Town of Underhill
RFP – Engineering Services

The Town of Underhill is accepting proposals for professional engineering services to prepare final design and provide construction support for a replacement stream crossing on Deane Road. The scope of services is summarized as follows:

Review of 2014 site hydrology and design hydraulics performed by others. Provide final design to include detailed construction drawings, technical specifications, plan and profile of the project site suitable for construction bidding purposes. Provision of complete contract forms, an opinion of a general construction schedule, probable construction cost and total project cost, assistance with obtaining all required permits. Support throughout the Construction phase, from preparation of advertisement through Notice to Proceed. Act as the Town's representative during Construction Contract Administration phase, liaison with the Contractor and provide Resident Project Representation to monitor the Contractor's schedule, staffing, quality of workmanship and progress.

The complete requirements for preparing a response to this RFP are available at the Underhill Town Hall, on the Town's website (www.underhillvt.gov) or by contacting Brian Bigelow (bbigelow@underhillvt.gov or 899-4434 x100). Submit sealed proposals by 4:00 p.m. Tuesday May 12, 2015 to Underhill Town Office, PO Box 120, Underhill, VT 05489.

TOWN OF UNDERHILL

REQUEST FOR PROPOSALS
Culvert Replacement Design and Construction Oversight Services
Deane Road, Underhill, VT

Issued: April 15, 2015 **Due: May 12, 2015**

Project Description: The Town of Underhill is seeking a qualified consultant to provide a professional engineered project design and management services for the replacement of an existing dry-laid stone culvert over Deane Brook on Deane Road (Town Highway #15). The project involves project development for the design, permitting, and oversight of construction of a new culvert/bridge. A non-mandatory pre-bid meeting will be held on April 30, 2015 at 1:00PM at the site: approximately 200 feet south of the intersection of Pleasant Valley Road and Deane Road.

Responses are due no later than **4:00PM, Tuesday, May 12, 2015**, at the Underhill Town Office, 12 Pleasant Valley Road, Underhill VT 05489. Sealed bids will be opened at the 6:00pm meeting of the Underhill Selectboard that same day. The envelope should include the statement "Deane Road Culvert Replacement Design." For more information or a copy of the detailed scope of work, contact Town Administrator Brian Bigelow at (802) 899-4434 x100 or by email at bbigelow@underhillvt.gov.

I. BACKGROUND

The hydrology of the watershed and recommended culvert sizing were provided to the Town of Underhill in a report by TR Fellows Engineering, "An Assessment of Road-Stream Crossings on Deane, Corbett and Mountain Roads" (ATTACHMENT #3). The Town of Underhill seeks to retain professional engineering services to prepare final design and construction engineering services for the stream crossing on Deane Road.

II. SCOPE OF WORK

This project is included in the Town of Underhill 2015-2016 Capital Budget. Application has been made for a FY16 Vermont Agency of Transportation (VTrans) Structures Grant. Preliminary results of the application (District 5 recommendation to Montpelier) will be available after April 27, 2015. All aspects of project design and development, must conform to federal and state regulations.

See ATTACHMENT #1 (Scope of Services) and ATTACHMENT #2 (Duties/Authority of Engineer's Field Agent) for full scope of work.

III. REQUIRED ELEMENTS OF PROPOSAL

A. Proposal. Four (4) copies of the proposal should be provided in a sealed envelope with "Deane Road Culvert Replacement Design" clearly indicated on the envelope. The proposal should include the following information:

1. A narrative description of the consultant's understanding of the project and their role in implementing the project.

2. A description or resume outlining the consultant's qualifications for the working on the project, including a listing of past project experience.

3. Three (3) references, with phone numbers and contact names.

4. Four (4) copies of a document containing information about hourly rates for all classifications of personnel who may be utilized for the services requested. These rates shall be presented and broken down by direct labor cost and indirect cost by percentage or by hourly rate. Include a listing of hourly rates and chargeable expense fees such as travel and reproductions. Final Design, Bid Phase Services should be submitted as a Lump Sum (LS). Construction Administration should be submitted as a Not to Exceed (NTE) amount.

IV. SELECTION CRITERIA AND PROCESS

A. The proposals will be evaluated considering the following factors:

1. Demonstrated understanding of the project, qualifications, references, and prior work experience of a similar nature and within a similar time frame.

2. Familiarity with applicable state and federal regulations or demonstrated experience with similar regulations which would indicate an ability to understand unfamiliar regulations.

3. Demonstrated experience with preparing requests for proposals/qualifications and scopes of services for hiring consultant services, with preparing, executing and managing such contracts and/or experience with similar type procurement.

4. Demonstrated experience with construction projects from start to finish, including administrative oversight.

B. Fees for service will be considered only after the technical proposals have been reviewed. Lowest hourly rate will not be the sole criterion for selection.

C. Proof of liability insurance listing the Town as additional insured in an amount no less than $1,000,000/$2,000,000 and completed W-9 will be required to be provided by the successful respondent.

D. Appeal. Any respondent aggrieved by the award of the contract may appeal in writing to the Underhill Selectboard, P.O. Box 120, Underhill, VT 05489. The appeal must be postmarked within fourteen (14) calendar days following the date of written notice to award the contract. Any decision of the Underhill Selectboard is final.

E. All proposals become the property of the Town upon submission. The cost of preparing, submitting, and presenting a proposal is the sole expense of the proposer.

F. Selectboard Authorization. The Town of Underhill, through its Selectboard, reserves the right to reject any or all proposals and to award the contract, in whole or in part, as determined to be in the best interests of the Town. The Town also reserves the right to waive any formality and any technicalities, or to cancel in part or in its entirety this request for proposals if it is in the best interest of the Town. This solicitation of proposals does not obligate the Town to award a contract.

G. Taxes Due the State. The successful respondent will need to certify compliance with State tax laws, including income tax withholding for employees performing services within the state, payment of use tax on property used within the state, corporate and/or personal income tax on income earned within the state; and that the successful bidder is in good standing with respect to or in full compliance with a plan to pay any and all taxes dues to the State of Vermont.

F. Standard Contract Provisions. Standard VTrans and State contract provisions will apply.

V. OTHER

A. Questions should be directed to Brian Bigelow, Town Administrator, at (802) 899-4434 x100 or e-mail at bbigelow@underhillvt.gov

B. Revisions or addenda to this request for proposals will be posted at www.underhillvt.gov and provided upon request. Bidders who submitted bid early will be contacted.

