Quality Matters
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from the Quality Assurance Branch (QAB) of Highway Design

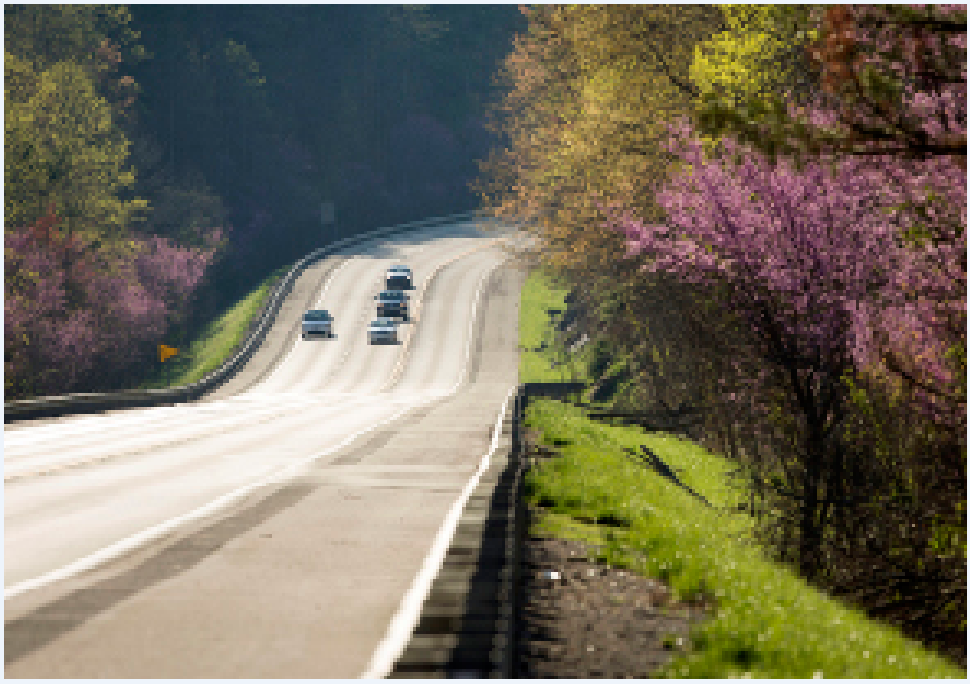
# VE Study Yields $66 Million in Cost Savings

The expansion of the Mountain Parkway will provide an interstate type facility from Campton to Prestonsburg with the goal of opening up Eastern Kentucky to new job opportunities and safer travel. At $753 million, this project requires a team of experts to complete. As part of the design process for a project of this magnitude, value engineering (VE) studies are completed to offer a third party review of the design and offer recommendations that could bring more value to the project.

The first of three value engineering studies for the Mountain Parkway occurred in May 2014 with a team of 10 members, including those with roadway, structural, drainage, geotechnical and construction backgrounds.

The first week long VE study was for the section of Mountain Parkway from KY 205 to KY 7 just west of Salyersville. It comprises seven separate and contiguous design projects with numerous bridges and significant cuts and fills.

During the study, project plans were reviewed and recommendations were developed based on ideas generated by the VE study team. The team brainstormed 78 ideas with 25 of them identified for further development into VE recommendations. After completing the study, recommendations were reviewed by the project team and implemented where practical. Accepted savings totaled $66 million. This represents a savings of $886 for every dollar spent on the VE study.



Governor Steve Beshear announced three of those recommendations from the VE study last September during a press conference. The first accepted recommendation, saving $32 million, shifts the alignment of the road near Kernie to eliminate five twin bridges. Unlike the design team, the VE team had the option to explore alignments outside the environmental footprint. The project team determined the savings did justify a new alignment. The project team will adjust the environmental document to reflect the shift.

One recommendation includes balancing earthwork by increasing the grade near KY 30, representing $3.5 million in savings. Another avoids relocating KY 134 between Wheelrim Road and Johnson Creek Road overpasses and raising the subgrade to save $4 million.

The next section of the Mountain Parkway project is being designed for the area between KY 205 and the existing four lane section near Campton. A VE study for this section was completed in March and results are now being considered for implementation.

You can access all value engineering studies from the new Study Library on the QAB website.

*by Shawn Russell PE, AVS*

# The Importance of Cross Sections

Cross sections are a large part of every plan set, but to the untrained eye they may appear very repetitive and not due much attention. So, what's the purpose of providing cross sections? They help the designer and builder visualize what will be constructed and some of the features (guardrail, pipes, etc.) that exist at specific locations.

