CHRISTOPHER DENT, P.E
SOUTHEAST STORMWATER ASSOCIATION
2021 ANNUAL CONFERENCE
October 7, 2021

UNDERGROUND DETENTION 101

AN OVERVIEW OF UD WITH A PUBLIC AND PRIVATE PERSPECTIVE

"Water will, increasingly, be detained, stored and then recycled or infiltrated in gardens"

– Tom Turner

UNDERGROUND DETENTION 101

OVERVIEW

I. What is Underground Detention (UD)
   i. Why use UD?
   ii. Different types of UD

II. Basic UD Design Considerations
   i. Designer
   ii. Regulator

III. Current UD Regulations

IV. UD Inspections

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OVERVIEW

I. What do you think of when you think about Underground Detention (UD)?

II. Is it new technology?

III. Is it complicated?

IV. Is it “cookie-cutter”?

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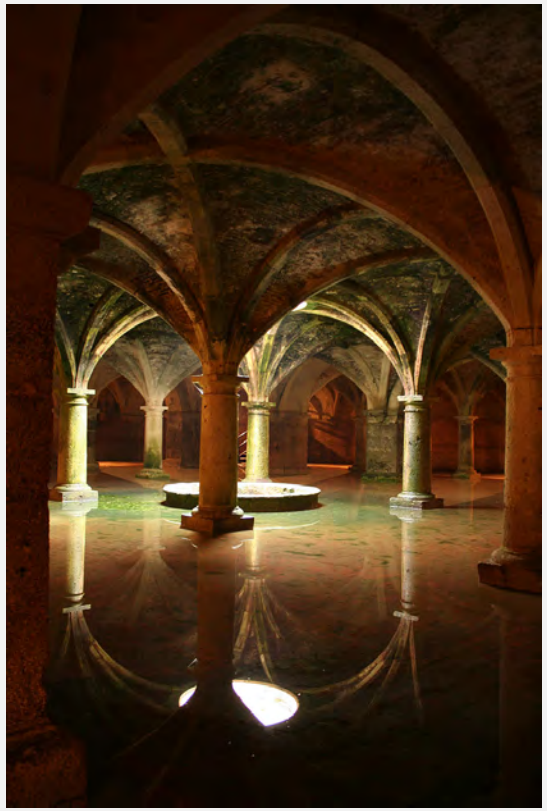
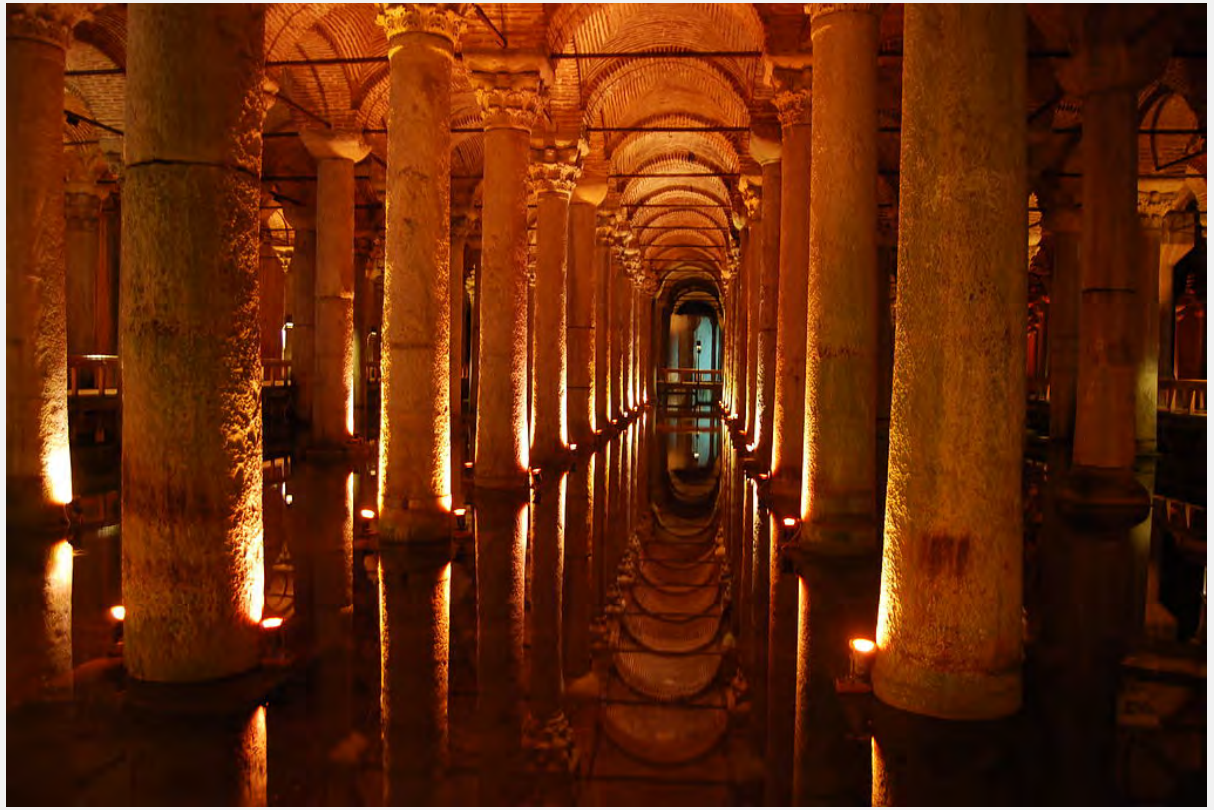
OVERVIEW





