

Environmentally Sensitive Maintenance for Dirt, Gravel, and Low-Volume Roads



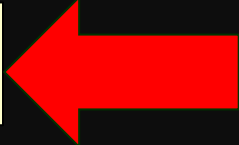
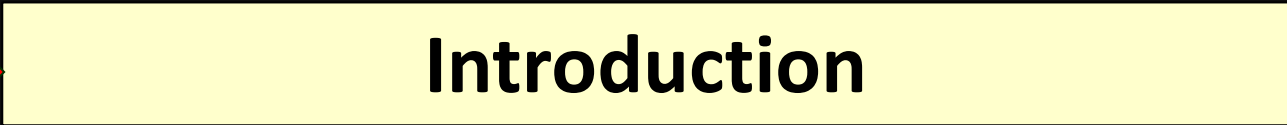
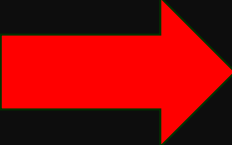
Road Base



Purpose:

- **Understand factors that affect road base stability**
- **Identify symptoms of an unstable road base**
- **Consider ESM alternatives to correct road base problems**

Road Base



Introduction

**Traditional Road Maintenance
Practices**

**Environmentally Sensitive
Maintenance Practices**

The most important part of a building is the part you can't see. Roads are the same.



The most important part of a building is the part you can't see. Roads are the same.



Road Base: Introduction



- Impossible to properly maintain the road surface if underlying problems are the cause.
- Surface irregularities hold water & further degrade the surface and base.

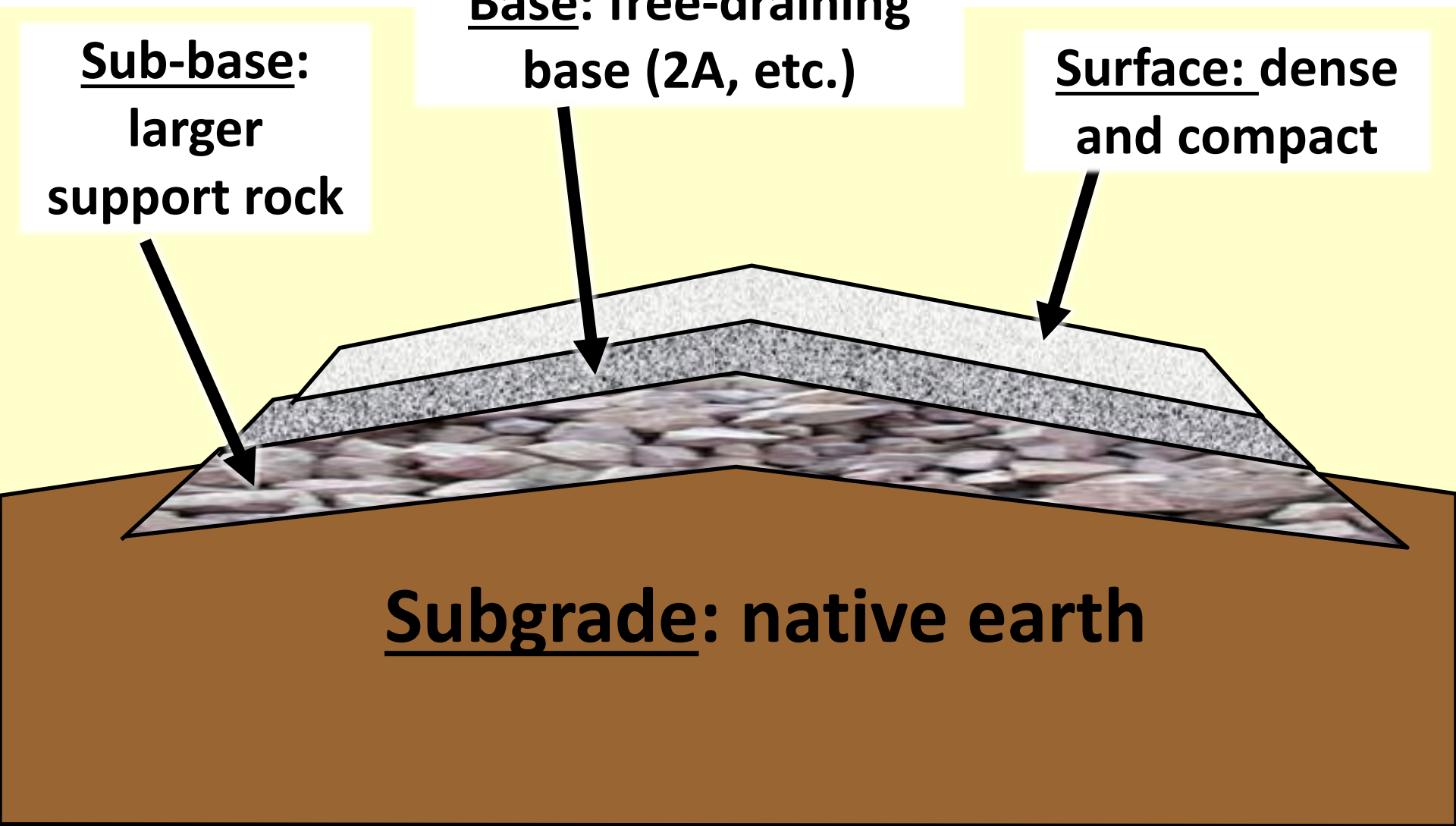
Ideal Unpaved Road Cross Section

(often does not exist)

Sub-base:
larger
support rock

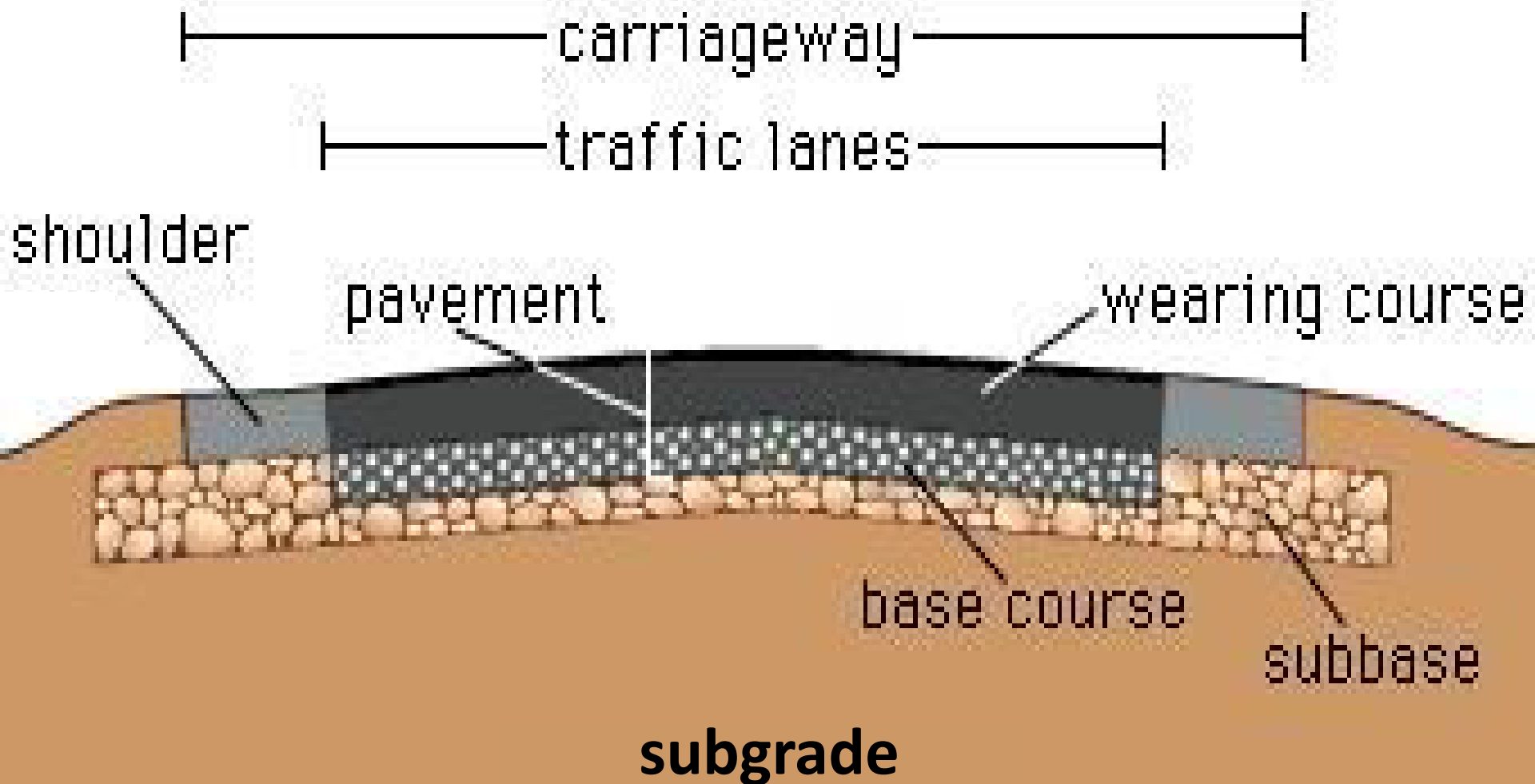
Base: free-draining
base (2A, etc.)

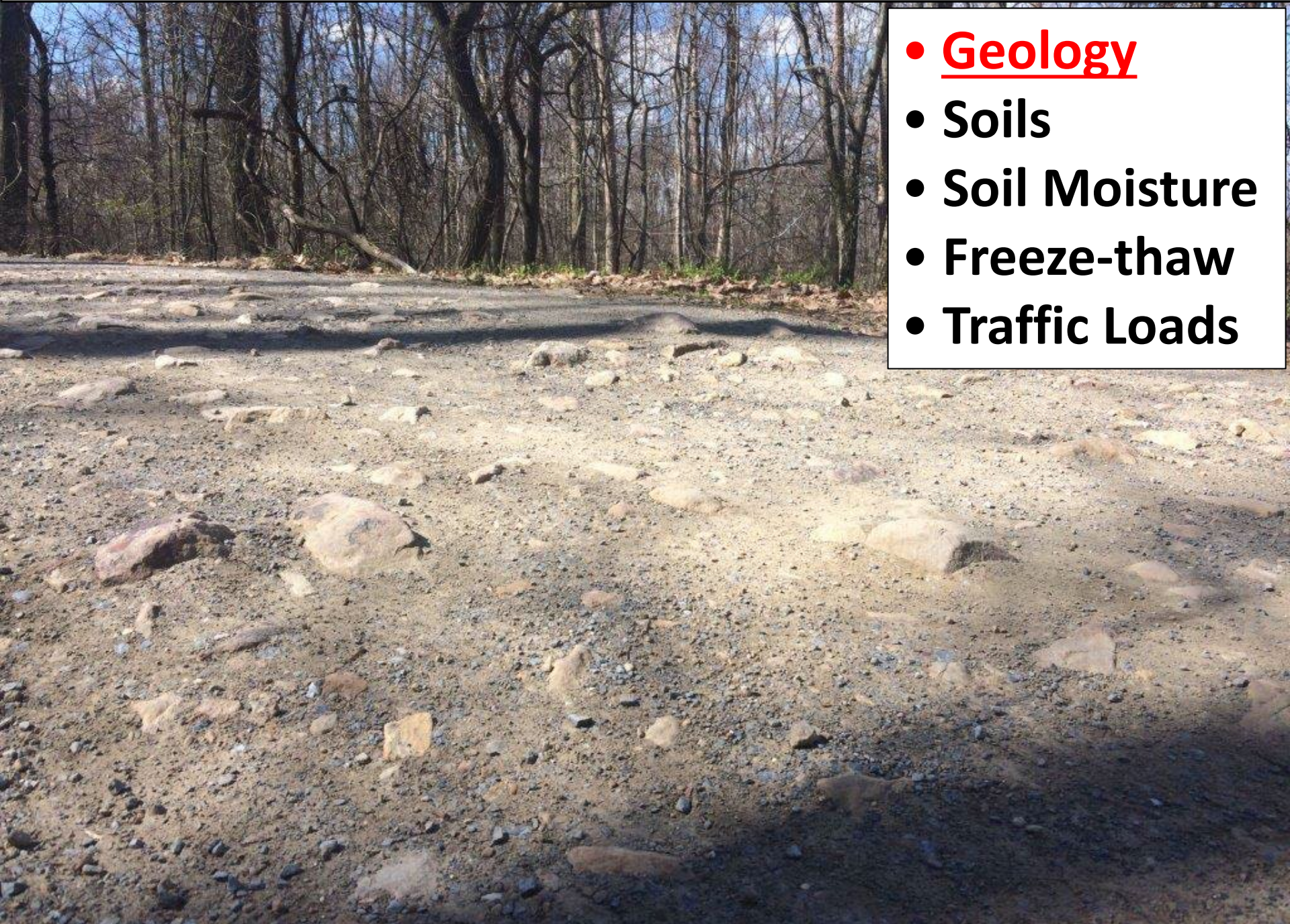
Surface: dense
and compact



Subgrade: native earth

Ideal Paved Road Cross Section





- **Geology**
- **Soils**
- **Soil Moisture**
- **Freeze-thaw**
- **Traffic Loads**

What do you have to work with?

