

# Underdrain, Storm Sewer & Infiltration



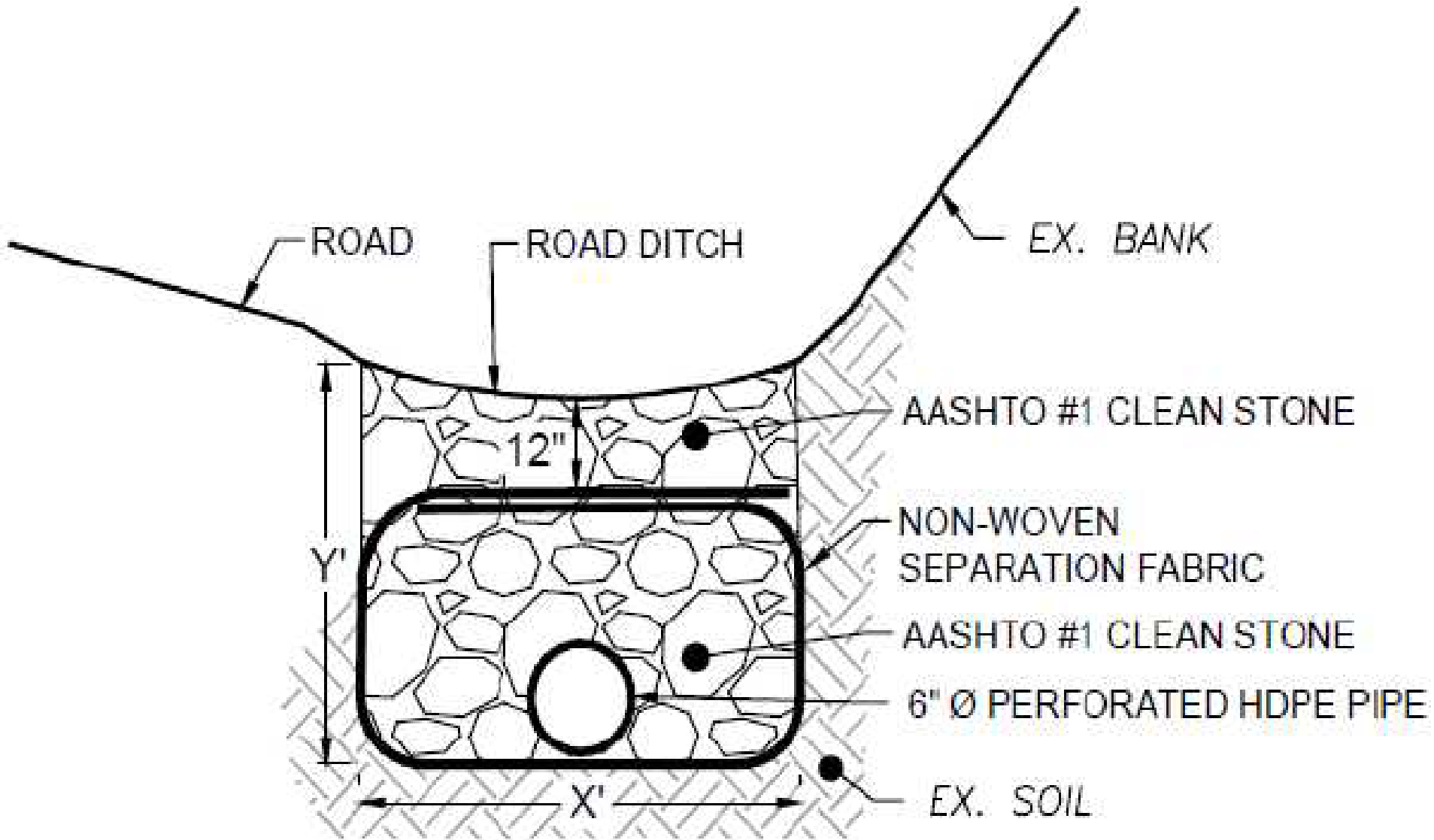


- **Underdrain**
  - **Carries:** groundwater
  - **Requires:** slope/fall to carry water
  - **Outlets:** on the surface
  
- **Storm sewer**
  - **Carries:** surface water underground
  - **Requires:** slope/fall to carry water
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- **Infiltration practices**
  - **Carries:** surface water underground
  - **Requires:** flat bottom and correct site conditions to achieve infiltration
  - **Outlets:** underground via infiltration
    - With a surface overflow

# **Underdrain, Storm Sewer & Infiltration**

- **Underdrains**
- **Storm Sewer**
- **Infiltration – Structural BMPs**

# Underdrains



CROSS-SECTION VIEW



When TO USE:

Groundwater!!!!

- Saturated road bases
- Perpetually wet ditches and banks



WHERE ROADS ARE CONSISTENTLY WET FROM GROUNDWATER WATER.



