MEMO

To: Town of Heath

From: Megan Rhodes, Livability Program Manager, FRCOG
Ryan Clary, Senior GIS Specialist, FRCOG

Date: September 30, 2026

Re: Assessment of Underwood Hill Road and Sadoga Road for Potential Improvements, Heath, MA

Sadoga Road

Overview

Sadoga Road in Heath is a 1.2 mile unpaved road that connects to Route 8A. There are 6 houses located along it. The road generally slopes downward from its northern end towards the intersection with Route 8A and is characterized by a dense tree canopy with several streams running under it. The road grade varies between flat sections to steeper areas with grades between 5% and 11%.

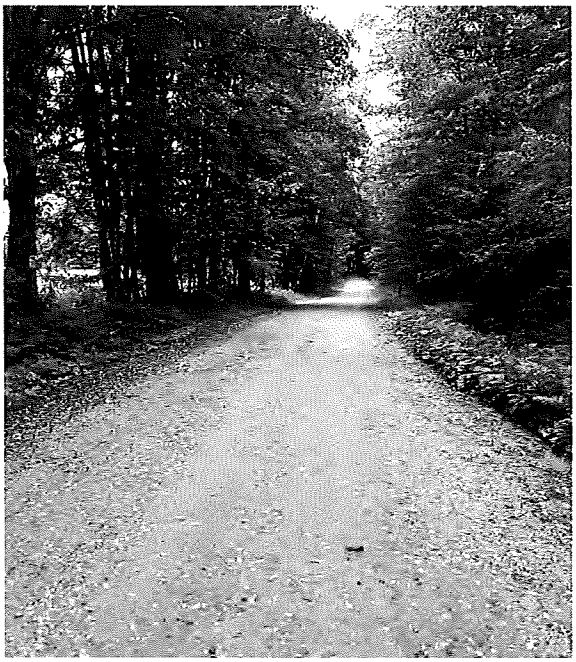


Figure 1. Sadoga Road with a narrow width and shady canopy.

Issue

The most significant performance issue with Sadoga Road is seasonal mud – particularly at the southern end in the segment between the bridge over Burrington Brook and the intersection with Route 8A. Residents, town staff, and the postal service report that this segment becomes particularly difficult to navigate during winter thaws with deep mud.

Analysis and Recommendations

FRCOG conducted a traffic count on Sadoga Road in August and found that the average daily traffic volume is 60 vehicles and that the vast majority of traffic was classified as cars

with only 13% of traffic classified as trucks. The average speed was 26 mph indicating that speed is not an issue on this stretch.

Overall, the road is well-crowned and does not have serious erosion issues due to stormwater.[1] There are locations that could benefit from additional roadside drainage improvements. The attached maps show the locations where drainage ditches and turnouts (also known as bleeders or diversion ditches) can be either expanded, formalized, or installed.

A simple step to encourage stormwater flow off the road quickly is to remove all plow or grader berms from the roadsides. These berms, while small, prevent the water from exiting the road surface and can cause secondary ditches to occur along with rills and gullies. The attached maps also show locations where grader berms should be removed.

To improve the section that experiences severe seasonal mud, there are several tools that can be employed. The first tool, and the most important, is the installation of geogrid under the subbase to stabilize the road. Geogrid is a mat made of polymer material with large regular-sized openings that stabilizes the road by preventing the base course from sinking into the subgrade soil and distributing vehicle loads to improve bearing capacity. Attached is a fact sheet and a design typical on geogrids from the FRCOG's Unpaved Roads Stormwater Management Toolkit.[2] In 2024, construction costs to install geogrid were $40.00/CY for excavation and $15.00/SY for the geogrid. Very rough measurements indicate that the entire segment between the bridge and Route 8A is 970 square yards.



Figure 2. Geogrid installation in the Town of Ashfield on a mud-prone section.

Another tool that can be installed along with the geogrid are underdrains. They are used to drain subsurface water and can further add stability to the road base. A fact sheet and design typical are also attached for this best management practice. Underdrains can be

[1] Best practices suggest maintaining a crown of ½ inch per foot.
[2] FRCOG Unpaved Roads Stormwater Management Toolkit, 2025, https://frcog.org/publications/unpaved-roads-stormwater-management-toolkit/.

installed for the length of the mud-prone segments or in spots that experience the most moisture.

A best practice on unpaved, gravel roads to prevent mud is to never use treated sand or melting agents on them during the winter. Unpaved roads perform best in the winter when they are able to remain frozen. Using untreated sand can provide traction while keeping the road frozen.[3] If the correct size sand is used, it can later be reincorporated into the gravel during regrading in the spring.

For the mud-prone area on Sadoga Road, an alternative way to improve the road is to pave that section. It is close to Route 8A and some other upcoming planned paving projects in town. To prepare for the paving, the road base will need to be reconstructed and may still warrant the installation of geogrid and/or underdrains to prevent future issues. This alternative is more expensive upfront but will result in much less future maintenance and resources.

Underwood Hill Road

Overview

Underwood Hill Road in Heath is an 0.83 mile long unpaved road that connects to Sadoga Road. There are 5 houses located along it. The road slopes downward from its northern end towards the intersection with Sadoga Road. The road grade varies between flat sections to very steep sections that range between 13.5-15.6% grade. There is one small stream that runs under the roadway. The northern half of the road is entrenched with the road surface below the adjoining land surface. The southern end the road has a thick tree canopy.



Figure 3. Underwood Hill Road at the northern end that often experiences seasonal mud.

Issue

Similar to Sadoga Road, the most significant performance issue with Underwood Hill Road is seasonal mud – particularly at the northern end

[3] Best practices suggest using half-inch minus crushed sand, while trying to avoid excess sanding which create a "loose" road surface.

where there are 2 locations prone to mud. Residents and town staff report that these segments become particularly difficult to navigate during winter thaws.

In addition to seasonal mud, the northern section of Underwood Hill Road is also very steep with minimal drainage. This leads to high amounts of erosion during storms.

Because of the entrenched nature of the northern section, not only is there little room to push snow off the road, there is also little room to add drainage features – making improvements challenging.

Analysis and Recommendations

Similar to Sadoga Road, this roadway is well-crowned. The segments of the road that experience mud and erosion are located between the intersection of Summer Stetson Road and the top of the hill after House #27. There is very little opportunity in this stretch for stormwater to exit the road due to an entrenched road and almost no culverts or turnouts. Best practices suggest that for a road with a grade between 11-15% such as this one, there should be drainage opportunities at least every 60-80 feet.[4] The southern section of Underwood Hill Road does have more frequent culverts, however almost all of them are in need of maintenance to ensure effective performance.

Table 1-4. Minimum recommended spacing for turnouts

Road grade (percent)	Distance between turnouts (ft)
2 – 5	135 – 250
5 – 10	80 – 135
11 – 15	60 – 80
16 – 20	45 – 60

Table 1-5. Spacing recommendations for stormwater drainage culverts

Road grade (percent)	Distance between culverts (ft)
2 – 5	135 – 250
5 – 10	80 – 135
11 – 15	60 – 80
16 – 20	45 – 60

The attached maps illustrate where possible culverts and turnouts can be added to improve stormwater management. Because of the entrenched nature of the roadway and the surrounding hills and structures, it will be difficult to install the recommended spacing of culverts. As a result, a large amount of stormwater will be collecting and flowing in the

[4] Source: Unpaved Roads Stormwater Management Toolkit, FRCOG, 2025.

proposed ditch and drainage structures and they will need to be sized appropriately to handle the water volume. For ditches on steep roads, they should be stone-lined with check dams to slow the water velocity and minimize erosion.[5] Also attached are fact sheets and design typicals for stone-lined ditches and check dams.

Table 1-3: Recommended ditch type by road grade

Grade	Ditch type
0 – 5%	Vegetated
5 – 8%	Vegetated with stone check dam
Greater than 8%	Stone-lined
As needed up to 10%	Stone-lined with stone check dam

For the areas of the roadway that are prone to seasonal mud, the recommendations are the same as Sadoga Road. Geogrid should be installed, possibly with underdrains if there is excess water flowing through the road subbase. Avoid the use of melting agents/treated sand in the winter to keep the road surface frozen.

Next Steps

Some of these tasks described in this memo can be undertaken with town staff and equipment, such as crowning the road and removing grader berms. Tasks such as creating and improving ditches and increasing the size of culverts are more expensive and may be beyond the town's resources. There are state grant funds available that could fund the design and construction of this work. The MassDOT Unpaved Road Program and the Small Town Assistance Program (STRAP) through the MassWorks Infrastructure Program are good candidates for this type of work.

[5] Source: Unpaved Roads Stormwater Management Toolkit, FRCOG, 2025.

Appendix A

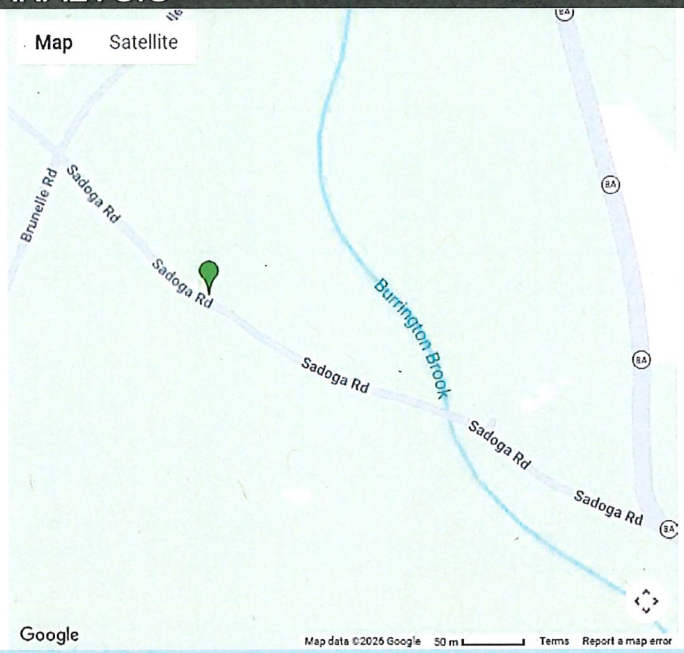
Traffic Count Results for Sadoga Road

Franklin Regional Council of Governments
12 Olive St Suite2 Greenfield MA 01301

CLASS DATA ANALYSIS

Location

Sadoga Road
between 8A & Brunelle Rd
Latitude: 42.718894
Longitude: -72.820880



Analysis Time Period

Start	End
9/3/2026	9/11/2026
11:18 AM	1:20 PM

Vehicles Analyzed

506

Unclassed

Unclassed
Volume: 11
Pct of Total: 2.2%
Average Speed: 5 MPH
Length: 12' 8"

Motorcycles

Motorcycles
Volume: 3
Pct of Total: 0.6%
Average Speed: 28 MPH
Length: 5' 4"

Bicycles

Bicycles
Volume: 1
Pct of Total: 0.2%
Average Speed: 14 MPH
Length: 5' 9"

Cars Trailers

Cars Trailers
Volume: 320
Pct of Total: 63.2%
Average Speed: 26 MPH
Length: 11' 5"

2 Axle Long

2 Axle Long
Volume: 124
Pct of Total: 24.5%
Average Speed: 28 MPH
Length: 13' 2"

Buses

Buses
Volume: 20
Pct of Total: 4.0%
Average Speed: 17 MPH
Length: 23' 2"

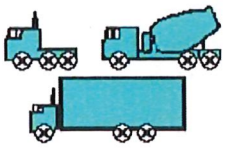
2 Axle 6 Tire

2 Axle 6 Tire
Volume: 26
Pct of Total: 5.1%
Average Speed: 26 MPH
Length: 14' 10"

Franklin Regional Council of Governments
12 Olive St Suite2 Greenfield MA 01301

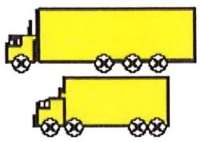
CLASS DATA ANALYSIS

3 Axle Single



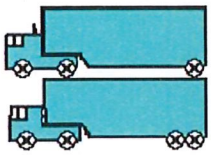
3 Axle Single
Volume: 0
Pct of Total: 0.0%
Average Speed: 0 MPH
Length: 0' 0"

4 Axle Single



4 Axle Single
Volume: 0
Pct of Total: 0.0%
Average Speed: 0 MPH
Length: 0' 0"

<5 Axl Double



<5 Axl Double
Volume: 1
Pct of Total: 0.2%
Average Speed: 14 MPH
Length: 40' 0"

