

Apple Street Roadbed Elevation & Culvert Replacement Project

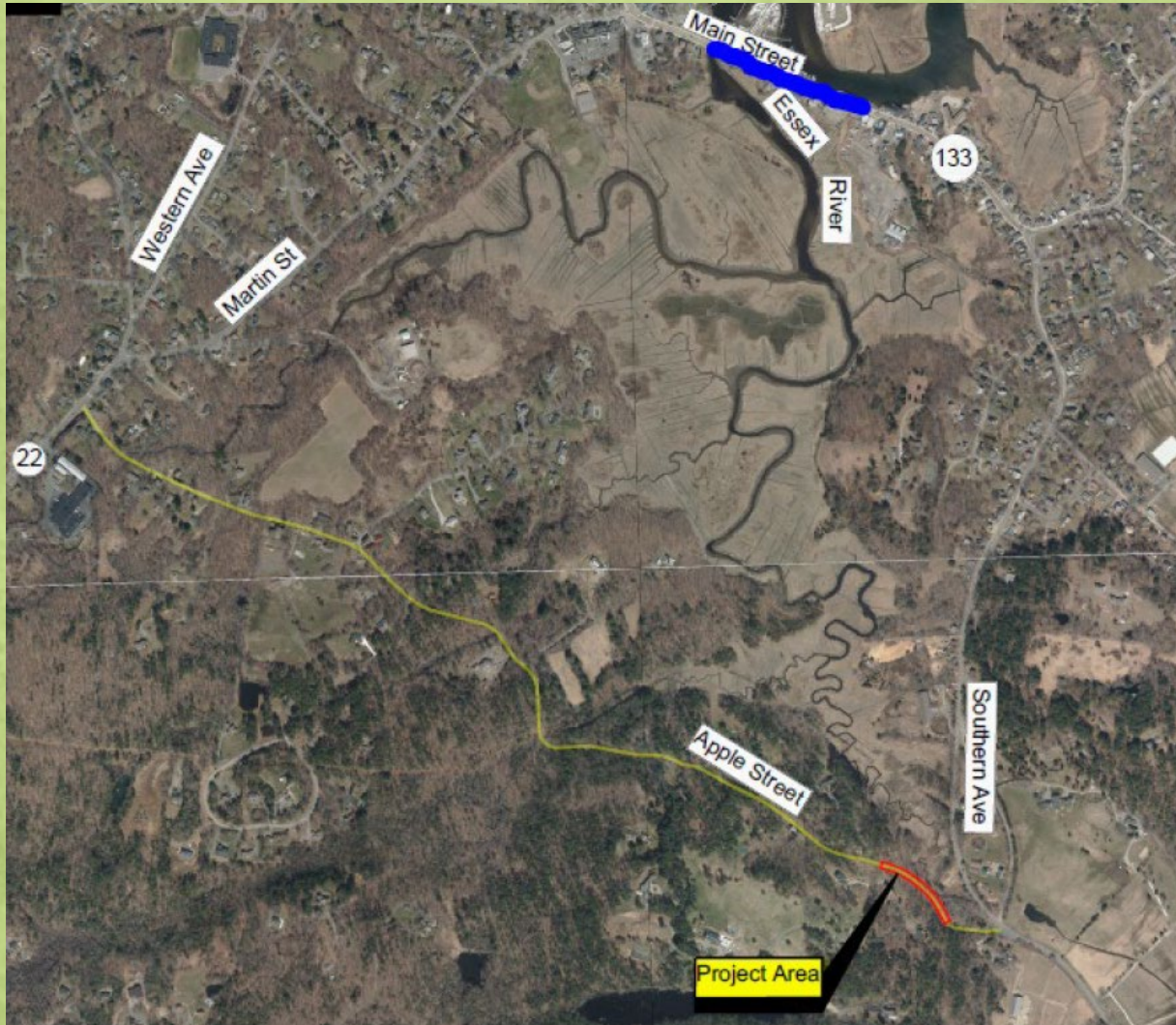
Town of Essex
Ipswich River Watershed Association
DER, CZM, MVP

The Problem – the Essex Causeway Floods...



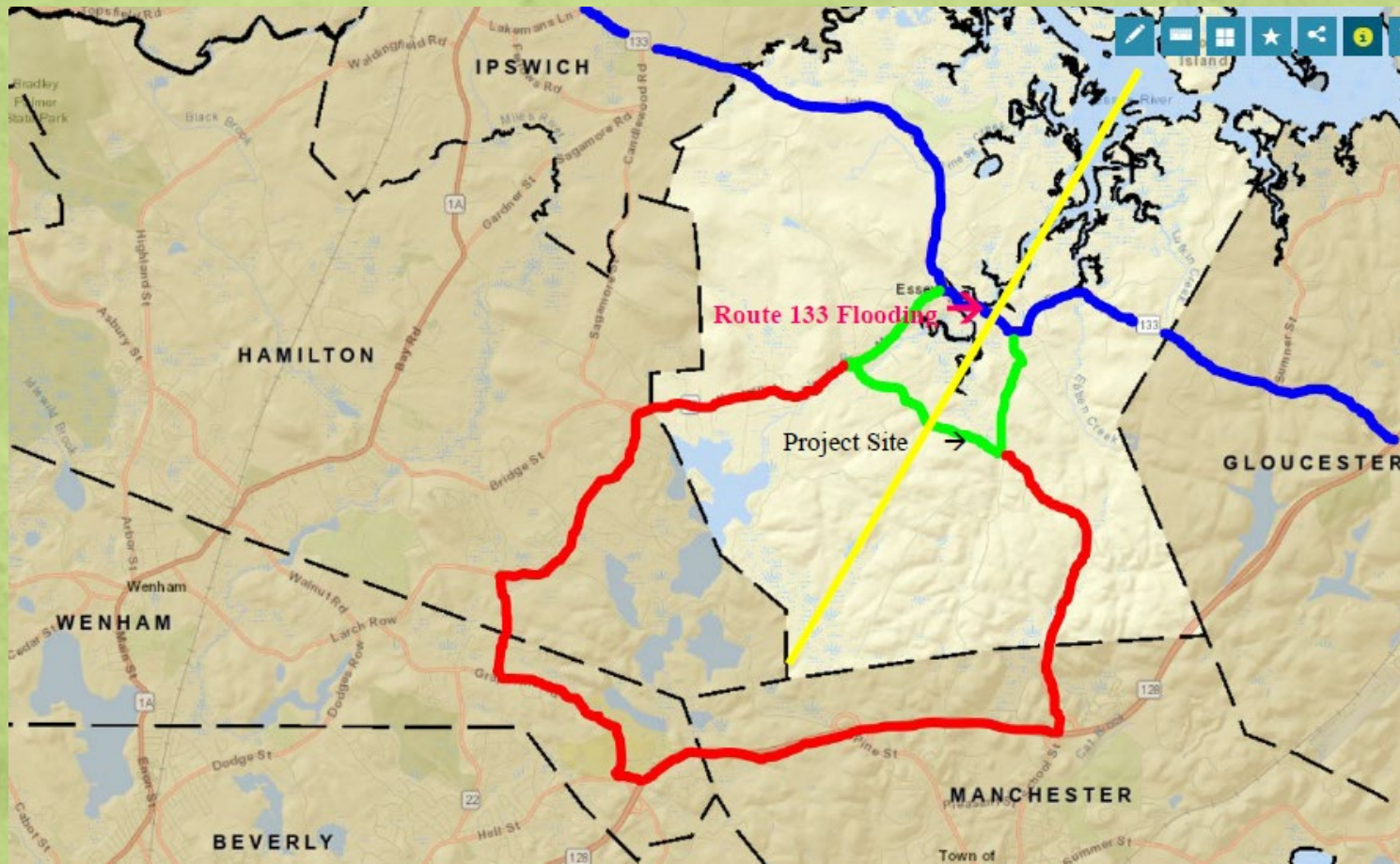
- The Essex Causeway on Route 133 floods with most storm surges and some astronomically-high tides.
- DOT decided several years ago not to elevate the roadway since that would conflict with the viability of some major businesses in downtown Essex.
- Even the replacement bridge over the Essex River that is being constructed presently is not being raised, since the required bridge approaches would conflict with business viability.

The Problem – so does Apple Street...



- The only other, in-Town roadway connecting the two halves of the Town is Apple Street, which can also flood along an approximately 800-foot section during larger coastal storm surges.
- In that same section, a substandard stream crossing interrupts the natural transition from wetland on one side of the road to upland stream on the other side of the road.
- With predictions for sea level rise and more frequent, more intense coastal storms on the horizon, now is the time to act to ensure an alternate emergency travel path for the future.

The Problem – it's a long way home...



- **BLUE** – Route 133
- **GREEN** – Apple Street route when causeway is flooded.
- **RED** – Alternate route using Route 128 when Apple Street is also flooded.
- **YELLOW** – Approximate division of the two halves of the Town connected by the causeway and Apple Street.

Picture This...as the future new "normal"



From DeRosa Environmental Drone Footage

The Apple Street Culvert is both an Ecological Problem and a Future Drainage Problem

APPLICATION FORM
CULVERT REPLACEMENT MUNICIPAL ASSISTANCE GRANT APPLICATION FORM
FY20 RFR ID: DER 2019-04
(See Section 3 in the RFR for instructions on how to fill out the Application Form)



i. Road Over Culvert:



ii. Culvert Inlet:

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iii. Upstream of Culvert:

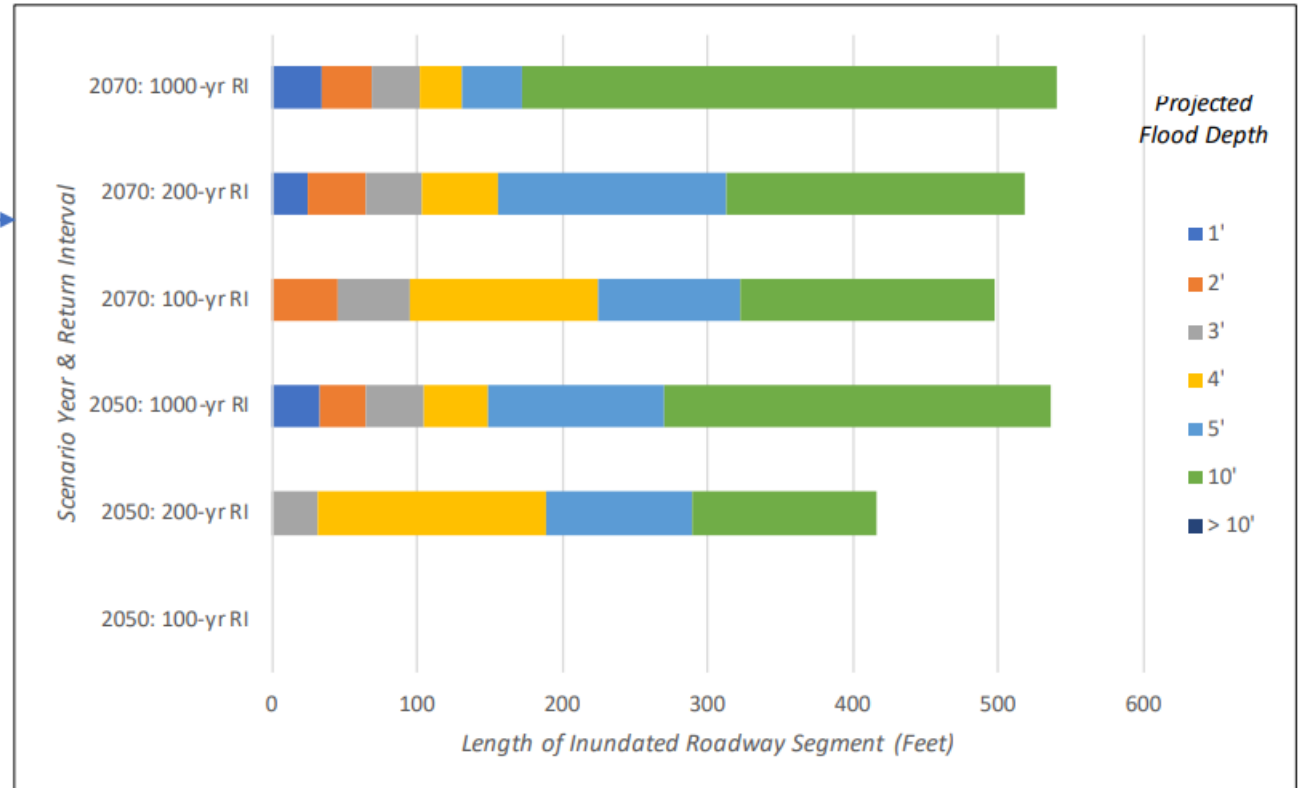


iv. Culvert Outlet:

The Solution – Assess Predictive Data

Length (feet) of Inundated Segments of Apple St. per Expected Flood Depth, Scenario Year, and Return Interval

Scenario & RI	Projected Flood Depths (feet)							Total
	1'	2'	3'	4'	5'	10'	> 10'	
2050: 100-yr RI	0	0	0	0	0	0	0	0
2050: 200-yr RI	0	0	31.9	156.6	100.8	127.5	0	416.8
2050: 1000-yr RI	32.4	32.9	38.8	44.1	121.3	266	0	535.5
2070: 100-yr RI	0	44.9	49.9	129.3	98.8	174.9	0	497.8
2070: 200-yr RI	24.2	40.6	38	52.2	157.2	205.8	0	518
2070: 1000-yr RI	33.7	35.3	32.7	28.6	41.6	368.2	0	540.1



The Solution – Assess Predictive Data

Length (feet) of Inundated Segments of Apple St. per Annual Coastal Flood Exceedance Probability (ACFEP) Zone

Scenario	0.1%	0.2%	0.5%	1%	2%	5%	10%	20%	25%	30%	50%	100%
2030	0	0	0	0	0	0	0	0	0	0	0	0
2050	52.9	62.1	127	0	0	0	0	0	0	0	0	0
2070	9.4	13.2	19.7	45.8	75.4	372.1	0	0	0	0	0	0

Data Sourcing and Methodology

Future flood depths and inundation extents for the study area, Apple Street, were calculated by performing an overlay analysis of GIS data pertaining to the location of the roadway and its relationship to expected flood scenarios identified in the Massachusetts Coastal Flood Risk Model (MC-FRM) produced by Woods Hole Group.

The MC-FRM is a dynamic model that incorporates critical components of storm induced flooding (winds, waves, wave-setup, storm surge, wave run-up, and overtopping) and calibrates those components with historical storm data to produce high resolution outputs capturing expected floodways in complex urban topographies. The model identifies Annual Coastal Flood Exceedance Probabilities and Expected Flood Depths for the Sea Level Rise scenarios of 2030, 2050, and 2070. The geographic footprint of each flood scenario and depth prediction were overlaid with US Census Roadway data for the study area of Apple Street to determine expected flood impacts to the roadway in each MC-FRM scenario. Impacts are measured in expected depths and lengths of roadway inundated under each scenario.

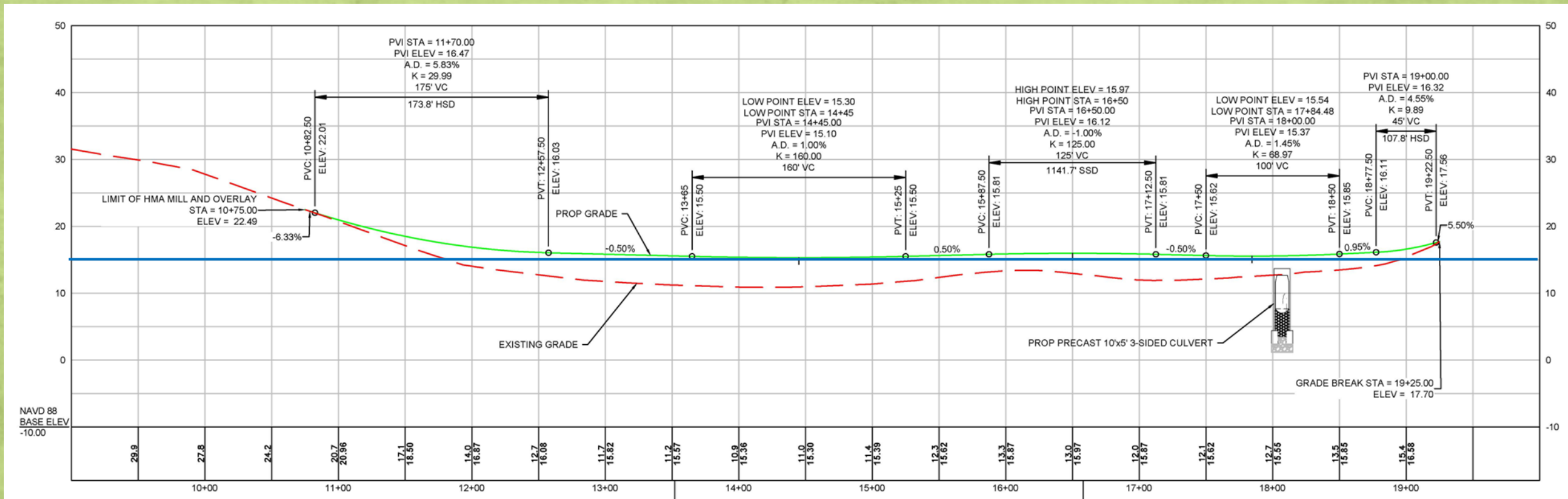
Graphical outputs of the overlay analysis are color-coded to differentiate expected depths, facilitating comparison across the given scenario periods. The tables and chart in *Essex_SLR_Tables_Chart.pdf* were derived by extracting roadway lengths and flood depths from the overlay analysis in each scenario. Measurements for the 2030 scenario were omitted because there were no predicted impacts to the study area during that period. Visual representations of the following figures are included in the presentation; *Essex Woods Hole SLR Mapping.ppt*. Data source and links to data documentation are recorded in following table.

Data Sourcing and Methodology

Data Layer Name	Data Source	Creator	Vintage	Documentation
Apple Street Roadway	Census 2010 TIGER Roads	United States Census	2010	https://www.mass.gov/info-details/massgis-data-2010-us-census
Annual Coastal Flood Exceedance Probability (ACFEP)	Massachusetts Coastal Flood Risk Model	Woods Hole Group	2015	https://www.mvcommission.org/sites/default/files/docs/MC-FRM_FAQ_Sheet_Final.pdf?msclkid=19562d10c1e611ec977e57e99342dca1
Expected Flood Depth	Massachusetts Coastal Flood Risk Model	Woods Hole Group	2015	https://www.mvcommission.org/sites/default/files/docs/MC-FRM_FAQ_Sheet_Final.pdf?msclkid=19562d10c1e611ec977e57e99342dca1

The Solution – Elevate the Apple Street Roadbed

Elevate Road to 15.30'



Challenges

- Obtaining field data gathering, design, and permitting funding using a patchwork of grants requires multiple years of preparation – this project has been in the works for four years, using four State grants (two DER grants, one CZM grant, and one MVP grant).
- Permitting in such a sensitive area on a designated scenic road will be complex and will include MEPA review and MA DOT bridge review (MGL Ch. 85), among several other permitting processes.
- Some in the community have pushed back against this project due to the alteration of the existing scenic corridor and admitted limited alterations to adjacent wetlands.
- By the time we are ready for construction, the project could cost in excess of \$4.5M. The project is presently on a “waiting list” via MEMA that may keep it eligible for 90% Federal funding under the COVID Disaster. We hope to apply for that funding and perhaps apply to State grant programs to help defray at least a portion of the remaining 10%.
- This project represents a form of “retreat” from sea level rise and increased storminess. The project provides an essential connection for public safety and public works but Apple Street is not a good candidate for the replacement of “everyday” traffic now handled by Route 133. What friction might develop along the Essex causeway in the future when existing business interests come up against regional transportation?