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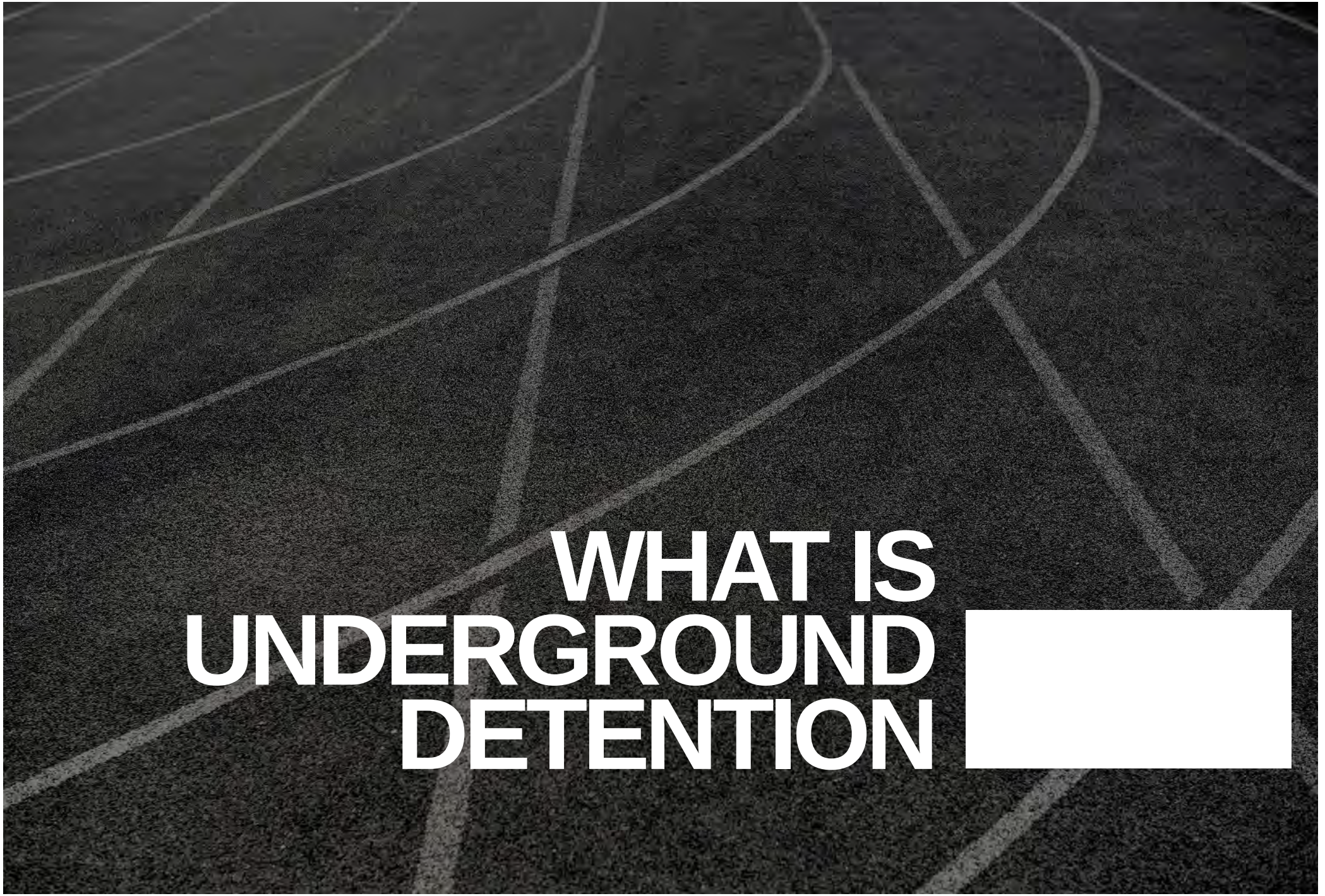