C. The Town of Underhill reserves the right to modify any technical and submission requirements associated with this request for proposals.

D. Qualified disadvantaged (DBE) and women-owned (WBE) business enterprises are encouraged to submit proposals. Underhill is an equal opportunity employer.

E. All plans, maps, data, reports, data bases, and materials, in digital (in the format specified by the Town) and hard copy form, used or created for this project will be delivered to and become the property of the Town of Underhill.

F. Responses are due no later than **4:00pm, Tuesday, May 12, 2015** delivered or mailed to the address below. The envelope should include the statement "Deane Road Culvert Replacement."

Delivery Address:
Brian Bigelow, Town Administrator
Underhill Town Hall
12 Pleasant Valley Road
Underhill, Vermont

Mailing Address:
Brian Bigelow, Town Administrator
P.O. Box 120
Underhill, VT 05489

ATTACHMENT # 1

SCOPE OF SERVICES

INTRODUCTION

The Town of Underhill (OWNER) plans to replace the existing dry-laid stone culvert over Deane Brook on Deane Road. The hydrology of the watershed and recommended culvert sizing were provided to the OWNER in a report by TR Fellows Engineering, "An Assessment of Road-Stream Crossings on Deane, Corbett and Mountain Roads".

Per the OWNER's request, the ENGINEER proposes to provide professional engineering services to prepare final design and construction engineering services for the stream crossing on Deane Road.

The ENGINEER will perform the following scope of services.

I. FINAL DESIGN

Field Surveys

The ENGINEER will conduct a field survey and office work related to said surveys as necessary for preparation of the final design and contract drawings for the project. All elevations will be referenced to NGVD 29 or NAVD 88 vertical control datum as appropriate.

Preparation of Final Design Plans and Specifications

The ENGINEER will make engineering investigations as are necessary and will compile such data as required for the design and drawings for the project. Drawings (plans), technical and construction specifications shall be prepared setting forth in sufficient detail the requirements for constructing the project. Specific tasks include:

1. Review of site hydrology and design hydraulics by TR Fellows Engineering (ATTACHMENT #3) to confirm basis of design.
2. Final design, detailed construction drawings, specifications, and contract forms complete and ready for construction bids for the culvert replacement. Subsurface explorations may be required.
3. This design shall include the following:
   a) A plan and profile of the project site. Specific information to be included on the plans will be the roadway and neighboring driveway limits, streambed, stream bank delineation, existing utilities locations, specimen trees, fences, and approximate right-of-way locations. The profile will include the existing grade along the centerline of the proposed improvements as necessary.
   b) Technical specifications for the project will be prepared as required to define the project.
   c) The technical specifications will be supplemented with "front-end" documents to make a set of construction contract documents suitable for public bidding purposes and in

accordance with OWNER requirements, which may include: Advertisement for Bids, Information for Bidders, Bid Form, Contract Form, and General Conditions.

4. For the "90% design review" draft, two (2) sets of the construction drawings, the specifications, and the contract documents shall be provided by the ENGINEER to the OWNER. For the final design plans, contract documents and specifications (construction set) the ENGINEER will provide two copies to the OWNER.

Opinion of Probable Construction Cost and Schedule
An opinion of probable construction cost and total project cost, based upon completed final drawings and specifications, will be furnished to the OWNER. A general schedule for the construction phase of the project will be furnished to the OWNER. The OWNER would like to construct the culvert replacement in 2015, Stream Alteration Permit requirements will require this construction to occur between July and October. The construction schedule will identify the following for which the construction contract work duration (continuous calendar days) is based: Execution of the Notice to Proceed, Field work commencement, Substantial and/or Final Completion of work.

Design Meetings
The ENGINEER will meet at reasonable and customary intervals to provide a close liaison with the OWNER to include at a minimum one kick-off meeting and one review meeting at 90% complete.

Project Permitting
The ENGINEER shall assist the OWNER in obtaining the necessary Stream Alteration Permit to allow for the construction of the project. The ENGINEER will prepare for and attend one field meeting related to permitting issues. The ENGINEER will provide notice to the Stream Alteration Engineer of project start-up and project completion.

II. CONSTRUCTION PHASE SERVICES

Bid Phase Services
The ENGINEER will provide the following support services to assist the OWNER in obtaining bids from contractors. The bid period for this project will be 21 consecutive calendar days to allow bidders adequate time to become familiar with the work. The ENGINEER will:

1. Prepare one Advertisement for Bid in a circulated publication chosen and paid for by the OWNER. Direct mail it to up to six selected contractors as approved by the OWNER.
2. Conduct one Pre-Bid Meeting with interested contractors and the OWNER. The ENGINEER will schedule the meeting no later than two weeks prior to the bid opening to allow bidders to become more familiar with the site and contract requirements. Bidder general and technical questions with the ENGINEER's responses will be published in the form of an addendum no later than five consecutive calendar days before the bid date.
3. Attend one Bid Opening, compare bids, check for compliance with the contract requirements, call references, confirm math and tabulate the results. Based upon this

review, the ENGINEER will make a written recommendation to the OWNER for award of the contract.

Construction Contract Administration

Throughout the construction period, the ENGINEER will act as the OWNER's representative and liaison to the Contractor as defined and authorized under the Construction Contract Documents. As the OWNER's representative, the ENGINEER will:

1. Conduct one project Preconstruction Meeting with the OWNER and the Contractor.
2. Review submittals for general conformance with the design plans and specifications. Submittals will be required for estimated work and payment schedules, and specified equipment and materials. The Contractor is responsible for the means and methods of completing all of the work, and all safety programs.
3. Prepare Change Orders for review and approval by the Contractor and OWNER.
4. Review payment requisitions as submitted by the Contractor and make recommendations to the OWNER for approval.
5. Conduct final completion review with the OWNER and make recommendations for payment as set forth in the Contract Documents.
6. Provide to the OWNER a final project cost summary.
7. Conduct an 11th month performance/contract warranty inspection with the OWNER and Contractor if required.