5 Axle Double



5 Axle Double
Volume: 0
Pct of Total: 0.0%
Average Speed: 0 MPH
Length: 0' 0"

>6 Axl Double



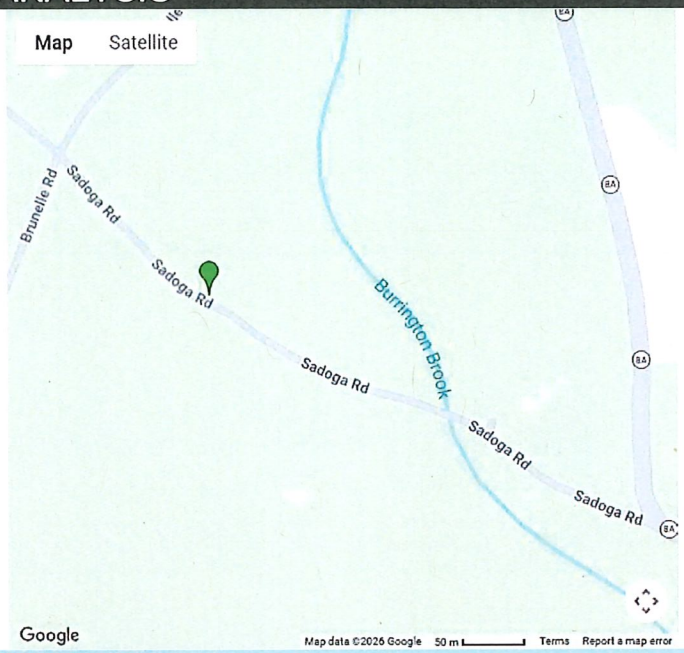
>6 Axl Double
Volume: 0
Pct of Total: 0.0%
Average Speed: 0 MPH
Length: 0' 0"

Franklin Regional Council of Governments
12 Olive St Suite2 Greenfield MA 01301

SPEED DATA ANALYSIS

Location

Sadoga Road
between 8A & Brunelle Rd
Latitude: 42.718894
Longitude: -72.820880



Analysis Time Period

Start	End
9/3/2026 11:18 AM	9/11/2026 1:20 PM

Vehicles Analyzed

506

Speed Limit



30

Total Enforceable Violations

9

Average Speed

26

% Enforceable Violations

2%

85th Percentile Speed

32

Enforcement Tolerance

10

Peak Time of Violations

9/4/2026
7:18 AM

Franklin Regional Council of Governments
12 Olive St Suite2 Greenfield MA 01301

Town: Heath
Counter: 11
Func. Class: 0,Local/Unpaved
Requested By: Town/FRCOG

Station ID: 1390026
Road: Sadoga Road
Location: between 8A & Brunelle Rd
Latitude: 42.718894
Longitude: -72.820880

8/31/2026	Monday		Tuesday		Wednesday		Thursday		Friday		Weekday Average		Saturday		Sunday	
Time	NB, L1	SB, L1	NB, L1	SB, L1	NB, L1	SB, L1	NB, L1	SB, L1	NB, L1	SB, L1	NB, L1	SB, L1	NB, L1	SB, L1	NB, L1	SB, L1
12:00 AM	*	*	*	*	*	*	*	*	1	0	1	0	1	0	0	0
1:00	*	*	*	*	*	*	*	*	0	0	0	0	0	0	0	0
2:00	*	*	*	*	*	*	*	*	0	0	0	0	0	0	0	0
3:00	*	*	*	*	*	*	*	*	0	0	0	0	0	0	0	0
4:00	*	*	*	*	*	*	*	*	1	2	1	2	1	0	0	0
5:00	*	*	*	*	*	*	*	*	0	1	0	1	0	0	0	0
6:00	*	*	*	*	*	*	*	*	1	1	1	1	0	0	0	1
7:00	*	*	*	*	*	*	*	*	1	6	1	6	0	3	1	1
8:00	*	*	*	*	*	*	*	*	1	1	1	1	1	1	0	2
9:00	*	*	*	*	*	*	*	*	0	2	0	2	1	3	1	2
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Day	0		0		0		49		55		61		58		42	
AM Peak							11:00	11:00	12:00 AM	7:00	11:00	7:00	10:00	11:00	10:00	8:00
Volume							5	2	1	6	2	6	3	5	2	2
PM Peak							1:00	3:00	5:00	2:00	3:00	2:00	12:00 PM	12:00 PM	2:00	1:00
Volume							4	3	5	4	4	3	4	2	3	2

Franklin Regional Council of Governments
12 Olive St Suite2 Greenfield MA 01301

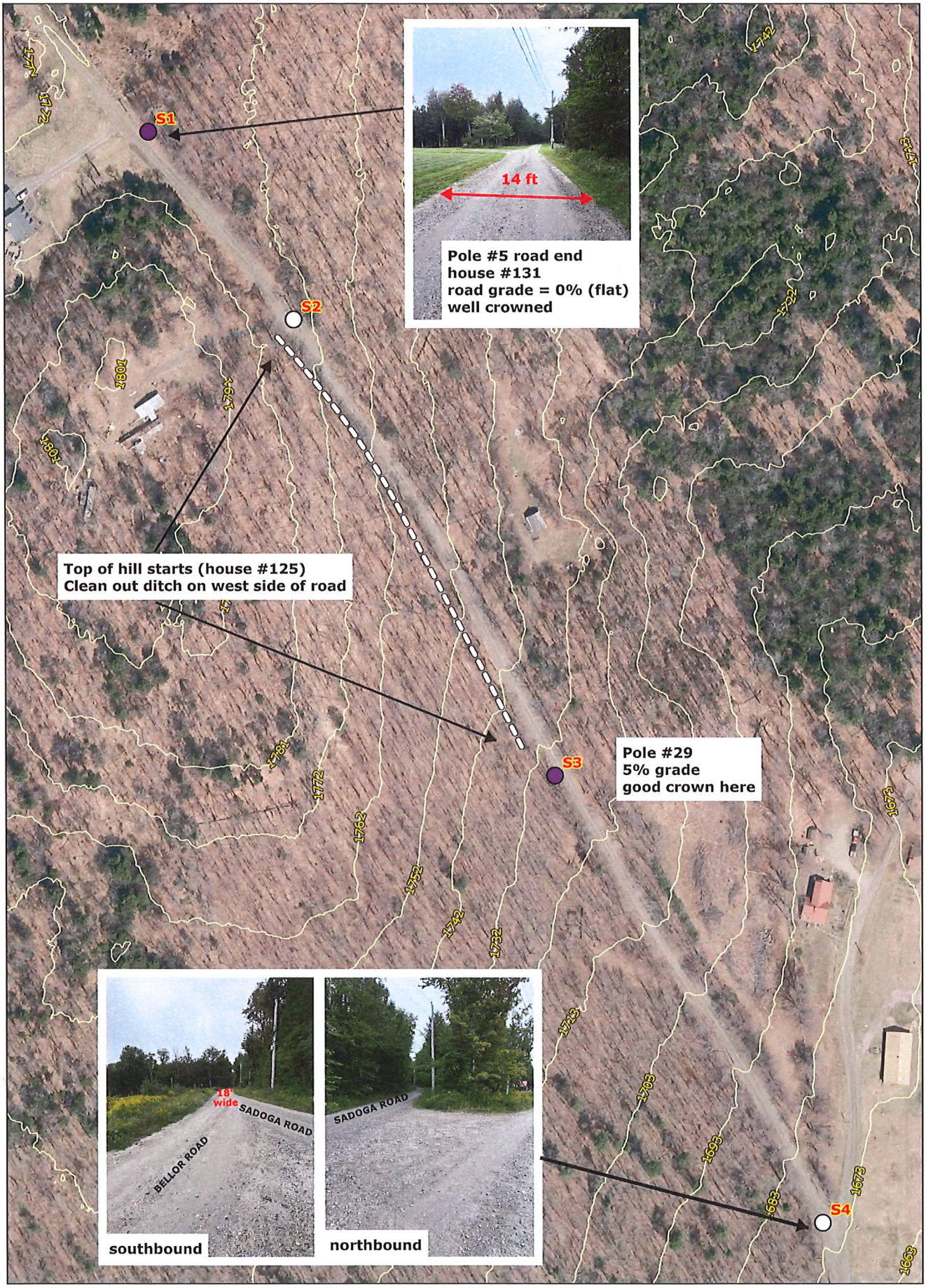
Town: Heath
Counter: 11
Func. Class: 0,Local/Unpaved
Requested By: Town/FRCOG

Station ID: 1390026
Road: Sadoga Road
Location: between 8A & Brunelle Rd
Latitude: 42.718894
Longitude: -72.820880

9/7/2026	Monday		Tuesday		Wednesday		Thursday		Friday		Weekday Average		Saturday		Sunday	
Time	NB, L1	SB, L1	NB, L1	SB, L1	NB, L1	SB, L1	NB, L1	SB, L1	NB, L1	SB, L1	NB, L1	SB, L1	NB, L1	SB, L1	NB, L1	SB, L1
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Total	16	20	29	35	40	47	36	47	10	22	29	36	0	0	0	0
Day	36		64		87		83		32		65		0		0	
AM Peak	10:00	9:00	10:00	7:00	9:00	7:00	10:00	7:00	8:00	7:00	10:00	7:00				
Volume	2	3	2	4	6	6	4	6	2	4	3	4				
PM Peak	1:00	4:00	4:00	5:00	3:00	1:00	4:00	2:00	12:00 PM	12:00 PM	3:00	2:00				
Volume	2	5	5	3	7	4	9	6	2	1	4	3				
Comb Total	36		64		87		132		87		126		58		42	
ADT		ADT: 60		AADT: 60												

Appendix B

Maps with Recommendations for Sadoga Road



Sadoga Rd Segment 1

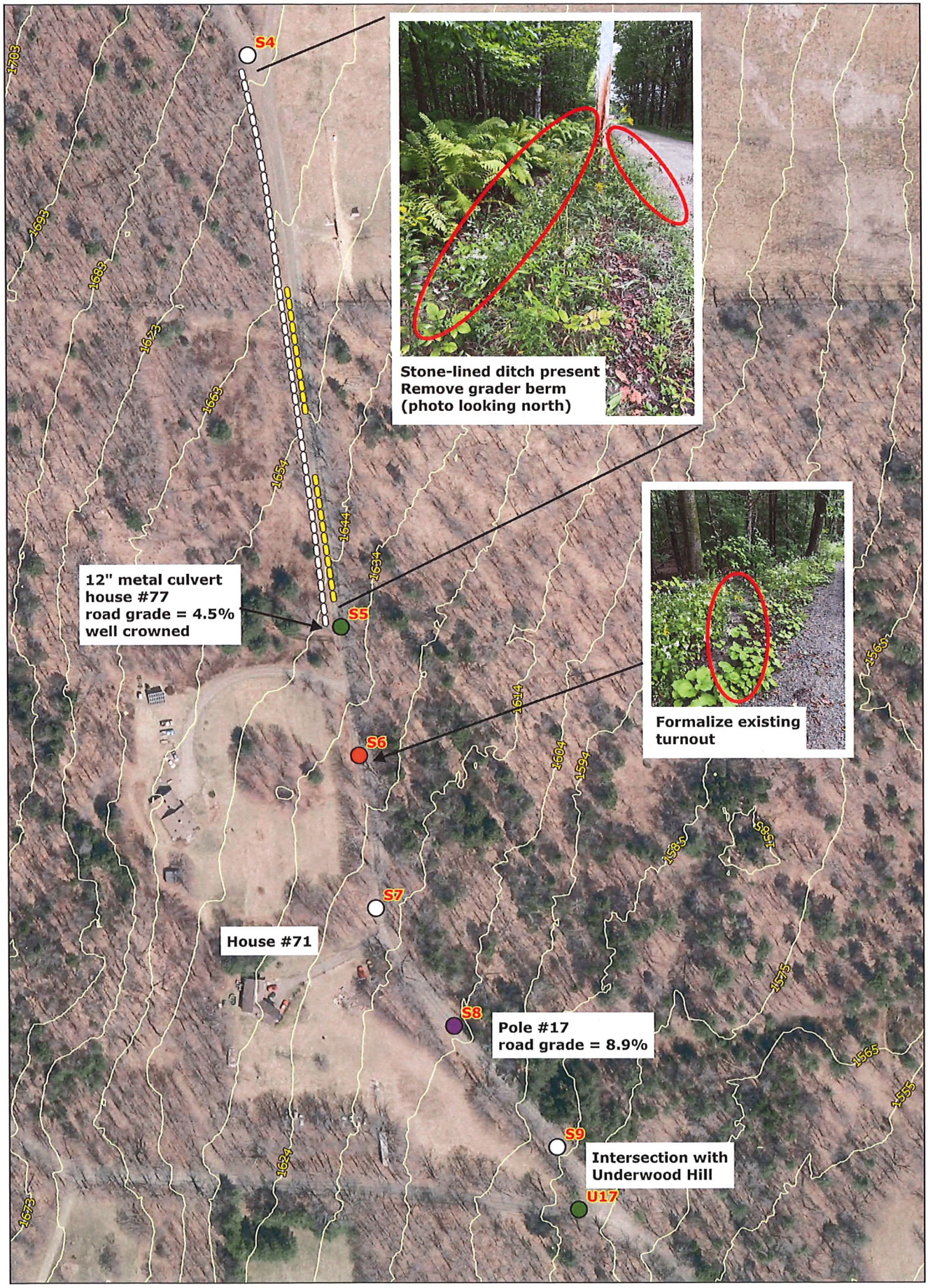
Field Assessment September 3, 2026

- Utility Pole
- Culvert
- Turnout
- GPS Reference Point
- Proposed ditch
- Existing ditch
- Grader Berm
- Contour Line (FT)

