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Controlling Debris at Pennsylvania Bridges

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16. Abstract <p>Woody debris from upstream areas of forested or wooded watersheds is often transported to streams during heavy rainfall events. If the debris reaches a bridge pier, it may catch and accumulate on the pier, effectively narrowing the waterway opening. As debris continues to accumulate during subsequent high-water events, problems of flooding, scour, and loading on the pier are often intensified. In some cases, the accumulated debris can block most or all of an entire span. Considerable maintenance costs are then required to continually remove the debris from the bridge piers. Although debris accumulation at bridges has been recognized as a significant concern, little research has been done to provide cost-effective guidance on structural and non-structural measures to control debris accumulation. There is a suite of structural methods, including debris sweepers, debris fins, and deflectors, as well as non-structural methods, such as watershed improvements, that are available for use. However, use of these methods requires knowledge and guidance as to which methods are efficient and cost effective under a range of conditions that can be expected at bridges in Pennsylvania. The objective of this project is to determine appropriate, cost-effective methods for controlling debris accumulation at bridge piers in Pennsylvania. In meeting these objectives, the research team will determine the state of the art of debris control, primarily focusing on structural methods; assess the reliability and sustainability of selected methods; evaluate the cost-effectiveness; and develop guidance for PennDOT engineers to determine the most feasible and effective methods to use at bridges as a function of characteristics associated with the bridge, stream, debris, and cost.</p>					
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INTRODUCTION

Woody debris from upstream areas of forested or wooded watersheds is often transported to streams during heavy rainfall events. If the debris reaches a bridge pier, it may catch and accumulate on the pier, effectively narrowing the waterway opening. As debris continues to accumulate during subsequent high-water events, problems of flooding, scour, and loading on the pier are often intensified. In some cases, the accumulated debris can block most or all of an entire span. Considerable maintenance costs are then required to continually remove the debris from the bridge piers. Although debris accumulation at bridges has been recognized as a significant concern, little research has been done to provide cost-effective guidance on structural and non-structural measures to control debris accumulation. There is a suite of structural methods, including debris sweepers, debris fins, and deflectors, as well as non-structural methods such as watershed improvements, that are available for use. However, the use of these methods requires knowledge and guidance as to which methods are efficient and cost-effective under a range of conditions that can be expected at bridges in Pennsylvania.

The objective of this project was to determine appropriate, cost-effective methods for controlling debris accumulation at bridge piers in Pennsylvania. In meeting these objectives, the following goals were undertaken: (1) determine the state of the art of debris control, primarily focusing on structural methods; (2) assess the reliability and sustainability of selected methods; (3) evaluate the cost-effectiveness of each method; and (4) develop guidance for Pennsylvania Department of Transportation (PennDOT) engineers to determine the most feasible and effective methods to use at bridges as a function of characteristics associated with the bridge, stream, debris, and cost.

STATE OF THE ART IN DEBRIS CONTROL AT BRIDGES

DEBRIS SUPPLY

The majority of debris found in stream channels originates from trees growing in close proximity to the stream channel (Murphy and Koski 1989; Diehl and Bryan 1993; Diehl 1997). Trees growing in the riparian zone are introduced to rivers through a variety of mechanisms, including bank erosion, logging, wind throw, ice accumulation, disease, landslides, and old age. Stream bank erosion processes are responsible for the majority of debris supply, though these other mechanisms can provide significant inputs under certain conditions (Diehl 1997).

Processes leading to stream bank erosion are important considerations, given that stream bank erosion is a dominant factor in the introduction of debris to the river environment. Watershed and channel characteristics are intricately related, and both influence stream bank erosion rates. At the watershed scale, human alteration of natural conditions will lead to changes in the hydrologic response of the watershed to precipitation. As natural vegetation is removed, soil is compacted, and impervious surfaces are constructed, Horton overland flow processes (e.g., flow of water horizontally across the earth's surface occurring when infiltration and storage capacities have been exceeded; Dunne and Leopold 1978) begin to dominate in catchments where sub-surface flow processes were historically the preferred hydrologic pathway. These changes result in increased peak discharge (by 200 – 500%; Hollis 1975), flow duration (500 – 1000%; Barker

et al. 1991), and frequency of channel-disturbing flows (Booth 1990; Booth 1991). A stream channel affected by upstream disturbance and alteration of the natural flow regime will adjust to an equilibrium condition based on the new characteristics of stream discharge. These adjustments are the primary cause of stream bank erosion and debris supply in urbanizing or otherwise disturbed watersheds.

Natural stream migration can also be a significant debris supply mechanism. Streams characterized by pronounced meander can generally be classified as having high rates of lateral migration. High debris supply rates are likely in stream systems of this configuration.

Logging has been identified as a major source of debris in surface water in several reports (Chang and Shen 1979; Lagasse and others 1991). However, Diehl (1997) concluded that debris accumulations contained very few saw-cut trees, indicating that this source is conditional. Logging practices that directly affect the riparian areas adjacent to stream channels are responsible for the majority of logging-related debris input (Bryant 1980; Bryant 1983). Stream bank logging practices can increase debris supply directly or indirectly by disturbing bank vegetation, causing bank failures, and compacting stream bank soils, thereby increasing surface runoff. While stream bank logging has been a problem historically, current logging regulations require a riparian buffer to be maintained, thereby limiting damage to stream banks and reducing debris loads. In Pennsylvania, state forest contracts for logging on public lands require that a buffer of 25 ft (7.6 m) on both banks be maintained to preserve the health of riparian areas (PA Bureau of Forestry, oral communication, 2008).

Extreme meteorological events have led to large inputs of debris in isolated circumstances. In the Mid-Atlantic region, hurricanes Agnes (O'Donnell 1973) in 1972 and Ivan in 2004 caused significant debris loading in surface waters that typically do not experience debris-related problems. The additional debris supply witnessed during extreme events is generated by mechanisms that are generally insignificant. O'Donnell (1973) identified wind throw of riparian trees as a significant source of debris to Pennsylvania rivers during Hurricane Agnes. Floodplains can also be a significant source of debris during extreme events. Since events of this magnitude occur rarely in Pennsylvania, a large amount of debris may accumulate on floodplains between events and then be transported to the channel by flood waters (Bradley et al. 2005).

DEBRIS CHARACTERISTICS

The transport and accumulation of debris in surface waters is influenced by physical characteristics of the debris, including debris length, diameter, and the presence/absence and diameter of the root structure. These dimensions are critical in determining whether a piece of debris is likely to be transported at a specific flow depth and whether the debris will become trapped or pass through a bridge opening.

Site studies conducted by Diehl (1997) show that the length of debris and the upstream channel width are the most important factors influencing the width of a debris accumulation. Based on the data collected during this study, design log length criteria were defined. These criteria represent the length above which debris is insufficiently abundant to produce debris accumulations equal to or greater than their length (Diehl 1997).

The calculation of a design log length differs based on the maximum height of mature trees in the region of interest. Figure 1 provides a plot of design log length as a function of stream width, created from the relationship developed by Diehl (1997) for the northern tier of the Eastern United States. The design log length can be used to assign a minimum recommendation for span length during the design phase of new bridges. Additionally, the design log length can be used at existing bridges to assess the potential for the formation of debris accumulations that completely block the span between piers, abutments, or distances between bridge structures and natural features such as mid-channel bars or islands. If a supply of debris is evident and the calculated design log length is greater than the distance between bridge structures and/or channel features, the potential for debris accumulation at the site is increased.

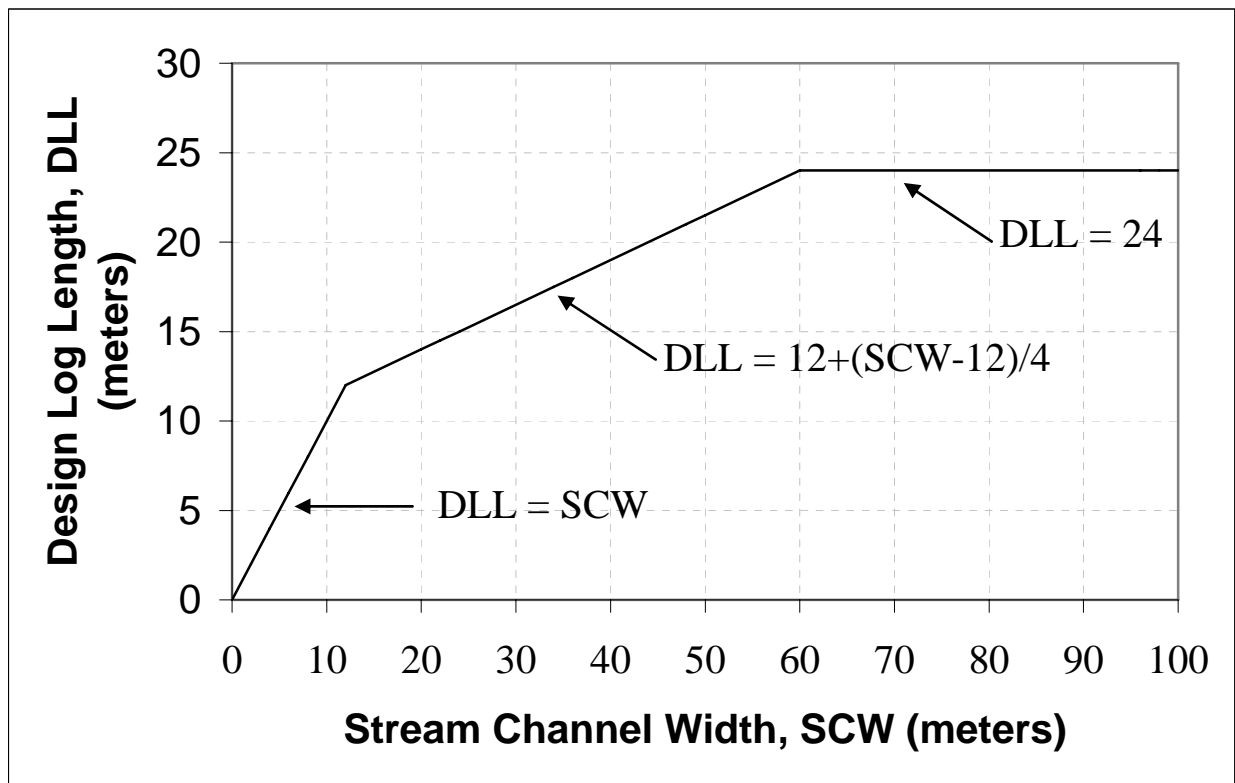


Figure 1. Relationship between design log length and stream channel width, developed by Diehl (1997) for the northern tier of the Eastern United States.

In Pennsylvania, the tallest tree species include white oak (*Quercus alba*), yellow poplar (*Liriodendron tulipifera*), eastern cottonwood (*Populus deltoids*), and white pine (*Pinus strobus*). Each of these four species is known to attain heights far greater than Diehl's (1997) maximum design log length. Documented heights of *Q. alba*, *L. tulipifera*, *P. deltoids*, and *P. strobus* in the Eastern United States indicate that these species typically reach heights of 26 m, 50 m, 35 m, and 50 m, respectively. *P. deltoids* and *L. tulipifera* preferentially occupy riparian areas and therefore are likely to play a role in debris accumulation in Pennsylvania streams and rivers. Given this information, it is important to note that Diehl's (1997) design log length relationship was developed from data collected on a subset of existing debris accumulations and may not adequately capture the maximum potential accumulation width in rivers that are wider than 60

and that drain areas where these large tree species exist in sufficient number to generate debris accumulations.

The presence and diameter of a root wad on trees often determines whether a piece of debris will be transported downstream by a specified flow. The depth of water required to float a piece of debris can be approximated by the dimensions of the trunk and root mass. Buoyant forces tend to dominate when the depth of water exceeds the diameter of the tree trunk plus the distance the root wad extends below the trunk. This sum was roughly equivalent to 3-5% of the log length in the debris accumulations surveyed by Diehl (1997). Based on this information, the probability of mobilizing a tree of known dimensions can be estimated based on measured channel cross-section dimensions and a discharge record.

DEBRIS TRANSPORT IN SURFACE WATERS

Debris transport in surface waters occurs when water depth and hydraulic forces reach magnitudes necessary to mobilize debris. Once debris is mobilized, it will be transported downstream until a fixed obstruction (e.g., bridge pier or abutment, bedrock outcrop, island, point bar, etc.) is encountered, or until water levels and hydraulic forces decrease to levels insufficient to transport debris. The timing of debris transport, transport characteristics, and preferred transport pathways are influenced by channel characteristics and the size of debris, and therefore vary depending on location.

Timing of debris transport

The cost and effort involved in continuous monitoring of debris transport and accumulation has limited the amount of information available on event-based debris transport. The current study's literature review revealed one study conducted by Lyn et al. (2006) in which video surveillance systems were installed at three bridges in Indiana to investigate event-based processes, including the timing of debris transport. Data from this study indicate that debris is generally mobilized and transported during the rising limb of the hydrograph. Data from the three video sites suggest that the majority of debris transport occurs during the first 12 hours of a hydrologic event. If the time to peak discharge is longer than 12 hours, relatively little debris is transported following the first 12 hours of rising water. From these observations Lyn et al. (2006) indicate that the timing of debris transport in the streams investigated may explain why the magnitude of the hydrologic event is not correlated with the magnitude of debris accumulation. Transport of debris during the early stages of an event also suggests that the source of debris to a location of interest is generally within a 12-hour maximum travel time of the site. Therefore, it appears that the debris-contributing area may be a fraction of the hydrologic contributing area in large watersheds.

Characteristics of debris transport

The majority of debris is transported downstream as individual logs, with occasional contact between individual members (Lagasse et al. 1991). However, rare instances of individual pieces of debris forming large debris rafts have been documented (National Transportation Safety Board 1990). It is unclear whether mobile debris rafts are generated by an accumulation of individual pieces of floating debris, or are due to existing debris accumulations breaking free of obstructions and travelling downstream as a solidified unit. Regardless of the method of formation, accumulations of floating, mobile debris accumulations are generally short-lived.

Most mobile aggregations observed by Diehl (1997) were quickly broken apart by turbulence or impact with the channel banks or other stationary obstructions.

The majority of debris is transported at the water surface, generally at the same velocity as surface waters. In observations recorded by Diehl (1997), logs were horizontal in the water, exposed above the water surface along their entire length, and did not rotate about a horizontal axis. Logs were not consistently aligned with flow, but rotated about a vertical axis due to eddies, obstructions, forces imparted by other debris, etc.

Submerged drift is transported along the bed. Therefore, pathways of submerged debris transport generally follow the dominant subsurface flow pathways (Diehl 1997). Due to the difficulties associated with observing and/or recording subsurface transport of debris, little information is available on the specifics of submerged debris transport behavior.

Debris Transport Pathway

Debris transport pathways are not random. In the majority of observations the spatial pattern of debris accumulation is repeatable, with the same pier(s) suffering from accumulation again and again. While the spatial pattern of debris transport and accumulation at bridges does appear to be predictable, it is dependent upon site-specific characteristics that have not been thoroughly documented in the literature.

Generally, floating debris is transported either along the thread of the stream, the thalweg of the stream, or both in locations where the thread and thalweg coincide. The thread of a stream is defined as the longitudinal line of flow where surface velocities are fastest. The thalweg of the stream is defined as the line extending down the channel corresponding to the lowest bed elevation.

In published literature on debris transport pathways, Chang and Shen (1979) and Lagasse et al. (1991) suggest, based on visual observations of debris transport, that the thalweg is the dominant transport pathway. Other studies note significant effects of meanders on preferential debris transport paths (Gilje 1979; Pangallo et al. 1992). In a statistical investigation of debris accumulations in Indiana, Lyn et al. (2006) conclude that the location of the thalweg at the bridge crossing is not strongly correlated with locations of debris transport or accumulation. Rather, channel meander characteristics seem to dictate the debris transport pathway. In bend reaches, the largest amount of debris is transported a short distance away from the outside bank (e.g., the stream thread), regardless of the location of the thalweg. Irrespective of whether drift transport occurs along the thalweg or the thread of the stream, the repeatability of debris accumulation in isolated regions of the stream channel (Lyn et al. 2006) and witnessed (Diehl 1997; Lagasse et al. 1991) and recorded (Lyn et al. 2006) evidence of transport pathways indicate that debris transport is typically confined to a path occupying a small portion of the total channel width.

Chang and Shen (1979) indicate a correlation between timing and debris transport pathways. In straight stream reaches, debris tends to be most concentrated in the center of the channel in rising waters and moves laterally towards the stream banks as waters recede. The reasons for this observed pattern are unclear, though Bradley et al. (2005) hypothesize that these preferred

transport pathways may reflect changes in the direction of secondary circulation patterns as stream discharge fluctuates.

DEBRIS ACCUMULATION IN RIVER CHANNELS

First and second-order stream channels rarely transport large debris, since the channel width and water depth are generally insufficient to convey mature trees of heights greater than the channel width, and with root mass radii that are greater than the channel depth. Logs longer than the channel width are typically transported a short distance before becoming lodged across the channel, supported by live trees on opposing banks. The debris will likely remain in a stable, cross-channel position until it decays or is broken into pieces small enough to be transported within the channel.

In third- and higher-order stream channels, debris accumulation in the river channel is a natural process involving supply, transport, deposition and decay of large woody debris. In natural channels, debris accumulations occur in areas where stream flow is retarded or obstructed. Susceptible in-stream locations include mid-channel bars, upstream heads of islands, point bars, and along the banks of meander bends. Abbe and Montgomery (1996) define three distinct types of debris accumulations in natural rivers: channel bar apex, meander, and bar top accumulations. Debris accumulations located at the apex of channel bars are typically formed of a key member with an attached root wad and secondary members oriented 10 to 90 degrees from upstream flow. This type of debris accumulation is typically stable in high flows and provides a sheltered location for additional deposition of debris and sediment. The correlation between mid-channel bars and debris accumulation has been confirmed in several studies (Hickin 1984; Wallace and Benke 1984), though it is unclear whether mid-channel bars trigger debris accumulation or vice versa. Meander accumulations are the most common type of debris accumulation found in larger rivers. Meander accumulations are formed from one or multiple trees with root wads deposited at the upstream head of a point bar, parallel to flow along the inside of stream meanders. Following deposition of the key members, additional debris collects normal to these members. The result is a stable accumulation that provides eddies for additional sediment and debris deposition. The third type of common debris accumulation is the bar top accumulation. This type of accumulation is characterized by an accumulation of logs with little vertical stacking, deposited on the top of the bar during receding storm flows. These accumulations are generally not stable and are likely to mobilize during a future high-water event.

In contrast to the process/structure-based classification system employed by Abbe and Montgomery (1996), Wallerstein and Thorne (1995) classify debris accumulations into four categories according to the “engineering-geomorphic impact” of the accumulation. Underflow jams occur when a fallen tree spans the entire bankfull width of the channel. The geomorphic impact of an underflow jam is generally minimal, though a scour hole below the tree is likely to develop. Dam jams are formed when trees approximately the height of the stream width are deposited in the stream channel, effectively damming the stream. Effects of dam jams include sediment deposition and additional debris accumulation upstream of the jam, and localized stream bank and bed scour. Deflector jams form when the stream width is slightly greater than the average tree height. By definition they do not span the entire width of the stream channel, and localized stream bank and bed scour result from the redirection and constriction of flow.

This often leads to additional input of debris to the stream. Parallel jams become increasingly common as river width increases. In wide rivers, debris is rotated by and aligns with the flow and deposits as water depths recede. These jams can help to stabilize the bank toe when deposited in the near-bank region, and promote the formation of mid-channel bars when deposited in the mid-channel region.

Rapid expansion of the stream channel cross-section from upstream to downstream reaches also promotes the accumulation of debris. A width expansion can be expected to lead to lower stream velocities, which increases the likelihood of debris being trapped. In laboratory experiments, Lyn et al. (2003) found that upstream velocity is an important variable in determining whether debris accumulation occurs at a bridge site, and identified several sites in the State of Indiana where upstream widening of the channel cross-section coincided with large accumulations of debris at bridges crossing the Eel and Wabash Rivers and Indian Creek (Lyn et al. 2006). Widening of the stream channel can also induce sediment deposition and the formation of mid-channel bars at the bridge (Newlin et al. 2008). As documented by Wallace and Benke (1984), mid-channel bars provide ideal locations for debris accumulation.

DEBRIS ACCUMULATION AT BRIDGES

At bridges, debris accumulations occur due to obstructions to flow or alterations in flow velocity caused by bridge piers or abutments, or channel cross section modifications. In an investigation of debris accumulations in the State of Indiana (Lyn et al. 2006), most of the large debris accumulations were found in the downstream reaches of Indiana's two major watersheds (the Wabash and White rivers). Data from this study (Lyn et al. 2006) also indicate that large accumulations of debris can develop within a relatively small contributing watershed. Therefore, the probability of large debris accumulations increasing with contributing area does not amount to a general rule.

When debris accumulations occur at a bridge, increased lateral forces on the bridge structure and local scour at bridge piers and abutments and decreased flood conveyance through the bridge opening can result (Diehl 1997). Specific bridge design factors play an important role in decreasing the likelihood and extent of debris accumulation in the vicinity of the bridge. Design considerations include pier placement, shape and alignment, deck height, and span length (Gilje 1979; Bradley et al. 2005; Lyn et al. 2006; Diehl 1997).

Bridge Pier Placement

In general, debris accumulation will occur with the highest frequency and greatest severity at locations where bridge piers and abutments are located in the path of floating debris. In straight stream reaches, debris tends to be most concentrated in the center of the channel in rising waters and moves laterally toward the stream banks as waters recede (Chang and Shen 1979). The reasons for this observed pattern are unclear. Bradley et al. (2005) suggest that these preferred transport pathways may reflect changes in the direction of secondary circulation patterns as stream discharge fluctuates. In bend reaches, momentum causes debris to concentrate in the region between the center of the channel and the outside bank (Gilje 1979), though not in contact with the bank itself (Diehl 1997; Lyn et al. 2006). Lyn et al. (2006) provide evidence to suggest that high points in the stream channel (e.g., islands, bars, peninsulas) are also prone to debris

accumulations. Given these general characteristics of debris transport, piers should be placed in regions removed from the dominant debris transport pathways (Bradley et al. 2005) and regions susceptible to debris accumulations (Lyn et al. 2006).

Bridge Pier Shape and Alignment

Pier shape and alignment influence the likelihood of debris accumulation. In general, solid, round-nose piers, aligned parallel with stream flow are recommended to decrease the likelihood of debris accumulation (Chang and Shen 1979; Lagasse et al. 1991; Diehl 1997). Open pile designs are likely to trap more debris than alternative configurations, since debris can become wedged in between the support members. Therefore, retrofitting existing multiple-column piers with a web wall between columns is recommended (Lagasse et al. 1991). Rounded piers create less flow disturbance, and are less prone to debris accumulation than other configurations (Diehl 1997). To further reduce the potential for debris accumulation, rounded piers can be designed with inclined upstream noses. An inclined nose functions like a debris fin, a structure which has been shown to reduce debris accumulations (Bradley et al. 2005). Debris fins and other debris control structures are discussed in detail in the sections below. Exposed pile caps provide an additional obstruction to flow, increasing the potential for debris accumulation. It is therefore recommended that pile caps be constructed at or below grade to reduce debris accumulation potential.

Bridge Deck Height and Design

Bridge deck height can influence debris accumulation if flood waters approach the bottom of the superstructure. When this occurs, debris can collect against the bridge deck. Most pieces of debris that contact the superstructure are likely to rotate sideways and remain at the water surface. However, if a large piece of debris contacts the bridge endwise, the upstream end of this piece can rotate downward. If the vertical gap between the low chord of the bridge and the stream bed is less than the length of the debris member, debris can become lodged between the bridge superstructure and the stream bed, effectively decreasing span lengths and leading to accelerated accumulation of debris at the bridge site (Diehl 1997, Bradley et al. 2005). As with other structural members of the bridge, decreasing the number of openings that can convey flow will limit the potential for debris accumulation. Superstructure designs that include a solid parapet and solid support beams that are directly attached to the bridge piers are recommended in waterways that typically transport large quantities of debris (Bradley et al. 2005).

Bridge Span Lengths

Horizontal gaps between adjacent bridge elements (e.g., pier to pier, abutment to pier) as well as between bridge elements and channel features (e.g., bars, banks, and islands) are influential in determining the potential for debris accumulation at a bridge site. During a debris transport event, pieces of debris are likely to contact an abutment, pier, or channel feature as debris passes through the bridge opening. When this occurs, the debris will rotate downstream under the force of the flow. If the debris is longer than the span between adjacent obstructions to flow, the debris becomes lodged against the two fixed objects. In bridge design, the design log length (Diehl 1997) should be considered when evaluating pier placement options. This concept can also be used to evaluate the susceptibility of existing structures to debris accumulation (see the discussion of Debris Characteristics on page 2).

DEBRIS ACCUMULATION COUNTERMEASURES

Structures designed to deflect or redirect drift so that it travels between piers have been investigated in a number of studies (Bradley et al. 2005; Richardson and Davis 1995; Saunders and Oppenheimer 1993). Structures of this type include debris fins, river-training structures (e.g., vanes, weirs), hydrofoils, debris deflectors, and debris sweepers. Additional techniques including construction of booms, debris basins, and/or crib structures at bridges prone to debris accumulation may help alleviate the problem (Bradley et al. 2005). An appropriate method of protecting a specific bridge should be selected from these options based on the suitability of a structure for debris transport and channel form characteristics at the site of interest, construction and maintenance costs, risk associated with failure of the structure(s), and aesthetic considerations.

Debris Fins

Debris fins, also commonly termed pier nose extensions, are walls built in the stream channel immediately upstream of a bridge. They are designed to align debris to pass unimpeded through a bridge opening. Debris fins should be carefully aligned with the upstream flow, and constructed with a downward sloping upstream face to limit impact forces and the probability of debris accumulation. These structures are recommended for control of medium to large debris, require moderate levels of maintenance, and have a relatively low environmental impact when properly designed and installed (Bradley et al. 2005). Figure 2 illustrates the concept of the debris fin.



Figure 2. Timber debris fin installation (from Bradley et al. 2005).

In-Channel Debris Basins

In-channel debris basins are structures placed across well-defined river channels to collect debris before it reaches a bridge or other structure of interest (Figure 3). Debris basins slow down river flow, thereby encouraging deposition of entrained sediment in addition to collecting floating debris. These structures are exceptionally efficient at collecting woody debris, detritus, and sediment. However, they are maintenance intensive (the basin must be cleaned out between storm events) and prevent the upstream/downstream movement of aquatic organisms. Due to maintenance and ecological concerns, in-channel debris basins are not a practical solution to debris problems in the majority of locations.



Figure 3. In-channel debris basin (from Bradley et al. 2005).

Flow-Altering Devices

Flow altering devices, including Iowa vanes, permeable and impermeable spurs, and vanes can be used in different configurations and under a range of environmental conditions to protect eroding stream banks, alter the course of a channel, promote sediment deposition, and/or alter flow patterns around infrastructure (Odgaard and Kennedy 1983). While each of these structures differs slightly in its design, all share a common purpose. Each of these structures is designed to disrupt the near-bed flow patterns and alter the circulation of secondary currents. Evidence presented by Diehl (1997) suggests that secondary flow characteristics influence debris transport pathways. Therefore, it is reasonable to assume that while the exact effects of secondary circulation on debris transport have not been determined, the alteration of these flow paths will affect preferred debris transport pathways.

There are two types of flow-altering devices. One type is used to break up vortices and reduce high flow velocities, particularly upstream of a pier. Sacrificial piles, such as sheet or cylindrical piles, are used for this purpose. Circular shields placed around the base of the pier have also been used as a means of breaking up the upstream vortices. These methods have proven rather ineffective because appropriate placement for the 100-year flood is difficult. They may also fail as shear stresses increase. These types of devices are not effective in transitioning flow through bridge openings and preventing sediment and debris accumulation. Increased lateral forces caused by debris accumulation have also been shown to cause failure of sacrificial piles (Bradley et al. 2005).

The second type of flow-altering device realigns the flow to mitigate against local and contraction scour as well as bank widening and lateral migration. They may also be effective in moving sediment and debris through bridge openings under certain conditions. These measures include submerged vanes, rock vanes and weirs, and bendway weirs. Small, isolated submerged vanes, also known as Iowa vanes, have been used for many years to deflect flows and sediment to control spiral flow in bends and erosion at banks. Experimental studies have shown that submerged vanes are effective across a wide range of flow depths from two to eight times the vane height (Odgaard and Kennedy 1983; Odgaard and Lee 1984; Odgaard and Mosconi 1987). The ratio of vane height to flow depth at the erosion-causing or design flow rates should be between 0.2 and 0.5. The length should be about three to four times the vane height with an optimum angle of about 20 degrees from the primary direction of flow. Lateral spacing of the vanes should be less than about twice the flow depth. Vanes are typically constructed from sheet pile or reinforced concrete set on adequately deep pilings, but could also be made of large rocks or wood with footers of adequate depth to resist erosional forces. The theory for the design of submerged vanes to control flow in bends was developed and tested by Odgaard and Wang (1990) and was used to develop design charts. The ability of submerged vanes to reduce scour at bridge piers was also tested (Lauchlan 1999); it was found that the vanes could reduce scour at piers by up to 50 percent. More recently, Newlin et al. (2008a; 2008b) used scaled laboratory models to show the ability of these structures to control sediment deposition patterns upstream of bridges in high bedload channels.

Rock vanes, cross vanes, w-weirs, and other similar structures are in-stream structures typically used to improve lateral stability and flow alignment and, in the cases of cross vanes and w-weirs, to provide some grade control on degrading beds. These structures tend to be very effective in flow depths up to about five times their height. Recent studies by Newlin et al. (2008b) show that these structures also have potential for conveying sediment and debris through bridge openings. While rock vanes are attached to the bank of the channel, they are placed at an angle of attack similar to that of submerged vanes (approximately 25 degrees). These structures were tested in a laboratory flume to assess their ability to move scour away from bridge piers and abutments (Johnson et al. 2001; Johnson et al. 2002) and to prevent sediment deposition in bridge waterway openings (Newlin et al. 2008b). The results showed that scour at the pier or abutment was generally reduced by 65 to 90 percent, depending on flow conditions and the structure configuration. The scour moved away from the abutment or pier into the center of the channel. They demonstrated limited potential for controlling sediment deposition upstream of low-chord bridges over artificially widened gravel-bed channels (Newlin 2008b). These structures have not yet been systematically tested in the field at bridges and were tested in the

laboratory for only two types of bridges. Preliminary design criteria for these structures and their appropriate applications are given in Johnson et al. (2001; 2002) and Newlin et al. (2008b).

Crib Structures

Crib structures are walls built between exposed piles of existing bridges to prevent debris from becoming trapped between the piles. Cribbs are generally constructed of either wood or metal. Debris accumulation at the bridge depicted in Figure 4 may be reduced by constructing cribs between the exposed piles. Crib structures are relatively inexpensive to install, and the environmental impact of the structures is minor. A moderate continuing investment is required to maintain the structures (Bradley et al. 2005).



Figure 4. Crib structures could be installed on the exposed multiple piles supporting this bridge to prevent debris from becoming trapped between the piles.

Debris Deflectors

Debris deflectors are sacrificial piles placed upstream of bridge piers to deflect debris away from the bridge pier and guide the debris through the bridge opening. They are normally arranged in a v-shaped configuration with the apex upstream. While cylindrical pile debris deflectors have been widely used throughout the United States, their effectiveness as a debris accumulation

countermeasure is questionable, and they may exacerbate the problem under certain conditions (Brice et al. 1978; Lyn et al. 2006). Figure 5 shows an example of this type of structure.



Figure 5. Cylindrical pile debris deflectors installed in an Indiana River (from Bradley et al. 2005).

Debris Sweepers

Debris sweepers are polyethylene devices that rotate around a vertical axis, under the force of flowing water. The debris sweeper device is designed and marketed by Debris Free, Inc., a California-based company specializing in bridge maintenance solutions. The rotating structure floats at the water surface, and travels up and down the vertical axis as water levels rise and fall. Floating debris is redirected if necessary, and guided through the bridge opening by the vortices surrounding the rotating sweeper.

Debris Free, Inc. has made three distinct revisions to the debris sweeper since its inception. In each of these product revisions, the structure used to support the rotating polyethylene cylinder was modified to address design shortcomings identified during field tests. In the first two generations, the sweeper was attached directly to the bridge pier. In generation one, the sweepers were mounted directly to the bridge pier using a variety of bracket designs that slid up and down the pier nose with rising and receding water levels. Generation two improved upon this design by installing brackets on the top and bottom of the pier, then using a tensioned cable to secure the sweeper while allowing the device to travel up and down the cable. The third and current design involves driving a pile into the stream bed to support the sweeper. While not

required, the top of the pile can be secured to the bridge pier or superstructure if feasible, based on the location of the pile in relation to the bridge. Figure 6 shows debris sweepers installed using first-, second-, and third-generation pier attachment technologies.



Figure 6. Clockwise from upper left, debris sweepers installed using the first-, second-, and third-generation pier attachment systems (from Debris Free, Inc.).

Bradley et al. (2005) identified four states where debris sweepers had been installed: Oklahoma, Virginia, Tennessee, and Oregon, but provided no information on success or failure of the structures in these states. Lyn et al. (2006) investigated several locations in the State of Indiana where debris sweepers were installed using the generation one and two mounting systems. Several of these structures had failed and been removed at the time of the study. Others were

still functional; however, the data collected by Lyn et al. (2006) at these sites were insufficient to draw any conclusions regarding the factors influencing success or failure of the structures.

Additional information on the debris sweeper design and failure rate statistics was provided by Debris Free, Inc. First-generation debris sweeper installations began in 2001. At present, the majority of these installations have failed. Approximately 50% of the second-generation installations, which began in 2003, are still operable. Several of these installations have survived several major hurricanes, and therefore are expected to remain functional through lesser events. Debris Free began installation of the third-generation devices in 2005. The far more robust pile support application appears to have eliminated many of the failures previously caused by insufficient support design. To date, only 10% of the installed third-generation structures have failed, and several of the failures that have occurred can be attributed to improper installation by construction contractors.

SURVEY OF STATE DEPARTMENTS OF TRANSPORTATION

Throughout the United States, individual state departments of transportation (DOTs) have installed countermeasures to alleviate the effects of debris accumulation at bridges. Many Eastern states were contacted to gain insight from their experience with these structures. The states were selected based on their proximity to Pennsylvania and/or documented activity in pursuing debris accumulation countermeasures. Federal Highway Administration (FHWA) and state DOT bridge and maintenance engineers in the following states were contacted: Wisconsin, Ohio, New York, Tennessee, Maryland, Virginia, Vermont, Indiana, Delaware, Iowa, and Connecticut. Contacts in each of these states received an email request for information on the location of bridges prone to significant debris accumulation and the presence of, or plan to construct countermeasures. Table 1 summarizes the responses received from these contacts. FHWA and DOT personnel from Iowa and Connecticut did not respond to repeated requests for information.

Table 1. Summary of debris accumulation countermeasure activities. Information based on responses to a request for information received from Federal Highway Administration and state DOT personnel.

State	Affiliation	Response
Wisconsin	Wisconsin DOT	Wisconsin had a Debris Free, Inc. installation (second-generation) but it failed due to bent support structure and was removed from the bridge.
Ohio	Ohio DOT	Installed a debris deflector upstream of a large box culvert. Effective for a few years until erosion caused the pile to fail.
New York	Federal Highway Administration, State of New York	No debris countermeasures currently installed or planned.
Tennessee	Tennessee DOT	There are a couple of Debris Free, Inc. installations within the state. The installations are functioning correctly. Debris fins have been used on culverts in TN.
Maryland	Maryland State Highway Administration	No debris countermeasures currently installed or planned.
Virginia	Virginia DOT	Provided a list of 12 sites where chronic debris accumulation is a problem. Debris Free, Inc. installations (generations one and two) at three of these sites were unsuccessful due to failure of pier mounting system.
Vermont	Vermont DOT	No debris countermeasures currently installed or planned.
Indiana	Indiana DOT	Referred us to Lyn et al. 2006 publication. There are many sites in the state with chronic debris accumulation problems. Debris countermeasures exist at several of these sites.
Delaware	Federal Highway Administration, State of Delaware	No debris countermeasures currently installed or planned.

FIELD OBSERVATIONS

In order to determine the factors that are important to the selection of appropriate countermeasures to reduce debris accumulation at existing bridges and to assess the likelihood of debris accumulation at new bridges, three basic sources of information were assembled and analyzed, including the results of literature review, a query of DOT officials, and field observations. The results of the literature review and DOT query were presented previously in the State-of-the-Art section.

During the course of this project, field observations were conducted at 12 bridges in Virginia, 6 bridges in Tennessee, and 7 bridges in Pennsylvania. The other mid-Atlantic states, New York, New Jersey, Maryland, Vermont, and Connecticut, are not actively addressing debris accumulation problems at bridges according to the DOT query described above. Table 2 provides a summary of the observations that were made at each bridge.

In Pennsylvania, bridges in Districts 1 and 2 were visited. In District 2, observations were made at the following bridges: SR 0103 over the Juniata River, Mifflin County, Lewistown; SR 3019 over Clearfield Creek, Clearfield County, Coalport; SR 3012 over Clearfield Creek, Clearfield County, Coalport; and SR 0153 over Bennett Branch, Clearfield County, near Penfield. Figures 7 through 13 show each of these sites. As shown in Table 2 and Figures 7 through 13, three of the four bridges visited in District 2 had moderately large sediment bars formed in the widened channel section at the bridge. Channel widening ranged from 90-100%. Also, in the widened sections, the flow was considerably shallower than in the upstream depths. It is hypothesized that the combined bar and shallow flow promotes debris accumulation by providing a place for floating debris to be snagged. The SR 0103 bridge over the Juniata had deeper flow with no visible channel widening at the bridge. In this case, the bridge is placed just downstream of a bend. The debris accumulates only on the pier closest to the outside of the bend, in the thalweg. The remainder of the Pennsylvania sites are in District 1 and include US Rt. 6 over French Creek in Crawford County north of Saegertown; SR 3017 over French Creek in Venango County, northwest of Franklin; and SR 2013 over East Sandy Creek in Venango County, south of Oil City. Channel widening at the bridge was observed at SR 2013 over East Sandy Creek, although no bar deposits were noted in the widened section. The other two sites over French Creek were not widened and no bars were evident. Debris accumulation was observed at the bridge at the SR 3017 site over French Creek.

In Virginia, 11 bridge sites were visited. These sites were identified by Virginia DOT engineers as chronic debris accumulation locations, and were selected for inclusion in this investigation based on this documented history of debris-related problems. The Virginia sites include: three bridges over the James River in central Virginia, two bridges over the Staunton, Dan, and Mehrrin Rivers in south-central Virginia, one bridge over the Hyco River in south-central Virginia, and one bridge over the Banister River in south-central Virginia. As shown in Table 2 and Figures 14 through 24, several of these sites, including US Rt. 360 over Staunton River, VA 880 over Dan River, VA 138 and VA 621 over Mehrrin River, and VA 522 and VA 621 over the James River, are characterized by mid-channel bars and/or shallow water depths in the vicinity of the bridge, which may increase the potential for debris accumulation. Debris accumulations at

multi-span bridges in VA exhibited similar characteristics to those witnessed at the Pennsylvania SR 0103 bridge over the Juniata River. Debris at these sites (e.g., US Rt. 360 over the Staunton River, VA 45 over the James River, VA 522 over the James River) tended to accumulate at specific piers. Those located at the outside of meander bends or centered in the thalweg in strait stream reaches had larger debris accumulations than other piers at the time of data collection. Lastly, the bridges crossing the Mehrrin, Hyco, and Bannister Rivers are perhaps prone to debris accumulation due to structural characteristics of the bridge, including piers poorly aligned with approaching flow, exposed piles, and pier placement.

In Tennessee, five bridge sites were visited (see Figures 25 through 30): the TN 249 and TN 250 bridges over the Harpeth River, the TN 005 (US 45W) bridge over the Obion River, and the TN 007 (US 31) and TN 274 bridges over the Elk River. The selection of debris accumulation sites was provided by the Tennessee DOT and represents locations of the most severe debris accumulation problems within the state. Debris accumulation at these locations seemed to be principally related to an abundant supply of debris in the watersheds and positioning of bridge piers directly in the path of debris flow. The TN 249 bridge over the Harpeth river is located downstream of a meander. Consequently, the bridge pier located closest to the outside of the meander bend collects the majority of debris at this site (Figure 25). At the remaining four Tennessee sites, observations suggest that the path of debris flow coincided with the center of the stream channel. At each of these sites, river reaches upstream of the bridges are relatively straight, with the deepest flow occurring roughly in the center of the channel. Bridge piers located in the center of the channel collected the majority of debris at each of these locations.

Table 2. Summary of site observations.

State	Bridge	Stream Order	% Channel Widening at Bridge	Bars/ Deposits	Number of Piers in Channel	Pier Type	Location and Size of Debris	Bed Material	Est. Span Width (ft)
PA	PA 103 over Juniata River	7	None	None	3	Solid, round nosed	Pier 3 from left bank; S-M	Silt, gravel	50
PA	PA 3019 over Clearfield Creek	4	150	At bridge in widened section; mod. width; gravel	1	Solid, round nosed	M-L debris; not centered on pier	Gravel	45
PA	PA 3012 over Clearfield Creek	4	100	At bridge in widened section; mod. width; gravel	1	Solid, round nosed	At pier; S-M-L	Gravel	35
PA	PA 153 over Bennett Branch	4	90	At bridge in widened section; mod. width; gravel	1	Solid, round nosed	At pier; S-M-L	Gravel	40
PA	PA 3017 over French Creek	6	None	None	2	Solid, round nosed	At pier; S, L	Gravel	110
PA	US Rt. 6 over French Creek (PA)	6	None	None	5	Single, round columns	Upstream at left bank; mostly L	Gravel	115
PA	PA 2013 over East Sandy Creek	4	180	None	1	Solid, round nosed	None	Gravel	50
VA	US Rt. 360 eastbound and westbound over Staunton River		None	Sediment deposition across width of channel, very shallow in vicinity of bridge	3	Solid, round nosed	At piers; M-L	Silt, sand, gravel, cobble, boulder	70
VA	VA 45 over James River		None	None	5	Solid, round nosed	At piers; M-L	Sand, gravel, cobble, boulder	115
VA	VA 58 eastbound over Hyco River		None	None	2	Single, round columns; square, columns	Span-blocking accumulation, between piers; S-M-L	Silt, sand, gravel, cobble	55
VA	VA 716 over Banister River		None	None	2	Multiple, exposed pier columns	At pier; L	Sand, gravel, cobble	45
VA	US Rt. 29 southbound over Dan River		None	None	3	Solid, round nosed	At piers; S-M-L	Silt, sand, gravel, cobble	120

State	Bridge	Stream Order	% Channel Widening at Bridge	Bars/Deposits	Number of Piers in Channel	Pier Type	Location and Size of Debris	Bed Material	Est. Span Width (ft)
VA	VA 668 over Staunton River		None	None	2	Solid, round nosed	None present (history and evidence of accumulation at bridge)	Silt, sand, gravel, cobble, boulder	60
VA	VA 880 over Dan River		None	Mid-channel bars	1	Solid, round nosed	At pier; S-M-L	Silt, sand, gravel	70
VA	VA 138 over Mehrrin River		None	Sediment deposition across width of channel, very shallow in vicinity of bridge	1	Solid, round nosed	At pier; S-M-L	Silt, sand, gravel, cobble	75
VA	VA 621 over Mehrrin River		None	Mid-channel, downstream of bridge	0	I-beam columns with crib walls	None present (history and evidence of accumulation at bridge)	Silt, sand, gravel	75
VA	VA 522 over James River		None	Mid-channel, upstream of bridge	6	Solid, round nosed	At piers; S-M-L	Silt, sand, gravel, cobble, boulder	120
VA	VA 603 over branch of James River		None	Mid-channel, upstream and downstream of bridge	3	Solid, round nosed	At piers; S-M-L	Silt, sand, gravel, cobble	45
TN	TN 249 bridge over the Harpeth River		None	None	2	Solid, round nosed	At pier; S-M-L	Silt, sand, gravel	80
TN	TN 250 bridge over Harpeth River		None	Point bar, at inside of meander upstream of bridge	4	Solid, round nosed	At pier; M-L	Silt, sand, gravel	45-60
TN	TN 005 (US 45W) bridge over Obion River		None	None	2	Rounded columns, 2 per pier	At pier, between columns; S-M-L	Silt, sand, gravel	55-70
TN	TN 007 (US 31) bridge over Elk River		None	None	4	Solid, round nosed	At pier; M-L	Silt, sand, gravel	50
TN	TN 274 bridge over Elk River		None	Mid-channel bars	3	Solid, round nosed	At pier; S-M	Silt, sand, gravel, cobble	70



Figure 7. SR 3012 bridge over Clearfield Creek, Clearfield Co., Coalport, PA.



Figure 8. PA 3019 over Clearfield Creek, Clearfield County, Coalport, PA.



Figure 9. PA 103 over the Juniata River, Mifflin County, Lewistown, PA.



Figure 10. PA 153 over Bennett Branch, Clearfield County, near Penfield, PA.



Figure 11. PA 3017 over French Creek, Venango County, northwest of Franklin, PA.



Figure 12. US Rt. 6 over French Creek in Crawford County, north of Saegertown, PA.



Figure 13. PA 2013 bridge over East Sandy Creek, Venango County, PA.



Figure 14. US Rt. 360 bridge over the Staunton River, Charlotte-Halifax Co. line, VA.



