. Improved sinkholes are otherwise physically and functionally different from SDWs as shown in the diagram below.



Improved Sinkhole vs. Stormwater Drainage Well

There are many existing sinkholes in Pennsylvania – all of which are intricately connected to surface water hydrology. Sinkholes are usually concentrated in areas with Karst Terrain – predominantly in Central/Southcentral PA, Southeast PA and in the Lehigh Valley – as shown in the solid blue areas on the map below.



PA Karst Map

Source: PA DCNR

More general information on sinkholes in Pennsylvania is available on DCNR's website.

Sinkholes, including improved sinkholes, do not treat stormwater runoff – rather they should be handled as a conveyance to the underlying aquifer which is a protected water of the Commonwealth under the Clean Streams Law. For more information about improved sinkholes go to "Stormwater Discharges to Improved Sinkholes".

III. FEDERAL (U.S. EPA) REGULATORY BASIS

A SDW is a subcategory of Class V Injection Wells falling under the purview of the EPA UIC Program and should comply with their pertinent application requirements and, when necessary, obtain approval or an UIC permit from EPA. Early coordination with EPA is highly encouraged. It would be highly advantageous for project proponents to coordinate with EPA prior to pre-application meetings or submission of any applications for state permits.

"Injection well" is a relatively broad term which EPA defines as "a bored, drilled, or driven shaft, or a dug hole that is deeper than it is wide, or an improved sinkhole, or a subsurface fluid distribution system". There are a total of 6 classes of injection wells, each regulated by EPAs UIC Program - a program geared towards protecting underground sources of drinking water under the authority of the Safe Drinking Water Act.

NOTE 2: As previously noted, this document does not cover improved sinkholes. For more information about improved sinkholes go to: "Stormwater Discharges to Improved Sinkholes".

The federal UIC regulations specifically define Class V Injection Wells to include "drainage wells used to drain surface fluid, primarily storm runoff, into a subsurface formation" (40 CFR 146.5(e)(4)).

NOTE 3: Despite the common use of the term "injection well", stormwater runoff is introduced into the subsurface through a bored shaft, or by other structures, where it "drains" into the ground under the influence of gravity. A "gravity drain" operates at atmospheric pressure utilizing only the head difference (i.e., pressure resulting from the difference in elevation between two points in a body of fluid) between the water level in the well casing and the static water level in the aquifer, rather than through forced injection, where fluid is pumped into the ground under pressure.

A. EPA's UIC Program and Injection Wells

The Safe Drinking Water Act requires that EPA protect Underground Sources of Drinking Water (USDWs) from injection activities. EPA has set minimum standards to address the threats posed by all injection wells, including SDWs.

Injection activities are a concern because stormwater may contain petroleum or other organic compounds that could harm USDWs. Other potential harmful contaminants include:

- Sediment (TSS)
- Nutrients (Nitrogen & Phosphorus)
- Metals
- Salts
- Microorganisms
    - Bacteria
    - Viruses
- Fertilizers
- Pesticides

Class V wells deal with injection of "non-hazardous fluids into or above underground sources of drinking water" and are "authorized by rule" (40 CFR 144.24).

NOTE 4: Though Class V injection wells may not require a permit from EPA, they may require submission of basic inventory information. This does not affect whether they need permits from PADEP. Per 40 CFR 144.25, a UIC Program Director may require the owner or operator of any Class V well to apply for and obtain an individual or area UIC permit.

The UIC program requirements consist of 40 CFR parts 124, 144, 146, 148, and any additional requirements set forth in the remainder of this subpart. Injection well owners and operators, and EPA shall comply with these requirements. Class V wells that are

authorized by rule may inject as long as they do not endanger USDWs (40 CFR 144.12), and the well owners or operators submit basic inventory information (40 CFR 144.26). Project proponents are encouraged to consult early with EPA to discuss and address these requirements.

B. Determining When Your Project is a Class V Stormwater Drainage Well

Due to confusion over the basic definition of a Class V injection well and in order to promote green infrastructure, EPA provided a clarification memo in 2008 describing which underground stormwater management facilities were regulated at the federal level. This clarification was necessary because a strict reading of the definition could inappropriately indicate that many stormwater management systems would be UIC regulated since they have dimensions of depth greater than their width or provide fluid distribution beneath the surface (e.g., infiltration trench and dry well to name a few). One of many clarifications was that surface impoundments do not include "dug, drilled or driven shafts" and are not Class V wells. Overall, it should be noted that the majority of infiltration BMPs utilized for land development in PA are not considered a Class V well per the "Class V Well Identification Guide" in the 2008 clarification.

To further aid the regulated community, EPA developed the following table to help determine if an applicant has a Class V SDW:

Answer the following questions to determine if you have a Class V stormwater drainage well.

Questions:	**If Your Answer Is Yes...**	**If Your Answer Is No...**
1. Do you operate a stormwater collection system that relies on infiltration to collect and dispose of storm water runoff?	Go to question 2.	You do not have a Class V Stormwater drainage well. **Stop here.**
2. Does your infiltration system discharge to the subsurface?	Go to question 3.	You do not have a Class V stormwater drainage well. **Stop here**.
3. Does your stormwater infiltration system consist of a drilled or driven shaft, or dug hole that is deeper than it is wide? Does it rely on a naturally occurring sinkhole? Does it include any subsurface piping?	**You have a Class V stormwater drainage well** and are subject to Class V requirements.	You do not have a Class V stormwater drainage well. **Stop here**.

Source: https://www.epa.gov/uic/stormwater-drainage-wells

IV. DEP'S REGULATORY BASIS

This document is supplementary to existing DEP guidance, including but not limited to the *Pennsylvania Stormwater Best Management Practices Manual (as updated)*, and has been prepared to assist in the planning, design, permitting, and operation/maintenance for these systems. While EPA has a Class V UIC Program and has primacy with that program in Pennsylvania, DEP also has regulatory responsibilities for addressing stormwater management and water quality in

accordance with Pennsylvania Code Title 25 - Chapter 102 and the broader protection of groundwater resources under the parent legislation, the Clean Streams Law.