Project Goals

- Improve community resiliency and ecological quality for the Town of Essex by:
 1. elevating 800 feet of Apple Street and
 2. replacing an existing undersized culvert with a larger structure that satisfies the Massachusetts Stream Crossing Standards
- Minimize impacts to the environment; replicate disturbed wetlands within project boundary
- Minimize impact to aesthetic character of Apple Street (scenic road); provide context sensitive design elements

Project Area

- Apple Street from Southern Avenue intersection to driveway at 129 Apple Street (~800 feet)
- Total Apple Street corridor ~ 1.3 miles
- Project limits represent ~ 12% of the entire scenic roadway



Existing Conditions – Project site



18-foot paved road

Trees along roadside

Stone walls



Rock and vegetated slope



Limited cover over culvert

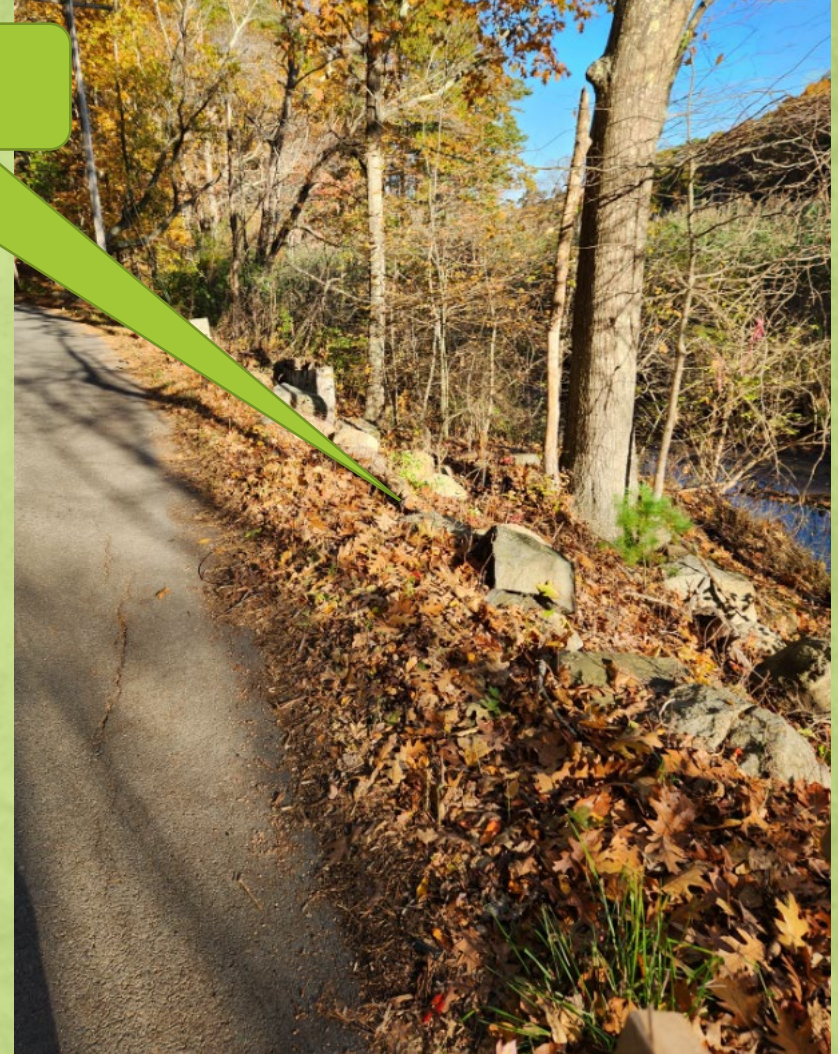
Undersized culvert

Aesthetic goals

Encourage use of vegetated slopes



Minimize stone wall disturbance



Use weathering steel guardrail treatment



Avoid pavement striping



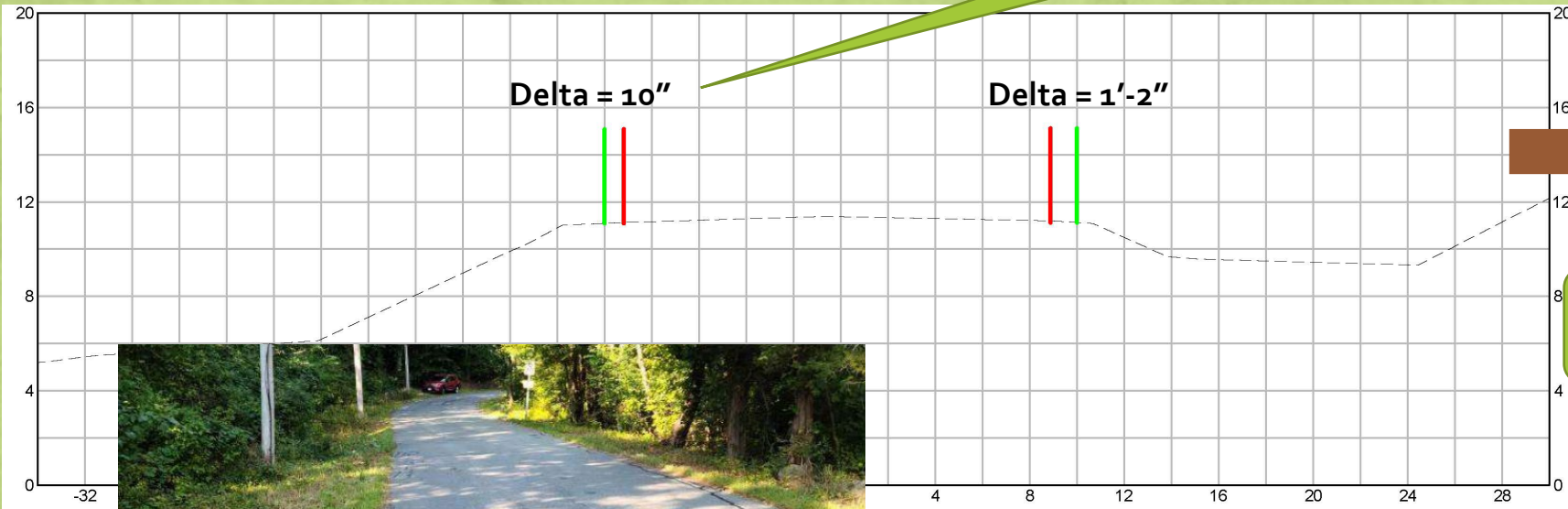
Alternatives Study – Roadbed Elevation

- Alternatives investigated:
 - Geometric design based on March 2018 observed flood elevation of 13.70 feet
 - Geometric design considering predicted storm surge and Sea Level Rise (SLR) – year 2070
- Factors considered included:
 - Wetland Impacts
 - Tree Removal
 - Utility Pole Impacts
 - Stone Wall disturbance
 - New Retaining Wall construction
 - Right of Way Impacts
 - Cost
- 20-foot-wide roadway will be proposed for all alternatives

Why 20 feet?

- AASHTO Table 5-5: 20' Width of Traveled Way
- 9' Lane, 1' Shoulder
- Approx 1' wider on both sides

Minor increase to pavement width



Proposed edge of pavement (orange flag)

U.S. Customary			
Design Speed (mph)	Minimum Width of Traveled Way (ft) for Specified Design Volume (veh/day)		
	under 400	400 to 2000	over 2000
15	18	20*	22
20	18	20*	22
25	18	20*	22
30	18	20*	22
35	18	20*	22
40	18	20*	22
45	20	22	22
50	20	22	22
55	22	22	22b
60	22	22	22b
65	22	22	22b
All speeds	Width of grass shoulder on each side of the road (ft)		
	2		6

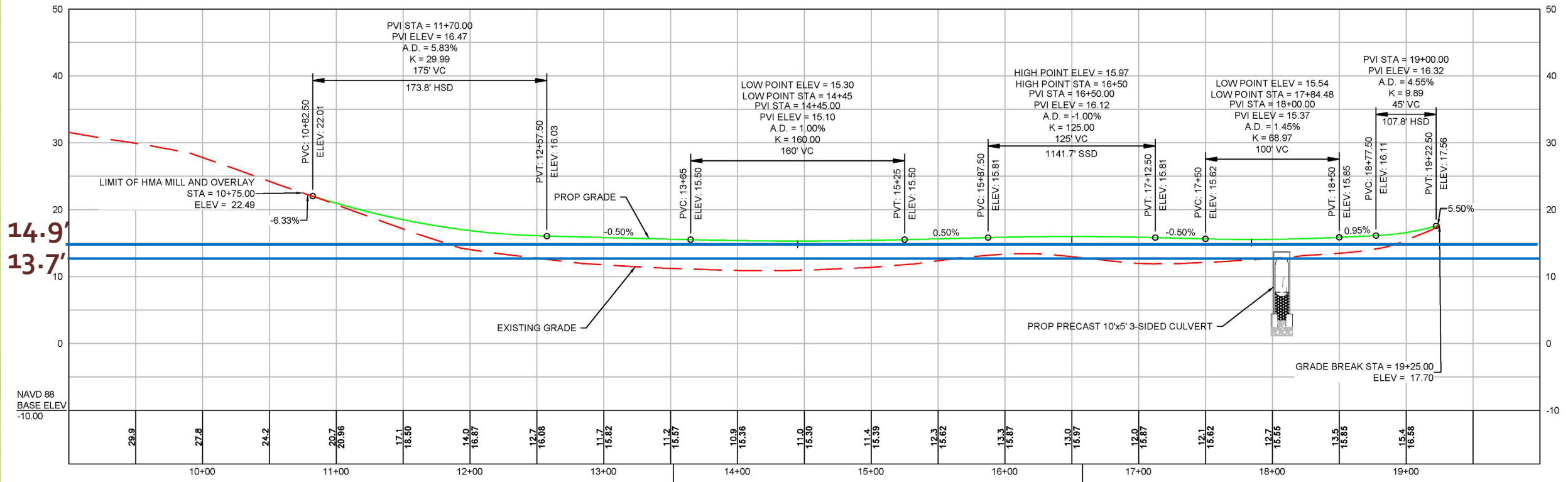
Apple Street ~ 800 VPD

2018 AASHTO Green Book Table 5-5

Why raise the road to a minimum of 15.30 feet?

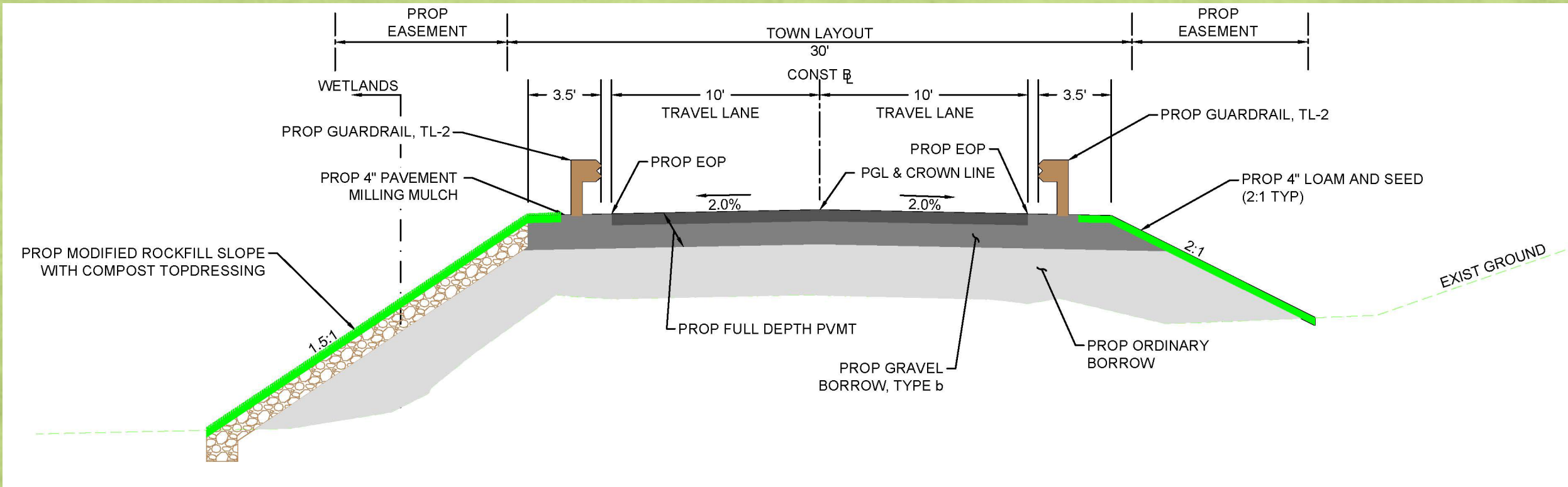
- Today's design 100-year storm elevation (downstream) = 10.60 feet
- Predicted SLR (2070) and storm surge (100-year storm) = 4.30 feet
- Predicted (2070) storm surge elevation considering SLR = 10.60 + 4.30 = 14.90 feet
- We are mindful of potential flood risk of nearby properties (raising road too much could impact homes)