Area of Detail

0 80 160 Feet

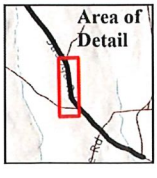
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Sadoga Rd Segment 2

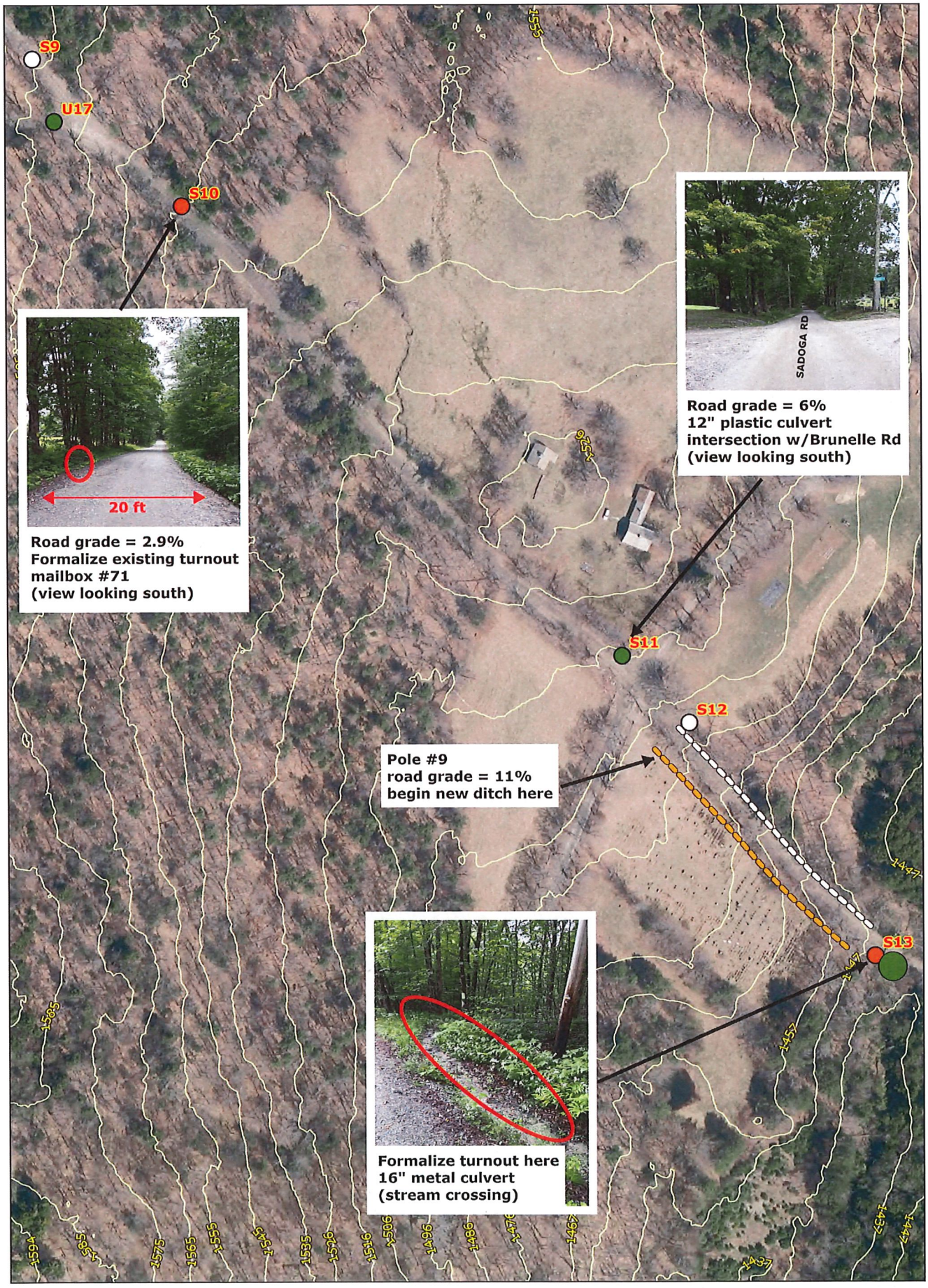
Field Assessment September 3, 2026

- Utility Pole
- Culvert
- Turnout
- GPS Reference Point
- Proposed ditch
- Existing ditch
- Grader Berm
- Contour Line (FT)



0 80 160 Feet

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Sadoga Rd Segment 3

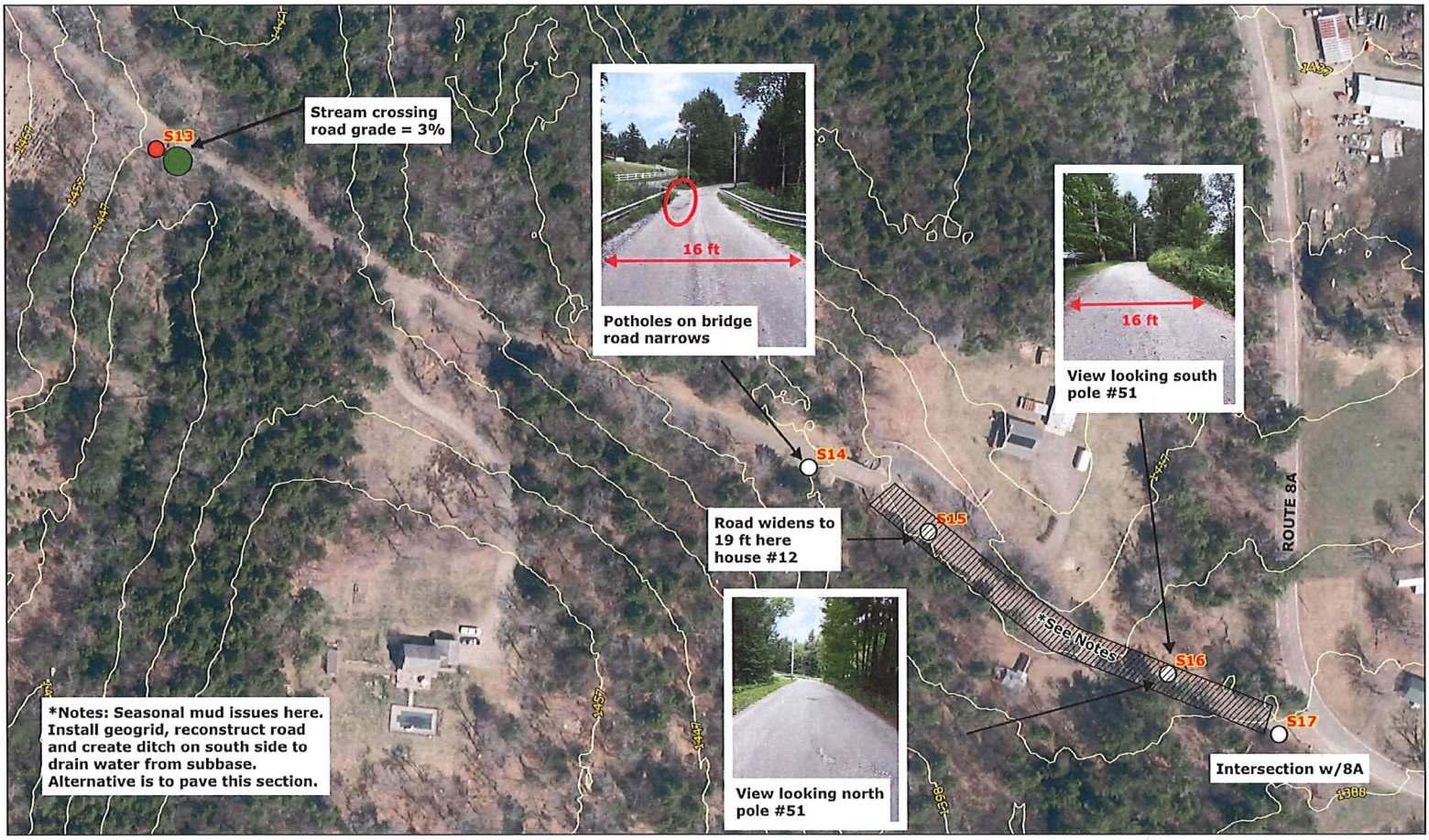
Field Assessment September 3, 2026

- Utility Pole
- Culvert
- Turnout
- GPS Reference Point
- Proposed ditch
- Existing ditch
- Grader Berm
- Contour Line (FT)



0 80 160 Feet

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Sadoga Rd
Segment 4

Field Assessment September 3, 2026

- Utility Pole
- Culvert
- Turnout
- GPS Reference Point
- Proposed ditch
- Existing ditch
- Grader Berm
- Contour Line (FT)