A. The Pros and Cons of Stormwater Drainage Wells

As noted below, SDWs are inherently different than other stormwater BMPs. It is the project proponent that decides their project layout and which stormwater BMPs to utilize. Hence, it is especially important that the project proponent understand the pros and cons from a variety of vantage points (e.g., planning, permitting, construction, monitoring and operation/maintenance).

Discharging to a SDW, when designed and built responsibly in accordance with applicable regulations and guidance, can offer significant post-construction volume management, maintain aquifer recharge, reduce the risk of sinkhole formation in karst areas, and have the added benefit of functioning year-round unlike other BMPs affected by freezing or other weather variation. However, SDWs require a more extensive process than other BMPs, including the following:

1. Upfront investment in hydrogeologic investigations to determine feasibility.
2. A source control treatment assessment prior to final site design to discern the most appropriate treatment method to achieve the cleanest runoff to be controlled using underground injection.
3. A heightened level of water quality treatment to protect groundwater resources.
4. Unless there are sufficient BMPs incorporated into both the E&S and PCSM Plans to remove sediment from construction runoff, SDWs should be taken offline during construction activities to prevent contamination from sediment-laden runoff.
5. A robust monitoring and operation/maintenance program of SDWs, and other appurtenant or supporting BMPs, after construction is completed.
6. Due to the public health and safety considerations, the design professional(s) involved with SDWs should be Pennsylvania licensed professional(s) experienced in local geologic and hydrogeologic conditions, trained in geology and hydrogeology, with demonstrated training and experience in siting and operating wells. This will require the services of both a P.E. and a P.G.
7. Use of SDWs as a stormwater management system will require early stage coordination. In addition to scheduling early consultation and a pre-application meeting with DEP, the project proponents are highly encouraged to contact EPA's UIC program for the most up-to-date information and to determine the need for approvals related to their proposed Class V SDW(s).
8. DEP regulates discharges to a SDW under various provisions in Pennsylvania Code Title 25 including Chapter 102 (Erosion Control & Stormwater Management), Chapter 93 (Water Quality Criteria and Antidegradation) and Chapter 91 (General Provisions of the Clean Streams Law). The latter requires protection of groundwater resources and additional permitting may be required under DEP's WQM Permit. See Section VIII (Permits/Authorizations) for more details.

In particular, there are applicable excerpts from the Underground Disposal Section of Chapter 91 (General Provisions) in *§ 91.51.* and *§ 91.52.*

Upon meeting with DEP, project proponents are advised to come prepared to discuss how they have appropriately considered all stormwater management alternatives and, when appropriate, satisfied DEP's PCSM Stormwater Objectives when proposing the use of SDWs. It is recommended that this demonstration follow a ranking of less maintenance-intensive BMPs for volume management beginning with traditional infiltration options and then through Managed Release Concept options. See Section VI for more details on managed release concept.

V. STORMWATER MANAGEMENT CRITERIA

SDWs are not applicable to every site, and careful consideration should be given during the BMP selection process. Maximizing developable footprint (i.e., lack of site area to incorporate traditional volume control BMPs such as infiltration basins) should not be the determining factor for utilizing SDWs as a BMP. The design professional(s) should tailor their stormwater strategy for a site with a combination of BMPs to manage rate, volume, and water quality. Preference should be given to BMPs that are the most resilient and require the least operation and maintenance (including monitoring). SDWs focus predominantly on volume management and therefore other BMPs will be necessary to achieve full PCSM compliance. More specifically, SDW systems should not be relied upon during extreme storm events which exceed the design standard for the SDW, such as for large tropical storms, which should be handled by rate control BMPs situated outside the SDW footprint.

SDWs are suited for land development and redevelopment (residential, commercial, and industrial) being proposed on parcels with carbonate geology/ karstic aquifers due to their unique hydrology[1]. Avoiding or minimizing the risk of sinkhole development from traditional infiltration practices is one factor influencing the use of SDWs. Appropriate analysis when selecting BMPs in karstic areas is required due to the unique characteristics of carbonate geology which can contribute to sinkhole formation, and little or no filtration of stormwater recharge to the subsurface.

SDWs may not be well suited for (1) areas adjacent to mined lands or quarries, (2) sites within close proximity to public or private water supplies, (3) other areas where existing wells or groundwater quality could be detrimentally impacted, or (4) sites with existing soil/groundwater contamination. SDWs cannot be used where on-site soils, that may come in contact with stormwater, have contaminant concentrations that exceed their respective residential or non-residential medium specific concentrations, as listed in 25 Pa. Code Chapter 250.

When evaluating a project for use of SDWs, possible sources of contamination of stormwater runoff need to be closely considered. Introduction of chemicals that are not treatable by conventional means are of particular concern (e.g., lawn chemicals and road salt). Runoff that contains problematic amounts of chemicals will likely need to be segregated/ diverted away from SDWs. See Attachment 1, entitled *Operations that Should Not Utilize Groundwater Discharge*

[1] "The groundwater storage capacity of karst bedrock is large as compared to porous or fractured media. Uncontrolled surface water recharge to the bedrock can raise the water table by tens of feet and more, over several days, as the result of the recharge filling the karst voids." (Lolcama, 2014)

for Stormwater Management, for a listing of operations where SDWs are not recommended for stormwater management.

Though normally considered in areas with carbonate geology, for which this document is focused, other applications of SDWs may be sought by the Licensed Professional as appropriate.

Stormwater Functions

The stormwater management functions and their application to SDWs are shown below.

Function	Level
Volume Management	• Achieved through direct recharge
Groundwater Recharge	• Achieved through direct recharge
Geomorphologic Protection Rate	• Achieved through volume reduction and rate control.
Peak Rate Control	• Secondary – limited storage for rate control.