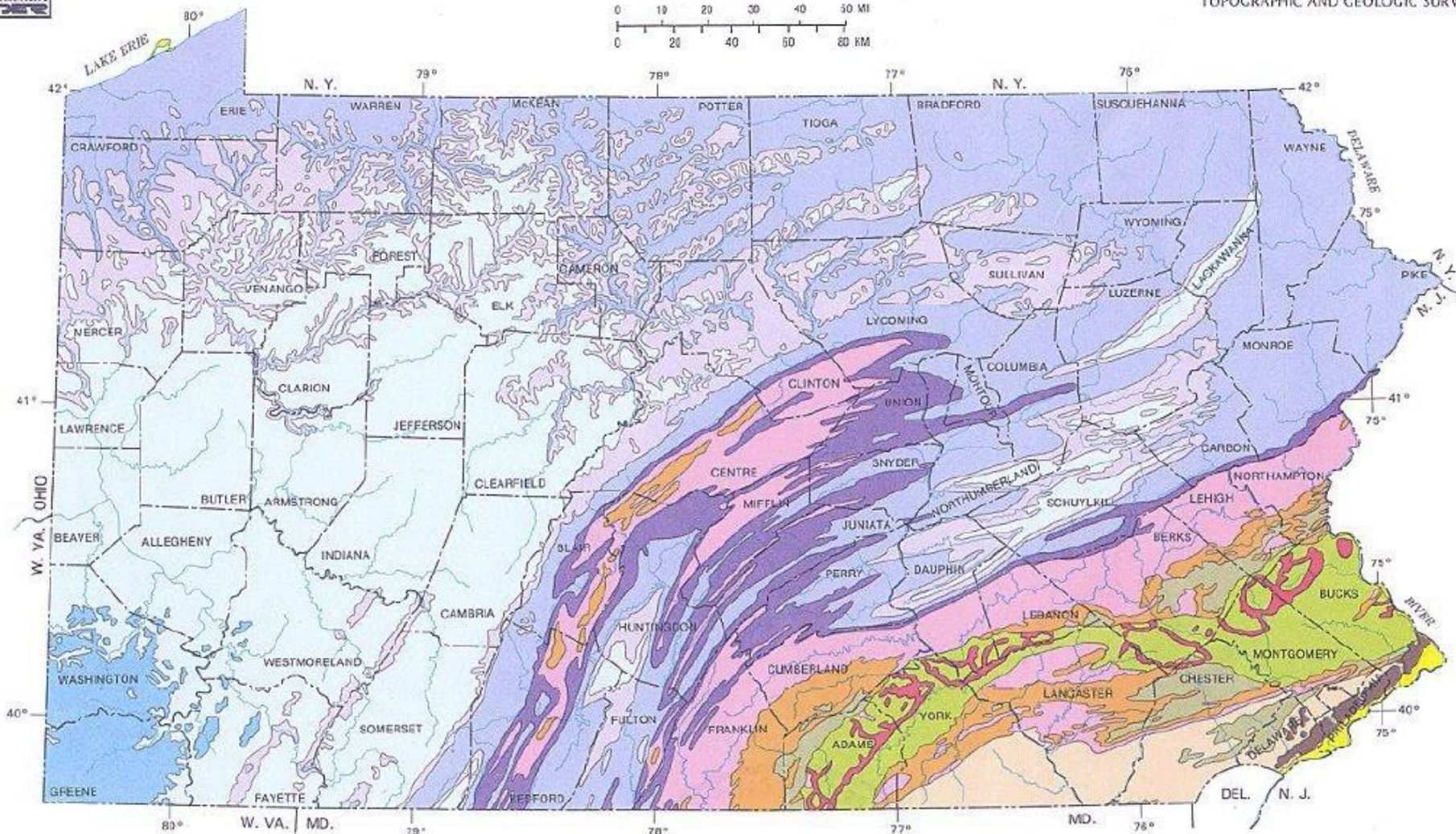
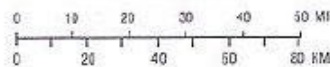
MAP 7



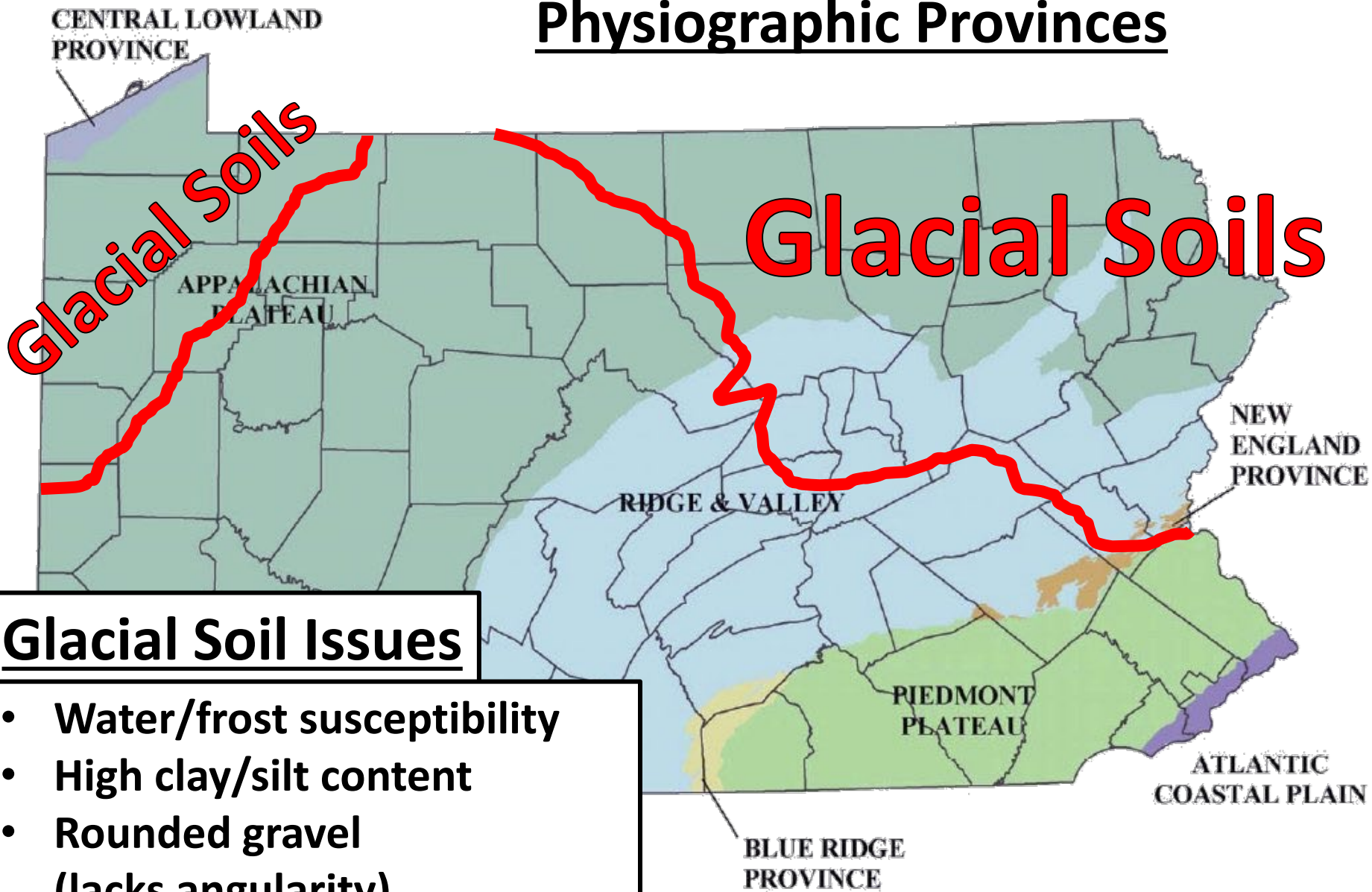
GEOLOGIC MAP OF PENNSYLVANIA

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
OFFICE OF RESOURCES MANAGEMENT
BUREAU OF
TOPOGRAPHIC AND GEOLOGIC SURVEY

SCALE 1:2,000,000



Physiographic Provinces

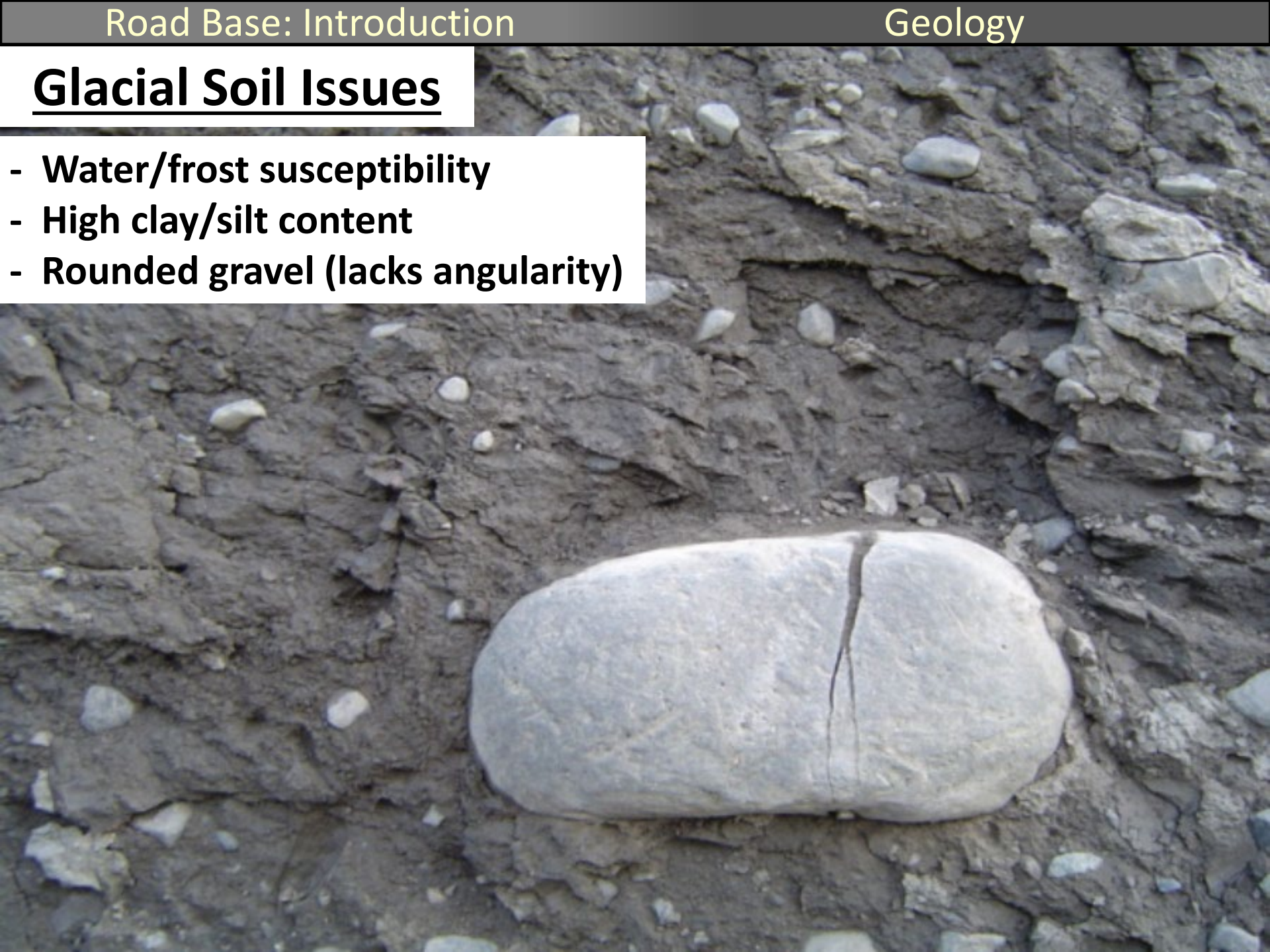


Glacial Soil Issues

- Water/frost susceptibility
- High clay/silt content
- Rounded gravel (lacks angularity)

Glacial Soil Issues

- Water/frost susceptibility
- High clay/silt content
- Rounded gravel (lacks angularity)



Soils are a mixture of:

Sand



Clay



Silt



- Sand – Large
- Silt – Small
- Clay – Extremely small and FLAT!!!

- Geology
- Soils
- Soil Moisture
- Freeze-thaw
- Traffic Loads



**How does
water move
underground?**

**Cracks in rock will channel
subsurface water**



Water runs downhill, right?

What about water underground?