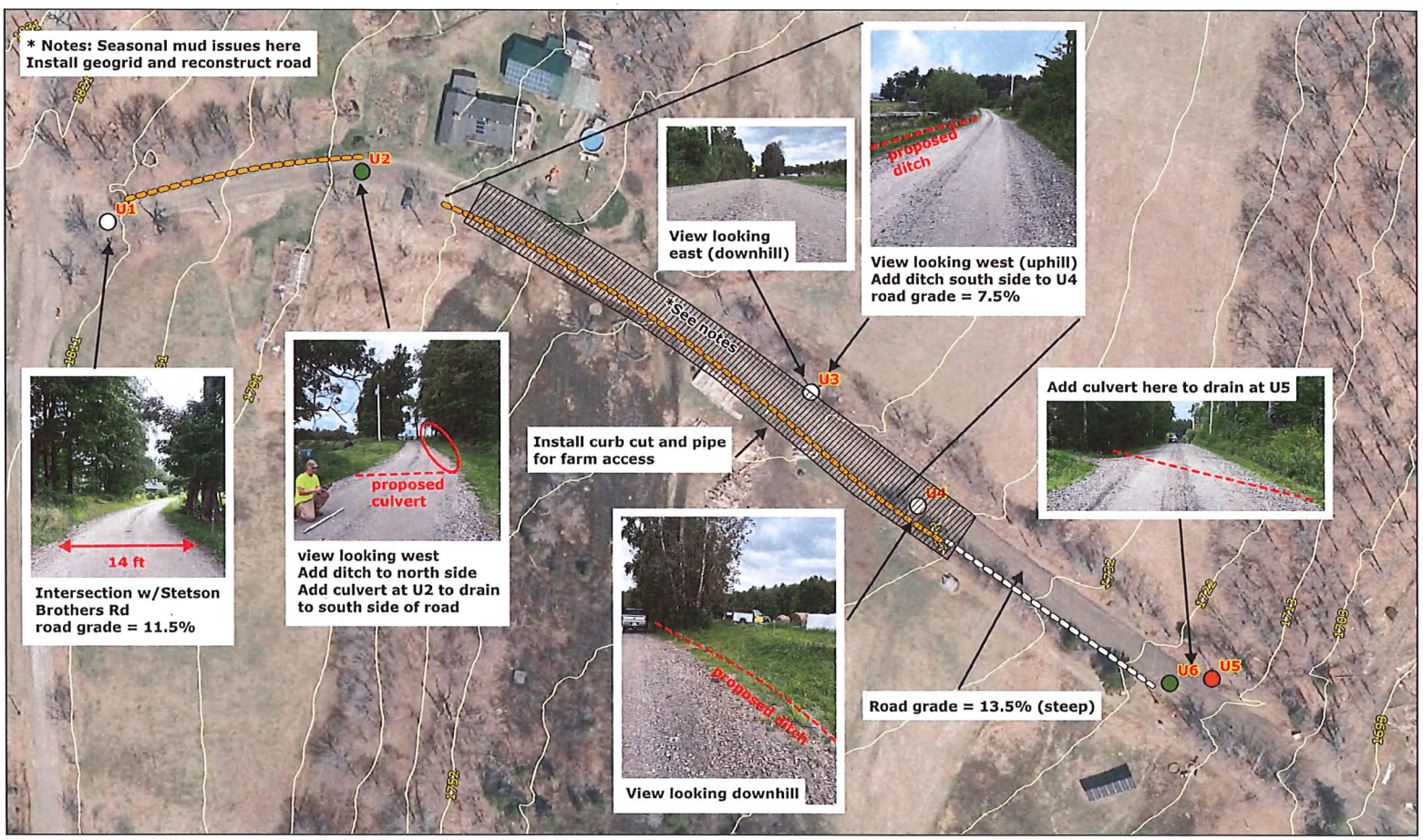
Area of Detail

0 100 200 Feet

Franklin Regional Council of Governments

Appendix C

Maps with Recommendations for Underwood Hill Road



Underwood Hill Rd
Segment 1
Field Assessment September 3, 2026

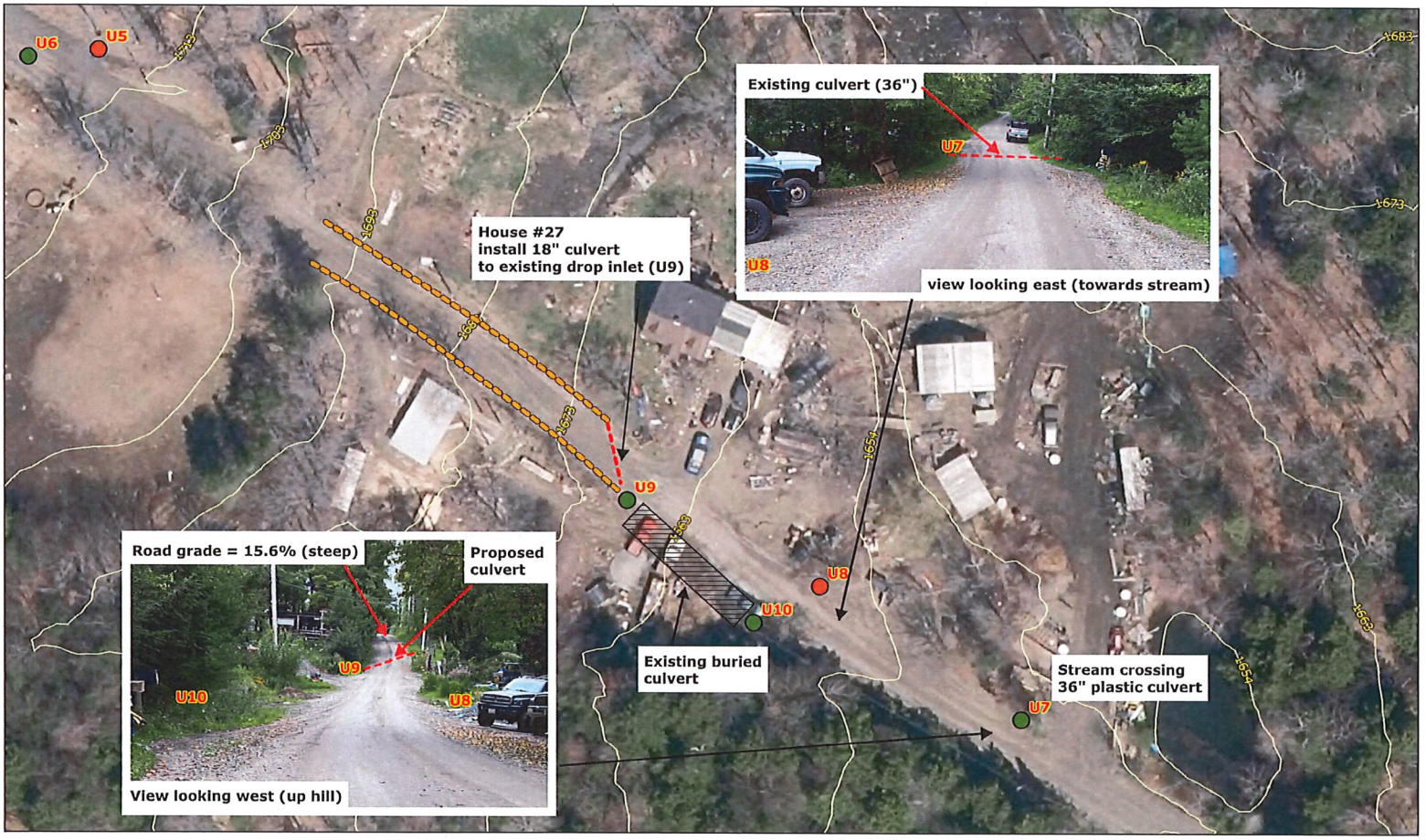
Culvert
Turnout
GPS Reference Point

Proposed ditch
Existing ditch
Grader Berm
Contour Line (FT)

Area of Detail

0 65 130 Feet

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Underwood Hill Rd
Segment 2
Field Assessment September 3, 2026

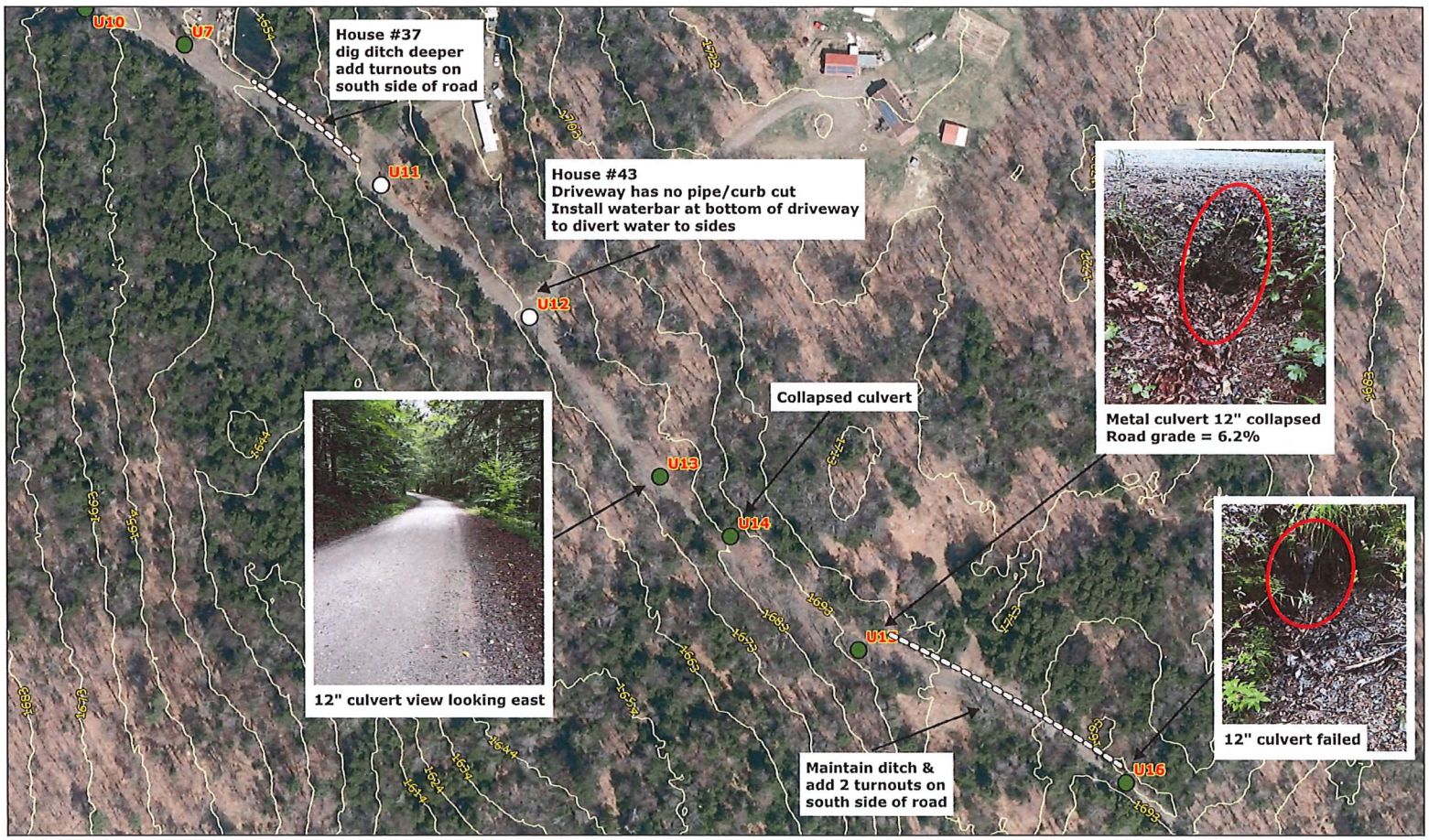
Culvert
Turnout
GPS Reference Point

Proposed ditch
Existing ditch
Grader Berm
Contour Line (FT)

Area of Detail

0 40 80 Feet

Franklin Regional Council of Governments



Underwood Hill Rd
Segment 3
Field Assessment September 3, 2026

Culvert
Turnout
GPS Reference Point

Proposed ditch
Existing ditch
Grader Berm
Contour Line (FT)

Area of Detail

0 125 250 Feet

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Underwood Hill Rd
Segment 4
Field Assessment September 3, 2026

- Utility Pole
- Culvert
- Turnout
- GPS Reference Point
- Proposed ditch
- Existing ditch
- Grader Berm
- Contour Line (FT)

Area of Detail

0 125 250 Feet

Franklin Regional Council of Governments

Appendix D

Fact Sheets and Design Typical for Unpaved Road Best Management Practices (BMPs)

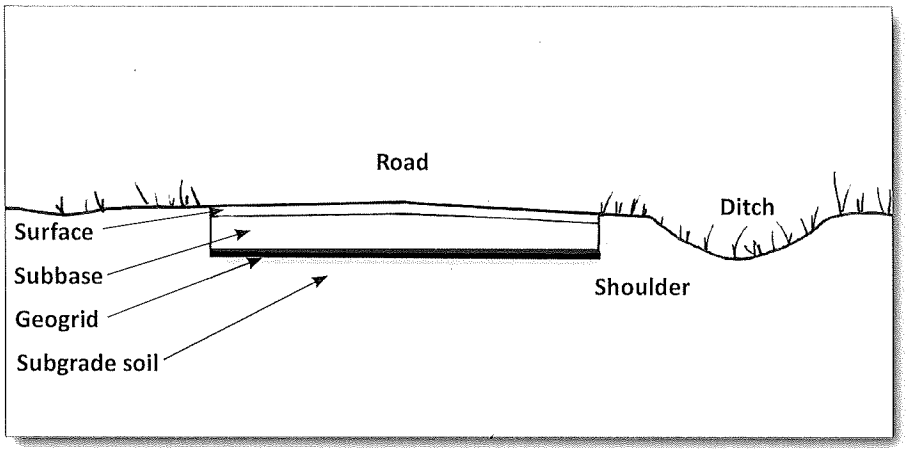
GEOGRID

Road Type

Adjacent to stream
Adjacent to wetland
Entrenched

BMP Function

Stabilization
Infiltration



Road cross section: Geogrid is a polymer gridded mat installed between the road subgrade and subbase to stabilize a wet or unstable road.

Description and Purpose

» A grid mat made of polymer material with large regular-sized openings.

» Stabilizes the road by separating and preventing the base course aggregate from migrating sideways or sinking into the subgrade soils.

Criteria for Use and Site Considerations

» Can be used at any site, but benefits are most obvious on unstable roads resulting from wet subbase.

Benefits

» Reduces rutting and other issues found on roads with wet subbase.

» On soft ground, distributes vehicle loads more widely, improving the effective bearing capacity.

» On firm ground, confines aggregate particles, interlocking itself with the fill materials, which will reduce the breakdown of the aggregate layer over time.

» Extends the service life of a road.

» Can be a solution to roads with heavy vehicle traffic that are not a candidate for paving.

Planning and Design

» Overlap ends of geogrid based on strength of subgrade: 3 – 4 feet when subgrade soils are soft, 1 – 2 feet when subgrade soils are strong.

» Gravel subbase should be at least 18 inches deep.

» Mesh size should be chosen based on the stability requirements of the road. Smaller mesh size is required for more stability.

GEOGRID

Material and Equipment

» Geogrid (for selection, refer to product specifications provided by manufacturer)

» Excavator or backhoe

» Dump truck

» Bulldozer

» Grader

» Vibratory roller

Maintenance

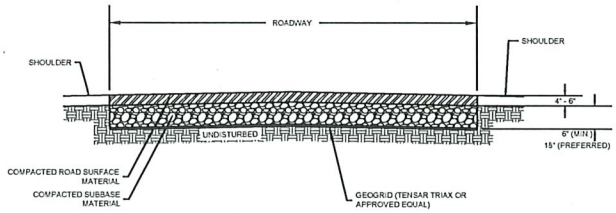
» Inspect road to ensure proper cover over geogrid is maintained.