Water Quality Pollutant Removal	• Must be achieved with other BMPs through robust water quality treatment (physical, biological, or chemical).
	• Extent of water quality treatment can vary dramatically depending on the source of runoff.
	  • **TSS**: Reduction can be achieved by settling and filtration.
	  • **N**: Reduction can be achieved through bioretention. See further information on Internal Water Storage (IWS) which can be used to enhance N removals. More information on IWS can be found by clicking here.
	  • **P**: Reduction can be achieved through bioretention and absorption by the soils and uptake by plants.
	  • **Other**:
	  ▪ Salts – Achieved by utilizing low pollutant surfaces such as rooftop drainage or through source reduction.
	  ▪ Metals - Hot spot areas should be diverted.
	  ▪ Oils/Grease – Hot spot areas should be diverted.
	  ▪ Bacteria – UV disinfection, or other methods, prior to discharge to the SDW may be required.
	  ▪ Other site-specific contaminants of concern
	  • **Thermal**: Temperature reduction is typically achieved through thermal transfer in soil/geothermal cooling.

Water Quality Treatment Standards for Stormwater Drainage Wells

Water quality treatment is of upmost importance when discharging to a SDW. Utilizing roof runoff, for example, addresses some fundamental concerns such as prioritizing inherently cleaner sources of runoff than that coming from parking lots, streets, or landscaped areas. Secondly, utilizing roof runoff addresses the risk of accidental spills that can occur on parking lots and roadways. Utilizing roof runoff can also ease the burden of any additional permits or approvals that may be required at the federal, state, or local level. (See Section VIII on Permits/Authorizations.)

Roof runoff will need some filtration especially for leaves and other detritus. This can be done with a combination of gutter guards and a downspout filter. Ideally, these systems should incorporate a bypass for overflows during extreme events which exceed the design standards for an individual SDW. Additional guidance can be found in EPA's Interim Revised NPDES Inspection Manual (Ch. 14, pgs. 327-328). The overall stormwater management plan should incorporate storage for detention/rate control of large storm events to address peak rate control requirements and to help avoid hydraulic overloading of SDW systems. To reduce the risk of hydraulic overloading the local aquifer, bypass equipment should be incorporated into the SDW design.

Runoff from non-roof areas will require a more complex design for water quality treatment (For general information, see 2006 PA Stormwater BMP Manual, Appendix A – Water Quality, as updated.). Stormwater designers have many treatment options, including directing runoff through water quality BMPs near the runoff source (i.e., hydrodynamic structures, oil-water separators, bioretention, etc.), or somewhere else along the treatment train. For example, runoff can be temporarily captured/detained/treated in a basin and, if additional water quality treatment is necessary, the flow can be slowly released through another water quality BMP prior to reaching the SDW. In doing so, specific pollutant targets should be identified so appropriate water quality BMPs can be selected.

In all cases, appropriate and reliable water quality treatment is necessary prior to discharging runoff into the SDW and ultimately into the groundwater. Depending on the aquifer, potable use from the aquifer, and/or the source of the runoff being injected, it may be necessary to incorporate higher levels of treatment - including disinfection. Additional permitting may also be necessary (See Section VIII – Permits/Authorizations). It should be noted that under certain circumstances, a discharge to an aquifer may be prohibited by either federal or state regulations.

According to EPA correspondence on this matter, authorization to operate injection well(s) is contingent upon compliance with the "prohibition of fluid movement" standard described in 40 CFR 144.12(a) which states that injection activity cannot allow the movement of fluid containing any contaminant into underground sources of drinking water if the presence of that contaminant may cause a violation of National Primary Drinking Water Standards, or may otherwise affect the health of persons. This prohibition applies

to well construction, operation, maintenance, plugging and closure. Pennsylvania has similar language for underground disposal under 25 Pa. Code § 91.51-52.

Other specifics for water quality treatment:

A. The level of treatment should be commensurate with the protection levels of the aquifer. This is a matter that the professional engineer/geologist will need to properly address during the design process. As mentioned earlier, early consultation or a pre-application meeting is highly encouraged and the applicant should come be prepared to discuss this information.

B. Source control is a major consideration for areas draining to the SDWs – especially ground level sources. The use of deicing materials, salts, and anti-skid materials within snow removal areas may affect groundwater quality especially groundwater chloride levels. The use of these materials within the drainage area of SDWs should be controlled to the maximum extent practicable and where sufficient countermeasures are in place as BMPs do not reliably remove chlorides. Potential impacts of these materials should be considered in the design and treatment process.

> **NOTE 5**: There are currently no convenient ways of treating runoff for chlorides. Compost and soil/compost mixtures may absorb runoff from these areas; however, chlorides will accumulate and lead to plant mortality, soil contamination, and other functional failures.

C. Stormwater discharges to aquifers used actively for potable water should be treated to state drinking water standards prior to entering a SDW. This may include filtration, settling, and when necessary, disinfection.

   a. Some key questions that should be addressed at this stage of the design, include:

      1. Has a thorough and complete assessment been conducted to identify both public and private water supplies in the vicinity of the SDW?
      2. Are any identified wells connected by the same aquifer?
      3. How transmissive is the aquifer?
      4. Is there potential for injected water via a SDW to reach and/or impact a potable well?

         > **NOTE 6:** A setback distance should not be the sole basis for this assessment – particularly in carbonate geology.

   b. The use of multiple BMPs including vegetated/soil systems, manufactured treatment devices, automated devices, or advanced treatment may be required to effectively treat stormwater prior to discharge.

   c. Depending on the source of runoff, UV light or another form of disinfection may be required to eliminate the potential for microorganisms in water.

      > **NOTE 7**: It should be noted that UV technology does not remove any other contaminants from water such as heavy metals, salts,

chlorine or man-made substances like petroleum products or pharmaceuticals. Filtration methods should be employed with UV to ensure that all contaminants are removed from the water. UV light is only functional when the discharge is clear and at the end of the water quality treatment train (See Section VIII – Permits/Authorizations– including WQM Permitting).

D. Control of sediment is critical – especially during construction activities. Control measures are needed to prevent sediment deposition/pollution from entering the well casing from the surface. Redundant measures may be necessary.