Provides 5 inches of freeboard to future storm elevation at roadway crown



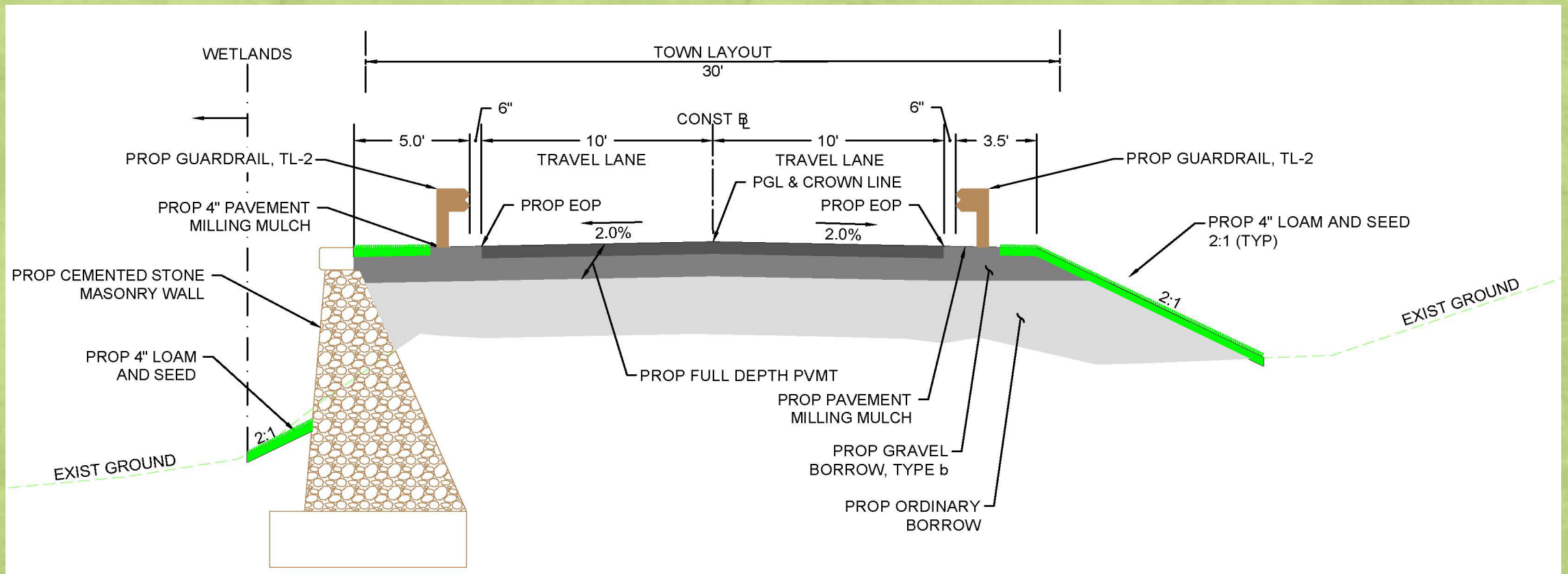
Proposed Alternatives

- Alternative 1 – Raise Apple Street to Elevation 14.0' (Above 2018 Flood Elevation)
 - Raise the existing Low Point 3.2'
 - Widen the Roadway to 20' Wide
 - Modified Rockfill Slope (Requires Wetland Mitigation)



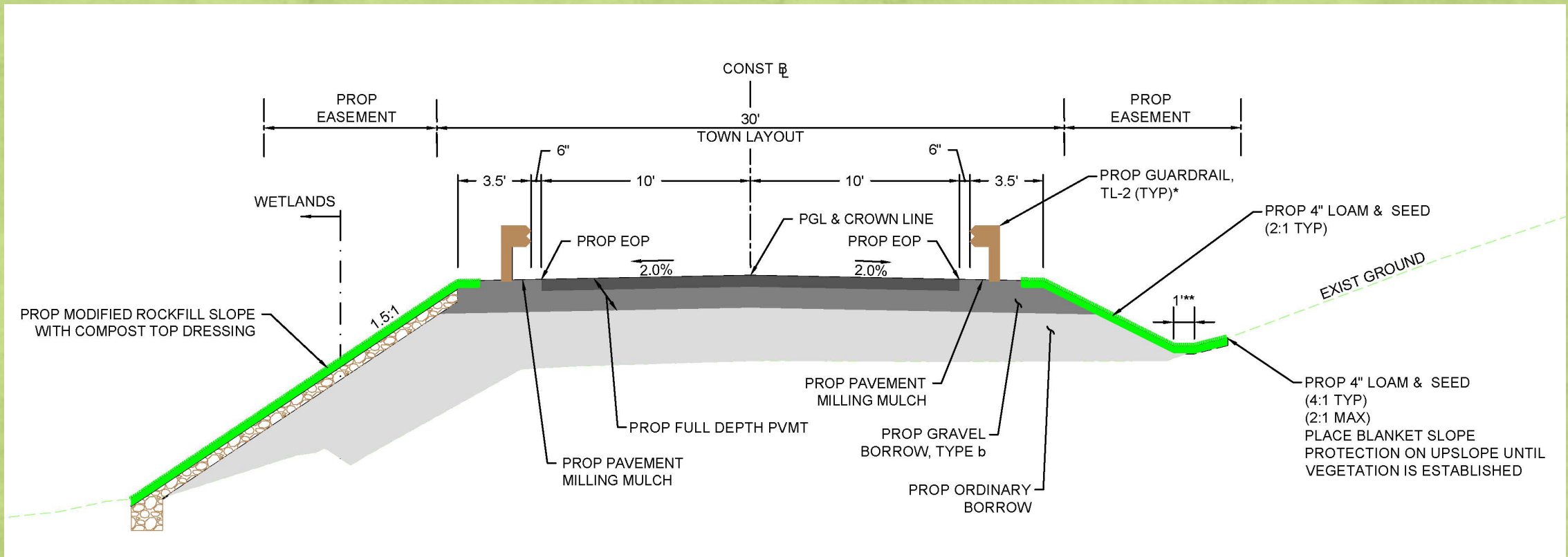
Proposed Alternatives

- Alternative 2 – Raise Apple Street to Elevation 14.0' – With Retaining Wall (Above 2018 Flood Elevation)
 - Raise the existing Low Point 3.2'
 - Widen the Roadway to 20' Wide
 - 270' of New Retaining Wall, Adjacent to Wetlands



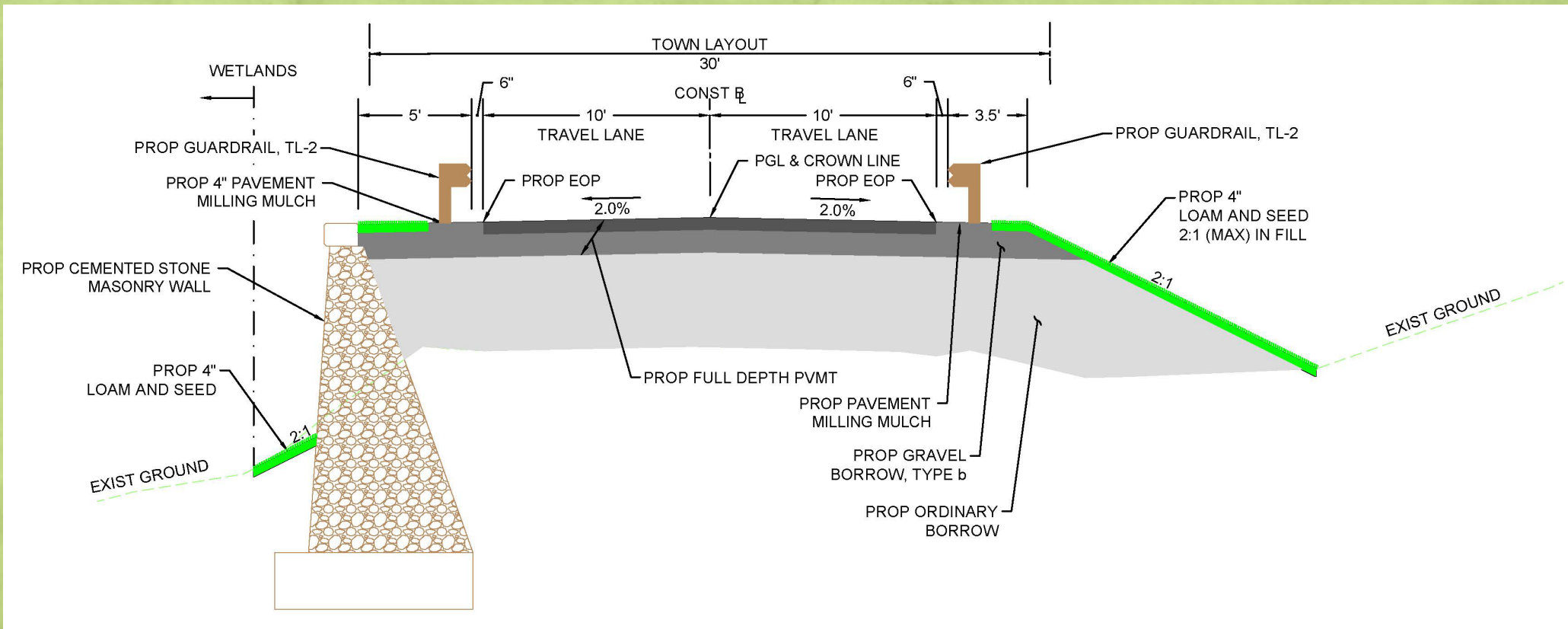
Proposed Alternatives

- Alternative 3 – Raise Apple Street to Elevation 15.3'
 - Raise the existing Low Point 4.4'
 - Widen the Roadway to 20' Wide
 - Modified Rockfill Slope (Requires Wetland Mitigation)



Proposed Alternatives

- Alternative 4 – Raise Apple Street to Elevation 15.3' – With Retaining Wall
 - Raise the existing Low Point 4.4'
 - Widen the Roadway to 20' Wide
 - 275' of New Retaining Wall, Adjacent to Wetlands