Figure 15. VA 45 bridge over the James River, Cumberland-Goochland Co. line, VA.



Figure 16. US Rt. 58 bridge over the Hycro River, Halifax Co., VA.



Figure 17. VA 716 bridge over the Banister River, Halifax Co., VA.



Figure 18. US Rt. 29 bridge over the Dan River, Pittsylvania Co., VA.



Figure 19. VA 668 bridge over the Staunton River, Pittsylvania-Campbell Co. line, VA.



Figure 20. VA 880 bridge over the Dan River, Pittsylvania Co., VA.



Figure 21. VA 138 bridge over the Mehrrin River, Lunenburg/Mecklenburg Co. line, VA.



Figure 22. VA 621 bridge over the Mehrrin River, Lunenburg/Mecklenburg Co. line, VA.



Figure23. VA 522 bridge over the James River, Goochland/Powhatan Co. line, VA.



Figure 24. VA 603 bridge over a branch of the James River, Goochland Co., VA.



Figure 25. TN 249 bridge over the Harpeth River, Cheatham Co., TN.



Figure 26. TN 250 bridge over the Harpeth River, Cheatham Co., TN.



Figure 27. TN 005 (US Rt. 45) over the Obion River, Obion Co., TN.



Figure 28. TN 003 (US Rt. 51) over the Wolf River, Shelby Co., TN.



Figure 29. TN 007 (US Rt. 31) over the Elk River, Giles Co., TN.



Figure 30. TN 274 over the Elk River, Lincoln Co., TN.

ANALYSIS OF FACTORS AND COUNTERMEASURES

Based on the literature review, DOT queries, and field observations, a set of factors that contribute to the accumulation of debris at bridges was determined that falls into three categories, as described below.

Stream and watershed characteristics influencing debris supply:

- Alteration of runoff. As land use changes, the hydrologic response may change to a flashier response to precipitation, higher peak flows, etc.
- Stream order. 1st- and 2nd-order streams rarely transport large debris, whereas 3rd- and 4th-order streams commonly do transport large debris that may become lodged at bridges.
- Channel confinement. The degree to which a channel is confined, or entrenchment, is related to stream bank stability.
- Channel sinuosity. Highly meandering streams tend to have a high rate of lateral movement, inducing bank erosion and introduction of debris to streams.
- Stream bank stability. Stream bank erosion is a dominant factor in the introduction of debris to the river environment.
- Stream bank material. The type of material can dictate the susceptibility of the banks to rapid erosion.
- Logging and other watershed disturbances. Such disturbances are a major source of debris to streams.

Stream characteristics influencing debris transport:

- Stream bed irregularities, including bridge-related channel modifications with a widened (shallow) section upstream and at the bridge as well as bars and sediment accumulation upstream of bridge piers.
- Bank irregularities that provide eddies, dead zones for debris to catch and collect, including widened sections at bridges.
- Upstream infrastructure, including bridges, culverts, and abandoned infrastructure.

Bridge characteristics affecting debris accumulation:

- Span length. If the debris is longer than the span between adjacent piers or piers and abutments, the debris may become lodged between them.
- Pier placement. Debris accumulation will occur with the highest frequency and greatest severity at locations where bridge piers and abutments are located in the path of floating debris.
- Exposed pile caps. Exposed pile caps provide an additional obstruction to flow, increasing the potential for debris accumulation.
- Pier shape and alignment. In general, solid, round-nosed piers, aligned parallel with stream flow are recommended to decrease the likelihood of debris accumulation.
- Scour countermeasures, particularly when dumped and mounded riprap at piers.

Based on this list of factors, it is clear that the most effective practices to alleviate debris accumulation at bridges would be to modify the stream and watershed characteristics to reduce the supply, alter stream characteristics that influence debris transport, or replace or modify the bridge substructure to permit debris passage beneath the bridge. In most cases, however, the

DOT will want to focus, at least initially, on countermeasures that will be effective in reducing the costs and efforts of ongoing maintenance due to debris at bridges and that will more effectively prevent debris from accumulating during high flows. Removal of debris after it has accumulated is not effective in preventing the problems associated with debris accumulation, such as flooding, scour, and loading, since these processes are active during the high flows while the debris is in place or accumulating.

The costs of countermeasures are highly varied. At most bridges where debris accumulates, one option is to modify the substructure to provide passage of debris by changing the pier configuration and/or span length to accommodate the debris. However, although this may be the ideal option, it is not likely to be economically feasible. Thus, the discussion here centers on the use of countermeasures rather than bridge modifications. Table 3 provides the benefits of each selected countermeasure, their disadvantages, and estimated costs.

Table 3. Benefits, disadvantages, and qualitative cost ranges for debris countermeasures.

Option	Benefits	Disadvantages	Annual Cost over 10-Year Period
Maintenance removal of debris	Simple operation	Required over life of bridge; disruptive of aquatic ecosystem; accumulation during flood events may jeopardize bridge, cause scour and flooding	Low to Moderate (over longer term)
Vanes/weirs employed to direct debris flow through bridge opening	Following installation, may alleviate or reduce additional maintenance requirements	Will lead to alteration of sediment transport processes; if not designed correctly can cause aggradation or erosion in the vicinity of the bridge. Debris may tend to hang up on structure	Low
Debris deflectors	Simple design and construction	May trap debris upstream of bridge requiring maintenance removal; known to fail under high lateral forces of trapped debris; failure of piles may jeopardize bridge	Low
Debris basin	Simple design, construction and operation; potential to sell collected timber and sediment	May need to purchase land if not located in right-of-way; requires periodic removal of collected sediment and debris; lack of sediment transmission may lead to erosion downstream; may adversely affect the passage of migratory species	Moderate to High
Debris sweepers	Active system; following installation, may alleviate additional maintenance requirements; requires little disturbance of the stream channel	Failure of system can increase potential for debris accumulation; not appropriate for certain bridge configurations (if span is less than maximum length of debris)	Low to Moderate
Crib walls, debris fins	May not require stream modification or continuing maintenance	Low reliability; problem may continue; maintenance required	Moderate
Reconfiguration of riprap at piers	Provides more effective scour protection as well as debris alleviation; can create system that alleviates both debris and scour	None	Moderate

Channelization or reconfiguring the channel	Prevent debris and sediment accumulation by increasing rate of flow through steepened reach	Higher velocity could cause scour at bridge; may cause erosion of bed and banks upstream; potential maintenance costs associated with erosion; not sustainable if river system is unstable	High
Removal of unneeded upstream infrastructure or other obstructions	Eliminates obstructions that may be causing sediment and/or debris-related problems in the vicinity of the bridge; no maintenance required following removal	Removal of obstructions may create new flow patterns, which may lead to additional sediment and/or debris related problems	Moderate to High

GUIDELINES FOR SELECTION OF COUNTERMEASURES AT BRIDGES

The selection of debris countermeasures at bridges in District 2 is a function of the bridge characteristics, environmental (stream and debris) factors, and the implementation and maintenance costs over period of time. Figure 31 provides a conceptualization of the process of selecting a countermeasure.

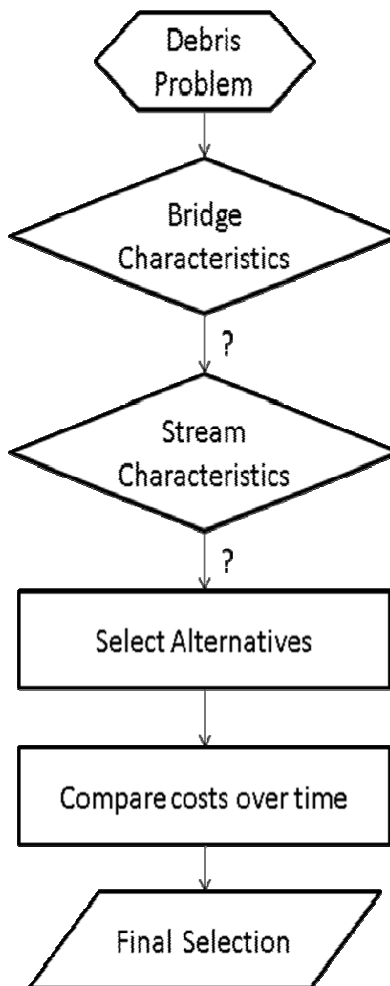


Figure 31. Flowchart conceptualizing the process of selecting a countermeasure for debris accumulation at bridges.

The factors described in the previous section and the concept presented in Figure 31 were used to develop a more detailed flowchart to assist in determining the best management solution for minimizing debris accumulations at bridge piers based on these factors. The following four questions, related to the bridge and stream characteristics described above, provide the basis of the detailed flowchart.

1. Are the bridge piers aligned approximately perpendicularly to the channel and/or approaching flow?

2. Are the bridge piers designed such that they minimize the collection of debris? For example, piers that are streamlined will tend to catch less debris than those that consist of exposed pile groupings and/or pile caps.
3. Is there evidence to suggest that the stream has been widened immediately upstream of the bridge site to accommodate the design flow?
4. Are there channel irregularities, such as sediment deposits, bars or islands, or infrastructure, such as abandoned bridge piers or abutments, immediately upstream of the debris accumulation site?

The first two questions relate to the bridge itself and the second two questions relate to the channel in the vicinity of the bridge. Based on these four questions, 16 non-unique solutions are possible. Figure 32 is the resulting flowchart for selection of the countermeasures. The selection of countermeasures for each solution is described below.

Riprap is frequently mounded at bridge piers as a countermeasure for scour. Mounded riprap at piers often provides a rough surface for debris to become caught and accumulate. Therefore, regardless of the solution path shown in Figure 32, the DOT should, as its first step in decreasing maintenance associated with debris accumulation, remove the mounded riprap and redesign the scour countermeasure according to the FHWA HEC-23 (Lagasse et al. 2001).

Clearly, the final selection of a countermeasure must include cost as a consideration. The relative costs are given in Table 3. The actual costs vary substantially between sites. Although cost should be considered, it may be that a higher cost countermeasure can provide a far more effective solution that will be actively protecting the bridge during high flows. Debris removal, the standard maintenance procedure, may not be as effective as some other measures since debris is often accumulating during high flows and affecting flooding, scour, and loading.

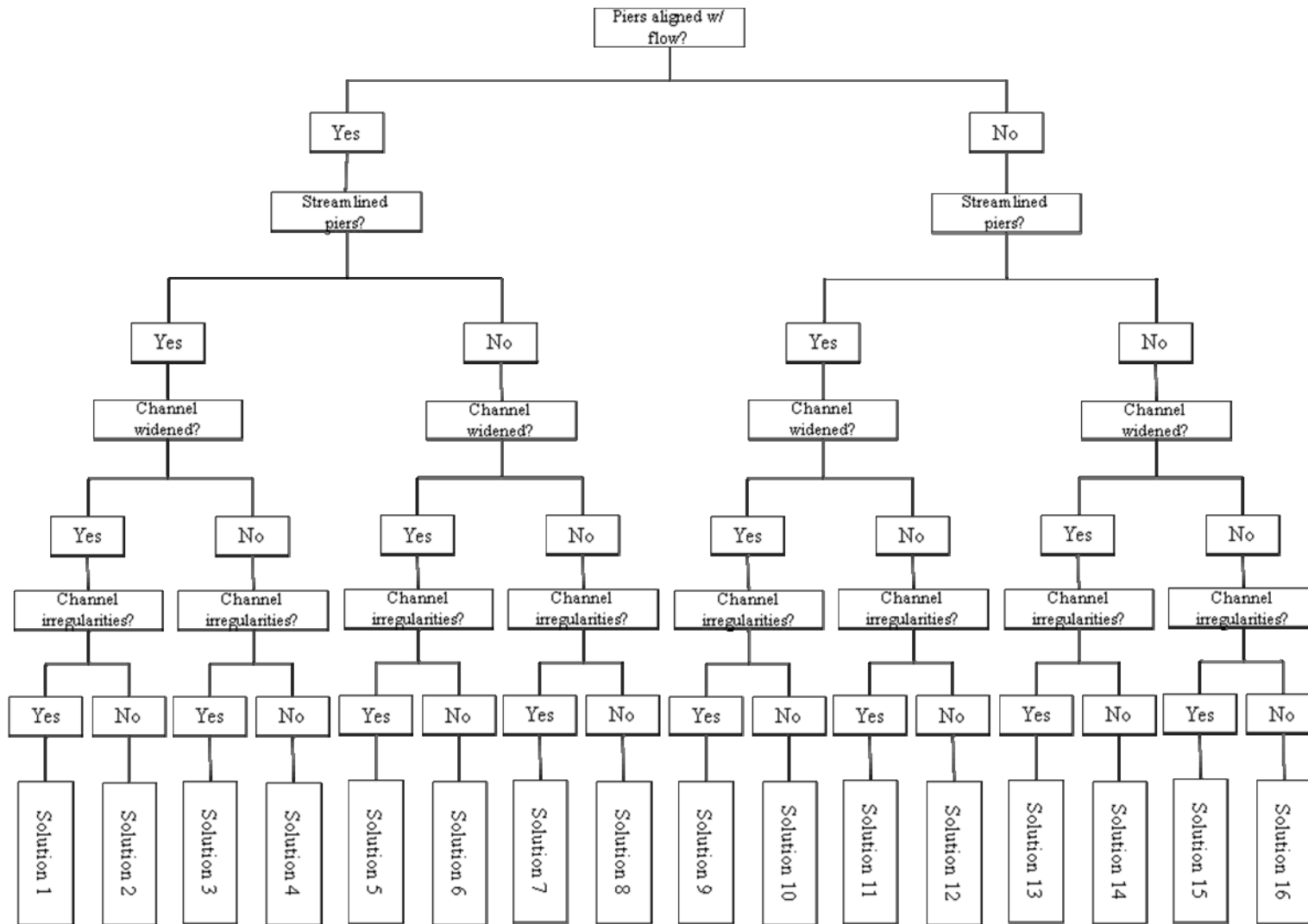


Figure 32. Solutions flowchart for debris accumulation at one or more piers.

Solution 1:

Remove upstream infrastructure if no longer in use. If upstream infrastructure is still in use, or is otherwise valuable, a system of in-stream hydraulic structures, such as vanes, can be used to direct primary flow pathways around the upstream infrastructure and properly align the flow to pass under the bridge. If there are stream bank irregularities immediately upstream of the bridge, vanes and similar structures will also promote the healing of the banks and eliminate eddies and flow obstructions that tend to promote debris accumulation. Artificially widened stream sections just upstream of bridges result in lower stream velocities and promote sediment deposition. As these areas become shallower they provide ideal locations for debris to collect. To concentrate the flow through the widened areas and through the bridge openings, a system of vanes and similar structures could be designed. Eliminating bar formation through the use of vanes will promote a more natural transport of debris through the bridge opening.

Solution 2:

Artificially widened stream sections just upstream of bridges result in lower stream velocities and promote sediment deposition. As these areas become shallower they provide ideal locations for debris to collect. To concentrate the flow through the widened areas and through the bridge openings, a system of vanes and similar structures could be designed. Eliminating bar formation through the use of vanes will promote a more natural transport of debris through the bridge opening.

Solution 3:

Remove upstream infrastructure if no longer in use. If upstream infrastructure is still in use, or is otherwise valuable, a system of in-stream hydraulic structures, such as vanes, can be used to direct primary flow pathways around the upstream infrastructure and properly align the flow to pass under the bridge. If there are stream bank irregularities immediately upstream of the bridge, vanes and similar structures will also promote the healing of the banks and eliminate eddies and flow obstructions that tend to promote debris accumulation. To further ensure that debris does not collect on the bridge pier, a debris sweeper could be installed to create vortices in the vicinity of the pier, disrupting the approaching flow and guiding debris away from the pier. If this option is considered, the distance between the pier where the sweeper is to be installed and adjacent piers and/or abutments should be greater than the design log length (see the literature review).

Solution 4:

The bridge pier has been constructed in the dominant debris flow pathway. The flow pathway can be altered using a system of in-stream hydraulic structures, such as vanes, to guide debris away from the bridge pier and through the bridge opening. To further ensure that debris does not collect on the bridge pier, a debris sweeper could be installed to create vortices in the vicinity of the pier, disrupting the approaching flow and guiding debris away from the pier. If this option is considered, the distance between the pier where the sweeper is to be installed and adjacent piers and/or abutments should be greater than the design log length (see the literature review).

Solution 5:

Piers designed with solid walls, a rounded pier nose, and pile caps that are below the stream bed elevation are less likely to trap floating debris than non-streamlined configurations. Thus, for

bridges with these less streamlined configurations, in-stream hydraulic structures, particularly submerged (Iowa-type) vanes, can be used to guide the flow and debris around the bridge piers. In addition, remove upstream infrastructure if no longer in use. If upstream infrastructure is still in use, or is otherwise valuable, a system of in-stream hydraulic structures, such as vanes, can be used to direct primary flow pathways around the upstream infrastructure and properly align the flow to pass under the bridge. If there are stream bank irregularities immediately upstream of the bridge, vanes and similar structures will also promote the healing of the banks and eliminate eddies and flow obstructions that tend to promote debris accumulation. Artificially widened stream sections just upstream of bridges result in lower stream velocities and promote sediment deposition. As these areas become shallower they provide ideal locations for debris to collect. To concentrate the flow through the widened areas and through the bridge openings, a system of vanes and similar structures could be designed. Eliminating bar formation through the use of vanes will promote a more natural transport of debris through the bridge opening.

Solution 6:

Piers designed with solid walls, a rounded pier nose, and pile caps that are below the stream bed elevation are less likely to trap floating debris than non-streamlined configurations. Thus, for bridges with these less streamlined configurations, in-stream hydraulic structures, particularly submerged (Iowa-type) vanes, can be used to guide the flow and debris around the bridge piers. Artificially widened stream sections just upstream of bridges result in lower stream velocities and promote sediment deposition. As these areas become shallower they provide ideal locations for debris to collect. To concentrate the flow through the widened areas and through the bridge openings, a system of vanes and similar structures could be designed. Eliminating bar formation through the use of vanes will promote a more natural transport of debris through the bridge opening.

Solution 7:

Piers designed with solid walls, a rounded pier nose, and pile caps that are below the stream bed elevation are less likely to trap floating debris than non-streamlined configurations. Thus, for bridges with these less streamlined configurations, in-stream hydraulic structures, particularly submerged (Iowa-type) vanes, can be used to guide the flow and debris around the bridge piers. Remove upstream infrastructure if no longer in use. If upstream infrastructure is still in use, or is otherwise valuable, a system of in-stream hydraulic structures, such as vanes, can be used to direct primary flow pathways around the upstream infrastructure and properly align the flow to pass under the bridge. If there are stream bank irregularities immediately upstream of the bridge, vanes and similar structures will also promote the healing of the banks and eliminate eddies and flow obstructions that tend to promote debris accumulation. To further ensure that debris does not collect on the bridge pier, a debris sweeper could be installed to create vortices in the vicinity of the pier, disrupting the approaching flow and guiding debris away from the pier. If this option is considered, the distance between the pier where the sweeper is to be installed and adjacent piers and/or abutments should be greater than the design log length (see the literature review).

Solution 8:

Piers designed with solid walls, a rounded pier nose, and pile caps that are below the stream bed elevation are less likely to trap floating debris than non-streamlined configurations. Thus, for

bridges with these less streamlined configurations, in-stream hydraulic structures, particularly submerged (Iowa-type) vanes, can be used to guide the flow and debris around the bridge piers. The bridge pier has been constructed in the dominant debris flow pathway. The flow pathway can be altered using a system of in-stream hydraulic structures, such as vanes, to guide debris away from the bridge pier and through the bridge opening. To further ensure that debris does not collect on the bridge pier, a debris sweeper could be installed to create vortices in the vicinity of the pier, disrupting the approaching flow and guiding debris away from the pier. If this option is considered, the distance between the pier where the sweeper is to be installed and adjacent piers and/or abutments should be greater than the design log length (see the literature review).

Solution 9:

Bridge piers that are not aligned perpendicularly to the approaching flow decrease the effective distance between adjacent piers and/or abutments, increase the effective width of the pier, create regions of increased flow velocity around the upstream face of the pier, and create eddies around the downstream face. These flow alterations increase the likelihood of debris accumulation at the bridge site. In-stream hydraulic structures, particularly submerged (Iowa-type) vanes, can be used to guide the flow and debris around the bridge piers. In addition, remove any upstream infrastructure if no longer in use. If upstream infrastructure is still in use, or is otherwise valuable, a system of in-stream hydraulic structures, such as vanes, can be used to direct primary flow pathways around the upstream infrastructure and properly align the flow to pass under the bridge. If there are stream bank irregularities immediately upstream of the bridge, vanes and similar structures will also promote the healing of the banks and eliminate eddies and flow obstructions that tend to promote debris accumulation.

Solution 10:

Bridge piers that are not aligned perpendicularly to the approaching flow decrease the effective distance between adjacent piers and/or abutments, increase the effective width of the pier, create regions of increased flow velocity around the upstream face of the pier, and create eddies around the downstream face. These flow alterations increase the likelihood of debris accumulation at the bridge site. In-stream hydraulic structures, particularly submerged (Iowa-type) vanes, can be used to guide the flow and debris around the bridge piers. Artificially widened stream sections just upstream of bridges result in lower stream velocities and promote sediment deposition. As these areas become shallower they provide ideal locations for debris to collect. To concentrate the flow through the widened areas and through the bridge openings, a system of vanes and similar structures could be designed. Eliminating bar formation through the use of vanes will promote a more natural transport of debris through the bridge opening.

Solution 11:

Bridge piers that are not aligned perpendicularly to the approaching flow decrease the effective distance between adjacent piers and/or abutments, increase the effective width of the pier, create regions of increased flow velocity around the upstream face of the pier, and create eddies around the downstream face. These flow alterations increase the likelihood of debris accumulation at the bridge site. In-stream hydraulic structures, particularly submerged (Iowa-type) vanes, can be used to guide the flow and debris around the bridge piers. In addition, remove any upstream infrastructure if no longer in use. If upstream infrastructure is still in use, or is otherwise valuable, a system of in-stream hydraulic structures, such as vanes, can be used to direct primary

flow pathways around the upstream infrastructure and properly align the flow to pass under the bridge. If there are stream bank irregularities immediately upstream of the bridge, vanes and similar structures will also promote the healing of the banks and eliminate eddies and flow obstructions that tend to promote debris accumulation. To further ensure that debris does not collect on the bridge pier, a debris sweeper could be installed to create vortices in the vicinity of the pier, disrupting the approaching flow and guiding debris away from the pier. If this option is considered, the distance between the pier where the sweeper is to be installed and adjacent piers and/or abutments should be greater than the design log length (see the literature review).

Solution 12:

Bridge piers that are not aligned perpendicularly to the approaching flow decrease the effective distance between adjacent piers and/or abutments, increase the effective width of the pier, create regions of increased flow velocity around the upstream face of the pier, and create eddies around the downstream face. These flow alterations increase the likelihood of debris accumulation at the bridge site. In-stream hydraulic structures, particularly submerged (Iowa-type) vanes, can be used to guide the flow and debris around the bridge piers. The bridge pier has been constructed in the dominant debris flow pathway. The flow pathway can be altered using a system of in-stream hydraulic structures, such as vanes, to guide debris away from the bridge pier and through the bridge opening. To further ensure that debris does not collect on the bridge pier, a debris sweeper could be installed to create vortices in the vicinity of the pier, disrupting the approaching flow and guiding debris away from the pier. If this option is considered, the distance between the pier where the sweeper is to be installed and adjacent piers and/or abutments should be greater than the design log length (see the literature review).

Solution 13:

Bridge piers that are not aligned perpendicularly to the approaching flow decrease the effective distance between adjacent piers and/or abutments, increase the effective width of the pier, create regions of increased flow velocity around the upstream face of the pier, and create eddies around the downstream face. These flow alterations increase the likelihood of debris accumulation at the bridge site. In-stream hydraulic structures, particularly submerged (Iowa-type) vanes, can be used to guide the flow and debris around the bridge piers. Piers designed with solid walls, a rounded pier nose, and pile caps that are below the stream bed elevation are less likely to trap floating debris than non-streamlined configurations. Thus, for bridges with these less streamlined configurations, in-stream hydraulic structures, particularly submerged (Iowa-type) vanes, can be used to guide the flow and debris around the bridge piers. Remove upstream infrastructure if no longer in use. If upstream infrastructure is still in use, or is otherwise valuable, a system of in-stream hydraulic structures, such as vanes, can be used to direct primary flow pathways around the upstream infrastructure and properly align the flow to pass under the bridge. If there are stream bank irregularities immediately upstream of the bridge, vanes and similar structures will also promote the healing of the banks and eliminate eddies and flow obstructions that tend to promote debris accumulation. Artificially widened stream sections just upstream of bridges result in lower stream velocities and promote sediment deposition. As these areas become shallower they provide ideal locations for debris to collect. To concentrate the flow through the widened areas and through the bridge openings, a system of vanes and similar structures could be designed. Eliminating bar formation through the use of vanes will promote a more natural transport of debris through the bridge opening.

Solution 14:

Bridge piers that are not aligned perpendicularly to the approaching flow decrease the effective distance between adjacent piers and/or abutments, increase the effective width of the pier, create regions of increased flow velocity around the upstream face of the pier, and create eddies around the downstream face. These flow alterations increase the likelihood of debris accumulation at the bridge site. In-stream hydraulic structures, particularly submerged (Iowa-type) vanes, can be used to guide the flow and debris around the bridge piers. Piers designed with solid walls, a rounded pier nose, and pile caps that are below the stream bed elevation are less likely to trap floating debris than non-streamlined configurations. Thus, for bridges with these less streamlined configurations, in-stream hydraulic structures, particularly submerged (Iowa-type) vanes, can be used to guide the flow and debris around the bridge piers. Artificially widened stream sections just upstream of bridges result in lower stream velocities and promote sediment deposition. As these areas become shallower they provide ideal locations for debris to collect. To concentrate the flow through the widened areas and through the bridge openings, a system of vanes and similar structures could be designed. Eliminating bar formation through the use of vanes will promote a more natural transport of debris through the bridge opening.

Solution 15:

Bridge piers that are not aligned perpendicularly to the approaching flow decrease the effective distance between adjacent piers and/or abutments, increase the effective width of the pier, create regions of increased flow velocity around the upstream face of the pier, and create eddies around the downstream face. These flow alterations increase the likelihood of debris accumulation at the bridge site. In-stream hydraulic structures, particularly submerged (Iowa-type) vanes, can be used to guide the flow and debris around the bridge piers. Piers designed with solid walls, a rounded pier nose, and pile caps that are below the stream bed elevation are less likely to trap floating debris than non-streamlined configurations. Thus, for bridges with these less streamlined configurations, in-stream hydraulic structures, particularly submerged (Iowa-type) vanes, can be used to guide the flow and debris around the bridge piers. Remove upstream infrastructure if no longer in use. If upstream infrastructure is still in use, or is otherwise valuable, a system of in-stream hydraulic structures, such as vanes, can be used to direct primary flow pathways around the upstream infrastructure and properly align the flow to pass under the bridge. If there are stream bank irregularities immediately upstream of the bridge, vanes and similar structures will also promote the healing of the banks and eliminate eddies and flow obstructions that tend to promote debris accumulation. If there are stream bank irregularities immediately upstream of the bridge, vanes and similar structures will also promote the healing of the banks and eliminate eddies and flow obstructions that tend to promote debris accumulation. To further ensure that debris does not collect on the bridge pier, a debris sweeper could be installed to create vortices in the vicinity of the pier, disrupting the approaching flow and guiding debris away from the pier. If this option is considered, the distance between the pier where the sweeper is to be installed and adjacent piers and/or abutments should be greater than the design log length (see the literature review).

Solution 16:

Bridge piers that are not aligned perpendicularly to the approaching flow decrease the effective distance between adjacent piers and/or abutments, increase the effective width of the pier, create

regions of increased flow velocity around the upstream face of the pier, and create eddies around the downstream face. These flow alterations increase the likelihood of debris accumulation at the bridge site. In-stream hydraulic structures, particularly submerged (Iowa-type) vanes, can be used to guide the flow and debris around the bridge piers. Piers designed with solid walls, a rounded pier nose, and pile caps that are below the stream bed elevation are less likely to trap floating debris than non-streamlined configurations. Thus, for bridges with these less streamlined configurations, in-stream hydraulic structures, particularly submerged (Iowa-type) vanes, can be used to guide the flow and debris around the bridge piers. To further ensure that debris does not collect on the bridge pier, a debris sweeper could be installed to create vortices in the vicinity of the pier, disrupting the approaching flow and guiding debris away from the pier. If this option is considered, the distance between the pier where the sweeper is to be installed and adjacent piers and/or abutments should be greater than the design log length (see the literature review).

EXAMPLES

Following Figure 32 and the solution descriptions that follow, several examples can be given using the data for bridges given in Table 2. For PA 103 over the Juniata, there is no artificial widening, bars or other channel irregularities. The piers are solid and streamlined, but in the path of floating debris. Following Figure 32, Solution 4 is suggested. In-stream hydraulic structures, such as vanes, may provide sufficient flow re-direction to guide debris around the bridge pier and through the bridge opening. To further ensure that debris does not collect on the bridge pier, a debris sweeper could be installed to create vortices in the vicinity of the pier, disrupting the approaching flow and guiding debris away from the pier. Since the debris is small to medium in size, the distance between the pier where the sweeper is to be installed and adjacent piers is greater than the design log length. Given that the channel is a 7th-order stream and is rather wide and deep, installation of vanes at the pier may prove to be a difficult and costly implementation. Thus, the sweeper is likely the best selection.

Both PA 3019 over Clearfield Creek and PA 153 over Bennett Creek are 4th-order streams with significant widening of the channels at the bridges and sediment deposition just upstream in the widened sections. From Figure 32, the suggested solution for both bridges is Solution 1. In these two cases, there is no upstream infrastructure to be removed. The primary irregularities in the channel are the presence of sediment bars at both bridges where debris can be caught. A set of vanes, particularly submerged (Iowa-type) vanes may be very useful in providing locally higher velocities so that the sediment moves through the bridge openings, reducing or eliminating the problematic sites and improving natural flow through the bridge openings.

US 6 over French Creek is a 6th-order stream that has not been widened, and bars of sediment deposition have not accumulated. The debris caught at the piers tends to be rather large, but not longer than the bridge span lengths. As for the Juniata River example, a 6th-order stream tends to be rather wide and deep. Thus, the most cost-effective solution is likely the debris sweeper.

Data on three additional bridges were collected to permit testing of the method developed in this report at bridges not included in the development of the method. These bridges were selected based on a documented history of recurring debris accumulation at the sites and include: PA 588

(Riverview Road) over Connoquenessing Creek; PA 3031 (Prestley Road) over Chartiers Creek; and PA 351 (Koppel Road) over the Beaver River. These three sites are shown in Figures 33 through 35. The relevant stream and bridge parameters are included in Table 4. For the PA 588 bridge over Connoquenessing Creek, the bridge piers are not well aligned with the approaching stream flow and significant channel irregularities, including mid-channel bars and bedrock outcrops, exist. Chronic debris accumulation at this site is likely due to these characteristics, despite the use of streamlined piers and preservation of the natural stream width at the site. Based on these characteristics, Figure 32 indicates that solution 15 is appropriate. Solution 15 recommends the use of in-stream hydraulic structures to align upstream flow with the bridge piers. Hydraulic structures can also be used to concentrate flow in the center of the channel upstream of the bridge, which may reduce the impact of existing mid-channel bars on debris transport and reduce the probability of additional sediment deposition at the site. If additional countermeasures are required to reduce the accumulation of debris at this site, a debris sweeper could be installed at one or both bridge piers to create currents that redirect debris around the bridge substructure.

Both the PA 3031 bridge over Chartiers Creek and the PA 351 bridge over the Beaver River are well aligned with approaching flow and were constructed using streamlined piers. Neither watercourse has been artificially widened in the vicinity of the bridge nor do stream irregularities adversely affect debris transport. Both of these bridges suffer from chronic debris accumulation due to piers that were placed in predominant debris flow pathways. Based on these characteristics, Figure 32 indicates that solution 4 is appropriate for both bridges. Solution 4 recommends that a system of in-stream hydraulic structures, such as vanes, be employed to guide debris away from bridge piers and through the bridge openings. A debris sweeper could be installed on each of the piers that are most prone to debris accumulation to further ensure that debris does not collect at the site. At the Chartiers Creek site, a single bridge pier is located directly in the center of the channel with span lengths of about 70 ft on either side of the pier. Care should be taken to ensure that the distance between the bridge abutments and pier is greater than the maximum length of debris transported downstream during a variety of debris transporting events. If this is not the case, additional sweepers and hydraulic structures may be required to rotate debris so that the major axis is aligned with flow, allowing the debris to travel through the bridge opening without blocking the span between the pier and abutment.



Figure 33. PA 588 over Connoquenessing Creek, Beaver County, PA.



Figure 34. PA 3031 over Chartiers Creek, Allegheny County, PA.



Figure 35. PA 351 over the Beaver River, Beaver County, PA.

Table 4. Summary of observations from sites used to test the debris accumulation countermeasure method.

State	Bridge	Stream Order	% Channel Widening at Bridge	Bars/Deposits	Number of Piers in Channel	Pier Type	Location and Size of Debris	Bed Material	Est. Span Width (ft)
PA	PA 588 over Connoque-nessing Creek	6	None	Gravel/cobble bars in vicinity of bridge	2	Solid, round nosed	None	Silt, sand, gravel, cobble	70
PA	PA 3031 over Chartiers Creek	5	None	None	1	Solid, round nosed	None	Silt, sand, gravel, cobble	70
PA	PA 351 over Beaver River	7	None	None	3	Solid, rip rap around base	At pier closest to right bank; S-M-L	Silt, sand, gravel, cobble, boulder	85

REFERENCES

- Abbe, T.B. and D.R. Montgomery. 1996. Large woody debris jams, channel hydraulics and habitat formation in large rivers. *Regulated Rivers: Research and Management* 12:201-221.
- Booth, D.B. 1990. Stream channel incision following drainage basin urbanization. *Water Resources Bulletin* 26(3): 407-417.
- Booth, D.B. 1991. Urbanization and the natural drainage system – impacts, solutions, and prognoses. *Northwest Environmental Journal* 7: 93-118.
- Bradley, J.B., D.L. Richards and C.D. Bahner. 2005. Debris control structures - evaluation and countermeasures: Federal Highway Administration Report No. FHWA-IF-04-016, Hydraulic Engineering Circular No. 9, 179 p.
- Brice, J.C., J.C. Blodgett, P.J. Carpenter, M.F. Cook, G.S. Craig, D.A. Eckhardt, M.S. Hines, K.L. Lindskov, D.O. Moore, R.S. Parker, A.G. Scott, and K.V. Wilson. 1978. Countermeasures for hydraulic problems at bridges, Volume 1 - analysis and assessment: Federal Highway Administration Report No. FHWA-RD-78-162, 169 p.
- Bryant, M.D. 1980. Evolution of large, organic debris after timber harvest: Maybeso Creek, 1949 to 1978: Pacific Northwest Forest and Range Experiment Station, U.S. Department of Agriculture, Forest Service General Technical Report No. PNW-101, 30 p.
- Bryant, M.D. 1983. The role and management of woody debris in west coast salmonid nursery streams. *North American Journal of Fisheries Management* 3(3): 322-330.
- Chang, F.F.M. 1973. A statistical summary of the cause and cost of bridge failures: Federal Highway Administration, Office of Research and Development, Report No. FHWA-RD-75-87, 42 p.
- Chang, F.F.M., and H.W. Shen. 1979. Debris problems in the river environment: Federal Highway Administration Report No. FHWA-RD-79-62, 67 p.
- Diehl, T.H. and B.A. Bryan. 1993. Supply of large woody debris in a stream channel, *in* Shen, H.W., S.T. Su, and F. Wen, eds., *Hydraulic Engineering '93*, proceedings of the 1989 national conference on hydraulic engineering: New York, American Society of Civil Engineers, p.1055-1060.
- Diehl, T.H. 1997. Potential drift accumulation at bridges: Federal Highway Administration Report No. FHWA-RD-97-028, 114 p.
- Dunne, T. and L.B. Leopold. 1978. *Water in Environmental Planning*. W.H. Freeman and Company, New York, New York. 818 p.
- Gilje, S.A. 1979. Debris problems in the river environment. *Public Roads* 42(4): 136-141.
- Hollis, G.E. 1975. The effects of urbanization on floods of different recurrence intervals. *Water Resources Research* 11:431-435.
- Johnson, P.A., M. Tessier, R.D. Hey and D.L. Rosgen. 2001. The use of vanes for local abutment scour reduction. *Journal of Hydraulic Engineering*, 127(9), 772-779.
- Johnson, P.A., R.D. Hey, E.R. Brown and D. Rosgen. 2002. Stream restoration in the vicinity of bridges. *Journal of the American Water Resources Association*, 38(1), 55-67.
- Lagasse, P.E, J.D. Schall, E.V. Richardson. 2001a. *Stream Stability at Highway Structures*, Third Edition. Washington, DC: U.S. Department of Transportation, Report No. FHWA NHI 01-002, HEC-20, Federal Highway Administration, Arlington, VA.

- Lagasse, P.F., L.W. Zevenbergen, J.D. Schall, and P.E. Clopper. 2001b. Bridge Scour and Stream Instability Countermeasures Experience, Selection, and Design Guidance, Second Edition. FHWA Report NHI-01-003, HEC-23, Federal Highway Administration, Arlington, VA.
- Lauchlan, C.S. 1999. Pier Scour Countermeasures. Auckland, New Zealand: University of Auckland, School of Engineering, Report No. 590.
- Lyn, D.A., T.J. Cooper, Y. Yi, R. Sinha, and A.R. Rao. 2003. Debris accumulation at bridge crossings: laboratory and field studies: Federal Highway Administration Report No. FHWA/IN/JTRP-2003/10, 59 p.
- Lyn, D.A., T.J. Cooper, C.A. Condon, and L. Gan. 2006. Factors in Debris Accumulation at Bridge Piers: Federal Highway Administration Report No. FHWA/IN/JTRP-2006/36, 104 p.
- Murphy, M.L. and K.V. Koski. 1989. Input and depletion of woody debris in Alaska streams and implications for streamside management. *North American Journal of fisheries Management* 9(4): 427-436.
- National Transportation Safety Board. 1990. Highway accident report – collapse of the Harrison Road Bridge spans, Miamitown, Ohio, May 26, 1989: Washington, D.C., National Transportation Safety Board, 45 p.
- Newlin, J.T., Johnson, P.A., 2008a. Adaptive management case study: stream channel mitigation methods at bridge crossings in the northern tier region, PA. *Journal of the American Water Resources Association*. (under review)
- Newlin, J.T., Johnson, P.A., and Miller, A.C., 2008b. Characterization of sediment transport at bridge sites in the Northern Tier, PA. *Journal of Hydraulic Engineering* (under review).
- O'Donnell, C.L. 1973. Observation on the causes of bridge damage in Pennsylvania and New York due to Hurricane Agnes: *Highway Research Record*, no. 479, p. 20-36.
- Odgaard, A.J. and J.E Kennedy. 1983. Riverbend bank protection by submerged vanes. *Journal of Hydraulic Engineering* 109, 1161-1173.
- Odgaard, A.J. and H.Y.E. Lee. 1984. Submerged vanes for flow control and bank protection in streams, Iowa City, IA: IIHR Report No. 279, Iowa Institute of Hydraulic Research, University of Iowa.
- Odgaard, A.J. and C.E. Mosconi. 1987. Streambank protection by submerged vanes. *Journal of Hydraulic Engineering*, 113, 520-536.
- Pangallo, J.D., T. Gray, W. Land, and S.E. Toillion. 2002. Bridge span lengths for passage of drift: Indianapolis, Indiana Department of Transportation, 11 p.
- Richardson, E.V. and S.R. Davis. 1995. Evaluating scour at bridges: Federal Highway Administration Report No. FHWA-IP-90-017, Hydraulic Engineering Circular No. 18, (3rd ed.), 204 p.
- Saunders, S. and M.L. Oppenheimer. 1993. A method of managing floating debris. *Hydraulic Engineering* 1993, ASCE 1373-1378.
- Wallace, J.B. and A.C. Benke. 1984. Quantification of wood habitat in subtropical coastal plain streams. *Canadian Journal of Fisheries and Aquatic Science* 41:1643-1652.
- Wallerstein, N., C.R. Thorne, and S.R. Abt. 1997. Debris control at hydraulic structures in selected areas of the United States and Europe: U.S. Army Engineer Waterways Experiment Station Report No. CHL-97-4, 122 p.