VI. SITE INVESTIGATION AND EVALUATION

Site investigation, evaluation, and associated documentation are a requirement as outlined in 25 Pa. Code § 102.8(g) as part of PCSM stormwater analysis. Site evaluation for SDW use is specific and includes, but is not limited to, consideration of existing features (both surface and subsurface) and the potential for deep aquifer recharge on-site as well as other limitations that may affect design, such as contamination of soil or groundwater.

A. Site investigations should include a preliminary desktop evaluation including a review of existing topographic mapping, karst features maps, geologic mapping, soil surveys, aerial photography, and any previous geotechnical or geologic reports covering the local area.

B. The site should be field evaluated for potential subsurface/geological issues prior to any earthmoving. A BMP feasibility study should be completed early in the design process, as effective design requires consideration of existing site characteristics (i.e. topography, natural features/drainage ways, soils, geology, open sinkholes, depressions, areas showing signs of collapse and subsidence sinkholes, areas showing evidence of past sinkhole activity, etc.). The field evaluation may employ various exploration techniques including, but not limited to: soil and bedrock borehole installation and short-duration potable water injection rate testing of the bedrock section of the borehole, water table static elevation and elevation response to injection testing, engineering assessment of the structural stability of the karst bedrock, piezometer/monitoring well installation, and geophysical surveys (including but not limited to: ground penetrating radar, electromagnetic conductivity surveys, and seismic surveys).

C. Karst loss infiltration and water table fluctuation up into the overburden are the leading contributors to sinkhole formation. As part of the desktop review, there are a variety of agencies that maintain an inventory of known sinkholes in PA – especially in areas of karst terrain. Click here for more information.

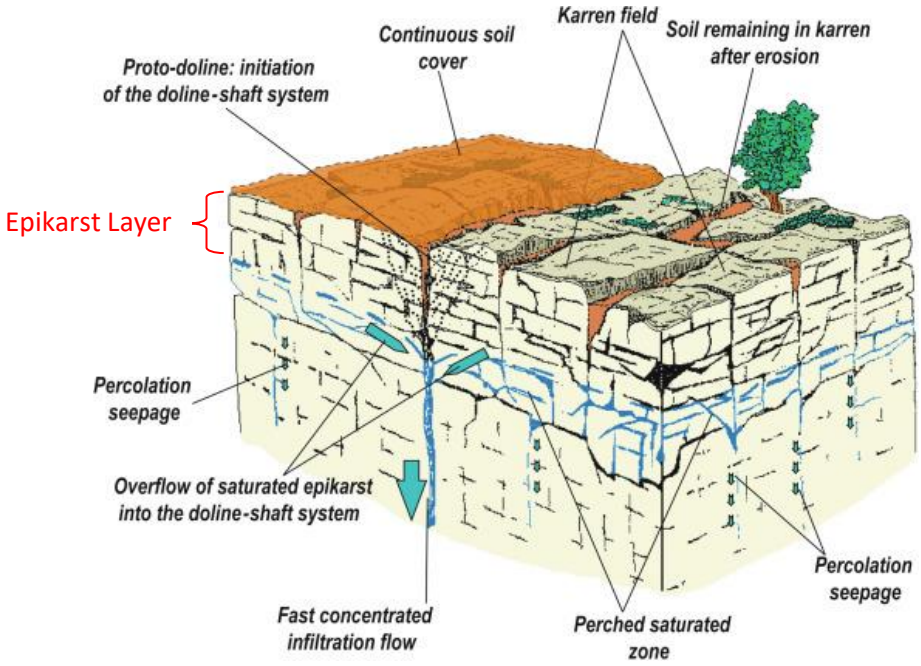
a. Compaction of the overburden to reduce permeability can significantly diminish karst loss infiltration.

NOTE 8: Depending on the results of the geotechnical and hydrogeological studies, the project proponent may want to consider deep dynamic compaction of the karst portions of the site especially if large structures are proposed. As there can be significant variability in geologic conditions

across a site, this may not be necessary in all locations. Involvement of experienced Licensed Professional(s) is critical if dynamic compaction is utilized.

b. It is essential that appropriate real-time automated monitoring of water table elevation be incorporated into the SDW design. This is needed for a site to maintain the aquifer water table well below the top of the epikarst layer, with the objective of controlling the rate of stormwater recharge to prevent water table mounding up into the overburden layer. The project proponent will need to develop a project-specific monitoring program (See Section VII – Table 2).

NOTE 9: Epikarst is a term used to describe the complex uppermost, near-surface portion of karst bedrock that includes the soil/bedrock interface. The epikarst is generally defined as the irregular, solutionally-derived bedrock surface and underlying highly porous bedrock zone that is often hidden beneath a layer of soil.



Epikarst

Source: Chapter 45 (Epikarst) – Encyclopedia of Caves (3rd Ed).

D. At a minimum, completion of Attachment 2, entitled *Supplemental Geologic and Groundwater Information for Stormwater Drainage Wells* should be completed in addition to the NPDES Individual Permit Application (3800-PM-BCW0408b).

Unlike other Class V wells which may receive flow in a continuous manner, SDWs usually transmit large volumes of runoff in a relatively short timeframe. Therefore, understanding of the underlying geology and receiving aquifer are critical considerations. For example, one potential issue with SDWs is water table mounding and impacts from water table rise into the soil overburden.

NOTE 10: The information required in Attachment 2 (Supplementary Geology and Groundwater Information for Stormwater Drainage Wells) should be provided by the applicant with all state permit applications. See Section VIII (Permitting/Authorizations) for more information.

