A Functional and Aesthetic solution for the Grassy Creek bridge in Ashe County, North Carolina

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ABSTRACT:

This paper will describe the planning, design and construction of the Grassy Creek Bridge in Ashe County, North Carolina. It will follow the evolution of the design from its initial conception as a simple box culvert to its final form as a precast concrete arch-structure with aesthetic treatments. This paper will focus on the cooperation between the North Carolina Department of Transportation, the users and the local residents, and how the final design considered and addressed the myriad concerns of the various parties leading to a successful, context - sensitive solution. This paper will include photographs of the bridge both during construction and after completion, and will also examine reaction to the final product by the project's stakeholders.

KEYWORDS

Public & Customer Involvement
Creative Precast Concrete Bridge Solutions
Bridge Aesthetics
Uniquely Functional Solutions

INTRODUCTION

The Grassy Creek Bridge (Bridge No. 123) in Ashe County, North Carolina carries a one-lane, gravel road(Garvey Bridge Rd. -SR 1549) over Grassy Creek in the Upper Northwest corner of North Carolina, about 2 miles from the Virginia state line. Grassy Creek is a small tributary that is roughly perpendicular to the New River, which runs alongside Garvey Bridge Rd. The existing structure, built in 1960, is a two-span, 71 foot long structure made up of a timber deck on steel girders. The clear roadway distance on the existing bridge is slightly more than 11 feet. The bridge carries less than 100 vehicles per day, two of which is a school bus that crosses the bridge twice a day. The structure was posted with weight restrictions of 9 tons for a single vehicle and 16 tons for a Tractor-Trailer semi-trailer. The bridge location is in a pristine, picturesque mountainous setting.

Figure 1: The old Grassy Creek Bridge carried a one-lane gravel road with a clear roadway width of just over 11 feet.

The Original Plan

Rehabilitation of the existing bridge was clearly no option –as the NCDOT's original planning report stated, it was "neither practical nor economical." The Bridge Maintenance Unit gave it a sufficiency rating of 20 out of a possible 100, and the estimated remaining life was less than 10 years. Besides deteriorating structurally, at less than 12 feet wide the bridge was obviously functionally obsolete and posed a danger to vehicles approaching one another near the bridge site.

The NCDOT planning report studied two replacement alternatives**:**

Alternate 1: a Reinforced Box culvert with an off-site detour, and
Alternate 2: a Reinforced Box culvert constructed in stages while traffic is maintained.

No other types of structures were considered in the planning document. The document recommended that the culvert be built in place due mainly to the poor condition of the proposed detour, which was described as having “multiple hairpin turns and gravel roads.” The average extra travel incurred by a motorist on the detour would be 2.6 miles, resulting in road user costs of $15,000 for the six month construction period.

The total cost of the Alt. 2 was estimated to be $640 K, which was about about $190K more than for Alt. 1. Although the 2nd Alternate was more expensive, it was recommended due to its "substantially higher factor of safety."

Once the planning report was finished, the Hydraulic Unit performed their analysis and concurred with the use of a culvert in this location. The original Hydaulic report specified a triple 12' X 9' Box Culvert. The Structure Design Unit developed the Structure Plans and performed the design.

The choice of using a Reinforced Concrete Box Culvert was based on cost and familiarity. The Department has been using RCBC' s for decades for anything that can’t be handled by pipes, and the design unit has standardized nearly all of the details. The Department developed a program some 30 years ago that with nothing more than the fill height, the skew, the length, and the number and size of the boxes, it will perform a structural design of the entire culvert, including bar sizes, complete bar schedule, and bill of materials. Indeed, the program is so simple to use that many design squads allow the Design Technicians to run the program themselves with very little oversight.

In addition to the ease of designing the boxes, RCBC's can be specified without taking any additional soil borings or doing any type of advanced soil analysis at the site, making it an extremely adaptable solution.

Aside from structural considerations, the choice of using an RCBC makes sense from a Hydraulic standpoint. The Square shape of the boxes makes it Hydraulically very efficient, more efficient than a Round or Oval shape. From a construction standpoint, the boxes are a very familiar construction item and pretty simple to construct.