**Use where ground water issues are affecting the road.**



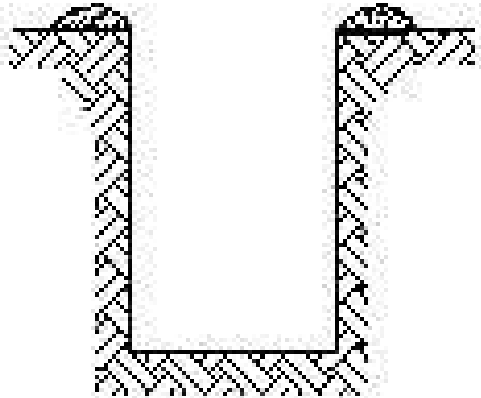


**Example Project #1: Exposed Underdrain**

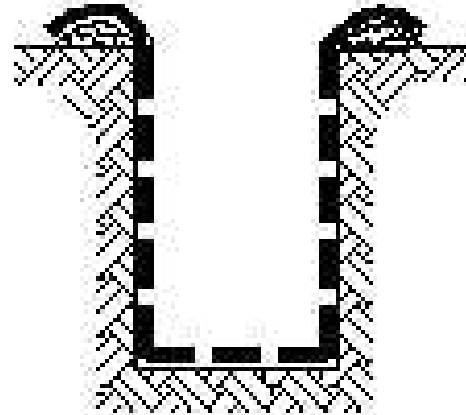




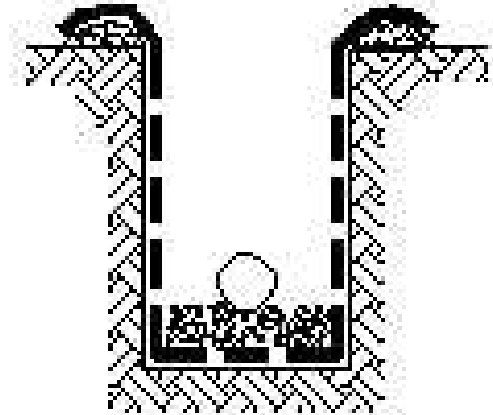
## Constructed Stone Underdrain



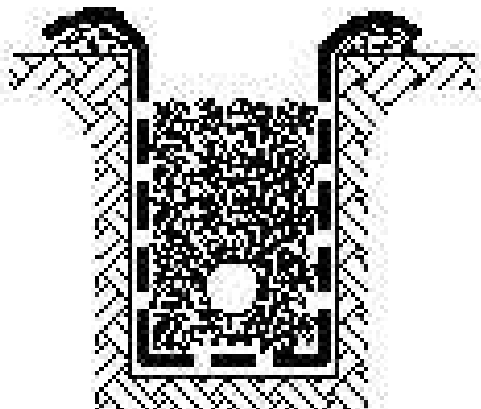
1. Excavate Trench



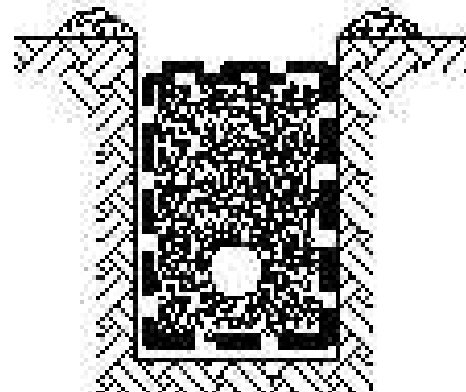
2. Place Geo-textile



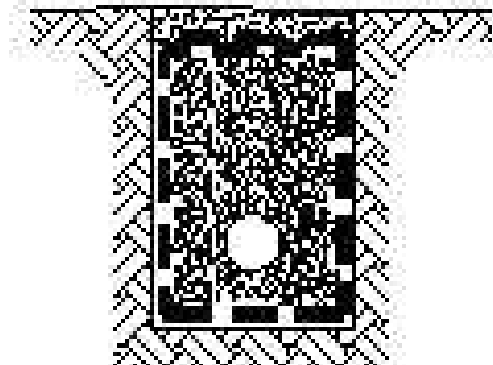
3. Add pipe and clean fill



4. Add clean fill



5. Wrap and overlap geo-textile



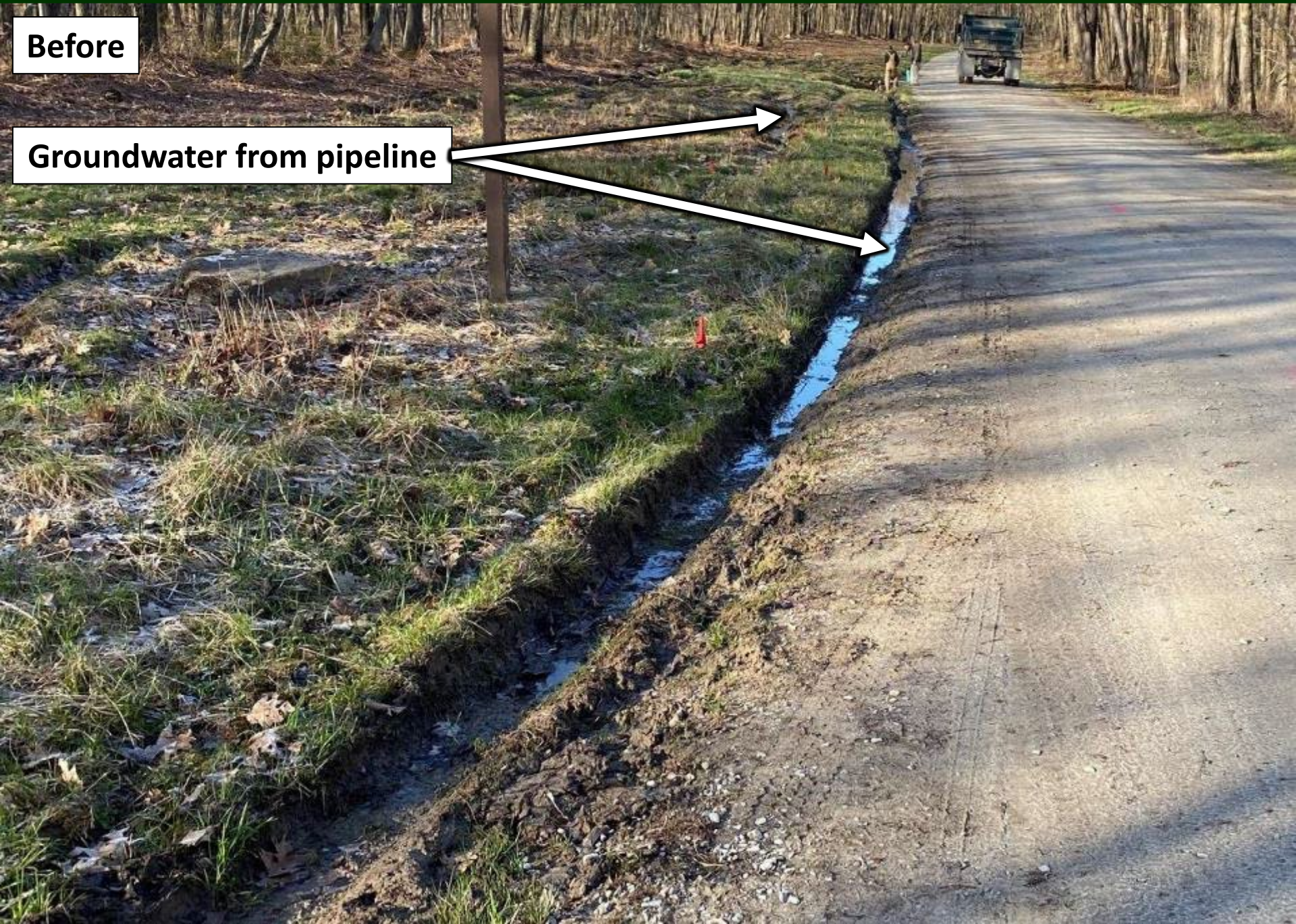
6. Cover geo-textile



# Underdrains

Before

Groundwater from pipeline





**During**

**Underdrain excavation**

**Ensure trench has positive drainage. Use Laser Level!**



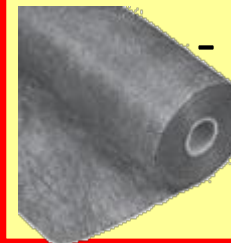


During

Non-Woven Fabric & Perforated Pipe Placement



**Non-Woven Fabric**



- separates  
- filters



During

AASHTO #1 Stone Backfill





During

AASHTO #1 Stone Backfill

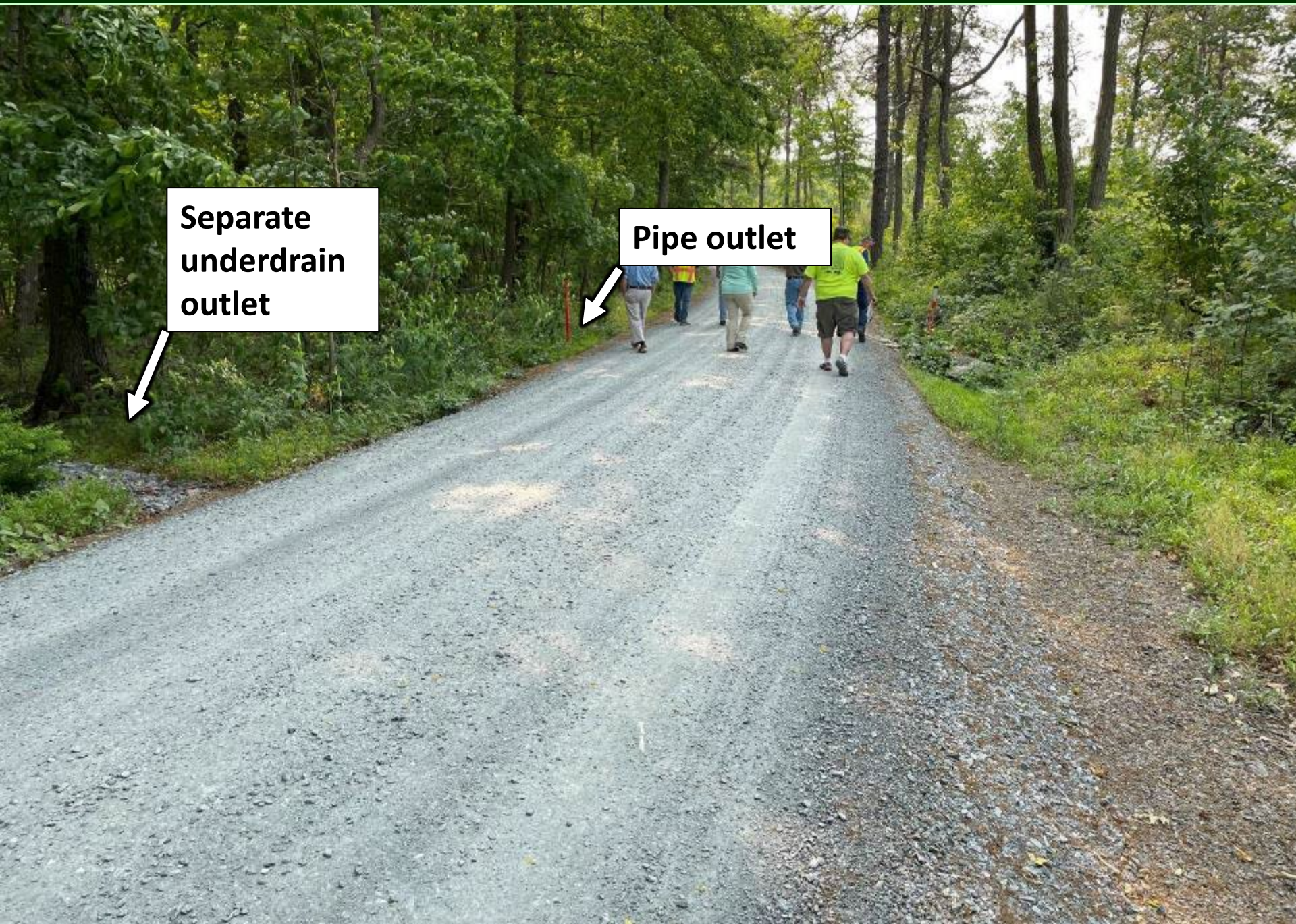




After







**Separate  
underdrain  
outlet**

**Pipe outlet**



Close up of separate underdrain outlet  
Looking from road





**Close up of separate underdrain outlet  
Facing road**





**Solid Pipe at Outfall.**

- Solid pipe prevents crushing
- Critter guards





**During**

# Example Project #2: Buried Underdrain



**Clean Stone**

**Perforated Pipe**

**Wet ditch from seep**



**During**

**Topsoil w/ Seeding & Mulching.  
Maintain ditch shape/profile.**





After



08/22/2017 09:52



**Considerations:****FROM ESM TRAINING**

- Use clean stone (with no fines) – AASHTO 1 a good choice
- Small stone (such as 2A) that is exposed at surface is prone to washouts and clogging.
- Cover with min 1' material – avoid reusing ditch spoils
- Use caution installing on slopes – often not needed here
- Use constructed stone underdrains wrapped in non-woven geofabric (use of fabric may be local decision)
- Outlet separately from ditch drainage when possible
- Easy to add underdrain with little effort in fill jobs



