MEMORANDUM

Turtle Crossing Project

Upper Maple Avenue, Atkinson, New Hampshire

Blanding's Turtle at the location of the proposed culvert crossing

Prepared by:

Northeast Conservation Services, LLC

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For:

Town of Atkinson Conservation Commission

19 Academy Avenue

Atkinson, NH 03811

MEMORANDUM

TO:	Town of Atkinson Conservation Commission, c/o Paul Wainwright, Chair
FROM:	Peter Steckler, Northeast Conservation Services, LLC
DATE:	December 12, 2023
RE:	Turtle Crossing Project, Maple Ave in Atkinson
CC:	Matt Sullivan, Public Works Director Steve Keach, Town Engineer Josh Megyesy, NH Fish and Game

The Town of Atkinson Conservation Commission retained Northeast Conservation Services, LLC (NCS) to evaluate the potential for a turtle-friendly wildlife crossing structure under upper Maple Avenue in Atkinson, New Hampshire. The site connects a ±58-acre upstream wetland to the east of Maple Avenue, known as the East Sawmill Swamp, to the ±121-acre West Sawmill Swamp on the downstream side of the road. Both of these wetlands are delineated in the Town's 2002 Prime Wetland Study, and both have been designated as prime wetlands in 2010 by vote of the Town of Atkinson (warrant article TM 2010-02). These wetlands are protected by town zoning, which calls for a 150-foot buffer of natural vegetation. In addition, NHDES requires a 100-foot buffer of natural vegetation around these wetlands. While municipalities are exempt from their own zoning ordinances, any work in the area will need New Hampshire Department of Environmental Services permits pertaining to the dredge and fill of wetlands.

An on-site meeting was held on November 6, 2023, with Paul Wainwright, Chair of the Atkinson Conservation Commission, John Fournier, Atkinson Conservation Commission member, Matt Sullivan, Atkinson Public Works Director, Steve Keach, Town Engineer, and Josh Megysey, a NH Fish and Game Wildlife Biologist who specializes in turtle habitat protection. Site photos from the November 6 site walk are provided in Appendix A of this memorandum.

This memorandum summarizes design considerations and alternatives based on information gathered at the November 6 meeting and follow-up analyses performed by NCS. NCS' analysis included consultation with both Conservation Chair Wainwright and NHFG Wildlife Biologist Megyesy, a review of a 2019 analysis by Town Engineer Keach (see Appendix B), and a review of the Northeast Blanding's Turtle Best Management Practices referenced at the end of this memo.

Project Context:

The drivers for replacing the existing culvert at Maple Ave are three-fold. First, the existing culvert needs replacement because it is undersized, resulting in burdensome maintenance by the Department of Public Works. Second, Maple Ave needs to be re-paved within the next few years; replacing the culvert along the same timeframe offers important efficiencies and cost savings. Lastly, occurrences of Blanding's turtles (*Emydoidea blandingii*), a state endangered species, have been documented at the Maple Ave crossing site by the Atkinson Conservation Commission and other members of the Atkinson community, and have been reported to the NH Natural Heritage Bureau. These occurrences include

