TOWN OF CALAIS

TOWN HIGHWAY No. 53, MARTIN ROAD

INFORMATIONAL REPORT re: the
EXISTING STONE BOX CULVERT
NEAR JUNCTION WITH TH 6, ADAMANT ROAD

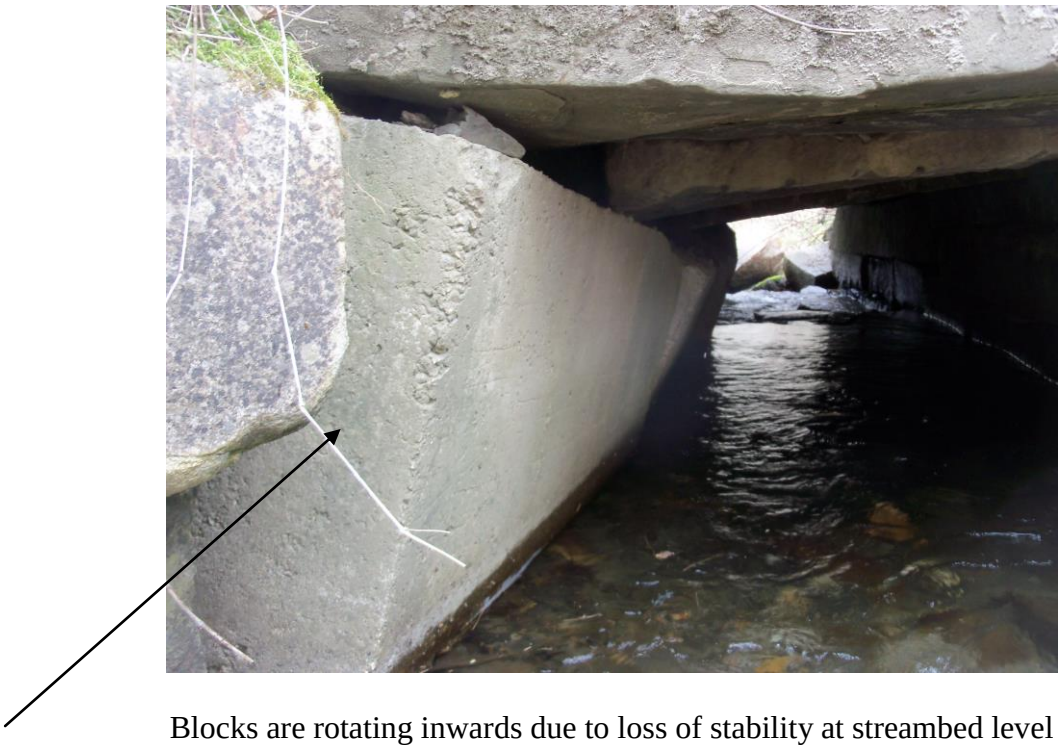
PREPARED BY NEWTON TECHNICAL SERVICES
MAY 2014

Introduction: This report is intended to provide some background information relative to the size and condition of the existing structure on Martin Road as well as provide some recommendations for upgrading the structure if the town so desires.

Location: The existing structure is located on TH 53, Martin Road approximately 50' – 60' from the intersection with TH 6, Adamant Road or Haggett Road. Standing at the intersection and looking northerly up Martin Road, the brook flows from left to right.

Existing Structure: The existing structure is an old 3-sided, stone box culvert that appears to have been in place for a long time; the inside dimensions of the box are approximately 5' wide x 4' high providing roughly 20 square feet of waterway area.

The southerly "wall" (on the side towards Adamant Road) of the box consists of a series of rectangular granite blocks laid on top of each other; the blocks appear to have been laid "dry" meaning that no mortar was used between the blocks. The northerly "wall" is made up of some concrete waste blocks; those blocks are 2'wide x 2' high x 4' long and are laid with the 4' dimension horizontal. Apparently at least 16 years ago, whatever had been used for the original wall on that side of the box had failed to the point that it was removed and these waste blocks were installed. Neither of the walls extends below streambed grade so any degradation of the stream might result in some scour and subsequent undermining of the walls. That appears to be what is happening to the waste blocks on the northerly wall; the blocks have become undermined to the point that the tops of them are starting to rotate in towards the stream and become unstable. The picture below indicates that rotation.



Blocks are rotating inwards due to loss of stability at streambed level

The “roof” of the stone box is made up of some large flat granite slabs that rest on the top of each wall and span across the opening. With the northerly wall starting to rotate inwards, the ends of the roof slabs on that end are not fully supported by the blocks. See the picture below.

Roof slabs are losing some of their bearing due to the rotation of the blocks on the northerly wall

The outlet end of the southerly wall has also started to fail and some of the granite blocks and stones on that end of the box have fallen into the brook and are constricting the flow.

Blocks have fallen out of place and are constricting the flow in the stream

Hydraulic Requirements: According to the hydraulics analysis done by the Vermont Agency of Transportation in March 2013, the drainage area for this crossing is 0.82 square miles or about 524 acres. The analysis also shows that the existing structure is undersized when compared to what is required for a structure on a town highway. That analysis is based on the worst storm you could theoretically get in a 25-year period; the structure at the site should be able to handle the rainfall from such a storm and still have 1' of freeboard in the structure. As noted above, the existing structure provides 20 square feet of waterway area; the hydraulics report suggests a structure with a minimum clear span of 8' and a minimum of 32 square feet of waterway area.