**FROM ESM TRAINING**

When **NOT TO USE:**

- For stormwater runoff.
- Where surface runoff has not been addressed.
- **As storm sewer systems to convey surface runoff.**





Lack of Outlets / Long Runs





- **Not for Surface Water Runoff!**
- **Underdrains are not Storm Sewer Systems**
- **Lack of Outlets / Long Runs**



**If ditch stabilization is needed ensure that rock lining is large enough to stay in place.**



**If ditch stabilization is needed ensure that rock lining is large enough to stay in place.**



- Large rock to prevent erosion.
- Ditch shape was maintained.



**Why are underdrains not suitable for storm water?**



# Underdrains





- Lack of Ditch Outlets.
- AASHTO #1 is not riprap.
- Utilize riprap if needed.

Surface runoff can expose underdrains.





## Underdrains

**Sediment can close off underdrain & shorten effective life span.**





**Maintain ditch shape and capacity over underdrains.**





## **UNDERDRAINS ARE NOT STORM SEWER SYSTEMS!**

- **Use underdrains to address groundwater.**
- **Use ditch and/or storm sewers to capture and convey storm water runoff.**
- **Maintain ditch shape and capacity to convey stormwater flows.**
- **If adequate outlets are not available, then evaluate use of storm sewer systems and/or rock lined ditches.**