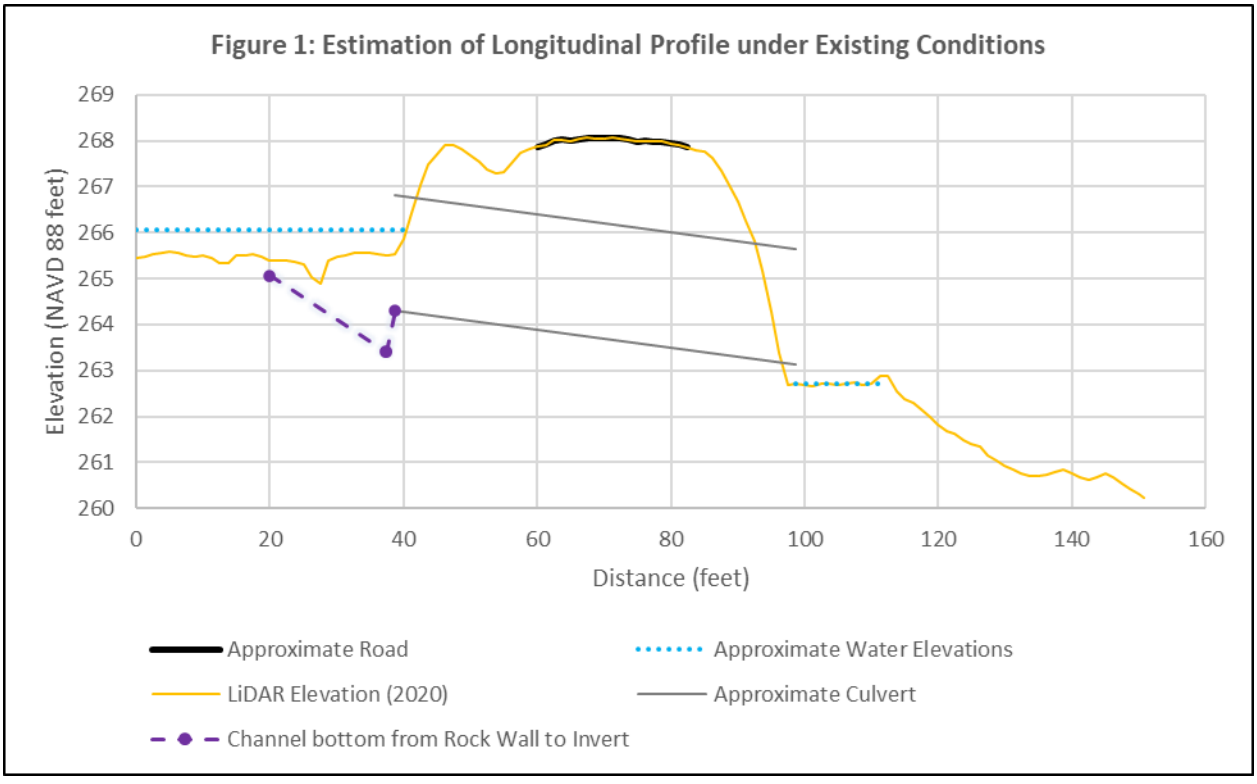
both live and road-killed records. The Town of Atkinson is planning to replace the existing culvert within the next two to three years, and the Atkinson Conservation Commission seeks to understand how a replacement structure can be designed to benefit Blanding's turtle and other terrestrial wildlife.

Existing Conditions:

Maple Avenue is a Legislative Class V Road maintained by the Atkinson Public Works Department. As of 2020, Maple Avenue's Average Annual Daily Traffic was reported at 399. A ±30-inch double wall corrugated plastic pipe carries drainage from the upstream wetland to the east of Maple Avenue to the downstream wetland to the west. The existing pipe is estimated to be ±60 feet long based on LiDAR measurements. The pipe is a chronic maintenance issue because of persistent beaver activity at the upstream inlet. At the November 6 site meeting the pipe was clogged and inundated on the upstream side by ±21" of water.

The elevation of Maple Avenue at the crossing site is quite low relative to the existing pipe's elevation and upstream water levels. Based on a rough estimate, the road surface at the crossing appears to be approximately two feet above the existing upstream water elevation. The downstream invert is estimated at five feet below the road surface. The outlet was perched by five inches as observed during the November 6 site walk, resulting in a barrier for aquatic organism passage. A rock wall crosses the stream channel upstream of Maple Avenue and appears to be serving as a hydraulic control. The water is ±12 inches deep at the rock wall currently. The channel bottom was also measured at the upstream invert. The upstream pipe is set ±11 inches above the channel bottom, with a water depth of ±32 inches.

A conceptual longitudinal profile approximating existing conditions, generated from LiDAR and the measurements described above, is included as Figure 1.



A reference channel downstream of the crossing is approximately 4.5’ wide based on measurements taken from LiDAR.

Overhead wires are present along Maple Avenue; a utility pole is located approximately six feet to the north of the structure on the downstream side.