A copy of that report is attached.

Vermont Agency of Natural Resources Requirements: When working in the waters of the state, towns, designers, landowners and contractors work closely with ANR to make sure that any work that is done and any new structures that are put in place meet the minimum requirements that ANR is looking for.

Each project requires a permit to do the work and meeting and working with ANR's local Stream Alteration Engineers early on in the process ensures that all involved are aware of the requirements and the language spelled out in the permit. In the last few years, ANR in conjunction with the Fish & Wildlife Department, has put a greater emphasis on having any new structure buried a minimum of 1' below the existing channel grade.

Burying the structure below streambed grade does 2 things: (1) it provides a natural bottom in the new structure making it easier for fish and other aquatic habitat to adapt to the new crossing and (2), in the case of large rainfall events it provides more stability for the structure and lessens the chance of it being washed out. Earlier this spring, ANR revised their policy on burying structures; ANR's Stream Alteration Engineer has recently visited this site and recommends that any new structure be buried at least 2' below the streambed.

Selecting a New Structure: When looking at options for a new structure, we took into account the size of the structure that would meet the hydraulic requirements, what size structure would fit the field conditions and the recommendations and requirements from the Stream Alterations Engineer.

One structure that would work is a corrugated aluminum pipe arch that has an 8'-10" span and a 6'-1" rise. It meets the minimum clear span of at least 8' and has an original waterway area of 43 square feet. When it is buried 2' to meet the ANR requirements, it loses some waterway area but still has 33.49 square feet left which is slightly more than the 32 sf that is required. The headwalls and wingwalls are also made from corrugated aluminum plate and have anchor rods and deadmen to provide stability; the anchor rods are attached to both the headwalls and the wingwalls; the ones from the headwalls are attached to the pipe arch and the ones attached to the wingwalls are buried in the slope.

This option is similar to the new structures that were installed on TH 48, Singleton Road in 2012.

This type of structure (both the pipe arch, and the wingwalls and headwalls), comes as a series of plates and are bolted together in the field. One of the nice features about this type of structure is that you don't need any specialized equipment such as a crane to set it in place; it's not so heavy but what a contractor can set it with a normal-size excavator which is something that is generally already on the project.

Another feature about this type of structure is that you can leave the majority of the roof section open when you set it in place; that allows the contractor to use an excavator to put the 2' of streambed material into the bottom of it rather than having to do it by hand. Once the material is in place, the rest of the roof panels can be set, bolted into place and then backfill and compaction operations can begin.

The estimated cost for a project using this type of structure is around $55,000 - $60,000.

Assembled aluminum pipe arch with headwalls about to be set in place
Portion of the roof section left open to facilitate adding streambed material once in place

Aluminum pipe arch being set in place; headwalls are already attached

Another option would be to install an aluminum box culvert. As with the pipe arch noted above, this structure comes as a series of corrugated aluminum plates that get assembled and bolted together at the site. The structure would have a span of 11'-8" and a rise of 5'-9". Initially it has a waterway area of 57.2 square feet but when buried 2' in the streambed, that area is reduced to 33.86 square feet which still meets the minimum requirement of 32 sf.

The headwalls and wingwalls would be of the same corrugated aluminum material with anchor rods and deadmen.

The estimated cost for a project using this type of structure would be in the range of $60,000 - $65,000.

A third option would be to install a precast, reinforced concrete box; the inside dimensions of the box would need to be a minimum of 8' wide x 6' high. That would need to be buried 2' as well, leaving an opening of 8' x 4' or 32 square feet of waterway area when complete. Concrete wingwalls would be installed off each corner of the box.

A couple of drawbacks with this option are (1) due to the weight of the pieces involved, a crane would be required to unload and set a structure like this and (2) all of the material used to infill the box so it's 2' below streambed would have to be done after the box is set in place; in addition, due to the thickness of the roof slab, there wouldn't be as much cover over the top of the structure and there is also a longer lead time to get this product.

The structure would be wide enough to use a skid-steer or something similar to move most of the streambed material in place, but it may also present a problem because of the relatively low height inside the box.

The estimated cost for a project utilizing a precast box culvert would be in the range of $65,000 - $70,000.

Summary: The existing laid-up stone box has been in-place for a long time and over the years, has started to become deteriorated to the point that it is in poor condition. If the precast waste blocks continue to rotate, and eventually fall into the stream, the roof stones will have lost half of their support and the top of the box will fail opening up a hole in the road. Hopefully things will not get to that point especially if it happened in the middle of the night.

The box is not large enough to meet today's hydraulic requirements; during a large rainfall event, overtopping will occur leaving that road impassable and requiring the town to repair any damage once the water recedes. Flooding would probably cause some additional scour, accelerate the rotation that is going on and increase the chances of a failure.

Road Commissioner Alfred Larrabee is aware of the issues associated with this structure and has some legitimate concerns regarding the overall safety and usefulness of it now and in the near future.

Of the infrastructure-related problems in town that he's aware of, this one ranks relatively high on his list of items that need attention.