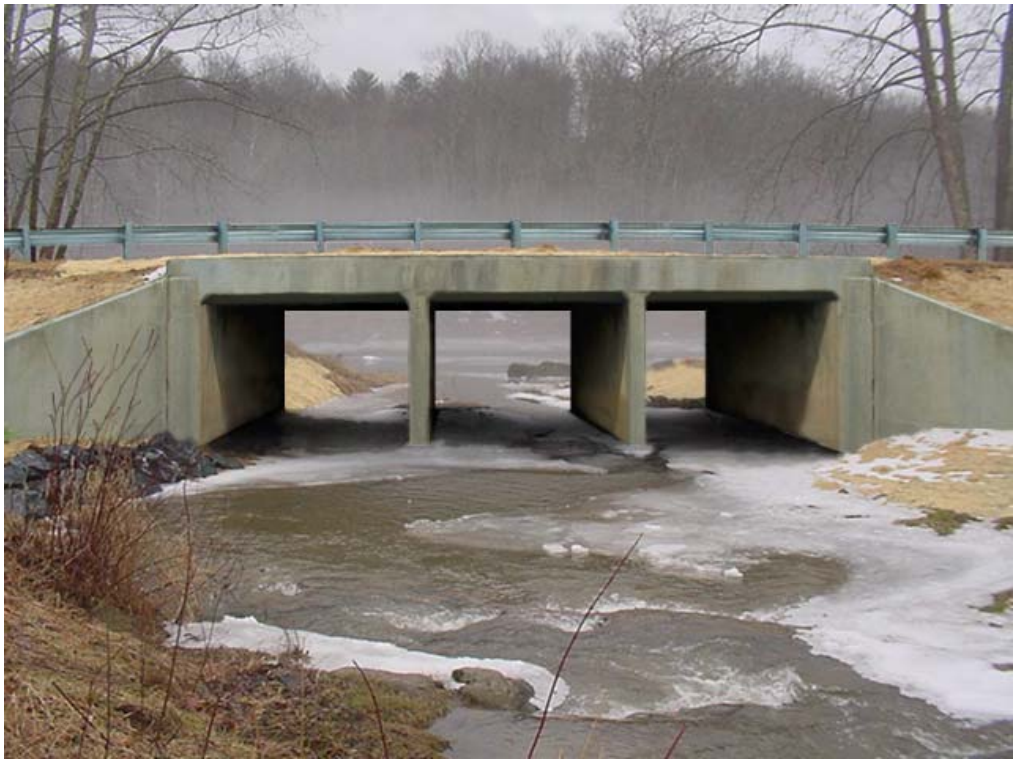


Figure 2: A computer visualization of the project utilizing a triple 12'X 9' RCBC. This option was derided by the community as being visually unappealing.

The Community Speaks

On August 20, 2001, a public hearing was held at the Grassy Creek United Methodist Church Fellowship Hall with a large crowd in attendance. The Preliminary plans were presented and the public was encouraged to give their comments verbally and in writing. The comments can be characterized as follows:

Comment	Number of Respondents
Support the project as designed(RCBC):	2
Keep and maintain the existing bridge	83
Replace the bridge with a one-lane bridge	10
Remove the bridge(replacement structure unspecified)	2

As the tabulated responses indicate, there was overwhelming and often boisterous opposition to the project, as most favored maintaining the status quo. The reasons for wanting to keep the original bridge were varied. The original road surface is a narrow gravel road, and most expressed a desire to preserve "the look" of the original bridge. Many were opposed to

replacing the bridge with a wider bridge, even if it increased safety to the rider, because they simply felt the original simple bridge, with its narrow roadway and simple post and beam wooden rails, was a more perfect fit for the structure's mountain setting. Some wanted to keep the bridge a one-lane structure with the idea that this would discourage speeders through the area. Perhaps the biggest surprise was that nearly all of the people interviewed preferred a one-lane off-site detour through steep, winding mountain roads to the two -lane on-site detour originally designed.

At the conclusion of the Public Hearing, DOT officials agreed to reexamine the different alternatives to respond to the community concerns. Approximately two weeks later, the design team met with North Carolina Board of Transportation member Nina Szlosberg, who represented the voice of the community, to discuss the new alternatives. The team, made up of members of the Hydraulics, Geotechnical, Structure Design, Construction and Planning Units, decided to re-evaluate every decision made concerning the structure up to that point. First, the team agreed to determine which of the citizen's requests were untenable. Despite the crowd's overwhelming support for maintaining the existing bridge, the team quickly decided that this was not an option. Maintaining the bridge would not just be a poor decision from an economic standpoint but from a safety one as well. The bridge report showed that the bridge included several fracture critical members-- i.e., single members whose failure would likely cause collapse of the entire structure. Similarly, the team decided that for safety reasons, replacing the structure with a one-lane structure would be unsafe and expose the Department to future liability. It was decided that the new structure would, at a minimum, allow for enough room so that two vehicles traveling in opposite directions could pass one another safely.