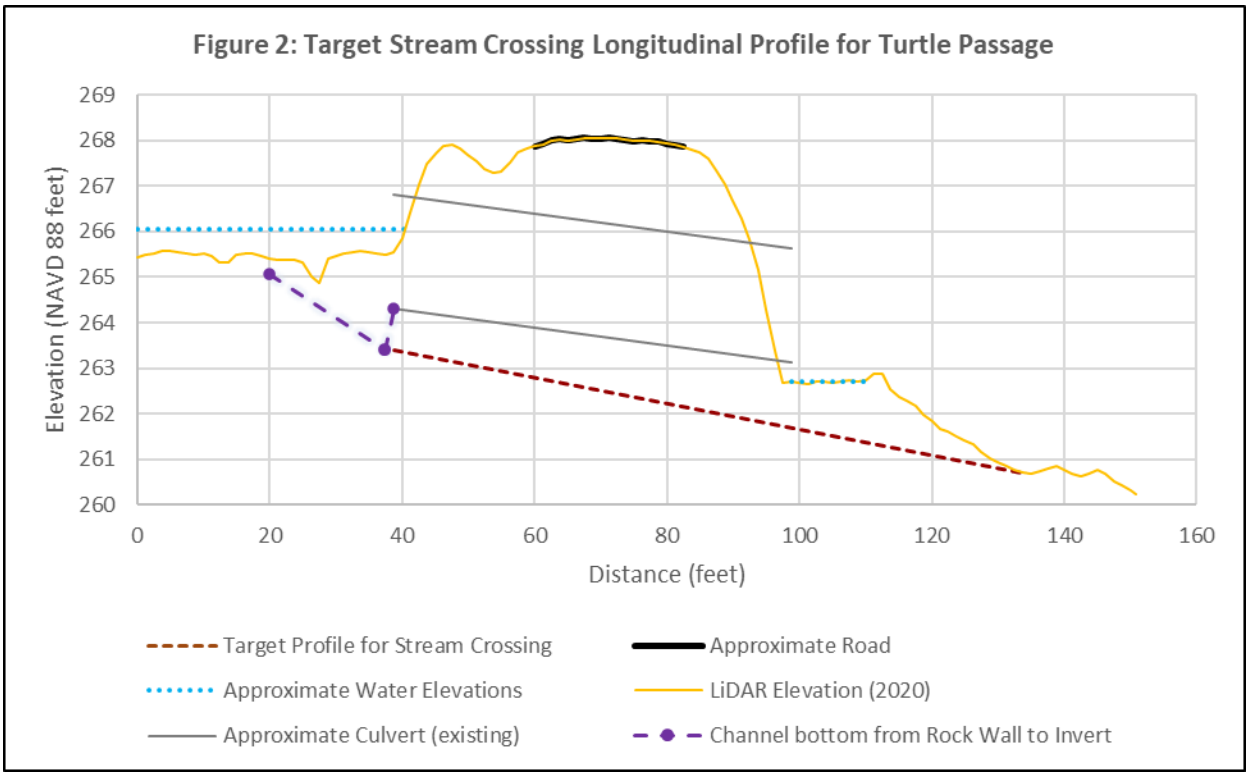
Structure Replacement Considerations:

A decision was made at the November 6, 2023, site walk that re-profiling (i.e., raising) Maple Avenue at the crossing site is not an option because of the cost that would be required to do so. Therefore, a replacement structure will need to be compatible with the existing road profile.

Town Engineer Steve Keach described that a four-sided concrete box culvert is the most appropriate structure type to install to avoid settlement associated with unstable underlying sub-surface materials. The surface area of the bottom of the box spreads the load of the structure and vehicles. The box culvert would incorporate stream simulation so that stream habitat within the structure will mimic upstream and downstream conditions.

The structure length could be reduced to the extent practicable based on site conditions. Initial estimates suggest that the structure length could be reduced from 60’ to approximately 44’. This assumes the upstream headwall would be offset approximately eight feet from the existing edge of pavement and the downstream outlet could be shortened by two to three feet.

Figure 2 displays the target stream crossing longitudinal profile to enhance passage for turtles, small to medium sized terrestrial wildlife, and aquatic organisms. Figure 2 does not account for reducing the length of the crossing structure, but rather shows a conceptual target for design and engineering.



Further details for a conceptual target replacement structure include:

Target Replacement structure length: ±44'

Target Clear height: ±3.5' (*this is the vertical clearance, or head room, inside the structure for passage*)

Target Structure height: ±5'

Stream Simulation: ±1.5' embedded

Conceptual Target Structure width:

- Ten feet to achieve the target openness ratio for Blanding's turtle, which is recommended at >0.82.
- Eight to nine feet would be a significant improvement over existing conditions, wouldn't meet NHDOT's definition of a bridge (maybe not a maintenance consideration for municipal roads), but wouldn't meet the target openness ratio for Blanding's turtle passage.
- Six feet should be the minimum target, which should meet 1.2 times bankfull width based on initial LiDAR measurements of ±4.5'. Bankfull width is defined by NHDES as "the distance between the left and right stream banks at bankfull stage, which is typically the 1.5 to 2-year flood frequency event." A six-foot structure would also be a significant improvement over existing conditions, would benefit critter crossings in general (e.g., raccoon, mink, otter, weasel) but would fall quite short of meeting the Blanding's turtle recommendation for openness ratio.

Openness Ratio for Blanding's turtle, among other design considerations, are detailed in the following document: Design Guidance for Wetland-Road Crossings to Reduce Blanding's Turtle Mortality Risk (UNH 2023, available at https://www.wildlife.nh.gov/sites/g/files/ehbemt746/files/inline-documents/sonh/10nov2023-guidance-for-wetland-road-crossings-for-blandings-turtles.pdf).