WHAT IS UNDERGROUND DETENTION

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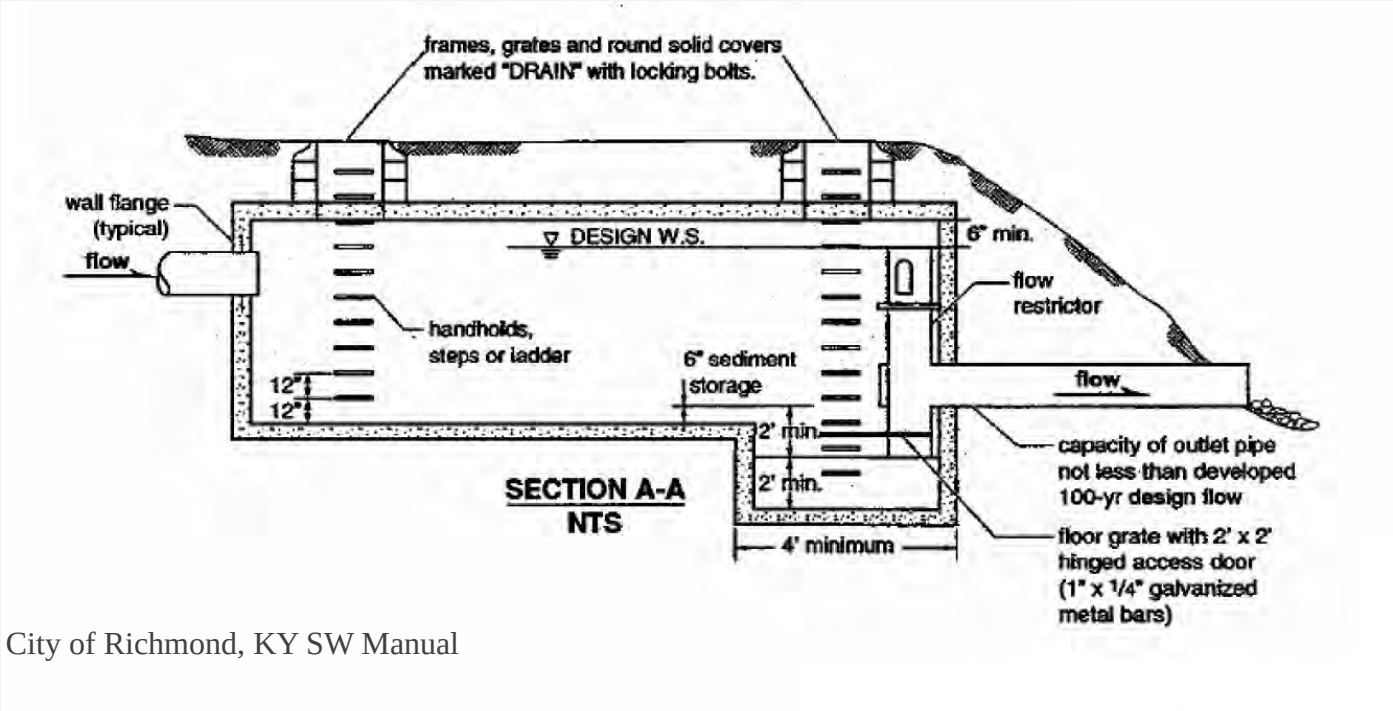
WHAT IS UDERGROUND DETENTION (UD)

A structure used to manage stormwater quantity located underground. These are similar to above ground detention basins in that they store stormwater runoff and release it at a controlled rate. Can be Precast or Cast-In-Place and be made of Concrete, Metal, Plastic, Fiberglass, Natural Materials, etc.



City of Richmond, KY SW Manual

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WHAT IS UDERGROUND DETENTION (UD)

WHY USE UD?