Other Alternatives Considered

- Do nothing – ***Not Preferred***
 - leaves the Town vulnerable to predicted more severe and longer duration events
- Work with MassDOT to elevate the causeway and causeway bridge – ***Not an Option***
 - Town previously asked but DOT did not elect to do
- Station DPW and Emergency Responders on either end of Apple Street – ***Not Preferred***
 - Not practical; Town equipment limited; approach not supported by several Town departments
- Rely on mutual aid – ***Not Preferred***
 - Other neighboring towns will be dealing with the same storm in their community
- Elevated structure – ***Not Preferred***
 - Not practical; costly; would significantly detract from Apple Street's scenic corridor designation

Other Alternatives Considered – Traffic Calming Techniques

- Speed bumps – ***Not Preferred***
 - Not supported by the Town DPW for maintenance and plowing issues
- Striping & Delineator Posts – ***Not Preferred***
 - would significantly detract from Apple Street's scenic corridor designation
- Portable speed humps – ***Not Preferred***
 - would significantly detract from Apple Street's scenic corridor designation



Alternatives Study – Summary Matrix

SUMMARY OF IMPACTS

ITEM	UNIT	QUANTITY			
		Alternative 1	Alternative 2	Alternative 3	Alternative 4
Bordering Vegetated Wetland Impacts	SF	2,200	0	2,350	0
Tree Removal (greater than 8")	EA	17	17	21	21
Utility Pole Impacts	EA	6	6	6	6
Existing Stone Wall Removed	FT	70	70	100	100
Existing Stone Wall Reset	FT	340	340	490	490
New Retaining Wall	FT	0	270	0	275
Temporary Easements	EA	5	5	5	5
Permanent Easements	EA	2	2	2	2

Manageable to mitigate within project area

Relatively consistent amongst alternative

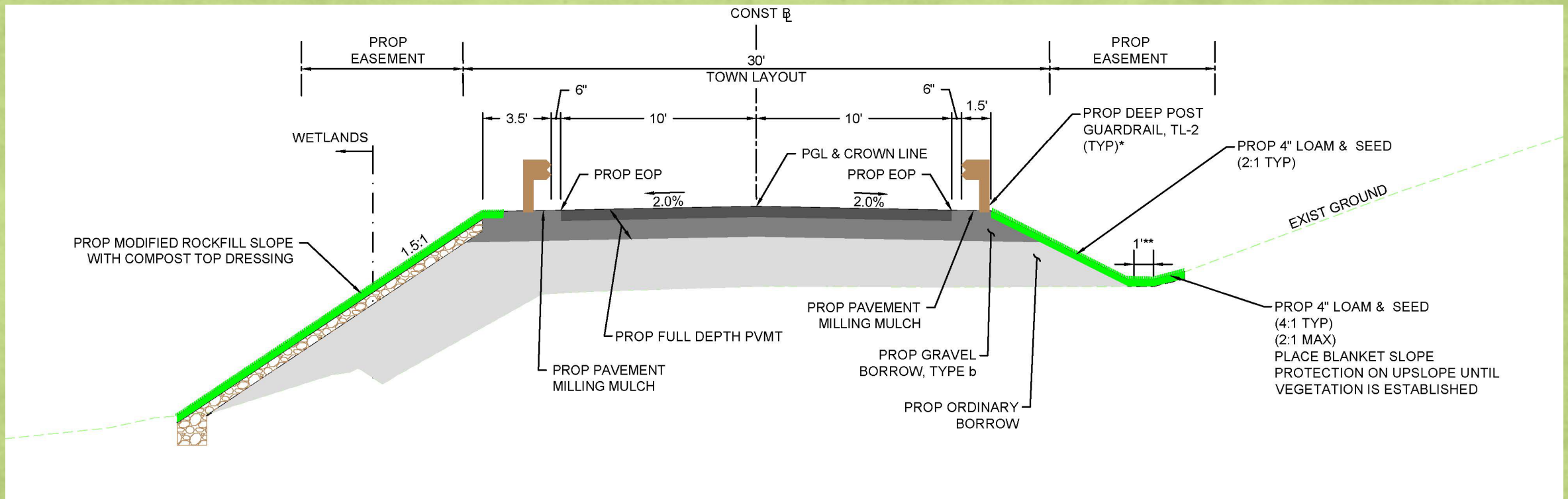
Similar Right of Way Impacts

PRELIMINARY COST ESTIMATES

	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Construction Cost	\$594,000	\$1,166,000	\$660,000	\$1,277,100
Construction Contingency 20%	\$118,800	\$233,200	\$132,000	\$255,420
Police Detail 10%	\$59,400	\$116,600	\$66,000	\$127,710
Construction Engineering	\$89,100	\$174,900	\$99,000	\$191,565
Design and Permitting	\$130,000	\$190,000	\$140,000	\$210,000
Utility Pole Relocation	\$120,000	\$120,000	\$120,000	\$120,000
Total	\$1,111,300	\$2,000,700	\$1,217,000	\$2,181,795

Preferred Alternative – Alternative 3

- Alternative 3 – Raise Apple Street to Elevation 15.3'
 - Provides Freeboard over predicted future water elevations
 - Provides safer roadside treatment to errant vehicles (when compared to retaining wall)
 - Provides more resiliency and **adaptive management** of the corridor
 - Potential to raise road further in the future (compared to retaining wall alternatives)

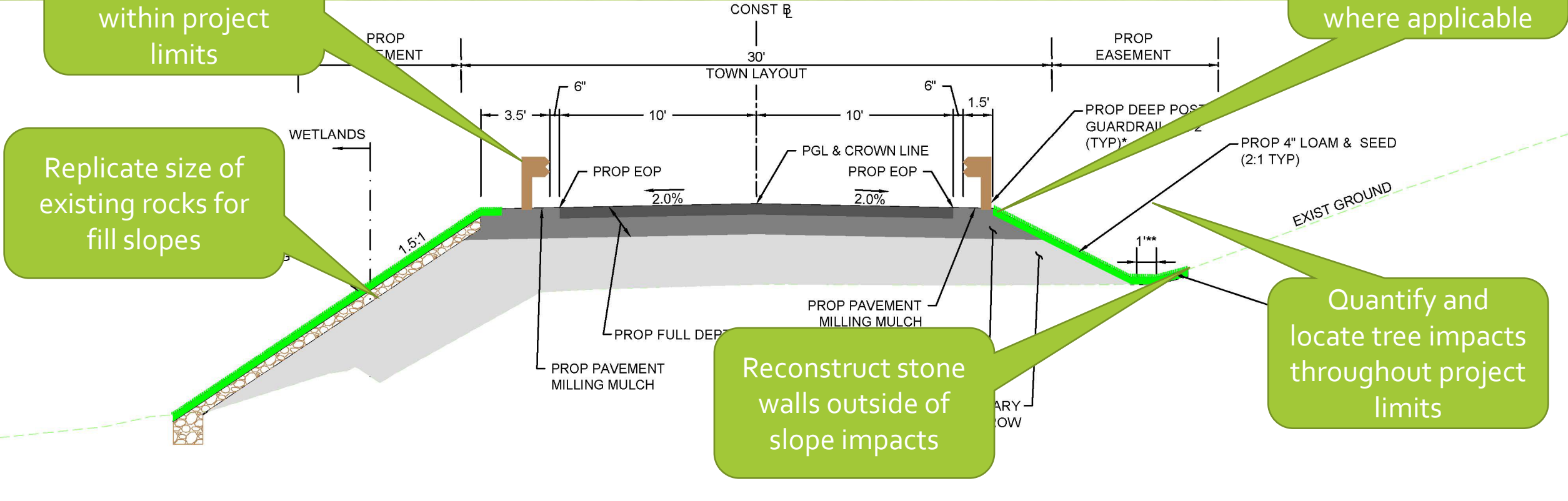


Incorporating Historic Commission feedback

Use weathering steel guardrail within project limits

Replicate size of existing rocks for fill slopes

Reduce slope impacts on adjacent properties where applicable



Reconstruct stone walls outside of slope impacts

Quantify and locate tree impacts throughout project limits

Examples of proposed slope treatment

- Top-dressed modified rock fill slope (Initial)



Allows for steeper slopes adjacent to resource areas

Examples of proposed slope treatment

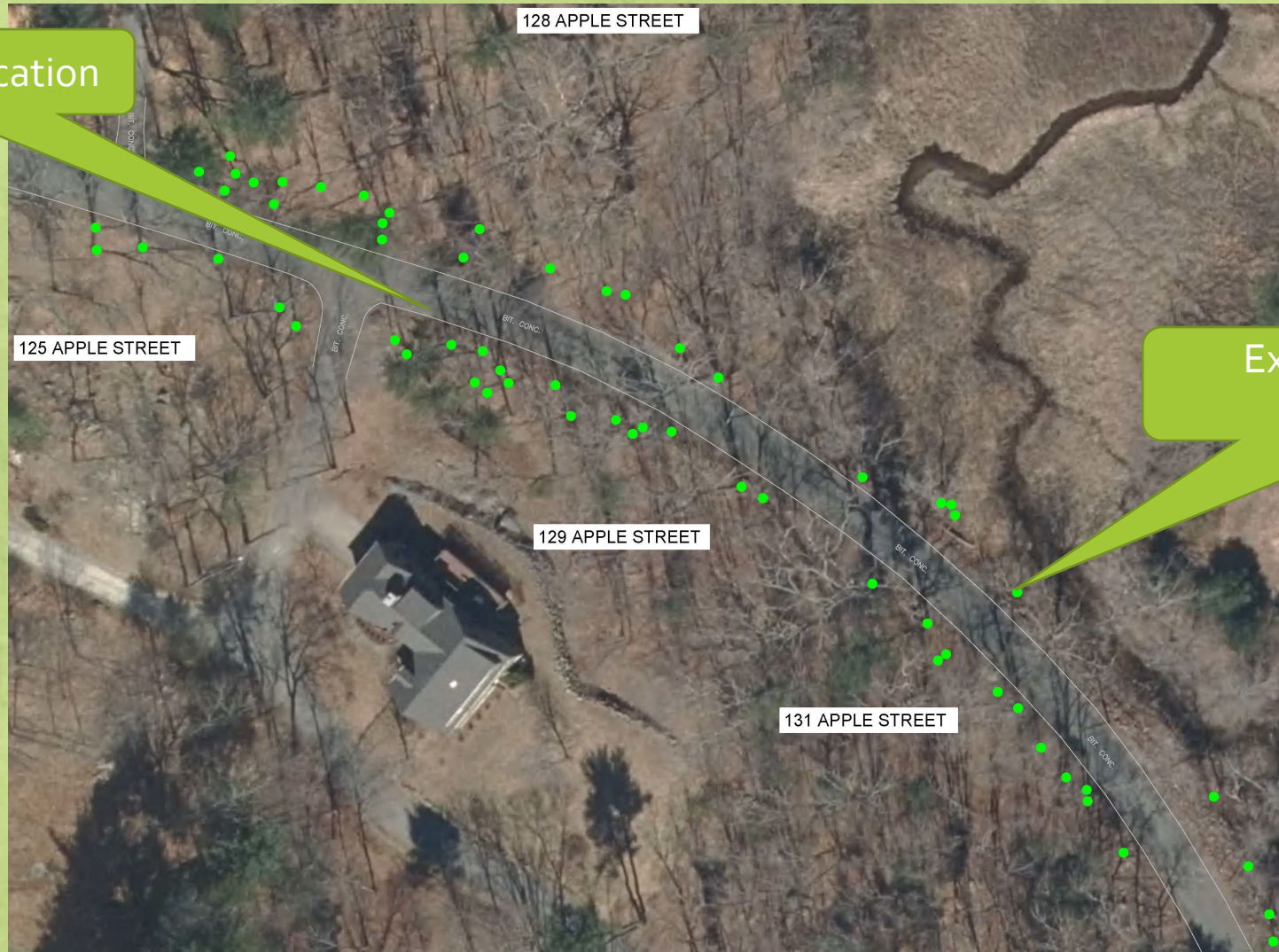
- Top-dressed modified rock fill slope – After a few growing seasons