Resident Project Representative (RPR)

Throughout the active construction period, the ENGINEER will provide RPR services to assist the ENGINEER in reviewing the work of the Contractor. The RPR(s) will:

1. Conduct on-site observations of the work to determine if it is in accordance with the Contract Documents.
2. Interpret the Contract Documents to address questions raised by the Contractor.
3. Make recommendations to the OWNER regarding work not meeting the requirements of the Contract Documents.
4. Witness equipment and material testing, and determine compliance with the Contract Documents.
5. Prepare regular field reports to document progress of the work.
6. Review work quantities submitted for payment by the Contractor and make recommendations to the OWNER.
7. Prepare work lists of items requiring completion or correction by the Contractor.
8. The project budget assumes part time RPR services throughout the active on-site work period for construction, estimated three weeks. A total of 50 man-hours including travel are available for part-time RPR services. The ENGINEER will adjust the RPR services coverage as necessary, subject to the contractors work activities and as per the OWNERs request.
9. See **ATTACHMENT #2** - **"Duties, Responsibilities and Limitations of Authority of the Resident Project Representative."** This document more definitively outlines the requirements of the RPR.

10. The ENGINEER will monitor the Contractor's schedule, staffing, quality of workmanship and progress throughout the construction period and advise the OWNER of deviations from the work schedules and the budget. If the Contractor is permitted to work outside the specified work hours or a proposed Contractor Change Order will add or delete contract time, the ENGINEER will review the approved budget for RPR services and immediately advise the OWNER, in writing, of any impact that this modification will have on the RPR or any other previously approved services.

III. ADDITIONAL SERVICES

The following services are not anticipated to be included in the scope of this Agreement, but may be requested by the OWNER, upon issuance of a written Amendment to this Agreement:

1. Property and/or boundary surveys; Preparation of plans for recording.
2. Redesigns ordered by the OWNER or REGULATORY AGENCIES after final design plans have been reviewed and accepted.
3. Assistance to the OWNER on matters of easements or land acquisition, litigation or arbitration in regard to the project
4. Other special services not identified herein, but which may become necessary at a later date.

END OF ATTACHMENT #1

ATTACHMENT # 2

DUTIES/AUTHORITY OF ENGINEER'S FIELD AGENT

The ENGINEER shall furnish a Field Agent to assist the ENGINEER in observing the progress that has been made and the quality of the various aspects of the Contractor's executed work. Based on this general observation, the ENGINEER will keep the OWNER informed about the progress of the Work and shall endeavor to guard the OWNER against deficiencies in the Work. The Field Agent is the ENGINEER's agent at the site and will act under the supervision and direction of the ENGINEER. The Field Agent shall deal directly with the ENGINEER and the Contractor, keeping the OWNER informed as appropriate.

The Contractor shall have sole responsibility over construction means, methods, techniques, sequences and safety precautions necessary to perform the Work in conformance with the Contract Documents and all applicable laws and regulations. The ENGINEER and their Field Agent shall not be responsible for any acts or omissions of the Contractor, their subcontractors or any other entity performing any portion of the Work. These rights and responsibilities are solely those of the Contractor in accordance with the Contract Documents and the Contractors mutual agreement with the OWNER. The ENGINEER and their Field Agent offer no warranty, expressed or implied that the Work provided by the Contractor conforms to the Contract Documents.

The duties and authority of the Field Agent are limited to those described below:

1. **Schedules:** Review the progress schedule, schedule of shop drawing submittals and schedule of values prepared by the Contractor and consult with the ENGINEER concerning acceptability.

2. **Conferences and Meetings:** Attend meetings with Contractor, such as the preconstruction conference, progress meetings, job conferences and other project related meetings. Prepare and circulate copies of minutes under the direction of the ENGINEER.

3. **Liaison:** Serve as the ENGINEER's liaison with the Contractor, working principally through the Contractor's superintendent to assist in understanding the intent of the Contract Documents. Assist the OWNER when the Contractor's operation affect the OWNER's operations and require coordination. Assist in obtaining additional details or information from the OWNER, when required for proper execution of the Work.

4. **Shop Drawings and Samples:** Record the date of receipt of Shop Drawings and samples. Receive samples which are furnished at the site by the Contractor, and notify the ENGINEER of the availability of samples for examination. Advise the ENGINEER and the Contractor of the commencement of any Work requiring a Shop Drawing or sample if the submittal has not been reviewed by the ENGINEER.

5. **Observation of the Work:** Conduct on-site observations of the Work in progress to assist the ENGINEER in determining if the Work is generally conforming to the Contract Documents. Advise the ENGINEER of any Work that is believed to be defective, damages or otherwise not in conformance with the Contract Documents.

6. **Visiting Inspectors:** Accompany visiting inspectors representing public or other agencies having jurisdiction over the Project. Record and report the results of these inspections to the ENGINEER.

7. **Quality Assurance Tests:** Verify that all quality assurance tests specified in the Contract Documents are completed satisfactorily. Witness tests as appropriate under the supervision of the ENGINEER.

8. **Interpretation of Contract Documents:** Report to the ENGINEER when clarification or interpretation of the Contract Documents is needed. Transmit clarifications and interpretations as issued by the ENGINEER to the Contractor.

9. **Deviation from the Contract Documents:** Consider and evaluate suggestions for deviation from the Contract Documents, presented by the Contractor. Review the recommendation with the ENGINEER and advise the Contractor of the ENGINEER's acceptance or rejection of the proposed deviation. The Field Agent shall not authorize any deviation from the Contract Documents or substitution of materials or equipment, unless specifically authorized by the ENGINEER.

10. **Reports:** Prepare a daily report, recording the Contractor's hours on the job site, weather conditions, list of job site visitors, daily activities, tests conducted and general observations. Maintain a file of daily reports and submit copies to the ENGINEER.

11. **Records:** Maintain orderly files for correspondence, reports of job conferences, shop drawings and samples, reproductions of original Contract Documents including all Addenda, Change Orders, Field Orders, ENGINEER's clarifications and interpretations of the Contract Documents, progress reports, and other Project related documents, issued subsequent to the execution of the Contract between the OWNER and the Contractor.

12. **Payment Requests:** Review draft applications for progress payment by the Contractor and forward with recommendations to the ENGINEER, noting particularly the relationship of the payment requested to the schedule of values, Work completed and materials and equipment delivered at the site but not incorporated in the Work.

13. **Certificates, Maintenance and Operation Manuals:** During the course of the Work, verify that certificates, maintenance and operation manuals and other data required to be assembled and furnished by the Contractor are applicable to the items actually installed and in accordance with the Contract Documents.

14. **Start-Up and Training:** Verify and observe that equipment and system start-ups and operator training are performed by appropriate personnel, conforming to the Contract Documents.

15. **Substantial and Final Completion:** Conduct a substantial completion inspection in the company of the ENGINEER, OWNER and Contractor and prepare a punchlist of items to be completed or corrected. Observe that all items on the punchlist have been completed or corrected and make recommendations to the ENGINEER concerning final acceptance of the Work.