- Limited surface area on site.
- Land Value is greater than cost for UD.
- Surface storage is not appropriate for site (i.e. safety around children, safety in public places, airports, etc.)
- Help meet regulations for infiltration.
- Reuse.

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WHAT IS UNDERGROUND DETENTION (UD)

DIFFERENT TYPES OF UD

- Pipes
- Chambers
- Tanks
- Compartments
- Modular systems
- Natural Materials
- Vaults
- Cisterns

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WHAT IS UNDERGROUND DETENTION (UD)

Ads-pipe.com; stormtrap.com; conteches.com; constructionecoservices.com

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WHAT IS UNDERGROUND DETENTION (UD)

BASIC UD DESIGN CONSIDERATIONS

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BASIC UD DESIGN CONSIDERATIONS

DESIGNER

- Is it worth it for the Owner?
- Location. On the site. Proximity to other features.
- Is infiltration needed? Wanted?
- Overflow size and location.
- What is anticipated to be above the system? What could be above the system?
- Is there anything that could be done now to make future maintenance easier for the owner? I.E. Treatment train, observation/access locations, maintenance vehicles, etc.

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BASIC UD DESIGN CONSIDERATIONS

REGULATOR

- Who will be doing inspections? Maintenance?
- Overflow size and location.
- Where is UD allowable?
- Oversize for Sediment?
- Allowable materials or products?
- Maximum drainage area?
- Pretreatment, required or preferred?
- Who certifies construction and inspections?
- Plans, As-Builts, Reports requirements.

CURRENT UD REGULATIONS

UNDERGROUND DETENTION 101

CURRENT UD REGULATIONS

ALABAMA

- LID Handbook for the State of Alabama - Underground Cisterns as Part of Rainwater Harvesting
- Birmingham Post Construction SW Design Manual – Section 6.17
- Birmingham Property Owner Guide to BMP Maintenance – Section 5.15
- Montgomery Post Construction SW Management Technical Memo March 1, 2020; Form 2C UD Design Form; Form 3C UD As-Built Certification; Form 4C UD Annual Inspection Form

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CURRENT UD REGULATIONS

FLORIDA

- City of Jacksonville Land Development Procedures Manual – No Mention of UD
- City of Orlando Engineering Standards Manual – No Mention of UD
- City of Tampa SW Technical Standards Manual for Private Development – Vaults IV.C.8 & IV.C.9

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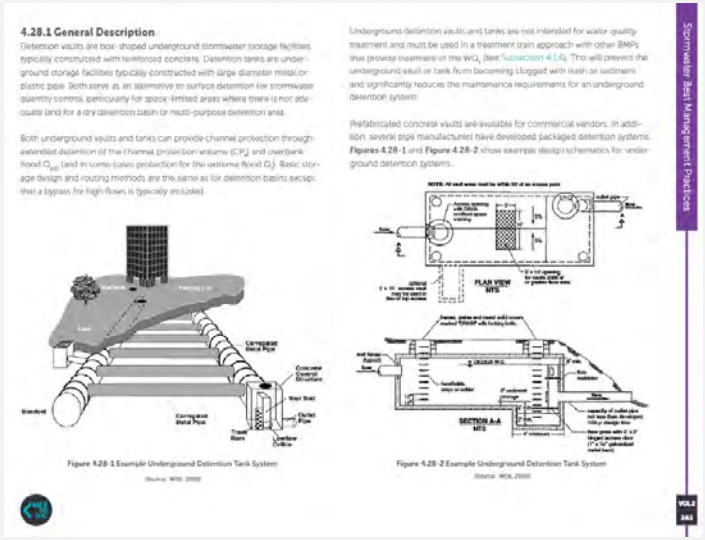
CURRENT UD REGULATIONS

GEORGIA

- Georgia SW Management Manual – Volume 2 (Technical Handbook) Section 4.28
- Coastal Georgia Supplement to the Georgia SW Management Manual – Section 8 “Limited Application Practices”



4.28.1 General Description

Detention vaults are box-shaped underground stormwater storage facilities typically constructed with reinforced concrete. Detention tanks are underground storage facilities typically constructed with large diameter metal or plastic pipe. Both serve as an alternative to surface detention for stormwater quantity control, particularly for space-limited areas where there is not adequate land for a dry detention basin or multi-purpose detention area.