The team reviewed all of the written comments received at the meeting. Many of the comments expressed clear disdain for the choice of a box culvert in this location and expressed a desire for an attractive structure. After entertaining several ideas for various bridge configurations, the design team decided to present to the citizens a fresh idea: an arch-type 3-sided culvert that would give the appearance of a traditional stone arch bridge. The footings of the culvert would be keyed into rock and would not need large amounts of rip rap to be dumped into the stream. The exposed stream-side faces of the culvert would consist of a cast-in-place curtain wall that would utilize concrete form liners to give it a stone look. Once cast, the concrete "stones" could be stained to give it a realistic, english-countryside look that would blend well with the structure's rural mountain setting. The Roadway Design Unit offered to specify guardrail with a brown finish instead of the traditionally shiny metallic look of galvanized guardrail. The roadway section was changed to a 16' gravel travelway with 6' grassy shoulders, which satisified both the department's need for passing width and the community's stated preference for a one-lane structure. The Construction Unit agreed to require work from the bank rather than the stream to minimize sedimentation, and the Hydraulics Unit determined that the culvert could be installed without diverting the channel or dumping the 20 Tons of Rip Rap required under the initial design. In response to other comments, it was decided to use a one-lane, on site detour.

The cost of the new structure was actually $150,000 cheaper than the box culvert originally proposed, mainly due to the elimination of the on-site detour.

Once the new design option was chosen, newsletters were sent out to the concerned citizens detailing the new option. The citizens approved of the new option and the structure plans were redone. Final plans were produced and the project was let in May 2002, just 4 months after the original let date of January 2002.