Cross sections show whether the road will be in a cut or fill section, and the extent of the earthwork required. The quantity of earthwork is calculated from these drawings and noted on each sheet. They may reveal some valuable information that can lead to important changes in the design of the alignment, slopes, benching or other features.

They also play a critical role in construction; more and more contractors are using them to develop a three-dimensional model that can be used to drive GPS-enabled equipment.

Designers should pay careful attention to the detailing and legibility of the cross sections. KYTC will be putting additional emphasis on improving the quality and information provided in cross sections during the plan development process.

Normally, cross sections are drawn at locations marked every 50 feet along the centerline. There may be locations, such as intersections or entrances, where it would be helpful to have more detail, requiring closer intervals. At intersections they can reveal how the road's superelevations transition and details about drainage flow. Closer cross section spacing may be helpful in short horizontal "S" curves and sharp curves requiring large amounts of excavation.

Additional details should be added within critical areas where widening tapers take place and underground utilities exist. Identifying clear zone, tying down fill slopes and detailing ditches may also be important in the drawing. Sometimes it can be beneficial to show buildings or topographic features beyond the right-of-way line on cross sections. For example, showing a building may help a reviewer understand why a fill slope has been steepened to avoid taking a property.

CADD software can automatically generate cross sections; however, it is often necessary to adjust the text orientation, text location or other features so that they are legible and understandable.

Finally, it may be important to provide cross sections that show Maintenance of Traffic (MOT) phasing. This may include the construction of temporary slopes. The designer should be sure that the cross sections are in unison with the MOT plan.

Cross sections are a critical part of each plan set. Remember, their quality plays a role in the quality of the overall project design and constructability.

*by Brent Sweger, PE*

## ~ Cross Section Elements & Labels ~

- Auxiliary lane
- Back slope
- Base material
- Benching
- Bicycle facility
- Buffer strip
- Building/structure of importance
- CAP feature
- Cross slope % (all pavement)
- Curb
- Curb ramp
- Ditch
- Drainage feature & elevations
- Driveway
- Easement boundary
- Environmental feature
- Erosion control feature
- Flow direction
- Guardrail & post depth
- Hinge point
- Median curbed, flush, depressed
- Median slope
- MOT item
- Note of importance
- Offset
- Pavement
- Pedestrian sidewalk & path
- Quantity of earthwork
- Right-of-way line
- Shoulder
- Shoulder slope %
- Station
- Street furniture & bus stop
- Toe of slope elevation

## WELCOME

Anthony Norman, EIT, is the latest addition to the Quality Assurance Branch and the new Lessons Learned Coordinator as of November, 2014. He graduated in 2011 from The Ohio State University with a Bachelor of Science in Civil Engineering. He is currently pursuing his master's degree in civil engineering, specializing in transportation, from the University of Kentucky. He began his state career with the Division of Air Quality (EEC) in 2011. There are numerous adventures that lie ahead for him at KYTC. If you would like to contact him, email:

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## WELCOME

Mike Spain joined the Quality Assurance Branch in December 2014 as an interim constructability reviewer. He worked for 28 years in the Bowling Green Resident's Office before retiring in 2012. While in construction, Mike inspected many projects including several U.S. 68/KY 80 widening projects many miles of I-65 widening projects, the William H. Natcher Parkway extension, and many other lower profile projects. He has an extensive knowledge of bridge construction. We look forward to our time with Mike as our reviewer. If you would like to contact him, email:

mike.spain@ky.gov

## WELCOME BACK

John Edwards is a returning constructability reviewer. He began his career with KYTC in 1984 working in as a construction inspector in the Campbellsville and Elizabethtown Resident Engineer Offices. Prior to his retirement in 2013 he spent 13 years in District 4 as the Utility Supervisor. He first came to QAB in early 2014. Now he returns once again as of March 2015 to assist with your project. If you would like to contact him, email:

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# Safety Grates for Culverts

Eliminating hazards within the clear zone of a roadway is a continuous challenge for roadway designers and those who maintain roadways. Large headwall openings (greater than 30 inches) for pipes and box culverts are one type of hazard frequently encountered. If an errant driver travels down a hillside and hits a culvert opening greater than 30 inches, there is a high chance of severe damage to the vehicle and occupants.

Often, to protect errant drivers from this situation, guardrail is installed at the pavement edge, even if the slope is traversable. Culverts are sometimes extended so the headwall is outside of the clear zone. This can require the purchase of additional right-of-way, adding time and cost to a project.