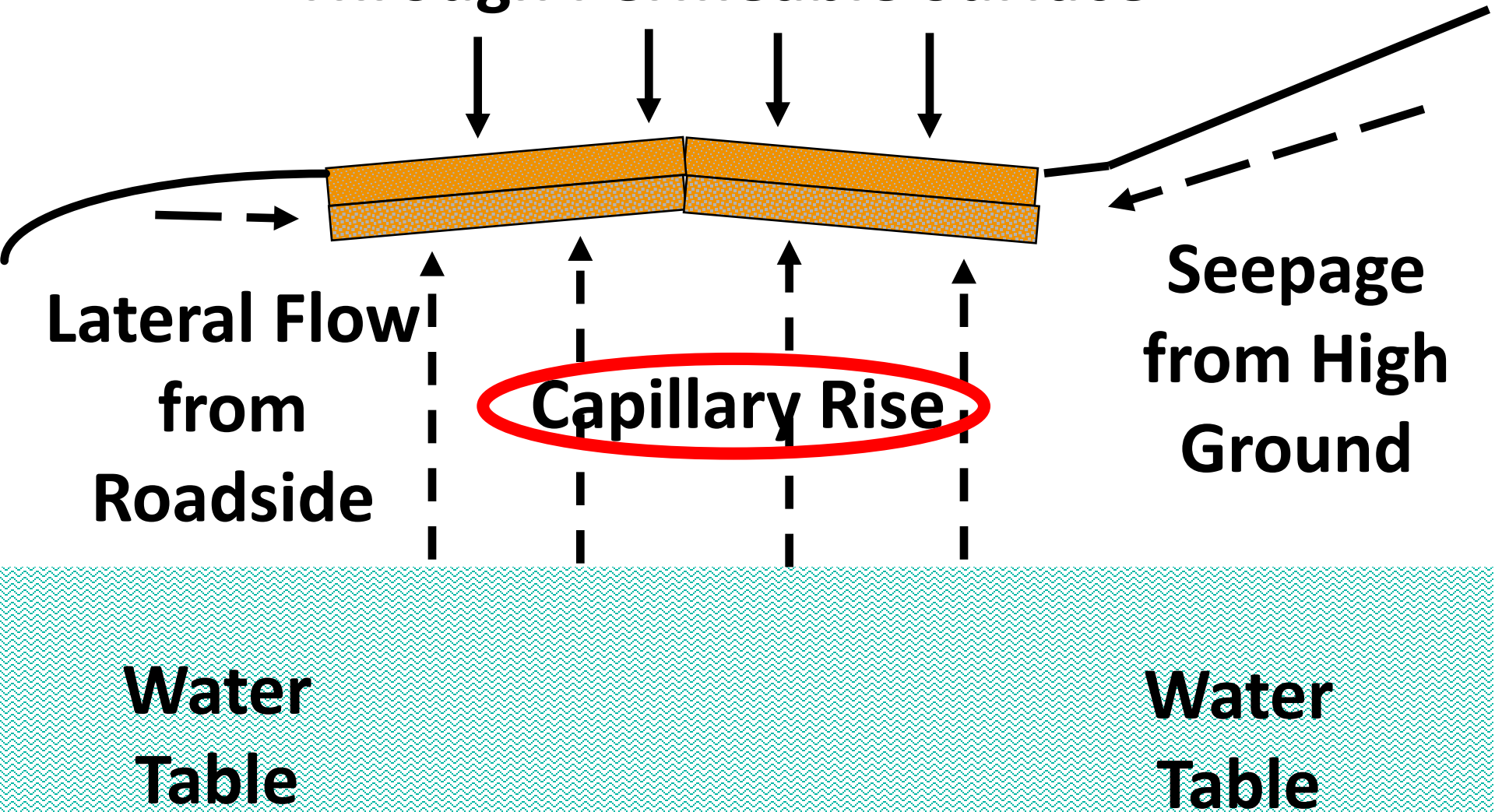
**Primary movement is downhill
by gravity.**

BUT.....

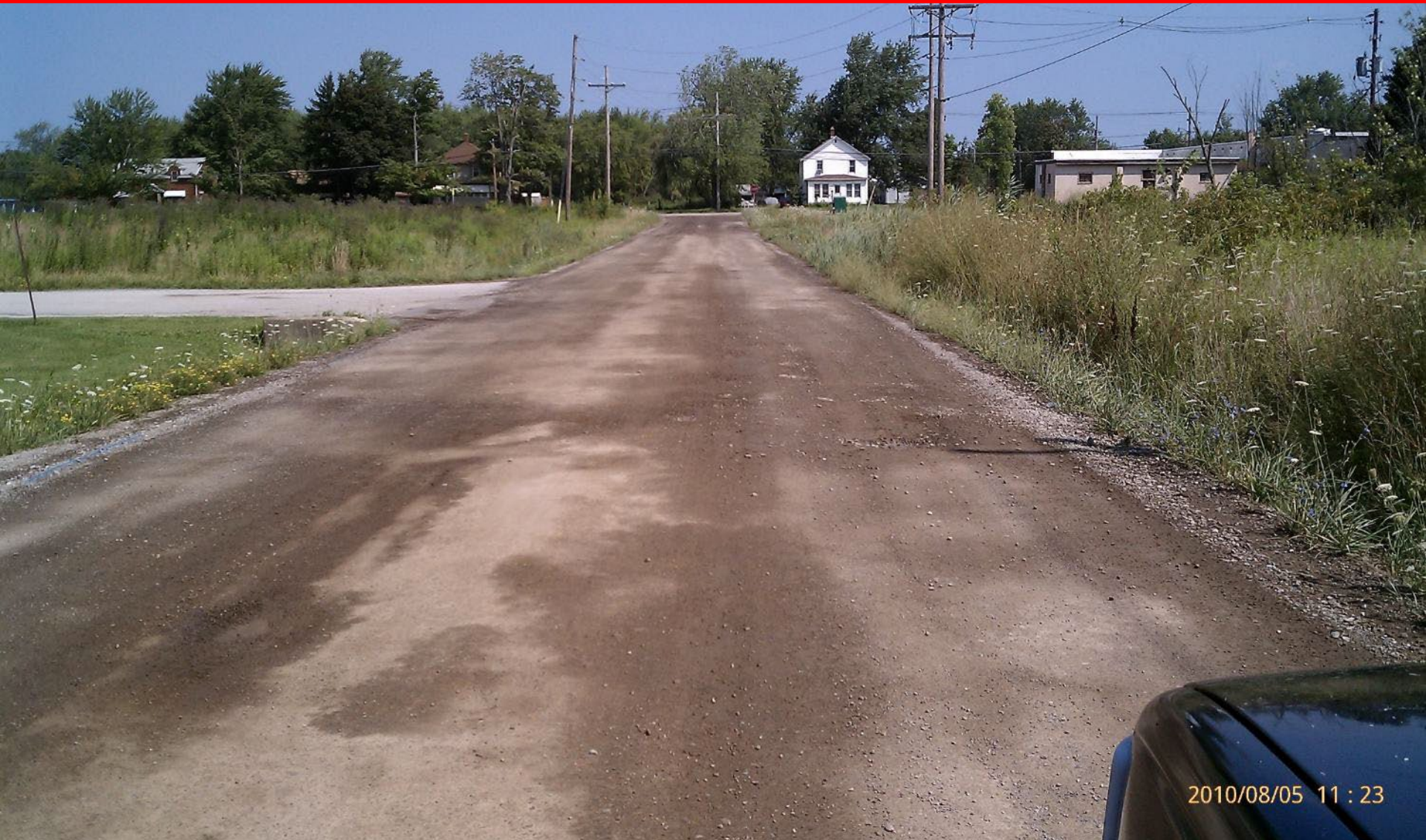
**Underground water can move
sideways, and even UP!**

How can water enter your road?

Through Permeable Surface



CAPILLARY RISE: Movement of water due to the forces of adhesion, cohesion, and surface tension



Height of Capillary Rise

<u>Soil Type</u>	<u>Height of rise (ft)</u>
Small Gravel	< 0.4
Coarse Sand	0.5-1
Fine Sand	1-3
Silt	3-30
Clay	30-90



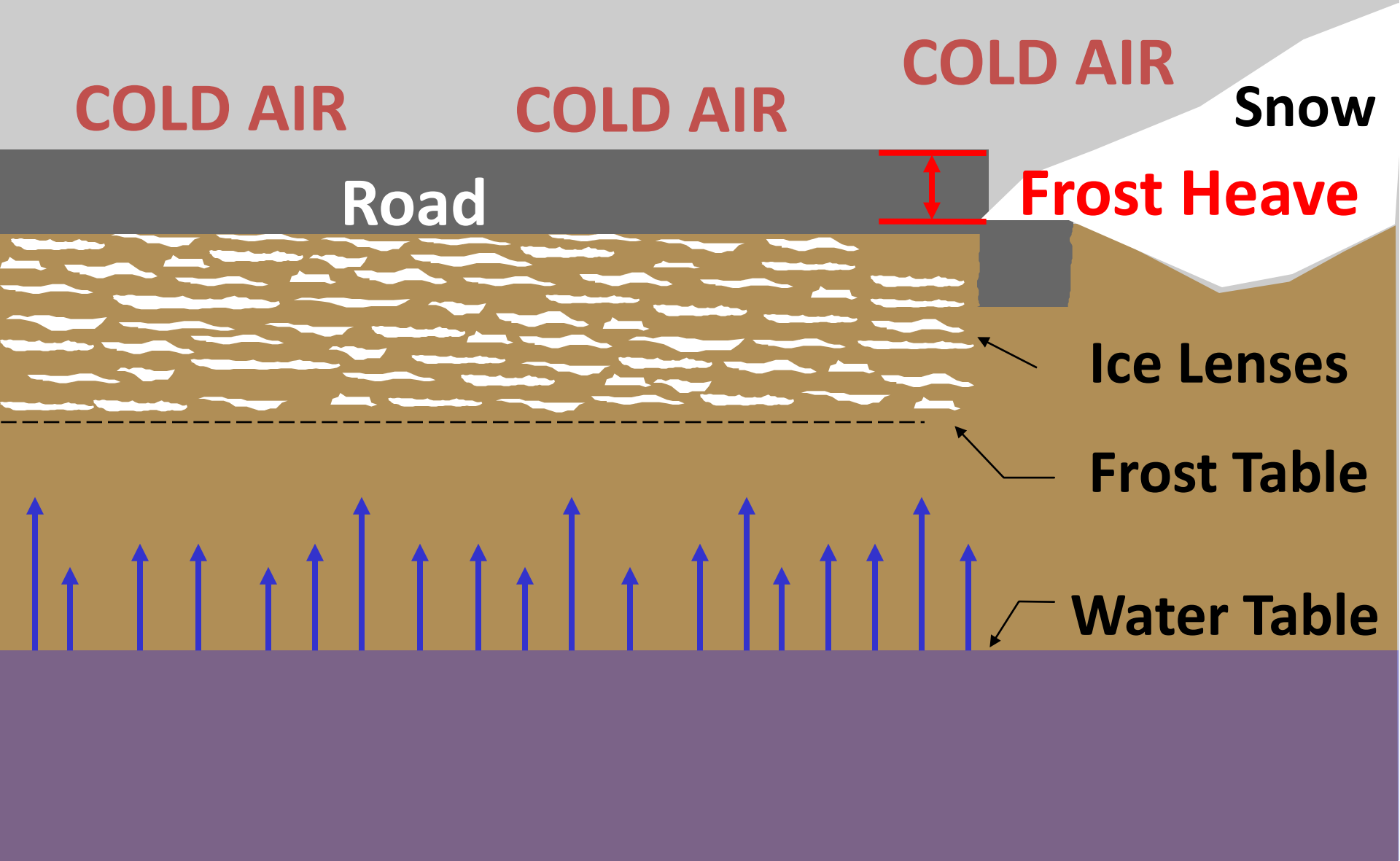
- Geology
- Soils
- Soil Moisture
- Freeze-thaw
- Traffic Loads

Let's talk about FROST

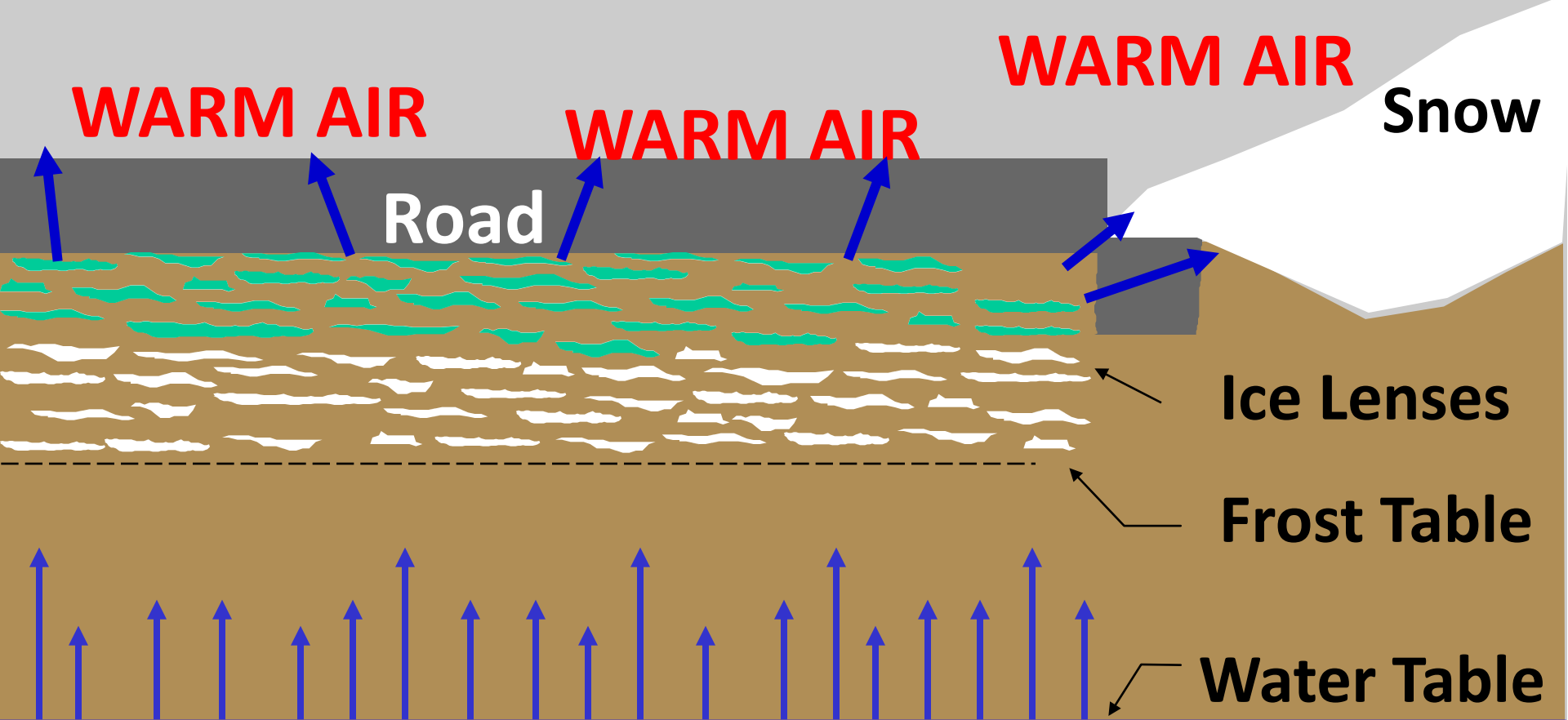
Three Conditions Causing Frost Heave

- Freezing Temperatures
- Frost Susceptible Soil
- Water in the Roadbed

The effect of frost on your roads



The effect of frost on your roads



FROST DAMAGE:

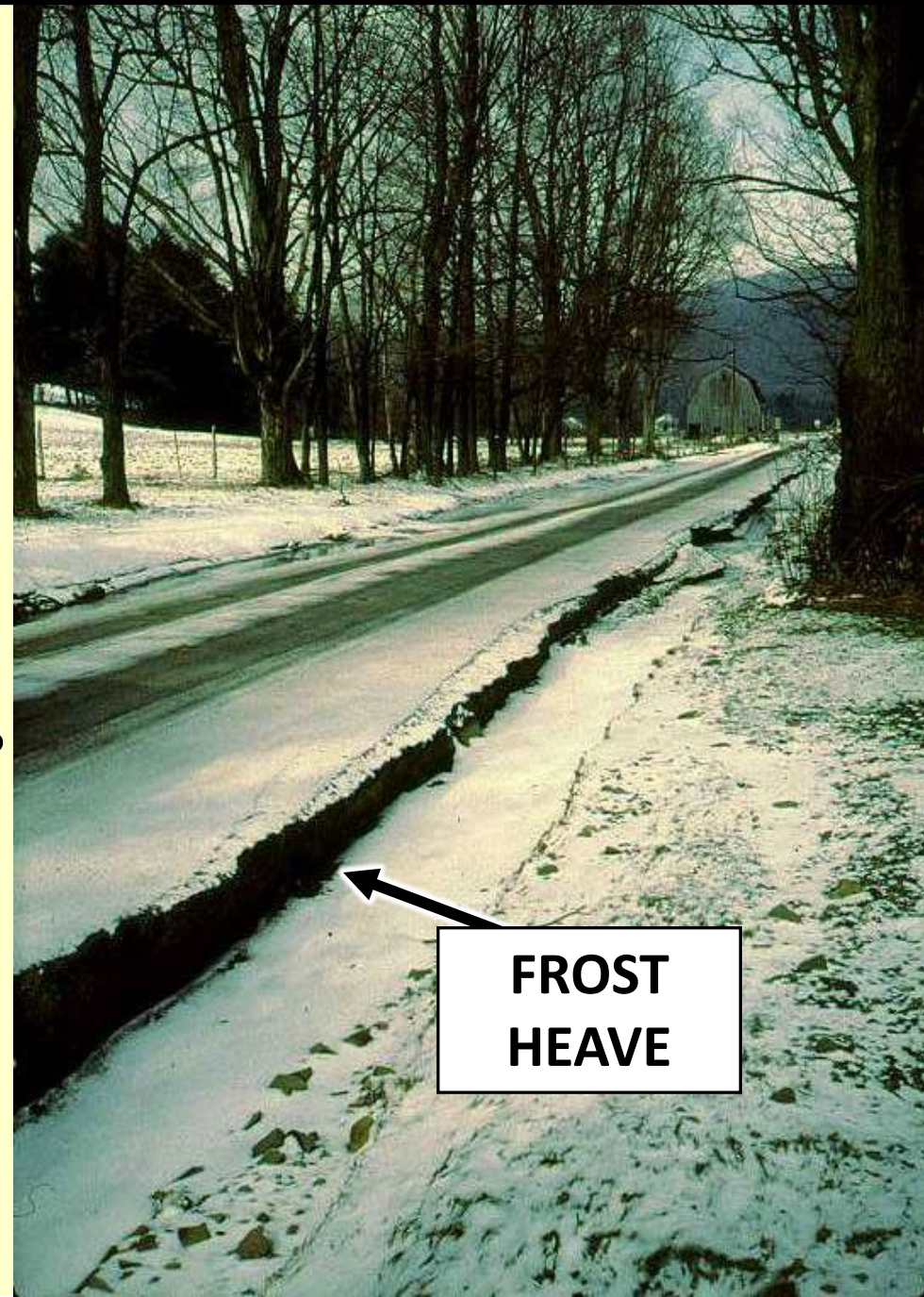
- **FREEZE/THAW**
- **EXCESS WATER**
- **FROST HEAVE**

Why is there so much water in the spring?

Why do my fence posts rise every winter?

Why do large rocks rise up into my road?

Why does frost damage my road?



- Geology
- Soils
- Soil Moisture
- Freeze-thaw
- Traffic Loads



Road Base

Introduction



Traditional Road Maintenance Practices

**Environmentally Sensitive
Maintenance Practices**

Traditional to ignore Base

- Costs too much
- Don't understand the problem
- Perceived as too big



Base: Traditional Practices

Traditional “fix” is just to throw rock at the soft spots.

- Spending money on symptoms, not fixing the problem
- Road has “no bottom”

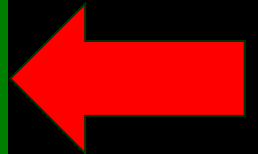
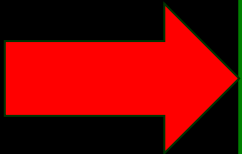


Road Base

Introduction

**Traditional Road Maintenance
Practices**

**Environmentally Sensitive
Maintenance Practices**



- 1. Structural Reinforcement**
- 2. French Mattress**
- 3. Underdrain**

Structural Reinforcement: Addition of rock and/or geosynthetics to establish a solid road base



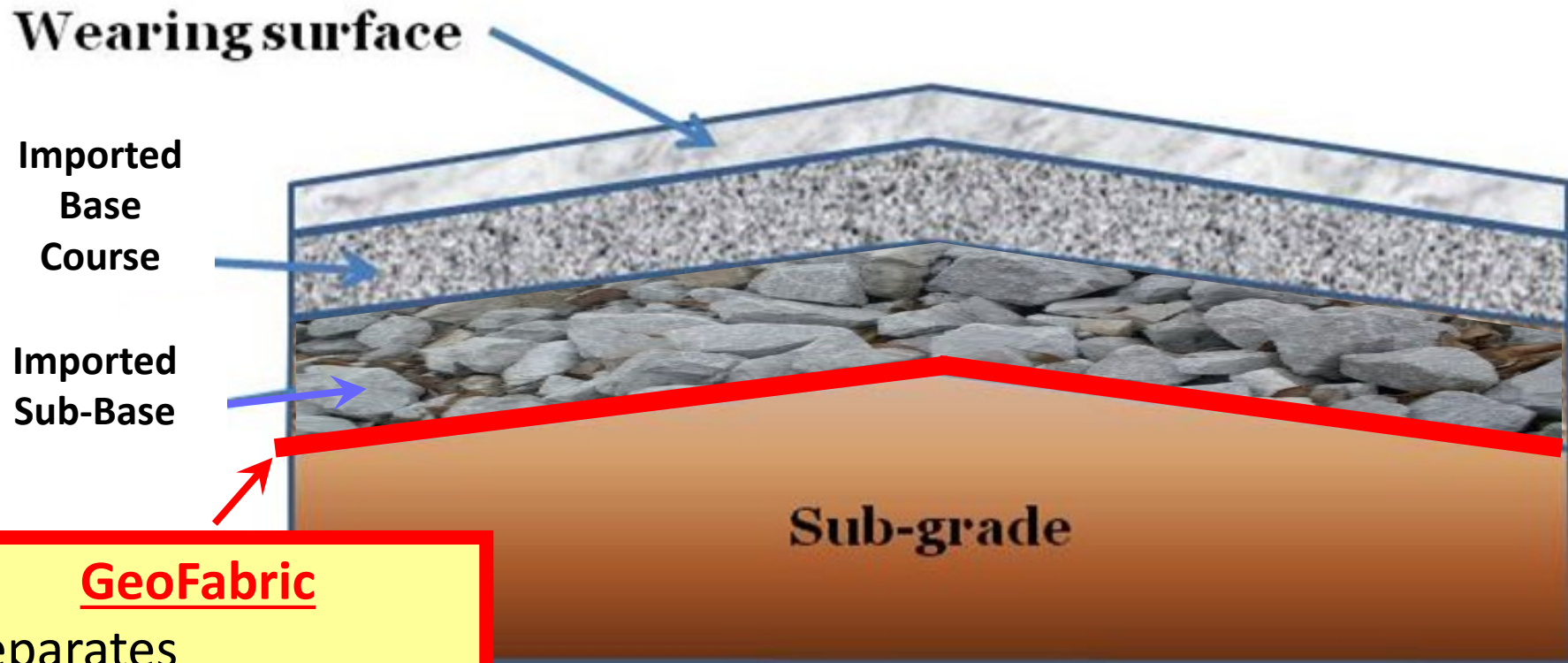
Importing Bridge Rock (rock used to bridge low strength soil)

- ~4"+ stone (AASHTO #1)
- Structural support
- Drainage



Separation:

Fabric keeps sub-base and sub-grade separate
(keeps mud below and stone on top)

**GeoFabric**

- separates
- filters
- adds support

Low lying LVR with saturated base soils



“Tar and chip” surface and underlying soil was excavated prior to placing fabric



GeoFabric

- separates
- filters
- adds support



The bridge rock was tailgated and spread with a loader



A top layer of fabric was added to separate the surface from the base.

Like a French Mattress - provides both drainage and support.



2RC was tailgated and will be
"chip sealed"



Any water that comes out of the ground under the road surface will now migrate into the ditch instead of saturating the road base

“Bridge Rock”





**“Bridge
Rock”**

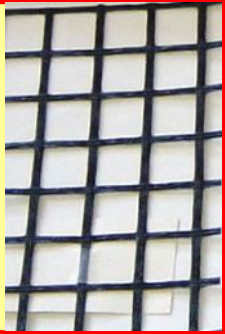


Before

One year later

Geo-GRID

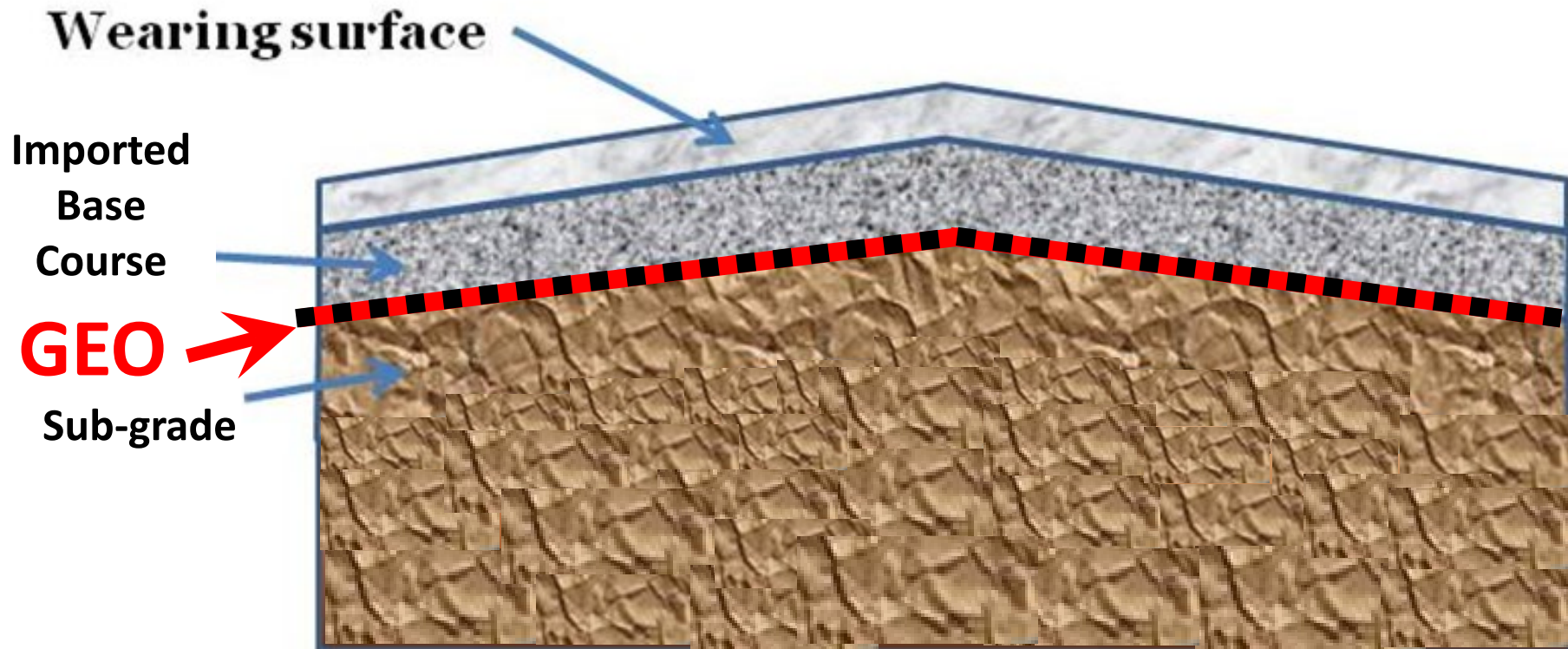
- “snowshoe”
- spreads load
- strong support