16. **Contractor's Responsibility:** The Field Agent shall not undertake any of the duties or responsibilities of the Contractor or their subcontractors. The Field Agent shall not advise on, issue directions relative to or assume control over any aspect of the means, methods, techniques, sequences or procedures of construction unless such advice or directions are specifically required by the Contract Documents, nor shall they advise on, issue directions regarding or assume control over safety precautions and programs in connection with the Work.

End of Attachment # 2

ATTACHMENT #3

Assessment of Road-Stream Crossings on Deane, Corbett, and Mountain Roads

The Town of Underhill, Vermont

October 29, 2014

Prepared by:

Jeremy Krohn, P.E.

T.R. FELLOWS ENGINEERING CIVIL & STRUCTURAL VT NH

www.trfellows.com

P.O. Box 56
Rochester, Vermont 05767
Ph. 802-318-7853
kricket@trfellows.com

134 County Road
Walpole, New Hampshire 03608
Ph. 603-756-4811
trifel@myfairpoint.net

TABLE OF CONTENTS

1. INTRODUCTION 2
2. DEANE BROOK CULVERT UNDER DEANE ROAD 3
   2.1 Location 3
   2.2 Existing Conditions 3
   2.3 Hydrology and Channel Characteristics 5
   2.4 Recommendations 6
3. SEYMOUR RIVER CULVERT UNDER CORBETT ROAD 7
   3.1 Location 7
   3.2 Existing Conditions 8
   3.3 Hydrology and Channel Characteristics 10
   3.4 Recommendations 10
4. HARVEY BROOK CULVERT ON MOUNTAIN ROAD 11
   4.1 Location 11
   4.2 Existing Conditions 12
   4.3 Hydrology and Channel Characteristics 14
   4.4 Recommendations 14
5. FURTHER RECOMMENDATIONS 15

1. INTRODUCTION

Preliminary recommendations for the three road-stream crossing structures (Deane Rd., Corbett Rd., and Mountain Rd.) assessed on August 5, 2014 are provided in this report. All three of the assessed streams had a drainage area equal to or greater than 0.5 square miles. This, in addition to other potential contributing factors, means that the structures fall under the jurisdiction of the Vermont DEC's *Stream Alterations General Permit*. The general permit sets forth minimum design requirements for road-stream crossing structures.

The current *Stream Alterations General Permit* requires stream crossing structure dimensions to be based, in part, on the bankfull width for a stable, representative section of the respective stream. All structures are to have a natural streambed. This is accomplished by construction of a bottomless structure or bridge, or by burying a culvert (i.e. infilling the lower portion of a pipe with specified streambed material). In essence, structures are to be designed to not only accommodate flow of water, but also to allow for the transport of streambed material (sediment, sand, cobbles, etc.) through the culvert at a rate that is similar to the adjacent sections of stream. The requirements of Stream Alterations General Permit can be summarized as:

- Structure width = 1.0 to 1.2 x bankfull width.
- Height of Opening = 4 x depth of channel.
- Depth of embedment = 30% of the height of the opening or D84 for boulder bed, whichever is larger.
- Match channel profile and create uniform longitudinal transitions at inlet and outlet.
- Structure shall not obstruct aquatic organism passage.

Consequently, newly designed, permitted, and constructed structures will typically be significantly larger than most existing structures. There are numerous benefits to this approach to road-stream crossing design including:

- ✓ significantly reduced risk of over-topping,
- ✓ reduced risk of failure due to clogging with sediment, ice, or woody debris,
- ✓ reduced risk of scour and undermining of structure,
- ✓ reduced wear on metal structures resulting from abrasion and corrosion, and
- ✓ improved aquatic organism passage.

The following preliminary structure recommendations are based on the current *Stream Alterations General Permit* requirements. Estimates of expected costs are based on recent projects of similar nature.

2. DEANE BROOK CULVERT UNDER DEANE ROAD

2.1 LOCATION

Deane Brook flows through a culvert on Deane Road approximately 200 feet south of Pleasant Valley Road. The culvert outlet is a few feet upstream of the Deane Brook confluence with the Seymour River (See Figure 1).

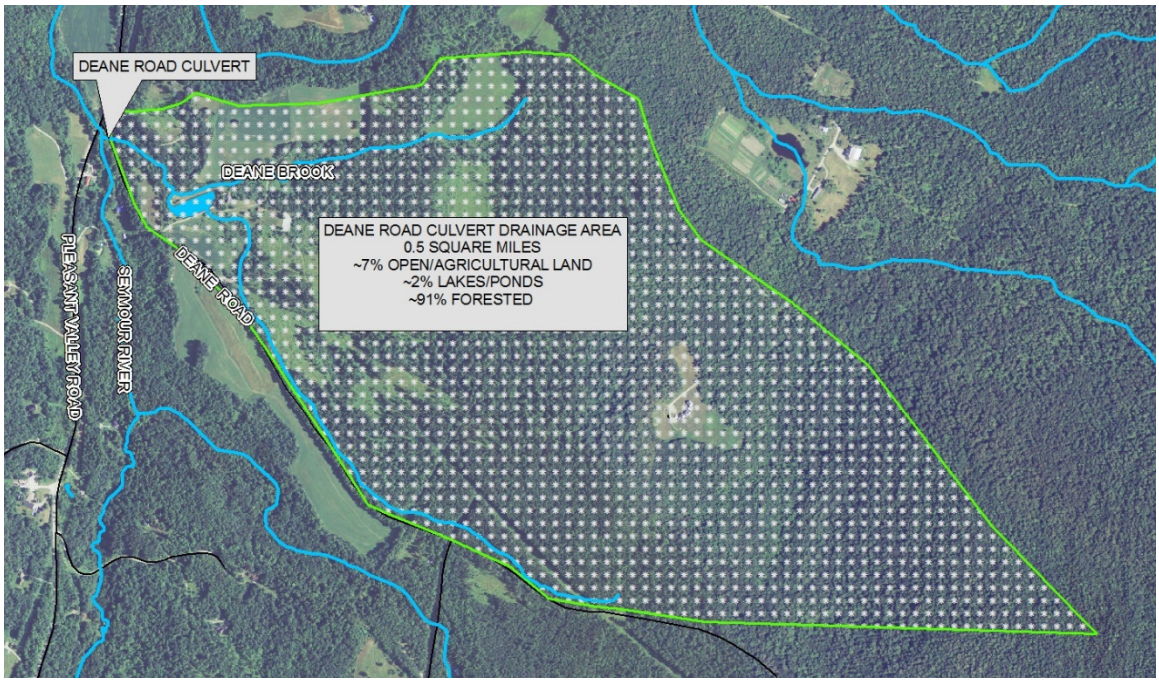

Figure 1. Deane Brook Culvert location and drainage area.