The engineering phase of the project will evaluate whether the targets suggested above are achievable based on existing site conditions from a survey and construction costs. A controlling factor is the depth of cover between the top of the replacement structure and the road surface. Town Engineer Steve Keach indicated that a minimum of two feet of cover is needed, three feet of cover is preferred.

To maximize effectiveness of a replacement structure for turtle passage, funnel fencing should be considered during the design process (fencing specifications are specified in the UNH guidance document provided above). Further coordination with New Hampshire Fish and Game should occur if a structure that doesn't meet the target openness ratio is selected. If turtles won't pass through the crossing because it is too small and fencing is used, the crossing could become a complete barrier for Blanding's turtle passage, which may be a bigger risk to the local population's health and stability.

Additional design consideration discussed at the site walk include:

- Possible Daylighting of a replacement culvert with grates, while beneficial for turtle passage and allows for smaller structure size, does not currently appear to be an acceptable alternative given maintenance concerns.
- Right Of Way is not anticipated to be a concern for reconstructing the crossing.
- The culvert design should avoid significantly lowering the water level in the upstream wetland, which could affect Blanding's turtle habitat. The upstream rock wall appears to be a hydraulic control that would maintain water levels in the upstream wetland approximately 12 inches lower than water levels estimated in Figures 1 and 2 that were observed on November 6, but lowering the East Sawmill Swamp prime wetland even by this amount could have unanticipated impacts on Blanding's turtle and other wildlife habitat.

References:

- **Design Guidance for Wetland-Road Crossings to Reduce Blanding's Turtle Mortality:** 10nov2023-guidance-for-wetland-road-crossings-for-blandings-turtles.pdf (nh.gov)
- **Town of Atkinson Prime Wetlands Study: http://atkinsonnh.civiccms.acsitefactory.com/sites/g/files/vyhlif8101/f/uploads/prime_wetland_study.pdf**

Attachments:

- **Appendix A – Photos made during the November 6, 2023 site visit**
- **Appendix B – 2020 Communications from Town Engineer Steve Keach**
- **Appendix C – 2023 Communications between Peter Steckler and Town Engineer Steve Keach**

Appendix A - 11/06/2023 Photos

Photo 1: Upstream view looking east-northeast from Maple Ave.

Photo 2: View of upstream culvert inlet, looking west-southwest from the rock wall upstream of Maple Ave.

Photo 3: Downstream view looking west-southwest from Maple Ave.

Photo 4: View of downstream culvert outlet, perched ±5", looking east-northeast.

Photo 5: View looking north along Maple Ave toward the crossing site.

Photo 6: View looking south along Maple Ave toward the crossing site. The existing culvert is approximately six feet beyond the utility pole on the right side of the photo.

Appendix B - 2020 Communications from Town Engineer Steve Keach

KNA KEACH-NORDSTROM ASSOCIATES, INC.

Memo

To: Mr. Edward Stewart; Road Agent – Town of Atkinson, New Hampshire

From: Steven B. Keach, P.E.

Date: November 30, 2020

Subject: **Maple Avenue Culvert Replacement**
Atkinson, New Hampshire
KNA Project No. 20-1130-1

Pursuant to your request we have considered the extent of work required to properly plan, design, permit and ultimately construct an environmentally friendly box culvert as a replacement for an existing 24-inch diameter round culvert at the subject location. Specifically, based on our recent conversation we understand your Department, working in conjunction with the Atkinson Conservation Commission, seek to undertake the planned replacement in order to not only accommodate anticipated stormwater volumes, but also to greatly enhance opportunities for "connectivity" of amphibian and wildlife habitats believed to exist within a wetland complex that is both situated at the headwaters of Hog Hill Brook and bifurcated by Upper Maple Avenue.