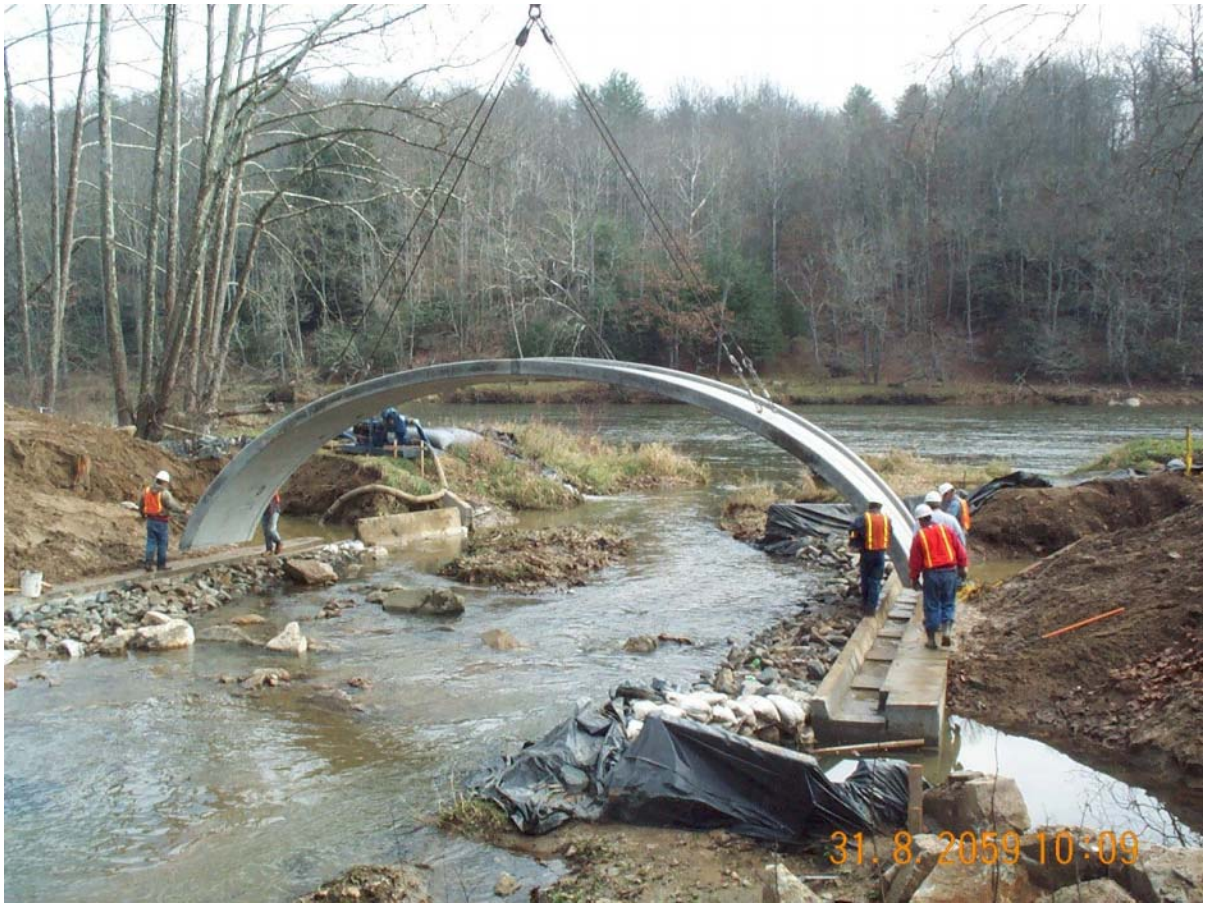


Figure 3: Installation of the first Precast arch segment

Construction

The Contractor chose to use a BEBO bridge system type of arch-culvert, produced by Rotondo Precast of Fredericksburg, Virginia. This design required that 4'-3" continuous, cast-in-place footings be keyed into rock, so that once the footings reached full strength the 6' wide precast culvert segments could be placed. The 6’-9” precast culvert segments provided a 40’-8 3/8” opening at the base, 10’-2” high at the highest point. The precast concrete was 5000 psi class A concrete.

While it was necessary to place temporary dikes to pour the footings, no stream diversion was necessary. Placement of the precast arch segments was fast and easy. For the

architectural facing, the contractor chose to use Custom Rock brand formliners. The project was completed, and the road back under traffic, by December of 2002, 7 months after the let date. Due to inclement weather, the stain for the simulated rock face was not applied until May, 2003. Despite the complete redesign of the project, the project was able to be completed only 4 months later than originally scheduled. The winning bid for the project was actually $333,000, which was 5% less than what was estimated in the planning report.