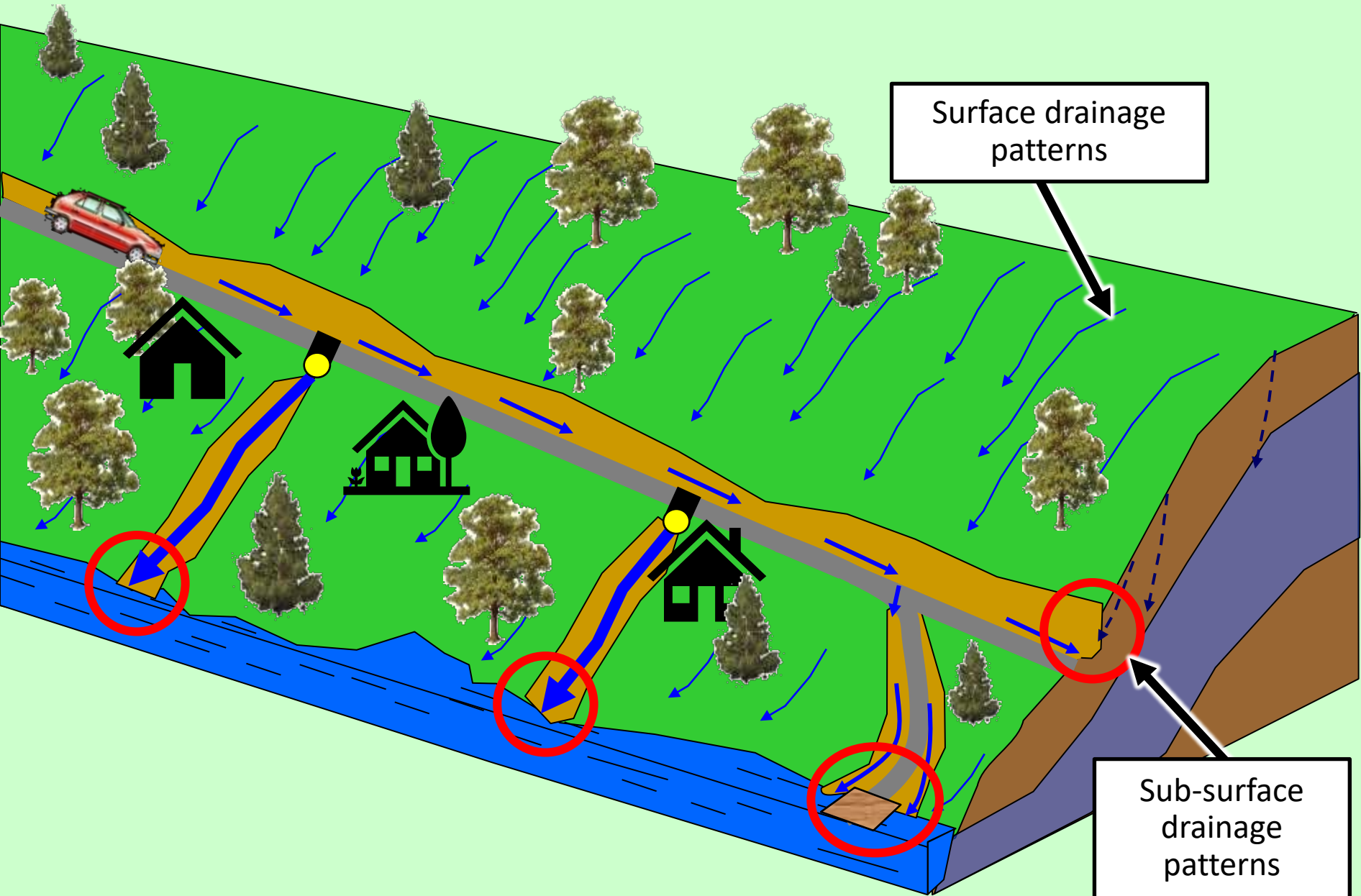


# Underdrain, Storm Sewer & Infiltration

- Underdrains
- **Storm Sewer**
- Infiltration – Structural BMPs



Existing Conditions - residential



Surface drainage patterns

Sub-surface drainage patterns



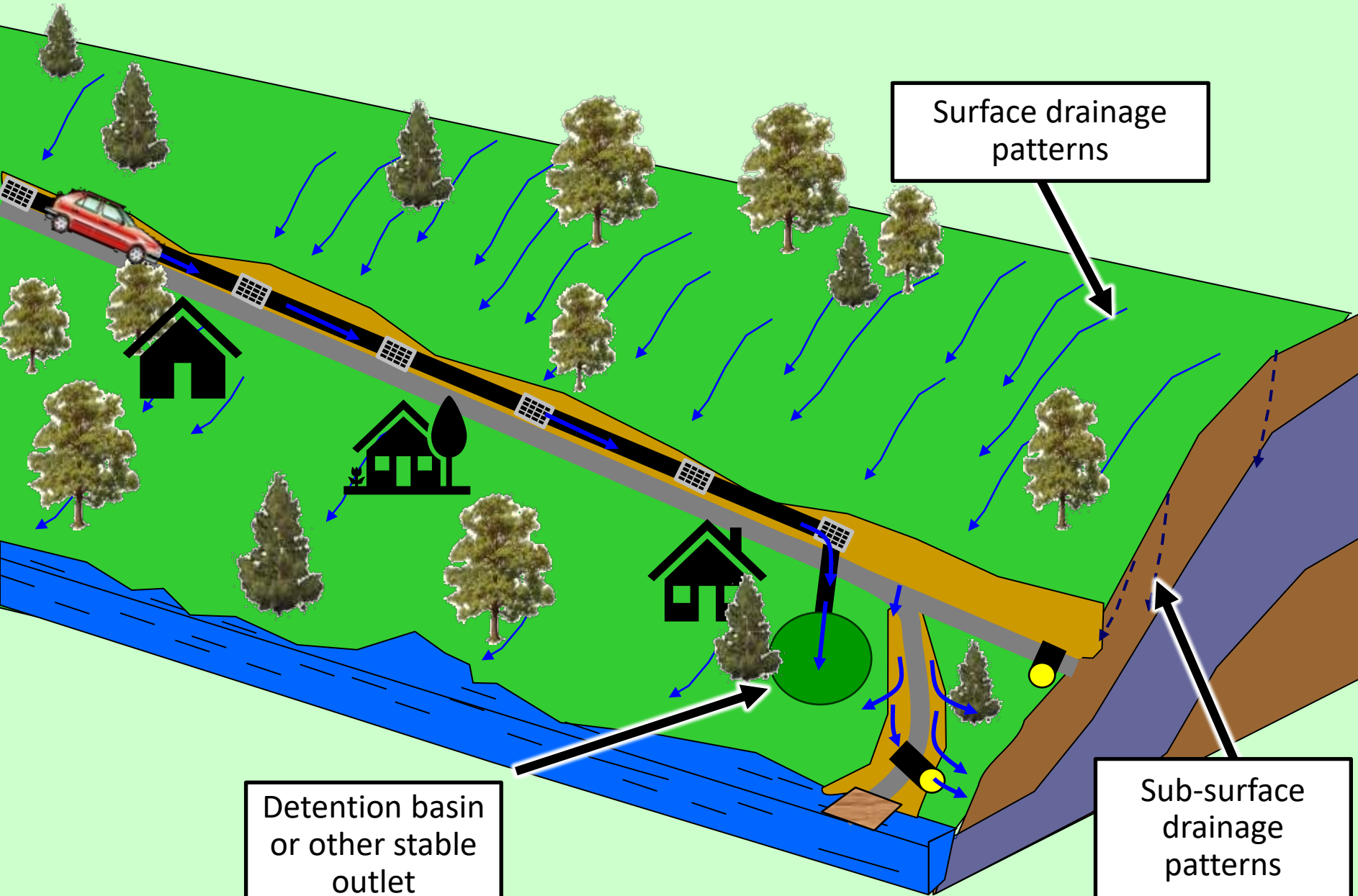
# Storm Sewer

Add storm sewer

Surface drainage patterns

Detention basin or other stable outlet

Sub-surface drainage patterns





## Considerations:

- **Will the storm sewer reduce sediment impacts?**
- **Consider when:**
  - **Outlet opportunities are limited.**
  - **Ditches are unstable due to excessive runoff.**
  - **Open ditches or cross pipes are not feasible in residential or urban settings.**
- **Consider grass swales over storm sewers.**
- **Where will the system outlet?**
- **How will the outlet location be stabilized?**