2.2 EXISTING CONDITIONS

Deane Road is a Class III town highway accessed from Pleasant Valley Road. The road surface consists entirely of gravel. The road extends approximately 0.8 miles southeast of the culvert before it terminates at a dead end. The road services private property including multiple residences and some agricultural land.

The existing culvert was constructed with dry-stacked stones. The inlet of the culvert is about 3ft wide by 4ft tall (see Figure 2). Much of the existing stone that makes up the wall of the culvert has shifted, narrowing the span of the culvert over time (see Figure 3). At the outlet, the culvert is approximately 1ft wide by 4ft tall. The narrowing of the culvert width from 3 feet to 1 foot constricts flow and makes it easy for debris to become lodged inside the culvert. Debris lodged within the culvert significantly increases that chance for culvert failure in even a moderate storm-event. Some debris was observed to be lodged in the culvert at time of the inspection (see Figure 4).

Figure 2. Deane Road culvert inlet. Approximately 3 feet wide by 4 feet tall.

Figure 3. Deane Road culvert outlet, approximately 1 foot wide by 4 feet tall. Timber cribbing has been installed to retain material and support the road above the culvert.

Figure 4. Inside of Deane Road culvert looking downstream. Debris is lodged in the culvert.

2.3 HYDROLOGY AND CHANNEL CHARACTERISTICS

The *USGS Stream Stats*[1] program was used to estimate peak flow rates at the Deane Road Culvert. GIS analysis for this Deane Road culvert produces a drainage area of 0.58 square miles. Stream Stats predicts a peak flow for a 1% annual exceedance event (100-year storm) to be 69.5 cubic feet per second (CFS). The reported 90% prediction interval ranges from 44.3 CFS to 141 CFS. This means that there is a 90% chance that the 1% (100-yr) storm event will produce flows within this range. The methods used to predict these flow rates rely on many independent variables that vary can significantly in accuracy and precision. The 90% prediction interval provides designers, planners, and other interested parties an idea of how much they can really rely on the predicted values. This range of values can be selectively used in design process to check various parameters and minimize risk of failure in the proposed structure. It should be noted that the current *Stream Alterations General Permit* requirements typically result in a final design that can pass flows beyond the 90% prediction interval of the 1% annual exceedance event.

Bankfull width of Deane Brook was measured to be 10 feet at a stable section of channel upstream of the culvert. The estimated bankfull width given by the 2006 Vermont Hydraulic Geometry Regression Curves[2] was 9.9 feet. This provides some evidence, along with observations made in the field that the stream is in a relatively stable state and capable of attaining equilibrium conditions.

The culvert is aligned with the stream channel which flows approximately perpendicular to Deane Road. The stream transitions from a steep profile through a bedrock channel 75 to 100 feet upstream of the culvert (see Figure 5) to a more moderately-sloped channel before entering the culvert. Transitions of this nature in a stream profile (i.e. from steeper sections to flatter sections) can increase the risk of aggradation. Aggradation is the process by which material that has eroded upstream is deposited in

---

[1] U.S. Geological Survey, 2012, The *StreamStats* program, online at http://streamstats.usgs.gov.

[2] *Vermont Regional Hydraulic Geometry Curves,* River Management Program- Vermont Department of Environmental Conservation. January 2006. Available online at: http://www.vtwaterquality.org/rivers/docs/rv_hydraulicgeocurves.pdf

slower moving sections in downstream reaches. This could potentially result in partial blockage of the culvert. The potential risk for aggradation should be taken into consideration in the structure selection and design.

Figure 5. Bedrock chute upstream of Deane Road culvert.

The Town of Underhill Road Foreman reported beaver activity upstream of the Deane Road culvert. Beaver dams can potentially fail releasing large amounts of water at greater rates than expected from extreme rainfall events alone. This potential impact should also be considered in the design of a structure at this location.

The design of a culvert at Deane Brook should also analyze and account for potential impacts from storm-events that could cause flooding of the Seymour River, which is the river that Deane Brook flows into just downstream from the outlet of the culvert in question. If flood waters from the Seymour River reach the Deane Brook Culvert at Deane Road, sediment could be deposited near or inside the culvert. This aggradation can occur when the faster-moving tributary waters flow into the slower moving flood waters of a receiving stream. The deposited sediment can partially block the culvert. This could result in added maintenance costs to clean out the culvert, or contribute to failure of the culvert.

2.4 RECOMMENDATIONS

Given that the drainage area for the Deane Road culvert is over 0.5 square miles, any work to improve or replace the culvert must meet the requirements of the Stream Alteration General Permit.

The Stream Alterations General Permit requirement is for a minimum 1.0 x bankfull width for stable streams and 1.2 x bankfull width for higher risk sites. Given the transitional nature of the stream profile (steep to flat) just before the culvert, the presence of an upstream beaver activity, and the proximity of

the culvert to the Deane Brook confluence with the Seymour River, the 1.2 x bankfull width standard is recommended and expected to be required by the Vermont DEC Regional River Management Engineer.

The first recommended option is a buried 11'-10"x 7'7", galvanized steel (or similar) pipe-arch with a minimum water way opening of 71 square feet. The galvanized pipe arch has a minimum expected life of 50 years. The structure would likely be delivered as unassembled plates that would be bolted together on site. Even with this added assembly time, the duration of construction for a buried pipe-arch structure is significantly less than for any options that require cast-in-place concrete. The total cost to install a pipe-arch of this size is expected to be $50,000-$75,000.

The second recommended option to be considered is a 12' x 6' precast concrete box culvert. The main advantages of this type of structure are an extended life-expectancy, and the lowest construction time when compared with other options. Precast structures do require a longer lead out time for manufacture (typically 3-6 months). They are also more costly than metal structures. Construction of a structure of this type is expected to be $75,000-$100,000.