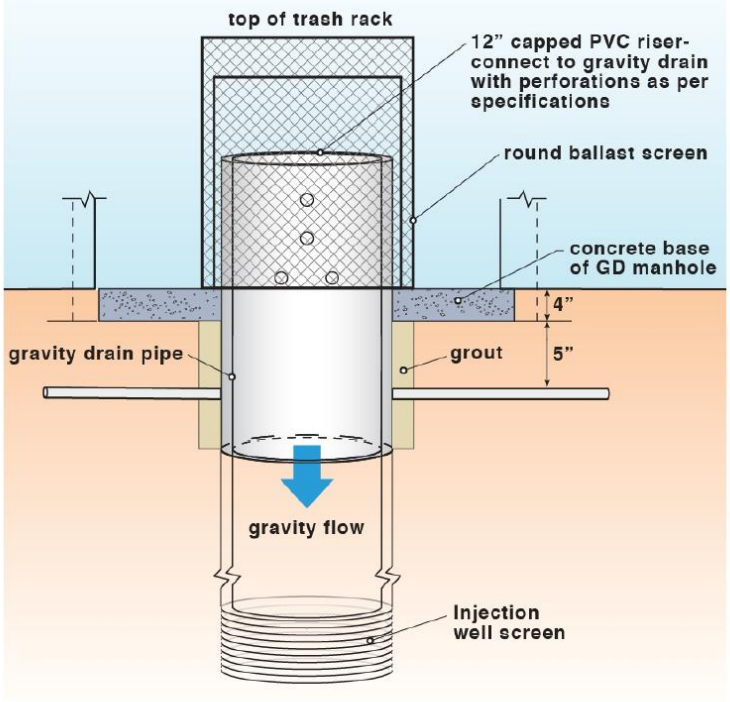
VII. GENERAL DESIGN GUIDELINES AND RECOMMENDATIONS

General elements and components should be designed in accordance with guidance provided in PA Stormwater BMP Manual, as amended and updated. The items contained in **Table 1** below, supplements the Manual.

Table 1: Specific Recommendations by Component

Component	Specific Recommendations
General	A. The licensed professional(s) should check local municipal and county ordinances to see if there are any restrictions. Some municipalities in Pennsylvania may not allow SDWs or have restrictions/conditions for their use. B. SDWs can be a complex and costly alternative and are normally only considered when no other low maintenance solution to meeting volume management regulatory targets can be constructed due to existing site limitations, health and safety considerations, or environmental justifications. In addition to infiltration and other volume reduction BMPs, the Managed Release Concept (MRC) should be evaluated as a viable alternative prior to proposing SDWs. C. SDWs are inherently different than traditional volume reduction (infiltration) BMPs for the following reasons: 1) SDWs rely on suitable geology to accept and transmit anticipated flow volumes rather than the soil's ability to infiltrate. In karst/sinkhole prone areas, the professional engineer/geologist (and local municipality) may find it to be a practicable alternative rather than infiltration after careful consideration of other factors. 2) SDWs are specifically designed to allow runoff to bypass the soil column, are anchored into bedrock, and discharge treated stormwater runoff directly into the aquifer. In essence, runoff does not infiltrate through a minimum of 2 feet of suitable native soil; rather SDWs use stormwater pretreatment, followed by direct recharge to the aquifer. 3) Traditional infiltration BMPs have inherent water quality buffering integrated since they are typically required to have a minimum of 2 vertical feet of separation distance from confining layers (either bedrock or the seasonally high water table) to allow filtering and biological/microbial treatment of contaminants through the soil column.

	NOTE 10: The Licensed Professional needs to account for potential impacts from surface water runoff such as salts/chlorides that may enter stormwater runoff as a contaminant. These are dissolved constituents that are not removed by any infiltration BMP. 4) Despite whether water quality treatment is proposed through 2 feet of bioretention soil media, there is still a risk for contaminants entering the aquifer for runoff from ground surfaces – especially if there is a spill, chemicals are applied to vegetated areas, or if salts/chlorides are used for deicing. This risk needs to be assessed and appropriate supplementary measures need to be put in place for this BMP to be acceptable. 5) SDWs, when done properly, generally require more investment in terms of investigation time, analysis, long-term management of recharge rate, and overall cost. D. In general, SDWs should <u>be avoided</u> within Zone I or Zone II wellhead protection areas. 1) This is especially important where the water supply wells are in unconfined aquifers of fractured limestone or dolomite. These easily recharged aquifers can become contaminated unless adequate stormwater pretreatment occurs first. 2) Local government officials should be contacted early when planning this type of BMP especially when located near sensitive areas. Some municipalities have specific ordinances that address land uses in these areas.
Inflow Components	• The SDW should include flow control/restricting elements designed in accordance with tested aquifer transmissivity. One way this could be accomplished is by utilizing a riser with customized perforations as shown in the figure below, and a shut-off valve to temporarily restrict or stop recharge during storm events that exceed design standards.

	 Figure 4. Gravity drain flow restrictor Gravity Drain Flow Restrictor Source: 27th Central PA Geotechnical Conference, Hershey PA April 23-25, 2014. • Also see Section V - Water Quality Treatment Standards for Stormwater Drainage Wells.
Well Construction Information	**Well Casing:** A. Well casing should meet the requirements of all applicable Federal, State, and local standards. B. SDWs should have their casings anchored 10 feet into competent bedrock and the casings need to be pressure grouted from the bottom of casing to the surface. Modification may be acceptable depending on site conditions. C. Well drilling operations should be in accordance with 25 Pa. Code § 91.31. D. Closing a well: When deemed necessary, the well should be closed in a way that prevents the movement of any contamination into underground sources of drinking water. Appropriate procedures are required for closing or capping the well. Also, any soil, gravel, sludge, liquids, or other materials removed from or adjacent to the well should be disposed or otherwise managed in accordance with all applicable Federal, State, and local regulations and requirements. **Real-Time Automated System/Controls:**

	A. Ideally, SDWs should incorporate real-time automated controls into their monitoring program. These systems facilitate a well-functioning SDW through the safe bypassing of flow into an automated overflow/extended storage system once the water elevation in the well reaches a predetermined maximum level. B. The potential for surface releases must be considered and, when necessary, incorporated into a Prevention, Preparedness and Contingency Plan or Environmental Emergency Response Plan. This is particularly important for runoff from areas other than roof surfaces that drain into a SDW, whereby provisions must be provided to prevent polluting substances from entering the well. These precautions would extend to interconnected BMPs, including runoff storage areas and water quality BMPs. The above-referenced plan, written in accordance with 25 Pa. Code § 91.34, should be prepared and available at the facility at all times both during and after construction. Though an automated system is in place, there should still be one or more designated employees/individuals that are properly trained, familiar with this plan, and available 24-hours a day/7-days a week to respond to emergencies – including a spill that needs to be dealt with prior to runoff entering the SDW. C. Where necessary and approvable, automatic emergency power should be provided to energize all electrical components of the entire treatment or detection system including UV lights and controls in the event of a power outage. The automatic emergency power system should be exercised/tested on a quarterly basis. Similar to other BMPs, the stormwater drainage well system requires a legally binding instrument recorded with the deed and specifically tied to the permanent maintenance plan. This would include procedures for taking the system offline or abandonment when deemed necessary.