**ROUGH GUIDE:**

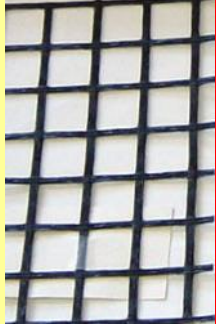
The structural support added by geo-grid typically can produce a 40% reduction in fill height for the same strength.*

**Rule of thumb only: depends on fill material, kind of grid, moisture, etc.*

Place **Geo-Synthetics** between sub-grade and base course



Geo-GRID

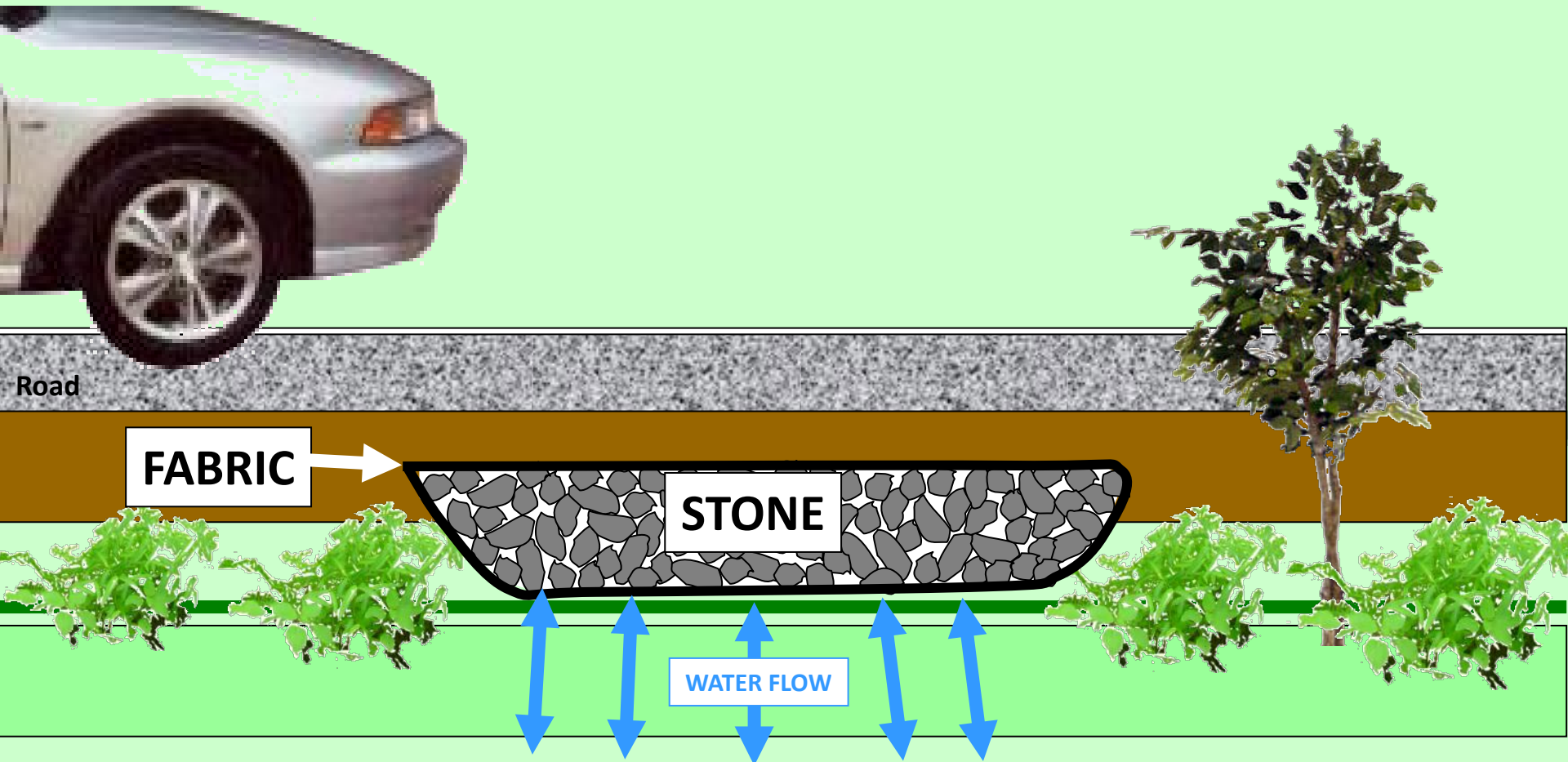


- “snowshoe”
- spreads load
- strong support



1. Structural Reinforcement
2. **French Mattress**
3. Underdrain

French Mattress: A drainage structure under a road consisting of coarse rock wrapped in fabric through which water can freely pass.



When to use a French Mattress

- To reconnect wetland hydrology divided by road
- Very effective in:
 - sloped and lowland wetlands
 - areas with wet banks
 - areas with saturated road base
 - floodplains

Project Walkthrough: Fulton County, Plessinger Road

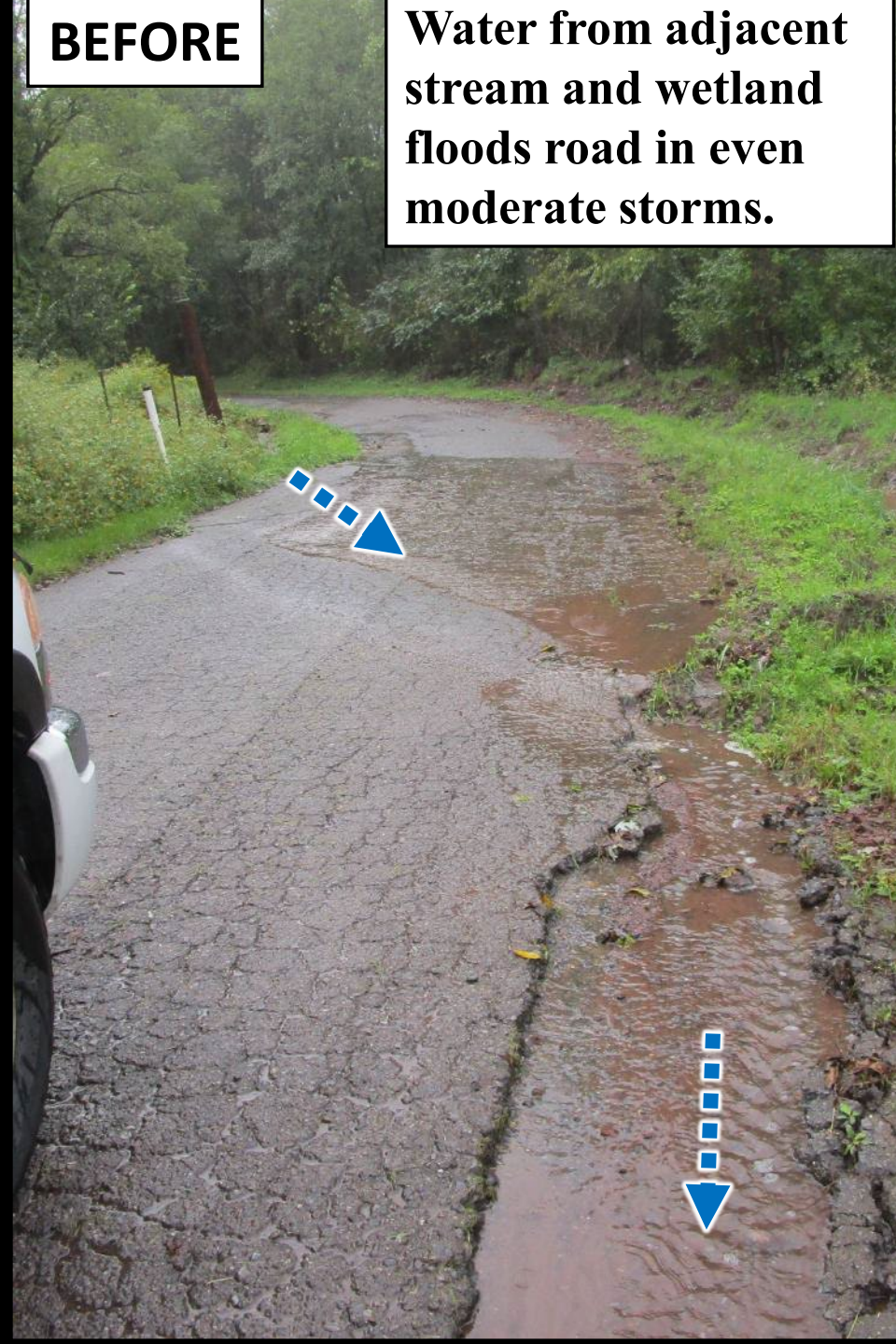
- **2020: \$14K Grant, \$6K in-kind**
- Road frequently flooded
- 250' x 18" long French Mattress
- Replace crosspipe through mattress



BEFORE



BEFORE

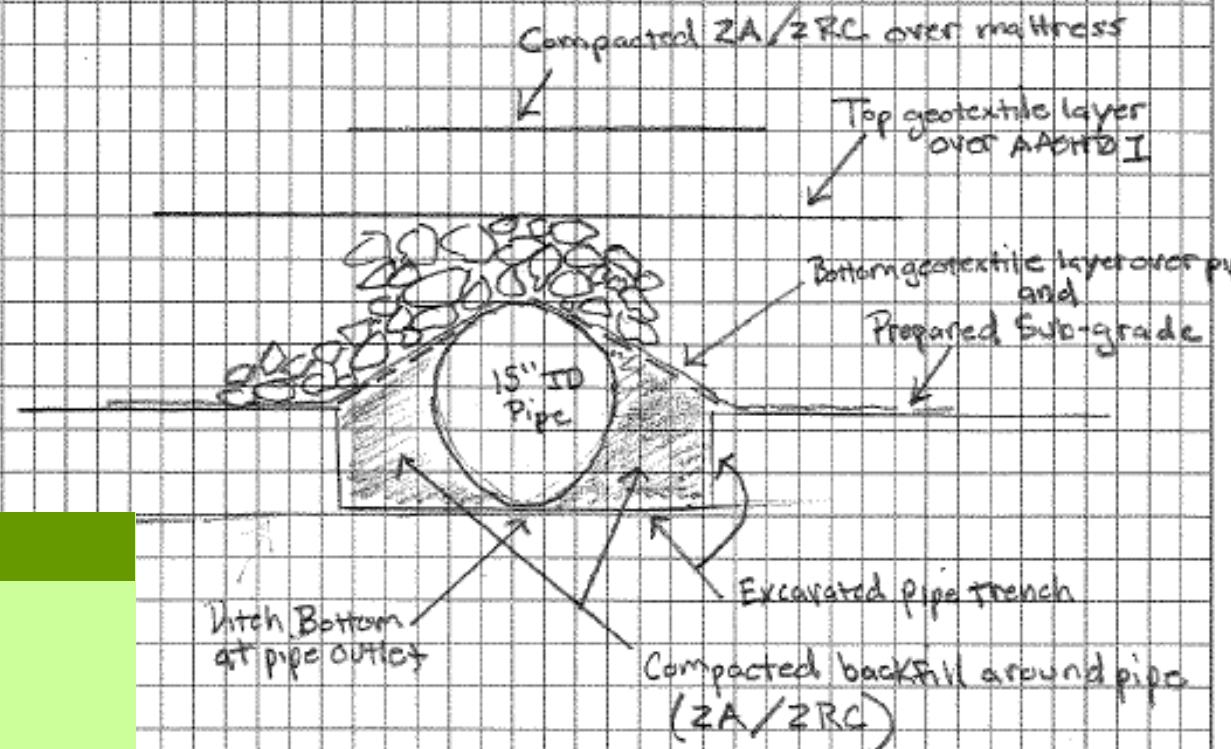
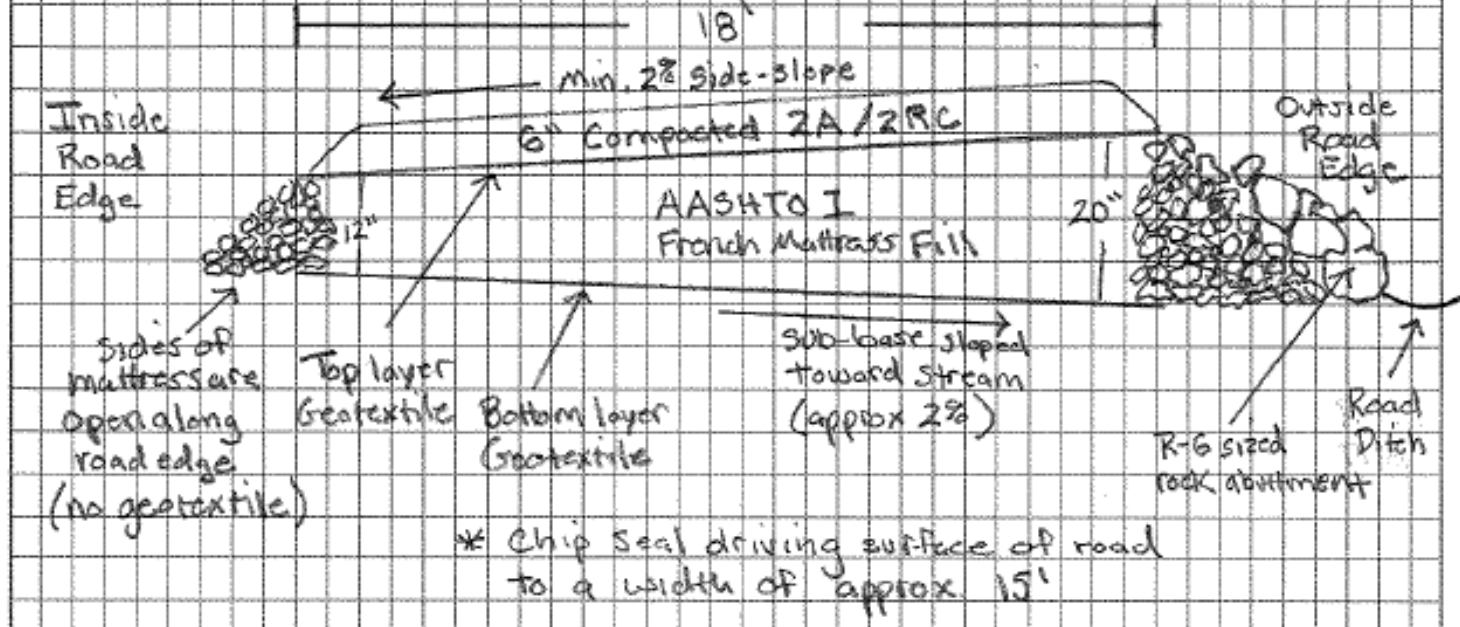


Water from adjacent stream and wetland floods road in even moderate storms.