APPENDIX
DATA SHEETS FROM FIELD SITES

Site 1

**STREAM RECONNAISSANCE
For Debris Accumulation at Bridges**

SECTION 1 - SITE DESCRIPTION

ROAD NAME/NUMBER

SR 3017, SEG 170

DATE

5/21/08

BRIDGE NUMBER

60-3017-170-1956

STREAM NAME

French Creek

GPS COORDINATES

N 41° 26.272' W 79° 57.328'

SECTION 2 - REGION AND VALLEY DESCRIPTION

PART 1: WATERSHED

Land Use

- Natural
- Agricultural
- Urban
- Suburban
- Rural
- Industrial
- Cattle grazing

Vegetation

- None
- Grass
- Pasture
- Crops
- Shrubs
- Deciduous Forest/trees
- Coniferous Forest/trees

PART 2: RIVER VALLEY CONDITION

Valley Side Failures

- None
- Occasional
- Frequent

Failure Locations

- None
- Away from river
- Along river

PART 3: FLOODPLAIN

Floodplain Width

- None
- <1 river width
- 1-5 river widths
- 5-10 river widths
- >10 river widths

Land Use

- Natural
- Agricultural
- Urban
- Suburban
- Rural
- Industrial
- Mining
- Cattle grazing

Vegetation

- None
- Grass
- Pasture
- Orchards
- Crops
- Shrubs
- Deciduous Forest/trees
- Coniferous Forest/trees

Riparian Buffer Strip

- None
- <1 river width
- 1-5 river widths
- >5 river widths

L.B., R.B. has none

PART 4: VERTICAL CONFINEMENT

Terraces

- None
- Left bank
- Right bank

Levees

- None
- Natural
- Constructed

Levee Location

- Along channel bank
- Set back <1 river width
- Set back >1 river width

PART 5: LATERAL RELATION OF CHANNEL TO VALLEY

Planform

- Straight
- Meandering
- Braided
- Anastomosed
- Engineered

Meander Characteristics

- Mild bends
- Moderate bends
- Tight bends

SECTION 3 - CHANNEL DESCRIPTION

PART 6: CHANNEL DESCRIPTION (select all that apply)

Bed Controls

- None
- Occasional
- Frequent
- Confined

Control Types

- None
- Bedrock
- Boulders
- Gravel armor
- Bridge protection
- Grade control
- Debris
- Dams (beaver, engineered)

Width Controls

- None
- Occasional
- Frequent
- Confined

Control Types

- None
- Bedrock
- Boulders
- Gravel armor
- Bridge protection
- Bridge abutments
- Bank stabilization
- Debris

Other

- Debris
- Mining
- Reservoir
- Knickpoint

M-B classification

- Cascade or step-pool
- Plane, pool-riffle, dune-ripple
- Braided

Corps classification (other)

- Modified (engineered)
- Regulated
- Arroyo

Flow Habit

- Perennial
- Flashy perennial
- Intermittent
- Ephemeral

Channel width = 222 ft

PART 7: BED SEDIMENT DESCRIPTION (select all that apply)

Bed Material

- Clay
- Silt
- Sand
- Gravel
- Cobbles
- Boulders

Bar Types

- None
- Alternate bars
- Point bars
- Mid-channel bars
- Diagonal bars
- Irregular/combination

Bar Material

- Silt
- Sand
- Gravel
- Cobbles

Bar Vegetation

- None
- Grasses
- Reeds/shrubs
- Trees

Bar Width

- None
- Narrow
- Moderate
- Wide

SECTION 4 - BANK SURVEY (select all that apply)

Bank Characteristic	Left Bank	Right Bank
Bank material	<input type="checkbox"/> clay <input checked="" type="checkbox"/> silt <input checked="" type="checkbox"/> sand <input checked="" type="checkbox"/> gravel <input checked="" type="checkbox"/> cobbles <input type="checkbox"/> boulders <input type="checkbox"/> bedrock	<input type="checkbox"/> clay <input checked="" type="checkbox"/> silt <input checked="" type="checkbox"/> sand <input checked="" type="checkbox"/> gravel <input checked="" type="checkbox"/> cobbles <input type="checkbox"/> boulders <input type="checkbox"/> bedrock
Layer material	<input checked="" type="checkbox"/> no layers <input type="checkbox"/> cohesive <input type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders	<input checked="" type="checkbox"/> no layers <input type="checkbox"/> cohesive <input type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders
Bank height	3-4 ft	6-8 ft
Bank slope	<input checked="" type="checkbox"/> steep <input type="checkbox"/> moderate ~ 45° <input type="checkbox"/> shallow	<input checked="" type="checkbox"/> steep <input type="checkbox"/> moderate ~ 45° <input type="checkbox"/> shallow
Bank vegetation	<input type="checkbox"/> none <input checked="" type="checkbox"/> grasses/annuals <input checked="" type="checkbox"/> reeds/shrubs <input checked="" type="checkbox"/> trees falling trees? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no tree density: <input type="checkbox"/> sparse <input checked="" type="checkbox"/> dense tree health: <input checked="" type="checkbox"/> good <input type="checkbox"/> poor tree ages: <input type="checkbox"/> young <input checked="" type="checkbox"/> mature <input type="checkbox"/> old tree diversity? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no	<input type="checkbox"/> none <input checked="" type="checkbox"/> grasses/annuals <input checked="" type="checkbox"/> reeds/shrubs <input checked="" type="checkbox"/> trees falling trees? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no tree density: <input type="checkbox"/> sparse <input checked="" type="checkbox"/> dense tree health: <input checked="" type="checkbox"/> good <input type="checkbox"/> poor tree ages: <input type="checkbox"/> young <input checked="" type="checkbox"/> mature <input type="checkbox"/> old tree diversity? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no
Bank erosion and failure location	location of erosion: <input type="checkbox"/> outside meander bend <input type="checkbox"/> inside meander bend <input type="checkbox"/> opposite bar or obstruction <input type="checkbox"/> general type of erosion: <i>Not Significant</i> <input type="checkbox"/> fluvial <input type="checkbox"/> geotechnical	location of erosion: <input checked="" type="checkbox"/> outside meander bend <input type="checkbox"/> inside meander bend <input type="checkbox"/> opposite bar or obstruction <input type="checkbox"/> general type of erosion: <input checked="" type="checkbox"/> fluvial <input type="checkbox"/> geotechnical

SECTION 5 -- DEBRIS CHARACTERISTICS

PART 8: EVIDENCE OF HIGH DEBRIS DELIVERY POTENTIAL

- Presence of debris at bridge (See Part 9)
- Presence of debris at upstream sites
- Documented need for debris removal at bridge (Contact: _____)
- Evidence of bank erosion

PART 9: DEBRIS TYPE / QUANTITY

- | | | | |
|---|------------|--|---------|
| <input type="checkbox"/> None | Percent | | Percent |
| <input type="checkbox"/> Small floating debris | <u>25%</u> | <input type="checkbox"/> Fine detritus | _____ |
| <input type="checkbox"/> Medium floating debris | _____ | <input type="checkbox"/> Coarse detritus | _____ |
| <input type="checkbox"/> Large floating debris | <u>75%</u> | <input type="checkbox"/> Boulders | _____ |

SECTION 6 - BRIDGE CHARACTERISTICS

PART 10: PIER MEASUREMENTS

Number of piers: 2

Width measurements:

Left bank or abutment to (1) pier: 5 ft *distance from right bank to abutment +*
 Right bank or abutment to pier: 5 ft

Width between piers:

Piers	1 - 2	2 - 3	3 - 4	4 - 5	5 - 6
Width (ft)	<u>113 ft</u>	<u>106 ft</u>			

Height of low chord above stream bed: 14 ft

PART 11: PIER CHARACTERISTICS

- Single, solid piers
- Multiple, closely spaced pier or pile groups
- Exposed pier footing piles
- Multiple piles, or row of pier columns skewed to approaching flow

PART 12: PIER LOCATION

- Sheltered location (Piers _____)
- Bank/floodplain (Piers 1)
- In the channel (Piers 2)
- In the path of debris flow (Piers 2)

Site 2

STREAM RECONNAISSANCE
For Debris Accumulation at Bridges

SECTION 1 - SITE DESCRIPTION

ROAD NAME/NUMBER

SR 6

DATE

5/21/08

BRIDGE NUMBER

20-0006-730-0862

STREAM NAME

French Creek

GPS COORDINATES

N41° 44.518' W80° 7.863'

SECTION 2 - REGION AND VALLEY DESCRIPTION

PART 1: WATERSHED

Land Use

- Natural
- Agricultural
- Urban
- Suburban
- Rural
- Industrial
- Cattle grazing

Vegetation

- None
- Grass
- Pasture
- Crops
- Shrubs
- Deciduous Forest/trees
- Coniferous Forest/trees

PART 2: RIVER VALLEY CONDITION

Valley Side Failures

- None
- Occasional
- Frequent

Failure Locations

- None
- Away from river
- Along river

PART 3: FLOODPLAIN

Floodplain Width

- None
- <1 river width
- 1-5 river widths
- 5-10 river widths
- >10 river widths

Land Use

- Natural
- Agricultural
- Urban
- Suburban
- Rural
- Industrial
- Mining
- Cattle grazing

Vegetation

- None
- Grass
- Pasture
- Orchards
- Crops
- Shrubs
- Deciduous Forest/trees
- Coniferous Forest/trees

Riparian Buffer Strip

- None
- <1 river width
- 1-5 river widths
- >5 river widths

large, mixed land use

- 1) upstream, from deck
- 2) downstream, from deck
- 3) left bank, downstream of bridge (note erosion)
- 4) debris on piers #3, from left bank upstream of bridge
- 5) " " 2 " " " "
- 6) mid-channel bar, from L.B. upstream of bridge

PART 4: VERTICAL CONFINEMENT

Terraces

- None
- Left bank
- Right bank

Levees

- None
- Natural
- Constructed

Levee Location

- Along channel bank
- Set back <1 river width
- Set back >1 river width

PART 5: LATERAL RELATION OF CHANNEL TO VALLEY

Planform

- Straight
- Meandering
- Braided
- Anastomosed
- Engineered

Meander Characteristics

- Mild bends
- Moderate bends
- Tight bends

SECTION 3 - CHANNEL DESCRIPTION

PART 6: CHANNEL DESCRIPTION (select all that apply)

Bed Controls

- None
- Occasional
- Frequent
- Confined

Control Types

- None
- Bedrock
- Boulders
- Gravel armor
- Bridge protection
- Grade control
- Debris
- Dams (beaver, engineered)

Width Controls

- None
- Occasional
- Frequent
- Confined

Control Types

- None
- Bedrock
- Boulders
- Gravel armor
- Bridge protection
- Bridge abutments
- Bank stabilization
- Debris

Other

- Debris
- Mining
- Reservoir
- Knickpoint

M-B classification

- Cascade or step-pool
- Plane, pool-riffle, dune-ripple
- Braided

Corps classification (other)

- Modified (engineered)
- Regulated
- Arroyo

Flow Habit

- Perennial
- Flashy perennial
- Intermittent
- Ephemeral

Channel width = ~ 250 feet

PART 7: BED SEDIMENT DESCRIPTION (select all that apply)

Bed Material

- Clay
- Silt
- Sand
- Gravel
- Cobbles
- Boulders

Bar Types

- None
- Alternate bars
- Point bars
- Mid-channel bars
- Diagonal bars
- Irregular/combination

Bar Material

- Silt
- Sand
- Gravel
- Cobbles

Bar Vegetation

- None
- Grasses
- Reeds/shrubs
- Trees

Bar Width

- None
- Narrow
- Moderate
- Wide

just downstream of bridge

upstream of bridge 2
on R.B.

SECTION 4 - BANK SURVEY (select all that apply)

Bank Characteristic	Left Bank	Right Bank
Bank material	<input type="checkbox"/> clay <input type="checkbox"/> silt <input checked="" type="checkbox"/> sand <input checked="" type="checkbox"/> gravel <input checked="" type="checkbox"/> cobbles <input checked="" type="checkbox"/> boulders <input type="checkbox"/> bedrock	<input type="checkbox"/> clay <input type="checkbox"/> silt <input checked="" type="checkbox"/> sand <input checked="" type="checkbox"/> gravel <input checked="" type="checkbox"/> cobbles <input checked="" type="checkbox"/> boulders <input type="checkbox"/> bedrock
Layer material	<input checked="" type="checkbox"/> no layers <input type="checkbox"/> cohesive <input type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders	<input checked="" type="checkbox"/> no layers <input type="checkbox"/> cohesive <input type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders
Bank height	4-5 feet	4-5 feet
Bank slope	<input checked="" type="checkbox"/> steep <input type="checkbox"/> moderate <input type="checkbox"/> shallow	<input checked="" type="checkbox"/> steep <input type="checkbox"/> moderate <input type="checkbox"/> shallow
Bank vegetation	<input type="checkbox"/> none <input checked="" type="checkbox"/> grasses/annuals <input checked="" type="checkbox"/> reeds/shrubs <input checked="" type="checkbox"/> trees falling trees? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no tree density: <input type="checkbox"/> sparse <input checked="" type="checkbox"/> dense tree health: <input checked="" type="checkbox"/> good <input type="checkbox"/> poor tree ages: <input type="checkbox"/> young <input checked="" type="checkbox"/> mature <input type="checkbox"/> old tree diversity? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no	<input type="checkbox"/> none <input checked="" type="checkbox"/> grasses/annuals <input checked="" type="checkbox"/> reeds/shrubs <input checked="" type="checkbox"/> trees falling trees? <input type="checkbox"/> yes <input checked="" type="checkbox"/> no tree density: <input checked="" type="checkbox"/> sparse <input type="checkbox"/> dense tree health: <input checked="" type="checkbox"/> good <input type="checkbox"/> poor tree ages: <input type="checkbox"/> young <input checked="" type="checkbox"/> mature <input type="checkbox"/> old tree diversity? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no
Bank erosion and failure location	location of erosion: <input checked="" type="checkbox"/> outside meander bend <i>downstream of bridge</i> <input type="checkbox"/> inside meander bend <input type="checkbox"/> opposite bar or obstruction <input type="checkbox"/> general type of erosion: <input checked="" type="checkbox"/> fluvial <input type="checkbox"/> geotechnical	location of erosion: <i>None visible</i> <input type="checkbox"/> outside meander bend <i>on R.B.</i> <input type="checkbox"/> inside meander bend <i>upstream</i> <input type="checkbox"/> opposite bar or obstruction <i>of bridge</i> <input type="checkbox"/> general type of erosion: <input type="checkbox"/> fluvial <input type="checkbox"/> geotechnical

SECTION 5 – DEBRIS CHARACTERISTICS

PART 8: EVIDENCE OF HIGH DEBRIS DELIVERY POTENTIAL

- Presence of debris at bridge (See Part 9)
- Presence of debris at upstream sites – *immediately upstream of bridge against L.B.*
- Documented need for debris removal at bridge (Contact: _____)
- Evidence of bank erosion

PART 9: DEBRIS TYPE / QUANTITY

- | | | | | |
|--|-----------|--|--|---------|
| <input type="checkbox"/> None | Percent | | <input type="checkbox"/> Fine detritus | Percent |
| <input type="checkbox"/> Small floating debris | | | <input type="checkbox"/> Coarse detritus | |
| <input checked="" type="checkbox"/> Medium floating debris | <u>25</u> | | <input type="checkbox"/> Boulders | |
| <input checked="" type="checkbox"/> Large floating debris | <u>75</u> | | | |

SECTION 6 - BRIDGE CHARACTERISTICS

PART 10: PIER MEASUREMENTS

Number of piers: 6

Width measurements:
 Left bank (or abutment) to pier: 0 *at water's edge*
 Right bank or abutment to pier: 0 *at water's edge*

Width between piers:

Piers	1 - 2	2 - 3	3 - 4	4 - 5	5 - 6
Width (ft)	<u>~115</u>	<u>~115</u>	<u>~115</u>	<u>~115</u>	<u>~115</u>

Height of low chord above stream bed:

PART 11: PIER CHARACTERISTICS

- Single, solid piers
- Multiple, closely spaced pier or pile groups
- Exposed pier footing piles
- Multiple piles, or row of pier columns skewed to approaching flow *poorly aligned w/ flow*

PART 12: PIER LOCATION

- Sheltered location (Piers 6 *at water's edge*)
- Bank/floodplain (Piers _____)
- In the channel (Piers 1, 2, 3, 4, 5)
- In the path of debris flow (Piers 2, 3)

Site 3

* bridge severely skewed to approaching flow

STREAM RECONNAISSANCE For Debris Accumulation at Bridges

SECTION 1 - SITE DESCRIPTION

ROAD NAME/NUMBER

SR 2013

DATE

5/21/08

BRIDGE NUMBER

60-2013-100-0000

STREAM NAME

East Sandy Creek

GPS COORDINATES

SECTION 2 - REGION AND VALLEY DESCRIPTION

PART 1: WATERSHED

Land Use

- Natural
- Agricultural
- Urban
- Suburban
- Rural
- Industrial
- Cattle grazing

Vegetation

- None
- Grass
- Pasture
- Crops
- Shrubs
- Deciduous Forest/trees
- Coniferous Forest/trees

PART 2: RIVER VALLEY CONDITION

Valley Side Failures

- None
- Occasional
- Frequent

Failure Locations

- None
- Away from river
- Along river

PART 3: FLOODPLAIN

Floodplain Width

- None
- <1 river width
- 1-5 river widths
- 5-10 river widths
- >10 river widths

Land Use

- Natural
- Agricultural
- Urban
- Suburban
- Rural
- Industrial
- Mining
- Cattle grazing

Vegetation

- None
- Grass
- Pasture
- Orchards
- Crops
- Shrubs
- Deciduous Forest/trees
- Coniferous Forest/trees

Riparian Buffer Strip

- None
- <1 river width
- 1-5 river widths
- >5 river widths

- 1) upstream face of bridge, from left bank, upstream
- 2) upstream, from L.B. under bridge
- 3) downstream, from bridge deck
- 4) downstream face of bridge, from right bank, downstream
(note mid-channel bar formation behind pier)
- 5) large timber (45 ft) against L.B.

PART 4: VERTICAL CONFINEMENT

Terraces

- None
- Left bank
- Right bank

Levees

- None
- Natural
- Constructed

Levee Location

- Along channel bank
- Set back <1 river width
- Set back >1 river width

PART 5: LATERAL RELATION OF CHANNEL TO VALLEY

Planform

- Straight
- Meandering
- Braided
- Anastomosed
- Engineered

Meander Characteristics

- Mild bends
- Moderate bends
- Tight bends

SECTION 3 - CHANNEL DESCRIPTION

PART 6: CHANNEL DESCRIPTION (select all that apply)

Bed Controls

- None
- Occasional
- Frequent
- Confined

Control Types

- None
- Bedrock
- Boulders
- Gravel armor
- Bridge protection
- Grade control
- Debris
- Dams (beaver, engineered)

Width Controls

- None
- Occasional
- Frequent
- Confined

Control Types

- None
- Bedrock
- Boulders
- Gravel armor
- Bridge protection
- Bridge abutments
- Bank stabilization
- Debris

Other

- Debris
- Mining
- Reservoir
- Knickpoint

M-B classification

- Cascade or step-pool
- Plane, pool-riffle, dune-ripple
- Braided

Corps classification (other)

- Modified (engineered)
- Regulated
- Arroyo

Flow Habit

- Perennial
- Flashy perennial
- Intermittent
- Ephemeral

Channel width = 125 ft at bridge
45 ft wide upstream

PART 7: BED SEDIMENT DESCRIPTION (select all that apply)

Bed Material

- Clay
- Silt
- Sand
- Gravel
- Cobbles
- Boulders

Bar Types

- None
- Alternate bars
- Point bars
- Mid-channel bars
- Diagonal bars
- Irregular/combination

Bar Material

- Silt
- Sand
- Gravel
- Cobbles

Bar Vegetation

- None
- Grasses
- Reeds/shrubs
- Trees

Bar Width

- None
- Narrow
- Moderate
- Wide

SECTION 4 - BANK SURVEY (select all that apply)

Bank Characteristic	Left Bank	Right Bank
Bank material	<input type="checkbox"/> clay <input type="checkbox"/> silt <input checked="" type="checkbox"/> sand - at bridge <input checked="" type="checkbox"/> gravel <input checked="" type="checkbox"/> cobbles } upstream of bridge <input type="checkbox"/> boulders <input type="checkbox"/> bedrock	<input type="checkbox"/> clay <input type="checkbox"/> silt <input checked="" type="checkbox"/> sand <input checked="" type="checkbox"/> gravel <input checked="" type="checkbox"/> cobbles <input checked="" type="checkbox"/> boulders <input type="checkbox"/> bedrock
Layer material	<input checked="" type="checkbox"/> no layers <input type="checkbox"/> cohesive <input type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders	<input checked="" type="checkbox"/> no layers <input type="checkbox"/> cohesive <input type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders
Bank height	1-2 ft	5 ft
Bank slope	<input type="checkbox"/> steep <input checked="" type="checkbox"/> moderate <input checked="" type="checkbox"/> shallow	<input checked="" type="checkbox"/> steep <input type="checkbox"/> moderate <input type="checkbox"/> shallow
Bank vegetation	<input type="checkbox"/> none <input checked="" type="checkbox"/> grasses/annuals <input checked="" type="checkbox"/> reeds/shrubs <input checked="" type="checkbox"/> trees falling trees? <input type="checkbox"/> yes <input checked="" type="checkbox"/> no tree density: <input checked="" type="checkbox"/> sparse <input type="checkbox"/> dense tree health: <input checked="" type="checkbox"/> good <input type="checkbox"/> poor tree ages: <input type="checkbox"/> young <input checked="" type="checkbox"/> mature <input type="checkbox"/> old tree diversity? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no	<input type="checkbox"/> none <input checked="" type="checkbox"/> grasses/annuals <input checked="" type="checkbox"/> reeds/shrubs <input checked="" type="checkbox"/> trees falling trees? <input type="checkbox"/> yes <input checked="" type="checkbox"/> no tree density: <input type="checkbox"/> sparse <input checked="" type="checkbox"/> dense tree health: <input checked="" type="checkbox"/> good <input type="checkbox"/> poor tree ages: <input type="checkbox"/> young <input checked="" type="checkbox"/> mature <input type="checkbox"/> old tree diversity? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no
Bank erosion and failure location	location of erosion: <input checked="" type="checkbox"/> outside meander bend <input type="checkbox"/> inside meander bend <input type="checkbox"/> opposite bar or obstruction <input type="checkbox"/> general type of erosion: <input checked="" type="checkbox"/> fluvial <input type="checkbox"/> geotechnical	location of erosion: <input checked="" type="checkbox"/> outside meander bend <input type="checkbox"/> inside meander bend <input type="checkbox"/> opposite bar or obstruction <input type="checkbox"/> general type of erosion: <input checked="" type="checkbox"/> fluvial <input type="checkbox"/> geotechnical

SECTION 5 - DEBRIS CHARACTERISTICS

PART 8: EVIDENCE OF HIGH DEBRIS DELIVERY POTENTIAL

- Presence of debris at bridge (See Part 9) - *none presently*
- Presence of debris at upstream sites
- Documented need for debris removal at bridge (Contact: _____)
- Evidence of bank erosion

PART 9: DEBRIS TYPE / QUANTITY

- | | | | |
|---|---------|--|---------|
| <input checked="" type="checkbox"/> None | Percent | | Percent |
| <input type="checkbox"/> Small floating debris | _____ | <input type="checkbox"/> Fine detritus | _____ |
| <input type="checkbox"/> Medium floating debris | _____ | <input type="checkbox"/> Coarse detritus | _____ |
| <input type="checkbox"/> Large floating debris | _____ | <input type="checkbox"/> Boulders | _____ |

SECTION 6 - BRIDGE CHARACTERISTICS

PART 10: PIER MEASUREMENTS

Number of piers: 1

Width measurements:

Left bank or abutment to pier: 59 ft

Right bank or abutment to pier: 47 ft

Bridge skewed to flow - decreases effective opening under bridge

(12 ft from bank to abutment)

Width between piers:

Piers	1 - 2	2 - 3	3 - 4	4 - 5	5 - 6
Width (ft)					

Height of low chord above stream bed: 19 ft

PART 11: PIER CHARACTERISTICS

- Single, solid piers - *skewed to flow - see pictures*
- Multiple, closely spaced pier or pile groups
- Exposed pier footing piles
- Multiple piles, or row of pier columns skewed to approaching flow

PART 12: PIER LOCATION

- Sheltered location (Piers _____)
- In the channel (Piers 1)
- Bank/floodplain (Piers _____)
- In the path of debris flow (Piers 1)

**STREAM RECONNAISSANCE
For Debris Accumulation at Bridges**

SECTION 1 - SITE DESCRIPTION

ROAD NAME/NUMBER DATE 9/20/2007
 SR 3012, Coalport, Clearfield Co .
 BRIDGE NUMBER STREAM NAME
 Clearfield Creek
 GPS COORDINATES

SECTION 2 - REGION AND VALLEY DESCRIPTION

PART 1: WATERSHED

- | Land Use | Vegetation |
|---|--|
| <input type="checkbox"/> Natural | <input type="checkbox"/> None |
| <input type="checkbox"/> Agricultural | <input type="checkbox"/> Grass |
| <input type="checkbox"/> Urban | <input type="checkbox"/> Pasture |
| <input type="checkbox"/> Suburban | <input type="checkbox"/> Crops |
| <input type="checkbox"/> Rural | <input type="checkbox"/> Shrubs |
| <input type="checkbox"/> Industrial | <input type="checkbox"/> Deciduous Forest/trees |
| <input type="checkbox"/> Cattle grazing | <input type="checkbox"/> Coniferous Forest/trees |

PART 2: RIVER VALLEY CONDITION

- | Valley Side Failures | Failure Locations |
|-------------------------------------|--|
| <input type="checkbox"/> None | <input type="checkbox"/> None |
| <input type="checkbox"/> Occasional | <input type="checkbox"/> Away from river |
| <input type="checkbox"/> Frequent | <input type="checkbox"/> Along river |

PART 3: FLOODPLAIN

- | Floodplain Width | Land Use | Vegetation | Riparian Buffer Strip |
|--|--|--|--|
| <input type="checkbox"/> None | <input type="checkbox"/> Natural | <input type="checkbox"/> None | <input type="checkbox"/> None |
| <input type="checkbox"/> <1 river width | <input type="checkbox"/> Agricultural | <input checked="" type="checkbox"/> Grass | <input type="checkbox"/> <1 river width |
| <input type="checkbox"/> 1-5 river widths | <input type="checkbox"/> Urban | <input type="checkbox"/> Pasture | <input checked="" type="checkbox"/> 1-5 river widths |
| <input type="checkbox"/> 5-10 river widths | <input checked="" type="checkbox"/> Suburban | <input type="checkbox"/> Orchards | <input type="checkbox"/> >5 river widths |
| <input checked="" type="checkbox"/> >10 river widths | <input type="checkbox"/> Rural | <input type="checkbox"/> Crops | |
| | <input type="checkbox"/> Industrial | <input checked="" type="checkbox"/> Shrubs | |
| | <input type="checkbox"/> Mining | <input checked="" type="checkbox"/> Deciduous Forest/trees | |
| | <input type="checkbox"/> Cattle grazing | <input type="checkbox"/> Coniferous Forest/trees | |

- 1) facing upstream
- 2) upstream nose from bridge deck

PART 4: VERTICAL CONFINEMENT

Terraces

- None
- Left bank
- Right bank

Levees

- None
- Natural
- Constructed

Levee Location

- Along channel bank
- Set back <1 river width
- Set back >1 river width

PART 5: LATERAL RELATION OF CHANNEL TO VALLEY

Planform

- Straight
- Meandering
- Braided
- Anastomosed
- Engineered

Meander Characteristics

- Mild bends
- Moderate bends
- Tight bends

SECTION 3 - CHANNEL DESCRIPTION

PART 6: CHANNEL DESCRIPTION (select all that apply)

Bed Controls

- None
- Occasional
- Frequent
- Confined

Control Types

- None
- Bedrock
- Boulders
- Gravel armor
- Bridge protection
- Grade control
- Debris
- Dams (beaver, engineered)

Width Controls

- None
- Occasional
- Frequent
- Confined

at bridge only

Control Types

- None
- Bedrock
- Boulders
- Gravel armor
- Bridge protection
- Bridge abutments
- Bank stabilization
- Debris

Other

- Debris
- Mining
- Reservoir
- Knickpoint

M-B classification

- Cascade or step-pool
- Plane, pool-riffle, dune-ripple
- Braided

Corps classification (other)

- Modified (engineered)
- Regulated
- Arroyo

Flow Habit

- Perennial
- Flashy perennial
- Intermittent
- Ephemeral

Channel width = 80 ft under bridge, 40 ft upstream/downstream of bridge

PART 7: BED SEDIMENT DESCRIPTION (select all that apply)

Bed Material

- Clay
- Silt
- Sand
- Gravel
- Cobbles
- Boulders

Bar Types

- None
- Alternate bars
- Point bars
- Mid-channel bars
- Diagonal bars
- Irregular/combination

Bar Material

- Silt
- Sand
- Gravel
- Cobbles

Bar Vegetation

- None
- Grasses
- Reeds/shrubs
- Trees

Bar Width

- None
- Narrow
- Moderate
- Wide

artificial, caused by dredging under bridge

SECTION 4 - BANK SURVEY (select all that apply)

Bank Characteristic	Left Bank	Right Bank
Bank material	<input type="checkbox"/> clay <input checked="" type="checkbox"/> silt <input checked="" type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders <input type="checkbox"/> bedrock	<input type="checkbox"/> clay <input checked="" type="checkbox"/> silt <input checked="" type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders <input type="checkbox"/> bedrock
Layer material	<input checked="" type="checkbox"/> no layers <input type="checkbox"/> cohesive <input type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders	<input checked="" type="checkbox"/> no layers <input type="checkbox"/> cohesive <input type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders
Bank height	6 ft	6 ft
Bank slope	<input checked="" type="checkbox"/> steep <input type="checkbox"/> moderate <input type="checkbox"/> shallow 45°	<input checked="" type="checkbox"/> steep <input type="checkbox"/> moderate <input type="checkbox"/> shallow 45
Bank vegetation	<input type="checkbox"/> none <input checked="" type="checkbox"/> grasses/annuals <input checked="" type="checkbox"/> reeds/shrubs <input checked="" type="checkbox"/> trees falling trees? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no tree density: <input type="checkbox"/> sparse <input checked="" type="checkbox"/> dense tree health: <input checked="" type="checkbox"/> good <input type="checkbox"/> poor tree ages: <input type="checkbox"/> young <input checked="" type="checkbox"/> mature <input type="checkbox"/> old tree diversity? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no	<input type="checkbox"/> none <input checked="" type="checkbox"/> grasses/annuals <input checked="" type="checkbox"/> reeds/shrubs <input checked="" type="checkbox"/> trees falling trees? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no tree density: <input type="checkbox"/> sparse <input checked="" type="checkbox"/> dense tree health: <input checked="" type="checkbox"/> good <input type="checkbox"/> poor tree ages: <input type="checkbox"/> young <input checked="" type="checkbox"/> mature <input type="checkbox"/> old tree diversity? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no
Bank erosion and failure location	location of erosion: <input type="checkbox"/> outside meander bend <input type="checkbox"/> inside meander bend <input type="checkbox"/> opposite bar or obstruction <input type="checkbox"/> general type of erosion: <input type="checkbox"/> fluvial <input type="checkbox"/> geotechnical	location of erosion: <input type="checkbox"/> outside meander bend <input type="checkbox"/> inside meander bend <input type="checkbox"/> opposite bar or obstruction <input type="checkbox"/> general type of erosion: <input type="checkbox"/> fluvial <input type="checkbox"/> geotechnical

SECTION 5 – DEBRIS CHARACTERISTICS

PART 8: EVIDENCE OF HIGH DEBRIS DELIVERY POTENTIAL

- Presence of debris at bridge (See Part 9)
- Presence of debris at upstream sites
- Documented need for debris removal at bridge (Contact: _____)
- Evidence of bank erosion

PART 9: DEBRIS TYPE / QUANTITY

- | | | | | |
|--|---------|-------|--|-------|
| <input type="checkbox"/> None | Percent | _____ | Percent | _____ |
| <input checked="" type="checkbox"/> Small floating debris | | _____ | <input type="checkbox"/> Fine detritus | _____ |
| <input checked="" type="checkbox"/> Medium floating debris | | _____ | <input type="checkbox"/> Coarse detritus | _____ |
| <input checked="" type="checkbox"/> Large floating debris | | _____ | <input type="checkbox"/> Boulders | _____ |

SECTION 6 - BRIDGE CHARACTERISTICS

PART 10: PIER MEASUREMENTS

Number of piers: 1 R. Bank → abutment : 8 ft
 L. Bank → abutment : 8 ft

Width measurements:
 Left bank or abutment to pier: 35 Right bank or abutment to pier: 35

Width between piers:

Piers	1 - 2	2 - 3	3 - 4	4 - 5	5 - 6
Width (ft)					

Height of low chord above stream bed: 15 ft

PART 11: PIER CHARACTERISTICS

- Single, solid piers Semicircular pier nose
- Multiple, closely spaced pier or pile groups
- Exposed pier footing piles
- Multiple piles, or row of pier columns skewed to approaching flow

PART 12: PIER LOCATION

- Sheltered location
- In the channel
- In the path of debris flow

**STREAM RECONNAISSANCE
For Debris Accumulation at Bridges**

SECTION 1 - SITE DESCRIPTION

ROAD NAME/NUMBER *SR 3019*
Mill Street + Water Street

DATE *9/20/2007*

BRIDGE NUMBER

STREAM NAME
Clearfield Creek

GPS COORDINATES

SECTION 2 - REGION AND VALLEY DESCRIPTION

PART 1: WATERSHED

Land Use

- Natural
- Agricultural
- Urban
- Suburban
- Rural
- Industrial
- Cattle grazing

Vegetation

- None
- Grass
- Pasture
- Crops
- Shrubs
- Deciduous Forest/trees
- Coniferous Forest/trees

PART 2: RIVER VALLEY CONDITION

Valley Side Failures

- None
- Occasional
- Frequent

Failure Locations

- None
- Away from river
- Along river

PART 3: FLOODPLAIN

Floodplain Width

- None
- <1 river width
- 1-5 river widths
- 5-10 river widths
- >10 river widths

Land Use

- Natural
- Agricultural
- Urban
- Suburban
- Rural
- Industrial
- Mining
- Cattle grazing

Vegetation

- None
- Grass
- Pasture
- Orchards
- Crops
- Shrubs
- Deciduous Forest/trees
- Coniferous Forest/trees

Riparian Buffer Strip

- None
- <1 river width
- 1-5 river widths
- >5 river widths

1. Upstream face of bridge
2. Upstream from bridge
3. Looking down at upstream face of bridge from bridge deck
4. Downstream from bridge deck
5. downstream from upstream of bridge
6. old abutment upstream of bridge on left bank
7. upstream from old abutment
8. bank debris upstream of bridge
9. upstream from 400 meters up from bridge

Add relation between stream width at bridge and upstream sections

PART 4: VERTICAL CONFINEMENT

Terraces

- None
- Left bank
- Right bank

Levees

- None
- Natural
- Constructed

Levee Location

- Along channel bank
- Set back <1 river width
- Set back >1 river width

PART 5: LATERAL RELATION OF CHANNEL TO VALLEY

Planform

- Straight
- Meandering
- Braided
- Anastomosed
- Engineered

Meander Characteristics

- Mild bends
- Moderate bends
- Tight bends

SECTION 3 - CHANNEL DESCRIPTION

PART 6: CHANNEL DESCRIPTION (select all that apply)

Bed Controls

- None
- Occasional
- Frequent
- Confined

Control Types

- None
- Bedrock
- Boulders
- Gravel armor
- Bridge protection
- Grade control
- Debris
- Dams (beaver, engineered)

Width Controls

- None
- Occasional
- Frequent
- Confined

Control Types

- None
- Bedrock
- Boulders
- Gravel armor
- Bridge protection
- Bridge abutments
- Bank stabilization
- Debris

Other

- Debris
- Mining
- Reservoir
- Knickpoint

M-B classification

- Cascade or step-pool
- Plane, pool-riffle, dune-ripple
- Braided

Corps classification (other)

- Modified (engineered)
- Regulated
- Arroyo

Flow Habit

- Perennial
- Flashy perennial
- Intermittent
- Ephemeral

Channel width = _____

PART 7: BED SEDIMENT DESCRIPTION (select all that apply)

Bed Material

- Clay
- Silt
- Sand
- Gravel
- Cobbles
- Boulders

Bar Types

- None
- Alternate bars
- Point bars
- Mid-channel bars
- Diagonal bars
- Irregular/combination

Bar Material

- Silt
- Sand
- Gravel
- Cobbles

Bar Vegetation

- None
- Grasses
- Reeds/shrubs
- Trees

Bar Width

- None
- Narrow
- Moderate
- Wide

SECTION 4 - BANK SURVEY (select all that apply)

Bank Characteristic	Left Bank	Right Bank
Bank material	<input type="checkbox"/> clay <input checked="" type="checkbox"/> silt <input checked="" type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders <input type="checkbox"/> bedrock	<input type="checkbox"/> clay <input checked="" type="checkbox"/> silt <input checked="" type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders <input type="checkbox"/> bedrock
Layer material	<input checked="" type="checkbox"/> no layers <input type="checkbox"/> cohesive <input type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders	<input checked="" type="checkbox"/> no layers <input type="checkbox"/> cohesive <input type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders
Bank height	3 ft	3 ft
Bank slope	<input checked="" type="checkbox"/> steep <input type="checkbox"/> moderate <input type="checkbox"/> shallow	<input checked="" type="checkbox"/> steep <input type="checkbox"/> moderate <input type="checkbox"/> shallow
Bank vegetation	<input type="checkbox"/> none <input checked="" type="checkbox"/> grasses/annuals <input checked="" type="checkbox"/> reeds/shrubs <input checked="" type="checkbox"/> trees falling trees? <input type="checkbox"/> yes <input checked="" type="checkbox"/> no tree density: <input type="checkbox"/> sparse <input checked="" type="checkbox"/> dense tree health: <input checked="" type="checkbox"/> good <input type="checkbox"/> poor tree ages: <input type="checkbox"/> young <input checked="" type="checkbox"/> mature <input type="checkbox"/> old tree diversity? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no	<input type="checkbox"/> none <input checked="" type="checkbox"/> grasses/annuals <input checked="" type="checkbox"/> reeds/shrubs <input checked="" type="checkbox"/> trees falling trees? <input type="checkbox"/> yes <input checked="" type="checkbox"/> no tree density: <input type="checkbox"/> sparse <input checked="" type="checkbox"/> dense tree health: <input checked="" type="checkbox"/> good <input type="checkbox"/> poor tree ages: <input type="checkbox"/> young <input checked="" type="checkbox"/> mature <input type="checkbox"/> old tree diversity? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no
Healthy Bank erosion and failure location	location of erosion: <input type="checkbox"/> outside meander bend <input type="checkbox"/> inside meander bend <input type="checkbox"/> opposite bar or obstruction <input type="checkbox"/> general type of erosion: <input type="checkbox"/> fluvial <input type="checkbox"/> geotechnical	location of erosion: <input type="checkbox"/> outside meander bend <input type="checkbox"/> inside meander bend <input type="checkbox"/> opposite bar or obstruction <input type="checkbox"/> general type of erosion: <input type="checkbox"/> fluvial <input type="checkbox"/> geotechnical

SECTION 5 - DEBRIS CHARACTERISTICS

PART 8: EVIDENCE OF HIGH DEBRIS DELIVERY POTENTIAL

- Presence of debris at bridge (See Part 9)
- Presence of debris at upstream sites - *look at photos*
- Documented need for debris removal at bridge (Contact: _____)
- Evidence of bank erosion *None*

PART 9: DEBRIS TYPE / QUANTITY

- | | | | |
|--|---------|--|---------|
| <input type="checkbox"/> None | Percent | | Percent |
| <input type="checkbox"/> Small floating debris | _____ | <input type="checkbox"/> Fine detritus | _____ |
| <input checked="" type="checkbox"/> Medium floating debris | _____ | <input type="checkbox"/> Coarse detritus | _____ |
| <input checked="" type="checkbox"/> Large floating debris | _____ | <input checked="" type="checkbox"/> Boulders | _____ |

debris not centered on pier, suggests debris jam resulted from shallow water, not purely b/c of pier location

SECTION 6 - BRIDGE CHARACTERISTICS

PART 10: PIER MEASUREMENTS

Number of piers: 1 *left bank → abutment: 9*
right bank → abutment: 9

Width measurements:
 Left bank or abutment to pier 40 Right bank or abutment to pier 40

Width between piers:

Piers	1 - 2	2 - 3	3 - 4	4 - 5	5 - 6
Width (ft)					

Height of low chord above stream bed: 16 ft

PART 11: PIER CHARACTERISTICS

- Single, solid piers
- Multiple, closely spaced pier or pile groups
- Exposed pier footing piles
- Multiple piles, or row of pier columns skewed to approaching flow

Semicircular pier nose

PART 12: PIER LOCATION

- Sheltered location
- In the channel
- Bank/floodplain
- In the path of debris flow

* Stream is widened 3x at bridge from upstream reach. Stream @ bridge is very shallow relative to upstream and downstream reaches

**STREAM RECONNAISSANCE
For Debris Accumulation at Bridges**

SECTION 1 - SITE DESCRIPTION

ROAD NAME/NUMBER

SR 0103, Lewistown, Mifflin Co.

DATE

9/18/2007

BRIDGE NUMBER

STREAM NAME

Juniata River

GPS COORDINATES

SECTION 2 - REGION AND VALLEY DESCRIPTION

PART 1: WATERSHED

Land Use

- Natural
- Agricultural
- Urban
- Suburban
- Rural
- Industrial
- Cattle grazing

Vegetation

- None
- Grass
- Pasture
- Crops
- Shrubs
- Deciduous Forest/trees
- Coniferous Forest/trees

PART 2: RIVER VALLEY CONDITION

Valley Side Failures

- None
- Occasional
- Frequent

Failure Locations

- None
- Away from river
- Along river

PART 3: FLOODPLAIN

Floodplain Width

- None
- <1 river width
- 1-5 river widths
- 5-10 river widths
- >10 river widths

Land Use

- Natural
- Agricultural
- Urban
- Suburban
- Rural
- Industrial
- Mining
- Cattle grazing

Vegetation

- None
- Grass
- Pasture
- Orchards
- Crops
- Shrubs
- Deciduous Forest/trees
- Coniferous Forest/trees

Riparian Buffer Strip

- None
- <1 river width
- 1-5 river widths
- >5 river widths

Picture 1: Debris from left bank, upstream (Pier 3)

2: Same

3: Same

4: Upstream from left bank, under bridge

5: Debris from left bank, under bridge

PART 4: VERTICAL CONFINEMENT

Terraces

- None
- Left bank
- Right bank

Levees

- None
- Natural
- Constructed

Levee Location

- Along channel bank
- Set back <1 river width
- Set back >1 river width

PART 5: LATERAL RELATION OF CHANNEL TO VALLEY

Planform

- Straight
- Meandering
- Braided
- Anastomosed
- Engineered

Meander Characteristics

- Mild bends
- Moderate bends
- Tight bends

SECTION 3 - CHANNEL DESCRIPTION

PART 6: CHANNEL DESCRIPTION (select all that apply)

Bed Controls

- None
- Occasional
- Frequent
- Confined

Control Types

- None
- Bedrock
- Boulders
- Gravel armor
- Bridge protection
- Grade control
- Debris
- Dams (beaver, engineered)

Width Controls

- None
- Occasional
- Frequent
- Confined

Control Types

- None
- Bedrock
- Boulders
- Gravel armor
- Bridge protection
- Bridge abutments
- Bank stabilization
- Debris

Other

- Debris
- Mining
- Reservoir
- Knickpoint

M-B classification

- Cascade or step-pool
- Plane, pool-ripple, dune-ripple
- Braided

NA

Corps classification (other)

- Modified (engineered)
- Regulated
- Arroyo

NA

Flow Habit

- Perennial
- Flashy perennial
- Intermittent
- Ephemeral

Channel width = _____

(see photo)

PART 7: BED SEDIMENT DESCRIPTION (select all that apply)

Bed Material

- Clay
- Silt
- Sand
- Gravel
- Cobbles
- Boulders

Bar Types

- None
- Alternate bars
- Point bars
- Mid-channel bars
- Diagonal bars
- Irregular/combination

Bar Material

- Silt
- Sand
- Gravel
- Cobbles

Bar Vegetation

- None
- Grasses
- Reeds/shrubs
- Trees

Bar Width

- None
- Narrow
- Moderate
- Wide

SECTION 4 - BANK SURVEY (select all that apply)

Bank Characteristic	Left Bank	Right Bank
Bank material	<input checked="" type="checkbox"/> clay <input checked="" type="checkbox"/> silt <input type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders <input type="checkbox"/> bedrock	<input checked="" type="checkbox"/> clay <input checked="" type="checkbox"/> silt <input type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders <input type="checkbox"/> bedrock
Layer material	<input type="checkbox"/> no layers <input type="checkbox"/> cohesive <input type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders	<input type="checkbox"/> no layers <input type="checkbox"/> cohesive <input type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders
Bank height	~ 10 ft	~ 10 ft
Bank slope	<input type="checkbox"/> steep <input checked="" type="checkbox"/> moderate <input type="checkbox"/> shallow	<input type="checkbox"/> steep <input checked="" type="checkbox"/> moderate <input type="checkbox"/> shallow
Bank vegetation	<input type="checkbox"/> none <input checked="" type="checkbox"/> grasses/annuals <input checked="" type="checkbox"/> reeds/shrubs <input checked="" type="checkbox"/> trees falling trees? <input type="checkbox"/> yes <input checked="" type="checkbox"/> no tree density: <input type="checkbox"/> sparse <input checked="" type="checkbox"/> dense tree health: <input checked="" type="checkbox"/> good <input type="checkbox"/> poor tree ages: <input type="checkbox"/> young <input checked="" type="checkbox"/> mature <input type="checkbox"/> old tree diversity? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no	<input type="checkbox"/> none <input checked="" type="checkbox"/> grasses/annuals <input checked="" type="checkbox"/> reeds/shrubs <input checked="" type="checkbox"/> trees falling trees? <input type="checkbox"/> yes <input checked="" type="checkbox"/> no tree density: <input type="checkbox"/> sparse <input checked="" type="checkbox"/> dense tree health: <input checked="" type="checkbox"/> good <input type="checkbox"/> poor tree ages: <input type="checkbox"/> young <input checked="" type="checkbox"/> mature <input type="checkbox"/> old tree diversity? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no
None Bank erosion and failure location	location of erosion: <input type="checkbox"/> outside meander bend <input type="checkbox"/> inside meander bend <input type="checkbox"/> opposite bar or obstruction <input type="checkbox"/> general type of erosion: <input type="checkbox"/> fluvial <input type="checkbox"/> geotechnical	location of erosion: <input type="checkbox"/> outside meander bend <input type="checkbox"/> inside meander bend <input type="checkbox"/> opposite bar or obstruction <input type="checkbox"/> general type of erosion: <input type="checkbox"/> fluvial <input type="checkbox"/> geotechnical

SECTION 5 - DEBRIS CHARACTERISTICS

PART 8: EVIDENCE OF HIGH DEBRIS DELIVERY POTENTIAL

- Minor Presence of debris at bridge (See Part 9)
 Presence of debris at upstream sites (sliding scale)
 Documented need for debris removal at bridge (Contact: _____)
 Evidence of bank erosion

PART 9: DEBRIS TYPE / QUANTITY

- | | | | |
|--|-----------|--|---------|
| <input type="checkbox"/> None | Percent | | Percent |
| <input checked="" type="checkbox"/> Small floating debris | <u>30</u> | <input type="checkbox"/> Fine detritus | _____ |
| <input checked="" type="checkbox"/> Medium floating debris | <u>70</u> | <input type="checkbox"/> Coarse detritus | _____ |
| <input type="checkbox"/> Large floating debris | _____ | <input type="checkbox"/> Boulders | _____ |

None presently, but previously documented

SECTION 6 - BRIDGE CHARACTERISTICS

PART 10: PIER MEASUREMENTS

Number of piers: 4

Width measurements: #3
 Left bank or abutment to pier 50 Right bank or abutment to pier 50 #1

Width between piers:

Piers	1 - 2	2 - 3	3 - 4	4 - 5	5 - 6
Width (ft)					

Height of low chord above stream bed: 36 ft

PART 11: PIER CHARACTERISTICS

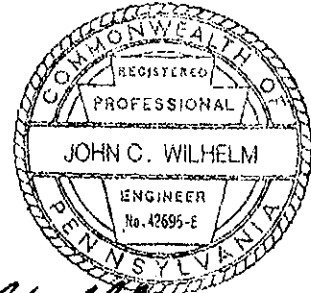
- Single, solid piers
 Multiple, closely spaced pier or pile groups
 Exposed pier footing piles
 Multiple piles, or row of pier columns skewed to approaching flow

PART 12: PIER LOCATION

- Sheltered location
 Bank/floodplain 4
 In the channel 1, 2, 3
 In the path of debris flow 3

 4

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION
DISTRICT 2-0
CLEARFIELD, PENNSYLVANIA



John C. Wilhelm 9-17-03
Registered Professional Engineer - Date

UNDERWATER BRIDGE INSPECTION

BMS NO. 44 0103 0556 0801



**S.R. 0103
OVER
JUNIATA RIVER
GRANVILLE TOWNSHIP
MIFFLIN COUNTY**

DATE OF INSPECTION : JULY 28, 2003

This structure safety inspection document is confidential pursuant to 65 P.S. §66.1 et seq., 75 Pa. C.S. §3754 and 23 U.S.C. §409 and may not be disclosed or used in litigation without written permission from the bridge owner.