Geogrid being laid on a wet section of road in early winter.

Project funded by the Massachusetts Municipal Vulnerability Preparedness (MVP) Program, 2025.

GEOGRID



CRITERIA FOR USE:

1. GEOGRID CAN BE USED TO IMPROVE COMPACTION OF SUBGRADE IN A ROADWAY PROFILE AND EXTEND THE SERVICE LIFE OF THAT ROADWAY.
2. GEOGRID IS USED TO AID ROADWAY STABILIZATION ISSUES.

DESIGN CONSIDERATIONS:

1. COMPACTED SUBBASE MATERIAL SHALL BE A MINIMUM OF 6" AND PREFERABLY, 15" OR MORE IN DEPTH.
2. WHEN CONSTRUCTED OVER SOFT GROUND, GEOGRID WILL DISTRIBUTE APPLIED LOADS MORE WIDELY, IMPROVING THE SUBGRADE SOIL'S EFFECTIVE BEARING CAPACITY.
3. WHEN CONSTRUCTED OVER FIRMER GROUND, GEOGRID WILL CONFINE AGGREGATE PARTICLES, INTERLOCKING ITSELF WITH THE FILL MATERIALS WHICH WILL REDUCE THE BREAKDOWN OF THE AGGREGATE LAYER OVERTIME.
4. GEOGRID OVERLAP VARIES DEPENDING ON THE STRENGTH OF THE SUBGRADE. FOR LOCATIONS WHERE THE SUBGRADE IS SOFTER, OVERLAPPING OF GEOGRID SHALL BE BETWEEN 3 AND 4 FT. WHEN THE SUBGRADE IS STRONGER, THE REQUIRED OVERLAP SHALL BE BETWEEN 1 AND 2 FT.
5. THE PREFERRED GRADATION FOR PAVED BASED REINFORCEMENT APPLICATIONS IF WELL-GRADED CRUSHED AGGREGATE FILL WITH A MAXIMUM PARTICLE SIZE OF 1.5" AND LESS THAN 10% FINES. SEE TABLE.
6. FOR UNPAVED SUBGRADE IMPROVEMENT APPLICATIONS, ANY CLEAN GRANULAR FILL MAY BE ACCEPTABLE.
7. MESH SIZING SHOULD BE CHOSEN BASED ON THE STABILITY REQUIREMENTS OF THE ROADWAY. LOCATIONS WHICH REQUIRE MORE STABILITY SHALL USE GEOGRID WITH A SMALLER MESH SIZE. LARGER MESH SIZES CAN BE USED WHEN LESS STABILITY IS REQUIRED.

PREFERRED FILL GRADATION	
SIZE	% PASSING
1½"	100
¾"	50-100
#4	25-50
#40	10-20
#100	5-15
#200	LESS THAN 10

CONSTRUCTION SPECIFICATIONS:

1 GEOGRID

THE PROPERTIES SHALL BE IN ACCORDANCE WITH ASTM D4759-02.
REFER TO PRODUCT SPECIFICATION PROVIDED BY GEOGRID MANUFACTURER.

CONSTRUCTION SEQUENCING:

1. CONTACT DIG SAFE (1-888-344-7233) A MINIMUM OF 72 BUSINESS HOURS PRIOR TO BEGINNING EXCAVATION WORK.
2. CLEAR & GRUB & EXCAVATE (IF NECESSARY) TO THE DESIGN SUBGRADE ELEVATION.
3. REMOVE AND REPLACE ANY UNSUITABLE MATERIALS FOUND.
4. PLACE THE GEOGRID OVER THE PREPARED SURFACE IN THE DIRECTION OF TRAVEL.
5. ANCHOR THE BEGINNING, CENTER, AND THE CORNERS OF THE ROLL WITH SMALL PIECES OF AGGREGATE BEFORE FULLY UNROLLING.
6. ONCE GEOGRID IS TIGHTENED AND ALIGNED IN PLACE, AGGREGATE MAY BE DUMPED DIRECTLY ONTO GEOGRID. COMPACT AGGREGATE FILL ACCORDING TO GUIDANCE PROVIDED IN "COMPACTION OF ROAD AFTER GRADING" SECTION OF THE UNPAVED STORMWATER MANAGEMENT TOOLKIT.

OPERATION AND MAINTENANCE:

1. ROADWAY SHOULD BE INSPECTED TO ENSURE PROPER COVER OVER GEOGRID IS MAINTAINED. REFER TO "PROPER ROAD STRUCTURE" GUIDANCE PROVIDED IN TOOL 7 OF THE UNPAVED ROADS STORMWATER MANAGEMENT TOOLKIT.

CONSTRUCTION COST:

UNIT COSTS:

EXCAVATION - $40.00/CY

GEOGRID - $15.00/SY

NOTE: BASED ON 2024 CONSTRUCTION PRICES. CONSTRUCTION PRICES VARY FREQUENTLY.

LIMITATIONS:

1. THE INFORMATION PRESENTED IS INTENDED TO PROVIDE GUIDANCE TO THE DEPARTMENT OF PUBLIC WORKS (DPW) OR HIGHWAY DEPARTMENT FOR THE IMPLEMENTATION OF BEST MANAGEMENT PRACTICES (BMPs) TO MANAGE STORMWATER, REDUCE EROSION OR UNPAVED ROADS, AND REDUCE SEDIMENTATION ENVIRONMENTAL RESOURCES.
2. THE USER SHALL REFERENCE UNPAVED ROADS STORMWATER MANAGEMENT TOOLKIT FOR A DESCRIPTION OF APPLICABILITY FOR THIS BMP.
3. BMP SHALL BE SIZED IN ACCORDANCE WITH THE GUIDANCE PRESENTED. A PROFESSIONAL ENGINEER SHALL BE CONSULTED FOR SIZING BMPs OUTSIDE THE LIMITS PRESENTED.

NOTE:
PROJECT FUNDED BY THE MASSACHUSETTS MUNICIPAL VULNERABILITY PREPAREDNESS (MVP) PROGRAM, 2025.

GEOGRID		
PREPARED BY: BSC GROUP (BUILD | SUPPORT | CONNECT)		PREPARED FOR: frcog
DATE: APRIL 2025	REVISION NO: -	FIGURE: G-1

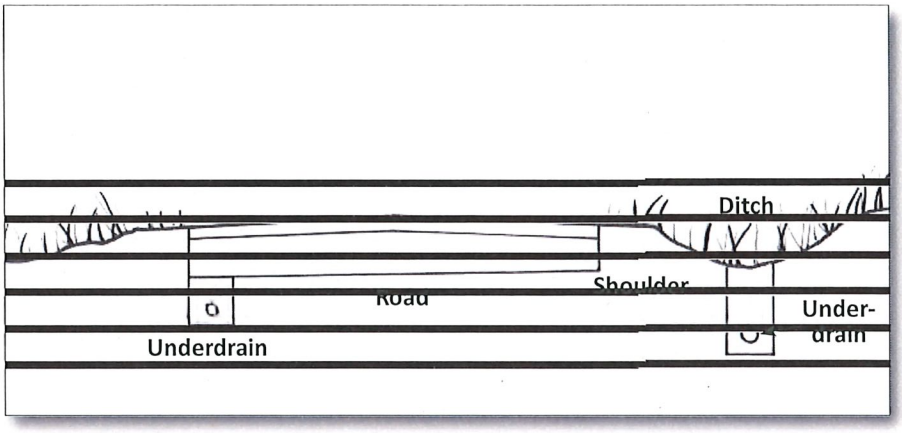
UNDERDRAIN

Road Type

Steep bank slope
Adjacent to stream
Adjacent to wetland
Entrenched

BMP Function

Conveyance

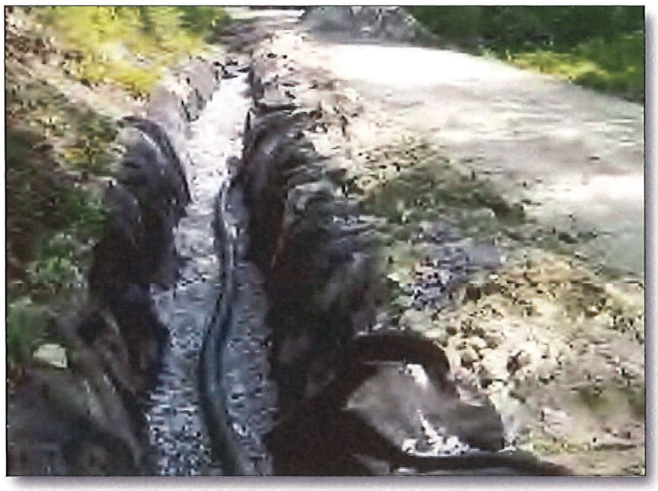


Road cross-section: Underdrain under road (left) and under ditch (right).

Description and Purpose

» A pre-fabricated perforated pipe installed under the drainage ditch or road shoulder in a bed of clean washed stone wrapped in geotextile fabric that allows water, particularly groundwater, to drain quickly through the pipe.

» Stabilizes soft road base, roadside ditches, and banks.



Underdrain under construction.

Criteria for Use and Site Considerations

» Use in areas where road ditches have standing water or active flow due to springs and seeps in the road or adjacent banks.

» Use in areas where the cut bank or road shoulder is unstable and frequently fails due to bank springs or a saturated ditch.

» Use in areas where subsurface water is suspected of causing stability problems in the road.

» Use in areas where road shoulders are wet, soft, and rutting.



Underdrain outlet with crush resistant drain pipe, animal guard to prevent clogging, and large rocks and posts to keep vehicles from damaging the pipe.

Benefits

» Improves subsurface drainage.

» Prevents subsurface water from mixing with sediment-laden surface runoff.

» Can be sized to handle site-specific flow volumes.

» Inexpensive and easy to install.

» Long service life.

UNDERDRAIN

Planning and Design

» Do not direct road surface runoff into an underdrain. Underdrains are meant to collect clean water from spring or seeps or to drain the subbase. Sediment and debris carried in surface runoff will clog the underdrain and make it nonfunctional.

» Install at an adequate slope to ensure proper drainage, at least 1% slope.

» Typical underdrain pipe size is 6 inches in diameter. Consider using a larger diameter pipe (12-inch diameter) if the length between outlets of underdrain is long (>300 feet) or the slope is under 1%.

» Install a minimum 2-foot-wide trench for perforated pipes under 12-inch diameter. For perforated pipe sizes over 12-inch diameter, install a trench with the minimum width of the diameter of the pipe plus 6 inches on each side of the pipe.

» Install trench deep enough for a minimum of 22 inches of stone below the pipe and 3 inches of stone above the pipe.

» Install a minimum of 12 inches of cover over the wrapped fabric structure to protect the integrity of the underdrain and prevent damage to the geotextile wrap.

» Do not use fine soils, such as clay, for cover directly above the drain.

» If possible, outlet underdrain separately from road drainage to keep it from mixing with sediment-laden stormwater runoff and to minimize the volume of concentrated flow.

» For long stretches of underdrain, consider installing an access point for flushing the pipe.

» Where outlet is exposed, consider installing animal guard to prevent small animals from nesting in the pipe during no-flow conditions and clogging.

Material and Equipment

» Minimum 4-inch-diameter perforated pipe, 6 inches is preferable

» MassDOT specifications for ½-inch or ¾-inch crushed stone

» Non-woven geotextile fabric (geotextile is a best practice for stabilizing added materials)

» Dump truck

» Excavator or backhoe

Maintenance

» Check outlets for indication of blocked flow; flush if possible.

» Check animal guards if installed.

This project has been financed with federal funds from the Environmental Protection Agency (EPA) to the Massachusetts Department of Environmental Protection (MASSDEP) under a §319 competetive grant (project 22-05/319). The contents do not necessarily reflect the views and policies of EPA or the Department, nor does the mention of trade names or commercial products constitute endorsement or recommendations for use. *Revised with funding from MVP June 2025.*

UNDERDRAIN

CRITERIA FOR USE:

1. AREAS WHERE THERE ARE SPRINGS OR SEEPS IN THE ROAD OR IN THE ROAD DITCH.
2. WHERE ROAD DITCHES HAVE STANDING WATER OR ACTIVE FLOW DUE TO SPRINGS AND SEEPS.
3. WHERE THE CUT BANK IS UNSTABLE AND FREQUENTLY FAILS DUE TO BANK SPRINGS OR A SATURATED TOE.
4. WHERE SUBSURFACE WATER IS SUSPECTED OF CAUSING STABILITY PROBLEMS IN THE ROAD.