Both underground vaults and tanks can provide channel protection through extended detention of the channel protection volume (CP_v) and overbank flood Q_{p25} (and in some cases protection for the extreme flood Q_f). Basic storage design and routing methods are the same as for detention basins except that a bypass for high flows is typically included.

Underground detention vaults and tanks are not intended for water quality treatment and must be used in a treatment train approach with other BMPs that provide treatment of the WQ_v (see Subsection 4.1.6). This will prevent the underground vault or tank from becoming clogged with trash or sediment and significantly reduces the maintenance requirements for an underground detention system.

Prefabricated concrete vaults are available for commercial vendors. In addition, several pipe manufacturers have developed packaged detention systems. **Figures 4.28-1** and **Figure 4.28-2** show example design schematics for underground detention systems.

Figure 4.28-1 Example Underground Detention Tank System

Figure 4.28-2 Example Underground Detention Tank System

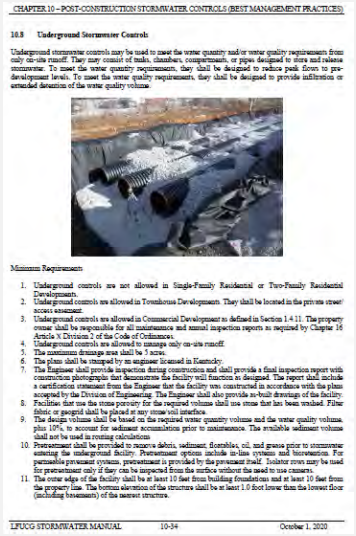
Stormwater Best Management Practices

UNDERGROUND DETENTION 101

CURRENT UD REGULATIONS

KENTUCKY

- Lexington SW Manual – Section 10.8
- Metropolitan Sewer District (MSD) Design Manual (Louisville) – Section 10.3.8.4
- Sanitation District No. 1 SW Best Management Practices Manual – Chapter 7 Subsurface Vault Fact Sheet



CHAPTER 10 – POST-CONSTRUCTION STORMWATER CONTROLS (BEST MANAGEMENT PRACTICES)

10.8 Underground Stormwater Controls

Underground stormwater controls may be used to meet the water quantity and/or water quality requirements from only on-site runoff. They may consist of tanks, chambers, compartments, or pipes designed to store and release stormwater. To meet the water quantity requirements, they shall be designed to reduce peak flows to pre-development levels. To meet the water quality requirements, they shall be designed to provide infiltration or extended detention of the water quality volume.

Minimum Requirements

1. Underground controls are not allowed in Single-Family Residential or Two-Family Residential Developments.
2. Underground controls are allowed in Townhouse Developments. They shall be located in the private street/ access easement.
3. Underground controls are allowed in Commercial Developments as defined in Section 1.4.11. The property owner shall be responsible for all maintenance and annual inspection reports as required by Chapter 16 Article X Division 2 of the Code of Ordinances.
4. Underground controls are allowed to manage only on-site runoff.
5. The maximum drainage area shall be 5 acres.
6. The plans shall be stamped by an engineer licensed in Kentucky.
7. The Engineer shall provide inspection during construction and shall provide a final inspection report with construction photographs that documents the facility will function as designed. The report shall include a certification statement from the Engineer that the facility was constructed in accordance with the plans accepted by the Division of Engineering. The Engineer shall also provide as-built drawings of the facility.
8. Facilities that use the stone porosity for the required volume shall use stone that has been washed. Filter fabric or geogrid shall be placed at any stone/soil interface.
9. The design volume shall be based on the required water quantity volume and the water quality volume, plus 10%, to account for sediment accumulation prior to maintenance. The available sediment volume shall not be used in routing calculations.
10. Pretreatment shall be provided to remove debris, sediment, floatables, oil, and grease prior to stormwater entering the underground facility. Pretreatment options include in-line systems and bioswales. For permeable pavement systems, pretreatment is provided by the pavement itself. Isolator rows may be used for pretreatment only if they can be inspected from the surface without the need to use cameras.
11. The outer edge of the facility shall be at least 10 feet from building foundations and at least 10 feet from the property line. The bottom elevation of the structure shall be at least 1.0 foot lower than the lowest floor (including basement) of the nearest structure.