Other options at this site include a bottomless arch, bottomless (or 3-sided) box culvert, or a bridge. These options have some minor advantages such as easier construction of the streambed within the structure. All of these options are more expensive and require longer construction times than the two previously discussed options. These bottomless options become more desirable and sometimes necessary if significant ledge or bedrock is expected to be encountered. Bedrock was observed upstream of the culvert but no evidence was observed in the immediate vicinity of the culvert location. These options could range from $90,000 to $130,000.

Regardless of the structure type, temporary access will need to be provided during the replacement of the structure since there are currently no detour options. This can add significant cost to a project. For the purposes of the estimates provided here, it is assumed that providing temporary access around the construction site will not exceed a cost of $10,000. In the event of unforeseen complications, these costs could be higher. An alternative for temporary access could be to use Corbett Road to access the furthest end of Deane Rd. The current *Town of Underhill State Classification of Roads Map*[3] shows connectivity with Highland (Corbett) Road via a Class IV town highway. It could be an option that this portion of road could be improved to a level that would access to properties on Deane Road that are to the south of the assessed culvert. If this is the case, a temporary bypass route utilizing the Class IV town highway could be more preferable than a temporary structure at the location of the culvert.

3. SEYMOUR RIVER CULVERT UNDER CORBETT ROAD

3.1 LOCATION

The Seymour River flows under Corbett Road through an existing 4-foot diameter culvert located about 0.3 miles north of the intersection with Pleasant Valley Road (see Figure 6). The culvert is located in the valley bottom between Sage Road and Waughbrook Lane.

[3] Chittenden County RPC, http://www.ccrpcvt.org/municipalities/underhill/underhill_classmap_20090310.pdf.

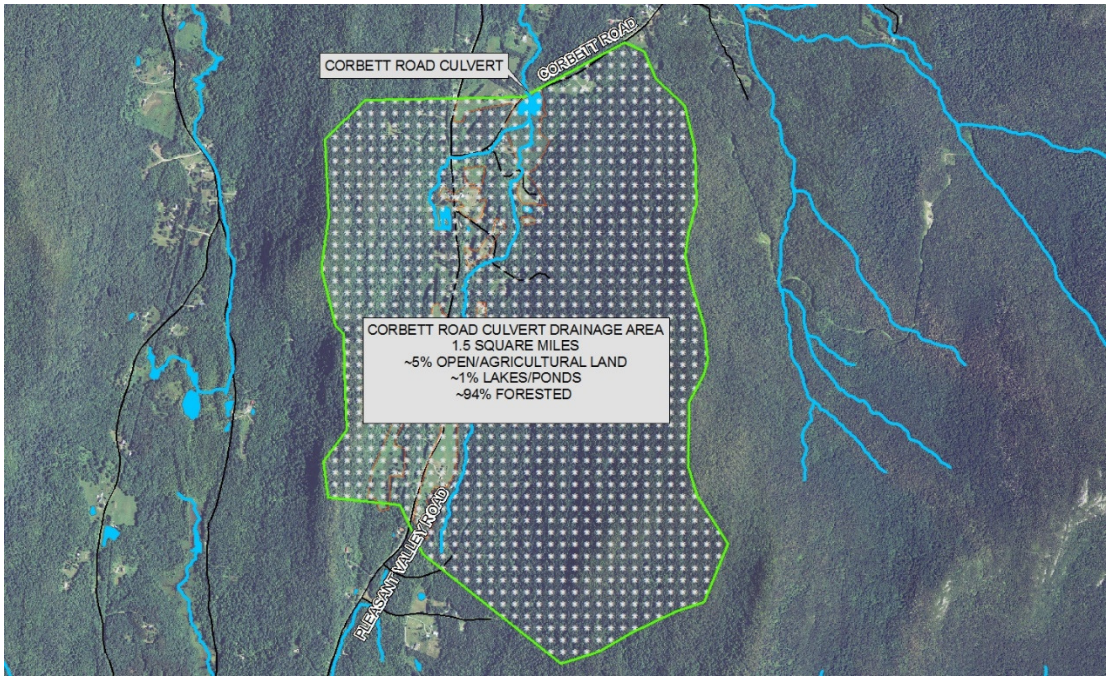

Figure 6. Corbett Road culvert location and drainage area.

3.2 EXISTING CONDITIONS

Corbett Road is a gravel-surface, Class III town highway accessed from Pleasant Valley Road. The road provides access to a number of residences, residential roads, and private roads.

The existing culvert consists of a 4-foot diameter steel pipe with concrete blocks that act as headers and wingwalls. The concrete blocks also essentially extend the length of the culvert (see Figure 7). The existing combination of pipe and waste blocks makes for an effective structure length of approximately 31 feet. Cover between the top of pipe and road surface is approximately 2 feet.

Figure 7. Corbett Road culvert inlet. Culvert consists of a 4-foot diameter steel pipe with concrete waste block extensions and wingwalls.

The assessed Corbett Road culvert currently lies between two beaver impoundments. Backwater from a beaver dam approximately 100 feet downstream from the road extends upstream through the culvert (see Figure 8). An additional beaver dam holding back a larger impoundment is located approximately 50 feet upstream of the culvert (see Figure 9).

Figure 8. Beaver impoundment on the Seymour River downstream of the Corbett Road Culvert.

Figure 9. Beaver Impoundment on Seymour River upstream of the Corbett Rd. Culvert.

3.3 HYDROLOGY AND CHANNEL CHARACTERISTICS

The *USGS Stream Stats* program estimates the drainage area for the Seymour River culvert at Corbett Road to be 1.5 square miles. This was confirmed with a GIS analysis using data provided by VCGI. The same data was used to analyze land cover. It was found that the drainage area has about 94% forest cover, 5% open land in agricultural use or as lawns, and about 1% is open water. Stream Stats predicts a peak flow for a 1% annual exceedance event (100-year storm) to be 206 cubic feet per second (CFS). The reported 90% prediction interval ranges from 102 CFS to 414 CFS.

The bankfull width of the stream could not be measured because the channel was inundated by the beaver impoundments at the time of the inspection. The channel width for this size drainage area was estimated to be an average of 15.7 feet based on the Vermont Hydraulic Geometry Regression Curves.[4] The existing culvert appears to be aligned with the stream channel but this is hard to confirm due to the inundation of the channel immediately upstream and downstream of Corbett Road.

As mentioned earlier, the culvert is situated between two existing beaver impoundments. The presence of a beaver colony can create significant challenges at a stream crossing site. Beavers tend to be opportunistic and will often build their dam against the upstream end of the culvert. This can lead to inundation or overtopping of the roadway. Downstream dams can have a similar effect. Upstream dams can fail, releasing a large surge of water and debris creating hydraulic conditions beyond what is expected in design storm-events.