PICKERING, CORTS & SUMMERSON, INC.
CONSULTING ENGINEERS & LAND SURVEYORS

828 B NEWTOWN - YARDLEY ROAD, NEWTOWN, PA 18940
1600 REED ROAD, SUITE 1, PENNINGTON, NJ 08534

215/968-9300 FAX 215/968-3849
609/737-2033 FAX 609/737-7306

ed 2/1

Date: 7/28/03

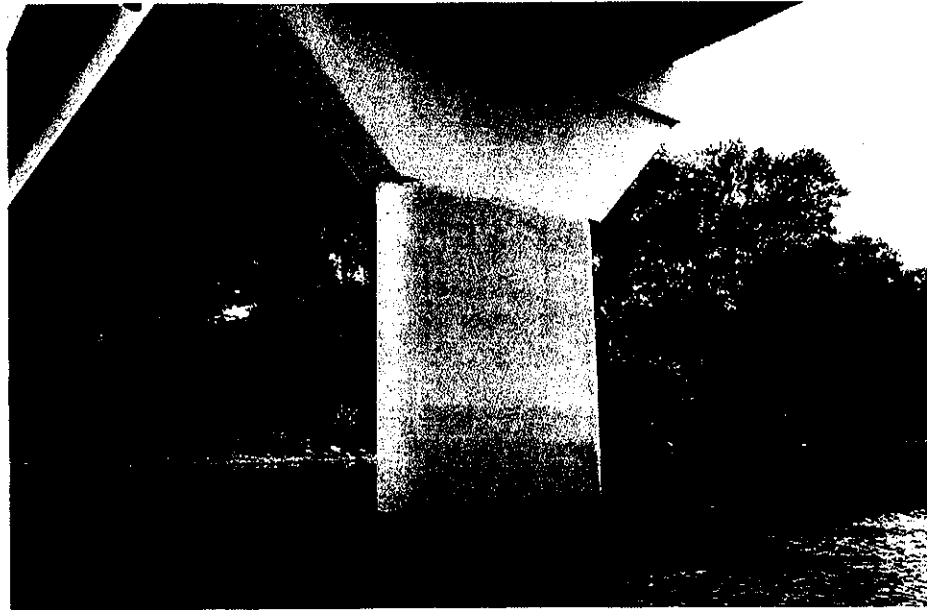


1. Right (downstream) elevation.



2. Left (upstream) elevation.

Date: 7/28/03



3. Pier 1, far face.



4. Pier 2, far face.

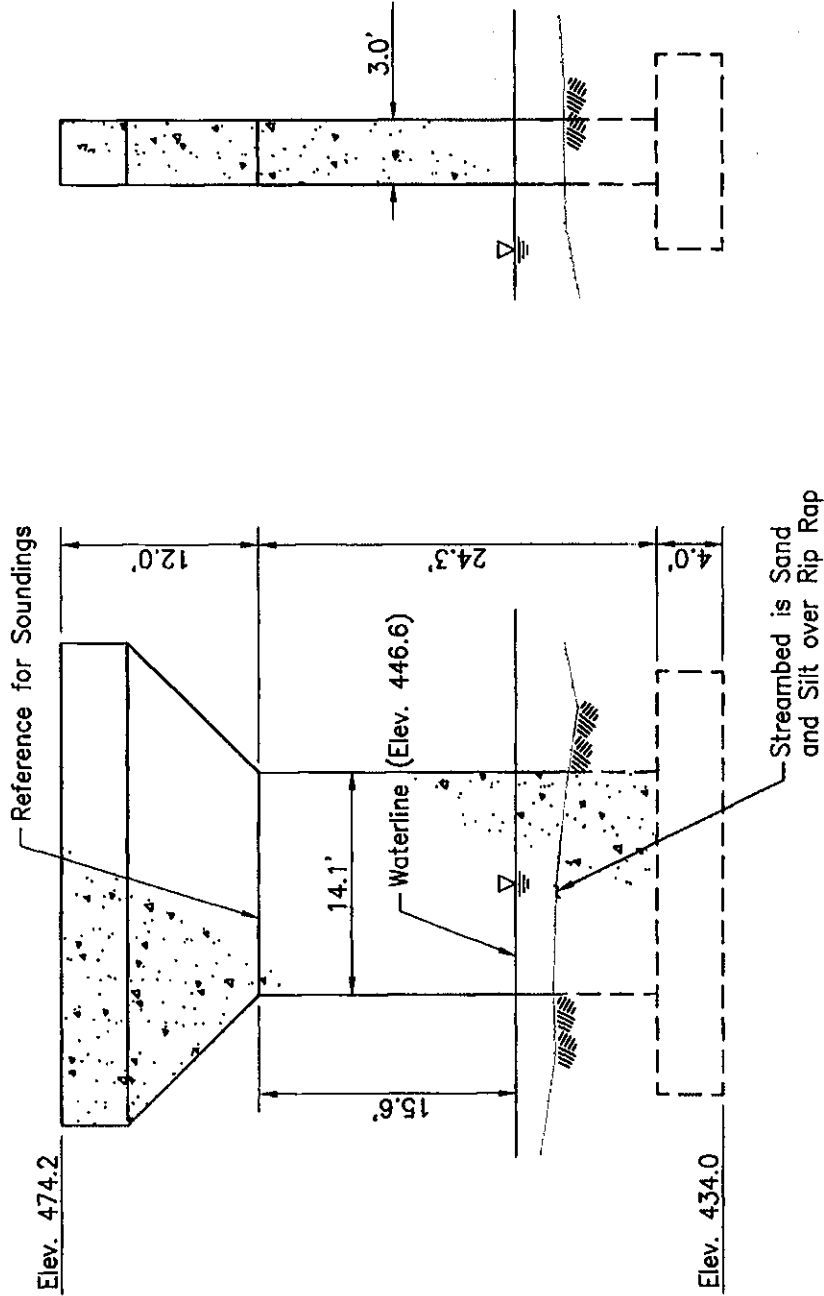
Date: 7/28/03



5. Pier 3, far face. Note the water gauge.



6. Pier 3, upstream nose. Note the large build-up of timber debris.



FAR FACE

LEFT NOSE

PIER 1

ELEVATION

SCALE: 3/32" = 1'-0"

NOTE:

1. All Dimensions are Plans and Field Measurements.

PENNDOT DISTRICT 2-0

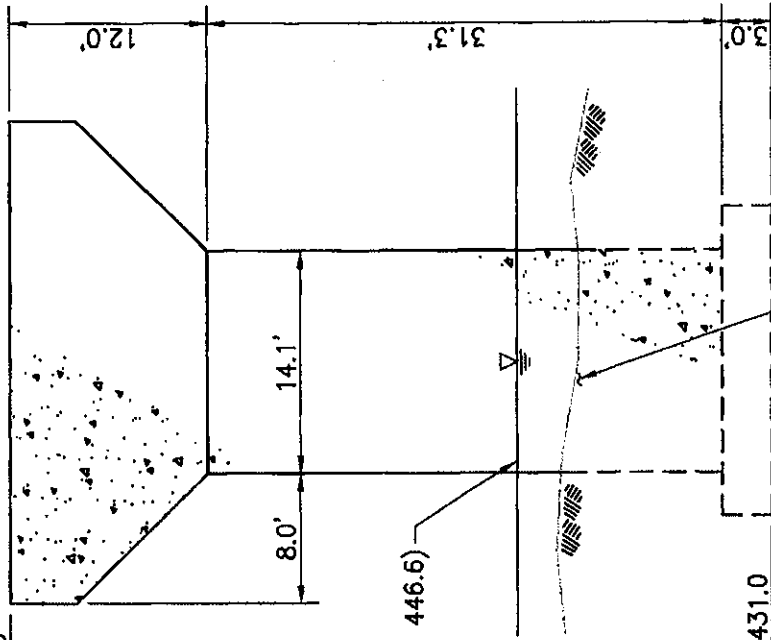
UNDERWATER BRIDGE INSPECTION

BMS NO.: 44 0103 0556 0801

PICKERING, CORTS &
SUMMERSON, INC.

DATE: 7-28-03

Elev. 477.3

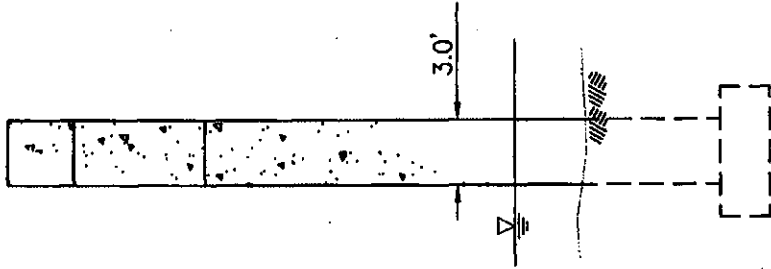


Waterline (Elev. 446.6)

Streambed is Sand
and Silt over Rip Rap

Elev. 431.0

FAR FACE



LEFT NOSE

NOTE:

1. All Dimensions are Plans and Field Measurements.

PIER 2

ELEVATION

SCALE: 3/32" = 1'-0

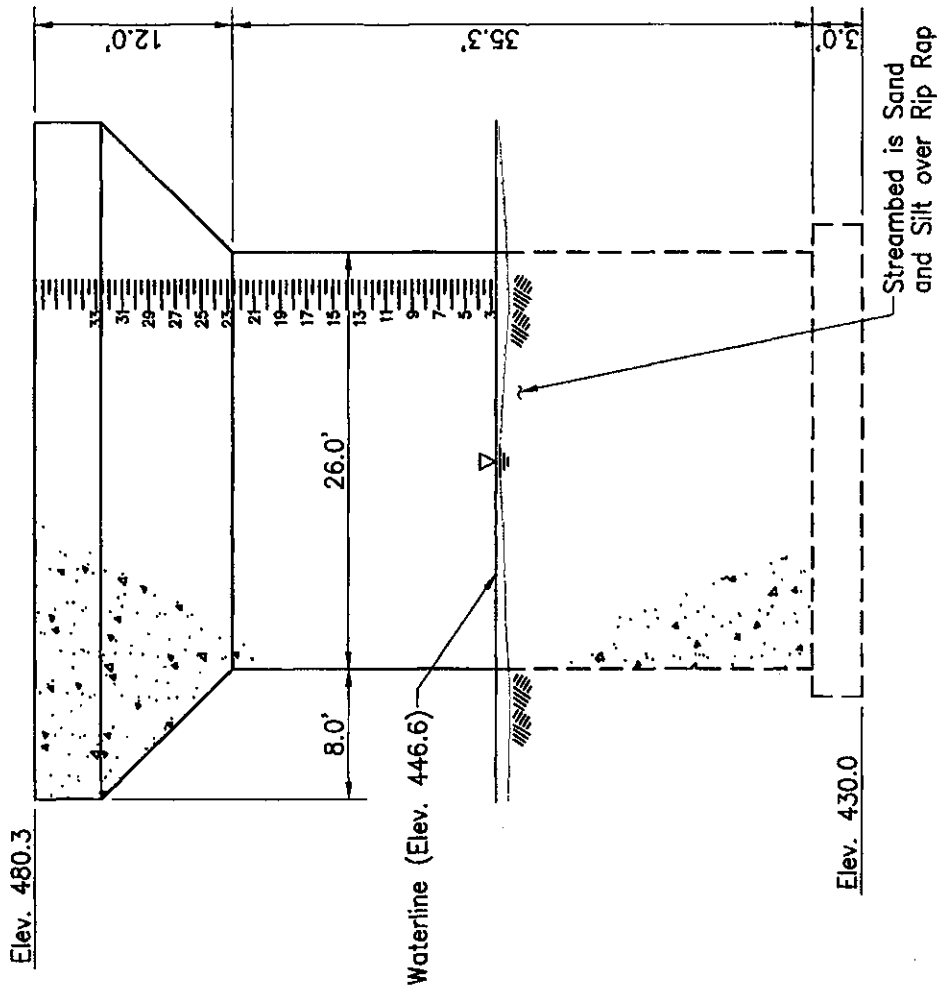
PENNDOT DISTRICT 2-0

UNDERWATER BRIDGE INSPECTION

BMS NO.: 44 0103 0556 0801

PICKERING, CORTIS &
SUMMERSON, INC.

DATE: 7-28-03



FAR FACE

LEFT NOSE

PIER 3
ELEVATION

NOTE:

1. All Dimensions are from Plans and Field Measurements.

PENNDOT DISTRICT 2-0
 UNDERWATER BRIDGE INSPECTION
 BMS NO.: 44 0103 0556 0801
 DATE: 7-28-03
 PICKERING, CORTIS &
 SUMMERSON, INC.

**STREAM RECONNAISSANCE
For Debris Accumulation at Bridges**

SECTION 1 - SITE DESCRIPTION

ROAD NAME/NUMBER

DATE

SR 0153, SEG 0630, OFFSET 0771

12/10/2007

BRIDGE NUMBER

STREAM NAME

GPS COORDINATES

SECTION 2 - REGION AND VALLEY DESCRIPTION

PART 1: WATERSHED

Land Use

- Natural
- Agricultural
- Urban
- Suburban
- Rural
- Industrial
- Cattle grazing

Vegetation

- None
- Grass
- Pasture
- Crops
- Shrubs
- Deciduous Forest/trees
- Coniferous Forest/trees

PART 2: RIVER VALLEY CONDITION

Valley Side Failures

- None
- Occasional
- Frequent

Failure Locations

- None
- Away from river
- Along river

PART 3: FLOODPLAIN

Floodplain Width

- None
- <1 river width
- 1-5 river widths
- 5-10 river widths
- >10 river widths

Land Use

- Natural
- Agricultural
- Urban
- Suburban
- Rural
- Industrial
- Mining
- Cattle grazing

Vegetation

- None
- Grass
- Pasture
- Orchards
- Crops
- Shrubs
- Deciduous Forest/trees
- Coniferous Forest/trees

Riparian Buffer Strip

- None
- <1 river width
- 1-5 river widths
- >5 river widths

20 ft - 100 ft

Pictures:

- 1) debris from under bridge, right bank
- 2) bridge from 150' downstream on right bank
- 3) upstream face of bridge, from right abutment
- 4) downstream face of bridge, from left abutment

PART 4: VERTICAL CONFINEMENT

Terraces

- None
- Left bank
- Right bank

Levees

- None
- Natural
- Constructed

Levee Location

- Along channel bank
- Set back <1 river width
- Set back >1 river width

PART 5: LATERAL RELATION OF CHANNEL TO VALLEY

Planform

- Straight
- Meandering
- Braided
- Anastomosed
- Engineered

Meander Characteristics

- Mild bends
- Moderate bends
- Tight bends

SECTION 3 - CHANNEL DESCRIPTION

PART 6: CHANNEL DESCRIPTION (select all that apply)

Bed Controls

- None
- Occasional
- Frequent
- Confined

Control Types

- None
- Bedrock
- Boulders
- Gravel armor
- Bridge protection
- Grade control
- Debris
- Dams (beaver, engineered)

Width Controls

- None
- Occasional
- Frequent
- Confined

Control Types

- None
- Bedrock
- Boulders
- Gravel armor
- Bridge protection
- Bridge abutments
- Bank stabilization
- Debris

Other

- Debris
- Mining
- Reservoir
- Knickpoint

M-B classification

- Cascade or step-pool
- Plane, pool-riffle, dune-ripple
- Braided

Corps classification (other)

- Modified (engineered)
- Regulated
- Arroyo

Flow Habit

- Perennial
- Flashy perennial
- Intermittent
- Ephemeral

Channel width = 85 ft at bridge, 45 ft upstream

PART 7: BED SEDIMENT DESCRIPTION (select all that apply)

Bed Material

- Clay
- Silt
- Sand
- Gravel *90%*
- Cobbles
- Boulders

Bar Types

- None
- Alternate bars
- Point bars
- Mid-channel bars
- Diagonal bars
- Irregular/combination

Bar Material

- Silt
- Sand
- Gravel *90%*
- Cobbles

Bar Vegetation

- None
- Grasses
- Reeds/shrubs
- Trees

Bar Width

- None
- Narrow
- Moderate *50% of width*
- Wide

SECTION 4 - BANK SURVEY (select all that apply)

Bank Characteristic	Left Bank	Right Bank
Bank material	<input type="checkbox"/> clay <input checked="" type="checkbox"/> silt <input checked="" type="checkbox"/> sand <input checked="" type="checkbox"/> gravel <input checked="" type="checkbox"/> cobbles <input type="checkbox"/> boulders <input type="checkbox"/> bedrock	<input type="checkbox"/> clay <input checked="" type="checkbox"/> silt <input checked="" type="checkbox"/> sand <input checked="" type="checkbox"/> gravel <input checked="" type="checkbox"/> cobbles <input type="checkbox"/> boulders <input type="checkbox"/> bedrock
Layer material	<input checked="" type="checkbox"/> no layers <input type="checkbox"/> cohesive <input type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders	<input checked="" type="checkbox"/> no layers <input type="checkbox"/> cohesive <input type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders
Bank height	2 ft	2 ft
Bank slope	<input checked="" type="checkbox"/> steep <input type="checkbox"/> moderate <input type="checkbox"/> shallow	<input checked="" type="checkbox"/> steep <input type="checkbox"/> moderate <input type="checkbox"/> shallow
Bank vegetation	<input type="checkbox"/> none <input checked="" type="checkbox"/> grasses/annuals <input checked="" type="checkbox"/> reeds/shrubs <input checked="" type="checkbox"/> trees falling trees? <input type="checkbox"/> yes <input checked="" type="checkbox"/> no tree density: <input checked="" type="checkbox"/> sparse <input type="checkbox"/> dense tree health: <input checked="" type="checkbox"/> good <input type="checkbox"/> poor tree ages: <input checked="" type="checkbox"/> young <input type="checkbox"/> mature <input type="checkbox"/> old tree diversity? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no	<input type="checkbox"/> none <input checked="" type="checkbox"/> grasses/annuals <input checked="" type="checkbox"/> reeds/shrubs <input checked="" type="checkbox"/> trees falling trees? <input type="checkbox"/> yes <input checked="" type="checkbox"/> no tree density: <input checked="" type="checkbox"/> sparse <input type="checkbox"/> dense tree health: <input checked="" type="checkbox"/> good <input type="checkbox"/> poor tree ages: <input checked="" type="checkbox"/> young <input type="checkbox"/> mature <input type="checkbox"/> old tree diversity? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no
Bank erosion and failure location	None location of erosion: <input type="checkbox"/> outside meander bend <input type="checkbox"/> inside meander bend <input type="checkbox"/> opposite bar or obstruction <input type="checkbox"/> general type of erosion: <input type="checkbox"/> fluvial <input type="checkbox"/> geotechnical	location of erosion: <input type="checkbox"/> outside meander bend <input type="checkbox"/> inside meander bend <input type="checkbox"/> opposite bar or obstruction <input type="checkbox"/> general type of erosion: <input type="checkbox"/> fluvial <input type="checkbox"/> geotechnical

SECTION 5 – DEBRIS CHARACTERISTICS

PART 8: EVIDENCE OF HIGH DEBRIS DELIVERY POTENTIAL

- Presence of debris at bridge (See Part 9)
- Presence of debris at upstream sites
- Documented need for debris removal at bridge (Contact: Mark Bush)
- Evidence of bank erosion

PART 9: DEBRIS TYPE / QUANTITY

- | | | | | |
|--|------------|--|--|---------|
| <input type="checkbox"/> None | Percent | | <input type="checkbox"/> Fine detritus | Percent |
| <input type="checkbox"/> Small floating debris | | | <input type="checkbox"/> Coarse detritus | |
| <input checked="" type="checkbox"/> Medium floating debris | <u>50%</u> | | <input type="checkbox"/> Boulders | |
| <input checked="" type="checkbox"/> Large floating debris | <u>50%</u> | | | |

SECTION 6 - BRIDGE CHARACTERISTICS

PART 10: PIER MEASUREMENTS

Number of piers: 1

Width measurements:

Left bank or abutment to pier: 40 ft Right bank or abutment to pier: 40 ft

Width between piers:

Piers	1 - 2	2 - 3	3 - 4	4 - 5	5 - 6
Width (ft)					

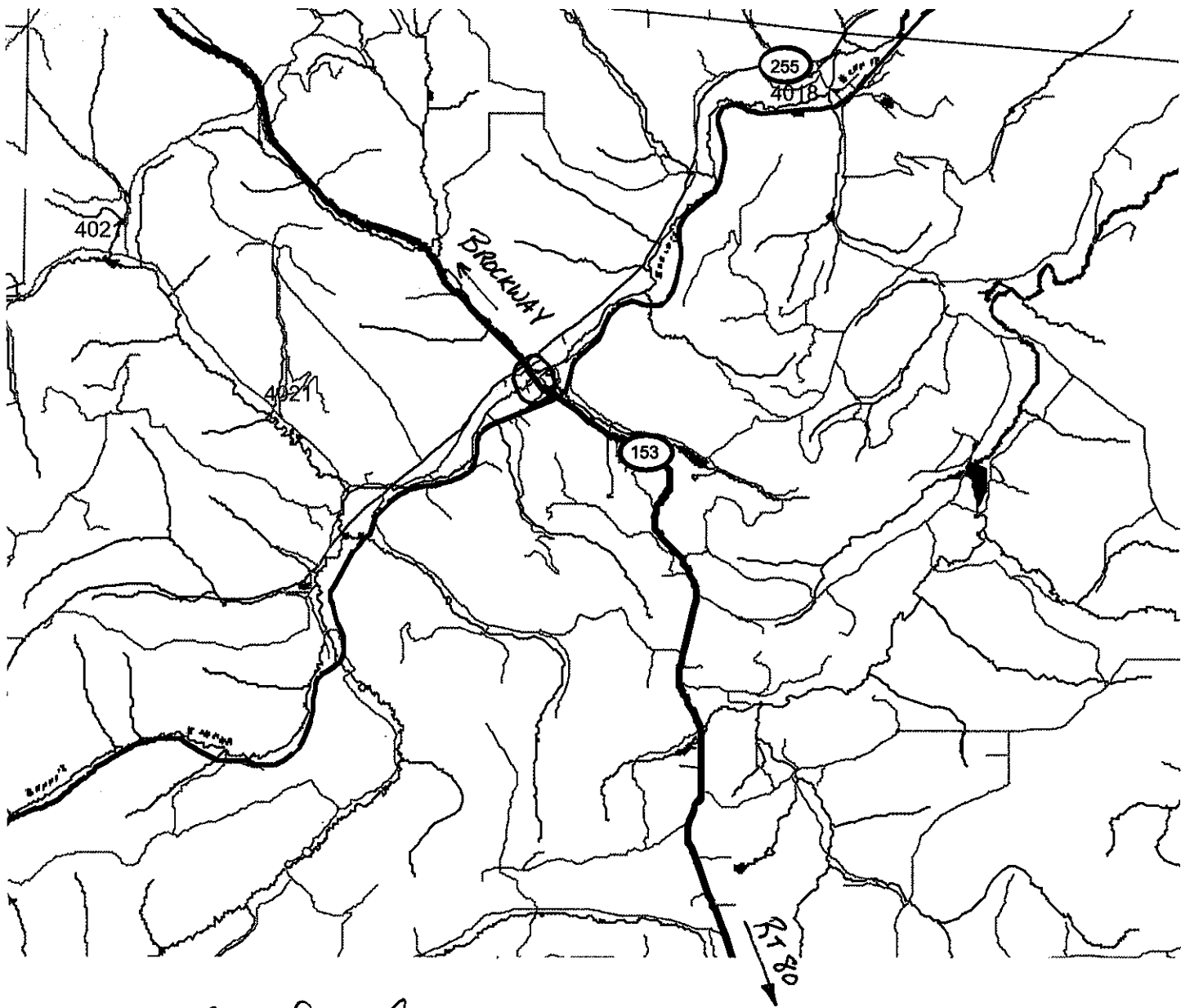
Height of low chord above stream bed: 10 ft

PART 11: PIER CHARACTERISTICS

- Single, solid piers
- Multiple, closely spaced pier or pile groups
- Exposed pier footing piles
- Multiple piles, or row of pier columns skewed to approaching flow

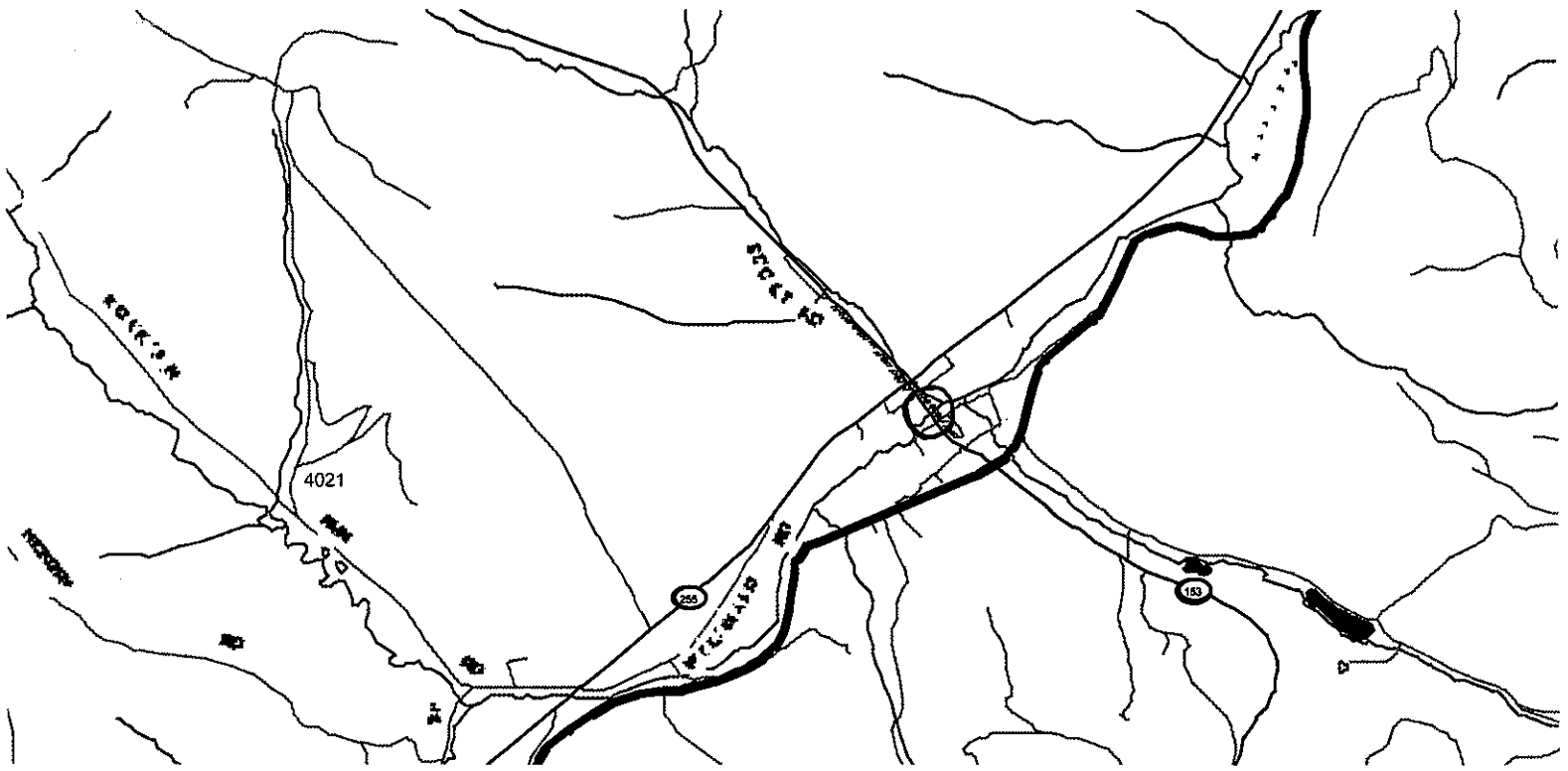
PART 12: PIER LOCATION

- Sheltered location (Piers _____)
- In the channel (Piers 1)
- Bank/floodplain (Piers _____)
- In the path of debris flow (Piers 1)



Directions from State College:

- 1) 322 W to Woodland
- 2) 80 W to 153 N
- 3) 153 N to site



CLEARFIELD CO, SR 0153, SEGMENT 0630, OFFSET 0771

NOTES: BRIDGE JUST SOUTH OF JUNCTION WITH SR 255
: RIGHT NEXT TO EXXON GAS STATION

**STREAM RECONNAISSANCE
For Debris Accumulation at Bridges**

SECTION 1 - SITE DESCRIPTION

ROAD NAME/NUMBER

DATE

SR 2018, SEG 0082, OFFSET 0000

12/10/2007

BRIDGE NUMBER

STREAM NAME

GPS COORDINATES

SECTION 2 - REGION AND VALLEY DESCRIPTION

PART 1: WATERSHED

Land Use

- Natural
- Agricultural
- Urban
- Suburban
- Rural
- Industrial
- Cattle grazing

Vegetation

- None
- Grass
- Pasture
- Crops
- Shrubs
- Deciduous Forest/trees
- Coniferous Forest/trees

PART 2: RIVER VALLEY CONDITION

Valley Side Failures

- None
- Occasional
- Frequent

Failure Locations

- None
- Away from river
- Along river

PART 3: FLOODPLAIN

Floodplain Width

- None
- <1 river width
- 1-5 river widths
- 5-10 river widths
- >10 river widths

Land Use

- Natural
- Agricultural
- Urban
- Suburban
- Rural
- Industrial
- Mining
- Cattle grazing

Vegetation

- None
- Grass
- Pasture
- Orchards
- Crops
- Shrubs
- Deciduous Forest/trees
- Coniferous Forest/trees

Riparian Buffer Strip

- None
- <1 river width
- 1-5 river widths
- >5 river widths

Not a suitable site due to shallow spring fed system. debris supply is from adjacent left bank. Right span entirely filled in with debris

photos:

- 1) upstream from bridge*
- 2) downstream from bridge*

PART 4: VERTICAL CONFINEMENT

Terraces

- None
- Left bank
- Right bank

Levees

- None
- Natural
- Constructed

Levee Location

- Along channel bank
- Set back <1 river width
- Set back >1 river width

PART 5: LATERAL RELATION OF CHANNEL TO VALLEY

Planform

- Straight
- Meandering
- Braided
- Anastomosed
- Engineered

Meander Characteristics

- Mild bends
- Moderate bends
- Tight bends

SECTION 3 - CHANNEL DESCRIPTION

PART 6: CHANNEL DESCRIPTION (select all that apply)

Bed Controls

- None
- Occasional
- Frequent
- Confined

Control Types

- None
- Bedrock
- Boulders
- Gravel armor
- Bridge protection
- Grade control
- Debris
- Dams (beaver, engineered)

Width Controls

- None
- Occasional
- Frequent
- Confined

Control Types

- None
- Bedrock
- Boulders
- Gravel armor
- Bridge protection
- Bridge abutments
- Bank stabilization
- Debris

Other

- Debris
- Mining
- Reservoir
- Knickpoint

M-B classification

- Cascade or step-pool
- Plane, pool-riffle, dune-ripple
- Braided

Corps classification (other)

- Modified (engineered)
- Regulated
- Arroyo

Flow Habit

- Perennial
- Flashy perennial
- Intermittent
- Ephemeral

Channel width = _____

PART 7: BED SEDIMENT DESCRIPTION (select all that apply)

Bed Material

- Clay
- Silt
- Sand
- Gravel
- Cobbles
- Boulders

Bar Types

- None
- Alternate bars
- Point bars
- Mid-channel bars
- Diagonal bars
- Irregular/combination

Bar Material

- Silt
- Sand
- Gravel
- Cobbles

Bar Vegetation

- None
- Grasses
- Reeds/shrubs
- Trees

Bar Width

- None
- Narrow
- Moderate
- Wide

SECTION 4 - BANK SURVEY (select all that apply)

Bank Characteristic	Left Bank	Right Bank
Bank material	<input type="checkbox"/> clay <input type="checkbox"/> silt <input type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders <input type="checkbox"/> bedrock	<input type="checkbox"/> clay <input type="checkbox"/> silt <input type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders <input type="checkbox"/> bedrock
Layer material	<input type="checkbox"/> no layers <input type="checkbox"/> cohesive <input type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders	<input type="checkbox"/> no layers <input type="checkbox"/> cohesive <input type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders
Bank height		
Bank slope	<input type="checkbox"/> steep <input type="checkbox"/> moderate <input type="checkbox"/> shallow	<input type="checkbox"/> steep <input type="checkbox"/> moderate <input type="checkbox"/> shallow
Bank vegetation	<input type="checkbox"/> none <input type="checkbox"/> grasses/annuals <input type="checkbox"/> reeds/shrubs <input type="checkbox"/> trees falling trees? <input type="checkbox"/> yes <input type="checkbox"/> no tree density: <input type="checkbox"/> sparse <input type="checkbox"/> dense tree health: <input type="checkbox"/> good <input type="checkbox"/> poor tree ages: <input type="checkbox"/> young <input type="checkbox"/> mature <input type="checkbox"/> old tree diversity? <input type="checkbox"/> yes <input type="checkbox"/> no	<input type="checkbox"/> none <input type="checkbox"/> grasses/annuals <input type="checkbox"/> reeds/shrubs <input type="checkbox"/> trees falling trees? <input type="checkbox"/> yes <input type="checkbox"/> no tree density: <input type="checkbox"/> sparse <input type="checkbox"/> dense tree health: <input type="checkbox"/> good <input type="checkbox"/> poor tree ages: <input type="checkbox"/> young <input type="checkbox"/> mature <input type="checkbox"/> old tree diversity? <input type="checkbox"/> yes <input type="checkbox"/> no
Bank erosion and failure location	location of erosion: <input type="checkbox"/> outside meander bend <input type="checkbox"/> inside meander bend <input type="checkbox"/> opposite bar or obstruction <input type="checkbox"/> general type of erosion: <input type="checkbox"/> fluvial <input type="checkbox"/> geotechnical	location of erosion: <input type="checkbox"/> outside meander bend <input type="checkbox"/> inside meander bend <input type="checkbox"/> opposite bar or obstruction <input type="checkbox"/> general type of erosion: <input type="checkbox"/> fluvial <input type="checkbox"/> geotechnical

SECTION 5 – DEBRIS CHARACTERISTICS

PART 8: EVIDENCE OF HIGH DEBRIS DELIVERY POTENTIAL

- Presence of debris at bridge (See Part 9)
- Presence of debris at upstream sites
- Documented need for debris removal at bridge (Contact: _____)
- Evidence of bank erosion

PART 9: DEBRIS TYPE / QUANTITY

- | | | | | |
|---|---------|--|--|---------|
| <input type="checkbox"/> None | Percent | | | Percent |
| <input type="checkbox"/> Small floating debris | _____ | <input type="checkbox"/> Fine detritus | | _____ |
| <input type="checkbox"/> Medium floating debris | _____ | <input type="checkbox"/> Coarse detritus | | _____ |
| <input type="checkbox"/> Large floating debris | _____ | <input type="checkbox"/> Boulders | | _____ |

SECTION 6 - BRIDGE CHARACTERISTICS

PART 10: PIER MEASUREMENTS

Number of piers: _____

Width measurements:

Left bank or abutment to pier: _____ Right bank or abutment to pier: _____

Width between piers:

Piers	1 - 2	2 - 3	3 - 4	4 - 5	5 - 6
Width (ft)					

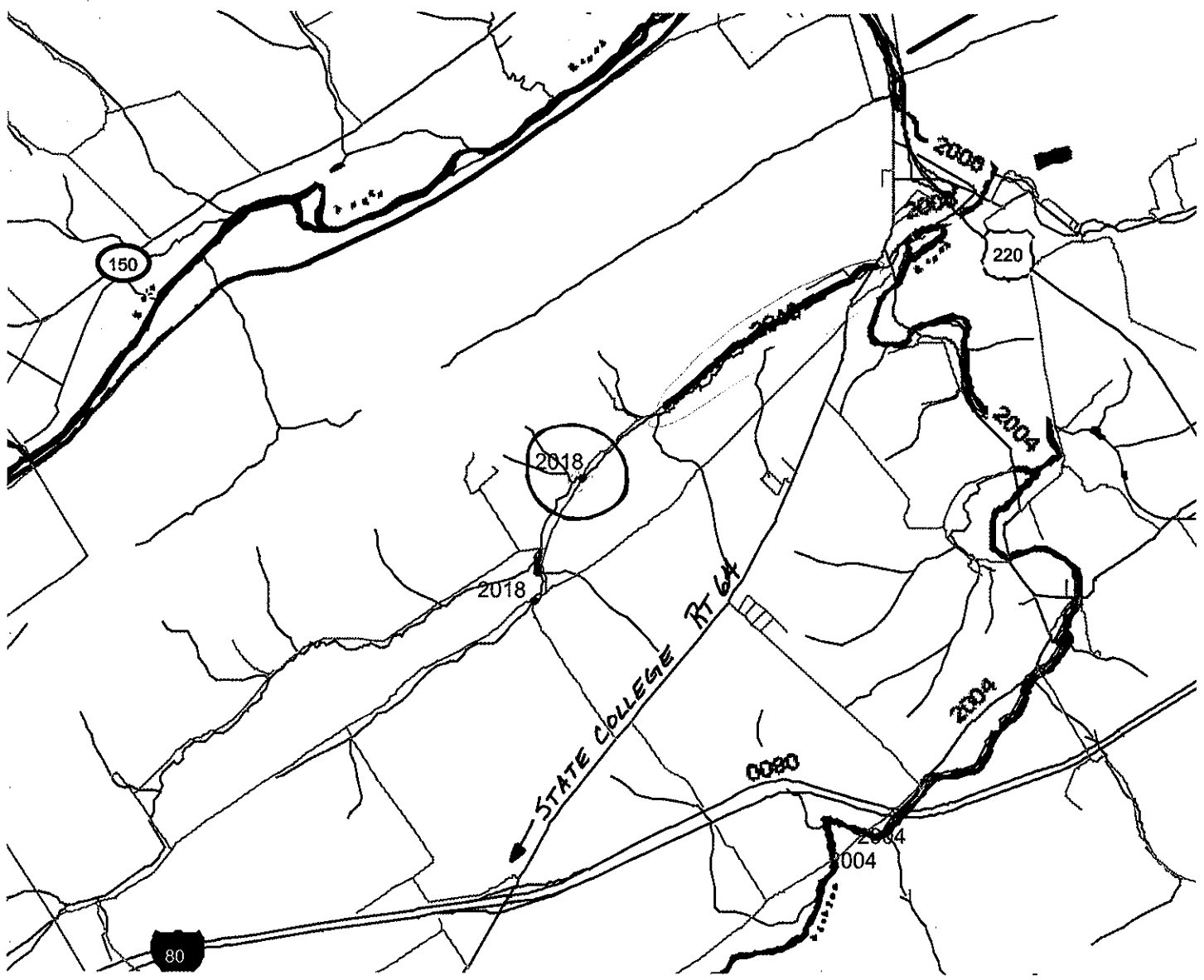
Height of low chord above stream bed:

PART 11: PIER CHARACTERISTICS

- Single, solid piers
- Multiple, closely spaced pier or pile groups
- Exposed pier footing piles
- Multiple piles, or row of pier columns skewed to approaching flow

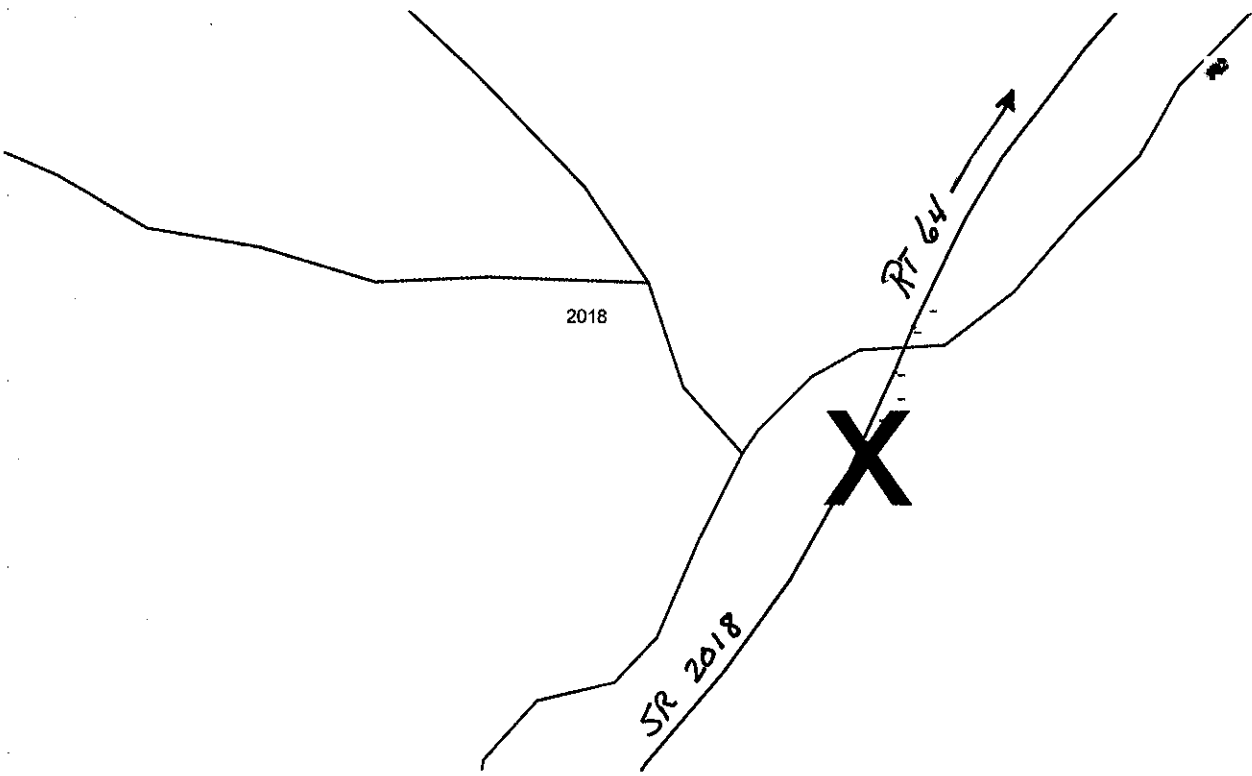
PART 12: PIER LOCATION

- Sheltered location (Piers _____)
- In the channel (Piers _____)
- Bank/floodplain (Piers _____)
- In the path of debris flow (Piers _____)



Directions from Site 2:

- 1) 6 ~~W~~ east to Galeton (Rt 144)
- 2) Rt 144 south to Rt 44
- 3) 44 south to 664 (Lock Haven)
- 4) 664 to 64
- 5) 64 towards State College



CLINTON COUNTY, SR2018, SEGMENT 0082, OFFSET 0000

Map ID # 2, Sequence ID # 6 also (characteristics are identical - see notes on back)
 Map ID # 1, Sequence ID # 5

**STREAM RECONNAISSANCE
 For Debris Accumulation at Bridges**

SECTION 1 - SITE DESCRIPTION

ROAD NAME/NUMBER

DATE

360 East / West

BRIDGE NUMBER

STREAM NAME

GPS COORDINATES

N 36° 49.664' }
 W 78° 41.250' } +/- 34 ft

Staunton River

SECTION 2 - REGION AND VALLEY DESCRIPTION

PART 1: WATERSHED

Land Use

- Natural
- Agricultural
- Urban
- Suburban
- Rural
- Industrial
- Cattle grazing

Vegetation

- None
- Grass
- Pasture
- Crops
- Shrubs
- Deciduous Forest/trees
- Coniferous Forest/trees

PART 2: RIVER VALLEY CONDITION

Valley Side Failures

- None
- Occasional
- Frequent

Failure Locations

- None
- Away from river
- Along river

PART 3: FLOODPLAIN

Floodplain Width

- None
- <1 river width
- 1-5 river widths
- 5-10 river widths
- >10 river widths

Land Use

- Natural
- Agricultural
- Urban
- Suburban
- Rural
- Industrial
- Mining
- Cattle grazing

Vegetation

- None
- Grass
- Pasture
- Orchards
- Crops
- Shrubs
- Deciduous Forest/trees
- Coniferous Forest/trees

Riparian Buffer Strip

- None
- <1 river width
- 1-5 river widths
- >5 river widths

in vicinity
 of bridge

Pictures: 24) upstream nose of WBL piers, from right bank

25) close-up of WBL-4 w/debris sweeper

26) close-up of WBL-5 w/bent support structure

27) upstream from bridge

28) downstream from bridge

29) upstream nose of EBL piers

all from right bank
 (left bank is inaccessible)

Very large watershed

PART 4: VERTICAL CONFINEMENT

Terraces

- None
- Left bank
- Right bank

Levees

- None
- Natural
- Constructed

Levee Location

- Along channel bank
- Set back <1 river width
- Set back >1 river width

PART 5: LATERAL RELATION OF CHANNEL TO VALLEY

Planform

- Straight
- Meandering
- Braided
- Anastomosed
- Engineered

Meander Characteristics

- Mild bends
- Moderate bends
- Tight bends

SECTION 3 - CHANNEL DESCRIPTION

PART 6: CHANNEL DESCRIPTION (select all that apply)

Bed Controls

- None
- Occasional
- Frequent
- Confined

Control Types

- None
- Bedrock
- Boulders
- Gravel armor
- Bridge protection
- Grade control
- Debris
- Dams (beaver, engineered)

Width Controls

- None
- Occasional
- Frequent
- Confined

Control Types

- None
- Bedrock
- Boulders
- Gravel armor
- Bridge protection
- Bridge abutments
- Bank stabilization
- Debris

Other

- Debris
- Mining
- Reservoir
- Knickpoint

M-B classification

- Cascade or step-pool
- Plane, pool-riffle, dune-ripple
- Braided

Corps classification (other)

- Modified (engineered)
- Regulated
- Arroyo

Flow Habit

- Perennial
- Flashy perennial
- Intermittent
- Ephemeral

Channel width = 200 ft

PART 7: BED SEDIMENT DESCRIPTION (select all that apply)

Bed Material

- Clay
- Silt
- Sand
- Gravel
- Cobbles
- Boulders

Bar Types

- None
- Alternate bars
- Point bars
- Mid-channel bars
- Diagonal bars
- Irregular/combination

Bar Material

- Silt
- Sand
- Gravel
- Cobbles

Bar Vegetation

- None
- Grasses
- Reeds/shrubs
- Trees

Bar Width

- None
- Narrow
- Moderate
- Wide

Too deep to determine 0/0's

SECTION 4 - BANK SURVEY (select all that apply)

Bank Characteristic	Left Bank	Right Bank
Bank material	<input checked="" type="checkbox"/> clay <input checked="" type="checkbox"/> silt <input checked="" type="checkbox"/> sand <input checked="" type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders <input type="checkbox"/> bedrock <i>Vegetated Soil</i>	<input checked="" type="checkbox"/> clay <input checked="" type="checkbox"/> silt <input checked="" type="checkbox"/> sand <input checked="" type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders <input type="checkbox"/> bedrock <i>Vegetated Soil</i>
Layer material	<input checked="" type="checkbox"/> no layers <input type="checkbox"/> cohesive <input type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders	<input checked="" type="checkbox"/> no layers <input type="checkbox"/> cohesive <input type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders
Bank height	10 ft	10 ft
Bank slope	<input checked="" type="checkbox"/> steep <input type="checkbox"/> moderate <input type="checkbox"/> shallow <i>> 45°</i>	<input checked="" type="checkbox"/> steep <input type="checkbox"/> moderate <input type="checkbox"/> shallow <i>> 45°</i>
Bank vegetation	<input type="checkbox"/> none <input checked="" type="checkbox"/> grasses/annuals <input type="checkbox"/> reeds/shrubs <input checked="" type="checkbox"/> trees falling trees? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no tree density: <input type="checkbox"/> sparse <input checked="" type="checkbox"/> dense tree health: <input checked="" type="checkbox"/> good <input type="checkbox"/> poor tree ages: <input checked="" type="checkbox"/> young <input checked="" type="checkbox"/> mature <input type="checkbox"/> old tree diversity? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no	<input type="checkbox"/> none <input checked="" type="checkbox"/> grasses/annuals <input type="checkbox"/> reeds/shrubs <input checked="" type="checkbox"/> trees falling trees? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no tree density: <input type="checkbox"/> sparse <input checked="" type="checkbox"/> dense tree health: <input checked="" type="checkbox"/> good <input type="checkbox"/> poor tree ages: <input checked="" type="checkbox"/> young <input checked="" type="checkbox"/> mature <input type="checkbox"/> old tree diversity? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no
Bank erosion and failure location	location of erosion: <input type="checkbox"/> outside meander bend <input checked="" type="checkbox"/> inside meander bend <input type="checkbox"/> opposite bar or obstruction <input type="checkbox"/> general type of erosion: <input checked="" type="checkbox"/> fluvial <input type="checkbox"/> geotechnical	location of erosion: <i>None visible</i> <input type="checkbox"/> outside meander bend <input type="checkbox"/> inside meander bend <input type="checkbox"/> opposite bar or obstruction <input type="checkbox"/> general type of erosion: <input type="checkbox"/> fluvial <input type="checkbox"/> geotechnical

left bank is steeper and is showing signs of active erosion (leaning trees, vertical banks, exposed soil, etc.)