When proposing SDW(s), the Licensed Professional(s) preparing the Individual NPDES Permit should include the items in **Table 2** in the PCSM Plan and Narrative. Projects proposing the use of SDWs need to be covered under an Individual NPDES Permit (see **Section VIII**). Additional guidance for filling out an Individual NPDES Permit Application with SDWs is provided in **Table 3**.

Table 2: BMP Specific Plan and Narrative Elements

Item	Instructions
Hydrogeologic Testing/ Geologist Report	The Individual NPDES Permit application shall include a detailed geologist report including site-specific geologic analysis / testing demonstrating applicability and suitability for the use of SDWs. At a minimum, the report shall include the following items provided under the seal and signature of a

	Professional Geologist, licensed to practice in the Commonwealth and knowledgeable in local geology: a. A completed Attachment 2 (Supplementary Geology and Groundwater Information for Stormwater Drainage Wells). b. A plan and supporting narrative describing all testing (geotechnical borings, geophysical testing, specific injection capacity or yield tests and other water table elevation criteria) used for analyzing the site and conclusions reached supporting the use of SDW(s). c. A plan and narrative describing the choice for the location for the SDW, or well field. This plan should include sufficient details of the surrounding geologic formation. d. Identification of the SDW(s); including specific identification number, the physical location and a statement of how the SDW system will be utilized. Corresponding monitoring wells and/or piezometers should also be identified. e. Boring logs showing the geologic strata, construction details of each of the SDWs, the elevation of the soil/bedrock interface, and groundwater elevation. f. Water bearing/receiving zones need to be identified. Borehole geophysics may be used to identify fractures, water-producing and water-receiving zones, and to measure fluid velocity. This information will help determine where into the aquifer the stormwater will be recharged. g. One or more of the following investigation methods should be used to evaluate 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 involved while conducting the investigation. 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 feature maps, geologic mapping, soil surveys, aerial photography, and any previous geotechnical or geologic reports covering the local area. 2) Soil Borings: To collect information on soil and rock stratigraphy, soil strength and consistency, and location of voids within the overburden. This information may also be included in the Engineer's Report. 3) CPT/HPT Borings: 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. This information may also be included in the Engineer's Report.

4) Groundwater Monitoring Devices: The use of selectively placed piezometers or monitoring wells to collect groundwater elevation data and/or groundwater quality data.
    i. Monitoring wells (MWs) shall be implemented in accordance with a Groundwater Monitoring Program. See the section on Monitoring, Reporting, and Corrective Action for more information.

5) Geophysical Methods: Ground penetrating radar, electromagnetic conductivity surveys, seismic surveys, or other methods can detect subsurface anomalies including subsurface voids.

h. The recharge capacity/ rate of each of the SDW(s) and the actual data, charts, and hydrographs used to determine each SDW's injection capacity.

i. Analysis of the existing aquifer, its use, and a complete inventory of all public and private wells within at least 1/2 mile of the SDW(s).

j. A statement indicating that the project is proposed in a manner consistent with the requirements of 25 Pa. Code § 91.51-52 and, when applicable, is consistent with the requirements under a WQM Permit. (See Section VIII – Permits/Authorizations.)

    1) Upon completion of construction and testing of all SDW(s), an additional report shall be submitted to DEP's RPCO, and the authorized conservation district; provided under the seal and signature of a Professional Geologist, licensed to practice in the Commonwealth and knowledgeable in local geology. When a WQM Permit is required, a copy of this report should also be submitted to DEP's Bureau of Clean Water. The report should include the following:

        i. Calculations confirming that the system will accept the volume of stormwater within the allotted period as identified in the permit application materials.

	ii. The remaining amount of capacity, if any, which is required to be obtained by the system for full functionality of the proposed SDW design. iii. Identification of site and regional rainfall conditions during installation and testing of the well(s). iv. Any relevant observations/decisions made by the Licensed Professional(s) who was on-site and responsible during critical stages of construction and testing. v. The location and label of any well drilled including wells not used and/or abandoned. vi. A narrative or log showing abandonment details for each well not used as part of the system. vii. A final plot plan showing the label and location of all SDWs, supporting well network, and wells not used and/or abandoned. viii. Well construction details and boring logs for all wells installed on the property including SDW(s), the supporting well network and wells not used and/or abandoned.
Engineer's Report	In addition to the standard information needed to demonstrate compliance with 25 Pa. Code § 102.8 (PCSM requirements), the Individual NPDES Permit application shall also require a detailed engineer's report including site-specific engineering analysis/testing supporting the applicability and suitability for the use of SDWs. At a minimum, the report shall include the following items provided under the seal and signature of a Professional Engineer, licensed to practice in the Commonwealth and knowledgeable in well construction: a. A site-specific plan and narrative supporting the findings and conclusions reached by the professional geologist (P.G.) for the use of SDW(s). b. Plans and specifications should be provided which clearly demonstrate an understanding of the basis of design and which have been checked collaboratively with the P.G. Refer to Table 1 for Specific Recommendations. c. The plan shall include: 1) All pipes and appurtenant structures related to the SDW. 2) Cross-section(s) through inlet and outlet.

a. Riser/ Flow restrictor

b. Bypass systems for events that exceed the design standard

3) Entire well and surrounding geologic formation, including any karst features.