In keeping with your request, the intent of this memorandum is to provide your Department with budgetary planning information applicable to this undertaking. As you are aware, apart from smaller cross-sectional dimensions, it is anticipated the planned replacement box culvert structure will be generally similar to the series of structures recently installed at Island Pond Road. That said given the intent that the replacement structure will provide enhanced opportunities for the accommodation of amphibian and wildlife passage, it will be necessary for the bottom of the structure to mimic natural stream channel conditions. In order to achieve that outcome, two alternative types of precast concrete box culvert structures should be considered. One type is a three-sided precast concrete structure supported by either poured-in-place or precast concrete footings. Often this alternative is selected when the stream channel has been preserved in either a natural or near natural condition and competent subsurface soil conditions exist. In this type of application, use of a three-sided structure enables continued preservation of the existing natural stream channel with limited impact during the construction period. The second general type of structure which should be considered is a four-sided precast concrete structure with baffling along the bottom length of its interior. This variety of structure is often used in order to enhance opportunities for successful stream channel restoration in applications (such as the

current location) where natural stream channel conditions have been lost due to prior human activities (such as installation of a traditional round culvert). In short, baffling cast into the bottom of this variety of structure is submerged below stream channel grade and used to secure placed soil and stone materials which mimic natural conditions. In practice this second variety of structure is often preferred over the first due to benefits associated with comparative ease of installation and better adaptability to imperfect subsurface soil conditions. Although we recommend consideration be given to both types of structures, based upon our initial viewing of the site we anticipate a four-sided structure will likely prove to be the preferred option for a variety of reasons including cost of installation.

Regardless of structure type we anticipate the resulting structure will require installation of precast concrete end-walls on both the inlet and discharge ends. The purpose and benefit of end-walls include improved culvert hydraulics; cut-off of ground and surface water transport along the barrel of the structure exterior; and enhanced roadside embankment stability.

Prior to proceeding with construction proposed improvements must first be approved by the NHDES Wetlands Bureau. Correspondingly, and similar to your Department's recent experiences at Island Pond Road, we recommend design and permitting functions commence approximately one year prior to planned installation date. Specific technical requirements necessary for proper planning, design and permitting of this proposed construction include: (a) on-site wetlands delineation and evaluation; (b) preparation of an existing conditions survey of the immediate project vicinity; (c) hydrological analysis of the proposed culvert crossing; (d) limited subsurface exploration and evaluation; (e) preliminary design and evaluation of various culvert options and geometries; (f) pre-application discussion and consideration of options with regulatory authorities and NHDES Wetland Bureau staff; (g) preparation of final design plans and bid/construction documents; and (h) project permitting.

Based on our experiences with a number of similar projects, including those at Island Pond Road, we offer the following budgetary estimates for planning purposes:

- Engineering Design and Environmental Permitting: $15,000
- Construction of Culvert & Related Roadway Improvements: $60,000 to $75,000
- Inspection, Testing & Contract Administration: $5,000
- Total Project Cost: $80,000 to $95,000

We trust you will find the content of this brief memorandum responsive to your recent request. In the event you should have specific questions or further instructions at this time, please contact the writer at your convenience.

Paul Wainwright

From: "Steve Keach" <skeach@keachnordstrom.com>
Date: Friday, December 18, 2020 9:36 AM
To: "Paul Wainwright" <paulwainwright@comcast.net>
Cc: <conservation@atkinson-nh.gov>; "Ted Stewart" <roadagent@atkinson-nh.gov>; "David Cressman" <townadmin@atkinson-nh.gov>
Attach: MapleAvenueCulvert.BudgetEst.Memo.11302020.pdf
Subject: RE: Culvert replacement on upper Maple

Paul:

Attached, please find a copy of a letter report we prepared last month at Ted's request. As you may be aware, earlier this fall Ted advised me of discussions that had occurred by and between the Conservation Commission and his Department regarding a desire to ultimately replace an existing 24 inch diameter traditional (round) culvert with a box culvert at the subject location. At that time, Ted asked that we provide recommendations regarding both project approach and anticipated cost of implementation. The attached memorandum addresses each of Ted's requests.

As indicated in this memorandum, our office has significant experience with similar projects. As you are likely aware, approximately a decade ago, the NHDES promulgated and adopted Stream Crossing Rules that are now applicable to all projects of this nature. In order to comply with applicable requirements of these Rules, essentially all stream crossings of perennial streams must now rely on use of box culverts or some other form of construction which mimics natural stream channel characteristics and are conducive to wildlife and amphibian passage. Correspondingly, since adoption of these Rules, the majority of municipal roadway stream crossing replacement or betterment projects we have been involved with have necessitated replacement of traditional round culverts with box culverts in order to gain required NHDES project permits. You may recall that in 2018 and 2019 the Atkinson Highway Department replaced each of three large diameter round culverts beneath Island Pond Road with rectangular shaped box culverts. Compliance with NHDES Stream Crossing Rules was a primary reason for use of box culverts at these locations. Based on the practical "data base" created by our experiences with other projects we were able to satisfy Ted's directives without initiating even preliminary design efforts. Correspondingly, as of this date, we have not been asked to commence project design.