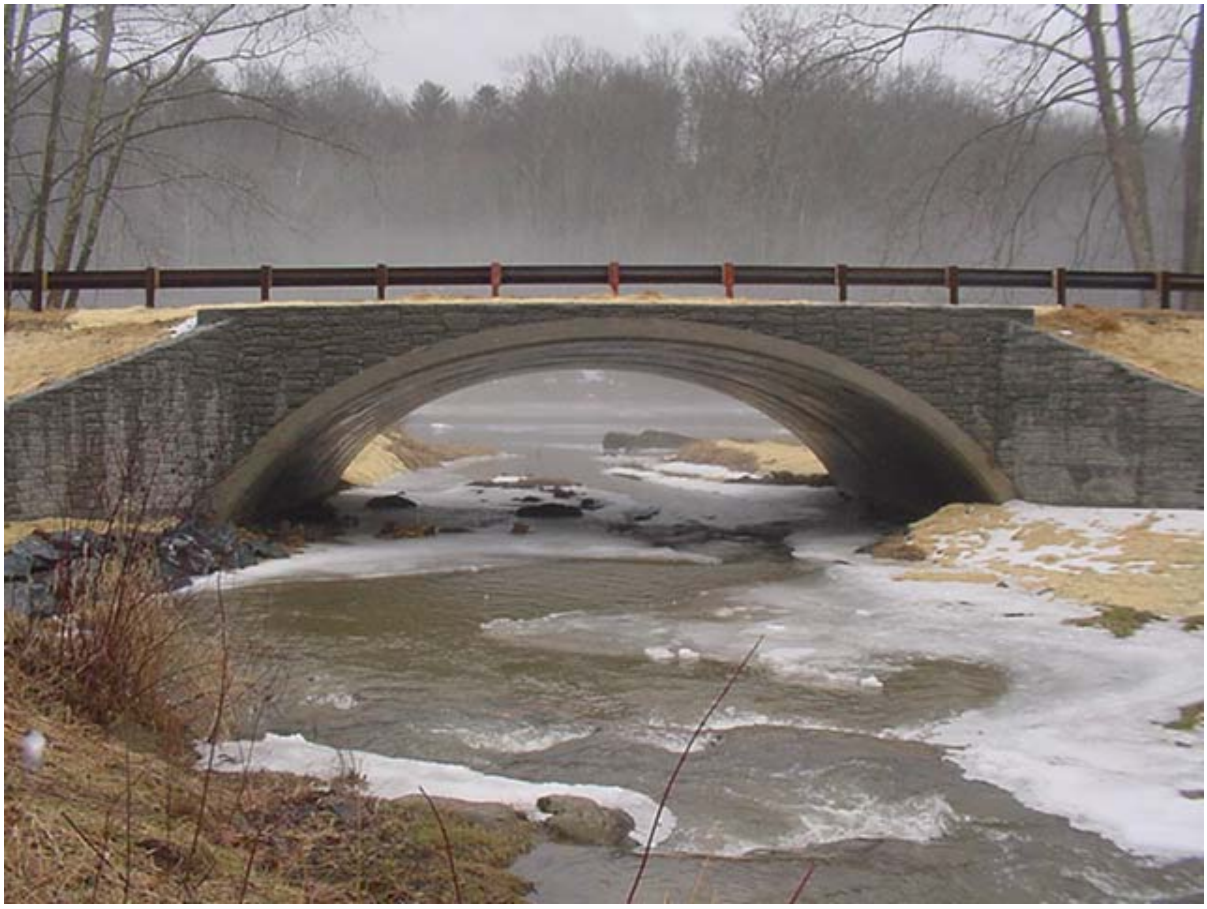
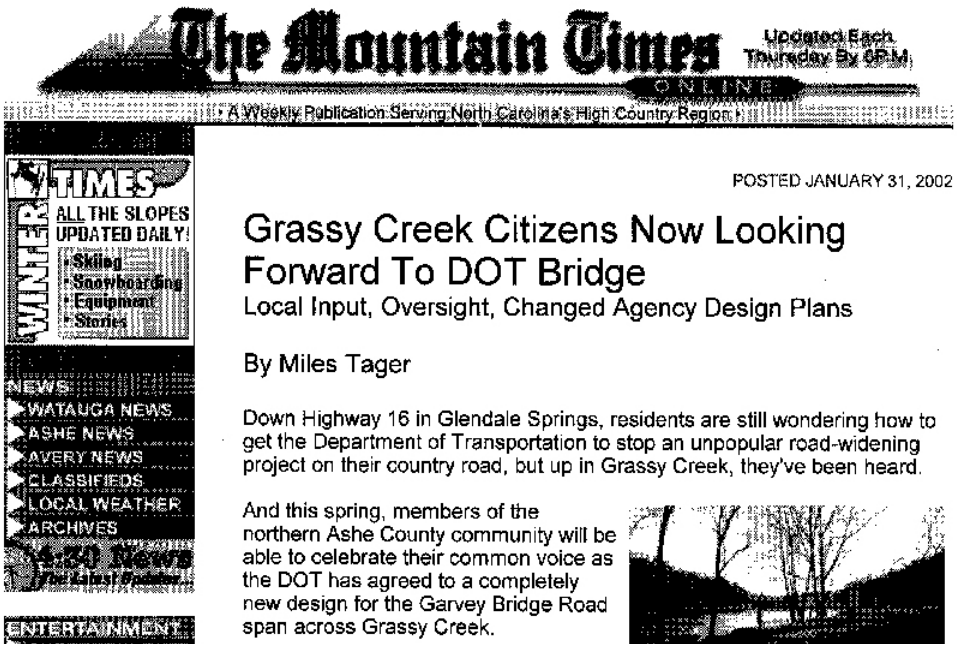


Figure 4: The stone arch look of the completed project was achieved by using concrete form liners. Due to low temperatures, the concrete stain has not yet been applied.

Community reaction

Community Reaction to the final bridge appearance was favorable but not enthusiastic, with the majority of the community still preferring that the original bridge be retained. To many of the engineers, the most surprising objection expressed by the community was the desire to keep a one lane, gravel structure over a safer, wider, more adaptable two-lane structure. While some of the community simply preferred the look of the old structure and did not want to change its appearance, the majority of the community who opposed the project freely admitted that their primary objection was that it would accommodate a wider road. To the community, wider roads did not mean safety and adaptability but higher design speeds and

the possibility of unwanted future development. Similarly, the use of guardrail on the structure approaches meant a hindrance to accessing their property, and not as an important safety feature for the motorist. These concerns notwithstanding, many individual community members expressed approval at the structure's final appearance.