4) Details of the well casing and surrounding structure, as appropriate.

5) All related water quality BMPs and specifications. (See Section V.)

6) All related rate control BMPs and specifications.

7) Measures taken to protect the SDW and immediate surrounding area during site construction.

8) Detailed Operation and Maintenance (O&M) Plan– including any automated systems (see Well Construction Information).

9) Appropriate access for O&M.

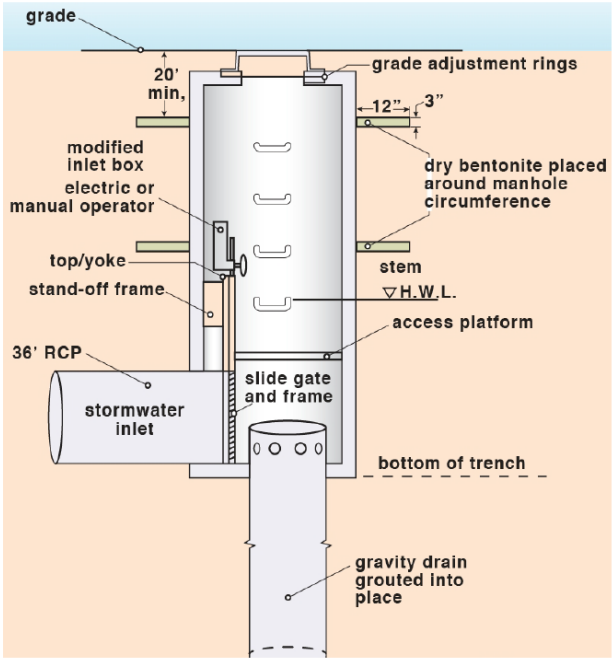


Figure 3. Injection well manhole design

Injection Well Manhole Design

Source: 27th Central PA Geotechnical Conference, Hershey PA April 23-25, 2014.

d. The narrative shall include:

1) SDW(s) design summary and details.

	2) Intended function of SDW (s) as part of overall PCSM Plan. 3) Provide all appropriate calculations regarding functionality of SDW (s) and other supporting BMPs and the ability to manage volume, rate, and water quality as part of overall PCSM Plan. (See Section V –Water Quality Treatment Standards for Stormwater Drainage Wells.) Calculations should include the volume and rate to be accepted by the SDW and the volume/rate that would need to bypass to additional BMPs. 4) Provide pre-development and post-development stormwater runoff quantity and quality analysis which accurately represents the effects of karst loss infiltration when applicable. 5) An assessment of all other BMPs that were considered for rate, volume, and water quality – including Managed Release Concept BMPs. 6) Considerations related to the required Monitoring Program (see below).
Monitoring, Reporting, and Corrective Action	Monitoring is required in accordance with the Monitoring, Reporting and Recordkeeping described in Part A of the Individual NPDES Construction Permit and in accordance with 25 Pa. Code § 92a.61. The following additional measures are necessary when utilizing SDW(s) which will also be reflected in the permit special conditions. a. The Groundwater Monitoring Program will involve two reports: 1. The Groundwater RESPONSE Monitoring Report - To assure the SDW functions as proposed and the volume of stormwater recharge introduced to the aquifer is not having unintended hydrogeologic consequences (e.g. groundwater mounding). This report shall contain the following elements: A. Tabulated groundwater level data (refer to "Groundwater Quality Monitoring" section below). B. Summary of observed responses to recharge events, including groundwater flow and water elevation variations. C. Evaluation of the aquifer capacity to accept the recharge from the storm events observed during the monitoring period. D. If the SDW is shown to have diminished recharge capacity or is not meeting design standards, a

corrective action plan shall be provided as part of the Report, to be reviewed by DEP's RPCO.

2. The Groundwater QUALITY Monitoring Report - To assure groundwater quality is being maintained and not degraded as a result of the stormwater recharge through the SDW. This report shall contain the following elements:

   A. Analytical water quality data from the SDW(s) and surrounding monitoring well(s). Monitoring wells shall be installed downgradient of the identified SDW(s). The number of monitoring wells will be determined during the DEP permitting review based on site-specific conditions. The monitoring well network shall be positioned to intercept the bedrock fracture zone that receives stormwater from the upgradient SDW. The final groundwater sampling requirements will be determined during the DEP permitting review, based on the discharge source areas, but will likely include measurement or analysis of the following:

      Field parameters: Temperature, conductivity, oxidation reduction potential (ORP), pH, turbidity.

      Analytical parameters: Total dissolved solids, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, zinc, total suspended solids, total phosphorus, nitrate-nitrogen, nitrite-nitrogen, iron, nickel, manganese, cyanide, calcium, magnesium, potassium, aluminum, sodium, sulfate, alkalinity, chlorides, benzene, toluene, ethylbenzene, xylenes, total petroleum hydrocarbons, and fecal coliform.

   B. Electronic dataloggers will be installed in the SDW and the monitoring well located directly downgradient having the capability to continuously measure and record the following parameters:

      Water level and water temperature.

   C. At least two (2) baseline samples shall be collected and analyzed prior to the use of the SDW(s). The data from the two (2) baseline samples must be kept for the life of system.

   D. Site map with monitoring well locations, groundwater elevations, and groundwater flow directions shown.

	E. Tabulated and graphical summary of groundwater sampling results, water level, and groundwater temperature results from the dataloggers along with the baseline results. Each report shall include the cumulative results from all sampling. F. An evaluation of the data including trend analysis with a determination of changes and impacts to the groundwater quality resulting from the stormwater recharge, including a determination of whether an adverse impact is projected or existing. G. If there are any projected or existing adverse impacts to groundwater resources, a **corrective action plan** to be reviewed by DEP's RPCO shall be included. b. The permittee/ co-permittee(s) shall develop the Groundwater Monitoring Program <u>prior to construction</u> of the SDW system. The Groundwater Monitoring Program shall be submitted to RPCO for review and approval within the timeframe established in the NPDES permit. c. The permittee/ co-permittee(s) shall submit <u>Groundwater Monitoring Program</u> Reports, both for Groundwater Response and Groundwater Quality, within three (3) months of installation of the first SDW and shall follow the schedule below: ▪ Quarterly monitoring for the first 5 years and semi-annually thereafter. The critical time period will be the first year when the system is being optimized**.** ▪ DEP reserves the right to require more frequent monitoring and/or reporting depending on previous data recovered and any project-specific concerns. The reports shall be signed and sealed by a Professional Geologist, licensed to practice in the Commonwealth and knowledgeable in local geology.