Despite lack of detailed design information you seek to assist the Commission in its endeavors to secure project funding, I believe it is generally understood what the geometry of a future box culvert installation would look like. Specifically:

1. The width of the culvert bottom would approximate the width of the natural stream channel that likely existed prior to construction of Maple Avenue. For the purposes of providing Ted a preliminary construction cost opinion, I assumed a width of six feet;

2. In order to be "inviting" to migration of wildlife and amphibians, the clear height (stream channel to interior box culvert roof) should generally be not less than approximately 2/3rd's of width. Correspondingly, I assumed a clear height dimension of four feet;

3. Presently, the westerly end of the existing round culvert is vertically situated approximately two feet above adjoining existing grade. This geometry is not conducive to migration. As such, I have assumed the interior channel bottom will be lowered by a vertical distance of approximately two feet to better accommodate the same; and

4. For improved culvert hydraulics and roadway embankment stability, I have presumed the resulting box culvert will be equipped with precast headwalls on each end.

Taken together, I anticipate the resulting box culvert geometry will approximate the geometry of each of the three box culverts recently installed at Island Pond Road. While box culvert dimensions many vary somewhat from those at Island Pond Road, Ted would have copies of plans of each of those completed installations available for you to view. Obviously, our office has those drawings as well, so let me know if you would like me to forward the same as I anticipate they effectively represent a "prototype" of what the resulting Maple Avenue installation would look like.

I hope this helps. If I can be of further assistance, contact me directly.

Steve K.

From: Paul Wainwright <paulwainwright@comcast.net>
Sent: Thursday, December 17, 2020 5:36 PM
To: Steve Keach <skeach@keachnordstrom.com>
Cc: conservation@atkinson-nh.gov; Ted Stewart <roadagent@atkinson-nh.gov>; David Cressman <townadmin@atkinson-nh.gov>
Subject: Culvert replacement on upper Maple

Hi Steve --

I just got off of a Zoom call about how to get grant money for culvert replacements that result in improved mobility of turtles and other critters. I think we may be able to get some grant money to help pay for the upper Maple project you are working on with Teddy, provided that the design would enhance turtle migration opportunities. Do you have a preliminary design I could share with the folks at DES and NH F&G to get their opinion about what grants might be applicable to this project, and/or get some suggestions from the wildlife biologists about improvements to the design that might benefit the critters?

Thanks,

-- Paul.

Paul Wainwright, Chair, Atkinson Conservation Commission
Please note my new preferred email address: paulwainwright@comcast.net

Atkinson Conservation Commission Web Page
Atkinson Conservation Commission Facebook Group
Paul Wainwright Photography Website

Appendix C – 2023 Communications between Peter Steckler and Town Engineer Steve Keach

From: Steve Keach
To: Peter Steckler
Cc: conservation@atkinson-nh.gov; Paul Wainwright; Joshua Megyesy; Atkinson Public Works
Subject: Re: Maple Ave Culvert
Date: Friday, November 10, 2023 11:05:27 AM
Attachments: image001.png

Peter

Looks like your schematic dimensions and elevations are in the ballpark. I suspect that after we have accurate on-ground survey information to work with we will be able to make a determination of feasibility and/or make modest adjustments to make things work.

As to you question about depth of cover, we need a minimum of 24-inches between pavement surface at top of concrete to accommodate 18-inches of aggregate roadway base gravel, 3 to 4-inches of pavement and a 2-inch thickness of Dow Board insulation directly above the top of concrete. To reduce risk of differential movement of pavement above and beyond the box culvert structure I generally like to see a minimum of 12-inches of sand between top of concrete and base gravels. Again, once we have accurate survey to work with we can establish precise design elevations and dimensions to see how close to a balance of competing needs can be achieved.

Steve K.

From: Peter Steckler <psteckler@neconservation.com>
Date: Friday, November 10, 2023 at 9:44 AM
To: Steve Keach <skeach@keachnordstrom.com>
Cc: conservation@atkinson-nh.gov <conservation@atkinson-nh.gov>, Paul Wainwright <paulwainwright@comcast.net>, Joshua Megyesy <joshua.megyesy@wildlife.nh.gov>, Atkinson Public Works <publicworks@atkinson-nh.gov>
Subject: Maple Ave Culvert

Hi Steve,

It was nice to meet you at the Maple Ave site walk on Monday. Thanks for talking us through some of the design considerations at the site. Following the meeting I took some measurements and have reviewed the 2020 LiDAR at the site. I generated a longitudinal profile based off of the LiDAR and then added some features based off of the measurements I took on-site. Note that I am not an engineer and am not pretending to be one here, just trying to use the available information we have to inform potential next steps. Mostly I am looking for you reaction to what I've laid out below.