LFUCG STORMWATER MANUAL 10-34 October 1, 2020

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CURRENT UD REGULATIONS

MISSISSIPPI

- Mississippi Handbook for Erosion Control, Sediment Control and Stormwater Management on Construction Sites and Urban Areas – Volume 2 (SW Management) Chapter 4 Dry Detention Pond Tank Storage
- City of Starkville Standards of Design & Specifications – Chapter 5, Section B.2 Underground Basins

UNDERGROUND DETENTION 101

CURRENT UD REGULATIONS

NORTH CAROLINA

- City of Durham – UD Design Summary Form
- City of Greensboro SW Management Manual – Section 17
- City of Raleigh – UD SCM Design Checklist

DURHAM 1869 CITY OF MEDICINE

City of Durham
Public Works Department
Stormwater Services Divisions
101 City Hall Plaza, Durham, North Carolina, 27701
Telephone (919) 560-4326 FAX (919) 560-4316

Underground Detention Design Summary

Stormwater Management Construction Plan Review:
A complete stormwater management construction plan submittal includes a design summary for each stormwater BMP, design calculations, plans and specifications showing BMP, inlet and outlet structure details.

I. PROJECT INFORMATION

Project Name: _____ Phase _____
PIN: _____ Case #: _____
Design Contact Person: _____ Phone #: (___) ___-_____
Legal Name of Owner: _____
Owner Contact: _____ Phone #: (___) ___-_____
Owner Address: _____
Deed Book _____ Page # _____ or Plat Book _____ Page# _____ for BMP Property
For projects with multiple basins, specify which pond this worksheet applies to: _____
Detention provided for: ☐ 1-year ☐ 2-year ☐ 10-year ☐ other _____

Elevations

Bottom elevation	_____ ft.	*(invert out elevation of system)*
1-year storm orifice/weir elevation	_____ ft.	*(invert elevation)*
1-year storm water surface elevation	_____ ft.	*(elevation at the outlet of system)*
2-year storm orifice/weir elevation	_____ ft.	*(invert elevation)*
2-year storm water surface elevation	_____ ft.	*(elevation at the outlet of system)*
10-year storm orifice/weir elevation	_____ ft.	*(invert elevation)*
10-year storm water surface elevation	_____ ft.	*(elevation at the outlet of system)*
Emergency spillway elevation	_____ ft.	*(invert of emergency spillway)*
Ground Surface Elevation	_____ ft.	*(elevation of ground above outlet)*
Maximum Water Surface Elevation (___-year storm)	_____ ft.	*(elevation at the outlet of system)*

Areas

Drainage area	_____ ac.	*(total drainage to the facility)*

Volumes

Total Storage Volume Provided	_____ ft³	*(volume detained at design storm)*

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CURRENT UD REGULATIONS

SOUTH CAROLINA

- SC DHEC SW Management BMP Handbook – UD Systems
- Southern Lowcountry SW Design Manual – Section 4.11
- City of Charleston SW Design Standards Manual – Section 3.3
- City of Columbia Best Management Practice Design Manual – Section 3.1.2 & 3.2.3
- Greenville County SW Management Design Manual – Section 7.1

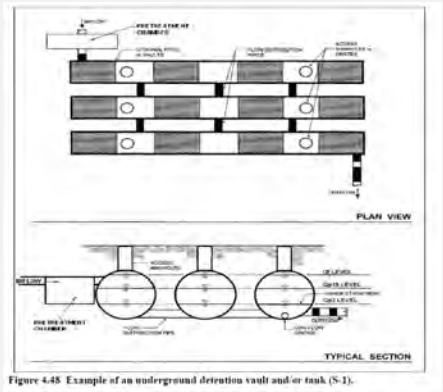

Figure 4.48 Example of an underground detention vault and/or tank (S-1).

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CURRENT UD REGULATIONS

TENNESSEE

- Tennessee Permanent SW Management and Design Guidance Manual – Section 5.4.12
- Knox County SW Management Manual – Section 4.4.6
- Metropolitan Government Nashville and Davidson County Low Impact Development Stormwater Management Manual – Volume 5 GIP-10 Cisterns

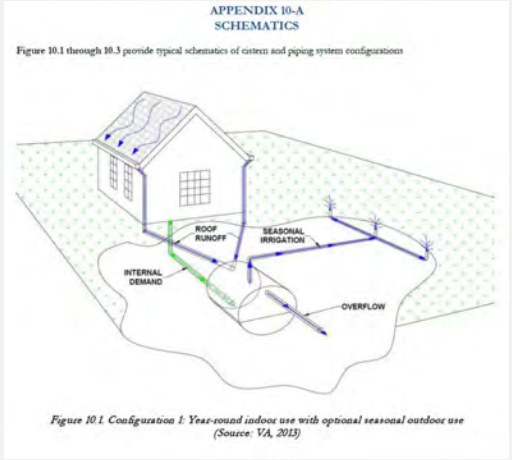
APPENDIX 10-A
SCHEMATICS

Figure 10.1 through 10.3 provide typical schematics of cistern and piping system configurations