DESIGN CONSIDERATIONS:

1. SURFACE WATERS
   - 1.1. ROAD SURFACE DRAINAGE SHOULD NOT BE DIRECTED INTO AN UNDERDRAIN. UNDERDRAINS ARE MEANT TO COLLECT CLEAN SPRING OR SEEPS, AND DRAIN THE SUBBASE. SEDIMENT AND DEBRIS CARRIED IN SURFACE RUNOFF WILL CLOG THE UNDERDRAIN AND MAKE IT NONFUNCTIONAL.
2. SLOPE
   - 2.1. UNDERDRAINS SHOULD BE INSTALLED AT AN ADEQUATE SLOPE TO ENSURE PROPER DRAINAGE. AT LEAST A 1% (1V: 100H) SLOPE.
3. PIPE SIZE
   - 3.1. TYPICAL UNDER DRAIN PIPE SIZE IS 6" DIA. CONSIDER USING A LARGER DIAMETER PIPE (12" DIA.) IF THE DISTANCE BETWEEN OUTLETS OF UNDERDRAIN IS LONG (300') OR THE SLOPE IS UNDER 1% (1V:100H)
4. TRENCH
   - 4.1. TRENCH WIDTH
     - 4.1.1. PIPE DIAMETER UNDER 12 INCHES. UNDERDRAIN TRENCH SHALL BE A MINIMUM OF 2 FEET IN WIDTH WHEN THE DIAMETER OF THE PERFORATED PIPE IS UNDER 12 INCHES.
     - 4.1.2. PIPE DIAMETER OVER 12 INCHES. UNDERDRAIN TRENCH SHALL BE A MINIMUM WIDTH OF THE DIAMETER OF THE PIPE PLUS 6 INCHES ON EACH SIDE OF THE PIPE.
   - 4.2. TRENCH DEPTH
     - 4.2.1. UNDERDRAIN TRENCH SHALL BE DEEP ENOUGH TO PROVIDE A MINIMUM OF 2 INCHES OF BEDDING FOR THE PIPE AND A MINIMUM OF 3 INCHES OF STONE ABOVE THE PIPE. RECOMMEND 12 INCHES OF STONE ABOVE THE PIPE.
5. COVER
   - 5.1. THE COVER OVER THE UNDERDRAIN SHALL PROTECT THE INTEGRITY OF THE UNDERDRAIN AND PREVENT DAMAGE TO THE GEOTEXTILE WRAP. COVER SHALL ALSO PROTECT PIPE FROM THE WEIGHT OF TRAFFIC. THE COVER OVER THE PIPE SHALL MEET THE REQUIREMENTS OF THE MANUFACTURER OR SHALL BE 12" AT A MINIMUM. DO NOT USE FINE SOILS, SUCH AS CLAY, FOR COVER DIRECTLY ABOVE THE DRAIN.
6. OUTLETS
   - 6.1. IF PRACTICABLE, OUTLET UNDERDRAINS SEPARATELY FROM SURFACE DRAINAGE.
   - 6.2. IF THE OUTLET PIPE IS VULNERABLE TO CRUSHING OR EQUIPMENT DAMAGE AT THE SURFACE OUTLET, CONSIDER ENDING THE DRAIN WITH A SHORT PIECE OF HEAVIER CRUSH RESISTANT PIPE.
   - 6.3. WHERE OUTLET IS EXPOSED, CONSIDER INSTALLING ANIMAL GUARDS TO PREVENT CLOGGING.
   - 6.4. IF NO STRUCTURE IS TO BE PLACED AT THE ENDS OF THE UNDERDRAIN, THE UNDERDRAIN TRENCH SHALL BE EXTENDED A DISTANCE OF 3 FEET BEYOND THE STRUCTURE END OF THE PIPE AND FILLED WITH STONE.
7. MAINTENANCE
   - 7.1. FOR LONG STRETCHES OF UNDERDRAIN, RISERS SHOULD BE CONSIDERED FOR CLEANOUT ACCESS POINTS.
   - 7.2. UNDER DRAINS THAT DAYLIGHT AT THE OUTLET SHOULD BE DESIGNED WITH ANIMAL GUARDS TO PREVENT ANIMALS FROM ENTERING THE PIPE. A SWING GATE OR A SCREEN MESH CAN BE USED AS AN ANIMAL GUARD. THE MINIMUM SIZE FOR A SCREEN MESH IS 1-INCH.

CONSTRUCTION SPECIFICATIONS:

1. CRUSHED STONE. STONE FOR UNDERDRAIN SHALL MEET MASSDOT SPECIFICATIONS FOR ¾ INCH (M2.01.5) OR ¾ INCH (M2.01.4) CRUSHED STONE.
2. GEOTEXTILE FABRIC. GEOTEXTILE FABRIC SHALL BE A NON-WOVEN GEOTEXTILE FABRIC CLASSIFIED AS CLASS 2 FABRIC ON MassDOT QUALIFIED CONSTRUCTION MATERIALS LIST.
3. UNDERDRAIN PIPE. PIPE USED FOR UNDERDRAIN SHALL BE SLOT PERFORATED CORRUGATED PLASTIC PIPE. PIPE SHALL MEET MassDOT MATERIAL SPECIFICATION M5.03.9. MINIMUM PIPE SIZE SHALL BE 4 INCHES. TYPICAL PERFORATED PIPE SIZE IS 6 INCHES.
4. INLET & OUTLET PROTECTION. INLET AND OUTLET SHALL BE COVERED WITH A #23 GAUGE GALVANIZED WIRE SCREEN OF ¼ INCH MESH SATISFACTORILY FASTENED TO THE PIPE.

CONSTRUCTION SEQUENCING:

1. CONTACT DIG-SAFE (1-888-344-7233) A MINIMUM OF 72 BUSINESS HOURS PRIOR TO BEGINNING EXCAVATION WORK.
2. UNDERDRAIN SHALL BE INSTALLED IN ACCORDANCE WITH SUBSECTION 260 OF THE 2025 MassDOT STANDARD SPECIFICATIONS FOR HIGHWAYS AND BRIDGES. SEQUENCE SHALL BE AS FOLLOWS:
   - 2.3. UNDERDRAIN TRENCH SHALL BE EXCAVATED TO THE DEPTH REQUIRED TO PROVIDE ADEQUATE COVER OF THE UNDERDRAIN OR TO A STRATUM OF IMPERVIOUS MATERIAL. TRENCH SHALL BE EXTENDED 3 FEET PAST END OF UNDERDRAIN WHERE NO OUTLET STRUCTURE IS PROPOSED.
   - 2.4. GEOTEXTILE FILTER FABRIC SHALL BE PLACED ALONG THE SIDES AND BOTTOM OF THE TRENCH. ENOUGH FABRIC SHALL BE LEFT TO LAY OVER THE TOP OF THE STONE ONCE TRENCH IS BACKFILLED. OVERLAP BETWEEN ANY ADJOINING PIECES OF FABRIC SHALL BE AT LEAST 2 FEET.
   - 2.5. PLACE PERFORATED PIPE IN THE CENTER OF THE TRENCH ON A BED OF 2 INCHES OF CRUSHED STONE.
   - 2.6. INSTALL OUTLET STRUCTURE AND INLET AND OUTLET WIRE SCREEN.
   - 2.7. FILL TRENCH, AND 3 FEET BEYOND THE END OF PIPE WITH CRUSHED STONE IF NO OUTLET STRUCTURE IS TO BE USED. CHINK STONE AROUND PERFORATED PIPE.
   - 2.8. BRING TRENCH TO FINISH GRADE. MINIMUM 12" OF COVER.

CONSTRUCTION COSTS:

COST PER LINEAR FOOT OF SUBDRAIN WILL VARY DEPENDING ON SIZE OF PERFORATED PIPE. CONSTRUCTION COST FOR TYPICAL UNDERDRAIN INSTALLED IS $75.00/L.F.

STONE:	$112.00/C.Y.
GEOTEXTILE FABRIC:	$10.00/S.Y.
PERFORATED PIPE:	PRICE VARIES PER PIPE DIAMETER

NOTE: BASED ON 2024 CONSTRUCTION PRICES. CONSTRUCTION PRICES VARY FREQUENTLY.

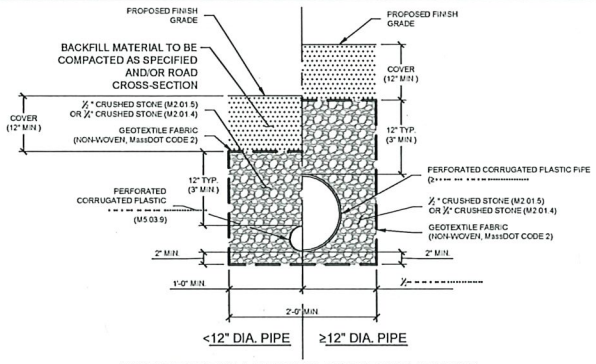
OPERATIONS AND MAINTENANCE:

1. INSPECT UNDERDRAINS BIANNUALLY AND AFTER MAJOR STORM EVENTS TO ENURE WATER IS FLOWING FREELY.
2. IN CASES WHERE THE UNDERDRAIN'S OUTLET IS DAYLIT, INSPECT THE OUTLET FOR ANY BLOCKAGES. UNDERDRAIN SHALL BE FLUSHED IF ANY BLOCKAGES ARE FOUND.

LIMITATIONS:

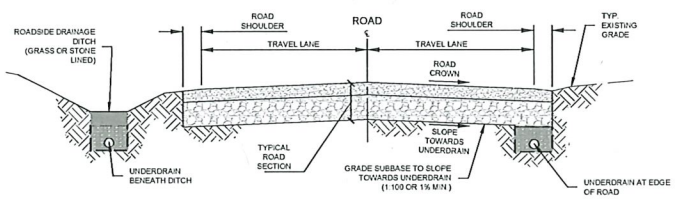
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2. THE USER SHALL REFERENCE UNPAVED ROADS STORMWATER MANAGEMENT TOOLKIT FOR A DESCRIPTION OF APPLICABILITY FOR THIS BMP.
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BMP ANNUAL STORMWATER POLLUTANT REDUCTION (LBS PER ACRE)						
	TSS (LBS/ACRE/YEAR)		TP (LBS/ACRE/YEAR)		TN (LBS/ACRE/YEAR)	
UNDERDRAIN	LOW	HIGH	LOW	HIGH	LOW	HIGH
	33.0	50.6	0.1	0.2	0.5	1.9



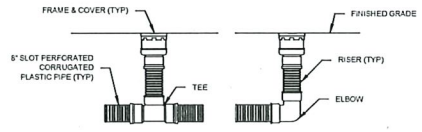
UNDERDRAIN CROSS-SECTION DETAIL

NTS



TYPICAL UNDERDRAIN LOCATION ALONG ROAD

NTS



RISER INSTALLATION OPTIONS

NTS

THIS PROJECT HAS BEEN FINANCED WITH FEDERAL FUNDS FROM THE ENVIRONMENTAL PROTECTION AGENCY (EPA) TO THE MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PROTECTION (THE DEPARTMENT) UNDER AN s. 319 COMPETITIVE GRANT. THE CONTENTS DO NOT NECESSARILY REFLECT THE VIEWS AND POLICIES OF EPA OR OF THE DEPARTMENT, NOR DOES THE MENTION OF TRADE NAMES OR COMMERCIAL PRODUCTS CONSTITUTE ENDORSEMENT OR RECOMMENDATION FOR USE.

REVISIONS FUNDED BY THE MASSACHUSETTS MUNICIPAL VULNERABILITY PREPAREDNESS (MVP) PROGRAM, 2025.

UNDERDRAIN

PREPARED BY:	REVISED BY:	PREPARED FOR:	
GZA	BSC GROUP	frcog	
DATE: SEP. 2024	REV DATE: JUN. 2025	REV NO: -	FIGURE: UD-1

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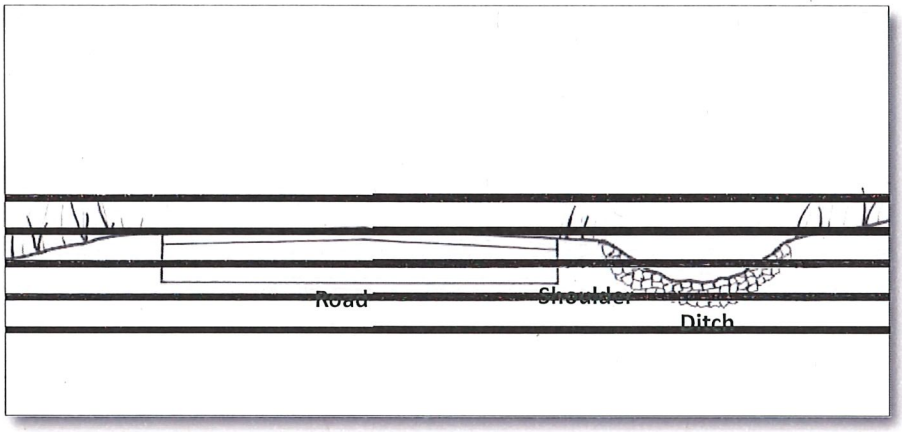
STONE-LINED DITCH

Road Type

Steep grade
Steep private driveway

BMP Function

Velocity Control
Stabilization
Infiltration
Conveyance



Road cross-section: Stone-lined ditches may be needed when the grade of the ditch is greater than 8%.