SECTION 5 – DEBRIS CHARACTERISTICS

PART 8: EVIDENCE OF HIGH DEBRIS DELIVERY POTENTIAL

- Presence of debris at bridge (See Part 9)
- Presence of debris at upstream sites
- Documented need for debris removal at bridge (Contact: debris sweeper installed but not functioning correctly)
- Evidence of bank erosion - predominantly left bank

PART 9: DEBRIS TYPE / QUANTITY

- | | | | |
|--|-----------|--|---------|
| <input type="checkbox"/> None | Percent | | Percent |
| <input checked="" type="checkbox"/> Small floating debris | <u>10</u> | <input type="checkbox"/> Fine detritus | _____ |
| <input checked="" type="checkbox"/> Medium floating debris | <u>50</u> | <input type="checkbox"/> Coarse detritus | _____ |
| <input checked="" type="checkbox"/> Large floating debris | <u>40</u> | <input type="checkbox"/> Boulders | _____ |

SECTION 6 - BRIDGE CHARACTERISTICS

PART 10: PIER MEASUREMENTS Pier numbers - facing downstream, counting L to R

Number of piers: 7

Width measurements:
Left bank or abutment to 3 pier: 30 Right bank or abutment to 5 pier: 35

Width between piers: All appear to be evenly spaced 70 ft apart

Piers	1 - 2	2 - 3	3 - 4	4 - 5	5 - 6
Width (ft)	70	70	70	70	70

Height of low chord above stream bed: 35 ft above water surface

PART 11: PIER CHARACTERISTICS

- Single, solid piers - well aligned w.r.t. flow direction, rounded noses
- Multiple, closely spaced pier or pile groups
- Exposed pier footing piles
- Multiple piles, or row of pier columns skewed to approaching flow

PART 12: PIER LOCATION

- Sheltered location (Piers _____)
- In the channel (Piers 3, 4, 5)
- Bank/floodplain (Piers 1, 2, 6, 7)
- In the path of debris flow (Piers 3, 4, 5)

See notes on back

Site # 3, Sequence # 11

**STREAM RECONNAISSANCE
For Debris Accumulation at Bridges**

SECTION 1 - SITE DESCRIPTION

ROAD NAME/NUMBER

45

DATE

1/9/08

BRIDGE NUMBER

STREAM NAME

James River

GPS COORDINATES N 37° 40.291' } +/- 31 ft
W 78° 05.193' }

SECTION 2 - REGION AND VALLEY DESCRIPTION

PART 1: WATERSHED

Land Use

- Natural
- Agricultural
- Urban
- Suburban
- Rural
- Industrial
- Cattle grazing

Vegetation

- None
- Grass
- Pasture
- Crops
- Shrubs
- Deciduous Forest/trees
- Coniferous Forest/trees

PART 2: RIVER VALLEY CONDITION

Valley Side Failures

- None
- Occasional
- Frequent

Failure Locations

- None
- Away from river
- Along river

PART 3: FLOODPLAIN

Floodplain Width

- None
- <1 river width
- 1-5 river widths
- 5-10 river widths
- >10 river widths

Land Use

- Natural
- Agricultural
- Urban
- Suburban
- Rural
- Industrial
- Mining
- Cattle grazing

Vegetation

- None
- Grass
- Pasture
- Orchards
- Crops
- Shrubs
- Deciduous Forest/trees
- Coniferous Forest/trees

Riparian Buffer Strip

- None
- <1 river width
- 1-5 river widths
- >5 river widths

Huge

See notes on back

pics 50) debris accumulation on pier 6 (approx 15 ft high above \bar{e})

51) upstream, from right bank under bridge

52) downstream, from right bank under bridge

53) debris accumulation on piers 5 + 6, from right bank downstream of bridge 1

54) view of bridge piers from right bank - Note accumulation on abandoned bridge piers

PART 4: VERTICAL CONFINEMENT

Terraces

- None
- Left bank
- Right bank

Levees

- None
- Natural
- Constructed

Levee Location

- Along channel bank
- Set back <1 river width
- Set back >1 river width

PART 5: LATERAL RELATION OF CHANNEL TO VALLEY

Planform

- Straight
- Meandering
- Braided
- Anastomosed
- Engineered

Meander Characteristics

- Mild bends
- Moderate bends - on map - large bend upstream
- Tight bends

SECTION 3 - CHANNEL DESCRIPTION

PART 6: CHANNEL DESCRIPTION (select all that apply)

Bed Controls

- None
- Occasional
- Frequent
- Confined

Control Types

- None
- Bedrock
- Boulders
- Gravel armor
- Bridge protection
- Grade control
- Debris
- Dams (beaver, engineered)

Width Controls

- None
- Occasional
- Frequent
- Confined

Control Types

- None
- Bedrock
- Boulders
- Gravel armor
- Bridge protection
- Bridge abutments
- Bank stabilization
- Debris

Other

- Debris
- Mining
- Reservoir
- Knickpoint

M-B classification

- Cascade or step-pool
- Plane, pool-riffle, dune-ripple
- Braided

Corps classification (other)

- Modified (engineered)
- Regulated
- Arroyo

Flow Habit

- Perennial
- Flashy perennial
- Intermittent
- Ephemeral

Channel width = 610 ft

$114 \times 5 + 40 = 610 \text{ ft}$
 approximate - based on estimated distance between piers 1, 2, 3, 4, 5 and measured distance between piers 6 and 7 and measured distance between LB and pier 1

PART 7: BED SEDIMENT DESCRIPTION (select all that apply)

Bed Material

- Clay
- Silt
- Sand
- Gravel
- Cobbles
- Boulders

Bar Types

- None
- Alternate bars
- Point bars
- Mid-channel bars
- Diagonal bars
- Irregular/combination

Bar Material

- Silt
- Sand
- Gravel
- Cobbles

Bar Vegetation

- None
- Grasses
- Reeds/shrubs
- Trees

Bar Width

- None
- Narrow
- Moderate
- Wide

SECTION 4 - BANK SURVEY (select all that apply)

Bank Characteristic	Left Bank	Right Bank
Bank material	<input type="checkbox"/> clay <input checked="" type="checkbox"/> silt <input checked="" type="checkbox"/> sand <input checked="" type="checkbox"/> gravel <input checked="" type="checkbox"/> cobbles <input type="checkbox"/> boulders <input type="checkbox"/> bedrock <p style="text-align: center;"><i>Vegetated Soil</i></p>	<input type="checkbox"/> clay <input checked="" type="checkbox"/> silt <input checked="" type="checkbox"/> sand <input checked="" type="checkbox"/> gravel <input checked="" type="checkbox"/> cobbles <input type="checkbox"/> boulders <input type="checkbox"/> bedrock <p style="text-align: center;"><i>Vegetated Soil</i></p>
Layer material	<input checked="" type="checkbox"/> no layers <input type="checkbox"/> cohesive <input type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders	<input checked="" type="checkbox"/> no layers <input type="checkbox"/> cohesive <input type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders
Bank height	12 - 20 ft	12 - 20 ft
Bank slope	<input checked="" type="checkbox"/> steep <input checked="" type="checkbox"/> moderate <input type="checkbox"/> shallow <p style="text-align: center;"><i>~ 30-60°</i></p>	<input checked="" type="checkbox"/> steep <input checked="" type="checkbox"/> moderate <input type="checkbox"/> shallow <p style="text-align: center;"><i>~ 30-60</i></p>
Bank vegetation	<input type="checkbox"/> none <input checked="" type="checkbox"/> grasses/annuals <input checked="" type="checkbox"/> reeds/shrubs <input checked="" type="checkbox"/> trees falling trees? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no tree density: <input type="checkbox"/> sparse <input checked="" type="checkbox"/> dense tree health: <input checked="" type="checkbox"/> good <input type="checkbox"/> poor tree ages: <input checked="" type="checkbox"/> young <input checked="" type="checkbox"/> mature <input type="checkbox"/> old tree diversity? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no	<input type="checkbox"/> none <input checked="" type="checkbox"/> grasses/annuals <input checked="" type="checkbox"/> reeds/shrubs <input checked="" type="checkbox"/> trees falling trees? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no tree density: <input type="checkbox"/> sparse <input checked="" type="checkbox"/> dense tree health: <input checked="" type="checkbox"/> good <input type="checkbox"/> poor tree ages: <input checked="" type="checkbox"/> young <input checked="" type="checkbox"/> mature <input type="checkbox"/> old tree diversity? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no
Erosion evidence: falling/leaning trees - little to no exposed soil Bank erosion and failure location	location of erosion: <input checked="" type="checkbox"/> outside meander bend <input type="checkbox"/> inside meander bend <input type="checkbox"/> opposite bar or obstruction <input type="checkbox"/> general type of erosion: <input checked="" type="checkbox"/> fluvial <input type="checkbox"/> geotechnical	location of erosion: <input type="checkbox"/> outside meander bend <input checked="" type="checkbox"/> inside meander bend <input type="checkbox"/> opposite bar or obstruction <input type="checkbox"/> general type of erosion: <input checked="" type="checkbox"/> fluvial <input type="checkbox"/> geotechnical

SECTION 5 - DEBRIS CHARACTERISTICS

PART 8: EVIDENCE OF HIGH DEBRIS DELIVERY POTENTIAL

- Presence of debris at bridge (See Part 9)
- Presence of debris at upstream sites
- Documented need for debris removal at bridge (Contact: _____)
- Evidence of bank erosion

PART 9: DEBRIS TYPE / QUANTITY

- | | | |
|--|-----------|--|
| <input type="checkbox"/> None | Percent | Percent |
| <input type="checkbox"/> Small floating debris | _____ | <input type="checkbox"/> Fine detritus |
| <input checked="" type="checkbox"/> Medium floating debris | <u>50</u> | <input type="checkbox"/> Coarse detritus |
| <input checked="" type="checkbox"/> Large floating debris | <u>50</u> | <input type="checkbox"/> Boulders |

SECTION 6 - BRIDGE CHARACTERISTICS

PART 10: PIER MEASUREMENTS

Number of piers: 7

Width measurements: 2 Left bank or abutment to pier: 42 ft Right bank or abutment to pier: 7 0 - at edge of water

Width between piers:

Piers	1 - 2	2 - 3	3 - 4	4 - 5	5 - 6	6 - 7
Width (ft)	<u>114</u>					<u>114</u>

Height of low chord above stream bed: 40 ft above water surface

PART 11: PIER CHARACTERISTICS

- Single, solid piers - rounded nose, aligned with flow
- Multiple, closely spaced pier or pile groups
- Exposed pier footing piles pile cap
- Multiple piles, or row of pier columns skewed to approaching flow

PART 12: PIER LOCATION

- Sheltered location (Piers 1, 7) *near bank*
- Bank/floodplain (Piers _____)
- In the channel (Piers 2, 3, 4, 5, 6)
- In the path of debris flow (Piers 6, 5)

based on debris accumulation, on day of visit, it appears that these are the most susceptible to debris accumulation

to wide to measure each span - assumed equal

4/4
106

Map ID # 4, Sequence ID # 3

STREAM RECONNAISSANCE For Debris Accumulation at Bridges

SECTION 1 - SITE DESCRIPTION

ROAD NAME/NUMBER

DATE

BRIDGE NUMBER

STREAM NAME

Hyco River

GPS COORDINATES $N 36^{\circ} 40.050'$
 $W 78^{\circ} 45.278'$ } $1/19$ feet

SECTION 2 - REGION AND VALLEY DESCRIPTION

PART 1: WATERSHED

Land Use

- Natural
- Agricultural
- Urban
- Suburban
- Rural
- Industrial
- Cattle grazing

Vegetation

- None
- Grass
- Pasture
- Crops
- Shrubs
- Deciduous Forest/trees
- Coniferous Forest/trees \rightarrow (pine plantation)

\rightarrow (no streambank fencing, in headwaters)

PART 2: RIVER VALLEY CONDITION

Valley Side Failures

- None
- Occasional
- Frequent

Failure Locations

- None
- Away from river
- Along river

PART 3: FLOODPLAIN

Floodplain Width

- None
- <1 river width
- 1-5 river widths
- 5-10 river widths
- >10 river widths

Land Use

- Natural
- Agricultural
- Urban
- Suburban
- Rural
- Industrial
- Mining
- Cattle grazing

Vegetation

- None
- Grass
- Pasture no
- Orchards
- Crops (trees) no
- Shrubs
- Deciduous Forest/trees
- Coniferous Forest/trees no

Riparian Buffer Strip

- None
- <1 river width
- 1-5 river widths
- >5 river widths

\rightarrow headwaters

- Pictures:
- 16) upstream face of bridge piers, from right bank
 - 17) upstream of bridge, from right bank
 - 18) downstream of bridge, from right bank
 - 19) debris blocking span between piers 2 + 3
(open between banks and piers)

PART 4: VERTICAL CONFINEMENT

Terraces

- None
- Left bank
- Right bank

Levees

- None
- Natural
- Constructed

Levee Location

- Along channel bank
- Set back <1 river width
- Set back >1 river width

PART 5: LATERAL RELATION OF CHANNEL TO VALLEY

Planform

- Straight
- Meandering
- Braided
- Anastomosed
- Engineered

Meander Characteristics

- Mild bends
- Moderate bends
- Tight bends

SECTION 3 - CHANNEL DESCRIPTION

PART 6: CHANNEL DESCRIPTION (select all that apply)

Bed Controls

- None
- Occasional
- Frequent
- Confined

Control Types

- None
- Bedrock
- Boulders
- Gravel armor
- Bridge protection
- Grade control
- Debris
- Dams (beaver, engineered)

Width Controls

- None
- Occasional
- Frequent
- Confined

Control Types

- None
- Bedrock
- Boulders
- Gravel armor
- Bridge protection
- Bridge abutments
- Bank stabilization
- Debris

Other

- Debris
- Mining
- Reservoir
- Knickpoint

M-B classification

- Cascade or step-pool
- Plane, pool-riffle, dune-ripple
- Braided

Corps classification (other)

- Modified (engineered)
- Regulated
- Arroyo

Flow Habit

- Perennial
- Flashy perennial
- Intermittent
- Ephemeral

Channel width = 130 ft

PART 7: BED SEDIMENT DESCRIPTION (select all that apply)

Bed Material

- Clay
- Silt
- Sand
- Gravel
- Cobbles
- Boulders

Bar Types

- None
- Alternate bars
- Point bars
- Mid-channel bars
- Diagonal bars
- Irregular/combination

Bar Material

- Silt
- Sand
- Gravel
- Cobbles

Bar Vegetation

- None
- Grasses
- Reeds/shrubs
- Trees

Bar Width

- None
- Narrow
- Moderate
- Wide

too deep to estimate 0/15

SECTION 4 - BANK SURVEY (select all that apply)

Bank Characteristic	Left Bank	Right Bank
Bank material	<input checked="" type="checkbox"/> clay <input checked="" type="checkbox"/> silt <input checked="" type="checkbox"/> sand <input checked="" type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders <input type="checkbox"/> bedrock <p style="text-align: right;">} Vegetated Soil</p>	<input checked="" type="checkbox"/> clay <input checked="" type="checkbox"/> silt <input checked="" type="checkbox"/> sand <input checked="" type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders <input type="checkbox"/> bedrock <p style="text-align: right;">} Vegetated Soil</p>
Layer material	<input checked="" type="checkbox"/> no layers <input type="checkbox"/> cohesive <input type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders	<input checked="" type="checkbox"/> no layers <input type="checkbox"/> cohesive <input type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders
Bank height	4 ft	4 ft
Bank slope	<input checked="" type="checkbox"/> steep <input type="checkbox"/> moderate <input type="checkbox"/> shallow <p style="text-align: right;">> 45°</p>	<input checked="" type="checkbox"/> steep <input type="checkbox"/> moderate <input type="checkbox"/> shallow <p style="text-align: right;">> 45°</p>
Bank vegetation	<input type="checkbox"/> none <input checked="" type="checkbox"/> grasses/annuals <input type="checkbox"/> reeds/shrubs <input checked="" type="checkbox"/> trees falling trees? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no tree density: <input type="checkbox"/> sparse <input checked="" type="checkbox"/> dense tree health: <input checked="" type="checkbox"/> good <input type="checkbox"/> poor tree ages: <input checked="" type="checkbox"/> young <input checked="" type="checkbox"/> mature <input type="checkbox"/> old tree diversity? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no	<input type="checkbox"/> none <input checked="" type="checkbox"/> grasses/annuals <input type="checkbox"/> reeds/shrubs <input checked="" type="checkbox"/> trees falling trees? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no tree density: <input type="checkbox"/> sparse <input checked="" type="checkbox"/> dense tree health: <input checked="" type="checkbox"/> good <input type="checkbox"/> poor tree ages: <input checked="" type="checkbox"/> young <input checked="" type="checkbox"/> mature <input type="checkbox"/> old tree diversity? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no
Bank erosion and failure location	location of erosion: <input type="checkbox"/> outside meander bend <input type="checkbox"/> inside meander bend <input type="checkbox"/> opposite bar or obstruction <input type="checkbox"/> general type of erosion: <input type="checkbox"/> fluvial <input type="checkbox"/> geotechnical	location of erosion: <input checked="" type="checkbox"/> outside meander bend <input type="checkbox"/> inside meander bend <input type="checkbox"/> opposite bar or obstruction <input type="checkbox"/> general type of erosion: <input type="checkbox"/> fluvial <input type="checkbox"/> geotechnical

evidence of erosion on outside of meander along right bank, left bank - no erosion - lots of deposition of LWD downstream of bridge on outside of meanders.

SECTION 5 – DEBRIS CHARACTERISTICS

PART 8: EVIDENCE OF HIGH DEBRIS DELIVERY POTENTIAL

- Presence of debris at bridge (See Part 9)
- Presence of debris at upstream sites
- Documented need for debris removal at bridge (Contact: _____)
- Evidence of bank erosion - right bank in vicinity of bridge

PART 9: DEBRIS TYPE / QUANTITY

- | | | | |
|--|-----------|--|---------|
| <input type="checkbox"/> None | Percent | | Percent |
| <input checked="" type="checkbox"/> Small floating debris | <u>25</u> | <input type="checkbox"/> Fine detritus | _____ |
| <input checked="" type="checkbox"/> Medium floating debris | <u>25</u> | <input type="checkbox"/> Coarse detritus | _____ |
| <input checked="" type="checkbox"/> Large floating debris | <u>50</u> | <input type="checkbox"/> Boulders | _____ |

SECTION 6 - BRIDGE CHARACTERISTICS

PART 10: PIER MEASUREMENTS

Number of piers: 4

Width measurements:
 Left bank or abutment to pier: 2 15 ft Right bank or abutment to pier: 3 44 ft

Width between piers:

Piers	1 - 2	2 - 3	3 - 4	4 - 5	5 - 6
Width (ft)	<u>55</u>	<u>55</u>	<u>55</u>		

Height of low chord above stream bed: 30 ft above water surface

PART 11: PIER CHARACTERISTICS

- Single, solid piers
- Multiple, closely spaced pier or pile groups
- Exposed pier footing piles
- Multiple piles, or row of pier columns skewed to approaching flow ~ 30° skew

PART 12: PIER LOCATION

- Sheltered location (Piers 1, 4)
- In the channel (Piers 2, 3)
- Bank/floodplain (Piers 1, 4)
- In the path of debris flow (Piers 2, 3)

See diagram on back

Site # 6, Sequence # 2, Tributary / Branch

**STREAM RECONNAISSANCE
For Debris Accumulation at Bridges**

SECTION 1 - SITE DESCRIPTION

ROAD NAME/NUMBER

DATE

BRIDGE NUMBER

STREAM NAME

GPS COORDINATES $N 36^{\circ} 34.229'$
 $W 79^{\circ} 22.346'$ } ± 20 ft

SECTION 2 - REGION AND VALLEY DESCRIPTION

PART 1: WATERSHED

Land Use

- Natural
- Agricultural
- Urban
- Suburban
- Rural
- Industrial
- Cattle grazing

Vegetation

- None
- Grass
- Pasture
- Crops
- Shrubs
- Deciduous Forest/trees
- Coniferous Forest/trees

PART 2: RIVER VALLEY CONDITION

Valley Side Failures

- None
- Occasional
- Frequent

Failure Locations

- None
- Away from river
- Along river

PART 3: FLOODPLAIN

Floodplain Width

- None
- <1 river width
- 1-5 river widths
- 5-10 river widths
- >10 river widths

Land Use

- Natural
- Agricultural
- Urban
- Suburban
- Rural
- Industrial
- Mining
- Cattle grazing

Vegetation

- None
- Grass
- Pasture
- Orchards
- Crops
- Shrubs
- Deciduous Forest/trees
- Coniferous Forest/trees

Riparian Buffer Strip

- None
- <1 river width
- 1-5 river widths
- >5 river widths

park w/ biking
trails adjacent
to river

pictures: 8) upstream face of pier #6, illustrating debris, from left bank
9, 10) view downstream of bridge, from left bank under bridge
11) view upstream of bridge from left bank
12) view of entire bridge from left bank, ~ 250 yards
downstream of bridge - note tributary confluence.

PART 4: VERTICAL CONFINEMENT

Terraces

- None
- Left bank
- Right bank

Levees

- None
- Natural
- Constructed

Levee Location

- Along channel bank
- Set back <1 river width
- Set back >1 river width

PART 5: LATERAL RELATION OF CHANNEL TO VALLEY

Planform

- Straight
- Meandering
- Braided
- Anastomosed
- Engineered

Meander Characteristics

- Mild bends
- Moderate bends
- Tight bends

SECTION 3 - CHANNEL DESCRIPTION

PART 6: CHANNEL DESCRIPTION (select all that apply)

Bed Controls

- None
- Occasional
- Frequent
- Confined

Control Types

- None
- Bedrock
- Boulders
- Gravel armor
- Bridge protection
- Grade control
- Debris
- Dams (beaver, engineered)

Width Controls

- None
- Occasional
- Frequent
- Confined

Control Types

- None
- Bedrock
- Boulders
- Gravel armor
- Bridge protection
- Bridge abutments
- Bank stabilization
- Debris

Other

- Debris
- Mining
- Reservoir
- Knickpoint

M-B classification

- Cascade or step-pool
- Plane, pool-riffle, dune-ripple
- Braided

Corps classification (other)

- Modified (engineered)
- Regulated
- Arroyo

Flow Habit

- Perennial
- Flashy perennial
- Intermittent
- Ephemeral

Channel width = 94.5 ft

PART 7: BED SEDIMENT DESCRIPTION (select all that apply)

Bed Material

- Clay
- Silt
- Sand
- Gravel
- Cobbles
- Boulders

Bar Types

- None
- Alternate bars
- Point bars
- Mid-channel bars
- Diagonal bars
- Irregular/combination

Bar Material

- Silt
- Sand
- Gravel
- Cobbles

Bar Vegetation

- None
- Grasses
- Reeds/shrubs
- Trees

Bar Width

- None
- Narrow
- Moderate
- Wide

*2 ft
high dam
~250 yards
upstream*

*too deep
to determine
%s*

*No bars
apparent at
current water
level*

SECTION 4 - BANK SURVEY (select all that apply)

Bank Characteristic	Left Bank	Right Bank
Bank material	<input checked="" type="checkbox"/> clay <input checked="" type="checkbox"/> silt <input checked="" type="checkbox"/> sand <input checked="" type="checkbox"/> gravel <input checked="" type="checkbox"/> cobbles <input type="checkbox"/> boulders - riprap under bridge <input type="checkbox"/> bedrock	<input checked="" type="checkbox"/> clay <input checked="" type="checkbox"/> silt <input checked="" type="checkbox"/> sand <input checked="" type="checkbox"/> gravel <input checked="" type="checkbox"/> cobbles <input type="checkbox"/> boulders - riprap under bridge <input type="checkbox"/> bedrock
Layer material	<input checked="" type="checkbox"/> no layers <input type="checkbox"/> cohesive <input type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders	<input checked="" type="checkbox"/> no layers <input type="checkbox"/> cohesive <input type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders
Bank height	12 ft	12 ft
Bank slope	<input checked="" type="checkbox"/> steep <input type="checkbox"/> moderate > 45° <input type="checkbox"/> shallow	<input checked="" type="checkbox"/> steep <input type="checkbox"/> moderate > 45° <input type="checkbox"/> shallow
Bank vegetation	<input type="checkbox"/> none <input checked="" type="checkbox"/> grasses/annuals <input type="checkbox"/> reeds/shrubs <input checked="" type="checkbox"/> trees falling trees? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no tree density: <input type="checkbox"/> sparse <input checked="" type="checkbox"/> dense tree health: <input checked="" type="checkbox"/> good <input type="checkbox"/> poor tree ages: <input checked="" type="checkbox"/> young <input checked="" type="checkbox"/> mature <input type="checkbox"/> old tree diversity? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no	<input type="checkbox"/> none <input checked="" type="checkbox"/> grasses/annuals <input type="checkbox"/> reeds/shrubs <input checked="" type="checkbox"/> trees falling trees? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no tree density: <input type="checkbox"/> sparse <input checked="" type="checkbox"/> dense tree health: <input checked="" type="checkbox"/> good <input type="checkbox"/> poor tree ages: <input checked="" type="checkbox"/> young <input checked="" type="checkbox"/> mature <input type="checkbox"/> old tree diversity? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no
Bank erosion and failure location	location of erosion: <input checked="" type="checkbox"/> outside meander bend <input type="checkbox"/> inside meander bend <input type="checkbox"/> opposite bar or obstruction <input type="checkbox"/> general type of erosion: <input checked="" type="checkbox"/> fluvial <input type="checkbox"/> geotechnical	location of erosion: <i>Note - on inside of meander @ bridge</i> <input type="checkbox"/> outside meander bend <input type="checkbox"/> inside meander bend <input type="checkbox"/> opposite bar or obstruction <input type="checkbox"/> general type of erosion: <input type="checkbox"/> fluvial <input type="checkbox"/> geotechnical

SECTION 5 – DEBRIS CHARACTERISTICS

PART 8: EVIDENCE OF HIGH DEBRIS DELIVERY POTENTIAL

- Presence of debris at bridge (See Part 9)
- Presence of debris at upstream sites
- Documented need for debris removal at bridge (Contact: _____)
- Evidence of bank erosion left bank (within visual site of bridge)

PART 9: DEBRIS TYPE / QUANTITY

- | | | | |
|--|------------|--|---------|
| <input type="checkbox"/> None | Percent | | Percent |
| <input checked="" type="checkbox"/> Small floating debris | <u>25%</u> | <input type="checkbox"/> Fine detritus | _____ |
| <input checked="" type="checkbox"/> Medium floating debris | <u>25%</u> | <input type="checkbox"/> Coarse detritus | _____ |
| <input checked="" type="checkbox"/> Large floating debris | <u>50%</u> | <input type="checkbox"/> Boulders | _____ |

SECTION 6 - BRIDGE CHARACTERISTICS

PART 10: PIER MEASUREMENTS

Number of piers: 7 *bridge has 7 piers - pier 6 is in middle of tributary, collecting debris, other piers are in floodplain (#7) or in mainstem which is inaccessible to survey*

Width measurements:

Left bank or abutment to pier 6 *45 feet* Right bank or abutment to pier: 55 ft

Width between piers:

Piers	1 - 2	2 - 3	3 - 4	4 - 5	5 - 6
Width (ft)					

Height of low chord above stream bed:

PART 11: PIER CHARACTERISTICS

- Single, solid piers *pier not aligned with flow*
- Multiple, closely spaced pier or pile groups
- Exposed pier footing *piles pile cap* *~ 15% off*
- Multiple piles, or row of pier columns skewed to approaching flow

PART 12: PIER LOCATION

- Sheltered location (Piers _____)
- Bank/floodplain (Piers 7)
- In the channel (Piers 6)
- In the path of debris flow (Piers 6)

Can't assess piers 1-5, which are on the mainstem, assessed on separate sheet

Site # 6. Sequence # 2, Mainstem

**STREAM RECONNAISSANCE
For Debris Accumulation at Bridges**

SECTION 1 - SITE DESCRIPTION

ROAD NAME/NUMBER

DATE

BRIDGE NUMBER

STREAM NAME

GPS COORDINATES

Same as trib/Branch

SECTION 2 - REGION AND VALLEY DESCRIPTION

PART 1: WATERSHED

Land Use

- Natural
- Agricultural
- Urban
- Suburban
- Rural
- Industrial
- Cattle grazing

Vegetation

- None
- Grass
- Pasture
- Crops
- Shrubs
- Deciduous Forest/trees
- Coniferous Forest/trees

PART 2: RIVER VALLEY CONDITION

Valley Side Failures

- None
- Occasional
- Frequent

Failure Locations

- None
- Away from river
- Along river

PART 3: FLOODPLAIN

Floodplain Width

- None
- <1 river width
- 1-5 river widths
- 5-10 river widths
- >10 river widths

Land Use

- Natural
- Agricultural
- Urban
- Suburban
- Rural
- Industrial
- Mining
- Cattle grazing

Vegetation

- None
- Grass
- Pasture
- Orchards (tree farm)
- Crops
- Shrubs
- Deciduous Forest/trees
- Coniferous Forest/trees

Riparian Buffer Strip

- None
- <1 river width
- 1-5 river widths
- >5 river widths

- pictures:
- 13) upstream face from right bank - note tree on pier 4
 - 14) upstream face of piers on downstream lanes
(note debris on pier 4 of this span, corresponds with location of debris on pier 4 of upstream bridge)
 - 15) upstream of bridge from right bank
(note debris on bedrock in center of channel ~ 100 yards upstream of bridge)

PART 4: VERTICAL CONFINEMENT

Terraces

- None
- Left bank
- Right bank

Levees

- None
- Natural
- Constructed

Levee Location

- Along channel bank
- Set back <1 river width
- Set back >1 river width

PART 5: LATERAL RELATION OF CHANNEL TO VALLEY

Planform

- Straight
- Meandering
- Braided
- Anastomosed
- Engineered

Meander Characteristics

- Mild bends
- Moderate bends
- Tight bends

SECTION 3 - CHANNEL DESCRIPTION

PART 6: CHANNEL DESCRIPTION (select all that apply)

Bed Controls

- None
- Occasional
- Frequent
- Confined

Control Types

- None
- Bedrock
- Boulders
- Gravel armor
- Bridge protection
- Grade control
- Debris
- Dams (beaver, engineered)

Width Controls

- None
- Occasional
- Frequent
- Confined

Control Types

- None
- Bedrock
- Boulders
- Gravel armor
- Bridge protection
- Bridge abutments
- Bank stabilization
- Debris

Other

- Debris
- Mining
- Reservoir
- Knickpoint

M-B classification

- Cascade or step-pool
- Plane, pool-riffle, dune-ripple
- Braided

Corps classification (other)

- Modified (engineered)
- Regulated
- Arroyo

Flow Habit

- Perennial
- Flashy perennial
- Intermittent
- Ephemeral

Channel width = 200 ft

PART 7: BED SEDIMENT DESCRIPTION (select all that apply)

Bed Material

- Clay
- Silt
- Sand
- Gravel
- Cobbles
- Boulders

Bar Types

- None
- Alternate bars
- Point bars
- Mid-channel bars
- Diagonal bars
- Irregular/combination

Bar Material

- Silt
- Sand
- Gravel
- Cobbles

Bar Vegetation

- None
- Grasses
- Reeds/shrubs
- Trees

Bar Width

- None
- Narrow
- Moderate
- Wide

too deep for 2/5

SECTION 4 - BANK SURVEY (select all that apply)

Bank Characteristic	Left Bank	Right Bank
Bank material	<input checked="" type="checkbox"/> clay <input checked="" type="checkbox"/> silt <input checked="" type="checkbox"/> sand <input checked="" type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders <input type="checkbox"/> bedrock <p style="text-align: right;">} vegetated soil</p>	<input checked="" type="checkbox"/> clay <input checked="" type="checkbox"/> silt <input checked="" type="checkbox"/> sand <input checked="" type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders <input type="checkbox"/> bedrock <p style="text-align: right;">} vegetated soil</p>
Layer material	<input checked="" type="checkbox"/> no layers <input type="checkbox"/> cohesive <input type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders	<input checked="" type="checkbox"/> no layers <input type="checkbox"/> cohesive <input type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders
Bank height	~ 8 ft	~ 8 ft
Bank slope	<input checked="" type="checkbox"/> steep <input type="checkbox"/> moderate <input type="checkbox"/> shallow <p style="text-align: right;">> 45°</p>	<input checked="" type="checkbox"/> steep <input type="checkbox"/> moderate <input type="checkbox"/> shallow <p style="text-align: right;">> 45°</p>
Bank vegetation	<input type="checkbox"/> none <input checked="" type="checkbox"/> grasses/annuals <input type="checkbox"/> reeds/shrubs <input checked="" type="checkbox"/> trees falling trees? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no tree density: <input type="checkbox"/> sparse <input checked="" type="checkbox"/> dense tree health: <input checked="" type="checkbox"/> good <input type="checkbox"/> poor tree ages: <input checked="" type="checkbox"/> young <input checked="" type="checkbox"/> mature <input type="checkbox"/> old tree diversity? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no	<input type="checkbox"/> none <input checked="" type="checkbox"/> grasses/annuals <input type="checkbox"/> reeds/shrubs <input checked="" type="checkbox"/> trees falling trees? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no tree density: <input type="checkbox"/> sparse <input checked="" type="checkbox"/> dense tree health: <input checked="" type="checkbox"/> good <input type="checkbox"/> poor tree ages: <input checked="" type="checkbox"/> young <input checked="" type="checkbox"/> mature <input type="checkbox"/> old tree diversity? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no
Bank erosion and failure location	location of erosion: <input type="checkbox"/> outside meander bend <input checked="" type="checkbox"/> inside meander bend <input type="checkbox"/> opposite bar or obstruction <input type="checkbox"/> general type of erosion: <input checked="" type="checkbox"/> fluvial <input type="checkbox"/> geotechnical	location of erosion: <input checked="" type="checkbox"/> outside meander bend <input type="checkbox"/> inside meander bend <input type="checkbox"/> opposite bar or obstruction <input type="checkbox"/> general type of erosion: <input checked="" type="checkbox"/> fluvial <input type="checkbox"/> geotechnical

mild erosion - soil (unvegetated) exposed in some places
 many trees leaning out over channel on both banks - more on left bank (inside of bend)

SECTION 5 - DEBRIS CHARACTERISTICS

PART 8: EVIDENCE OF HIGH DEBRIS DELIVERY POTENTIAL

- Presence of debris at bridge (See Part 9) - *not much, on tree on pier 4, several*
- Presence of debris at upstream sites → *in mid-channel, upstream of bridge, caught*
- Documented need for debris removal at bridge (Contact: _____) *on bedrock*
- Evidence of bank erosion

PART 9: DEBRIS TYPE / QUANTITY

- | | | | |
|---|-------------|--|---------|
| <input type="checkbox"/> None | Percent | | Percent |
| <input type="checkbox"/> Small floating debris | _____ | <input type="checkbox"/> Fine detritus | _____ |
| <input type="checkbox"/> Medium floating debris | _____ | <input type="checkbox"/> Coarse detritus | _____ |
| <input checked="" type="checkbox"/> Large floating debris | <u>100%</u> | <input type="checkbox"/> Boulders | _____ |
- ↳ one tree*

SECTION 6 - BRIDGE CHARACTERISTICS

PART 10: PIER MEASUREMENTS

Number of piers: 4 *(6 total, remaining 2 in tributary/branch section)*

Width measurements:

Left bank or abutment to pier: 4 *~ 10 feet* Right bank or abutment to pier: 3 *56 ft*

Width between piers:

Piers	1 - 2	2 - 3	3 - 4	4 - 5	5 - 6
Width (ft)		<u>118</u>	<u>118</u>		

Height of low chord above stream bed:

$\frac{177}{59} \rightarrow$ *piers 1, 2 are in floodplain*
118

PART 11: PIER CHARACTERISTICS

- Single, solid piers
- Multiple, closely spaced pier or pile groups
- Exposed pier footing *piles pile cap*
- Multiple piles, or row of pier columns skewed to approaching flow

PART 12: PIER LOCATION

- Sheltered location (Piers 1, 2) *(flood plain)*
- In the channel (Piers 3, 4) *4 is < 10 ft from left bank*
- Bank/floodplain (Piers 1, 2)
- In the path of debris flow (Piers 3, 4)

Map ID 7, Sequence # 9

**STREAM RECONNAISSANCE
For Debris Accumulation at Bridges**

SECTION 1 - SITE DESCRIPTION

ROAD NAME/NUMBER

668

DATE

BRIDGE NUMBER

STREAM NAME

GPS COORDINATES

N 37° 06.334' }
W 79° 17.150' } +/- 32 feet

Staunton R

SECTION 2 - REGION AND VALLEY DESCRIPTION

PART 1: WATERSHED

Land Use

- Natural
- Agricultural
- Urban
- Suburban
- Rural
- Industrial
- Cattle grazing

Vegetation

- None
- Grass
- Pasture
- Crops
- Shrubs
- Deciduous Forest/trees
- Coniferous Forest/trees

PART 2: RIVER VALLEY CONDITION

Valley Side Failures

- None
- Occasional
- Frequent

Failure Locations

- None
- Away from river
- Along river

PART 3: FLOODPLAIN

Floodplain Width

- None
- <1 river width
- 1-5 river widths
- 5-10 river widths
- >10 river widths

Land Use

- Natural
- Agricultural
- Urban
- Suburban
- Rural
- Industrial
- Mining
- Cattle grazing

Vegetation

- None
- Grass
- Pasture
- Orchards
- Crops
- Shrubs
- Deciduous Forest/trees
- Coniferous Forest/trees

Riparian Buffer Strip

- None
- <1 river width
- 1-5 river widths
- >5 river widths

large watershed

-note bridge
~ 3/4 mile
upstream

- Pictures:
- 40) upstream, from left bank - note bedrock outcrop ~ 100 m
 - 41) downstream, from left bank upstream from bridge
 - 42) upstream nose of piers - note debris, sweeper mounting brackets
 - 43) slight width expansion at bridge (left bank)

PART 4: VERTICAL CONFINEMENT

Terraces

- None
- Left bank
- Right bank

Levees

- None
- Natural
- Constructed

Levee Location

- Along channel bank
- Set back <1 river width
- Set back >1 river width

PART 5: LATERAL RELATION OF CHANNEL TO VALLEY

Planform

- Straight
- Meandering
- Braided
- Anastomosed
- Engineered

Meander Characteristics

- Mild bends
- Moderate bends
- Tight bends

SECTION 3 - CHANNEL DESCRIPTION

PART 6: CHANNEL DESCRIPTION (select all that apply)

Bed Controls

- None
- Occasional
- Frequent
- Confined

Control Types

- None
- Bedrock
- Boulders
- Gravel armor
- Bridge protection
- Grade control
- Debris
- Dams (beaver, engineered)

Width Controls

- None
- Occasional
- Frequent
- Confined

Control Types

- None
- Bedrock
- Boulders
- Gravel armor
- Bridge protection
- Bridge abutments
- Bank stabilization
- Debris

Other

- Debris
- Mining
- Reservoir
- Knickpoint

M-B classification

- Cascade or step-pool
- Plane, pool-riffle, dune-ripple
- Braided

Corps classification (other)

- Modified (engineered)
- Regulated
- Arroyo

Flow Habit

- Perennial
- Flashy perennial
- Intermittent
- Ephemeral

Channel width = 175 ft @ bridge

PART 7: BED SEDIMENT DESCRIPTION (select all that apply)

Bed Material

- Clay
- Silt
- Sand
- Gravel
- Cobbles
- Boulders

Bar Types

- None
- Alternate bars
- Point bars
- Mid-channel bars
- Diagonal bars
- Irregular/combination

Bar Material

- Silt
- Sand
- Gravel
- Cobbles

Bar Vegetation

- None
- Grasses
- Reeds/shrubs
- Trees

Bar Width

- None
- Narrow
- Moderate
- Wide

119
53
66
175

SECTION 4 - BANK SURVEY (select all that apply)

Bank Characteristic	Left Bank	Right Bank
Bank material	<input checked="" type="checkbox"/> clay <input checked="" type="checkbox"/> silt <input checked="" type="checkbox"/> sand <input checked="" type="checkbox"/> gravel <input checked="" type="checkbox"/> cobbles <input type="checkbox"/> boulders <input type="checkbox"/> bedrock <i>vegetated Soil</i>	<input checked="" type="checkbox"/> clay <input checked="" type="checkbox"/> silt <input checked="" type="checkbox"/> sand <input checked="" type="checkbox"/> gravel <input checked="" type="checkbox"/> cobbles <input type="checkbox"/> boulders <input type="checkbox"/> bedrock <i>vegetated Soil</i>
Layer material	<input checked="" type="checkbox"/> no layers <input type="checkbox"/> cohesive <input type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders	<input checked="" type="checkbox"/> no layers <input type="checkbox"/> cohesive <input type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders
Bank height	10-15 ft	10-15 ft
Bank slope	<input checked="" type="checkbox"/> steep <input type="checkbox"/> moderate <input type="checkbox"/> shallow <i>> 45°</i>	<input checked="" type="checkbox"/> steep <input type="checkbox"/> moderate <input type="checkbox"/> shallow <i>> 45°</i>
Bank vegetation	<input type="checkbox"/> none <input checked="" type="checkbox"/> grasses/annuals <input checked="" type="checkbox"/> reeds/shrubs <input checked="" type="checkbox"/> trees falling trees? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no tree density: <input type="checkbox"/> sparse <input checked="" type="checkbox"/> dense tree health: <input checked="" type="checkbox"/> good <input type="checkbox"/> poor tree ages: <input checked="" type="checkbox"/> young <input checked="" type="checkbox"/> mature <input type="checkbox"/> old tree diversity? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no <i>many inclined</i>	<input type="checkbox"/> none <input checked="" type="checkbox"/> grasses/annuals <input checked="" type="checkbox"/> reeds/shrubs <input checked="" type="checkbox"/> trees falling trees? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no tree density: <input type="checkbox"/> sparse <input checked="" type="checkbox"/> dense tree health: <input checked="" type="checkbox"/> good <input type="checkbox"/> poor tree ages: <input checked="" type="checkbox"/> young <input checked="" type="checkbox"/> mature <input type="checkbox"/> old tree diversity? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no <i>many inclined</i>
Bank erosion and failure location	location of erosion: <input checked="" type="checkbox"/> outside meander bend <input type="checkbox"/> inside meander bend <input type="checkbox"/> opposite bar or obstruction <input type="checkbox"/> general type of erosion: <input checked="" type="checkbox"/> fluvial <input type="checkbox"/> geotechnical <i>~ 400 yards upstream</i>	location of erosion: <input type="checkbox"/> outside meander bend <input type="checkbox"/> inside meander bend <input type="checkbox"/> opposite bar or obstruction <input type="checkbox"/> general type of erosion: <input type="checkbox"/> fluvial <input type="checkbox"/> geotechnical <i>None near bridge</i>