Montgomery County

Webber Road

\$24,000 Grant, \$2,000 in kind

## Problems:

- Excessive surface flow
- Nowhere to outlet water

## Practices Used:

- Small storm sewer
- Widened grass-lines swale







**BEFORE**

## 2016 LVR Project

Montgomery County, Webber Road

**\$24K Spent, \$2K in kind**

### ESMs Used:

- Small storm sewer
- Widened grass-lined swale

**Constant ditch washouts,  
erosion into yards**



**BEFORE**

**2016 LVR Project**

Montgomery County, Webber Road

**\$24K Spent, \$2K in kind**

**ESMs Used:**

- Small storm sewer
- Widened grass-lined swale

**Yards drain to road.  
Nowhere to outlet water**

02.24.2016 01:31



**BEFORE**



## 2016 LVR Project

Montgomery County, Webber Road

**\$24K Spent, \$2K in kind**

### ESMs Used:

- Small storm sewer
- Widened grass-lined swale

**Constant ditch washouts,  
erosion into yards**



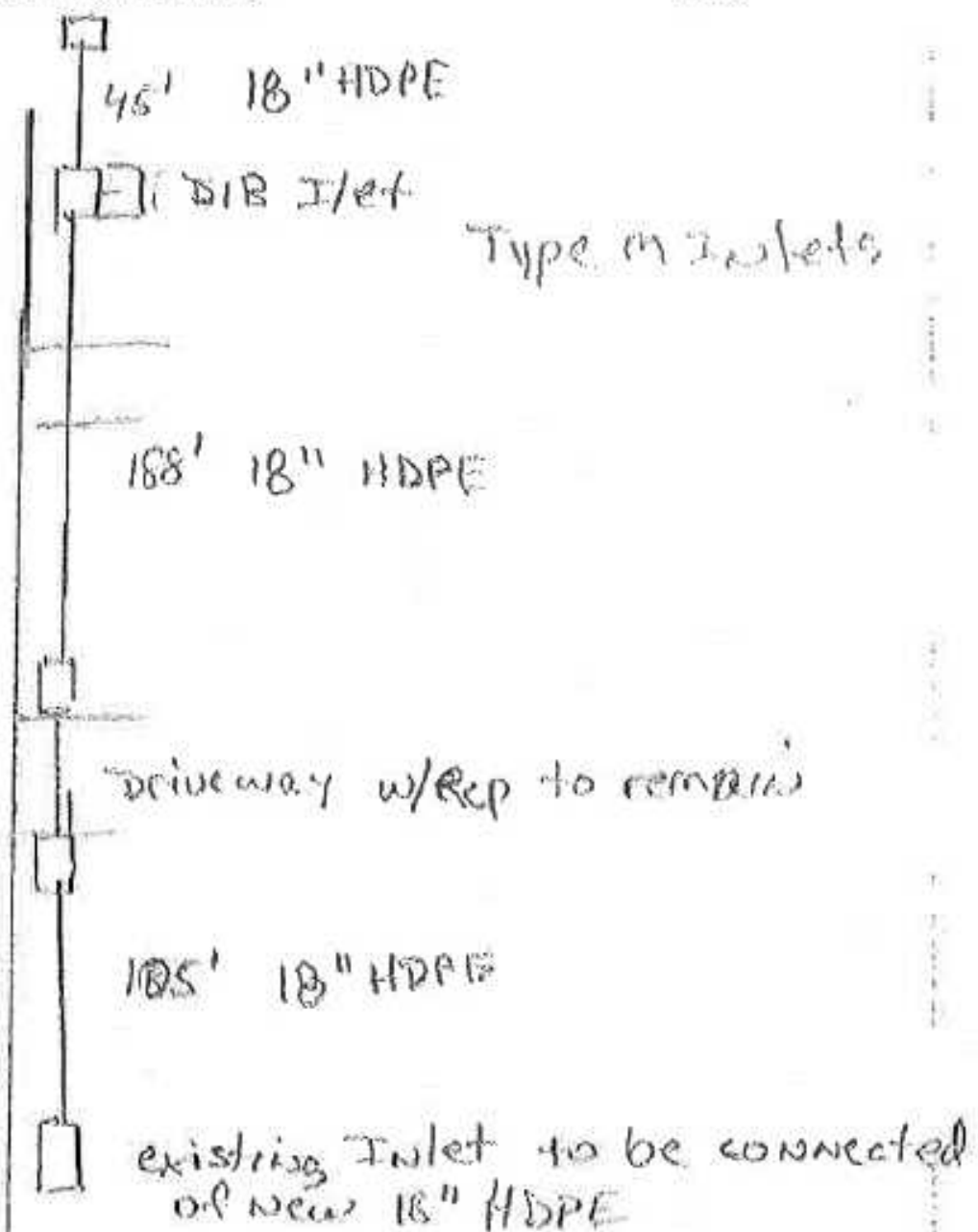
Applicant

Road Name / ID Num

Date

From Grant Application

Webber Road





AFTER

## 2016 LVR Project

Montgomery County, Webber Road

**\$24K Spent, \$2K in kind**

### ESMs Used:

- Small storm sewer
- Widened grass-lined swale

- Short storm sewer
- Widened grass swale





AFTER

## 2016 LVR Project

Montgomery County, Webber Road

**\$24K Spent, \$2K in kind**

### ESMs Used:

- Small storm sewer
- Widened grass-lined swale

- Short storm sewer
- Widened grass swale

05.24.2016 21:45



AFTER

## 2016 LVR Project

Montgomery County, Webber Road

**\$24K Spent, \$2K in kind**

### ESMs Used:

- Small storm sewer
- Widened grass-lined swale

- Short storm sewer
- Widened grass swale

05.24.2016 21:43



AFTER

## 2016 LVR Project

Montgomery County, Webber Road

**\$24K Spent, \$2K in kind**

### ESMs Used:

- Small storm sewer
- Widened grass-lined swale



- Off-ROW drainage to storm sewer
- Widened grass swale



AFTER

## 2016 LVR Project

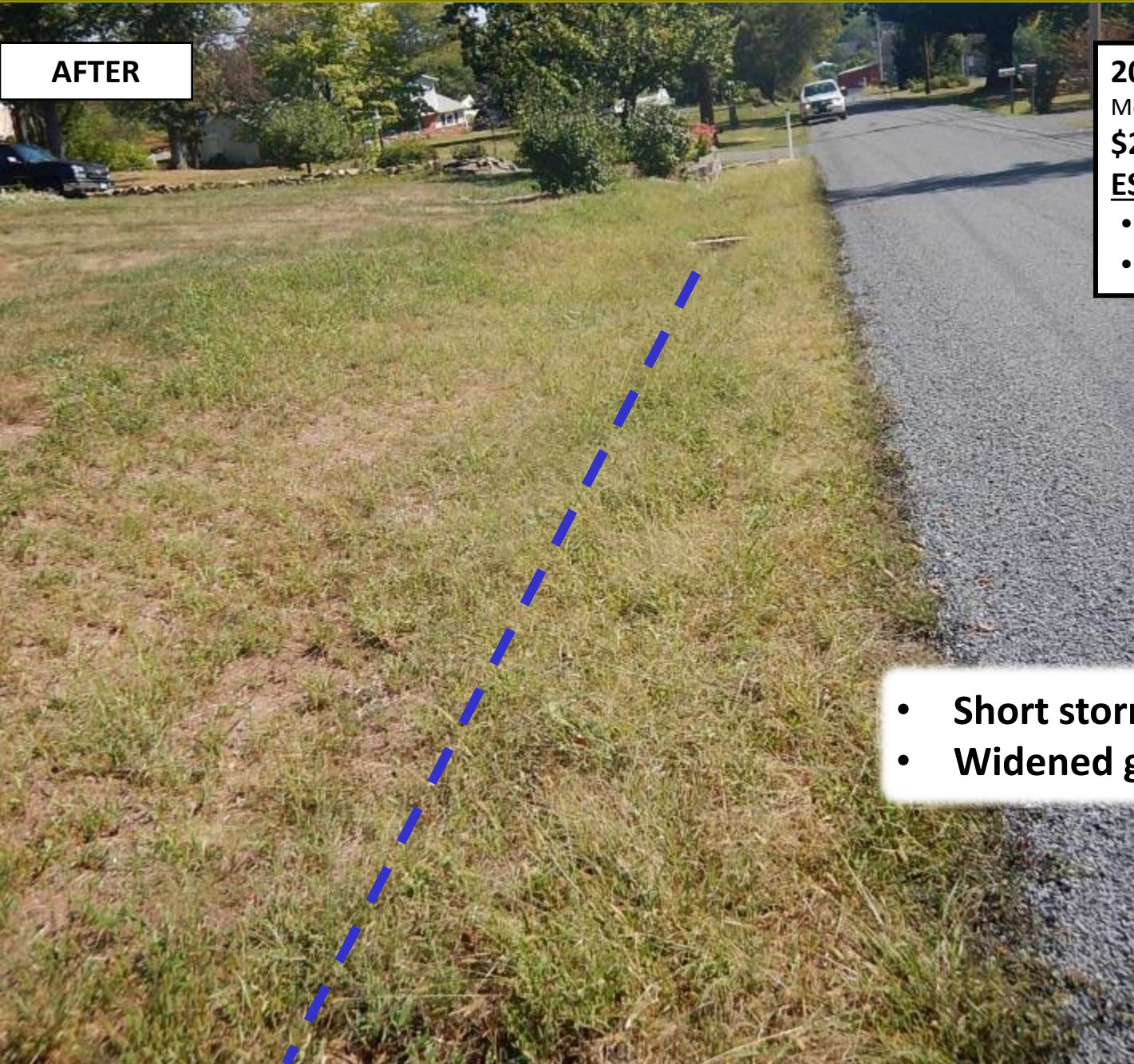
Montgomery County, Webber Road

**\$24K Spent, \$2K in kind**

### ESMs Used:

- Small storm sewer
- Widened grass-lined swale

- Short storm sewer
- Widened grass swale







**BEFORE**



**AFTER**

## **2016 LVR Project**

Montgomery County, Webber Road

**\$24K Spent, \$2K in kind**

### **ESMs Used:**

- Small storm sewer
- Widened grass-lined swale



Pike County

Bartleson Road

\$99,000 Grant, \$17,000 in kind

## Problems:

- Excessive surface flow from small development
- Flow erodes roadside ditch
- Flow enters stream at bottom of hill.

## Practices Used:

- Storm Sewer
- Energy Dissipater at Outlets
- Reduce Flow Lengths



After



**Before**



**Constant ditch washouts,  
erosion into yards**



**Before**

**Existing pipe outlet was unstable and required constant maintenance.**





**Before**

**Ditch drained directly  
to stream.**





After



**Inlet boxes located at intersection to capture flow.**



# PROJECT SPOTLIGHT

## Bartleson Road, Pike County

After

Multiple inlets & cross pipes to reduce flow lengths & break up flow volumes at





After

A total of 4 separate “teardrop” basins were constructed for the outlets of 5 different pipes.





After

A total of 4 separate “teardrop” basins were constructed for the outlets of 5 different pipes.





## Underdrain

- Carries groundwater underground
- Outlets on surface

## Storm sewer

- Carries surface water underground
- Outlets on surface



## **What if groundwater impacts where you want to install storm sewer?**

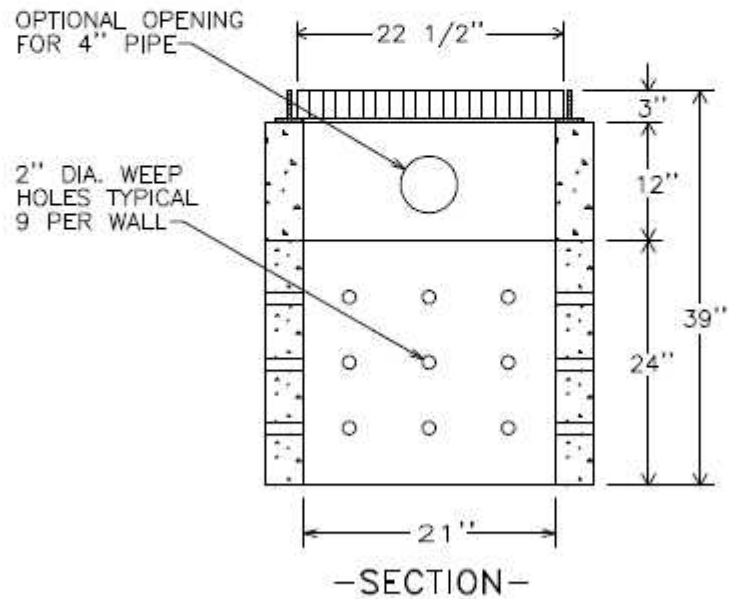
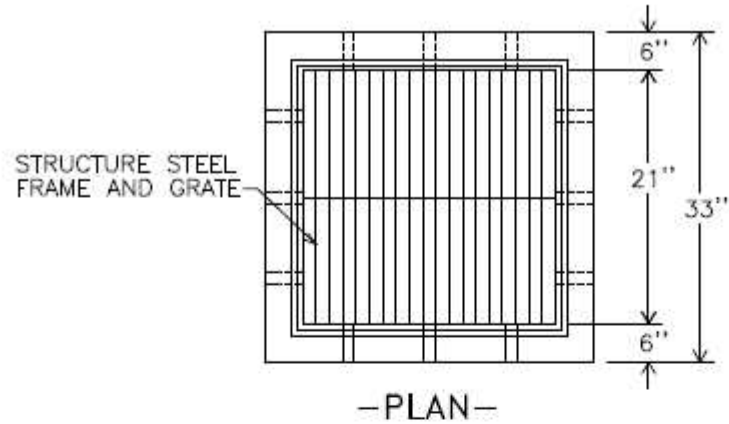
- **Can surface and groundwater be separated?**
- **Underdrains can be installed in conjunction with Storm Sewers.**
  - **Install underdrain to address groundwater issues and install storm sewer to convey storm water.**
- **Seek as many outlets as possible and ensure outlets are stabilized.**
- **Perforated storm sewer can collect both surface and groundwater.**
  - **Use and installation based on project goals**
    - **Infiltration vs. Capture**



## **CONSIDERATIONS for perforated storm sewer:**

- **Size appropriately for the volume of water being carried.**
- **Bed/backfill in clean stone .**
- **Wrap pipe and stone in non-woven geotextile fabric.**
- **Consider perforated inlet boxes for infiltration projects.**