Description and Purpose

» Stone-lined roadside trench that collects and carries surface runoff from roads, roadside banks, springs, or seeps in a controlled manner.

» Controls and slows the flow of higher velocity road runoff.

Criteria for Use and Site Considerations

» Install along any road where water cannot shed off the edge as dispersed flow and there is room for a ditch.

» Use on steep stretches of roads (a slope greater than 8% or where stone check dams on vegetated ditches are not performing well).



A stone-lined ditch (left side of road) ends in a stone-lined turnout.

Benefits

» Prevents erosion in the ditch.

» Collects debris and allows sediment to settle out.

» Allows road subbase to drain.

Planning and Design

» Can be built anytime the ground is not frozen.

» Construct ditch with a U or parabolic shape; ditches with a V shape are not recommended.

» Ditch depth from road shoulder should be minimum 1 foot, ideally 2 to 3 feet for drainage.

» Construct ditch side slopes at a maximum 2H: 1V (50% slope); steeper side slopes are unstable and have a tendency to collapse, which erodes soil and creates maintenance problems.

» If possible, size ditch so that it is large enough to handle runoff from the contributing drainage area during a major storm, together with any contributions from uphill driveways or seeps and springs.

STONE-LINED DITCH

» Stone should be placed lower than the elevation of the shoulder so that water can flow from the road into the ditch and so that grading and other maintenance operations do not impact the stone lining.

» A minimum of 1 foot must be maintained from the top of the stone in the bottom of the ditch to the road shoulder. Do not fill the ditch with stone.

Material and Equipment

» Non-woven geotextile fabric (geotextile is a best practice for stabilizing added materials)

» ¾-inch crushed stone for bedding

» Riprap:
- Road slopes 8 – 10%: 6 – 8-inch stone or the equivalent
- Road slopes greater than 10%: 12-inch minus stone, also referred to as stone fill
- Largest dimension of the stone can vary from 1 – 12 inches; at least 50% of the volume of the stone in-place should have a minimum dimension of 4 inches

» Dump truck

» Rubber-tire excavator with an articulated bucket (preferred)

» Skeleton bucket on an excavator to support separation of stone from sediment on-site

Maintenance

» Inspect and repair twice yearly at minimum for major obstructions, erosion, or collapsed banks. Prioritize fall and spring when plants are dormant and after major storm events.

» Remove sediment, leaves, and debris to prevent overflows and washouts.

» Preventing erosion from uphill slopes can lengthen the time needed between ditch cleanings.

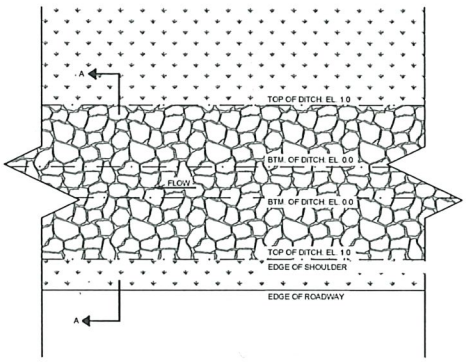
» Highway staff are understandably cautious about lining ditches with stone because the spaces between the stone will inevitably fill with silt. If a skeleton bucket is not available to clean the stone or replacement is not possible, an alternative is to scrape accumulated sediment off the top of the stone and add loam and seed it with a grass mix, maintaining the ditch as a vegetated ditch.

» Remove any grader berm left on the roadside from grading and plowing to allow proper road drainage.

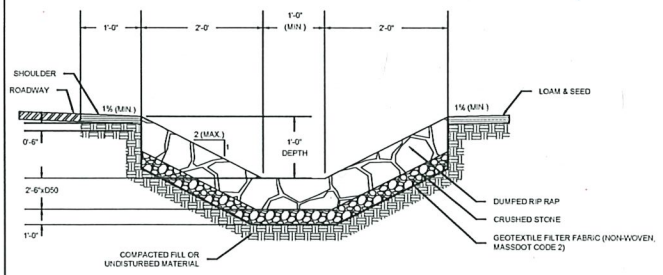
Recommended ditch types by road grade

Grade	Ditch type
0 – 5%	Vegetated
5 – 8%	Vegetated with stone check dam
Greater than 8%	Stone-lined
As needed up to 10%	Stone-lined with stone check dam

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TRAPEZOIDAL DITCH PLAN VIEW
NTS



CROSS-SECTION A - A
NTS

STONE-LINED DRAINAGE DITCH

CRITERIA FOR USE:

1. STONE-LINED DITCHES SHOULD BE USED FOR ROADS WITH A SLOPE GREATER THAN 5% WHERE STONE CHECK DAMS ARE NOT PERFORMING WELL, WHERE WATER CANNOT SHED OFF THE EDGE AS SHEET FLOW.

DESIGN CONSIDERATIONS:

1. FOR ROAD SLOPES 5-10%, USE 6 - 8-INCH STONE OR THE EQUIVALENT. FOR ROAD SLOPES GREATER THAN 10%, USE 12-INCH MINUS STONE, ALSO REFERRED TO AS STONE FILL, TYPE 1 FOR DITCH LINING. THE LONGEST DIMENSION OF THE STONE CAN VARY FROM 1 - 12-INCHES , AND AT LEAST 50% OF THE VOLUME OF THE STONE IN-PLACE SHOULD HAVE MINIMUM DIMENSION OF 4-INCHES.
2. STONE SHOULD BE PLACED LOWER THAN THE ELEVATION OF THE SHOULDER SO THAT WATER CAN FLOW FROM THE ROAD INTO THE DITCH AND SO THAT GRADING AND OTHER MAINTENANCE OPERATIONS DON'T NEGATIVELY IMPACT STONE LINING.
3. DO NOT FILL DITCH WITH ROCKS, RUNOFF FLOWING OFF OF THE ROADWAY MUST BE ABLE TO FLOW FROM THE ROADWAY AND INTO THE DITCH.
4. A MINIMUM OF 1' MUST BE MAINTAINED FROM THE TOP OF STONE TO THE ROADWAY ELEVATION.

GRADE	DITCH TYPE
0 - 5%	VEGETATED
5 - 8%	VEGETATED WITH STONE CHECK DAM
GREATER THAN 8%	STONE-LINED
AS NEEDED	STONE-LINED WITH STONE CHECK DAM

CONSTRUCTION SPECIFICATIONS:

1. STONE
   1.1. DUMPED RIPRAP
   STONE SHALL MEET MASSDOT SPECIFICATIONS FOR DUMPED RIPRAP (M 02.2) FOR ROAD SLOPES 8-10%, 25 LB STONES SHALL BE USED. FOR ROAD SLOPES GREATER THAN 10%, 75 LB STONES SHALL BE USED (SEE TABLE M2.02.2-1 FOR GRADATION REQUIREMENTS)
   1.2. CRUSHED STONE
   CRUSHED STONE FOR BEDDING SHALL MEET THE MASSDOT SPECIFICATIONS FOR ¾" CRUSHED STONE (M2.01.4)
2. GEOTEXTILE FABRIC
   GEOTEXTILE FABRIC SHALL BE A NON-WOVEN GEOTEXTILE FABRIC CLASSIFIED AS A CLASS 2 FABRIC ON MASSDOT QUALIFIED CONSTRUCTION MATERIALS LIST (QCML)

CONSTRUCTION SEQUENCING:

1. CONTACT DIG SAFE (1-888-344-7233) A MINIMUM OF 72 BUSINESS HOURS PRIOR TO BEGINNING EXCAVATION WORK.
2. CLEAR & GRUB ROAD SHOULDER WHERE DITCH IS GOING TO BE LOCATED.
3. EXCAVATE SHOULDER TO DEPTH AND REQUIRED SLOPE.
4. INSTALL GEOTEXTILE FABRIC INTO THE DITCH AND PLACE ¾" CRUSHED STONE BED.
5. DUMP RIPRAP MATERIAL WITH THE USE OF MACHINERY, BEGINNING AT THE DOWNGRADIENT END OF THE DITCH. FILL GAPS OF THE RIPRAP MATERIAL WITH SMALLER STONE TO FORM A STABLE UNIFORMED SURFACE.
6. WHERE DITCH SIDE SLOPES ARE 2H:1V, PLACE RIPRAP BY MACHINERY OR HAND, BEGINNING AT THE BOTTOM AND WORKING UP SLOPE. CHINK RIPRAP MATERIAL TO FORM A UNIFORMED SURFACE.

OPERATION AND MAINTENANCE:

1. INSPECT AFTER MAJOR STORM EVENTS FOR MAJOR OBSTRUCTIONS, EROSION, OR COLLAPSED BANKS.
2. CLEAN DITCHES OUT WHEN THEY BECOME FILLED WITH SEDIMENT OR DEBRIS TO PREVENT OVERFLOWS AND WASHOUTS.
3. PREVENTING EROSION FROM UPHILL SLOPES CAN LENGTHEN THE TIME NEEDED BETWEEN DITCH CLEANINGS.
4. TO CLEAN SEDIMENT BETWEEN STONE USE ONE OF TWO METHODS.
   A. DIG UP THE STONE, HAUL IT TO A LOCATION WHERE IS CAN BE SIFTED AND CLEANED, AND REPLACE IT.
   B. SCRAPE THE SEDIMENT OFF THE TOP OF THE STONE, AND LOAM AND SEED IT WITH A GRASS MIX; THIS STRATEGY REQUIRES DITCH CLEANING AND RESEEDING WHEN NEEDED, SIMILAR TO MAINTENANCE OF A VEGETATED DITCH.

CONSTRUCTION COST:

UNIT COSTS

EXCAVATION -	$40.00/CY
STONE -	
¾" CRUSHED STONE -	$84.00/CY
RIPRAP -	$120.00/CY
LOAM -	$90.00/CY
SEED -	$3.50/SY
GEOTEXTILE FABRIC -	$3.00/SY

NOTE: BASED ON 2024 CONSTRUCTION PRICES. CONSTRUCTION PRICES VARY FREQUENTLY.

LIMITATIONS:

1. THE INFORMATION PRESENTED IS INTENDED TO PROVIDE GUIDANCE TO THE DEPARTMENT OF PUBLIC WORKS (DPW) OR HIGHWAY DEPARTMENT FOR THE IMPLEMENTATION OF BEST MANAGEMENT PRACTICES (BMPs) TO MANAGE STORMWATER, REDUCE EROSION OR UNPAVED ROADS, AND REDUCE SEDIMENTATION IN ENVIRONMENTAL RESOURCES.
2. THE USER SHALL REFERENCE UNPAVED ROADS STORMWATER MANAGEMENT TOOLKIT FOR A DESCRIPTION OF APPLICABILITY FOR THIS BMP.
3. BMP SHALL BE SIZED IN ACCORDANCE WITH THE GUIDANCE PRESENTED. A PROFESSIONAL ENGINEER SHALL BE CONSULTED FOR SIZING BMPs OUTSIDE THE LIMITS PRESENTED.

NOTE:
PROJECT FUNDED BY THE MASSACHUSETTS MUNICIPAL VULNERABILITY PREPAREDNESS (MVP) PROGRAM, 2025.