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Grassy Creek Citizens Now Looking Forward To DOT Bridge

Local Input, Oversight, Changed Agency Design Plans

By Miles Tager

Down Highway 16 in Glendale Springs, residents are still wondering how to get the Department of Transportation to stop an unpopular road-widening project on their country road, but up in Grassy Creek, they've been heard.

And this spring, members of the northern Ashe County community will be able to celebrate their common voice as the DOT has agreed to a completely new design for the Garvey Bridge Road span across Grassy Creek.

Figure 5: The local community were eventually pleased with the look of the structure.

Figure 6: The final appearance was achieved by the use of stained concrete.

Lessons Learned

Overall, the choice of using a precast, 3-sided arch culvert for this project was an outstanding one. The Department got an attractive, safe, cost-effective structure while the local citizens received a structure that met their wishes for a simple, aesthetic structure that was an excellent fit for its environment. The final analysis reveals that the project achieved what every project strives for, the coveted but not always realized "win-win" solution for the project's stakeholders. While neither side was fully satisfied with the final result, both sides were able to compromise and achieve a workable solution. On a positive note for state government, the Department was able to overcome the initial accusations of recalcitrance and reveal itself as responsive to the community it serves.

Yet, even as the department celebrates the success of this project, it is worth noting that the original planning report did not even consider the final chosen option. The reasons for this are several: the perceived expense of the final option, the success experienced by prior use of RCBC's, departmental inertia. It is worth examining the reasons why the original design was chosen and why the final design was not initially considered.

There are several reasons a precast arch culvert was not initially chosen. Since an arch culvert's footings need to be keyed into rock, the rock line needs to be relatively near to the surface(< 5 ft.). In addition, good subsurface information is essential; a rock line that remains relatively stable for half the length of the culvert, only to plunge well below the surface will cause problems and delays during construction if not accounted for during design. There are relatively few places in the state that are ideally suited for arch culverts; this site happens to be one of them. The second reason an arch culvert was not initially chosen is the perceived cost of this option. There is a perception that fully precast structures tend to be more expensive than their cast-in-place equivalents because the prime contractors don't like to "give away" their profit to the precasters and hence pad their own costs. Finally, there is simply that reinforced box culverts have been the workhorse drainage structure in the state--they are cheap, easy to build, can be installed anywhere and are, above all, familiar.

In the case of the aesthetic treatments, the reason that they were not initially called for are simple-- no policy existed at the time to use aesthetic treatment on a drainage structure. At the time, any type of aesthetic treatment on a structure was determined on a case-by-case basis. These cases tended to be high-profile areas and/or areas with high community interest: historic downtown areas, state or national parks, scenic sites. Almost always, these treatments were offered as a ways to mitigate community concern with a project. The reason for this is simple economics; the cost of the aesthetic treatment on this project was estimated to be $50,000. In fact, the three bids the department received for the architectural treatment were $17K, $32K and $89K.

Perhaps the most substantial change from the original planning document is the change from an on-site to an off-site detour. The reasons for choosing the on-site detour have already been discussed; safety was the overwhelming reason. Though the community was successful in

changing the detour, it must be noted that the change decreased safety to the travelling motorist and perhaps increased the department's liability risk. For this reason, it is difficult to find fault with the original decision to keep the detour on-site.

Long Term Changes

The lessons learned from this project has led to long-ranging policy changes at North Carolina DOT. The most prominent change is the development of a bridge aesthetics policy for all projects. Instead of a case-by-case solution that was too often a mollifying response to community discord, the new policy will adopt a systematic approach that will allow project managers to choose from a variety of aesthetic options based on factors such as cost, visibility, and community interest. While it would be naïve to say such a policy will be beyond the influence of political pressure, the policy will allow planners and community leaders to choose from a menu of options that are framed by a clear, published policy.

The other prominent change that resulted from this project is the reevaluation of the role that precast arch culverts can play in future projects. Precast arch culverts have proven themselves to be an adaptable, cost-effective and quick-to-install solution for highway drainage structures. As with most states, the pressure to both finish projects as quickly as possible and to minimize wetland impacts is increasing tremendously, and the addition of the precast arch culvert to the planner's options will do much to alleviate that pressure. Accordingly, design engineers are revisiting the previous policy of detailing these structures only where the footings can be keyed into rock, with the intention of expanding their use. While not utilized on this project, using precast wings, headwalls and footings would greatly increase the speed at which these structures are installed; this makes them invaluable for fast track construction projects where typically road user costs are high and minimizing traffic disruption is a primary concern.