21" X 21" PRECAST CONCRETE  
LEACHING BOX

DWG. LR-3



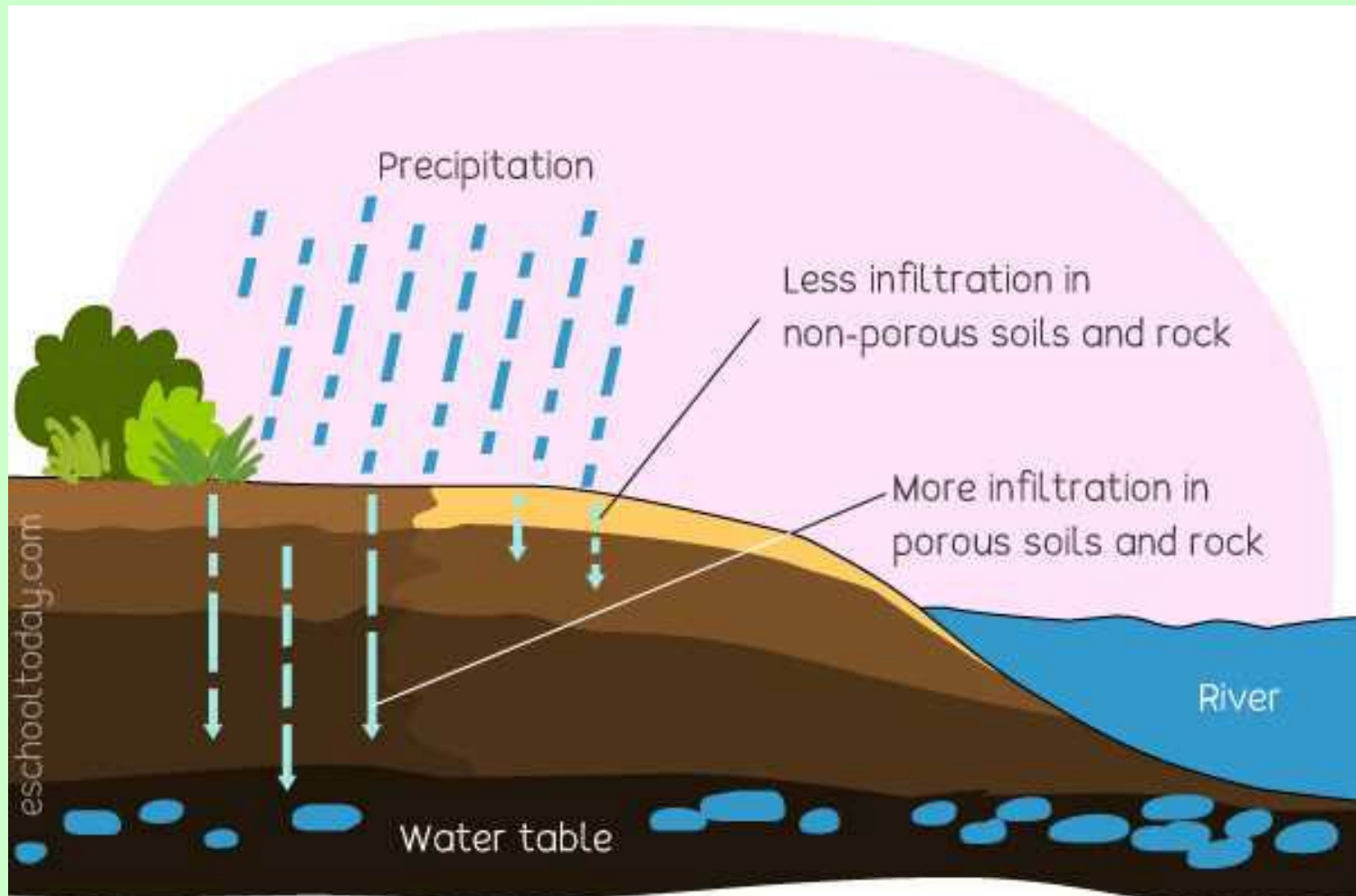
# Underdrain, Storm Sewer & Infiltration

- Underdrains
- Storm Sewer
- **Infiltration – Structural BMPs**



# Infiltration - Water moving downward into the space between soil particles.

- **Structural infiltration BMPs can be used when storm water is collected and conveyed to a single location.**





## Site Evaluation

- Soil Type(s) – soil mapping, wetlands, drainage
- Slopes
- Hydrology, Drainage Patterns
- Buildings
- Aerial Photographs
  - Area evaluation

Is the site suitable  
for infiltration???





## Infiltration Design

- **Size based upon infiltration rate**
- **Structure design should include the following:**
  - **Level Bottom**
  - **Uncompacted Bottom / Amended Soils**
  - **Limit Water Depth**
  - **Drawdown time**
  - **Positive Overflow**
  - **Flow path:**
    - **Will flow re-concentrate?**
    - **Is permission required for discharge?**



# Infiltration Basins





Rain Garden



07/31/2023



Rain Garden



07/31/2023



# Rain Garden Basins



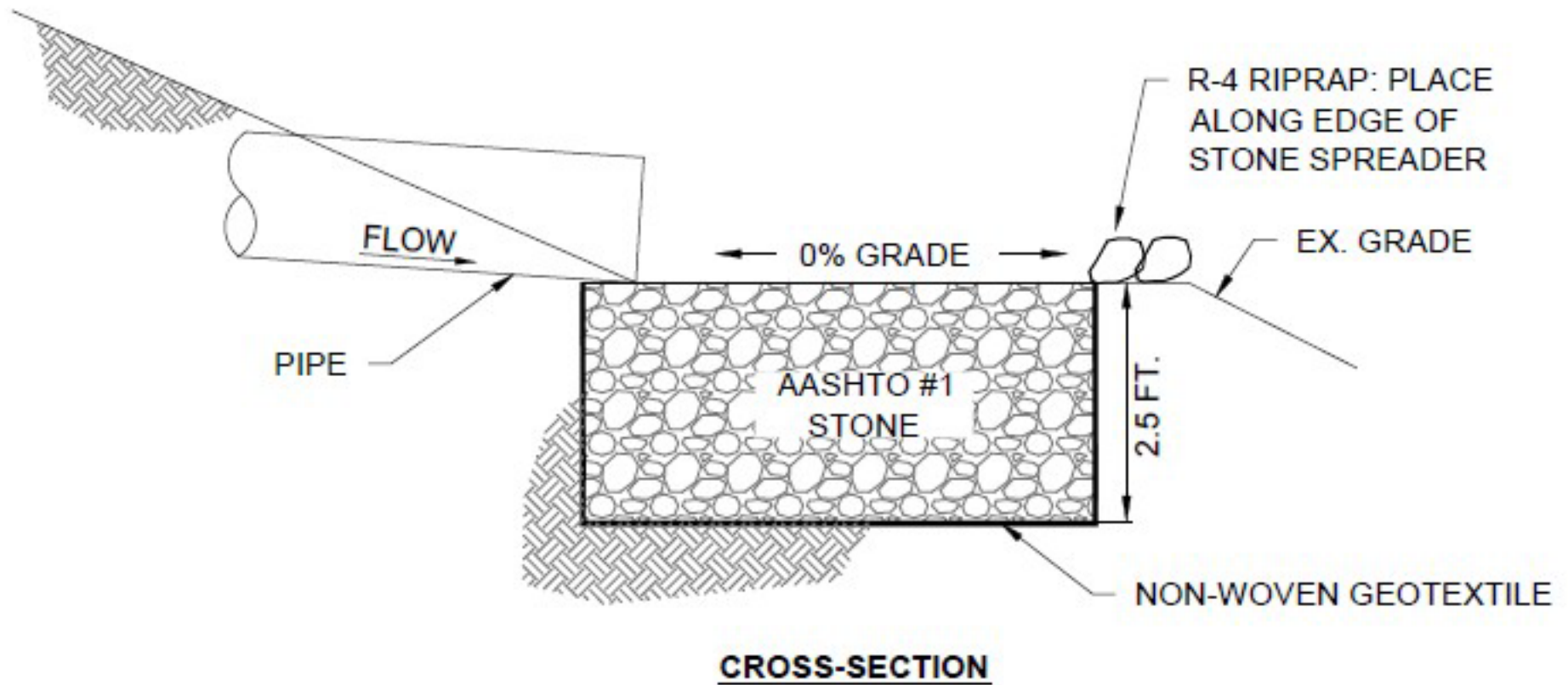


**Bioretention Swales**





# Infiltration Sump





**Infiltration Sump**



**3' Deep, filled w/ R4 and edged with pallet stone.**



# PROJECT SPOTLIGHT

BEFORE

Dauphin County

Penbrook Borough

31<sup>st</sup> Street

\$93,019 Spent, \$10,126 In-Kind

## Problems:

- 2.8 ac. drainage enters alley
- Failed storm inlets
- Eroding roadway & outlet
- Discharges to Spring Creek