SECTION 5 - DEBRIS CHARACTERISTICS

PART 8: EVIDENCE OF HIGH DEBRIS DELIVERY POTENTIAL

- Presence of debris at bridge (See Part 9)
- Presence of debris at upstream sites
- Documented need for debris removal at bridge (Contact: _____)
- Evidence of bank erosion *minor - 2 large timbers between piers 3 + 4 - Submerged*

PART 9: DEBRIS TYPE / QUANTITY

- | | | | | |
|---|------------|--|---------|-------|
| <input type="checkbox"/> None | Percent | _____ | Percent | _____ |
| <input type="checkbox"/> Small floating debris | _____ | <input type="checkbox"/> Fine detritus | _____ | |
| <input type="checkbox"/> Medium floating debris | _____ | <input type="checkbox"/> Coarse detritus | _____ | |
| <input checked="" type="checkbox"/> Large floating debris | <u>100</u> | <input type="checkbox"/> Boulders | _____ | |

SECTION 6 - BRIDGE CHARACTERISTICS

PART 10: PIER MEASUREMENTS

Number of piers: 5

Width measurements:

Left bank or abutment to pier: 0

Right bank or abutment to pier: 0 *Pier 4 @ water edge*

Width between piers:

Piers	1 - 2	2 - 3	3 - 4	4 - 5	5 - 6
Width (ft)	<u>60 ft</u>	<u>60 ft</u>	<u>60 ft</u>	<u>60 ft</u>	

Height of low chord above stream bed: 24 ft above water surface

PART 11: PIER CHARACTERISTICS

- Single, solid piers - *rounded nose, aligned w/flow*
- Multiple, closely spaced pier or pile groups
- Exposed pier footing piles
- Multiple piles, or row of pier columns skewed to approaching flow

PART 12: PIER LOCATION

- Sheltered location (Piers 1, 4) *~ against bank*
- In the channel (Piers 2, 3)
- Bank/floodplain (Piers 5)
- In the path of debris flow (Piers 2, 3)

had debris sweepers installed on piers 2 + 3. removed or destroyed - only mounting brackets remain both mounting brackets severely damaged

Site # 8, Sequence # 1

**STREAM RECONNAISSANCE
For Debris Accumulation at Bridges**

SECTION 1 - SITE DESCRIPTION

ROAD NAME/NUMBER

DATE

BRIDGE NUMBER

STREAM NAME

Dan River

GPS COORDINATES

N 36° 32.510' (+/- 16 feet)
W 79° 36.302'

SECTION 2 - REGION AND VALLEY DESCRIPTION

PART 1: WATERSHED

Land Use

- Natural
- Agricultural
- Urban
- Suburban
- Rural
- Industrial
- Cattle grazing

Vegetation

- None
- Grass
- Pasture
- Crops
- Shrubs
- Deciduous Forest/trees
- Coniferous Forest/trees

PART 2: RIVER VALLEY CONDITION

Valley Side Failures

- None
- Occasional
- Frequent

Failure Locations

- None
- Away from river
- Along river

PART 3: FLOODPLAIN

Floodplain Width

- None
- <1 river width
- 1-5 river widths
- 5-10 river widths
- >10 river widths

Land Use

- Natural
- Agricultural
- Urban
- Suburban
- Rural
- Industrial
- Mining
- Cattle grazing

Vegetation

- None
- Grass
- Pasture
- Orchards
- Crops
- Shrubs
- Deciduous Forest/trees
- Coniferous Forest/trees

Riparian Buffer Strip

- None
- <1 river width
- 1-5 river widths
- >5 river widths

Picture: 1) Upstream from bridge deck

2) Downstream from bridge deck

3) eddy downstream of bridge pier

4) debris @ upstream side of bridge pier - note bar formation upstream

5) debris from right bank¹

6) upstream face of bridge from left bank

7) bar forming against left bank upstream of bridge

PART 4: VERTICAL CONFINEMENT

Terraces

- None
- Left bank
- Right bank

Levees

- None
- Natural
- Constructed

Levee Location

- Along channel bank
- Set back <1 river width
- Set back >1 river width

PART 5: LATERAL RELATION OF CHANNEL TO VALLEY

Planform

- Straight
- Meandering
- Braided
- Anastomosed
- Engineered

Meander Characteristics

- Mild bends
- Moderate bends
- Tight bends

SECTION 3 - CHANNEL DESCRIPTION

PART 6: CHANNEL DESCRIPTION (select all that apply)

Bed Controls

- None
- Occasional
- Frequent
- Confined

Control Types

- None
- Bedrock
- Boulders
- Gravel armor
- Bridge protection
- Grade control
- Debris
- Dams (beaver, engineered)

Width Controls

- None
- Occasional
- Frequent
- Confined

Control Types

- None
- Bedrock
- Boulders
- Gravel armor
- Bridge protection
- Bridge abutments
- Bank stabilization
- Debris

Other

- Debris
- Mining
- Reservoir
- Knickpoint

M-B classification

- Cascade or step-pool
- Plane, pool-riffle, dune-ripple
- Braided

Corps classification (other)

- Modified (engineered)
- Regulated
- Arroyo

Flow Habit

- Perennial
- Flashy perennial
- Intermittent
- Ephemeral

Channel width = _____

PART 7: BED SEDIMENT DESCRIPTION (select all that apply)

Bed Material

- Clay
- Silt
- Sand
- Gravel
- Cobbles
- Boulders

Bar Types

- None
- Alternate bars
- Point bars
- Mid-channel bars
- Diagonal bars
- Irregular/combination

Bar Material

- Silt
- Sand
- Gravel
- Cobbles

Bar Vegetation

- None
- Grasses
- Reeds/shrubs
- Trees

Bar Width

- None
- Narrow
- Moderate
- Wide

*Too deep to determine %
There are bar forms*

upstream & down stream of central pier

Submerged

~ 10 feet

SECTION 4 - BANK SURVEY (select all that apply)

Bank Characteristic	Left Bank	Right Bank
Bank material	<input checked="" type="checkbox"/> clay <input checked="" type="checkbox"/> silt <input checked="" type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders <input type="checkbox"/> bedrock	<input checked="" type="checkbox"/> clay <input checked="" type="checkbox"/> silt <input checked="" type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders <input type="checkbox"/> bedrock
Layer material	<input checked="" type="checkbox"/> no layers <input type="checkbox"/> cohesive <input type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders	<input checked="" type="checkbox"/> no layers <input type="checkbox"/> cohesive <input type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders
Bank height	12 feet	12 feet
Bank slope	<input checked="" type="checkbox"/> steep <input type="checkbox"/> moderate 45° <input type="checkbox"/> shallow	<input checked="" type="checkbox"/> steep <input type="checkbox"/> moderate 45° <input type="checkbox"/> shallow
Bank vegetation	<input type="checkbox"/> none <input checked="" type="checkbox"/> grasses/annuals <input type="checkbox"/> reeds/shrubs <input checked="" type="checkbox"/> trees falling trees? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no tree density: <input type="checkbox"/> sparse <input checked="" type="checkbox"/> dense tree health: <input checked="" type="checkbox"/> good <input type="checkbox"/> poor tree ages: <input type="checkbox"/> young <input checked="" type="checkbox"/> mature <input type="checkbox"/> old tree diversity? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no	<input type="checkbox"/> none <input checked="" type="checkbox"/> grasses/annuals <input type="checkbox"/> reeds/shrubs <input checked="" type="checkbox"/> trees falling trees? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no tree density: <input type="checkbox"/> sparse <input checked="" type="checkbox"/> dense tree health: <input checked="" type="checkbox"/> good <input type="checkbox"/> poor tree ages: <input type="checkbox"/> young <input checked="" type="checkbox"/> mature <input type="checkbox"/> old tree diversity? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no
Bank erosion and failure location	location of erosion: <input type="checkbox"/> outside meander bend <input type="checkbox"/> inside meander bend <input type="checkbox"/> opposite bar or obstruction <input checked="" type="checkbox"/> general type of erosion: <input checked="" type="checkbox"/> fluvial <input type="checkbox"/> geotechnical	location of erosion: <input type="checkbox"/> outside meander bend <input type="checkbox"/> inside meander bend <input type="checkbox"/> opposite bar or obstruction <input checked="" type="checkbox"/> general type of erosion: <input checked="" type="checkbox"/> fluvial <input type="checkbox"/> geotechnical

SECTION 5 - DEBRIS CHARACTERISTICS

PART 8: EVIDENCE OF HIGH DEBRIS DELIVERY POTENTIAL

- Presence of debris at bridge (See Part 9)
- Presence of debris at upstream sites
- Documented need for debris removal at bridge (Contact: _____)
- Evidence of bank erosion

PART 9: DEBRIS TYPE / QUANTITY

<input type="checkbox"/> None	Percent		Percent
<input type="checkbox"/> Small floating debris	<u>25</u>	<input type="checkbox"/> Fine detritus	<u>0</u>
<input type="checkbox"/> Medium floating debris	<u>25</u>	<input type="checkbox"/> Coarse detritus	<u>0</u>
<input type="checkbox"/> Large floating debris	<u>50</u>	<input type="checkbox"/> Boulders	<u>0</u>

SECTION 6 - BRIDGE CHARACTERISTICS

PART 10: PIER MEASUREMENTS

Number of piers: 3

Width measurements:

Left bank or abutment to pier: 8 ft Right bank or abutment to pier: 8 ft

Width between piers:

Piers	1 - 2	2 - 3	3 - 4	4 - 5	5 - 6
Width (ft)	<u>70</u>	<u>70 ft</u>			

Height of low chord above stream bed: 27 ~~ft~~ feet to water surface

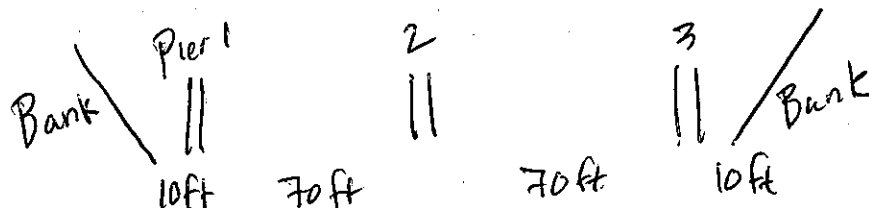
PART 11: PIER CHARACTERISTICS

- Single, solid piers
- Multiple, closely spaced pier or pile groups
- Exposed pier footing piles
- Multiple piles, or row of pier columns skewed to approaching flow

PART 12: PIER LOCATION

- Sheltered location (Piers 1, 3 ^{close to bank})
- In the channel (Piers 2)
- Bank/floodplain (Piers _____)
- In the path of debris flow (Piers 2)

From upstream: left bank



Site # 9, Sequence # 7

**STREAM RECONNAISSANCE
For Debris Accumulation at Bridges**

SECTION 1 - SITE DESCRIPTION

ROAD NAME/NUMBER

DATE

SR 138 @ Lunenburg/Mecklenburg Co. Line

BRIDGE NUMBER

STREAM NAME

GPS COORDINATES

N 36° 47.499' }
W 78° 04.972' } ± 21 ft

Meherrin River

SECTION 2 - REGION AND VALLEY DESCRIPTION

PART 1: WATERSHED

Land Use

- Natural
- Agricultural
- Urban
- Suburban
- Rural
- Industrial
- Cattle grazing

Vegetation

- None
- Grass
- Pasture
- Crops
- Shrubs
- Deciduous Forest/trees
- Coniferous Forest/trees

PART 2: RIVER VALLEY CONDITION

Valley Side Failures

- None
- Occasional
- Frequent

Failure Locations

- None
- Away from river
- Along river

PART 3: FLOODPLAIN

Floodplain Width

- None
- <1 river width
- 1-5 river widths
- 5-10 river widths
- >10 river widths

Land Use

- Natural
- Agricultural
- Urban
- Suburban
- Rural
- Industrial
- Mining
- Cattle grazing

Vegetation

- None
- Grass
- Pasture
- Orchards
- Crops
- Shrubs
- Deciduous Forest/trees
- Coniferous Forest/trees

Riparian Buffer Strip

- None
- <1 river width
- 1-5 river widths
- >5 river widths

forested @ bridge site

- Pictures: 29) picture of debris jam on pier 2, from right bank upstream of bridge
- 30) Stream upstream of bridge, from deck
- 31) Stream downstream of bridge, from deck (note bar formation and old bridge piers)
- 32) debris jam, from left bank downstream upstream of bridge

Couldn't get pics from upstream on left bank - DOC crew

PART 4: VERTICAL CONFINEMENT

Terraces

- None
- Left bank
- Right bank

Levees

- None
- Natural
- Constructed

Levee Location

- Along channel bank
- Set back <1 river width
- Set back >1 river width

PART 5: LATERAL RELATION OF CHANNEL TO VALLEY

Planform

- Straight
- Meandering
- Braided
- Anastomosed
- Engineered

Meander Characteristics

- Mild bends
- Moderate bends
- Tight bends

SECTION 3 - CHANNEL DESCRIPTION

PART 6: CHANNEL DESCRIPTION (select all that apply)

Bed Controls

- None
- Occasional
- Frequent
- Confined

Control Types

- None
- Bedrock
- Boulders
- Gravel armor
- Bridge protection
- Grade control
- Debris
- Dams (beaver, engineered)

Width Controls

- None
 - Occasional
 - Frequent
 - Confined
- heavy rip rap under bridge*

Control Types

- None
- Bedrock
- Boulders
- Gravel armor
- Bridge protection
- Bridge abutments
- Bank stabilization
- Debris

Other

- Debris
- Mining
- Reservoir
- Knickpoint

M-B classification

- Cascade or step-pool
- Plane, pool-riffle, dune-ripple
- Braided

Corps classification (other)

- Modified (engineered)
- Regulated
- Arroyo

Flow Habit

- Perennial
- Flashy perennial
- Intermittent
- Ephemeral

Channel width = 100 ft

PART 7: BED SEDIMENT DESCRIPTION (select all that apply)

Bed Material

- Clay
- Silt
- Sand
- Gravel
- Cobbles
- Boulders

Bar Types

- None
- Alternate bars
- Point bars
- Mid-channel bars
- Diagonal bars
- Irregular/combination

Bar Material

- Silt
- Sand
- Gravel
- Cobbles

Bar Vegetation

- None
- Grasses
- Reeds/shrubs
- Trees

Bar Width

- None
- Narrow
- Moderate (12 ft)
- Wide

one bar, ~250 yards upstream, on inside of meander

one bar, directly downstream of mid-channel pier

one bar forming, center of channel, upstream of bridge

SECTION 4 - BANK SURVEY (select all that apply)

Bank Characteristic	Left Bank	Right Bank
Bank material	<input checked="" type="checkbox"/> clay <input checked="" type="checkbox"/> silt <input checked="" type="checkbox"/> sand <input checked="" type="checkbox"/> gravel <input checked="" type="checkbox"/> cobbles <input type="checkbox"/> boulders <input type="checkbox"/> bedrock <p style="text-align: center;"><i>Vegetated Soil</i></p>	<input checked="" type="checkbox"/> clay <input checked="" type="checkbox"/> silt <input checked="" type="checkbox"/> sand <input checked="" type="checkbox"/> gravel <input checked="" type="checkbox"/> cobbles <input type="checkbox"/> boulders <input type="checkbox"/> bedrock <p style="text-align: center;"><i>Vegetated Soil</i></p>
Layer material	<input checked="" type="checkbox"/> no layers <input type="checkbox"/> cohesive <input type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders	<input checked="" type="checkbox"/> no layers <input type="checkbox"/> cohesive <input type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders
Bank height	6-12 feet <i>depending on location</i>	6-12 feet <i>depending on location</i>
Bank slope	<input checked="" type="checkbox"/> steep <input type="checkbox"/> moderate <i>~ 45°</i> <input type="checkbox"/> shallow	<input checked="" type="checkbox"/> steep <input type="checkbox"/> moderate <i>~ 45°</i> <input type="checkbox"/> shallow
Bank vegetation	<input type="checkbox"/> none <input checked="" type="checkbox"/> grasses/annuals <input checked="" type="checkbox"/> reeds/shrubs <input checked="" type="checkbox"/> trees falling trees? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no tree density: <input type="checkbox"/> sparse <input checked="" type="checkbox"/> dense tree health: <input checked="" type="checkbox"/> good <input type="checkbox"/> poor tree ages: <input checked="" type="checkbox"/> young <input checked="" type="checkbox"/> mature <input type="checkbox"/> old tree diversity? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no	<input type="checkbox"/> none <input checked="" type="checkbox"/> grasses/annuals <input checked="" type="checkbox"/> reeds/shrubs <input checked="" type="checkbox"/> trees falling trees? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no tree density: <input type="checkbox"/> sparse <input checked="" type="checkbox"/> dense tree health: <input checked="" type="checkbox"/> good <input type="checkbox"/> poor tree ages: <input checked="" type="checkbox"/> young <input checked="" type="checkbox"/> mature <input type="checkbox"/> old tree diversity? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no
Bank erosion and failure location	<p><i>None evident in proximity to bridge on either bank</i></p> location of erosion: <input type="checkbox"/> outside meander bend <input type="checkbox"/> inside meander bend <input type="checkbox"/> opposite bar or obstruction <input type="checkbox"/> general type of erosion: <input type="checkbox"/> fluvial <input type="checkbox"/> geotechnical	location of erosion: <input type="checkbox"/> outside meander bend <input type="checkbox"/> inside meander bend <input type="checkbox"/> opposite bar or obstruction <input type="checkbox"/> general type of erosion: <input type="checkbox"/> fluvial <input type="checkbox"/> geotechnical

SECTION 5 – DEBRIS CHARACTERISTICS

PART 8: EVIDENCE OF HIGH DEBRIS DELIVERY POTENTIAL

- Presence of debris at bridge (See Part 9)
- Presence of debris at upstream sites
- Documented need for debris removal at bridge (Contact: _____)
- Evidence of bank erosion

PART 9: DEBRIS TYPE / QUANTITY

- | | | | |
|---|-----------|--|---------|
| <input type="checkbox"/> None | Percent | | Percent |
| <input type="checkbox"/> Small floating debris | <u>30</u> | <input type="checkbox"/> Fine detritus | _____ |
| <input type="checkbox"/> Medium floating debris | <u>15</u> | <input type="checkbox"/> Coarse detritus | _____ |
| <input type="checkbox"/> Large floating debris | <u>55</u> | <input type="checkbox"/> Boulders | _____ |

See notes on back

SECTION 6 - BRIDGE CHARACTERISTICS

PART 10: PIER MEASUREMENTS

Number of piers: 3 piers 1 and 3 are located at top of bank
 pier 2 is located in center of river

Width measurements:

Left bank or abutment to pier: _____ Right bank or abutment to pier 2 43 ft

Width between piers:

Piers	1 - 2	2 - 3	3 - 4	4 - 5	5 - 6
Width (ft)		<u>76 ft</u>			

Height of low chord above stream bed:

PART 11: PIER CHARACTERISTICS

- Single, solid piers rounded nose, aligned with flow
- Multiple, closely spaced pier or pile groups
- Exposed pier footing piles
- Multiple piles, or row of pier columns skewed to approaching flow

PART 12: PIER LOCATION

- Sheltered location (Piers _____)
- In the channel (Piers 2)
- Bank/floodplain (Piers 1, 3)
- In the path of debris flow (Piers 2)

Map ID # 10 , Sequence # 8

**STREAM RECONNAISSANCE
For Debris Accumulation at Bridges**

SECTION 1 - SITE DESCRIPTION

ROAD NAME/NUMBER

SR 621

DATE

BRIDGE NUMBER

STREAM NAME

GPS COORDINATES

N 36° 46.984' }
W 78° 02.566' } +/- 23 ft
Mehrrin River

SECTION 2 - REGION AND VALLEY DESCRIPTION

PART 1: WATERSHED

Land Use

- Natural
- Agricultural
- Urban
- Suburban
- Rural
- Industrial
- Cattle grazing

Vegetation

- None
- Grass
- Pasture
- Crops
- Shrubs
- Deciduous Forest/trees
- Coniferous Forest/trees

PART 2: RIVER VALLEY CONDITION

Valley Side Failures

- None
- Occasional
- Frequent

Failure Locations

- None
- Away from river
- Along river

PART 3: FLOODPLAIN

Floodplain Width

- None
- <1 river width
- 1-5 river widths
- 5-10 river widths
- >10 river widths

Land Use

- Natural
- Agricultural
- Urban
- Suburban
- Rural
- Industrial
- Mining
- Cattle grazing

Vegetation

- None
- Grass
- Pasture
- Orchards
- Crops
- Shrubs
- Deciduous Forest/trees
- Coniferous Forest/trees

Riparian Buffer Strip

- None
- <1 river width
- 1-5 river widths
- >5 river widths

↓
Except for
Sand mine
processing area

→ Sand mining in river
upstream from bridge
< 1 acre cleared floodplain

Roanoke
is in
headwaters
of
watershed

38) debris caught on bridge deck
39) large debris caught between abutment and road grade

- picture: 33) right bridge abutment, from downstream right bank
 34) evidence of debris accumulation on bridge deck
 35) upstream, from bridge deck (note debris on left bank)
 36) downstream, from bridge deck (note large debris quantity)
 37) left abutment, from upstream in stream
 left bank

PART 4: VERTICAL CONFINEMENT

Terraces

- None
- Left bank
- Right bank

Levees

- None
- Natural
- Constructed

Levee Location

- Along channel bank
- Set back <1 river width
- Set back >1 river width

PART 5: LATERAL RELATION OF CHANNEL TO VALLEY

Planform

- Straight
- Meandering
- Braided
- Anastomosed
- Engineered

Meander Characteristics

- Mild bends
- Moderate bends
- Tight bends

SECTION 3 - CHANNEL DESCRIPTION

PART 6: CHANNEL DESCRIPTION (select all that apply)

Bed Controls

- None
- Occasional
- Frequent
- Confined

Control Types

- None
- Bedrock
- Boulders
- Gravel armor
- Bridge protection
- Grade control
- Debris
- Dams (beaver, engineered)

Width Controls

- None
- Occasional
- Frequent
- Confined

→ except
bridge abutments

Control Types

- None
- Bedrock
- Boulders
- Gravel armor
- Bridge protection
- Bridge abutments
- Bank stabilization
- Debris

Other

- Debris
- Mining (sand) upstream
- Reservoir
- Knickpoint

M-B classification

- Cascade or step-pool
- Plane, pool-riffle, dune-ripple
- Braided

Corps classification (other)

- Modified (engineered)
- Regulated
- Arroyo

Flow Habit

- Perennial
- Flashy perennial
- Intermittent
- Ephemeral

Channel width = 78 ft at bridge

PART 7: BED SEDIMENT DESCRIPTION (select all that apply)

Bed Material

- Clay
- Silt
- Sand
- Gravel
- Cobbles
- Boulders

Bar Types

- None
- Alternate bars
- Point bars
- Mid-channel bars
- Diagonal bars
- Irregular/combination

Bar Material

- Silt
- Sand
- Gravel
- Cobbles

Bar Vegetation

- None
- Grasses
- Reeds/shrubs
- Trees

Bar Width

- None
- Narrow
- Moderate
- Wide

SECTION 4 - BANK SURVEY (select all that apply)

Bank Characteristic	Left Bank	Right Bank
Bank material	<input checked="" type="checkbox"/> clay <input checked="" type="checkbox"/> silt <input checked="" type="checkbox"/> sand <input checked="" type="checkbox"/> gravel <input checked="" type="checkbox"/> cobbles <input type="checkbox"/> boulders <input type="checkbox"/> bedrock <i>Vegetated Soil</i>	<input checked="" type="checkbox"/> clay <input checked="" type="checkbox"/> silt <input checked="" type="checkbox"/> sand <input checked="" type="checkbox"/> gravel <input checked="" type="checkbox"/> cobbles <input type="checkbox"/> boulders <input type="checkbox"/> bedrock <i>Vegetated Soil</i>
Layer material	<input checked="" type="checkbox"/> no layers <input type="checkbox"/> cohesive <input type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders	<input checked="" type="checkbox"/> no layers <input type="checkbox"/> cohesive <input type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders
Bank height	12 - 15 ft	12 - 15 ft
Bank slope	<input checked="" type="checkbox"/> steep <input type="checkbox"/> moderate <input type="checkbox"/> shallow <i>> 45°</i>	<input checked="" type="checkbox"/> steep <input type="checkbox"/> moderate <input type="checkbox"/> shallow <i>> 45°</i>
Bank vegetation	<input type="checkbox"/> none <input checked="" type="checkbox"/> grasses/annuals <input checked="" type="checkbox"/> reeds/shrubs <input checked="" type="checkbox"/> trees falling trees? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no tree density: <input type="checkbox"/> sparse <input checked="" type="checkbox"/> dense tree health: <input checked="" type="checkbox"/> good <input type="checkbox"/> poor tree ages: <input checked="" type="checkbox"/> young <input checked="" type="checkbox"/> mature <input type="checkbox"/> old tree diversity? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no	<input type="checkbox"/> none <input checked="" type="checkbox"/> grasses/annuals <input checked="" type="checkbox"/> reeds/shrubs <input checked="" type="checkbox"/> trees falling trees? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no tree density: <input type="checkbox"/> sparse <input checked="" type="checkbox"/> dense tree health: <input checked="" type="checkbox"/> good <input type="checkbox"/> poor tree ages: <input checked="" type="checkbox"/> young <input checked="" type="checkbox"/> mature <input type="checkbox"/> old tree diversity? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no
Bank erosion and failure location	<i>No Significant Signs of erosion @ bridge</i> location of erosion: <input type="checkbox"/> outside meander bend <input type="checkbox"/> inside meander bend <input type="checkbox"/> opposite bar or obstruction <input type="checkbox"/> general type of erosion: <input type="checkbox"/> fluvial <input type="checkbox"/> geotechnical	location of erosion: <input type="checkbox"/> outside meander bend <input type="checkbox"/> inside meander bend <input type="checkbox"/> opposite bar or obstruction <input checked="" type="checkbox"/> general type of erosion: <input checked="" type="checkbox"/> fluvial <input type="checkbox"/> geotechnical <i>erosion of bank downstream of bridge</i>

SECTION 5 - DEBRIS CHARACTERISTICS

PART 8: EVIDENCE OF HIGH DEBRIS DELIVERY POTENTIAL

- Presence of debris at bridge (See Part 9)
- Presence of debris at upstream sites
- Documented need for debris removal at bridge (Contact: _____)
- Evidence of bank erosion

PART 9: DEBRIS TYPE / QUANTITY

- | | | | |
|--|---------|--|---------|
| <input type="checkbox"/> None | Percent | | Percent |
| <input type="checkbox"/> Small floating debris | _____ | <input type="checkbox"/> Fine detritus | _____ |
| <input checked="" type="checkbox"/> Medium floating debris | _____ | <input type="checkbox"/> Coarse detritus | _____ |
| <input type="checkbox"/> Large floating debris | _____ | <input type="checkbox"/> Boulders | _____ |

→ one piece stuck on deck - road crew at site said debris was recently removed

SECTION 6 - BRIDGE CHARACTERISTICS

PART 10: PIER MEASUREMENTS

Number of piers: 0

Width measurements:

Left bank or abutment to pier: _____ Right bank or abutment to pier: _____

Width between piers: Abutment to Abutment: 78 ft

Piers	1 - 2	2 - 3	3 - 4	4 - 5	5 - 6
Width (ft)					

Height of low chord above stream bed: 15 ft above water surface

- PART 11: PIER CHARACTERISTICS - No piers - abutments located at water edge - low chord at bank height
- Single, solid piers
 - Multiple, closely spaced pier or pile groups
 - Exposed pier footing piles
 - Multiple piles, or row of pier columns skewed to approaching flow

PART 12: PIER LOCATION

- Sheltered location (Piers _____)
- In the channel (Piers _____)
- Bank/floodplain (Piers _____)
- In the path of debris flow (Piers _____)

See notes on back

- No piers - single span bridge
- Road workers say that river commonly (return period unknown) floods to level of low chord
- Low chord and abutments provide structure to catch debris - see pictures for bridge design

Site # 1

**STREAM RECONNAISSANCE
For Debris Accumulation at Bridges**

SECTION 1 - SITE DESCRIPTION

ROAD NAME/NUMBER

SR 249

DATE

3/10/2008

BRIDGE NUMBER

11-249-2.56

STREAM NAME

Harpeth River

GPS COORDINATES

N 36° 06.435', +/- 20 feet
W 87° 04.408'

SECTION 2 - REGION AND VALLEY DESCRIPTION

PART 1: WATERSHED

Land Use

- Natural
- Agricultural
- Urban
- Suburban
- Rural
- Industrial
- Cattle grazing

Vegetation

- None
- Grass
- Pasture
- Crops
- Shrubs
- Deciduous Forest/trees
- Coniferous Forest/trees

PART 2: RIVER VALLEY CONDITION

Valley Side Failures

- None
- Occasional
- Frequent

Failure Locations

- None
- Away from river
- Along river

PART 3: FLOODPLAIN

Floodplain Width

- None
- <1 river width
- 1-5 river widths
- 5-10 river widths
- >10 river widths

Land Use

- Natural
- Agricultural
- Urban
- Suburban
- Rural
- Industrial
- Mining
- Cattle grazing

Vegetation

- None
- Grass
- Pasture
- Orchards
- Crops
- Shrubs
- Deciduous Forest/trees
- Coniferous Forest/trees

Riparian Buffer Strip

- None
- <1 river width
- 1-5 river widths
- >5 river widths

- Pictures:
- 1) Debris buildup on pier 3, from right bank, upstream
 - 2) Close up of pier 3 " " " " (note pier nose damage)
 - 3) Debris from right bank, upstream of bridge
 - 4) Upstream, from bridge deck
 - 5) Downstream, from bridge deck

PART 4: VERTICAL CONFINEMENT

Terraces

- None
- Left bank
- Right bank

Levees

- None
- Natural
- Constructed

Levee Location

- Along channel bank
- Set back <1 river width
- Set back >1 river width

PART 5: LATERAL RELATION OF CHANNEL TO VALLEY

Planform

- Straight
- Meandering
- Braided
- Anastomosed
- Engineered

Meander Characteristics

- Mild bends
- Moderate bends
- Tight bends

SECTION 3 - CHANNEL DESCRIPTION

PART 6: CHANNEL DESCRIPTION (select all that apply)

Bed Controls

- None
- Occasional
- Frequent
- Confined

Control Types

- None
- Bedrock
- Boulders
- Gravel armor
- Bridge protection
- Grade control
- Debris
- Dams (beaver, engineered)

Width Controls

- None
- Occasional
- Frequent
- Confined

Control Types

- None
- Bedrock
- Boulders
- Gravel armor
- Bridge protection
- Bridge abutments
- Bank stabilization
- Debris

Other

- Debris
- Mining
- Reservoir
- Knickpoint

M-B classification

- Cascade or step-pool
- Plane, pool-riffle, dune-ripple
- Braided

Corps classification (other)

- Modified (engineered)
- Regulated
- Arroyo

Flow Habit

- Perennial
- Flashy perennial
- Intermittent
- Ephemeral

Channel width = 150 ft

PART 7: BED SEDIMENT DESCRIPTION (select all that apply)

Bed Material

- Clay
- Silt
- Sand
- Gravel
- Cobbles
- Boulders

Bar Types

- None
- Alternate bars
- Point bars
- Mid-channel bars
- Diagonal bars
- Irregular/combination

Bar Material

- Silt
- Sand
- Gravel
- Cobbles

Bar Vegetation

- None
- Grasses
- Reeds/shrubs
- Trees

Bar Width

- None
- Narrow
- Moderate
- Wide

SECTION 4 - BANK SURVEY (select all that apply)

Bank Characteristic	Left Bank	Right Bank
Bank material	<input type="checkbox"/> clay <input checked="" type="checkbox"/> silt <input checked="" type="checkbox"/> sand <input checked="" type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders <input type="checkbox"/> bedrock	<input type="checkbox"/> clay <input checked="" type="checkbox"/> silt <input checked="" type="checkbox"/> sand <input checked="" type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders <input type="checkbox"/> bedrock
Layer material	<input checked="" type="checkbox"/> no layers <input type="checkbox"/> cohesive <input type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders	<input checked="" type="checkbox"/> no layers <input type="checkbox"/> cohesive <input type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders
Bank height	10 feet	10 feet
Bank slope	<input checked="" type="checkbox"/> steep <input type="checkbox"/> moderate <input type="checkbox"/> shallow	<input checked="" type="checkbox"/> steep <input type="checkbox"/> moderate <input type="checkbox"/> shallow
Bank vegetation	<input type="checkbox"/> none <input checked="" type="checkbox"/> grasses/annuals <input type="checkbox"/> reeds/shrubs <input checked="" type="checkbox"/> trees falling trees? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no tree density: <input type="checkbox"/> sparse <input checked="" type="checkbox"/> dense tree health: <input checked="" type="checkbox"/> good <input type="checkbox"/> poor tree ages: <input checked="" type="checkbox"/> young <input checked="" type="checkbox"/> mature <input type="checkbox"/> old tree diversity? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no	<input type="checkbox"/> none <input checked="" type="checkbox"/> grasses/annuals <input type="checkbox"/> reeds/shrubs <input checked="" type="checkbox"/> trees falling trees? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no tree density: <input type="checkbox"/> sparse <input checked="" type="checkbox"/> dense tree health: <input checked="" type="checkbox"/> good <input type="checkbox"/> poor tree ages: <input checked="" type="checkbox"/> young <input checked="" type="checkbox"/> mature <input type="checkbox"/> old tree diversity? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no
Bank erosion and failure location	location of erosion: <input type="checkbox"/> outside meander bend <input type="checkbox"/> inside meander bend <input type="checkbox"/> opposite bar or obstruction <input checked="" type="checkbox"/> general type of erosion: <input checked="" type="checkbox"/> fluvial <input type="checkbox"/> geotechnical	location of erosion: <input type="checkbox"/> outside meander bend <input type="checkbox"/> inside meander bend <input type="checkbox"/> opposite bar or obstruction <input checked="" type="checkbox"/> general type of erosion: <input checked="" type="checkbox"/> fluvial <input type="checkbox"/> geotechnical

SECTION 5 – DEBRIS CHARACTERISTICS

PART 8: EVIDENCE OF HIGH DEBRIS DELIVERY POTENTIAL

- Presence of debris at bridge (See Part 9)
- Presence of debris at upstream sites
- Documented need for debris removal at bridge (Contact: _____)
- Evidence of bank erosion

PART 9: DEBRIS TYPE / QUANTITY

- | | | | | |
|--|-----------|--|--|---------|
| <input type="checkbox"/> None | Percent | | <input type="checkbox"/> Fine detritus | Percent |
| <input checked="" type="checkbox"/> Small floating debris | <u>25</u> | | <input type="checkbox"/> Coarse detritus | _____ |
| <input checked="" type="checkbox"/> Medium floating debris | <u>25</u> | | <input type="checkbox"/> Boulders | _____ |
| <input checked="" type="checkbox"/> Large floating debris | <u>50</u> | | | |

SECTION 6 - BRIDGE CHARACTERISTICS

PART 10: PIER MEASUREMENTS

Number of piers: 4

Width measurements: (2) Left bank or abutment to pier: 5 Right bank or abutment to pier: (3) 55

Width between piers:

Piers	1 - 2	2 - 3	3 - 4	4 - 5	5 - 6
Width (ft)	<u>80</u>	<u>80</u>	<u>80</u>		

Height of low chord above stream bed: 30 ft above ∇

PART 11: PIER CHARACTERISTICS

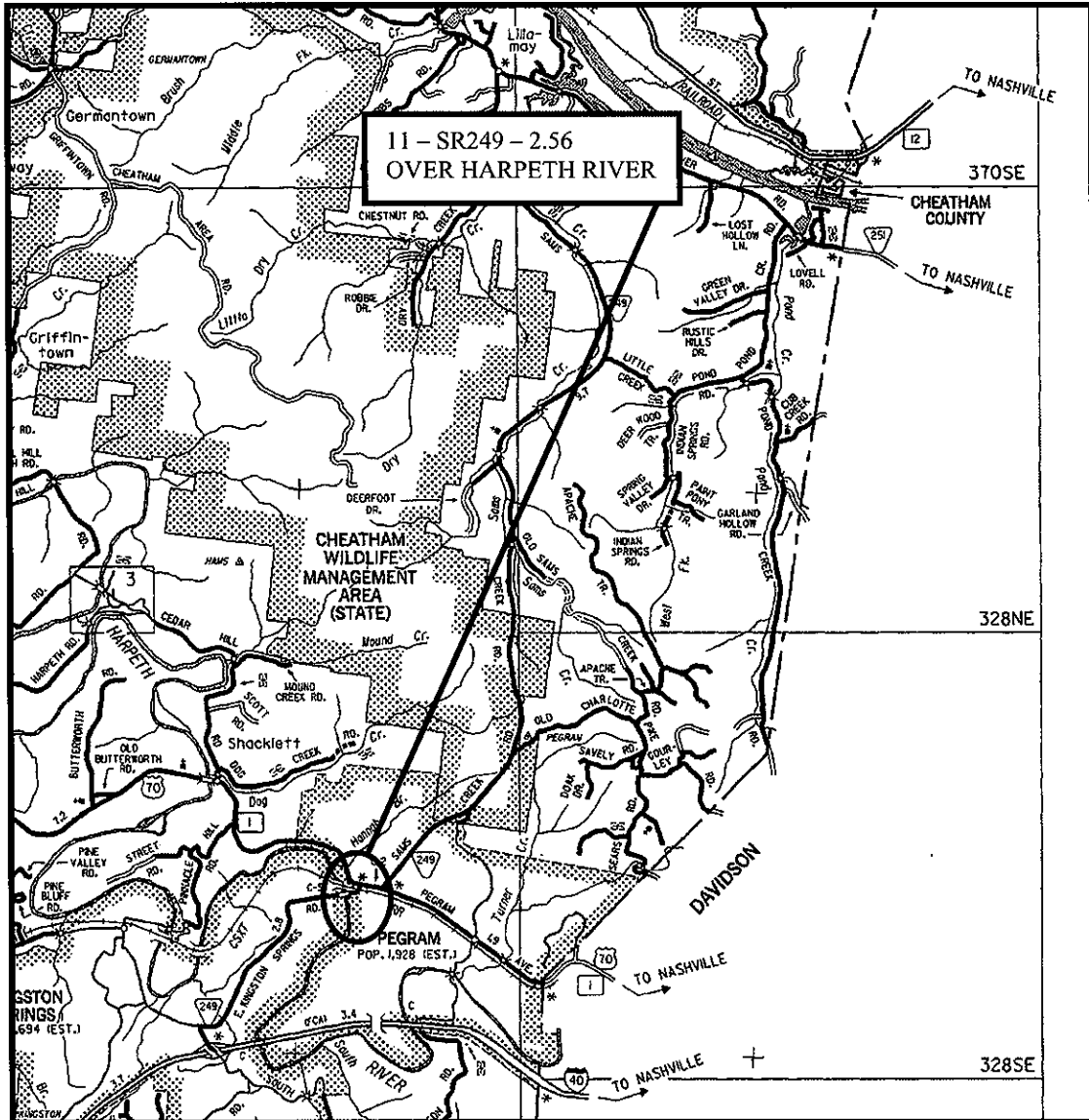
- Single, solid piers
- Multiple, closely spaced pier or pile groups
- Exposed pier footing piles
- Multiple piles, or row of pier columns skewed to approaching flow

PART 12: PIER LOCATION

- Sheltered location (Piers _____)
- In the channel (Piers 2,3)
- Bank/floodplain (Piers 1,4)
- In the path of debris flow (Piers 3)

Site # 1

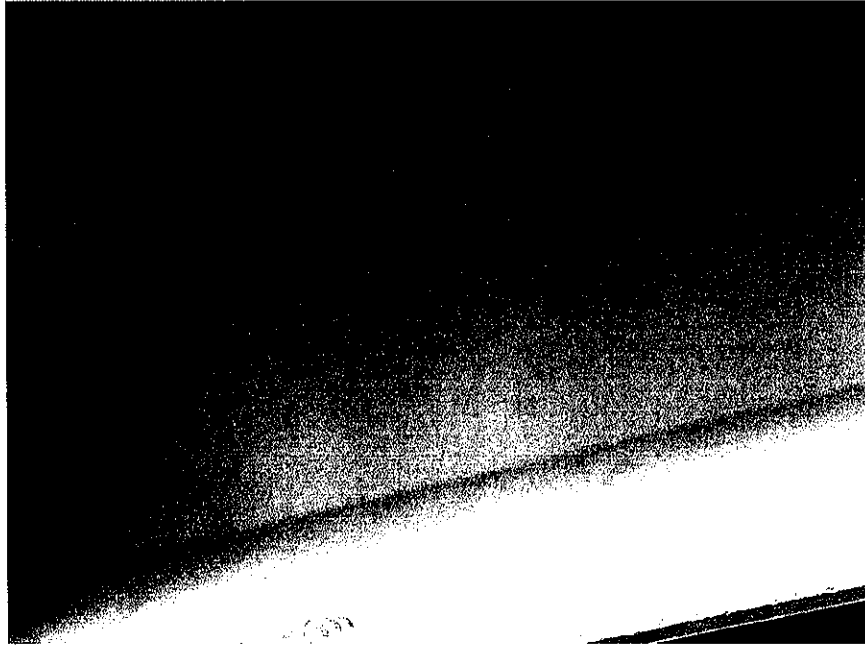
CHEATHAM COUNTY



Photographs

Bridge ID#: 11S61520005

Date: 09/25/2006



BRIDGE NO.



APPROACH #1

Photographs

Bridge ID#: 11S61520005

Date: 09/25/2006



LOOKING DOWNSTREAM



VIEW ACROSS TOP OF DECK

Photographs

Bridge ID#: 11S61520005

Date: 09/25/2006



RIGHT SIDE VIEW OF BRIDGE



ABUTMENT #1

Photographs

Bridge ID#: 11S61520005

Date: 09/25/2006



HEAVY DRIFT AT PIER #3

BRIDGE INSPECTION REPORT

Page No. _____

Form BIR 3.0
(Rev. 9-22-98)
DT-0069Field Report No. 18 Date 9/25/2006
Previous Report No. 17 Date 9/13/2004
Plans: YESBridge No. 11S61520005Bridge Location No. 11 - SR249 - 2.56 NEleven Digit No. _____
STATE ROUTE NO. 249 over HARPETH RIVER RUDOLPH CARUTHERS BRIDG
Road Name Crossing Structure Name (If Named)
Year Constructed 1995 ESTIMATED County CHEATHAM Maintenance District 33
Year Widened _____ Year Rehabilitated _____

FEATURES

Wearing Surface CONCRETE Depth _____ (in.)
Flared Width NO Median Width NONE
Navigational Control NO Bridge Skew 83° RT
Structure Type (Main Span) PPCIB
Structure Type (Appr.Spans) N.A.
No. Main Spans 5 No. Approach Spans 0
Maximum Span Length 82.71 (**.* ft.)
Total Length 412.02 (**.* ft.)

INSPECTORS

1. CHOATE
2. HOWELL
3. WILLIAMS
4. GARBER
5. _____
6. _____
7. _____
8. _____

WIDTHS (*.* ft.)

Deck Out-to-Out 42
Roadway Curb/Curb 40
Roadway Rail/Rail _____
Sidewalk Rt. _____ Lt. _____
*Approach Roadway 24
*(Does Not Include Shoulders)
Approach Shoulder Rt. 9
Lt. 9

CLEARANCES

Min. Vertical Clearance over Deck _____ (ft.-in.)
Min. Vertical Under Clearance _____ (ft.-in.)
Min. Lateral Under Clearance Rt. _____ (*.* ft.)
Min. Lateral Under Clearance Lt. _____ (*.* ft.)FRACTURE CRITICAL: NO
(If Yes, Include BIR 3.9)NBIS Bridge Length (<25 ft.) >25 (ft.-in.)