Vegetation conceals
rock slope

Existing Trees – 128, 129, & 131 Apple Street

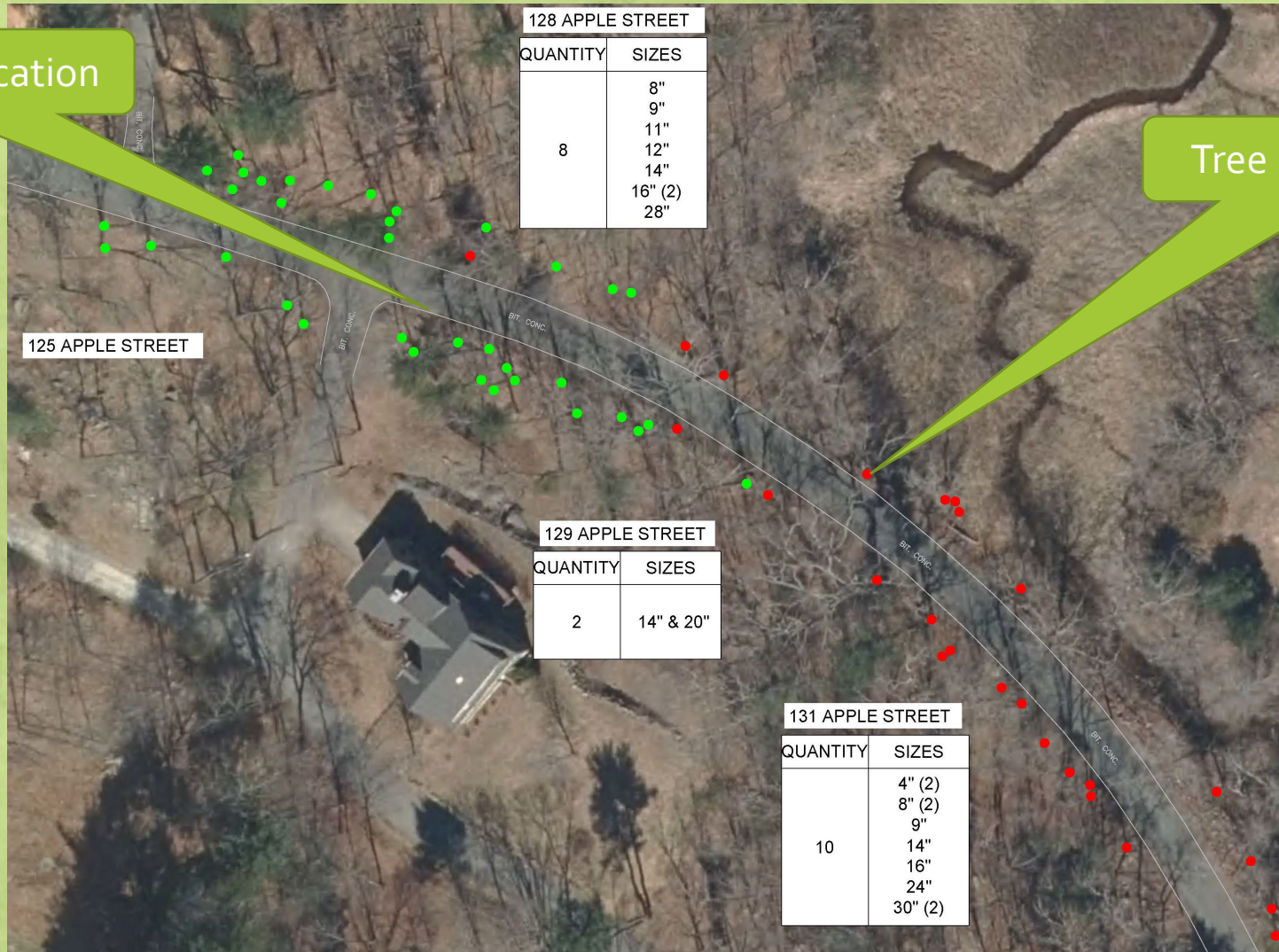
Project Start Location



Existing Tree Next To Roadway (typ.)

Impacts to Existing Trees - 128, 129, & 131 Apple Street

Project Start Location

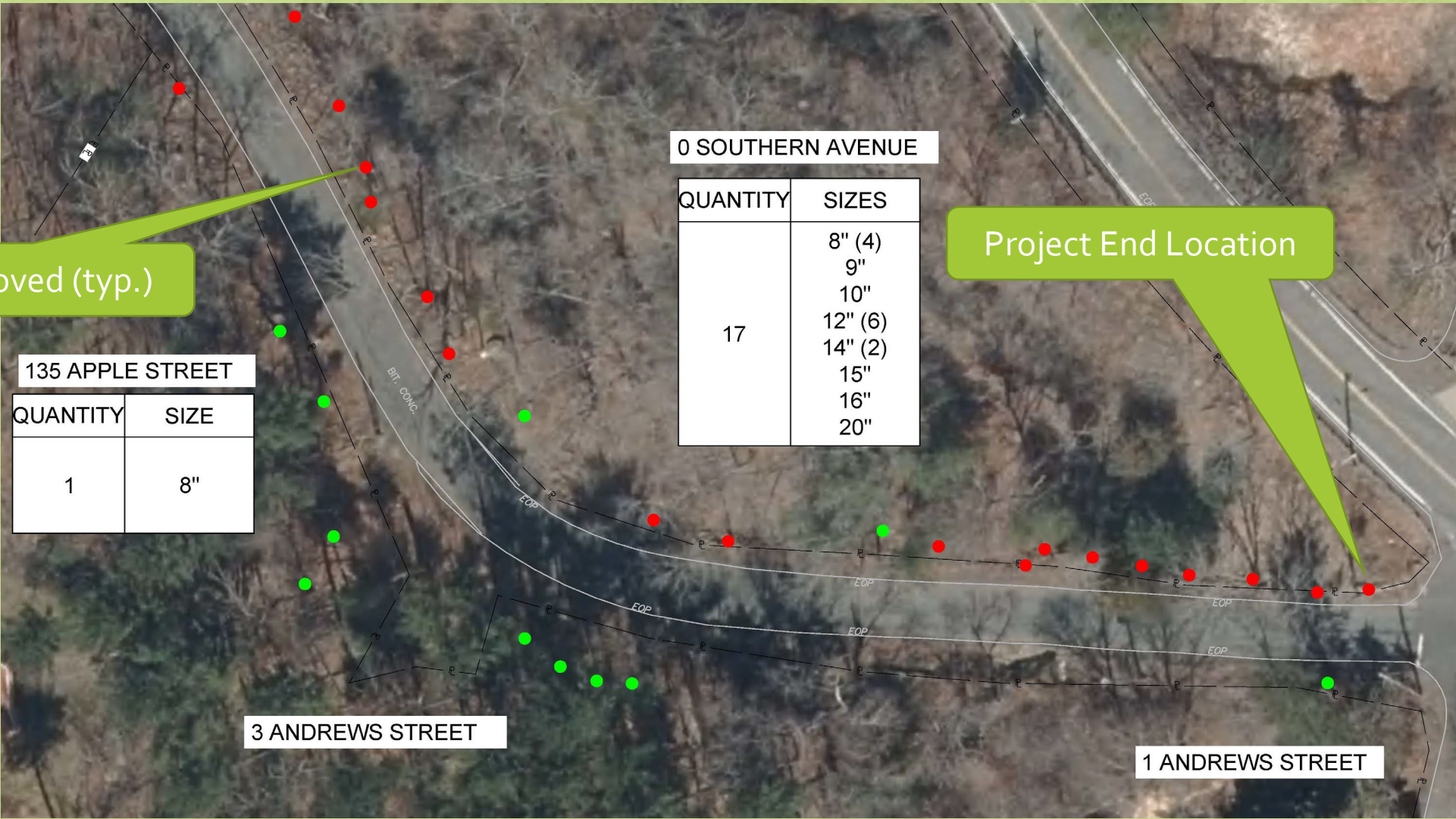


Tree Removed (typ.)

Existing Trees – 135 Apple, 0 Southern, 1 & 3 Andrews Streets



Impacts to Existing Trees



0 SOUTHERN AVENUE

QUANTITY	SIZES
17	8" (4)
	9"
	10"
	12" (6)
	14" (2)
	15"
	16"
20"	

Project End Location

Tree Removed (typ.)