## Practices Used:

- Infiltration
- Retention
- Stabilized outlet





# 31<sup>st</sup> & Charles Street, Penbrook Borough



Project Site

© 2016 Google

Charles St  
Google earth

Imagery Date: 4/15/2018 1993

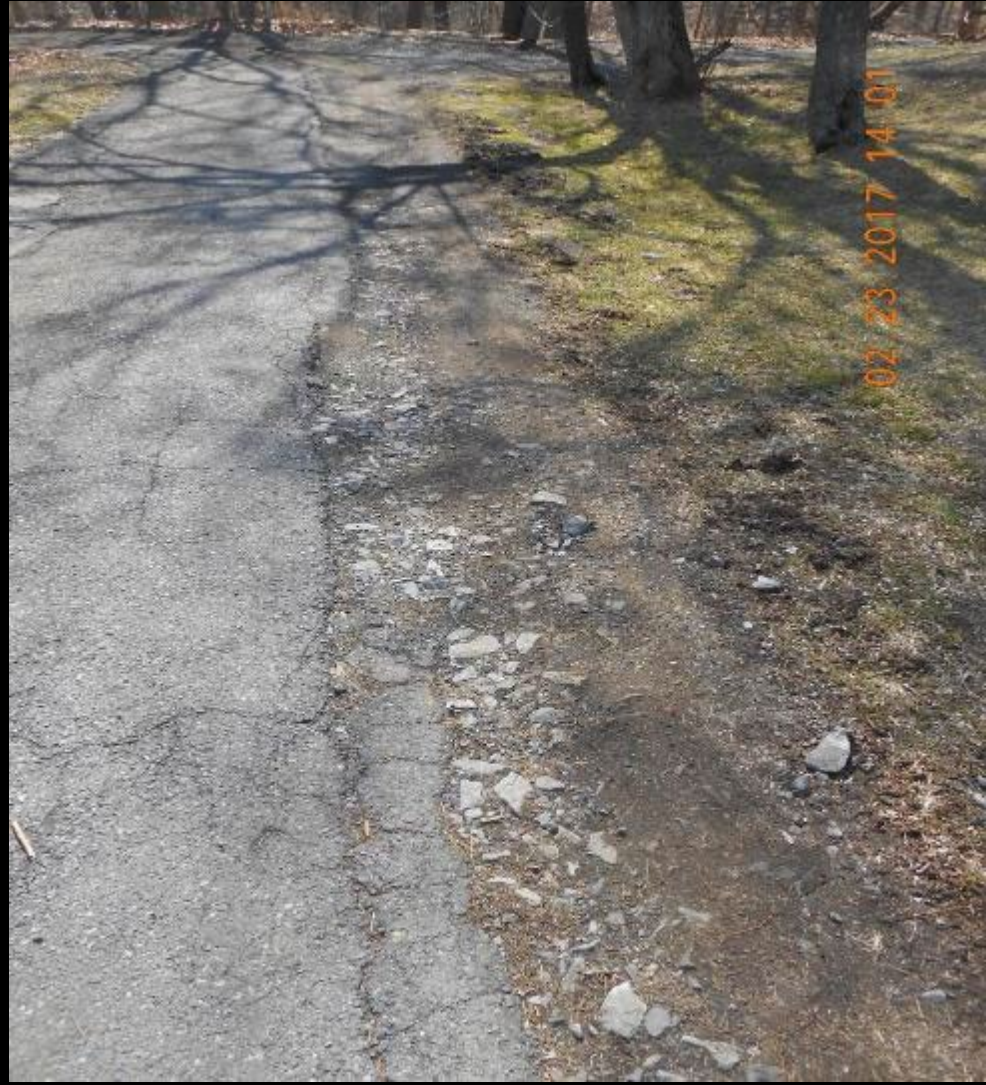
40°18'24.41" N 78°50'30.20" W elev 459 ft

Eye alt 899 ft







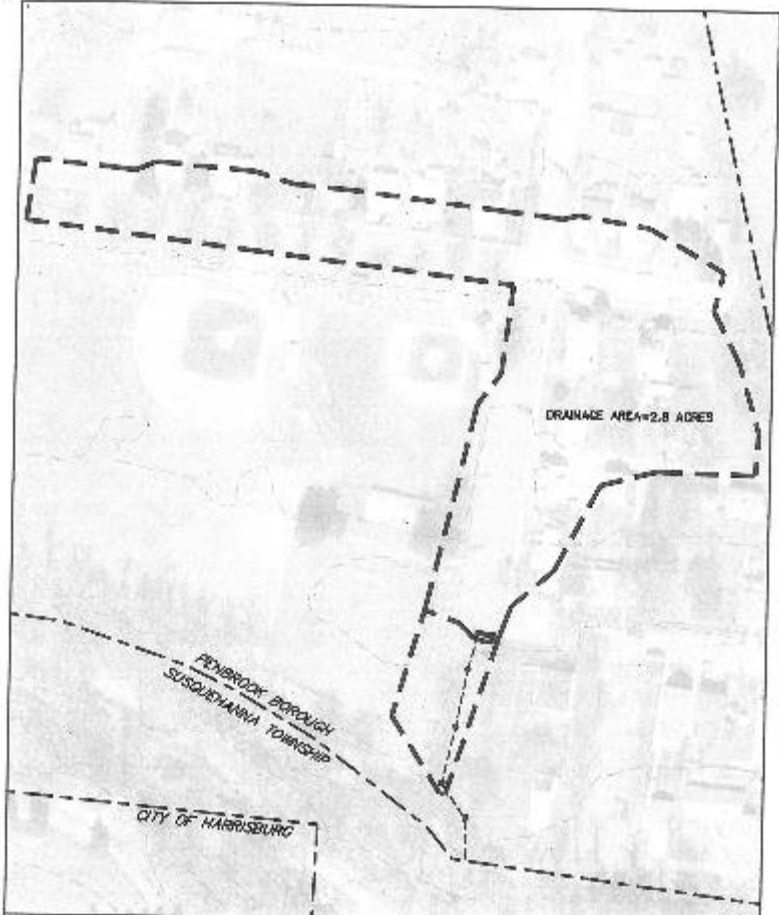








b



DRAINAGE AREA=2.8 ACRES

FENBROOK BOROUGH  
SUSQUEHANNA TOWNSHIP

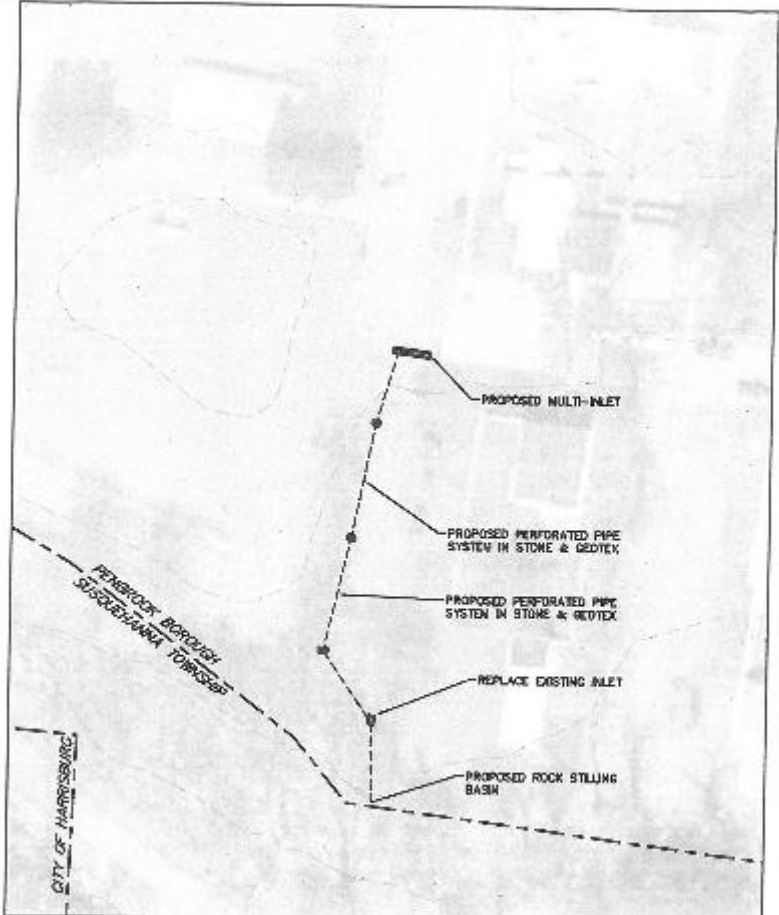
CITY OF HARRISBURG

SKETCH PLAN  
S. 31st ST. & CHARLES ST.  
DRAINAGE IMPROVEMENTS  
FENBROOK BOROUGH      WILKIN CO.