Fulton, Plessinger 2/7

- Road frequently flooded
- 250' x 18" long French Mattress
- Replace crosspipe through mattress

**Sketch Plan:
Raise road with
French Mattress,
add pipes**



- Fulton, Plessinger 3/7**
- Road frequently flooded
 - 250' x 18" long French Mattress
 - Replace crosspipe through mattress

DURING

**Removing old crosspipe
and preparing for
mattress installation**

Old crosspipe clogged



Fulton, Plessinger 4/7

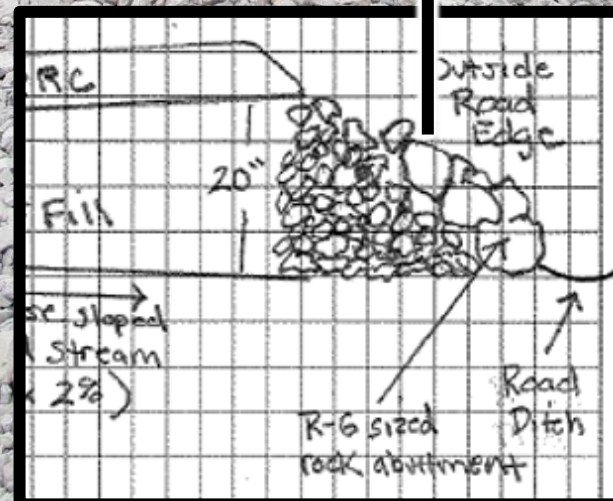
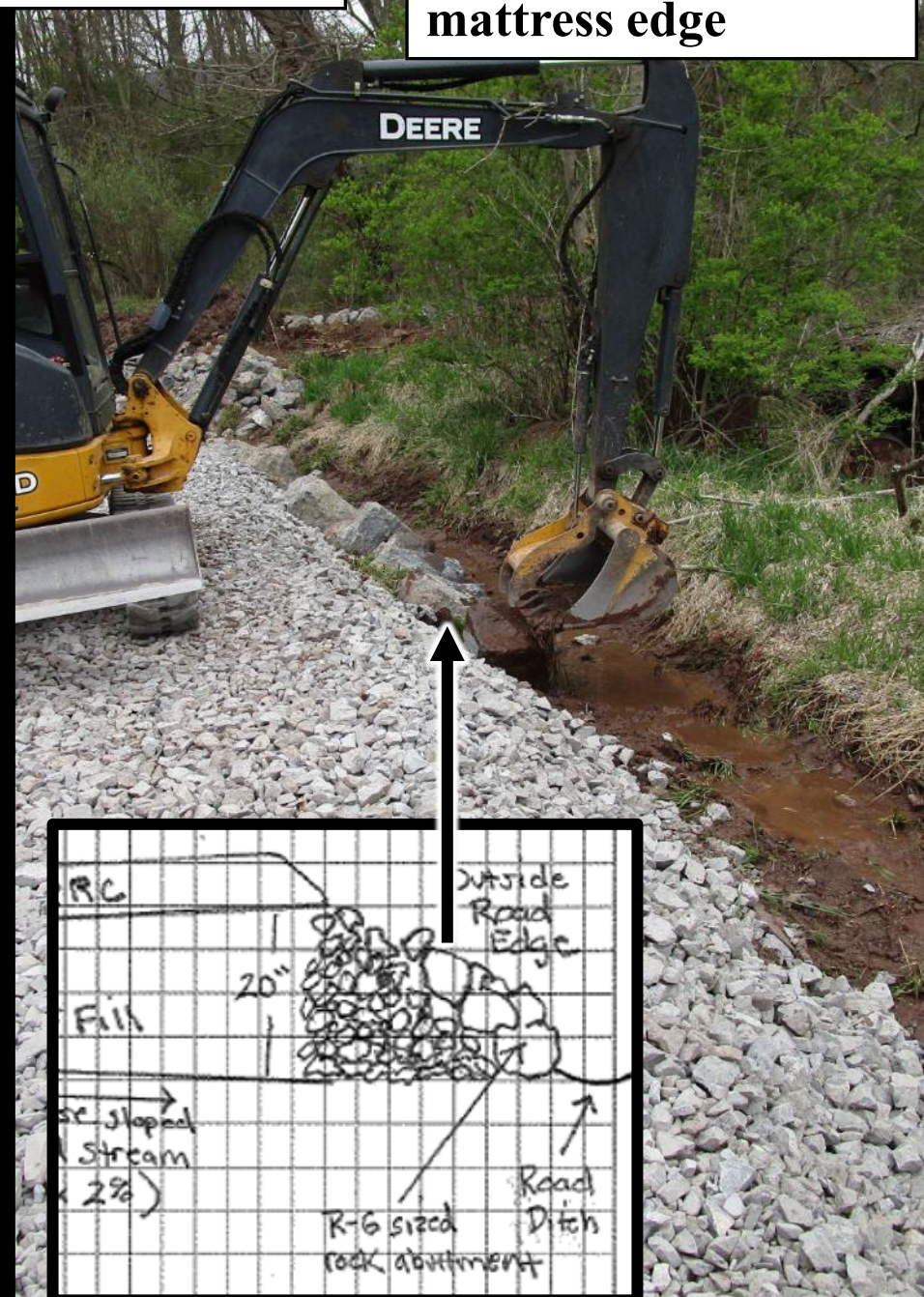
- Road frequently flooded
- 250' x18" long French Mattress
- Replace crosspipe through mattress

DURING

AASHTO #1 Placement for Mattress

Large stones protect mattress edge

**New
crosspipe
(outlet)**



Fulton, Plessinger 5/7

- Road frequently flooded
- 250' x 18" long French Mattress
- Replace crosspipe through mattress

BEFORE



AFTER



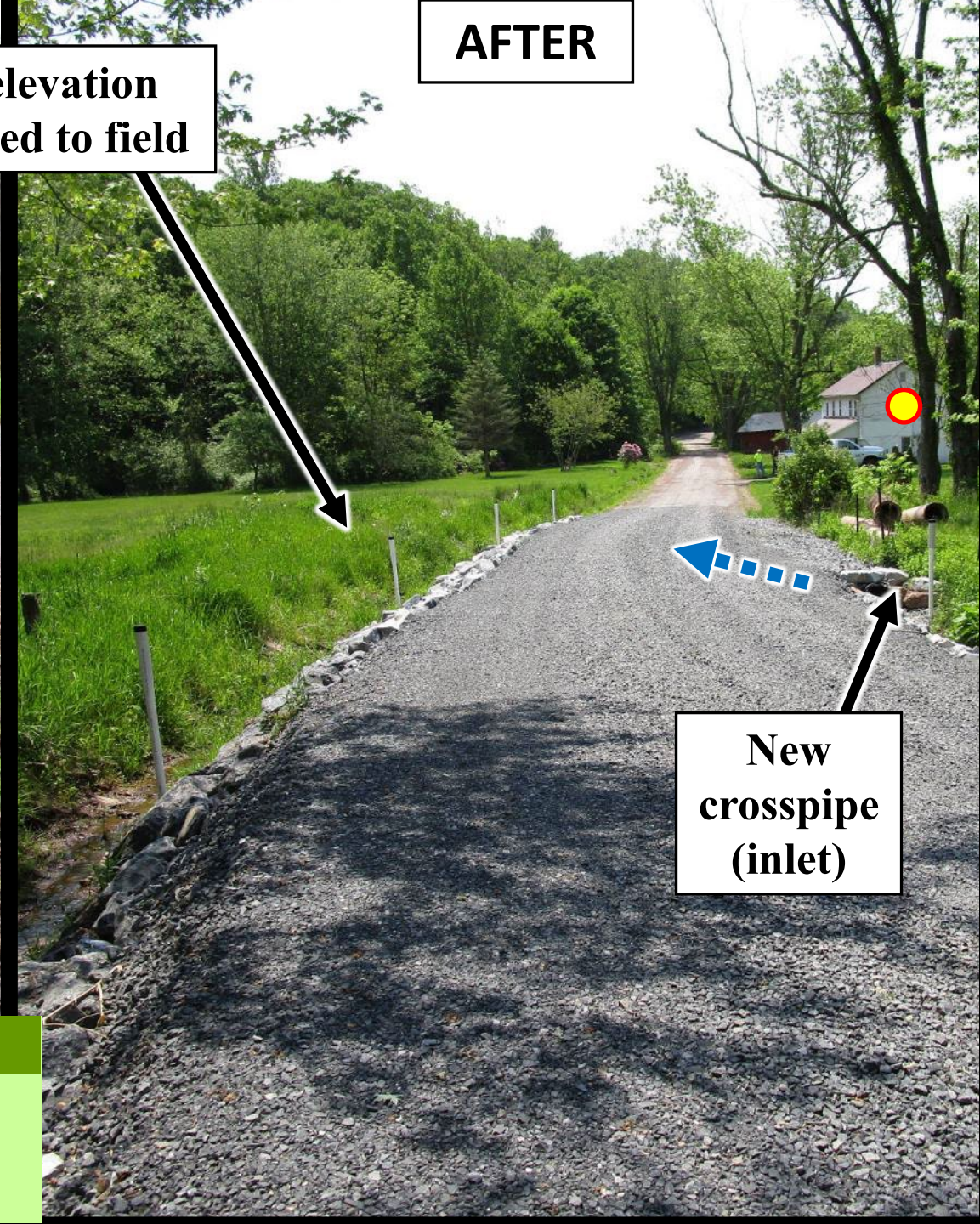
Fulton, Plessinger 6/7

- Road frequently flooded
- 250' x 18" long French Mattress
- Replace crosspipe through mattress

BEFORE

AFTER

**Note elevation
compared to field**

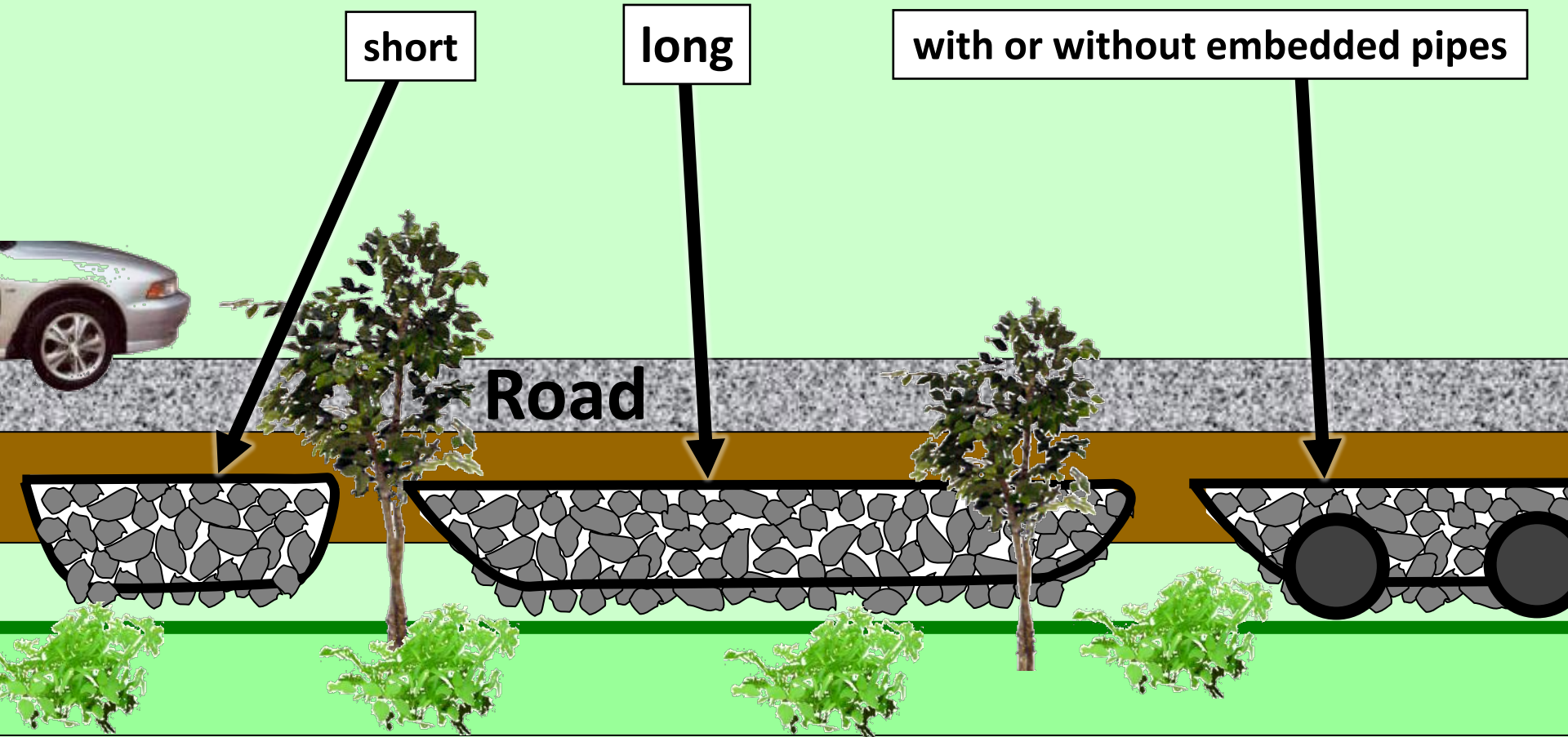


Fulton, Plessinger 7/7

**New
crosspipe
(inlet)**

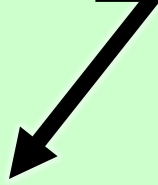
- Road frequently flooded
- 250' x 18" long French Mattress
- Replace crosspipe through mattress

A French Mattress is very flexible to fit your site!