135 APPLE STREET

QUANTITY	SIZE
1	8"

3 ANDREWS STREET

1 ANDREWS STREET

Impacts to Existing Trees

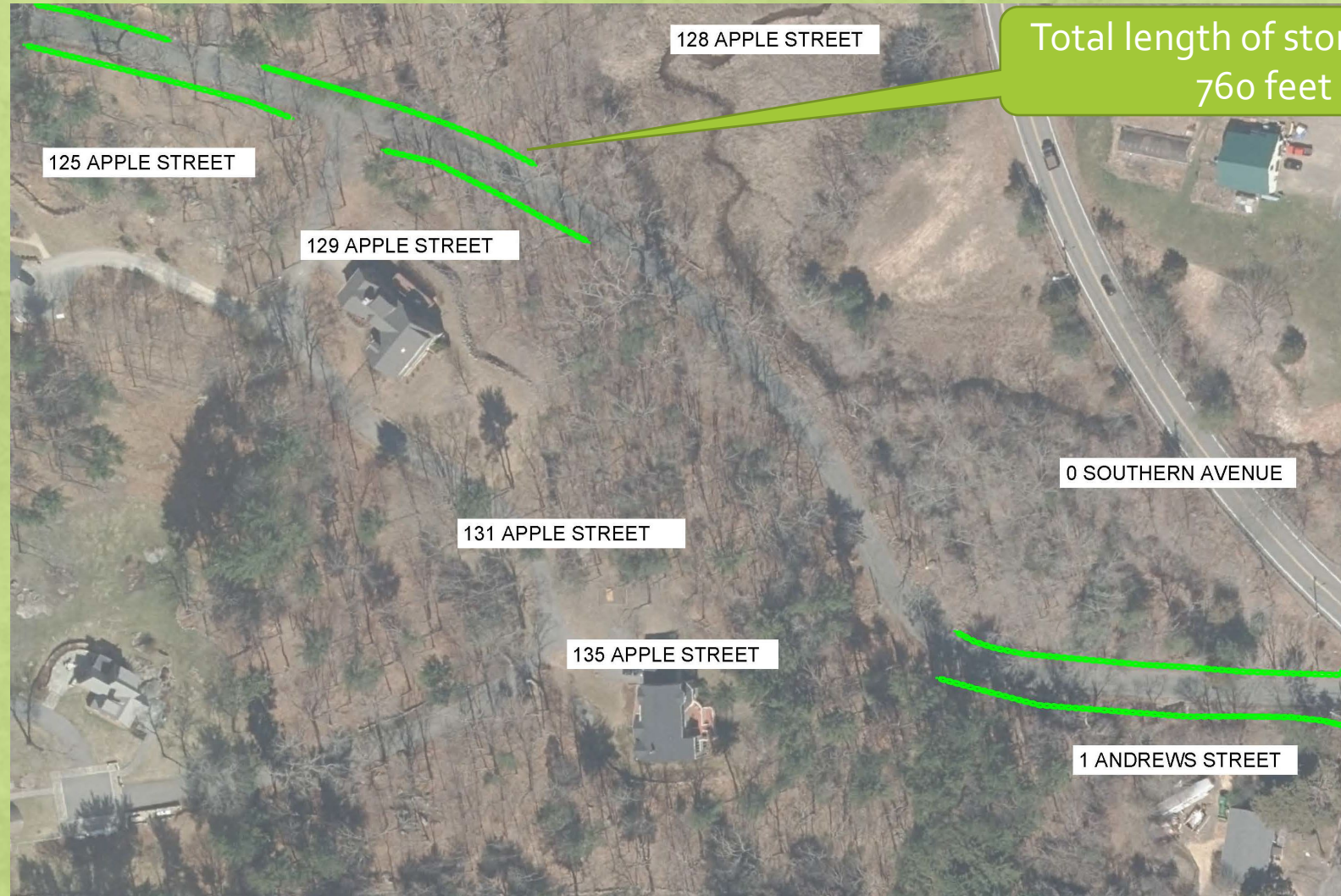


131 Apple Street looking away from Southern Avenue

o Southern Ave looking towards Southern Avenue

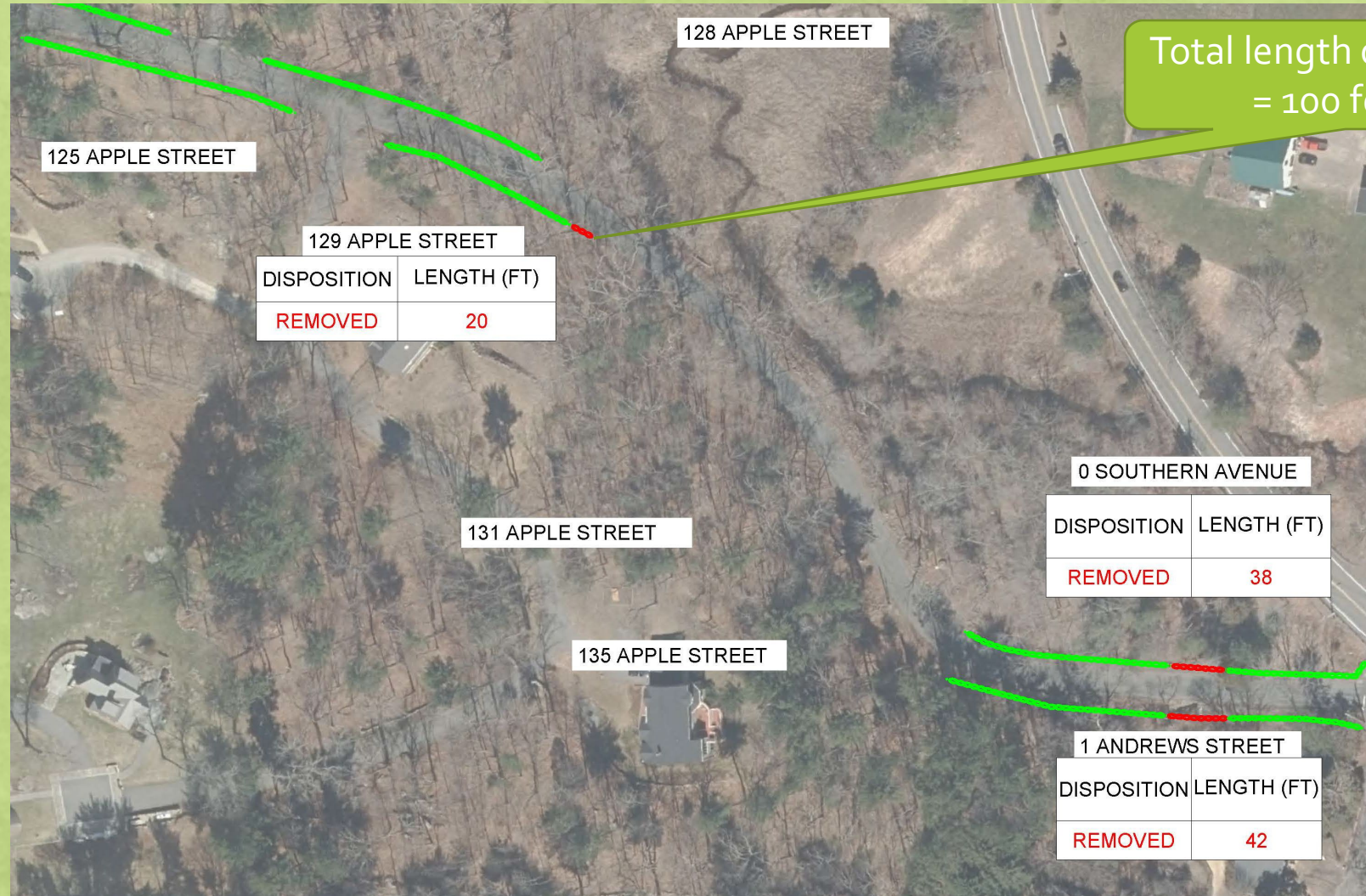


Existing Stone Walls – Project Area

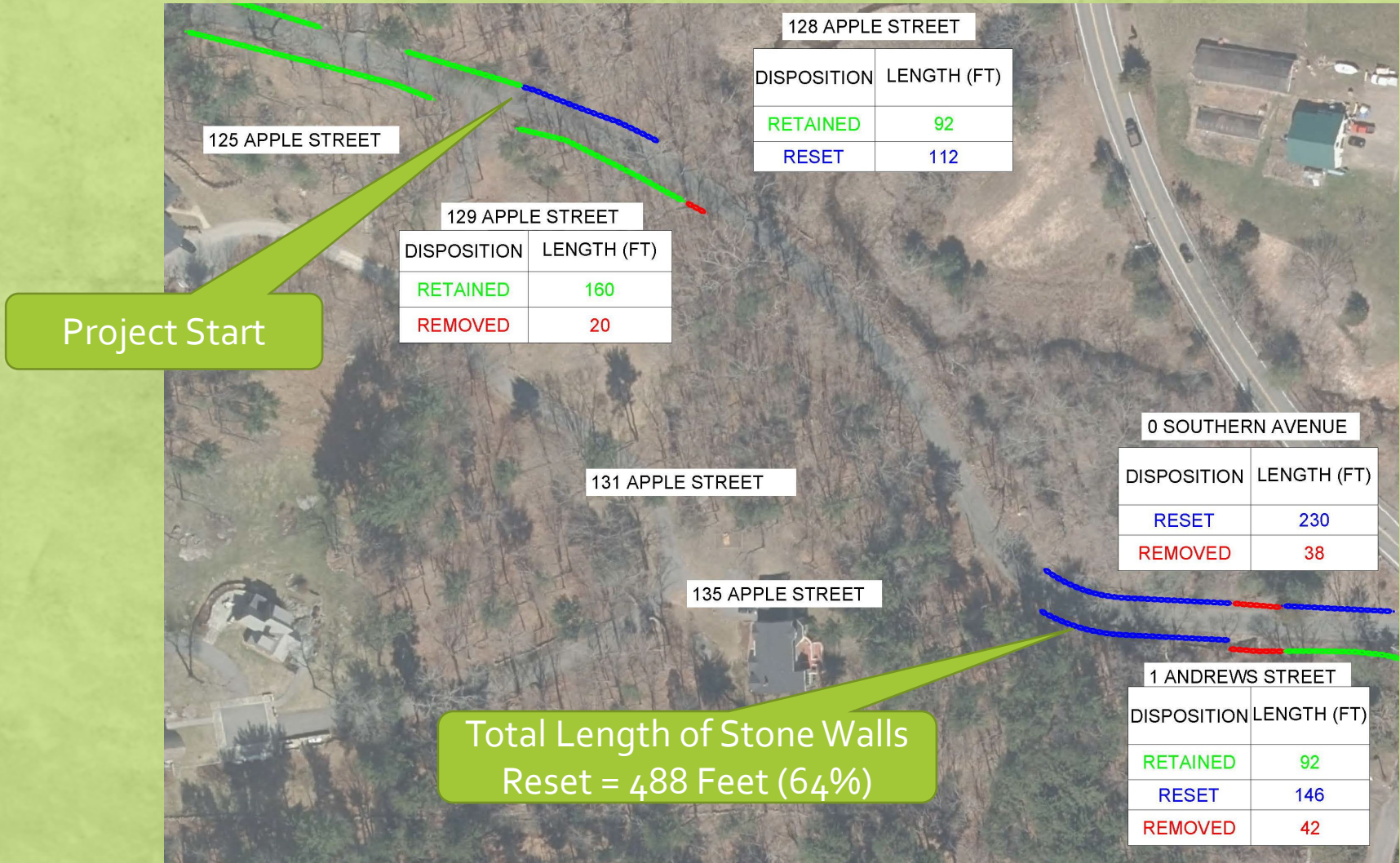


Total length of stone walls =
760 feet

Impacts to Stone Walls



Impacts to Stone Walls



Impacts to Stone Walls



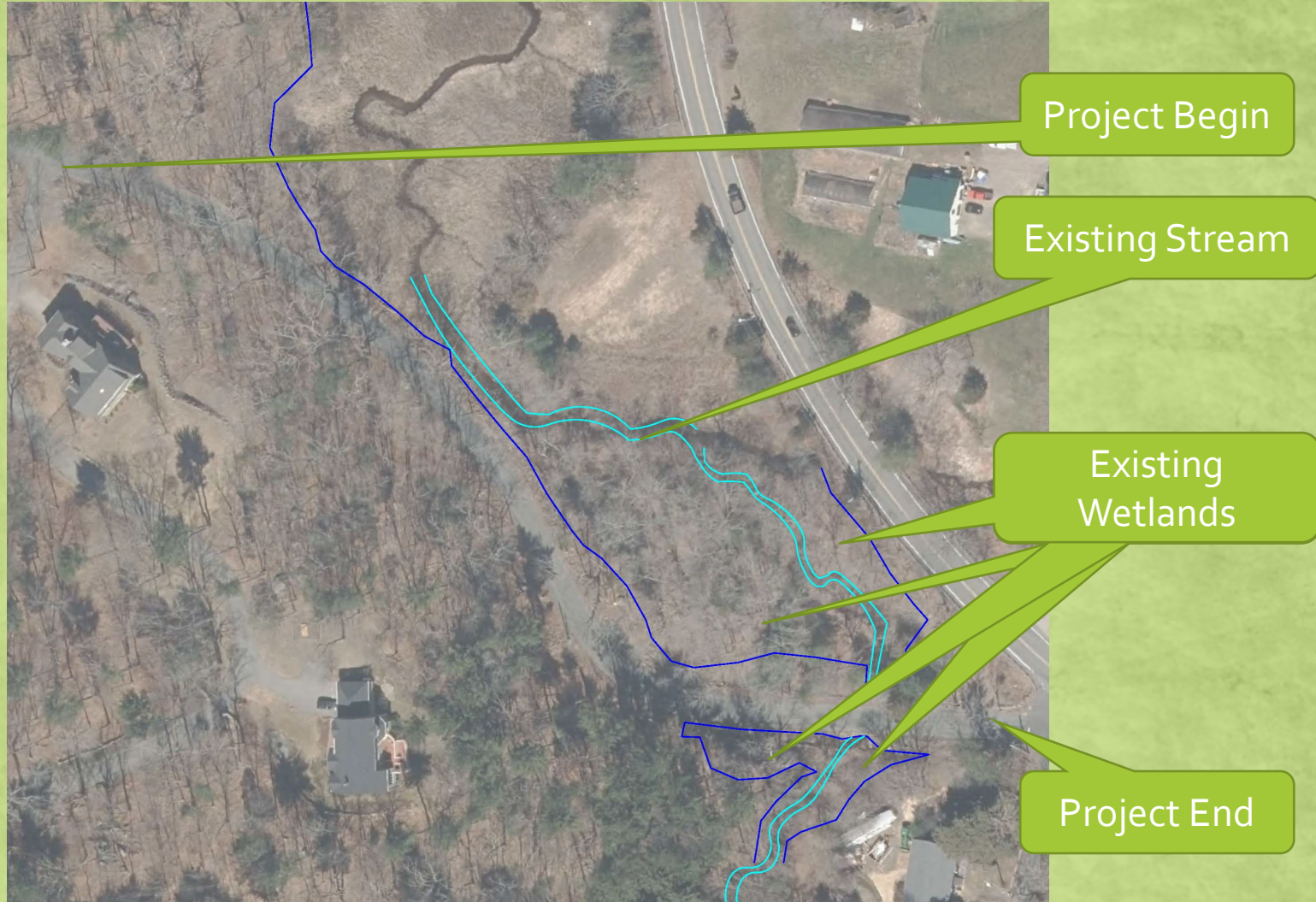
Southern Side of Apple Street stone walls removed for culvert construction



Northern Side of Apple Street stone walls removed for culvert construction

Existing Wetlands – Project Area

- Wetland Impacts:
 - Permanent: 3,600 SF
 - Temporary: 620 SF
- Bank Impacts
 - Temporary: 25 FT



Wetland Replication – Project Area

- Wetland Impacts:
 - Permanent: 3,600 SF
 - Temporary: 620 SF
- Bank Impacts
 - Temporary: 25 FT
- Replication Area (3,650 SF):
 - 1: 1,000 SF
 - 2: 1,150 SF
 - 3: 1,500 SF
- Ratio: ~ 1:1



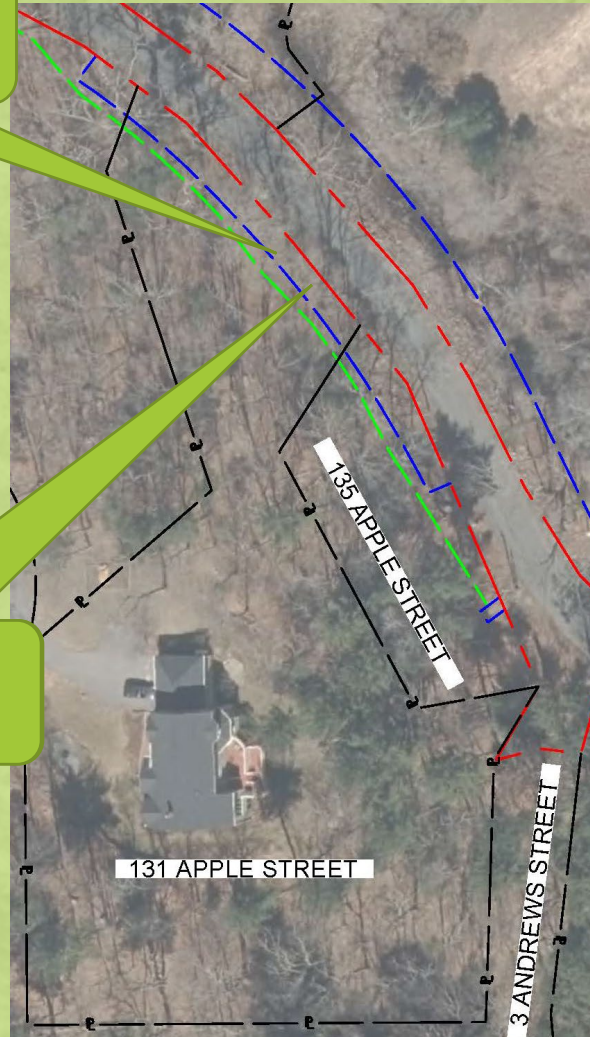
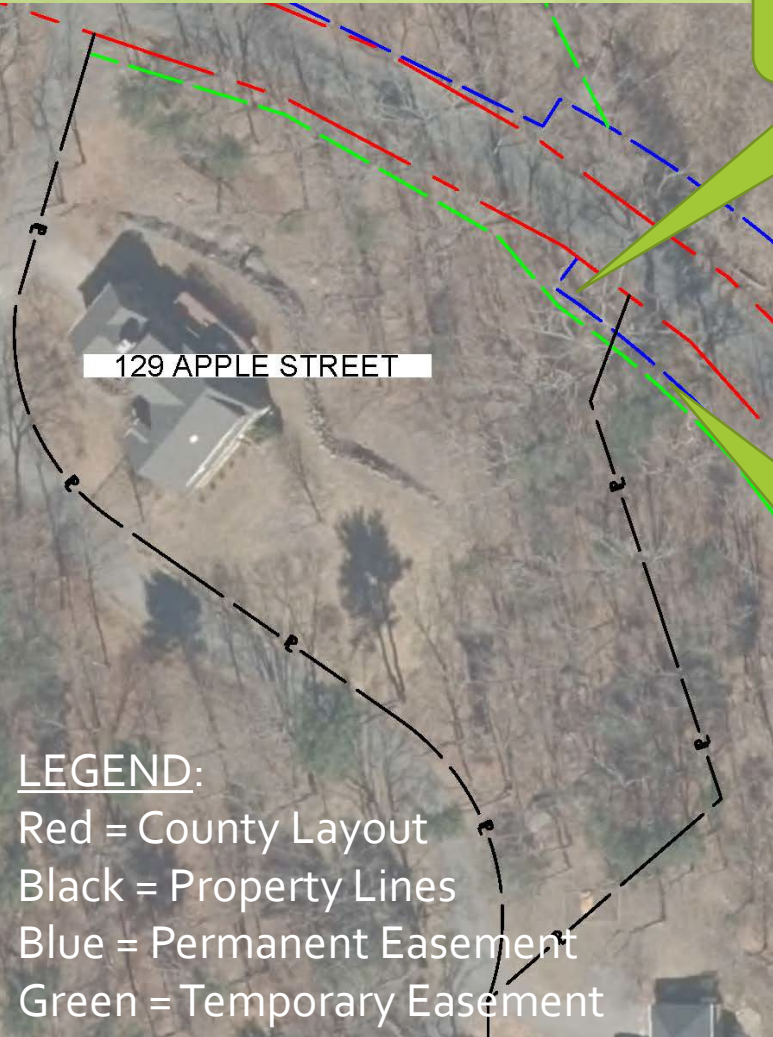
Right of Way Impacts

~ 5' Temporary Impact

~ 6' Permanent Impact

~ 12' Permanent Impact (typ.)

~ 5' Temporary Impact (typ.)