UNDERWATER INSPECTION

To Be Performed By: CONTRACT DIVERS Date _____Change in Structural Condition: NO Major Repairs Made: NO BRIDGE is: OPEN

COMMENTS:

WATER DEPTH IS OVER 4'-0" DEEP

Supervising Bridge Inspector: _____

BRIDGE RATING: GOOD

STREAM CHANNEL DATA AND CONDITIONS

Stream Crossing: HARPETH RIVER

- I. 1. Type of bed material? GRAVEL/ MUD
- 2. Has channel shifted? _____ (Yes/ No/ Not Apparent)
- 3. Condition of rip-rap? GOOD Est. % failed _____ %
- 4. Overall condition of channel? GOOD
- 5. Item 61 - Code values 0 thru 9 according to the recording and coding guide currently in effect: 8
- 6. Underwater diver inspection recommended? NO
If yes, why? _____

- II. Channel and bank stability conditions: (yes if applicable)
 - 1. Steep bank conditions: Failures upstream _____ Failures downstream _____
 - 2. Moderate bank erosion _____
 - 3. Bank vegetation: a. low growth YES b. large timber YES c. clear banks _____
d. dead trees upstream _____ e. dead trees downstream _____
 - 4. Sediment or gravel accumulation: NO (Yes/ No/ Unknown)
 - 5. Channel altered or straightened: NO (Yes/ No/ Unknown)
 - 6. Stable conditions: a. live growth YES b. bedrock _____
c. boulders _____ d. flat slopes (<=2:1) _____

- III. Waterway adequacy and debris characteristics: (yes if applicable)
 - 1. Bridge deck elevations:
 - a. level with approach roadway. YES
 - b. higher than approach roadway. _____
 - c. roadway approach >= 2 ft. above natural ground line. . YES
 - 2. Abutment encroaches into channel. _____
 - 3. Large scour (blowhole) under bridge. _____
 - 4. Indications that flood waters overtop bridge: NO (Yes/No)
If YES, Answer: Occasionally, Frequently, or Unknown _____
 - 5. Debris characteristics:
 - a. debris/drift present YES
 - b. debris/drift likely to accumulate YES
 - c. dead trees upstream _____ dead trees downstream _____

IV. Comments: VERY HEAVY DRIFT PRESENT ON PIER NO. 3.

SPECIAL INSPECTION DATA - FOR REASONS OTHER THAN FC OR SCOUR

- I. Does this bridge need a special inspection? NO
- II. Reason for special inspection:

Site #2

**STREAM RECONNAISSANCE
For Debris Accumulation at Bridges**

SECTION 1 - SITE DESCRIPTION

ROAD NAME/NUMBER

SR 250

DATE

3/10/2008

BRIDGE NUMBER

22-SR250-6.14

STREAM NAME

Harpeth River

GPS COORDINATES

N 36° 11.552' 17.14 feet
W 87° 10.093'

SECTION 2 - REGION AND VALLEY DESCRIPTION

PART 1: WATERSHED

Land Use

- Natural
- Agricultural
- Urban
- Suburban
- Rural
- Industrial
- Cattle grazing

Vegetation

- None
- Grass
- Pasture
- Crops
- Shrubs
- Deciduous Forest/trees
- Coniferous Forest/trees

PART 2: RIVER VALLEY CONDITION

Valley Side Failures

- None
- Occasional
- Frequent

Failure Locations

- None
- Away from river
- Along river

alt. large watershed

PART 3: FLOODPLAIN

Floodplain Width

- None
- <1 river width
- 1-5 river widths
- 5-10 river widths
- >10 river widths

Land Use

- Natural
- Agricultural
- Urban
- Suburban
- Rural
- Industrial
- Mining
- Cattle grazing

Vegetation

- None
- Grass
- Pasture
- Orchards
- Crops
- Shrubs
- Deciduous Forest/trees
- Coniferous Forest/trees

Riparian Buffer Strip

- None
- <1 river width
- 1-5 river widths
- >5 river widths

- 1) Bridge, from right bank, downstream
- 2) floodplain piers, right bank
- 3) instream piers
- 4) debris on pier 3 (note damage on pier face, old mounting brackets for debris sweeper)
- 5) upstream from deck
- 6) downstream from deck
- 7) " " deck

PART 4: VERTICAL CONFINEMENT

Terraces

- None
- Left bank
- Right bank

Levees

- None
- Natural
- Constructed

Levee Location

- Along channel bank
- Set back <1 river width
- Set back >1 river width

PART 5: LATERAL RELATION OF CHANNEL TO VALLEY

Planform

- Straight
- Meandering
- Braided
- Anastomosed
- Engineered

Meander Characteristics

- Mild bends
- Moderate bends
- Tight bends

SECTION 3 - CHANNEL DESCRIPTION

PART 6: CHANNEL DESCRIPTION (select all that apply)

Bed Controls

- None
- Occasional
- Frequent
- Confined

Control Types

- None
- Bedrock
- Boulders
- Gravel armor
- Bridge protection
- Grade control
- Debris
- Dams (beaver, engineered)

Width Controls

- None
- Occasional
- Frequent
- Confined

Control Types

- None
- Bedrock
- Boulders
- Gravel armor
- Bridge protection
- Bridge abutments
- Bank stabilization
- Debris

Other

- Debris
- Mining
- Reservoir
- Knickpoint

M-B classification

- Cascade or step-pool
- Plane, pool-riffle, dune-ripple
- Braided

Corps classification (other)

- Modified (engineered)
- Regulated
- Arroyo

Flow Habit

- Perennial
- Flashy perennial
- Intermittent
- Ephemeral

Channel width = 150

PART 7: BED SEDIMENT DESCRIPTION (select all that apply)

Bed Material

- Clay
- Silt
- Sand
- Gravel
- Cobbles
- Boulders

Bar Types

- None
- Alternate bars
- Point bars
- Mid-channel bars
- Diagonal bars
- Irregular/combination

Bar Material

- Silt
- Sand
- Gravel
- Cobbles

Bar Vegetation

- None
- Grasses
- Reeds/shrubs
- Trees

Bar Width

- None
- Narrow
- Moderate
- Wide

SECTION 4 - BANK SURVEY (select all that apply)

Bank Characteristic	Left Bank	Right Bank
Bank material	<input type="checkbox"/> clay <input checked="" type="checkbox"/> silt <input checked="" type="checkbox"/> sand <input checked="" type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders <input type="checkbox"/> bedrock	<input type="checkbox"/> clay <input checked="" type="checkbox"/> silt <input checked="" type="checkbox"/> sand <input checked="" type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders <input type="checkbox"/> bedrock
Layer material	<input checked="" type="checkbox"/> no layers <input type="checkbox"/> cohesive <input type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders	<input checked="" type="checkbox"/> no layers <input type="checkbox"/> cohesive <input type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders
Bank height	8-12 feet	8-12 feet
Bank slope	<input checked="" type="checkbox"/> steep <input type="checkbox"/> moderate <input type="checkbox"/> shallow	<input checked="" type="checkbox"/> steep <input type="checkbox"/> moderate <input type="checkbox"/> shallow
Bank vegetation	<input type="checkbox"/> none <input checked="" type="checkbox"/> grasses/annuals <input type="checkbox"/> reeds/shrubs <input checked="" type="checkbox"/> trees falling trees? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no tree density: <input type="checkbox"/> sparse <input checked="" type="checkbox"/> dense tree health: <input checked="" type="checkbox"/> good <input type="checkbox"/> poor tree ages: <input checked="" type="checkbox"/> young <input checked="" type="checkbox"/> mature <input type="checkbox"/> old tree diversity? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no	<input type="checkbox"/> none <input checked="" type="checkbox"/> grasses/annuals <input type="checkbox"/> reeds/shrubs <input checked="" type="checkbox"/> trees falling trees? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no tree density: <input type="checkbox"/> sparse <input checked="" type="checkbox"/> dense tree health: <input checked="" type="checkbox"/> good <input type="checkbox"/> poor tree ages: <input checked="" type="checkbox"/> young <input checked="" type="checkbox"/> mature <input type="checkbox"/> old tree diversity? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no
Bank erosion and failure location	location of erosion: <input checked="" type="checkbox"/> outside meander bend <i>downstream of bridge</i> <input type="checkbox"/> inside meander bend <input type="checkbox"/> opposite bar or obstruction <input type="checkbox"/> general type of erosion: <input checked="" type="checkbox"/> fluvial <input type="checkbox"/> geotechnical	location of erosion: <input checked="" type="checkbox"/> outside meander bend <i>upstream of bridge</i> <input type="checkbox"/> inside meander bend <input type="checkbox"/> opposite bar or obstruction <input type="checkbox"/> general type of erosion: <input checked="" type="checkbox"/> fluvial <input type="checkbox"/> geotechnical

SECTION 5 – DEBRIS CHARACTERISTICS

PART 8: EVIDENCE OF HIGH DEBRIS DELIVERY POTENTIAL

- Presence of debris at bridge (See Part 9)
- Presence of debris at upstream sites
- Documented need for debris removal at bridge (Contact: _____)
- Evidence of bank erosion

PART 9: DEBRIS TYPE / QUANTITY

- | | | | | |
|--|-----------|--|--|---------|
| <input type="checkbox"/> None | Percent | | <input type="checkbox"/> Fine detritus | Percent |
| <input type="checkbox"/> Small floating debris | _____ | | <input type="checkbox"/> Coarse detritus | _____ |
| <input checked="" type="checkbox"/> Medium floating debris | <u>25</u> | | <input type="checkbox"/> Boulders | _____ |
| <input checked="" type="checkbox"/> Large floating debris | <u>75</u> | | | |

SECTION 6 - BRIDGE CHARACTERISTICS

PART 10: PIER MEASUREMENTS

Number of piers: many in floodplain, 4 in channel

Width measurements:
 Left bank or abutment to pier: 0 Right bank or abutment to pier: 5

Width between piers:

Piers	1 - 2	2 - 3	3 - 4	4 - 5	5 - 6
Width (ft)	<u>45 ft</u>	<u>60 ft</u>	<u>45 ft</u>		

Height of low chord above stream bed: ~40 feet

PART 11: PIER CHARACTERISTICS

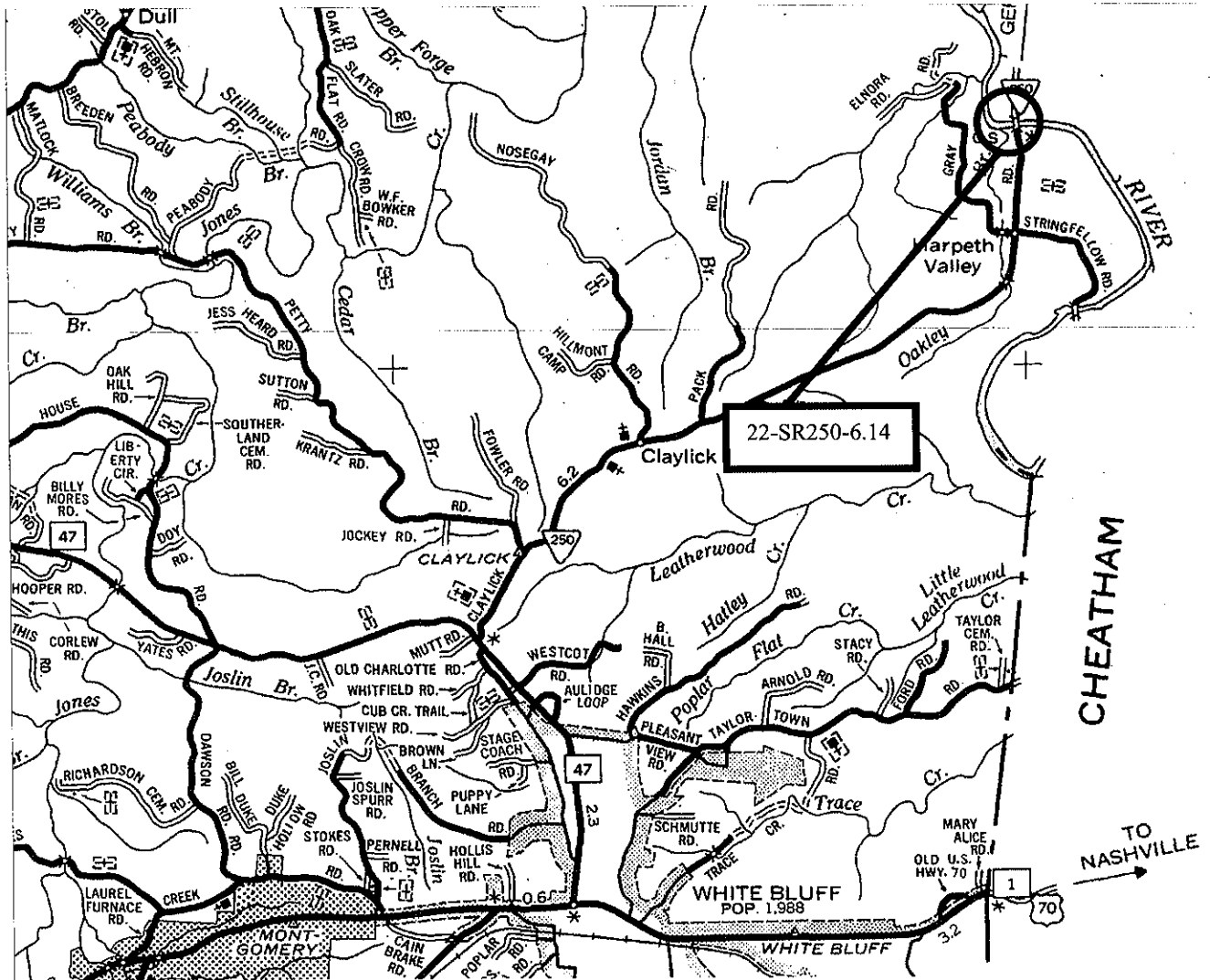
- Single, solid piers 2 and 3
- Multiple, closely spaced pier or pile groups
- Exposed pier footing piles
- Multiple piles, or row of pier columns skewed to approaching flow
- H-piles - piers 1 and 4

PART 12: PIER LOCATION

- Sheltered location (Piers 1, 4)
- In the channel (Piers 2, 3)
- Bank/floodplain (Piers many)
- In the path of debris flow (Piers 3)

Site # 2

DICKSON



Bridge No.: 22 — SR250 — 6.14
Crossing: HARPETH RIVER
Federal No.: 22S614900031

Date: June 30, 2006

PIC1

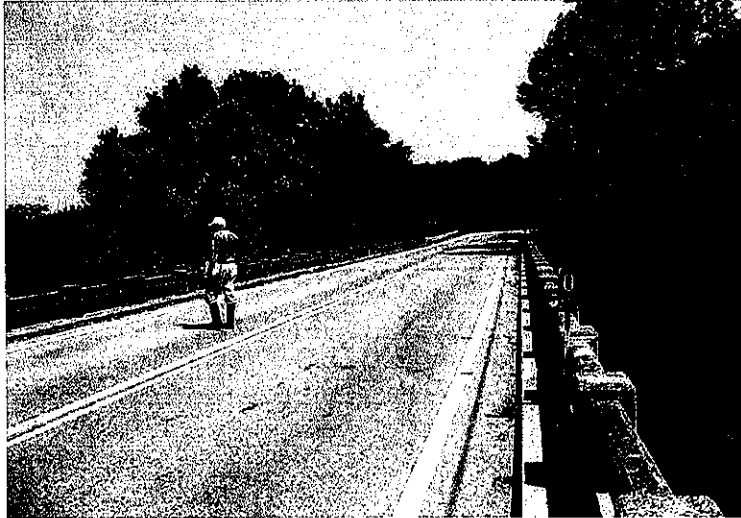


BRIDGE NO. ABUTMENT NO. 1

Bridge No.: 22 —SR250 — 6.14
Crossing:: HARPETH RIVER
Federal No 22S614900031

Date: June 30, 2006

PIC2



APPROACH ABUTMENT NO. 2

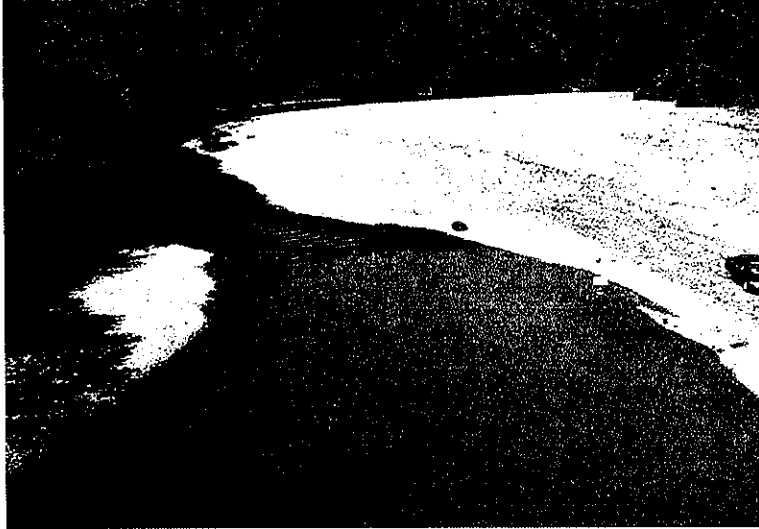
PIC3



UPSTREAM

Bridge No.: 22 — SR250 — 6.14 RIGHT
Crossing:: HARPETH RIVER
Federal No.: 22S614900031 Date: June 30, 2006

PIC4



DOWNSTREAM

PIC5



ACROSS TOP OF DECK

Bridge No.: 22 — SR250 — 6.14
Crossing:: HARPETH RIVER
Federal No.: 22S614900031

Date: June 30, 2006

PIC6



EXPOSED PILES "D" AT BENT NO. 10

PIC7



ELEV. VIEW, RIGHT SIDE

Bridge No.: 22 —SR250 — 6.14
Crossing:: HARPETH RIVER
Federal No.: 22S614900031

Date: June 30, 2006

PIC8



CHIPS AT PIER NO. 1

PIC9



CHIPS AT PIER NO. 2

Bridge No.: 22 — SR250 — 6.14 RIGHT
Crossing:: HARPETH RIVER
Federal No.: 22S614900031 Date: June 30, 2006

PIC10



CHIPS AT RIGHT END OF BENT NO. 12.

PIC11



BENT NO. 12-TYP CONCRETE

Bridge No.: 22 — SR250 — 6.14
Crossing: HARPETH RIVER
Federal No.: 22S614900031

Date: June 30, 2006

PIC12



BENT NO. 13 TYP- STEEL

PIC13



PIER NO. 2-TYP

BRIDGE INSPECTION REPORT

Page No. _____

Form BIR 3.0
(Rev. 9-22-98)
DT-0069Field Report No. 18 Date 6/30/2006
Previous Report No. 17 Date 6/29/2004
Plans: YESBridge No. 22S61490003
Eleven Digit No.Bridge Location No. 22 - SR250 - 6.14 N
Co. Route Log MileSTATE ROUTE 250 over HARPETH RIVER HERBERT L.(HUB) HARRIS
Road Name Crossing Structure Name (If Named)Year Constructed 1961 ACTUAL County DICKSON Maintenance District 35
Year Widened _____ Year Rehabilitated _____

FEATURES

Wearing Surface ASPHALT Depth 4 (in.)Flared Width NO Median Width NONENavigational Control NO Bridge Skew 90°Structure Type (Main Span) C.D.G.Structure Type (Appr.Spans) C.D.G.No. Main Spans 3 No. Approach Spans 16Maximum Span Length 60 (**.* ft.)Total Length 608 (**.* ft.)

INSPECTORS

1. CHOATE2. HOWELL3. FORD

4. _____

5. _____

6. _____

7. _____

8. _____

WIDTHS (*.* ft.)

Deck Out-to-Out 28.5Roadway Curb/Curb 24

Roadway Rail/Rail _____

Sidewalk Rt. _____ Lt. _____

*Approach Roadway 20

*(Does Not Include Shoulders)

Approach Shoulder Rt. 10Lt. 10

CLEARANCES

Min. Vertical Clearance over Deck _____ (ft.-in.)

Min. Vertical Under Clearance _____ (ft.-in.)

Min. Lateral Under Clearance Rt. _____ (*.* ft.)

Min. Lateral Under Clearance Lt. _____ (*.* ft.)

FRACTURE CRITICAL: NO

(If Yes, Include BIR 3.9)

NBIS Bridge Length (<25 ft.) _____ (ft.-in.)

UNDERWATER INSPECTION

To Be Performed By: CONTACT DIVERS / GARV Date 8/10/2001Change in Structural Condition: NO Major Repairs Made: NO BRIDGE is: OPEN

COMMENTS:

Supervising Bridge Inspector: _____

BRIDGE RATING: FAIR

STREAM CHANNEL DATA AND CONDITIONS

Stream Crossing: HARPETH RIVER

- I. 1. Type of bed material? GRAVEL
- 2. Has channel shifted? NO (Yes/ No/ Not Apparent)
- 3. Condition of rip-rap? GOOD Est. % failed _____ %
- 4. Overall condition of channel? FAIR
- 5. Item 61 - Code values 0 thru 9 according to the recording and coding guide currently in effect: 5
- 6. Underwater diver inspection recommended? NO
If yes, why? _____

- II. Channel and bank stability conditions: (yes if applicable)
 - 1. Steep bank conditions: Failures upstream _____ Failures downstream _____
 - 2. Moderate bank erosion _____
 - 3. Bank vegetation: a. low growth YES b. large timber YES c. clear banks _____
d. dead trees upstream _____ e. dead trees downstream _____
 - 4. Sediment or gravel accumulation: NO (Yes/ No/ Unknown)
 - 5. Channel altered or straightened: NO (Yes/ No/ Unknown)
 - 6. Stable conditions: a. live growth YES b. bedrock _____
c. boulders _____ d. flat slopes (<=2:1) _____

- III. Waterway adequacy and debris characteristics: (yes if applicable)
 - 1. Bridge deck elevations:
 - a. level with approach roadway. YES
 - b. higher than approach roadway. _____
 - c. roadway approach >= 2 ft. above natural ground line. . YES
 - 2. Abutment encroaches into channel. _____
 - 3. Large scour (blowhole) under bridge. _____
 - 4. Indications that flood waters overtop bridge: NO (Yes/No)
If YES, Answer: Occasionally, Frequently, or Unknown _____
 - 5. Debris characteristics:
 - a. debris/drift present YES
 - b. debris/drift likely to accumulate YES
 - c. dead trees upstream _____ dead trees downstream _____

- IV. Comments: HEAVY DRIFT PRESENT ON PIER NO. 2

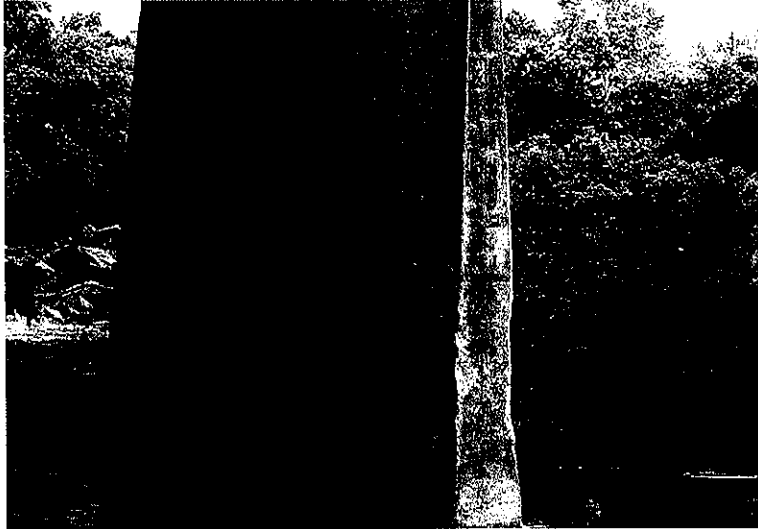
SPECIAL INSPECTION DATA - FOR REASONS OTHER THAN FC OR SCOUR

- I. Does this bridge need a special inspection? NO
- II. Reason for special inspection:

Bridge No.: 22 — SR250 — 6.14
Crossing:: HARPETH RIVER
Federal No.: 22S614900031

Date: June 29, 2004

PIC12



CHIPS ON RIGHT END OF PIER NO. 1

PIC13



CHIPS ON RIGHT END OF PIER NO. 2

Site # 3

STREAM RECONNAISSANCE
For Debris Accumulation at Bridges

SECTION 1 - SITE DESCRIPTION

ROAD NAME/NUMBER

SR 005 (US 45 W)

DATE

3/11/2008

BRIDGE NUMBER

66-SR005-0547

STREAM NAME

Obion River

GPS COORDINATES

N 36° 16.563' 1.17 feet

W 89° 03.655'

SECTION 2 - REGION AND VALLEY DESCRIPTION

PART 1: WATERSHED

Land Use

- Natural
- Agricultural
- Urban
- Suburban
- Rural
- Industrial
- Cattle grazing

Vegetation

- None
- Grass
- Pasture
- Crops
- Shrubs
- Deciduous Forest/trees
- Coniferous Forest/trees

PART 2: RIVER VALLEY CONDITION

Valley Side Failures

- None
- Occasional
- Frequent

Failure Locations

- None
- Away from river
- Along river

PART 3: FLOODPLAIN

Floodplain Width

- None
- <1 river width
- 1-5 river widths
- 5-10 river widths
- >10 river widths

Land Use

- Natural
- Agricultural
- Urban
- Suburban
- Rural
- Industrial
- Mining
- Cattle grazing

Vegetation

- None
- Grass
- Pasture
- Orchards
- Crops
- Shrubs
- Deciduous Forest/trees
- Coniferous Forest/trees

Riparian Buffer Strip

- None
- <1 river width
- 1-5 river widths
- >5 river widths

5) debris on right bank at bridge

6) upstream from bridge deck

7) downstream from bridge deck

8) debris sweeper on pier 3, from under bridge

1) upstream of bridge, from right bank

2) debris floating down center of channel (approx 25' long) passed under bridge between piers 2 + 3 without incident

3) debris sweepers installed on piers 2 + 3 - pier 3 structure was rotating, pier 2 structure was not

4) debris on pier 3 - possible misalignment of sweeper?

Very large watershed

137
65
72

PART 4: VERTICAL CONFINEMENT

Terraces

- None
- Left bank
- Right bank

Levees

- None
- Natural
- Constructed

Levee Location

- Along channel bank
- Set back <1 river width
- Set back >1 river width

PART 5: LATERAL RELATION OF CHANNEL TO VALLEY

Planform

- Straight
- Meandering
- Braided
- Anastomosed
- Engineered

Meander Characteristics

- Mild bends
- Moderate bends
- Tight bends

SECTION 3 - CHANNEL DESCRIPTION

PART 6: CHANNEL DESCRIPTION (select all that apply)

Bed Controls

- None
- Occasional
- Frequent
- Confined

Control Types

- None
- Bedrock
- Boulders
- Gravel armor
- Bridge protection
- Grade control
- Debris
- Dams (beaver, engineered)

Width Controls

- None
- Occasional
- Frequent
- Confined

Control Types

- None
- Bedrock
- Boulders
- Gravel armor
- Bridge protection
- Bridge abutments
- Bank stabilization
- Debris

Other

- Debris
- Mining
- Reservoir
- Knickpoint

M-B classification

- Cascade or step-pool
- Plane, pool-riffle, dune-ripple
- Braided

Corps classification (other)

- Modified (engineered)
- Regulated
- Arroyo

Flow Habit

- Perennial
- Flashy perennial
- Intermittent
- Ephemeral

Channel width = 165 ft

(approximate)

PART 7: BED SEDIMENT DESCRIPTION (select all that apply)

Bed Material

- Clay
- Silt
- Sand
- Gravel
- Cobbles
- Boulders

Bar Types

- None
- Alternate bars
- Point bars
- Mid-channel bars
- Diagonal bars
- Irregular/combination

Bar Material

- Silt
- Sand
- Gravel
- Cobbles

Bar Vegetation

- None
- Grasses
- Reeds/shrubs
- Trees

Bar Width

- None
- Narrow
- Moderate
- Wide

SECTION 4 - BANK SURVEY (select all that apply)

Bank Characteristic	Left Bank	Right Bank
Bank material	<input type="checkbox"/> clay <input checked="" type="checkbox"/> silt <input checked="" type="checkbox"/> sand <input checked="" type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders <input type="checkbox"/> bedrock	<input type="checkbox"/> clay <input checked="" type="checkbox"/> silt <input checked="" type="checkbox"/> sand <input checked="" type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders <input type="checkbox"/> bedrock
Layer material	<input checked="" type="checkbox"/> no layers <input type="checkbox"/> cohesive <input type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders	<input checked="" type="checkbox"/> no layers <input type="checkbox"/> cohesive <input type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders
Bank height	8 - 12 ft	8 - 12 ft
Bank slope	<input checked="" type="checkbox"/> steep <input type="checkbox"/> moderate <input type="checkbox"/> shallow	<input checked="" type="checkbox"/> steep <input type="checkbox"/> moderate <input type="checkbox"/> shallow
Bank vegetation	<input type="checkbox"/> none <input checked="" type="checkbox"/> grasses/annuals <input checked="" type="checkbox"/> reeds/shrubs <input checked="" type="checkbox"/> trees falling trees? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no tree density: <input type="checkbox"/> sparse <input checked="" type="checkbox"/> dense tree health: <input checked="" type="checkbox"/> good <input type="checkbox"/> poor tree ages: <input checked="" type="checkbox"/> young <input checked="" type="checkbox"/> mature <input type="checkbox"/> old tree diversity? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no	<input type="checkbox"/> none <input checked="" type="checkbox"/> grasses/annuals <input checked="" type="checkbox"/> reeds/shrubs <input checked="" type="checkbox"/> trees falling trees? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no tree density: <input type="checkbox"/> sparse <input checked="" type="checkbox"/> dense tree health: <input checked="" type="checkbox"/> good <input type="checkbox"/> poor tree ages: <input checked="" type="checkbox"/> young <input checked="" type="checkbox"/> mature <input type="checkbox"/> old tree diversity? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no
Bank erosion and failure location	location of erosion: <input checked="" type="checkbox"/> outside meander bend <input type="checkbox"/> inside meander bend <input type="checkbox"/> opposite bar or obstruction <input type="checkbox"/> general type of erosion: <input checked="" type="checkbox"/> fluvial <input type="checkbox"/> geotechnical	location of erosion: <input checked="" type="checkbox"/> outside meander bend <input type="checkbox"/> inside meander bend <input type="checkbox"/> opposite bar or obstruction <input type="checkbox"/> general type of erosion: <input checked="" type="checkbox"/> fluvial <input type="checkbox"/> geotechnical

SECTION 5 - DEBRIS CHARACTERISTICS

PART 8: EVIDENCE OF HIGH DEBRIS DELIVERY POTENTIAL

- Presence of debris at bridge (See Part 9)
- Presence of debris at upstream sites
- Documented need for debris removal at bridge (Contact: _____)
- Evidence of bank erosion

PART 9: DEBRIS TYPE / QUANTITY

- | | | | | |
|--|-----------|--|--|---------|
| <input type="checkbox"/> None | Percent | | <input type="checkbox"/> Fine detritus | Percent |
| <input checked="" type="checkbox"/> Small floating debris | <u>33</u> | | <input type="checkbox"/> Coarse detritus | _____ |
| <input checked="" type="checkbox"/> Medium floating debris | <u>33</u> | | <input type="checkbox"/> Boulders | _____ |
| <input checked="" type="checkbox"/> Large floating debris | <u>33</u> | | | |

SECTION 6 - BRIDGE CHARACTERISTICS

PART 10: PIER MEASUREMENTS

Number of piers: 4 near river, many others in floodplain

Width measurements: (2) Left bank or abutment to pier: 25' Right bank or abutment to pier: 4 pier 4 at edge of water

Width between piers:

Piers	1 - 2	2 - 3	3 - 4	4 - 5	5 - 6
Width (ft)	<u>55</u>	<u>70</u>	<u>55</u>		

Height of low chord above stream bed: 12 ft ^{approximate} above

PART 11: PIER CHARACTERISTICS

- Single, solid piers - each pier consists of two round columns
- Multiple, closely spaced pier or pile groups
- Exposed pier footing piles
- Multiple piles, or row of pier columns skewed to approaching flow

PART 12: PIER LOCATION

- Sheltered location (Piers _____)
- Bank/floodplain (Piers 1, 4)
- In the channel (Piers 2, 3)
- In the path of debris flow (Piers 2, 3)

Site # 3

66-SR005-0547

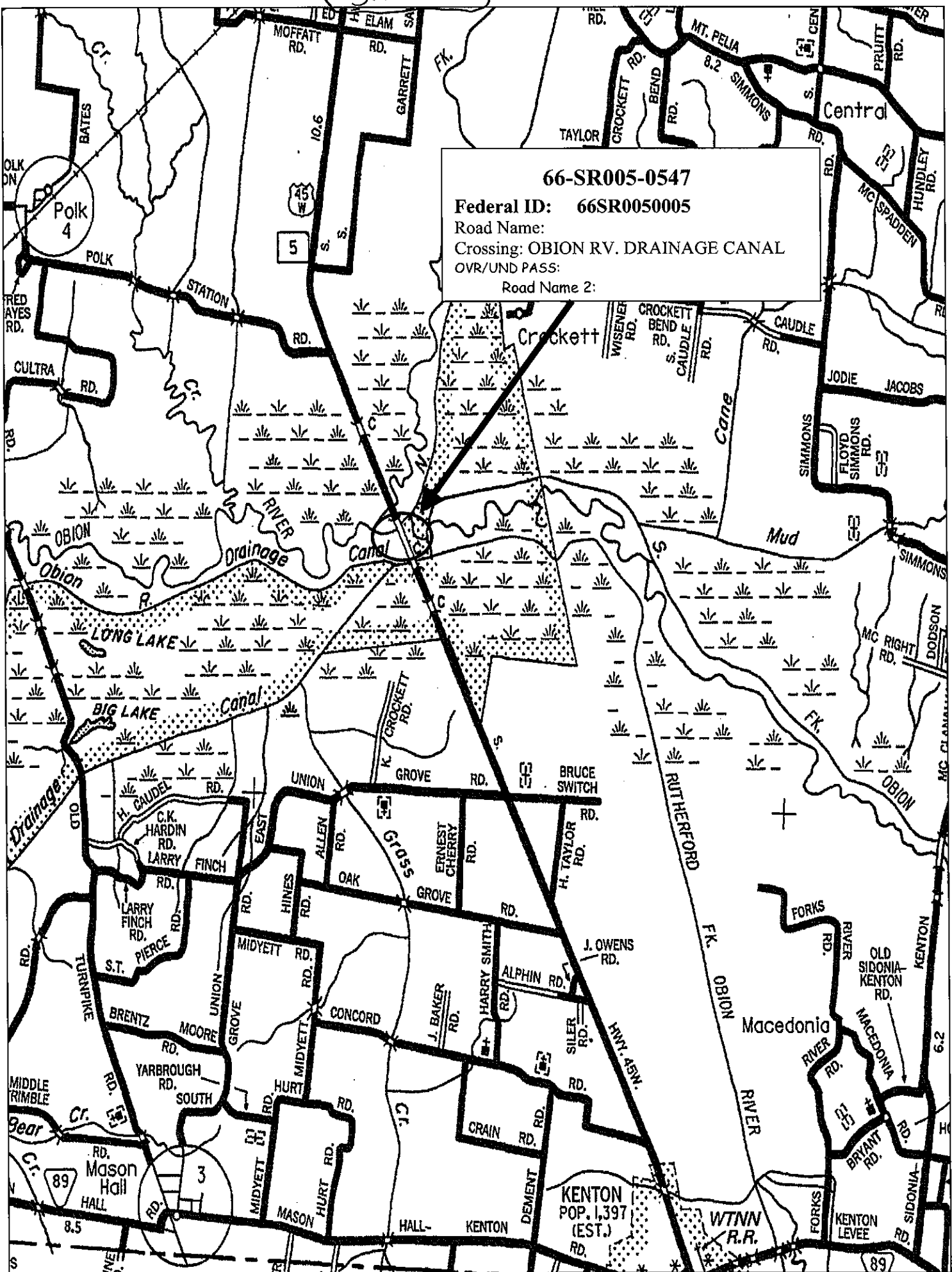
Federal ID: 66SR0050005

Road Name:

Crossing: OBION RV. DRAINAGE CANAL

OVR/UND PASS:

Road Name 2:



JAN 14 2008

BRIDGE INSPECTION REPORT

COMPLETED 1/14/08

Form BIR 3.0
(Rev. 9-22-98)
DT-0069

Field Report No.: 18 Date: 1/7/08
Previous Report No.: 17 Date: 11-30-05
Co. Seq 01 Plans: YES () NO ()

Bridge No. 66SR0050005 Bridge Location No. 66 - SR005 - 0547
Eleven Digit No. Co. Route Log Mile OVER/UNDER PASS

OBION RIVER DRAINAGE CANAL

Road Name _____ Feature Intersected _____ CITY _____
Year Constructed 1968 County Obion Maint. Dist: 42 Maint. Resp: 02
Year Widened _____ Year Rehabilitated _____

Structure Name (If Named) _____

FEATURES

Wearing Surface Concrete () Timber () Asphalt () Depth 4 (in.)
Flared Width Yes () No () Median Width Open () None () Closed ()
Navigational Control Yes () No () Bridge Skew 90 ° LT () RT ()
Structure Type (Main Span) CONCRETE BOX BEAM & CONCRETE I. BEAM
Structure Type (Appr. Spans) _____
No. Main Spans 32 No. Approach Spans _____
Maximum Span Length 56.8 (**. * ft.)
Total Length 1824.7 (**. * ft.)

INSPECTORS

1. LEWIS
2. GREEN
3. LOVE
4. ADAMS
5. BLANKENSHIP
6. ELLISON
7. JONES
8. EMMS WOODS

WIDTHS (*. * ft.)

Deck Out-to-Out 46.2
Roadway Curb/Curb 44.1
Roadway Rail/Rail _____
Sidewalk Rt. _____ Lt. _____
*Approach Roadway 24.0
*(Does Not Include Shoulders)
Approach Shoulder Rt. 12.0
Lt. 12.0

CLEARANCES

Min. Vertical Clearance over Deck _____ (ft.-in.)
Min. Vertical Under Clearance _____ (ft.-in.)
Min. Lateral Under Clearance Rt. _____ (*. * ft.)
Min. Lateral Under Clearance Lt. _____ (*. * ft.)
FRACTURE CRITICAL: _____
(If Yes, Include BIR 3.9)
NBIS Bridge Length (<25 ft.) _____ (ft.-in.)

UNDERWATER INSPECTION

To Be Performed By: _____ Date _____
DOT FIELD TEAM () CONTRACT DIVERS () NONE REQUIRED ()
Change in Structural Condition: Yes () No () Major Repairs Made: Yes () No ()

COMMENTS:

LEE LEWIS

Digitally signed by LEE LEWIS
DN: cn=LEE LEWIS, o=DOT, ou=DOT, email=lee.lewis@dot.gov, c=US
Date: 2008.01.14 14:12:54
+0500
Location: OTT

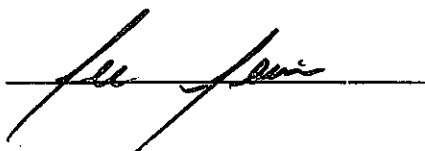
LATITUDE: N36 ° 16.3150 ' _____

LONGITUDE: W89 ° 3.4700 ' _____

G.P.S. Location

BRIDGE RATING: () () () ()
GOOD FAIR POOR CRITICAL

Supervising Bridge Inspector: _____



Bridge Location No. 66 - SR005 - 0547
Co. _____ Route _____ Log Mile _____

Date _____

STREAM CHANNEL DATA AND CONDITIONS

Stream Crossing: OBION RV. DRAINAGE CANAL

- I. 1. Type of bed material? SAND & ROCK
- 2. Has channel shifted? YES () NO () NOT APPARENT ()
- 3. Condition of rip-rap? GFC Est. % failed _____ % N/A ()
- 4. Overall condition of channel? GFC
- 5. Item 61 - Code values 0 thru 9 according to the recording and coding guide currently in effect: 6
- 6. Underwater diver inspection recommended? YES () NO ()
If yes, why? WATER DEPTH @ COLUMN BENTS #28 & #29 ARE OVER 3.5'D

- II. Channel and bank stability conditions: (check if applicable)
 - 1. Steep bank conditions: - Failures upstream () Failures downstream ()
 - 2. Moderate bank erosion ()
 - 3. Bank vegetation: a. low growth () b. large timber () c. clear banks ()
d. dead trees upstream () e. dead trees downstream ()
 - 4. Sediment or gravel accumulation: YES () NO () UNKNOWN ()
 - 5. Channel altered or straightened: YES () NO () UNKNOWN ()
 - 6. Stable conditions: a. live growth () b. bedrock ()
c. boulders () d. flat slopes (<=2:1) ()

- III. Waterway adequacy and debris characteristics: (check if applicable)
 - 1. Bridge deck elevations:
 - a. level with approach roadway. ()
 - b. higher than approach roadway. ()
 - c. roadway approach >= 2 ft. above natural ground line. ()
 - 2. Abutment encroaches into channel. ()
 - 3. Large scour (blowhole) under bridge. ()
 - 4. Indications that flood waters overtop bridge:
NO () YES () OCASSIONALLY () FREQUENTLY () UNKNOWN ()
 - 5. Debris characteristics:
 - a. debris/drift present YES () NO ()
 - b. debris/drift likely to accumulate YES () NO ()
 - c. dead trees upstream () dead trees downstream

IV. Comments: LARGE DRIFT ON BENTS 29

SPECIAL INSPECTION DATA - FOR REASONS OTHER THAN FC OR SCOUR

- I. Does this bridge need a special inspection? YES () NO ()
- II. Reason for special inspection: _____

Bridge Loc. No: 66 - SR005 - 05.47 Date: 01-14-08



LOOKING AHEAD ON ROUTE

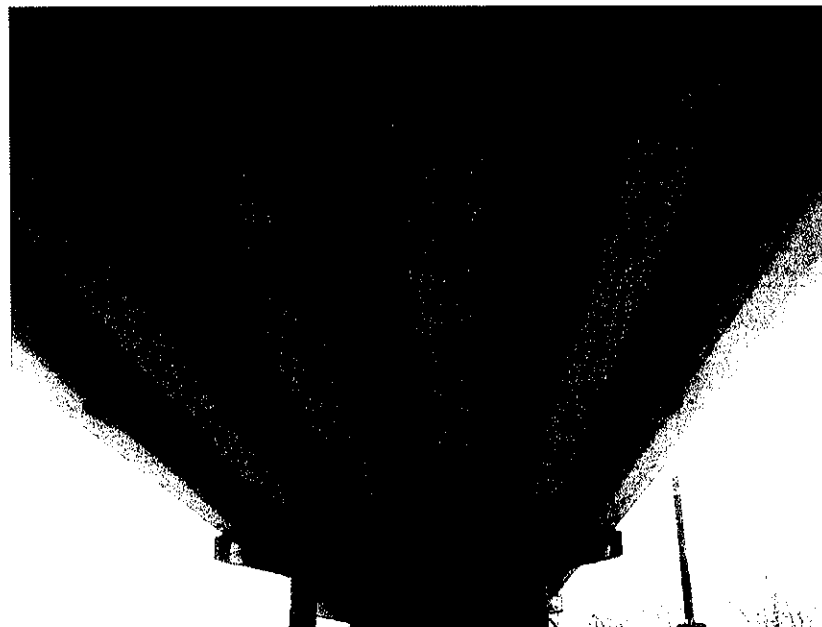


VIEW ACROSS TOP OF DECK

Bridge Loc. No: 66 - SR005 - 05.47 Date: 01-07-08



ELEVATION RIGHT SIDE



SPAN #29, BOTTOM OF DECK

Bridge Loc. No: 66 - SR005 - 05.47 Date: 01-07-08



BENT #29, FRONT SIDE



BENT #28, BOTTOM OF CAP

Bridge Loc. No: 66 - SR005 - 05.47 Date: 01-07-08



ELEVATION LEFT SIDE

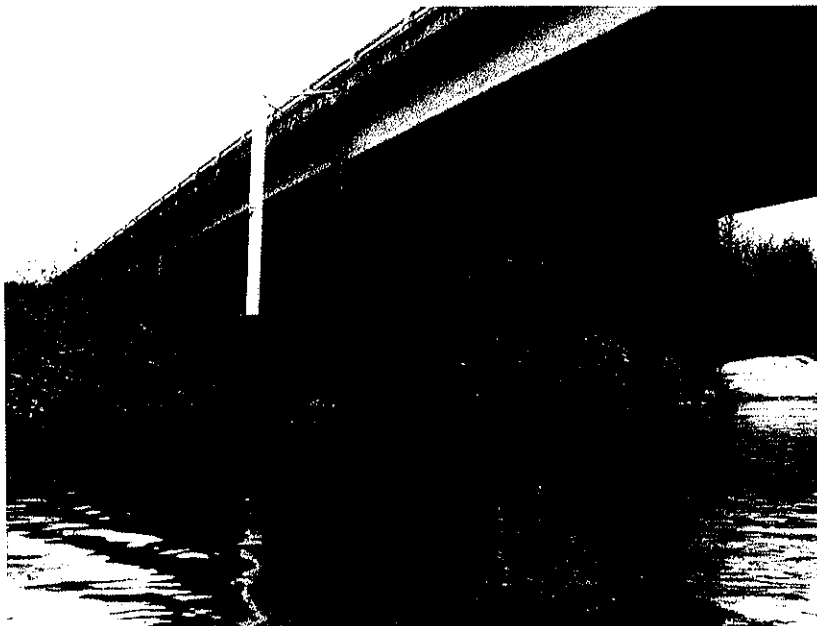


LOOKING DOWNSTREAM

Bridge Loc. No: 66 - SR005 - 05.47 Date: 01-07-08



LOOKING UPSTREAM



BENT #28, REAR SIDE

Bridge Loc. No: 66 - SR005 - 05.47 Date: 01-07-08



SPAN #28, BOTTOM OF DECK



BENT #29 WITH DRIFT

JAN 14 2006

BRIDGE INSPECTION REPORT

COMPLETED 1/14/08

Form BIR 3.0
(Rev. 9-22-98)
DT-0069

Field Report No.: 18 Date: 1/7/08
Previous Report No.: 17 Date: 11-30-05
Co. Seq 01 Plans: YES () NO ()

Bridge No. 66SR0050005 Bridge Location No. 66 - SR005 - 0547
Eleven Digit No. Co. Route Log Mile OVER/UNDER PASS

Road Name OBION RIVER DRAINAGE CANAL Feature Intersected CITY

Year Constructed 1968 County Obion Maint. Dist: 42 Maint. Resp: 02

Year Widened _____ Year Rehabilitated _____ Structure Name (If Named)

FEATURES

Wearing Surface Concrete () Timber () Asphalt () Depth 4 (in.)
Flared Width Yes () No () Median Width Open () None () Closed ()
Navigational Control Yes () No () Bridge Skew 90 ° LT () RT ()
Structure Type (Main Span) CONCRETE BOX BEAM & CONCRETE I. BEAM
Structure Type (Appr.Spans) _____
No. Main Spans 32 No. Approach Spans _____
Maximum Span Length 56.8 (**. * ft.)
Total Length 1824.7 (**. * ft.)