Another solution beginning to gain favor is the traversable safety grate. Culvert wingwalls are formed so they match the slope of the hill. The grate is then attached to the wingwalls and the top of the headwall.

Another variation used to retrofit large box culverts is the use of a safety grate that is sometimes called "pipe runners." These pipes are sloped to match the hillside and sized to attach to the top of the headwall and at the bottom to the apron. Recently, District 4 installed pipe runner safety grates on box culverts in Breckinridge and Marion counties.

Crash tests have proven that safety grates are acceptable for slopes of 3 to 1 or flatter (see Transportation Research Record 2060). The maximum spacing of the bars or pipes should be 30 inches. This spacing allows a vehicle to drive over it, yet is wide enough to let most debris within a stream pass through without snagging on the bars. The bars must be of adequate diameter and thickness to support a vehicle.

Safety grates help improve the roadside by eliminating the need for guardrail and making culvert openings traversable. Eliminating the need for guardrail or a culvert extension on a project makes safety grates an affordable solution.

*by Anthony Norman, EIT*

# Lessons Learned

## Highway Widening Projects

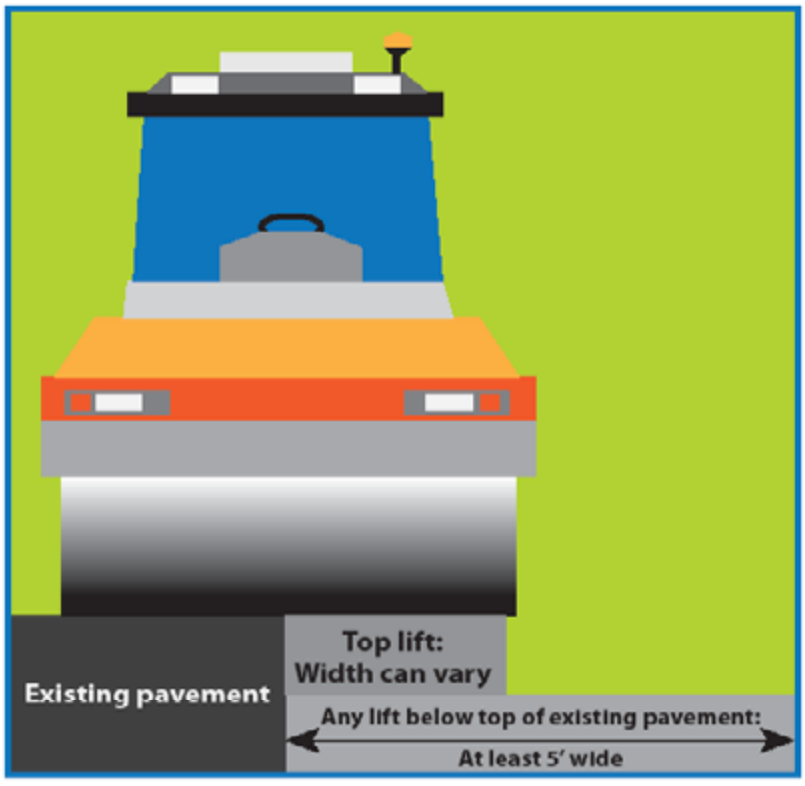
Widening existing roadways to accommodate increasing volumes of traffic has become commonplace for KYTC. This type of project can improve traffic flow by adding width to existing travel lanes, shoulders or turning lanes. The designer should be aware of a potential constructability issue when developing the plan set.

**The issue:** When widening the roadway to the outside by less than 5 feet, it is difficult for the contractor to compact the stone or asphalt base. The rollers acceptable for compaction of these materials have drums 4 to 5 feet wide. This creates a problem when adding narrow widths or a turning lane that requires a taper.

Until the width of the base material equals or exceeds the roller width, the roller will hang over the edge and thus roll at an angle (not flat). This will cause uneven compaction, resulting in a thinner than desirable lift on the outside edge and not enough compaction next to the existing roadway pavement. Over time, these weak places will result in rutting, potholes, and joint separation between new and existing pavement.

**The solution:** Place lifts, both stone and asphalt base, that have a top elevation below the existing pavement elevation, at a minimum of 5 feet wide. For lifts that have a top elevation equal to or above the existing pavement elevation, the width can be variable, allowing for a narrow paved shoulder or a taper for a turning lane.

*by Mike Spain*

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**Basic Concepts of Open Channel Flow HEC-RAS**
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*KYTC employees should contact **Kevin Martin** to schedule training.*