Right of Way Impacts



Temporary
Impacts for
Wetland
Mitigation Area

~ 18' Permanent
Impact

LEGEND:

Red = County Layout

Black = Property Lines

Blue = Permanent Easement

Green = Temporary Easement

~ 10' Temporary
Impact

~ 15' Permanent
Impact

Preferred culvert alternative – 10'x5' precast concrete frame

Accommodates 10-yr storm per DOT standards without overtopping roadway

3-sided precast concrete frame

Provide terrestrial passage beneath road

Natural stream bottom



Next Steps

- Public Input
- Advance Preferred Alternative to 75% Design Level
- Initiate Right of Way Process
- Initiate Permitting Process (now through springtime 2023)
 - Agency Consultation with NHESP, USFWS, NOAA/MADMF, MESA
 - MEPA Environmental Notification Form (ENF)
 - Notice of Intent with Essex Conservation Commission
 - MassDEP Water Quality Certification
 - MassDEP Chapter 91 Waterways License Permit
 - US Army Corps of Engineers
- Planning Board and Tree Warden Review of project (scenic road jurisdiction)
- Final Design in FY 24 (to be completed prior to June 30th, 2024)

Contact Information

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 - bzubricki@essexma.org
 - (978) 768-6531
 - [Apple Street Roadbed Elevation & Culvert Replacement Project | Essex MA](#)