3.4 RECOMMENDATIONS

Given that the drainage area for the Deane Road culvert is over 1.5 square miles, any work to improve or replace the culvert must meet the requirements of the Stream Alteration General Permit.

The Stream Alterations General Permit requirement is for a minimum 1.0 x bankfull width for stable streams and 1.2 x bankfull width for higher risk sites. Given the presence of an upstream beaver activity, and the proximity of the culvert to the floodplain of the Seymour River, the 1.2 x bankfull width standard is expected to be required by the Vermont DEC Regional River Management Engineer at a minimum. This would equate to a culvert with a minimum width of 18’-10”.

A pipe arch is not a viable option at this site due to the lack of cover provided by the existing road at the current elevation. The typical height for an 18’-9” pipe arch is over 12 feet. Even if the structure was partially buried, a pipe arch would require significant additional fill and a change in the longitudinal profile of the existing road.

The lack of cover reduces viable options to low-profile structures such as:

- a 19’ x 6’-4” low-profile bottomless arch, on concrete abutments,
- a 19’ x 6’ precast box culvert with headwalls and wingwalls, or
- a 35’ to 40’ span, steel beam bridge with a pressure treated wood or concrete slab deck.

---

[4] *Vermont Hydraulic Geometry Curves.* River Management Program, Vermont Department of Environmental Conservation, January, 2006; Available online at http://www.vtwaterquality.org/rivers/docs/rv_hydraulicgeocurves.pdf

The bottomless arch still has cover issues although not to the extent of a pipe arch. The arch would also require cast-in-place stemwalls and footings which would add to the cost and construction time. While this option is feasible, it is not recommended based on the information gathered in this assessment.

A 19' x 6' buried precast box culvert is an appealing option because of its reduced construction time compared to options which require cast-in-place concrete. If headwalls and wingwalls are included the length of this culvert is expected to be 35-40 feet. This size structure is expected to have added capacity to handle a large storm event or other occurrence resulting in failure of the upstream beaver dam. Even with properly designed infill (streambed) material placed in the structure, it is possible that this material could be transported out of the structure due to scour forces. However, in these potentially high-flow events, the stability of a precast box structure is not expected to be compromised. If material were to be washed out of the culvert during an event that exceeds the design-flow rate, the stream bed would simply need to be re-constructed through the culvert. Knowing this is a risk, grade control structures in the form of large stones/boulders buried and keyed into the streambed can be included in the design upstream and downstream of the structure. The estimated cost for a precast concrete box culvert of this size and type would be expected to be in the range of $175,000-$200,000. A buried, pre-cast structure has a minimum life expectancy of 75 years.

The preferred recommendation at this site is a simple, steel beam bridge with a wood or concrete deck, or a concrete slab (precast or cast-in-place) deck bridge. In the long-term a bridge will be the most resilient structure because it would provide the largest waterway opening. This means that a bridge will be able to pass greater flows and be better equipped to pass debris being washed downstream in the event of a catastrophic beaver impoundment breach. This greater hydraulic capacity also reduces shear stress in the stream channel when compared to the culvert options. This means that there is less risk of the stream channel eroding. A bridge may also provide advantages during construction. While construction time would include the time to form, place, and cure concrete abutments, this work would happen outside of the main stream channel. This simplifies management of the stream during construction and reduces dewatering challenges.

The concrete abutments and steel beams have a minimum life expectancy of 75 years. A concrete deck is expected to last a similar duration. A pressure-treated wood deck is expected to last 50 years with the wearing planks needing replacement every 10 to 15 years. The estimated cost for a steel girder with wood deck bridge is approximately $175,000. The estimated cost for a bridge with a concrete slab deck is approximately $200,000.

Temporary access would need to be maintained for the residents that live past the Seymour River culvert. This could be accomplished with a temporary road with a bypass culvert or a temporary bridge. An alternate option would be to improve the Class IV town highway between Deane Road and Corbett Road beyond the Seymour River culvert as discussed in Section 2.4 of this report. Once again, it is important to keep in mind that complications with temporary access can add significant costs to a project.

4. HARVEY BROOK CULVERT ON MOUNTAIN ROAD

4.1 LOCATION

Harvey Brook flows through a concrete structure under Mountain Road approximately 0.3 miles east of Pleasant Valley Road (see Figure 10).