Below you will see the following:

1. Map with LiDAR shading stretched between elevations 260' (blue) and 266' (red) for the site. The black line is the line I used to generate the longitudinal profile
2. A ***conceptual*** graph I created to inform existing conditions and potential replacement structures. My measurements are approximate, for conceptual purposes only. Note:
    a. I approximated the existing culvert's elevation based on the existing water surface elevation being about 2' below the road surface on the upstream side, and 21" of water depth to the invert. On the downstream side the water elevation is about 5.5' below the road surface, and the invert is perched 5". Using these measurements I also drew in the approximate water surface elevations.
    b. I took a couple of water depth measurements upstream to approximate channel elevations, one at the invert where the channel depth is about 11" below the invert (32" water depth total), and one at the rock wall where the water depth is about 12". The good news is that the rock wall is serving as a

hydraulic control, and will likely help to maintain water surface elevation in the upstream wetland even if we lower the upstream invert.

c. Then I drew in a target slope to match the existing upstream channel elevation with downstream channel conditions, the "Target Slope?" line.

If my analysis and measurements are in the ballpark of reality, here is what I think is in the realm of possibilities to make this crossing as critter and turtle friendly as possible using the "Target Slope?" line as the proposed channel elevation:

Target Replacement structure length: ~44'
Target Clear height: ~3.5'
Structure height: 5', 1.5' embedded
Structure width:

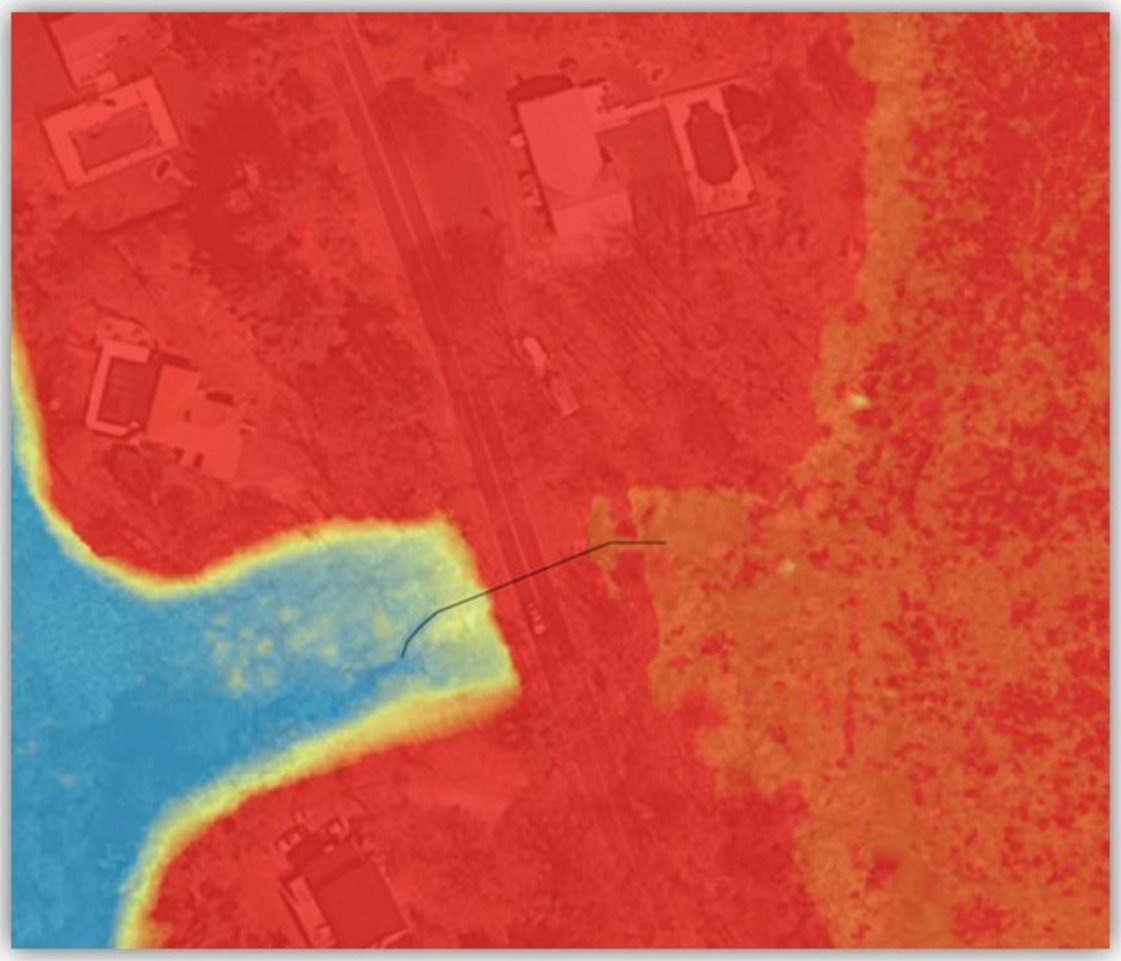
- 10' is just about right to achieve the target openness ration for Blanding's, which is recommended at >0.82
- 8' would be a huge improvement but wouldn't meet the target openness ratio
- 6' would be minimum target, should meet 1.2x BF width. I estimated downstream BF width off of the LiDAR at ~4.5'. This would also be a huge improvement over existing conditions, would benefit critter crossings in general (e.g. raccoon, mink, otter, weasel) but would fall quite short of meeting the Blanding's turtle recommendation for structure size