STONE-LINED DITCH

PREPARED BY:	PREPARED FOR:	
BSC GROUP (BUILD | SUPPORT | CONNECT)	frcog	
DATE: APRIL 2025	REVISION NO: -	FIGURE: SLD-1

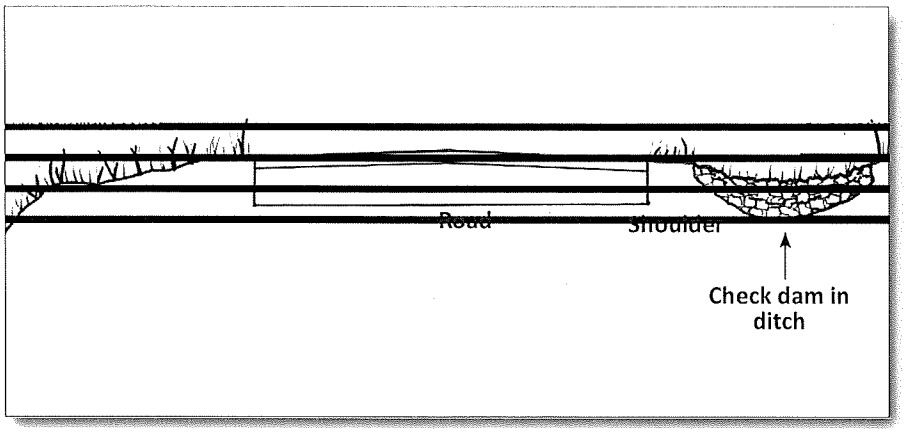
STONE CHECK DAM

Road Type

Steep grade
Steep private driveway

BMP Function

Velocity control
Detention
Accessory



Road cross-section: Stone check dams are useful in vegetated or stone-lined ditches with 5 – 10% grade where additional velocity control is needed.

Description and Purpose

» Stone dam constructed across the ditch, usually as a series.

» Designed to slow the flow velocity of runoff in a ditch to reduce erosion and allow sediment to settle out.

Criteria for Use and Site Considerations

» Use in ditches that drain 10 acres or less.

» Use in ditches with a 5 – 10% grade.

» Use in stone-lined ditches where additional velocity control is needed.

Benefits

» Inexpensive and easy to install and remove.

Planning and Design

» Can be added to a ditch anytime.

» First check dam should be installed 15 feet from nearest upgradient outlet and at regular intervals thereafter.

» Installed at a distance and a height to allow small pools to form behind them.

» The minimum spacing between the dams is variable and should be such that the bottom of the up-stream dam is at the same elevation as the top of the next downstream dam.

» Install maximum check dam height of 2 feet when draining less than 5 acres and 3 feet when draining 5 to 10 acres.

» The height of the check dam should be approximately two thirds of the ditch depth.

» Set the center of check dam approximately 6 inches lower than the outer edges to form a weir.

STONE CHECK DAM

» Side slopes not to exceed 2H:1V in slope (50% slope).

» Check dams should be keyed into the ditch bottom and abutments (sides) to a minimum depth of 6 inches, or up to 12 inches.

» Use 4- to 6-inch stone for check dams, or larger if needed.

» The rock must be placed by hand or mechanical placement (do not dump rock to form dam) to achieve complete coverage of the ditch and to ensure that the center of the dam is lower than the edges.

Material and Equipment

» Non-woven geotextile fabric (geotextile is a best practice for stabilizing added materials)

» MassDOT specifications for modified rockfill, or minimum 2-inch dense graded crushed stone

» Excavator or backhoe; final placement will be manual

» Skeleton bucket on an excavator to support separation of stone from sediment on-site

Maintenance

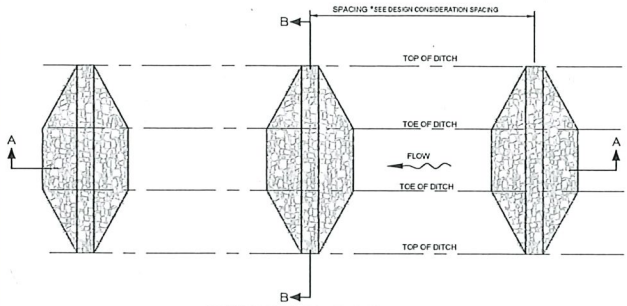
» Inspect and repair twice yearly at minimum for major obstructions, erosion, or collapsed banks. Prioritize fall and spring when plants are dormant and after major storm events.

» Remove sediment, leaves, and debris to prevent overflows and washouts.

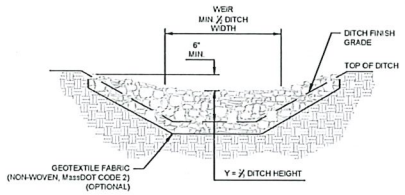
» Because a smaller amount of rock is needed for check dams, can be cost-effectively maintained by completely removing and replacing the rock when it becomes filled with silt; this is in contrast to rock-lined ditches, which require extensive amounts of hauling to clean or replace rocks.

» Alternatively, a skeleton bucket attachment can help separate stone from sediment on site.

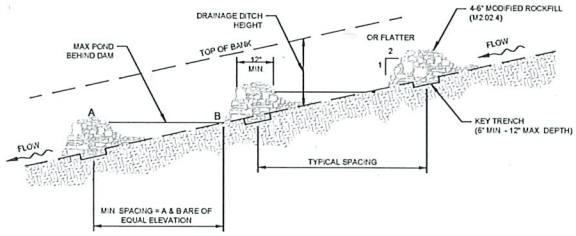
This project has been financed with federal funds from the Environmental Protection Agency (EPA) to the Massachusetts Department of Environmental Protection (MASSDEP) under a §319 competetive grant (project 22-05/319). The contents do not necessarily reflect the views and policies of EPA or the Department, nor does the mention of trade names or commercial products constitute endorsement or recommendations for use. *Revised with funding from MVP June 2025.*



TRAPEZOIDAL DITCH PLAN VIEW
NTS



CROSS SECTION B-B
NTS



DITCH PROFILE A-A
NTS

STONE CHECK DAM

NTS

CRITERIA FOR USE:

1. CHECK DAMS SHOULD BE USED IN SMALL OPEN DITCHES WITH THE FOLLOWING CHARACTERISTICS:
   - 1.1 CHECK DAMS SHOULD BE USED IN DITCHES THAT DRAIN 10 ACRES OR LESS.
   - 1.2 CHECK DAMS SHOULD BE USED IN DITCHES WITH SLOPES ≤10% (1V:10H) DITCHES WITH SLOPES STEEPER THAN 8% SHOULD BE STONE LINED.
2. CHECK DAMS SHOULD BE UTILIZED IN GRASS LINED DITCHES TO REDUCE FLOW VELOCITY TO 1 FOOT PER SECOND.
3. CHECK DAMS CAN BE UTILIZED WITHIN STONE LINED DITCHES TO REDUCE FLOW VELOCITY IN DITCHES WITH SLOPES >8%. CHECK DAMS INSTALLED WITHIN STONE LINED DITCHES SHALL FOLLOW CONSTRUCTION OF CHECK DAMS IN GRASS LINED DITCHES.

DESIGN CONSIDERATIONS:

1. CHECK DAM TYPICAL SPACING SHALL BE AS FOLLOWS:

SLOPE	SPACING*
2% OR LESS	60 FEET
2.1% TO 4%	40 FEET
4.1% TO 7%	25 FEET
7.1% TO 10%	15 FEET
> 10%	STONE LINED DITCH

2. MINIMUM CHECK DAM SPACING SHALL BE THE DISTANCE WHEN THE MAX POND BEHIND A DAM (POINT A IN PROFILE (A-A) MEETS THE TOE OF STONE OF THE UPGRADIENT CHECK DAM (POINT B IN PROFILE A-A)
3. MAXIMUM HEIGHT (Y) OF A CHECK DAM SHALL BE AS FOLLOWS:
   - 3.1 2 FEET IN HEIGHT WHEN DRAINING LESS THAN 5 ACRES
   - 3.2 3 FEET IN HEIGHT WHEN DRAINING 5 TO 10 ACRES.
   - 3.3 THE HEIGHT OF CHECK DAM SHALL BE LOWER THAN THE ADJACENT EDGE OF ROADWAY.
4. CENTER OF CHECK DAM SHALL BE APPROXIMATELY 6 INCHES LOWER THAN THE OUTER EDGES TO FORM A WEIR.
5. CHECK DAM SIDE SLOPES SHALL NOT EXCEED 2H:1V IN SLOPE.
6. CHECK DAMS SHOULD BE KEYED INTO THE DITCH BOTTOM AND ABUTMENTS (SIDES) TO A DEPTH OF 6" (MIN.) TO 12" (MAX.)
7. STONE MATERIAL SHALL BE SIZED APPROPRIATELY FOR THE ANTICIPATED FLOWS.
8. THE INSTALLATION OF CHECK DAMS IS NOT RECOMMENDED FOR SLOPES EXCEEDING 10%.

CONSTRUCTION SPECIFICATIONS:

1. STONE
   - 1.1 4-6" MODIFIED ROCKFILL (MINIMUM) (M2.02.4)
2. GEOTEXTILE FABRIC:
   - 2.1 NON-WOVEN GEOTEXTILE SEPARATION FABRIC. FABRIC MUST BE ON MassDOT QUALIFIED CONSTRUCTION MATERIAL LIST (QCML) AS A NON-WOVEN CODE 2 FABRIC

CONSTRUCTION SEQUENCING:

1. CONTACT DIG-SAFE (1-888-344-7233) A MINIMUM OF 72 BUSINESS HOURS PRIOR TO BEGINNING EXCAVATION WORK.
2. DETERMINE THE EXACT LOCATION, SIZE, TYPE, ETC. OF ALL UTILITIES THAT MAY BE AFFECTED BY THE WORK.
3. LOCATE AND MARK OUT THE SITE FOR EACH CHECK DAM TO AVOID UTILITIES AND OPTIMIZE EFFECTIVENESS OF EACH CHECK DAM.
4. REMOVE DEBRIS AND OTHER UNSUITABLE MATERIALS THAT WOULD INTERFERE WITH THE PLACEMENT OF CHECK DAM MATERIAL.
5. EXCAVATE A SHALLOW KEY TRENCH (6"-12" DEEP AND AT LEAST 12" WIDE) ACROSS THE CHANNEL.
6. PLACE GEOTEXTILE FABRIC WITHIN KEY TRENCH AND ALONG BASE BOTTOM OF THE DITCH.
7. PLACE CRUSHED STONE UPON GEOTEXTILE FABRIC VIA MACHINE AND/OR HAND CRUSHED STONE SHALL NOT BE DUMPED INTO DITCH.
8. WORK AND SHAPE CHECKDAM TO DESIGNED DIMENSIONS.

OPERATION AND MAINTENANCE:

1. INSPECT CHECK DAMS AT LEAST TWICE ANNUALLY, PRIORITIZING FALL AND SPRING WHEN PLANTS ARE DORMANT. REMOVE ANY DEBRIS FROM BEHIND CHECK DAMS AS NECESSARY.
2. INSPECT CHECK DAMS AFTER MAJOR STORMS. LOOK FOR EVIDENCE OF SOIL EROSION, EXCESSIVE PONDING, AND SEDIMENT ACCUMULATIONS.
3. REMOVE SEDIMENT WHEN IT REACHES 1/2 THE HEIGHT OF THE CHECK DAM.
4. REPAIR CHECK DAMS AS NECESSARY.

CONSTRUCTION COST:

CONSTRUCTION COST OF CHECK DAM WILL VARY BASED ON DITCH DEPTH AND WIDTH. THE COST OF A CHECK DAM BASED ON A 2'-6" DEEP BY 2'-0" WIDE DITCH IS $200.00/CHECK DAM.

MODIFIED ROCKFILL:	$175.00/C.Y.
GEOTEXTILE FABRIC:	$10.00/S.Y.

STONE NOTE_BASED ON 2024 CONSTRUCTION PRICES. CONSTRUCTION PRICES VARY FREQUENTLY.

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BMP ANNUAL STORMWATER POLLUTANT REDUCTION (LBS PER ACRE)						
	TSS (LBS/ACRE/YEAR)		TP (LBS/ACRE/YEAR)		TN (LBS/ACRE/YEAR)	
STONE CHECK DAM	LOW	HIGH	LOW	HIGH	LOW	HIGH
	44.3	50.6	0.1	0.3	0.2	2.1

THIS PROJECT HAS BEEN FINANCED WITH FEDERAL FUNDS FROM THE ENVIRONMENTAL PROTECTION AGENCY (EPA) TO THE MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PROTECTION (THE DEPARTMENT) UNDER AN s. 319 COMPETITIVE GRANT. THE CONTENTS DO NOT NECESSARILY REFLECT THE VIEWS AND POLICIES OF EPA OR OF THE DEPARTMENT, NOR DOES THE MENTION OF TRADE NAMES OR COMMERCIAL PRODUCTS CONSTITUTE ENDORSEMENT OR RECOMMENDATION FOR USE.

REVISIONS FUNDED BY THE MASSACHUSETTS MUNICIPAL VULNERABILITY PREPAREDNESS (MVP) PROGRAM, 2025.

STONE CHECK DAM			
PREPARED BY: GZA	REVISED BY: BSC GROUP	PREPARED FOR: frcog	
DATE: SEP. 2024	REV DATE: JUN. 2025	REV NO.: -	FIGURE: SCD-1

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