DRAWN BY: JES  
DATE: 10/26/18  
SCALE: 1"=50'  
DWG. NO. 181442005-2018

b



PROPOSED MULTI-INLET

PROPOSED PERFORATED PIPE  
SYSTEM IN STONE & GEOTEX

PROPOSED PERFORATED PIPE  
SYSTEM IN STONE & GEOTEX

REPLACE EXISTING INLET

PROPOSED ROCK STILLING  
BASIN

FENBROOK BOROUGH  
SUSQUEHANNA TOWNSHIP

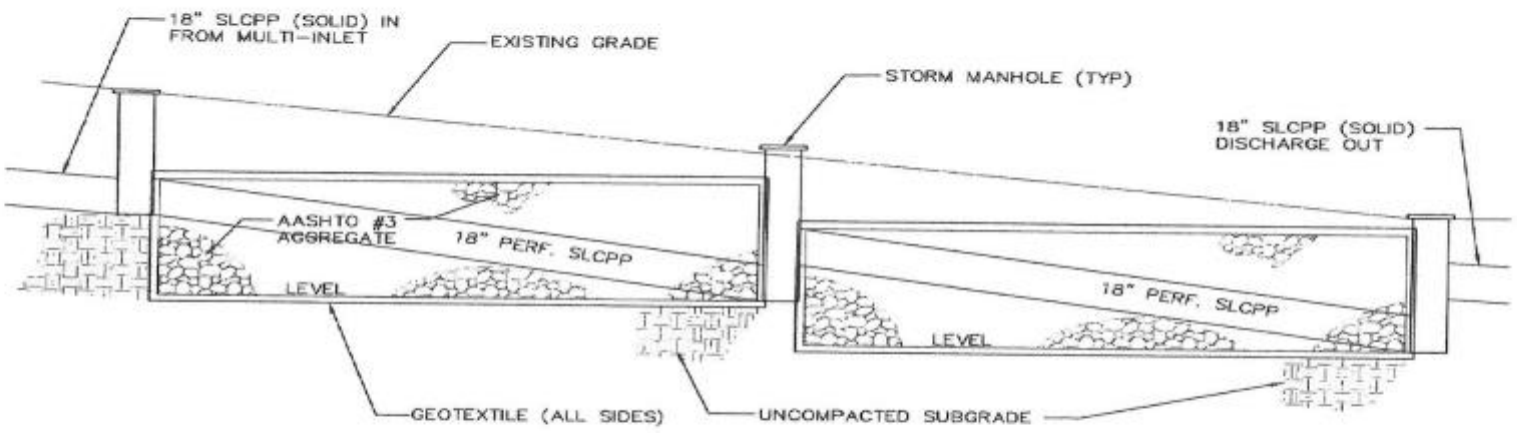
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FENBROOK BOROUGH      WILKIN CO.



DRAWN BY: JES  
DATE: 10/26/18  
SCALE: 1"=50'  
DWG. NO. 181442005-2018





**SUBSURFACE INFILTRATION BMP**

NOT TO SCALE  
SD\SD080

SKETCH PLAN  
S. 31st ST. & CHARLES ST.  
**DRAINAGE IMPROVEMENTS**  
PENNSYLVANIA BOROUGH  
DAUPHIN CO.



DRAWN BY: JJS  
DATE: 10/05/16  
SCALE: NTS  
DWG. NO. 011442000-2016















- **When NOT to use infiltration practices:**
  - **When site conditions limit infiltration:**
    - Clay soils
    - Shallow Bedrock
    - Saturated soils – spring seeps, wetlands, etc.
    - Houses, septic systems, utilities may be impacted.
    - Infiltration in the upslope ditch may saturate road base
  - **When no one can maintain the practice.**
  - **If the practice will be outside the right-of-way and:**
    - Written permission is not obtained.
    - Off-ROW practices that are **35% or more of the project cost** or **500+ ft outside the ROW** require SCC permission



- **Underdrain**
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# Technical Bulletin: Underdrains, Storm Sewers & Infiltration

Compares Underdrain vs. Storm Sewers & Infiltration

<https://dirtandgravel.psu.edu/general-resources/technical-bulletins/>



**PURPOSE:** To identify the basics of underdrains, infiltration practices, and storm sewers, and to identify common issues and confusions often seen between them.

- **UNDERDRAINS:** Collect and convey GROUNDWATER from springs and seeps to dry out the roadbed. Consist of buried perforated pipe (typically 4" or 6"), usually wrapped in clean stone and fabric.
- **STORM SEWER:** Collect and convey SURFACE water from precipitation runoff to a stable outlet. Consist of buried solid pipe with inlets for surface runoff.
- **INFILTRATION PRACTICES:** Receive SURFACE water and promote infiltration into groundwater. Wide variety such as bioretention swales, infiltration basins, green alleys, rain gardens, etc.

See pages 2-4 for details on the three specific practices.

## Common Issues and misunderstandings when using Underdrain, Storm Sewers & Infiltration practices:

- **Using underdrain for surface runoff:** Underdrains are designed to handle small subsurface springs and seeps. These underground flows are typically consistent and clean. Surface runoff is much more variable and contains sediment and other debris. When surface runoff is directed into underdrains, the higher flows and debris load can often cause underdrains to either clog, washout, or both (*Photo #1*).
- **Trying to infiltrate in the road ditch:** Attempting to infiltrate water in roadside ditches, especially the uphill road ditch, can create base





# Technical Bulletin: Underdrains

## Underdrain construction

<https://dirtandgravel.psu.edu/general-resources/technical-bulletins/>

### Technical Bulletin

## Underdrains



12/2023



**UNDERDRAIN** – A drainage feature installed underground to collect groundwater and transport it to a stable surface outlet. Underdrains can be used in several road drainage applications and can be sized for specific flow volumes. Underdrains are bedded in clean stone and usually wrapped in geotextile fabric to allow water to enter the conduit while keeping sediment out.

#### HOW DO UNDERDRAINS WORK?

An underdrain is designed to collect groundwater before it saturates the road surface or the road ditch. By intercepting springs and groundwater, underdrains can help to dry and stabilize the road base, road ditches, and banks that would otherwise be softened by emerging springs and seeps. Underdrains also help to reduce erosive surface flow in the road ditch and prevent groundwater water from mixing with sediment-laden surface runoff. The clean water collected by an underdrain can be directed to a stable outlet location separate from road surface drainage.



**Photo 1:** The ditch was always wet from roadside springs. This underdrain will collect spring flow to keep the roadbed and ditch dry.



**Questions? Discussion?**





## 5-Year Spending Update

- All funding from agreement must be spent out by 6/30/24
- Current CD Status as of 2/13/2024
  - Spent everything: 23 DGR, 20 LVR
  - Committed everything: 24 DGR, 29 LVR
  - Not committed: 17 DGR, 17 LVR



## 5-Year Spending Update - Financials

- **Dirt and Gravel**
  - **Committed: \$4,279,904.22**
  - **Not Committed: \$484,442.34**
- **Low Volume**
  - **Committed: \$2,842,816.66**
  - **Not Committed: \$867,122.70**
- **Total**
  - **DGR: \$4,764,346.56**
  - **LVR: \$3,709,939.36**
  - **Total: \$8,474,285.92**



## Question:

How do I know how much I need to spend to meet my spending requirements?

## Answer:

This information is available in the GIS.

Previous 5-Year Agreement	
"Old Money" Balance: \$	286,990.64
Currently Spent: \$	38,127.38
Balance Remaining: \$	248,863.26

Previous 5-Year Agreement	
"Old Money" Balance: \$	393,512.50
Currently Spent: \$	0.00
Balance Remaining: \$	393,512.50



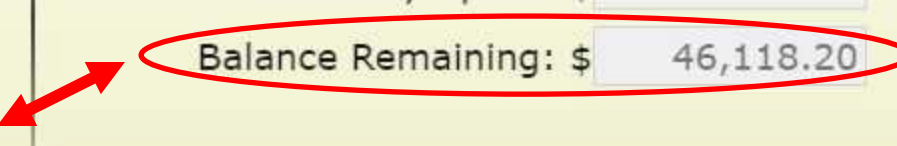
**Question:**

How do I know if I have all my “old money” contracted?

**Answer:**

If your Committed Remaining is greater than the Balance Remaining.

Spending Status	Previous 5-Year Agreement
Unreported Advance: \$ 0.00	"Old Money" Balance: \$ 46,118.20
Unreported Replenishments: \$ 0.00	Currently Spent: \$ 0.00
Current Balance: \$ 146,534.97	Balance Remaining: \$ 46,118.20
Committed Remaining: \$ 115,986.74	
Uncommitted Balance: \$ 30,548.23	





**Question:**

How do I know if I still have “old money” to contract?

**Answer:**

If your Committed Remaining is less than the Balance Remaining.

Spending Status	Previous 5-Year Agreement
Unreported Advance: \$ <input type="text" value="0.00"/>	"Old Money" Balance: \$ <input type="text" value="4,443.13"/>
Unreported Replenishments: \$ <input type="text" value="0.00"/>	Currently Spent: \$ <input type="text" value="0.00"/>
Current Balance: \$ <input type="text" value="51,121.09"/>	<b>Balance Remaining: \$ <input type="text" value="4,443.13"/></b>
<b>Committed Remaining: \$ <input type="text" value="0.00"/></b>	
Uncommitted Balance: \$ <input type="text" value="51,121.09"/>	



## 5-Year Spending Update

- If you are **Green** in both DGR and LVR, great job!
- If you are **Yellow** or **Red** in DGR and/or LVR, expect follow-up status calls/emails.