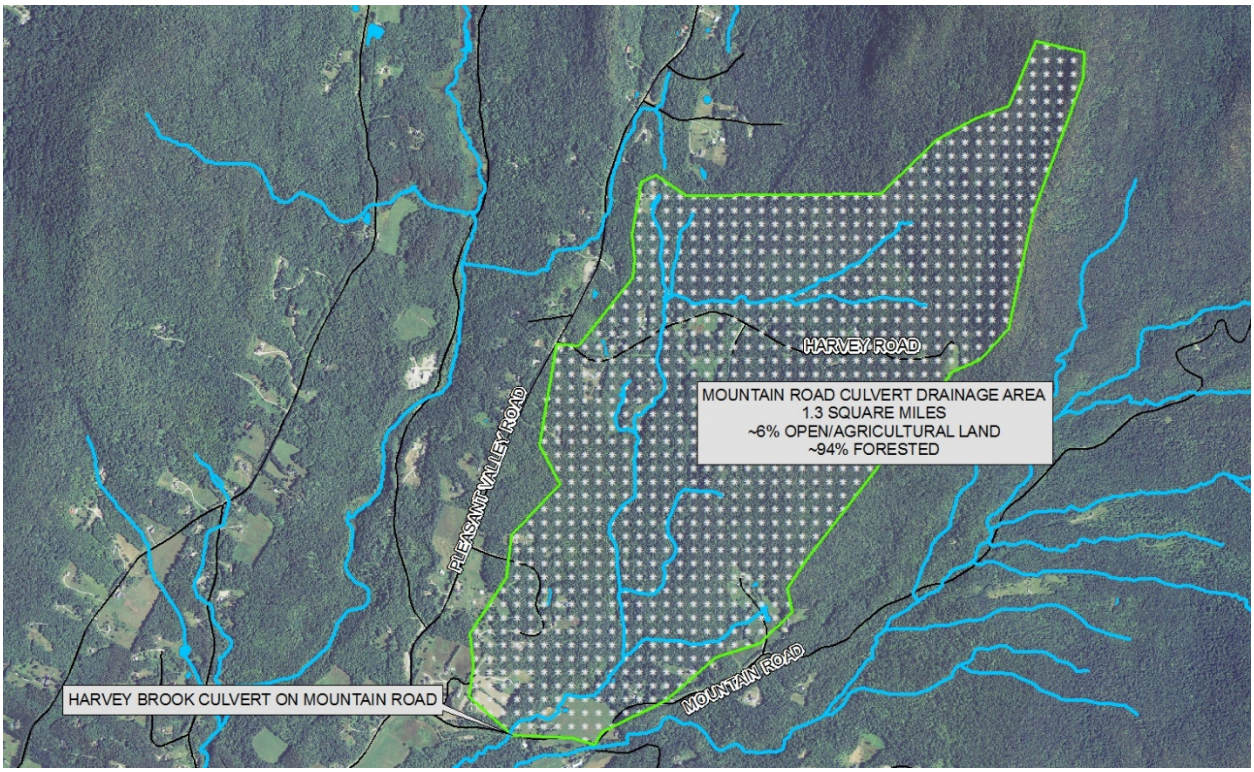

Figure 10. Mountain Road location and drainage area.

4.2 EXISTING CONDITIONS

The existing Harvey Brook structure at Mountain Road is an 8’ wide x 6’ tall x 30’ long concrete slab bridge (sometimes referred to as a three-sided box culvert or rigid-frame structure). The existing footings for the stemwall and wingwall on the left side at the inlet have been undermined (see Figure 11 and Figure 12). The left inlet wingwall has separated from the structure and is beginning to lean in towards the stream. Eventual collapse of this wall is imminent. The right inlet wingwall is also showing signs of failure in the form of a crack running from the top of the wingwall to the footing.

Figure 11. Inlet to Harvey Brook Culvert on Mountain Road. Left wingwall has been undermined is starting to lean in towards the brook.

Figure 12. Another view of the inlet left wing wall that has been undermined and is separating from the main structure.

Portions of the concrete stemwall and wingwall on the river right side of the culvert outlet have deteriorated significantly as well (see Figure 13). The deterioration extends nearly through the full thickness of the wall. Eventual failure of this wingwall is also imminent.

Figure 13. Deteriorating wingwall and stemwall at culvert outlet on river right.

4.3 HYDROLOGY AND CHANNEL CHARACTERISTICS

The *USGS Stream Stats* program estimates the drainage area for the Seymour River Culvert at Corbett Road to be 1.33 square miles. This was confirmed with a GIS analysis using data provided by VCGI. The same data was used to analyze land cover. It was found that the drainage area has about 94% forest cover and 6% open land in agricultural use or as lawns. Stream Stats predicts a peak flow for a 1% annual exceedance event (100-year storm) to be 198 cubic feet per second (CFS). The reported 90% prediction interval ranges from 98 CFS to 399 CFS.

4.4 RECOMMENDATIONS

Given that the drainage area for the Corbett Road culvert is 1.3 square miles, any work to improve or replace the culvert must meet the requirements of the Stream Alteration General Permit. The stream appears to be in a stable condition. Provided no major development is expected upstream, and no other stabilization issues are discovered, it is expected that a structure width of 1.0 x bankfull width will satisfy the Stream Alterations General Permit requirements. Bankfull width at this site is approximately 15 feet. Three recommended structures for this site include:

- a 15’-4”x 10’-2” buried multi-plate pipe-arch,
- a 15’-0”x 6’-0” precast box culvert or 3-sided box culvert, and
- a 15’-0”x 6’-7” bottomless multi-plate arch set on cast-in-place stemwalls.

The 15’-4”x10’-2” buried multi-plate arch would likely be the most cost-effective option at this site. For this reason, it is recommended as the preferred option. Minimum cover over the culvert will not be a problem. Assembly of this structure will take more time than that of a precast structure, but much less than anything requiring cast-in-place concrete. Stem walls and headwalls are recommended to minimize

the amount of structural fill needed to create the road embankment. A galvanized pipe- arch would have a minimum expected life of 50 years. The expected cost for a pipe arch at this site is $150,000-$175,000.

A second option for this site is a 15'-0"x 6'-0" buried, precast concrete box culvert. The two primary advantages of a precast structure are shorter duration of construction and longer life expectancy. Precast structures can be expected to last 75-100 years. A precast structure for this site is expected to cost $190,000-$215,000.

The third viable option at this site is a 15'-0"x 6'-7", bottomless, galvanized, multi-plate arch. This type of structure would only be a favorable consideration if ledge or bedrock is discovered or expected within the vicinity of the structure. In all situations, one significant advantage of bottomless arches are that the streambed can be easily constructed within the structure once the stemwalls are complete. The disadvantage of this type of structure is the need for cast-in-place stemwalls which can add to the construction duration and cost of a project. A bottomless arch at this site is expected to cost in the range of $190,000 to $220,000.

Temporary access beyond the Harvey Brook culvert on Mountain Road is expected to be accomplished with a detour utilizing Maple Leaf Road.

5. FURTHER RECOMMENDATIONS

All of the three culverts included in this report are in functional condition. This is to say that all are currently passing water, and for the time being, allowing for relatively safe passage of vehicle traffic. However, each culvert has serious issues that need to be addressed in the near future.

If the Town of Underhill wishes to prioritize the projects, attention should first go to the culvert on Deane Road. This culvert is in the worst condition and is functioning in a manner that severely reduces its capacity. The debris that is currently lodged in the culvert should be removed immediately. The structure should be inspected regularly for stability and clogging.

The next priority is the culvert on Corbett Road. Replacing the existing structure with a new structure that meets current design standards will greatly reduce the risk of damage to the road due to inundation or breach of the upstream beaver impoundment. It should be noted that while trying to control the local beaver population may reduce risk in the short-term, this method does not eliminate the likely possibility of new populations from establishing in the same location. It is the nature of young beavers to roam from the habitat area of their original colony in search of a new location. A site which has been deemed favorable for a beaver colony in the past will likely be taken over by a new colony in the near future.

The Harvey Brook culvert on Mountain Road is the lowest on the priority list only because it has the best hydraulic conditions—meaning that it has capacity in its current state to convey relatively high flows. That being said, the concrete that comprises this structure, especially the wingwalls, is in very poor condition. Eventual failure of one or more of the upstream wingwalls is expected. This will likely result in destabilization of the road embankment and potentially a loss of a portion of the roadway.