Figure 10.1. Configuration 1: Year-round indoor use with optional seasonal outdoor use (Source: VA, 2013)


4.4.6 Underground Detention

Limited Application Stormwater BMP

Description: Detention storage located in underground pipe systems or vaults designed to provide water quantity control through detention and/or extended detention of storm-water runoff.

KEY CONSIDERATIONS

DESIGN GUIDELINES:
- Maximum drainage area = 25 acres
- Maximum drainage area = 1 acre for structures passing the $Q_{P_{10}}$
- Access point for maintenance required.
- Used downstream of a water quality BMP.

ADVANTAGES / BENEFITS:
- To be used for space-limited applications only.
- Good for retrofitting small urbanized lots.
- Concrete vaults or pipe systems can be used.
- Longevity is high, with proper maintenance.

DISADVANTAGES / LIMITATIONS:
- Discouraged unless other options unfeasible.
- Controls for stormwater quantity only – not intended to provide water quality treatment.
- Dissolved pollutants are not removed.
- Frequent maintenance required.

MAINTENANCE REQUIREMENTS:
- Remove debris from inlet and outlet structures
- Monitor sediment accumulation
- Clean out sediment and floatable debris using catch basin cleaning equipment (vacuum pumps).

STORMWATER MANAGEMENT SUITABILITY

☐	Water Quality
☑	Channel Flood Protection
☑	Overbank Flood Protection
★	Extreme Flood Protection

★ in certain situations

FEASIBILITY CONSIDERATIONS

H-H	Land Requirement
H-H	Capital Cost
H-H	Maintenance Burden

Residential/Subdivision Use: No

Drainage Area: 25 acres maximum, 1 acre maximum for $Q_{P_{10}}$

Soils: *Not dependent upon soil type*

POLLUTANT REMOVAL

L	Total Suspended Solids
L	Nutrients: Total Phosphorus / Total Nitrogen
L	Metals: Cadmium, Copper, Lead, and Zinc
L	Pathogens: Coliform, Streptococci, E.Coli

L=Low M=Moderate H=High

UD INSPECTIONS

UNDERGROUND DETENTION 101

UD INSPECTIONS

https://www.youtube.com/watch?v=_C4onQG3ViY

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UD INSPECTIONS

THINGS TO CONSIDER

- Where is it? Are there Plans?
- Can you get access? Confined Space Entry?
- What are the surface conditions?
- What are the downstream conditions?
- Are there any defects observed?
- Sediment/trash amounts and locations?
- When did it last rain? What is the current weather?
- Is it holding water?
- Has anything changed from last inspection?

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UD INSPECTIONS

Where is the UD?

Surface condition?

UNDERGROUND DETENTION 101

UD INSPECTIONS

Where is the UD?

Surface condition?

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UD INSPECTIONS

Where is the UD?

Surface condition?

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UD INSPECTIONS

Can you get access?

Control Structure?

UNDERGROUND DETENTION 101

UD INSPECTIONS

Can you get access?

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UD INSPECTIONS

Can you get access?

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UD INSPECTIONS

Can you get access?

Control Structure?

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UD INSPECTIONS

Control Structure?

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UD INSPECTIONS

Are any defects observed?

Sediment/trash?

UNDERGROUND DETENTION 101

UD INSPECTIONS

Are any defects observed?

Sediment/trash?

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UD INSPECTIONS

Are any defects observed?

Sediment/trash?

Control Structure?

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UD INSPECTIONS

When did it last rain?

Is it holding water?

Sediment/trash?

UNDERGROUND DETENTION 101

UD INSPECTIONS

Is it holding water?

Sediment/trash?

Treatment train?

UNDERGROUND DETENTION 101

UD INSPECTIONS

When did it last rain?

Is it holding water?

Sediment/trash?

Treatment train?

UNDERGROUND DETENTION 101

QUESTIONS

"Do unto those downstream
as you would have those upstream
do unto you."
– Wendall Berry

QUESTIONS?

THANK YOU

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