Please let me know what you think of what I've laid out here. In particular, the replacement box as I've described above would not be able to achieve 3' of cover given existing conditions. Are there ways to design this replacement to reduce the amount of cover needed to 2'? If helpful I am happy to jump on a call with you next week to discuss further.

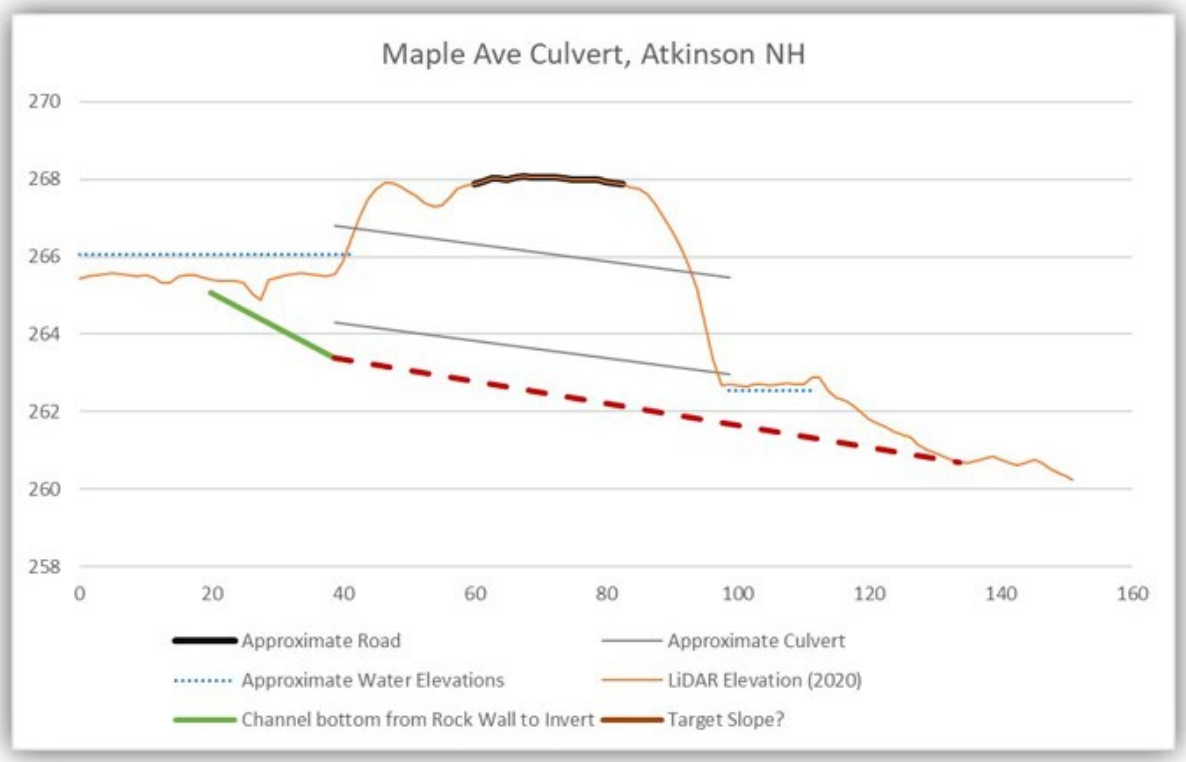
Thanks!

Pete

1. **LiDAR Map**



2. **Conceptual Longitudinal Profile plus other elements**



Peter Steckler
Principal

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Northeast Conservation Services

Northeast Conservation Services, LLC. Peter Steckler, Member