VIII. PERMITS/AUTHORIZATIONS

DEP requires all land development projects proposing one acre or more of earth disturbance to obtain an Individual NPDES Permit for Stormwater Discharges Associated with Construction Activities. Additionally, those projects proposing the use of SDWs need to be covered under an <u>Individual</u> NPDES Permit. The use of an Individual NPDES Permit:

1. Allows DEP to include various special conditions, such as monitoring, which are a normal part of all projects proposing SDWs.
2. Provides for increased compliance inspections by DEP and delegated County Conservation Districts (CCDs) during construction.

3. Helps DEP coordinate the project with other DEP approvals or with other agencies such as EPA.

It is strongly encouraged for the project proponent and their design professional(s) to contact DEP's RPCO to request a project consultation or a pre-application meeting. To maximize the effectiveness of a pre-application meeting, the applicant is encouraged to come prepared to share all geotechnical and hydrogeologic studies/tests that were conducted on the site and how these studies were factored into the proposed development plan. RPCO can be contacted at 717-772-5987 or RA-EPREGIONALPERMIT@pa.gov. Information may also be found on RPCO's webpage at www.dep.pa.gov/RPCO.

The following permits/approvals may be required for projects proposing SDWs:

U.S. EPA:

- Consultation with EPAs UIC Program is highly recommended.
  - EPA Region 3 may determine if the project falls under the permit by rule or if a UIC permit is required. Federal requirements for injection wells can be obtained from the U.S. Environmental Protection Agency, Region III, Source Water Protection Program, 1650 Arch St., Philadelphia, PA 19103, or by calling 215-814-3367.
  - A copy of this permit or other federal approval should be included with the NPDES permit application.
  - As appropriate, DEP's RPCO will coordinate the review and approval of state permits with EPA. Prior coordination with EPA by the applicant would be helpful to DEP's permit review process.

PA DEP:

- An NPDES Individual Permit is required for projects proposing one acre or more of earth disturbance.
  - Due to the nature of the proposed BMP, applicants should submit Attachment 2 (Attachment 2 - Supplementary Geology and Groundwater Information).
  - Any additional or supplemental geologic and hydrogeologic information requested by DEP will need to be submitted.
  - The Individual NPDES permit application will be filed with DEP's RPCO. RPCO will coordinate their permit review with the corresponding CCD. All DEP Permits will be coordinated in accordance with DEP's Policy for Permit Coordination.

Table 3: Supplemental Instructions for Chapter 102 Permit Application

Section	Items
PCSM Plan Design Criteria	• This BMP as part of an overall system satisfies 25 Pa. Code § 102.8 (g)(2) with respect to net change for storms up to and including the 2-year/24-hour storm event when compared to pre-construction runoff volume and water quality. • The plan preparer should indicate if a current and approved Act 167 Plan exists and note if any rate or volume requirements conflict with the MRC guidance.

Calculation and Measurement Data	• The volume that is directly recharged can be reported in PCSM Module 2 and in the Structural BMP table of DEP's PCSM Spreadsheet (Volume Worksheet).
Other	• SDWs, when constructed in accordance with these guidelines, satisfies 25 Pa. Code § 102.8.(h)(2), relating to antidegradation requirements to utilize ABACT if environmental constraints are proven. This is considered a Non-Discharge alternative if the net change for storms up to and including the 2-year/24-hour storm event when compared to pre-construction runoff volume is directly recharged.

- When deemed necessary by DEP, a WQM Permit pursuant to 25 Pa. Code § 91.51(a) (relating to potential pollution resulting from underground disposal) will be required.
    - A WQM Permit may be necessary when extensive treatment is required. In addition, a WQM Permit may be required if the project is of a sufficient size and complexity that it warrants long-term monitoring as well as operation and maintenance. Generally, if a project is (1) small to moderate in size[2], (2) discharges only roof drainage into proposed SDW(s), and (3) incorporates appropriate, site-specific, water quality treatment BMPs, a WQM Permit will not be necessary[3].
    - The WQM Permit application, when deemed necessary, is to be filed with DEP's Bureau of Clean Water. The Individual NPDES application is to be filed with RPCO. A courtesy copy of the WQM permit application should be included with the NPDES permit application.
    - The WQM Permit Application, accompanying report and supporting documentation is to be completed by the Licensed Professional Engineer and Licensed Professional Geologist completing the NPDES permit application.

Other Permits

- The local municipality, including the county, may also require additional permits/authorizations. For instance, projects in the Lehigh Valley may warrant a review from the Lehigh County Planning Commission.

Permit Application and Annual Fees:

A. Both the Individual NPDES Construction Permit and WQM Permit applications will have their normal permit application fees. See pertinent permit application and instructions for more details.

B. The NPDES Permit will remain in effect until a Notice of Termination (NOT) is submitted upon completion of the project and stabilization of the site. The applicant will be responsible to pay an annual fee until the NOT is approved. Since the WQM permit does not terminate, permittees will be responsible to perpetually perform

[2] Less than 1 acre of total impervious cover per each SDW system

[3] If a project necessitates disinfection based on a site-specific analysis, a WQM permit will be required.

operation, maintenance and monitoring and provide regular reports to the office that issued the WQM permit.

Attachment 1

Operations that Should Not Utilize Groundwater Discharge for Stormwater Management

Attachment 2

Supplementary Geology and Groundwater Information for Stormwater Drainage Wells (Word) (PDF)