A French Mattress is very flexible to fit your site!

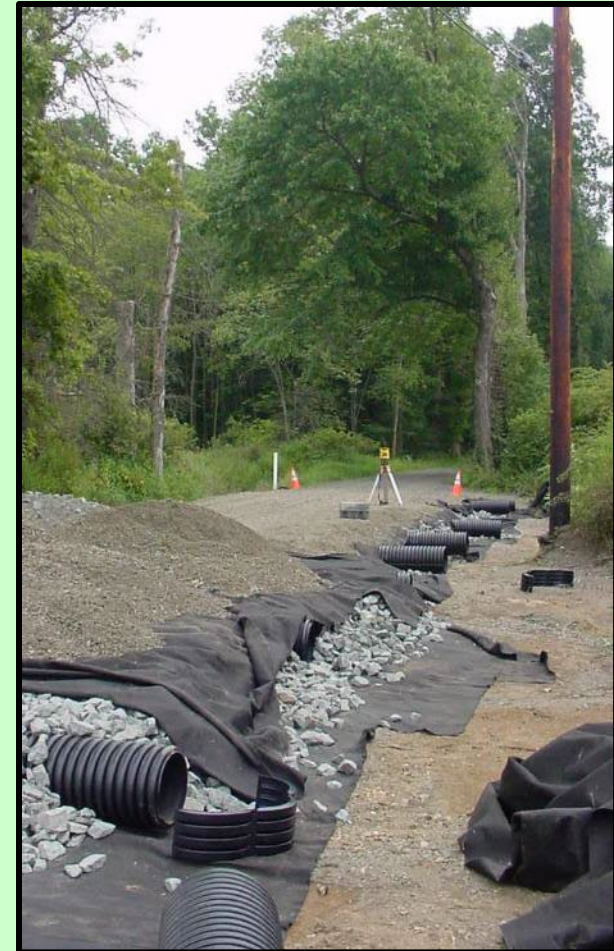
short



long



with or without embedded pipes



Mattresses are flexible, a few examples: Bedford County

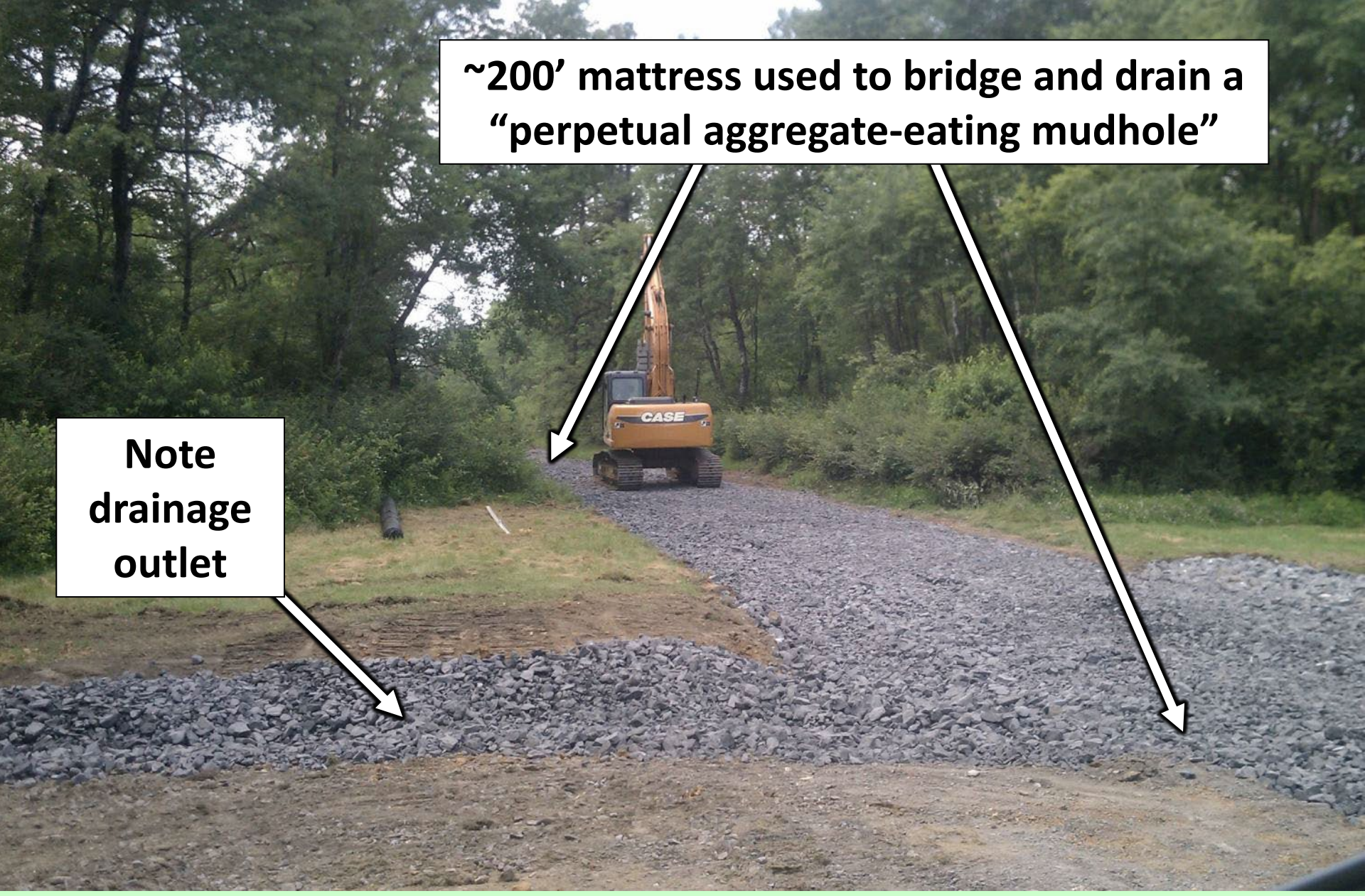
Can use French Mattress
to build up road over
unstable wetland soils



Mattresses are flexible, a few examples: Centre County

~200' mattress used to bridge and drain a "perpetual aggregate-eating mudhole"

Note drainage outlet

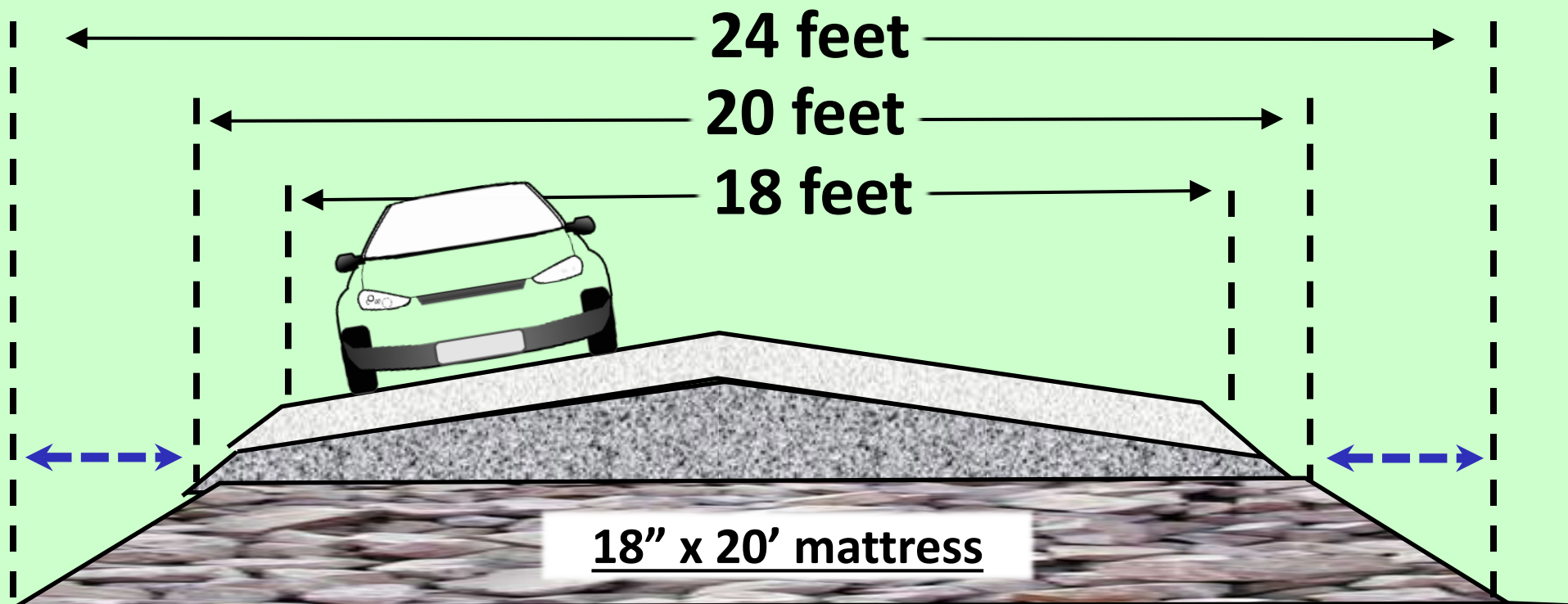


Mattresses are flexible, a few examples: Pike County



Long mattress with pipes
due to wetland and
backwatering from lake

Every situation is different, but you may need a 24' wide mattress at the base to achieve a 18' final road width!



1. Structural Reinforcement
2. French Mattress
3. **Underdrain**

Underdrain : A buried drainpipe that collects subsurface water before it surfaces on the road and directs it to a stable outlet.



When TO USE:

- Saturated road bases
- Perpetually wet ditches and banks

**ANY CONSISTENTLY
WET AREAS!**



When NOT TO USE:

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

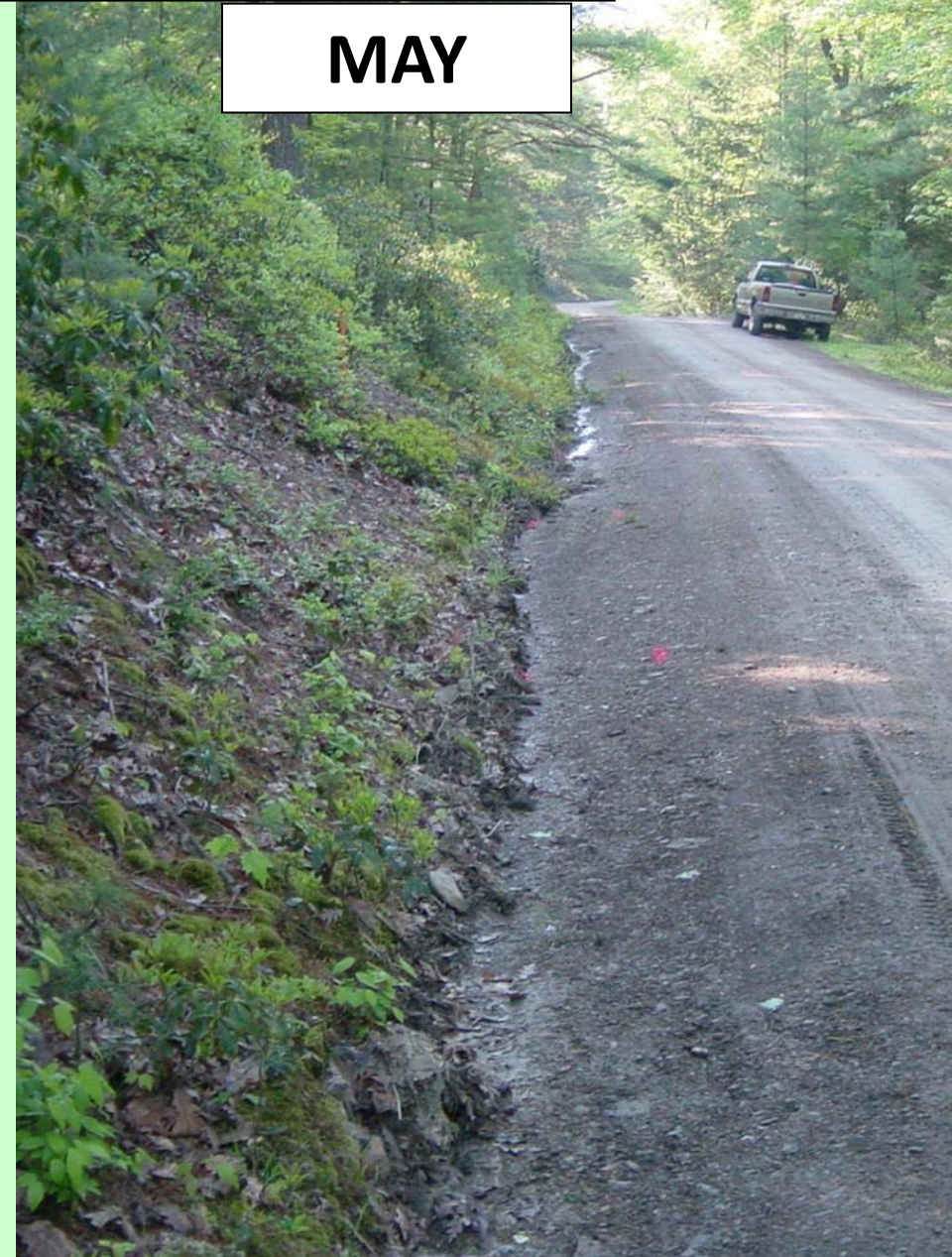


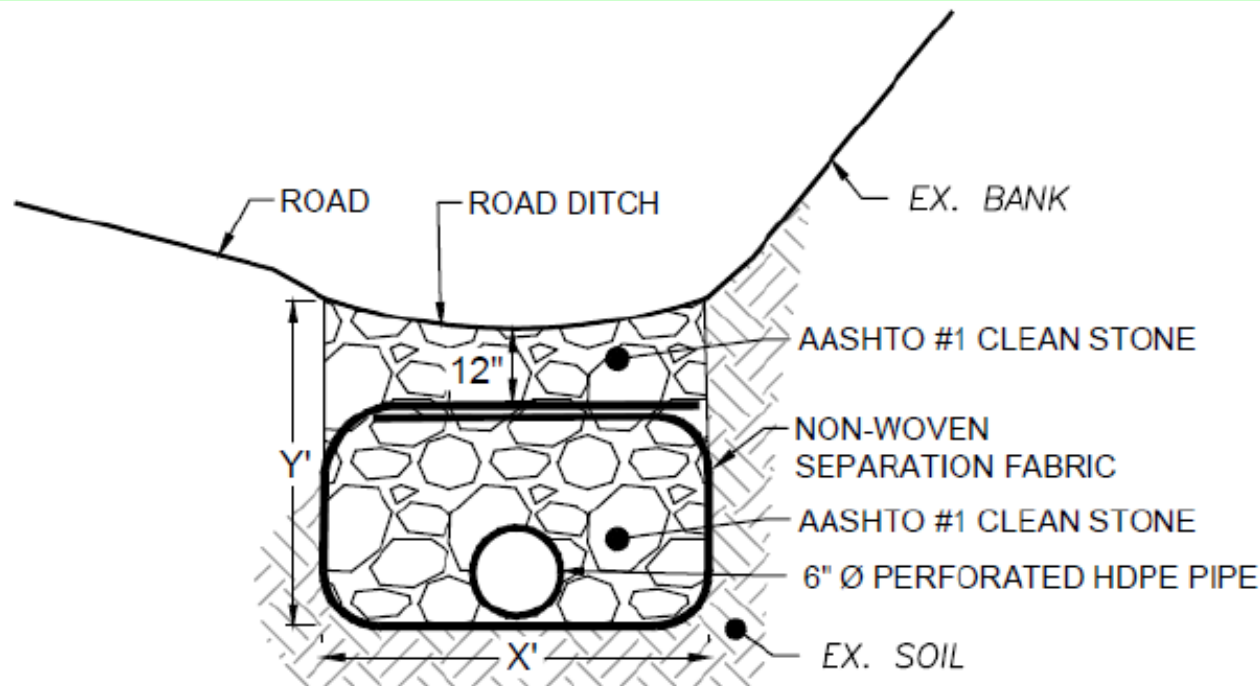
Consider time of year, this is the same site in:

MARCH



MAY



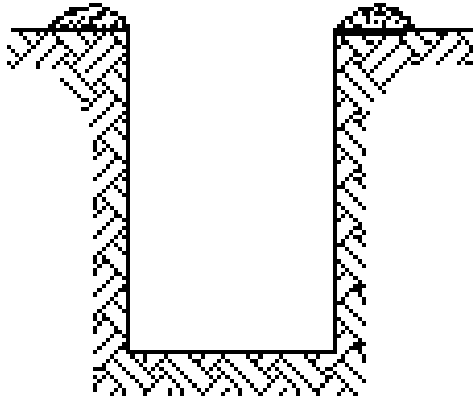


CROSS-SECTION VIEW

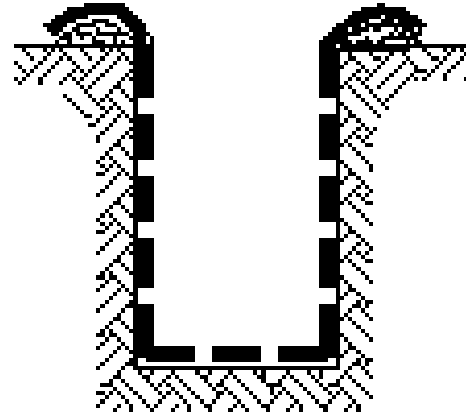
NOTES:

1. AASHTO #1 STONE SHALL BE CLEAN & FREE OF FOREIGN MATERIAL.
2. OVERLAP SEPARATION FABRIC SEAMS THE FULL WIDTH OVERTOP OF THE UNDERDRAIN.
3. PROVIDE A MINIMUM 12" STONE COVER OVER SEPARATION FABRIC.
4. CREATE AND MAINTAIN DITCH SHAPE.
5. HDPE: HIGH-DENSITY POLYETHYLENE
6. CONTACT PA ONE-CALL A MINIMUM OF 3 DAYS PRIOR TO START OF ANY EARTHMOVING ACTIVITIES.

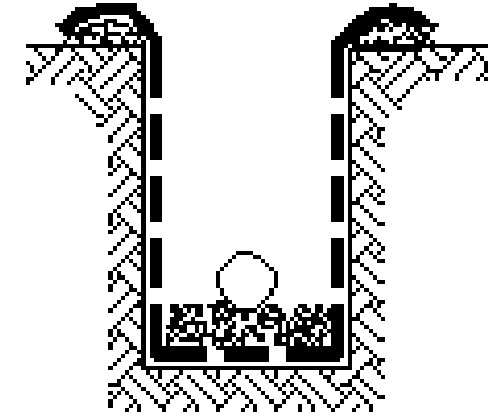
Constructed Stone Underdrain



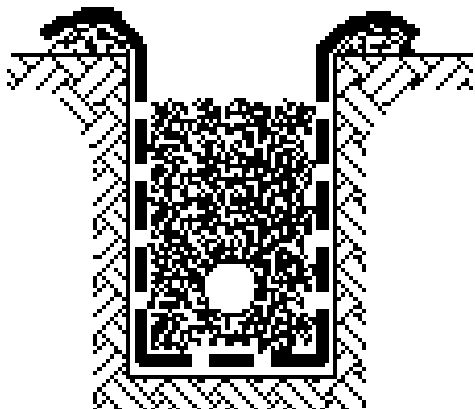
1. Excavate Trench



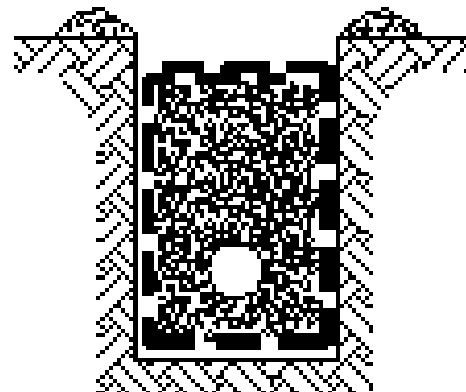
2. Place Geo-textile



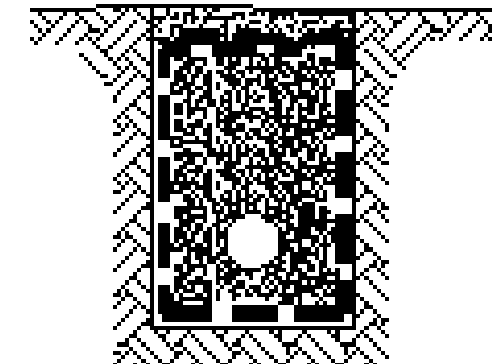
3. Add pipe and clean fill



4. Add clean fill



5. Wrap and overlap geotextile



6. Cover geo-textile

Considerations:

- **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**

Before

Example 1

Underdrain excavation

MAY 3



**Should have min.
1% slope, like a
pipe**

**Plan to remove
excavated
material**



Placing fabric in trench

Page 12 in Field Guide



Non-Woven Fabric



- separates
- filters

Page 12 in Field Guide

Clean Stone

Perforated Pipe

Constructing Underdrain





Underdrain Outlet

Keep runs short and outlet as frequently as possible

Constructing Underdrain



Underdrain Outlet

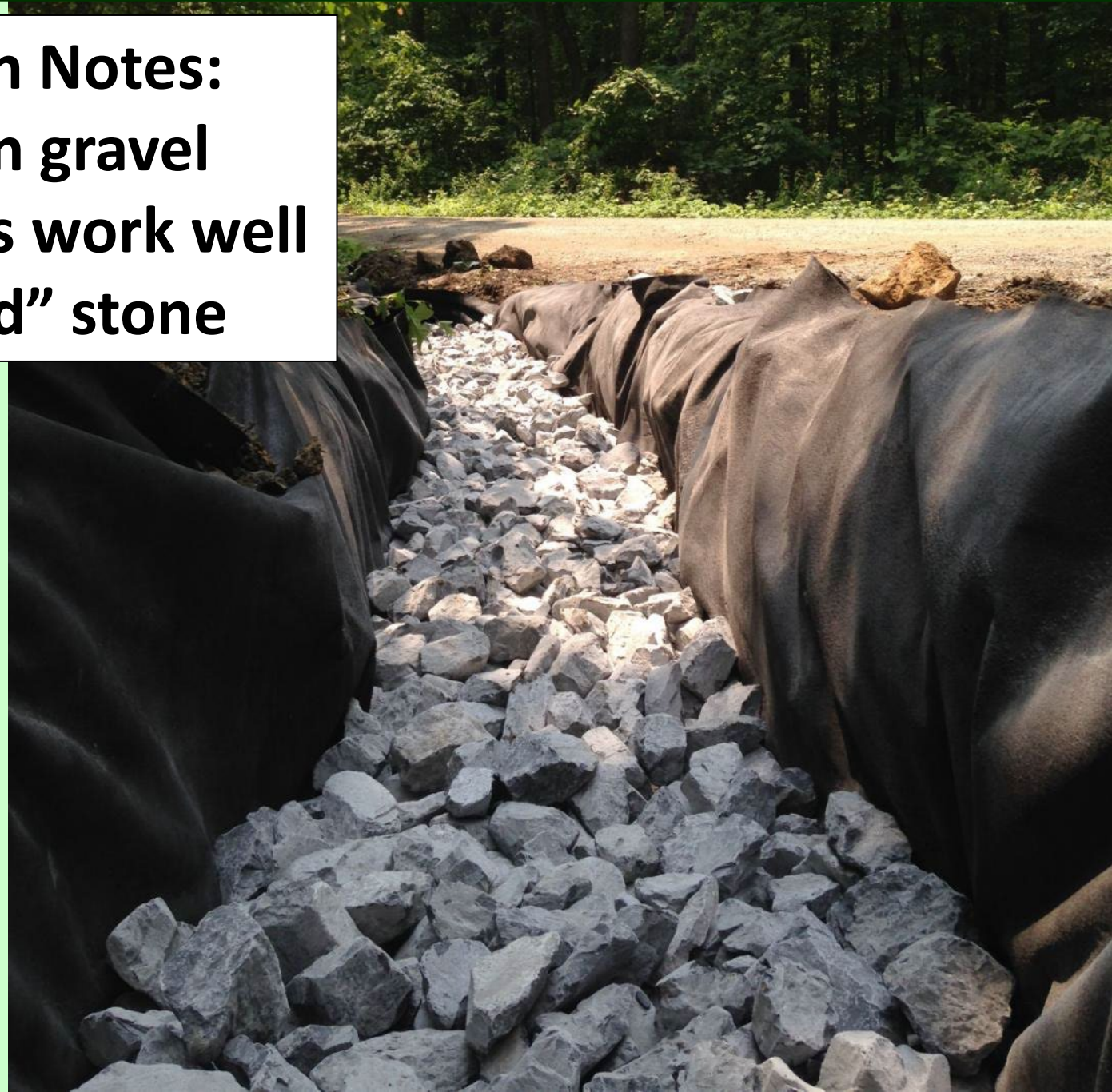


Keep runs short and outlet as frequently as possible

Constructing Underdrain

Underdrain Notes:

- Use clean gravel
- AASHTO #1's work well
- "Fist-sized" stone



Underdrain Notes:

- Wrap all sides in fabric
- Overlap all fabric seams 1'+



Non-Woven Fabric



- separates
- filters

Underdrain Notes:

- **Cover the fabric to hold it in place.**
- **Try to build a ditch shape with the rock used to cover the fabric.**



1 year later



Underdrain Outlets:

- Solid pipe prevents crushing
- Critter guards



Jung Road – Bradford County



BEFORE: Top of hill is entrenched and channeling water



DURING: Fill provided needed cover for under drain

You can take advantage of deep ditches for underdrains. Much of the excavation is already done for you.

Road Base

ADDITIONAL RESOURCES:

- Your Conservation District
- Your Municipal Engineer
- www.dirtandgravelroads.org
 - Fill RFQ



next chapter:
Entrenched Roads