INSPECTORS

1. LEWIS
2. GREEN
3. LOVE
4. ADAMS
5. BLANKENSHIP
6. ELLISON
7. JONES
8. EVANS WOODS

WIDTHS (*. * ft.)

Deck Out-to-Out 46.2
Roadway Curb/Curb 44.1
Roadway Rail/Rail _____
Sidewalk Rt. _____ Lt. _____
*Approach Roadway 24.0
*(Does Not Include Shoulders)
Approach Shoulder Rt. 12.0
Lt. 12.0

CLEARANCES

Min. Vertical Clearance over Deck _____ (ft.-in.)
Min. Vertical Under Clearance _____ (ft.-in.)
Min. Lateral Under Clearance Rt. _____ (*. * ft.)
Min. Lateral Under Clearance Lt. _____ (*. * ft.)

FRACTURE CRITICAL: _____
(If Yes, Include BIR 3.9)

NBIS Bridge Length (<25 ft.) _____ (ft.-in.)

UNDERWATER INSPECTION


To Be Performed By: _____ Date _____
DOT FIELD TEAM (CONTRACT DIVERS () NONE REQUIRED ()
Change in Structural Condition: Yes () No () Major Repairs Made: Yes () No ()

COMMENTS:

 LEE LEWIS
Digitally signed by LEE LEWIS
DN: cn=LEE LEWIS, o=DOT
Date: 2008.01.14 14:13:24
+0500
Location: OTT

LATITUDE: N36 ° 16.3150 '
LONGITUDE: W89 ° 3.4700 '
G.P.S. Location

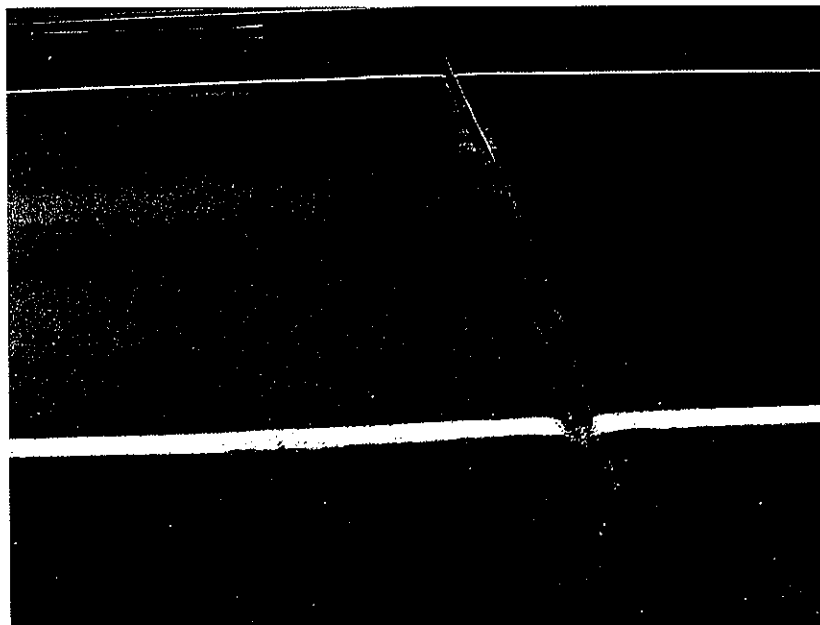
BRIDGE RATING: () () () ()
GOOD FAIR POOR CRITICAL

Supervising Bridge Inspector: 

Bridge Loc. No: 66 - SR005 - 05.47 Date: 12-16-03

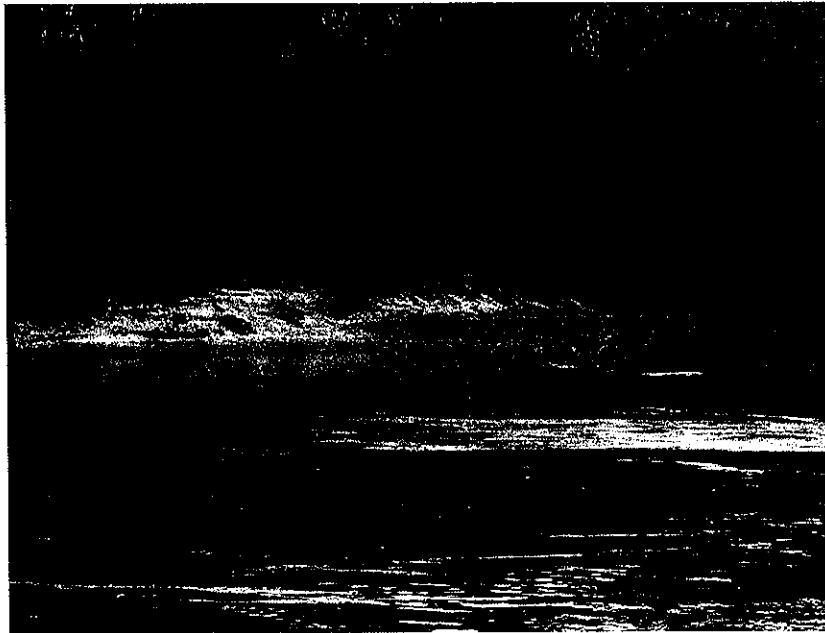


BRIDGE NO. ON APPROACH #1, RIGHT RAIL



SPAN #1 WITH DEBRIS IN ROADWAY JOINT

Bridge Loc. No: 66 - SR005 - 05.47 Date: 12-16-03



VIEW OF CHANNEL LOOKING DOWNSTREAM



BENT #29 & DRIFT PROTECTOR



Photo No. 9 – Bent No. 29 (Back – 7/25/00)



Photo No. 10 – Bent No. 29 (Debris at Upstream Column – 7/25/00)

Site # 4

Under construction
See notes on back

**STREAM RECONNAISSANCE
For Debris Accumulation at Bridges**

SECTION 1 - SITE DESCRIPTION

ROAD NAME/NUMBER

US 51 / SR003

DATE

3/11/2008

BRIDGE NUMBER

79-SR003-15.25

STREAM NAME

Wolf River

GPS COORDINATES

SECTION 2 - REGION AND VALLEY DESCRIPTION

PART 1: WATERSHED

Land Use

- Natural
- Agricultural
- Urban
- Suburban
- Rural
- Industrial
- Cattle grazing

Vegetation

- None
- Grass
- Pasture
- Crops
- Shrubs
- Deciduous Forest/trees
- Coniferous Forest/trees

PART 2: RIVER VALLEY CONDITION

Valley Side Failures

- None
- Occasional
- Frequent

Failure Locations

- None
- Away from river
- Along river

PART 3: FLOODPLAIN

Floodplain Width

- None
- <1 river width
- 1-5 river widths
- 5-10 river widths
- >10 river widths

Land Use

- Natural
- Agricultural
- Urban
- Suburban
- Rural
- Industrial
- Mining
- Cattle grazing

Vegetation

- None
- Grass
- Pasture
- Orchards
- Crops
- Shrubs
- Deciduous Forest/trees
- Coniferous Forest/trees

Riparian Buffer Strip

- None
- <1 river width
- 1-5 river widths
- >5 river widths

Upper watershed
Rural, lower
Watershed
Urban

PART 4: VERTICAL CONFINEMENT

Terraces

- None
- Left bank
- Right bank

Levees

- None
- Natural
- Constructed

Levee Location

- Along channel bank
- Set back <1 river width
- Set back >1 river width

PART 5: LATERAL RELATION OF CHANNEL TO VALLEY

Planform

- Straight
- Meandering
- Braided
- Anastomosed
- Engineered

Meander Characteristics

- Mild bends
- Moderate bends
- Tight bends

SECTION 3 - CHANNEL DESCRIPTION

PART 6: CHANNEL DESCRIPTION (select all that apply)

Bed Controls

- None
- Occasional
- Frequent
- Confined

Control Types

- None
- Bedrock
- Boulders
- Gravel armor
- Bridge protection
- Grade control
- Debris
- Dams (beaver, engineered)

Width Controls

- None
- Occasional
- Frequent
- Confined

Control Types

- None
- Bedrock
- Boulders
- Gravel armor
- Bridge protection
- Bridge abutments
- Bank stabilization
- Debris

Other

- Debris
- Mining
- Reservoir
- Knickpoint

M-B classification

- Cascade or step-pool
- Plane, pool-riffle, dune-ripple
- Braided

Corps classification (other)

- Modified (engineered)
- Regulated
- Arroyo

Flow Habit

- Perennial
- Flashy perennial
- Intermittent
- Ephemeral

Channel width = _____

PART 7: BED SEDIMENT DESCRIPTION (select all that apply)

Bed Material

- Clay
- Silt
- Sand
- Gravel
- Cobbles
- Boulders

Bar Types

- None
- Alternate bars
- Point bars
- Mid-channel bars
- Diagonal bars
- Irregular/combination

Bar Material

- Silt
- Sand
- Gravel
- Cobbles

Bar Vegetation

- None
- Grasses
- Reeds/shrubs
- Trees

Bar Width

- None
- Narrow
- Moderate
- Wide

SECTION 4 - BANK SURVEY (select all that apply)

Bank Characteristic	Left Bank	Right Bank
Bank material	<input type="checkbox"/> clay <input type="checkbox"/> silt <input type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders <input type="checkbox"/> bedrock	<input type="checkbox"/> clay <input type="checkbox"/> silt <input type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders <input type="checkbox"/> bedrock
Layer material	<input type="checkbox"/> no layers <input type="checkbox"/> cohesive <input type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders	<input type="checkbox"/> no layers <input type="checkbox"/> cohesive <input type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders
Bank height		
Bank slope	<input type="checkbox"/> steep <input type="checkbox"/> moderate <input type="checkbox"/> shallow	<input type="checkbox"/> steep <input type="checkbox"/> moderate <input type="checkbox"/> shallow
Bank vegetation	<input type="checkbox"/> none <input type="checkbox"/> grasses/annuals <input type="checkbox"/> reeds/shrubs <input type="checkbox"/> trees falling trees? <input type="checkbox"/> yes <input type="checkbox"/> no tree density: <input type="checkbox"/> sparse <input type="checkbox"/> dense tree health: <input type="checkbox"/> good <input type="checkbox"/> poor tree ages: <input type="checkbox"/> young <input type="checkbox"/> mature <input type="checkbox"/> old tree diversity? <input type="checkbox"/> yes <input type="checkbox"/> no	<input type="checkbox"/> none <input type="checkbox"/> grasses/annuals <input type="checkbox"/> reeds/shrubs <input type="checkbox"/> trees falling trees? <input type="checkbox"/> yes <input type="checkbox"/> no tree density: <input type="checkbox"/> sparse <input type="checkbox"/> dense tree health: <input type="checkbox"/> good <input type="checkbox"/> poor tree ages: <input type="checkbox"/> young <input type="checkbox"/> mature <input type="checkbox"/> old tree diversity? <input type="checkbox"/> yes <input type="checkbox"/> no
Bank erosion and failure location	location of erosion: <input type="checkbox"/> outside meander bend <input type="checkbox"/> inside meander bend <input type="checkbox"/> opposite bar or obstruction <input type="checkbox"/> general type of erosion: <input type="checkbox"/> fluvial <input type="checkbox"/> geotechnical	location of erosion: <input type="checkbox"/> outside meander bend <input type="checkbox"/> inside meander bend <input type="checkbox"/> opposite bar or obstruction <input type="checkbox"/> general type of erosion: <input type="checkbox"/> fluvial <input type="checkbox"/> geotechnical

SECTION 5 – DEBRIS CHARACTERISTICS

PART 8: EVIDENCE OF HIGH DEBRIS DELIVERY POTENTIAL

- Presence of debris at bridge (See Part 9)
- Presence of debris at upstream sites
- Documented need for debris removal at bridge (Contact: _____)
- Evidence of bank erosion

PART 9: DEBRIS TYPE / QUANTITY

- | | | | | | |
|---|---------|-------|--|---------|-------|
| <input type="checkbox"/> None | Percent | _____ | <input type="checkbox"/> Fine detritus | Percent | _____ |
| <input type="checkbox"/> Small floating debris | Percent | _____ | <input type="checkbox"/> Coarse detritus | Percent | _____ |
| <input type="checkbox"/> Medium floating debris | Percent | _____ | <input type="checkbox"/> Boulders | Percent | _____ |
| <input type="checkbox"/> Large floating debris | Percent | _____ | | | |

SECTION 6 - BRIDGE CHARACTERISTICS

PART 10: PIER MEASUREMENTS

Number of piers: _____

Width measurements:

Left bank or abutment to pier: _____ Right bank or abutment to pier: _____

Width between piers:

Piers	1 - 2	2 - 3	3 - 4	4 - 5	5 - 6
Width (ft)					

Height of low chord above stream bed:

PART 11: PIER CHARACTERISTICS

- Single, solid piers
- Multiple, closely spaced pier or pile groups
- Exposed pier footing piles
- Multiple piles, or row of pier columns skewed to approaching flow

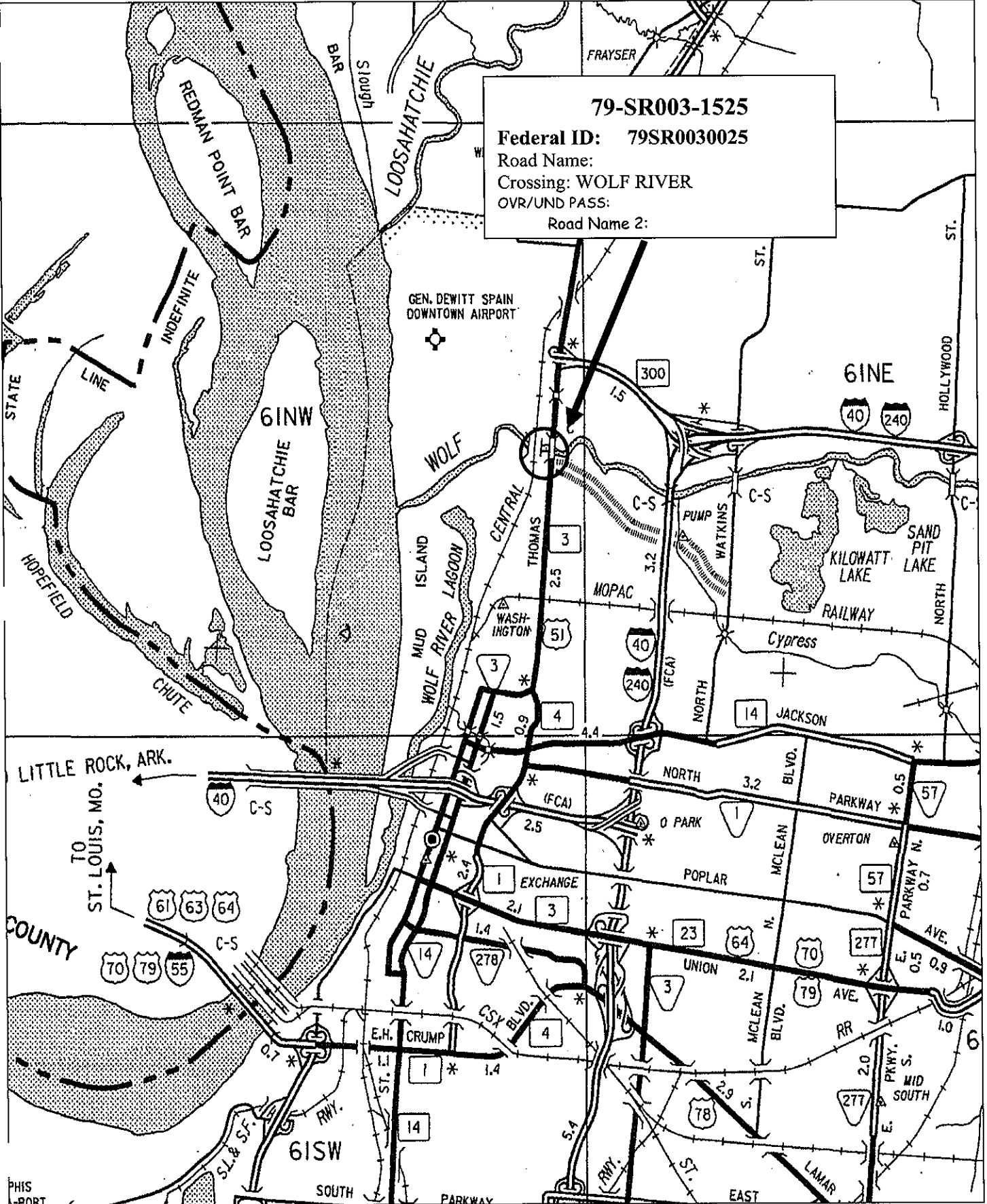
PART 12: PIER LOCATION

- Sheltered location (Piers _____)
- In the channel (Piers _____)
- Bank/floodplain (Piers _____)
- In the path of debris flow (Piers _____)

Site #4

SHELBY COUNTY

79-SR003-1525
Federal ID: 79SR0030025
Road Name:
Crossing: WOLF RIVER
OVR/UND PASS:
Road Name 2:

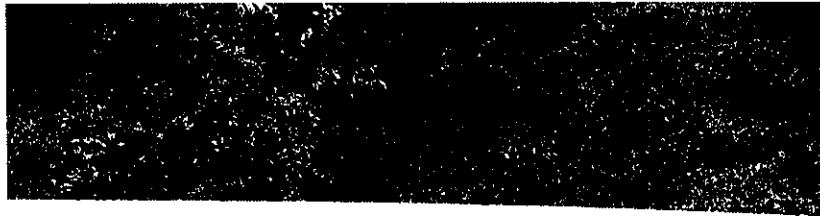


PHIS
PORT

Bridge Loc. No: 79 - SR003 - 15.25 Date: 07-16-07



LOOKING AHEAD ON ROUTE



BRIDGE NO. ON RIGHT BRIDGERAIL

Bridge Loc. No: 79 - SR003 - 15.25 Date: 07-16-07



ELEVATION LEFT SIDE AT BENTS #5, #6, #7 & #8



VIEW OF CHANNEL LOOKING RIGHT, UPSTREAM

Bridge Loc. No: 79 - SR003 - 15.25 Date: 07-16-07

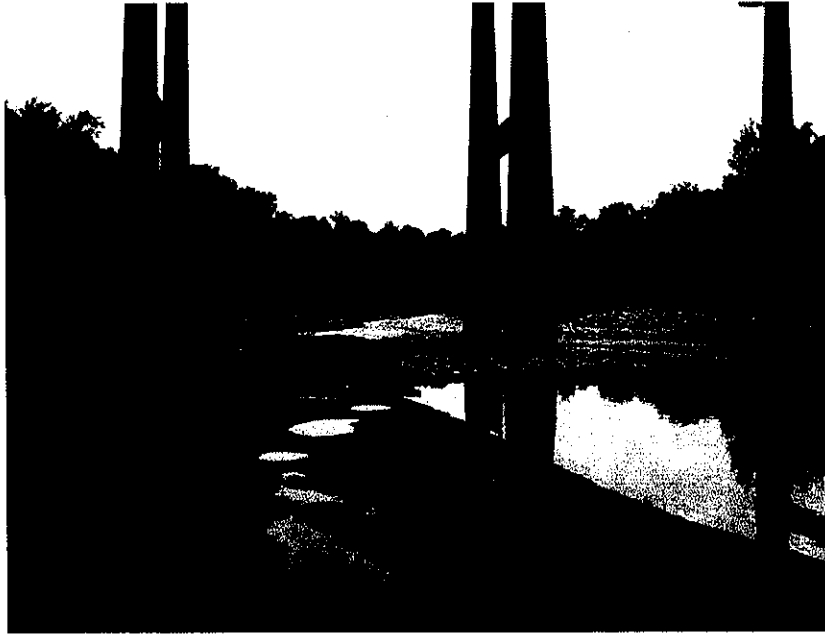


LEFT SIDE OF BRIDGE



BENT #8, LEFT END OF CAP SPALLED TO STEEL

Bridge Loc. No: 79 - SR003 - 15.25 Date: 07-16-07



VIEW LOOKING ACROSS CHANNEL



BENTS #6, #7 & #8

STREAM CHANNEL DATA AND CONDITIONS

Stream Crossing: WOLF RIVER

- I. 1. Type of bed material? SILT + SAND
- 2. Has channel shifted? YES () NO () NOT APPARENT (X)
- 3. Condition of rip-rap? (C) F P C Est. % failed _____ % N/A ()
- 4. Overall condition of channel? G (F) P C
- 5. Item 61 - Code values 0 thru 9 according to the recording and coding guide currently in effect: 5
- 6. Underwater diver inspection recommended? YES () NO (X) (7/15/07)
If yes, why? _____

- II. Channel and bank stability conditions: (check if applicable)
- 1. Steep bank conditions: - Failures upstream () Failures downstream ()
- 2. Moderate bank erosion ()
- 3. Bank vegetation: a. low growth (X) b. large timber (X) c. clear banks ()
d. dead trees upstream (X) e. dead trees downstream (X)
- 4. Sediment or gravel accumulation: YES () NO (X) UNKNOWN ()
- 5. Channel altered or straightened: YES () NO (X) UNKNOWN ()
- 6. Stable conditions: a. live growth (X) b. bedrock ()
c. boulders () d. flat slopes (<=2:1) ()

- III. Waterway adequacy and debris characteristics: (check if applicable)
- 1. Bridge deck elevations:
 - a. level with approach roadway. (X)
 - b. higher than approach roadway. ()
 - c. roadway approach >= 2 ft. above natural ground line. . (X)
- 2. Abutment encroaches into channel. ()
- 3. Large scour (blowhole) under bridge. ()
- 4. Indications that flood waters overtop bridge:
NO (X) YES () OCASSIONALLY () FREQUENTLY () UNKNOWN ()
- 5. Debris characteristics:
 - a. debris/drift present YES (X) NO () BOLT #6 + BOLT #7
 - b. debris/drift likely to accumulate YES (X) NO ()
 - c. dead trees upstream (X) dead trees downstream (X)

IV. Comments: _____

SPECIAL INSPECTION DATA - FOR REASONS OTHER THAN FC OR SCOUR

- I. Does this bridge need a special inspection? YES () NO (X)
- II. Reason for special inspection: _____

Bridge Loc. No: 79 - SR003 - 15.25 Date: 07-21-05



VIEW OF CHANENL LOOKING RIGHT



VIEW OF CHANNEL LOOKING RIGHT AT DRIFT

Bridge Loc. No: 79 - SR003 - 15.25 Date: 07-21-05

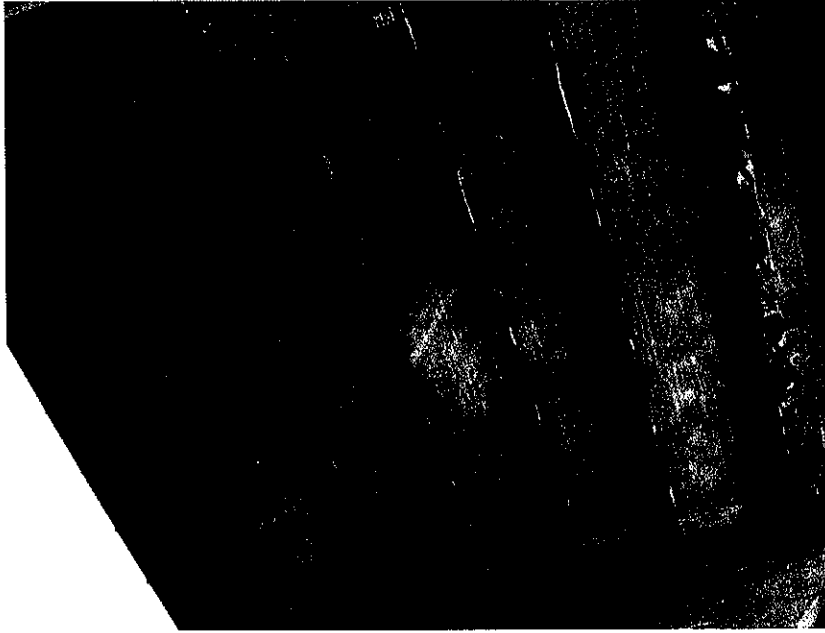


VIEW OF CHANNEL LOOKING LEFT



ELEVATION RIGHT SIDE, LOOKING AHEAD

Bridge Loc. No: 79 - SR003 - 15.25 Date: 07-21-05



SPAN #6, BOTTOM OF DECK



DRIFT AT RIGHT SIDE AT BENTS #6 & #8

Bridge Loc. No: 79 - SR003 - 15.25 Date: 07-21-05



DRIFT AT BENT #8, TYPICAL



ELEVATION LEFT SIDE LOOKING AT CHANNEL

Bridge Loc. No: 79 - SR003 - 15.25 Date: 07-21-05

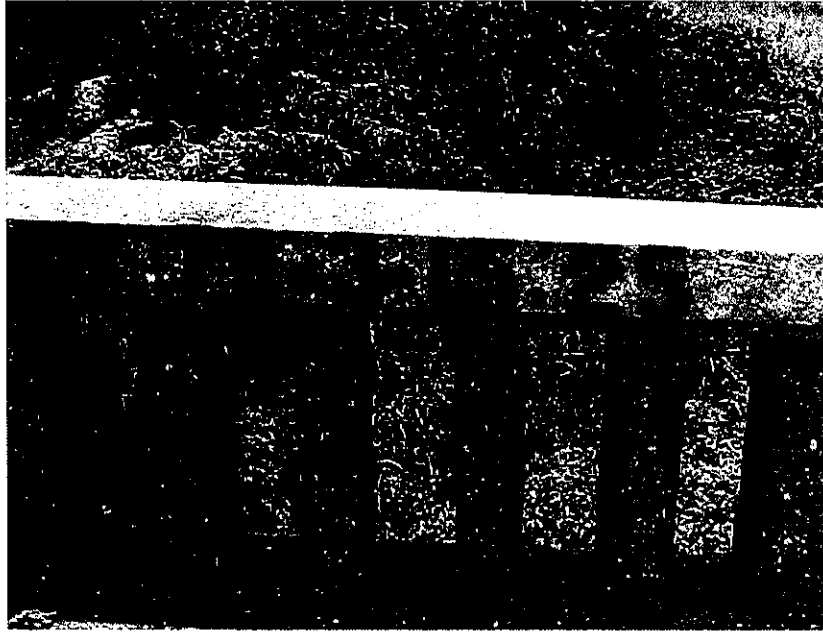


BENT #1, COLUMN "A" SPALLED



DRIFT AT BENT #8, RIGHT SIDE

Bridge Loc. No: 79 - SR003 - 15.25 Date: 07-16-03



BRIDGE NO. ON SPAN #1, RIGHT BRIDGE RAIL



ELEVATION RIGHT SIDE

Site # 5

**STREAM RECONNAISSANCE
For Debris Accumulation at Bridges**

SECTION 1 - SITE DESCRIPTION

ROAD NAME/NUMBER

US 31 / SR007

DATE

3/12/2008

BRIDGE NUMBER

28-SR007-5.45

STREAM NAME

EIK RIVER

GPS COORDINATES

N 35° 02.834' +/- 24 feet

W 86° 53.275'

SECTION 2 - REGION AND VALLEY DESCRIPTION

PART 1: WATERSHED

Land Use

- Natural
- Agricultural
- Urban
- Suburban
- Rural
- Industrial
- Cattle grazing

Vegetation

- None
- Grass
- Pasture
- Crops
- Shrubs
- Deciduous Forest/trees
- Coniferous Forest/trees

PART 2: RIVER VALLEY CONDITION

Valley Side Failures

- None
- Occasional
- Frequent

Failure Locations

- None
- Away from river
- Along river

PART 3: FLOODPLAIN

Floodplain Width

- None
- <1 river width
- 1-5 river widths
- 5-10 river widths
- >10 river widths

Land Use

- Natural
- Agricultural
- Urban
- Suburban
- Rural
- Industrial
- Mining
- Cattle grazing

Vegetation

- None
- Grass
- Pasture
- Orchards
- Crops
- Shrubs
- Deciduous Forest/trees
- Coniferous Forest/trees

Riparian Buffer Strip

- None
- <1 river width
- 1-5 river widths
- >5 river widths

- 1) upstream face of piers, from left bank (note debris on pier 3)
- 2) upstream of bridge, from bridge deck (note large quantities of debris, steep banks, inward-leaning trees)
- 3) debris on pier 3, taken from railroad bridge immediately upstream of road bridge
- 4) debris against right bank, immediately upstream of bridge
- 5) downstream, from bridge deck

PART 4: VERTICAL CONFINEMENT

Terraces

- None
- Left bank
- Right bank

Levees

- None
- Natural
- Constructed

Levee Location

- Along channel bank
- Set back <1 river width
- Set back >1 river width

PART 5: LATERAL RELATION OF CHANNEL TO VALLEY

Planform

- Straight
- Meandering
- Braided
- Anastomosed
- Engineered

Meander Characteristics

- Mild bends
- Moderate bends
- Tight bends

SECTION 3 - CHANNEL DESCRIPTION

PART 6: CHANNEL DESCRIPTION (select all that apply)

Bed Controls

- None
- Occasional
- Frequent
- Confined

Control Types

- None
- Bedrock
- Boulders
- Gravel armor
- Bridge protection
- Grade control
- Debris
- Dams (beaver, engineered)

Width Controls

- None
- Occasional
- Frequent
- Confined

Control Types

- None
- Bedrock
- Boulders
- Gravel armor
- Bridge protection
- Bridge abutments
- Bank stabilization
- Debris

Other

- Debris
- Mining
- Reservoir
- Knickpoint

M-B classification

- Cascade or step-pool
- Plane, pool-riffle, dune-ripple
- Braided

Corps classification (other)

- Modified (engineered)
- Regulated
- Arroyo

Flow Habit

- Perennial
- Flashy perennial
- Intermittent
- Ephemeral

Channel width = 182 feet

PART 7: BED SEDIMENT DESCRIPTION (select all that apply)

Bed Material

- Clay
- Silt
- Sand
- Gravel
- Cobbles
- Boulders

Bar Types

- None
- Alternate bars
- Point bars
- Mid-channel bars
- Diagonal bars
- Irregular/combination

Bar Material

- Silt
- Sand
- Gravel
- Cobbles

Bar Vegetation

- None
- Grasses
- Reeds/shrubs
- Trees

Bar Width

- None
- Narrow
- Moderate
- Wide

SECTION 4 - BANK SURVEY (select all that apply)

Bank Characteristic	Left Bank	Right Bank
Bank material	<input type="checkbox"/> clay <input checked="" type="checkbox"/> silt <input checked="" type="checkbox"/> sand <input checked="" type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders <input type="checkbox"/> bedrock	<input type="checkbox"/> clay <input checked="" type="checkbox"/> silt <input checked="" type="checkbox"/> sand <input checked="" type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders <input type="checkbox"/> bedrock
Layer material	<input checked="" type="checkbox"/> no layers <input type="checkbox"/> cohesive <input type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders	<input checked="" type="checkbox"/> no layers <input type="checkbox"/> cohesive <input type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders
Bank height	10 - 15 feet	10 - 15 feet
Bank slope	<input checked="" type="checkbox"/> steep <input type="checkbox"/> moderate <input type="checkbox"/> shallow	<input checked="" type="checkbox"/> steep <input type="checkbox"/> moderate <input type="checkbox"/> shallow
Bank vegetation	<input type="checkbox"/> none <input checked="" type="checkbox"/> grasses/annuals <input checked="" type="checkbox"/> reeds/shrubs <input checked="" type="checkbox"/> trees falling trees? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no tree density: <input type="checkbox"/> sparse <input checked="" type="checkbox"/> dense tree health: <input checked="" type="checkbox"/> good <input type="checkbox"/> poor tree ages: <input type="checkbox"/> young <input checked="" type="checkbox"/> mature <input type="checkbox"/> old tree diversity? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no	<input type="checkbox"/> none <input checked="" type="checkbox"/> grasses/annuals <input checked="" type="checkbox"/> reeds/shrubs <input checked="" type="checkbox"/> trees falling trees? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no tree density: <input type="checkbox"/> sparse <input checked="" type="checkbox"/> dense tree health: <input checked="" type="checkbox"/> good <input type="checkbox"/> poor tree ages: <input type="checkbox"/> young <input checked="" type="checkbox"/> mature <input type="checkbox"/> old tree diversity? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no
Bank erosion and failure location	location of erosion: <input type="checkbox"/> outside meander bend <input type="checkbox"/> inside meander bend <input type="checkbox"/> opposite bar or obstruction <input checked="" type="checkbox"/> general type of erosion: <input checked="" type="checkbox"/> fluvial <input type="checkbox"/> geotechnical	location of erosion: <input type="checkbox"/> outside meander bend <input type="checkbox"/> inside meander bend <input type="checkbox"/> opposite bar or obstruction <input checked="" type="checkbox"/> general type of erosion: <input checked="" type="checkbox"/> fluvial <input type="checkbox"/> geotechnical

Erosion appears uniformly distributed

SECTION 5 – DEBRIS CHARACTERISTICS

PART 8: EVIDENCE OF HIGH DEBRIS DELIVERY POTENTIAL

- Presence of debris at bridge (See Part 9)
- Presence of debris at upstream sites
- Documented need for debris removal at bridge (Contact: _____)
- Evidence of bank erosion

PART 9: DEBRIS TYPE / QUANTITY

- | | | | |
|--|-----------|--|---------|
| <input type="checkbox"/> None | Percent | | Percent |
| <input type="checkbox"/> Small floating debris | _____ | <input type="checkbox"/> Fine detritus | _____ |
| <input checked="" type="checkbox"/> Medium floating debris | <u>50</u> | <input type="checkbox"/> Coarse detritus | _____ |
| <input checked="" type="checkbox"/> Large floating debris | <u>50</u> | <input type="checkbox"/> Boulders | _____ |

SECTION 6 - BRIDGE CHARACTERISTICS

PART 10: PIER MEASUREMENTS

Number of piers: 20 (4 cement, in channel; others in floodplain)

Width measurements:

Left bank or abutment to pier: (1) 25 ft Right bank or abutment to pier: (4) 0, at edge of water

Width between piers:

Piers	1 - 2	2 - 3	3 - 4	4 - 5	5 - 6
Width (ft)	<u>50</u>	<u>50</u>	<u>50</u>		

Height of low chord above stream bed: 29 feet above ∇

PART 11: PIER CHARACTERISTICS

- Single, solid piers
- Multiple, closely spaced pier or pile groups
- Exposed pier footing piles
- Multiple piles, or row of pier columns skewed to approaching flow

PART 12: PIER LOCATION

- Sheltered location (Piers 1, 4)
- Bank/floodplain (Piers _____)
- In the channel (Piers 1, 2, 3, 4)
- In the path of debris flow (Piers 2, 3)

GILES CO

PULASKI
POP. 7,916

Aymett Town

Tarpley

Five Points

Bunker Hill

Wheeler

Baugh

28-SR007-5.45
28SR0070007

Liberty

ELKTON
POP. 448

ARDMORE
POP. 866

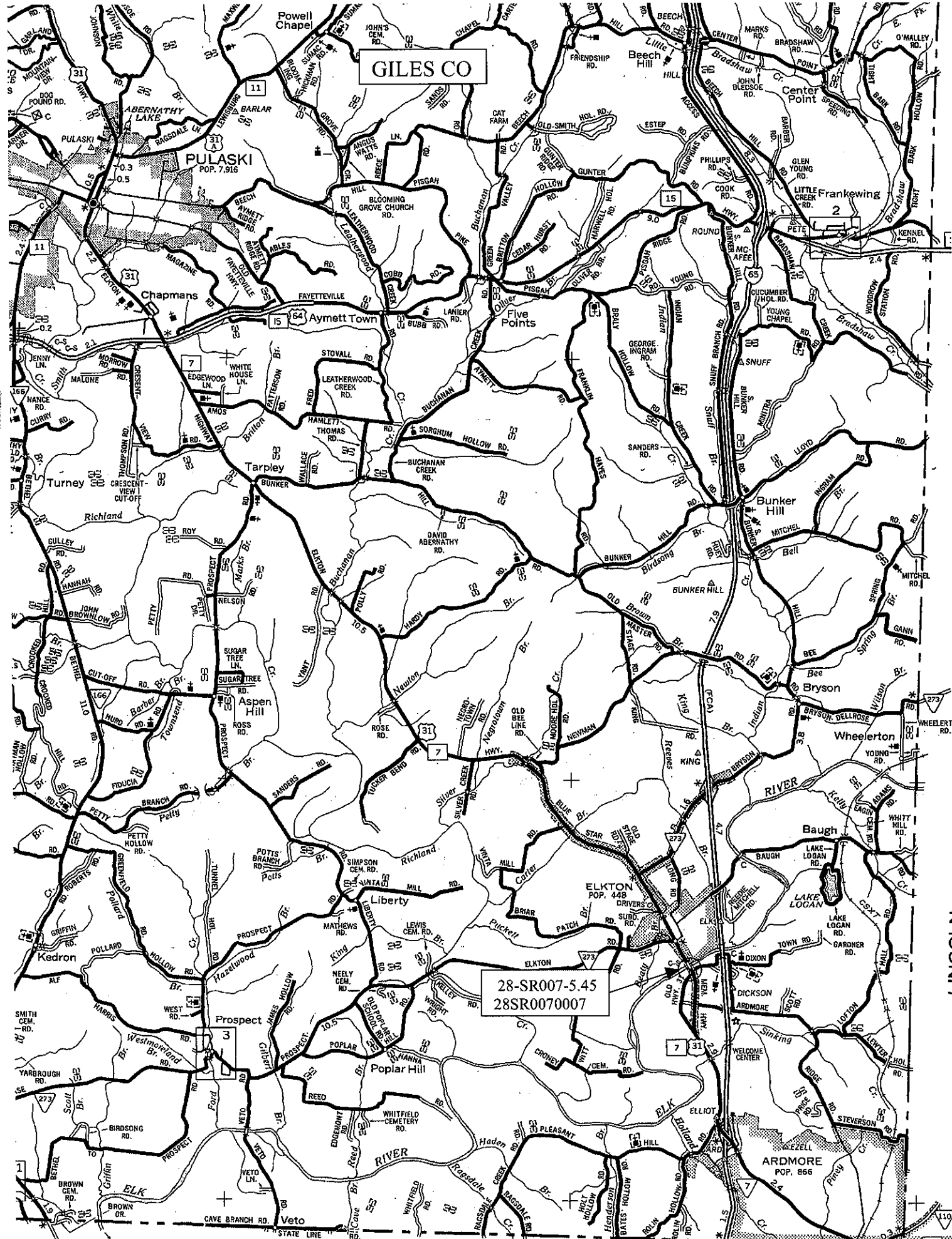
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TO
ATHENS, ALA.

COUNTY

(65) 31

IN COU



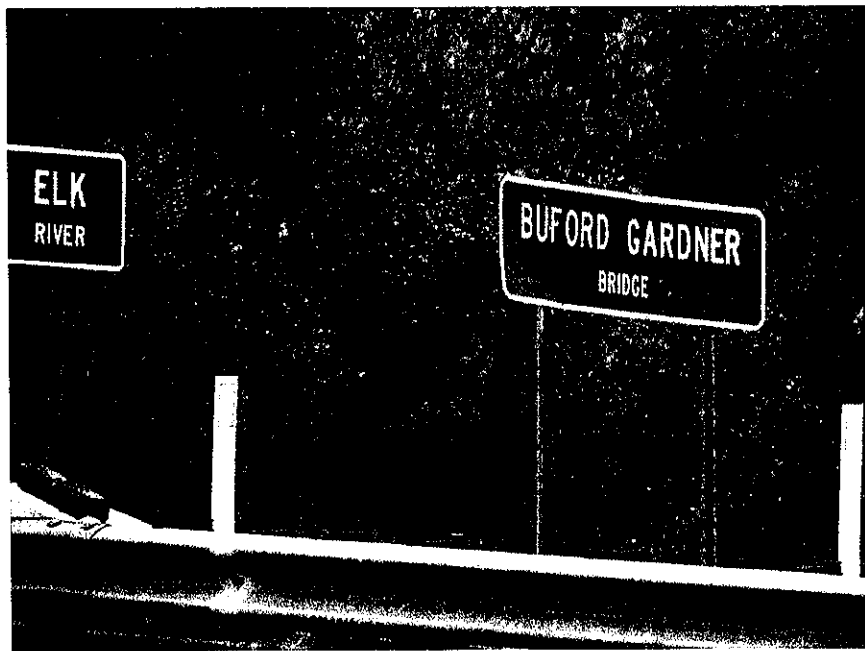
Photographs

Bridge ID#: 28SR0070007

Date: 11/13/2007



PIER



SIGNS TYP. OF BOTH ENDS

BRIDGE INSPECTION REPORT

Page No. _____

Form BIR 3.0
(Rev. 9-22-98)
DT-0069

Field Report No. 17 Date 11/13/2007
Previous Report No. 16 Date 11/9/2005
Plans: Design

Bridge No. 28SR0070007
Eleven Digit No.

Bridge Location No. 28 - SR007 - 5.45 N
Co. Route Log Mile

SR 7 over ELK RIVER Buford Gardner Bridge
Road Name Crossing Structure Name (If Named)
Year Constructed 1959 Actual County Giles Maintenance District 36
Year Widened NA NA Year Rehabilitated 2004 Actual

FEATURES

Wearing Surface Asphalt Depth 3" (in.)
Flared Width No Median Width NONE
Navigational Control No Bridge Skew 90° NA
Structure Type (Main Span) CONCRETE DECK GIRDER
Structure Type (Appr.Spans) NA
No. Main Spans 21 No. Approach Spans NA
Maximum Span Length 53.0' (**.* ft.)
Total Length 689.0' (**.* ft.)

INSPECTORS

- 1. HOWELL
- 2. LAFLEUR
- 3. STAHL
- 4. _____
- 5. _____
- 6. _____
- 7. _____
- 8. _____

WIDTHS (*.* ft.)

Deck Out-to-Out 34.5'
Roadway Curb/Curb N/A
Roadway Rail/Rail 29
Sidewalk Rt. N/A Lt. N/A
*Approach Roadway 22.0'
*(Does Not Include Shoulders)
Approach Shoulder Rt. 3.0'
Lt. 3.0'

CLEARANCES

Min. Vertical Clearance over Deck NA (ft.-in.)
Min. Vertical Under Clearance NA (ft.-in.)
Min. Lateral Under Clearance Rt. NA (*.* ft.)
Min. Lateral Under Clearance Lt. NA (*.* ft.)

FRACTURE CRITICAL: No
(If Yes, Include BIR 3.9)

NBIS Bridge Length (<25 ft.) >25' (ft.-in.)

UNDERWATER INSPECTION

To Be Performed By: Contract Divers Date 5/24/2000

Change in Structural Condition: No Major Repairs Made: No BRIDGE is: Open

COMMENTS:

Top deck has been replaced with 3" asphalt, and concrete parapets have been placed for the railing system. Former joints have been sealed with concrete, and three joints were replaced 2004. Underwater Report dated 5-24-2000 by HNTB Corporation dived all four piers and found them in a good condition with no scour, distress or deterioration.

Supervising Bridge Inspector: HOWARD STAHL

BRIDGE RATING: FAIR

STREAM CHANNEL DATA AND CONDITIONS

Stream Crossing: ELK RIVER

- I. 1. Type of bed material? See divers report
- 2. Has channel shifted? No (Yes/ No/ Not Apparent)
- 3. Condition of rip-rap? Good Est. % failed 10 %
- 4. Overall condition of channel? Fair
- 5. Item 61 - Code values 0 thru 9 according to the recording and coding guide currently in effect: 6
- 6. Underwater diver inspection recommended? Yes
If yes, why? Deep Water at Piers

- II. Channel and bank stability conditions: (yes if applicable)
 - 1. Steep bank conditions: Failures upstream _____ Failures downstream _____
 - 2. Moderate bank erosion Yes
 - 3. Bank vegetation: a. low growth Yes b. large timber Yes c. clear banks _____
d. dead trees upstream Yes e. dead trees downstream Yes
 - 4. Sediment or gravel accumulation: Unknown (Yes/ No/ Unknown)
 - 5. Channel altered or straightened: No (Yes/ No/ Unknown)
 - 6. Stable conditions: a. live growth Yes b. bedrock _____
c. boulders _____ d. flat slopes (<=2:1) _____

- III. Waterway adequacy and debris characteristics: (yes if applicable)
 - 1. Bridge deck elevations:
 - a. level with approach roadway. Yes
 - b. higher than approach roadway. _____
 - c. roadway approach >= 2 ft. above natural ground line. _____
 - 2. Abutment encroaches into channel. _____
 - 3. Large scour (blowhole) under bridge. No
 - 4. Indications that flood waters overtop bridge: No (Yes/No)
If YES, Answer: Occasionally, Frequently, or Unknown _____
 - 5. Debris characteristics:
 - a. debris/drift present YES
 - b. debris/drift likely to accumulate Yes
 - c. dead trees upstream Yes dead trees downstream Yes

IV. Comments: No significant change in channel profile.

SPECIAL INSPECTION DATA - FOR REASONS OTHER THAN FC OR SCOUR

- I. Does this bridge need a special inspection? No
- II. Reason for special inspection:

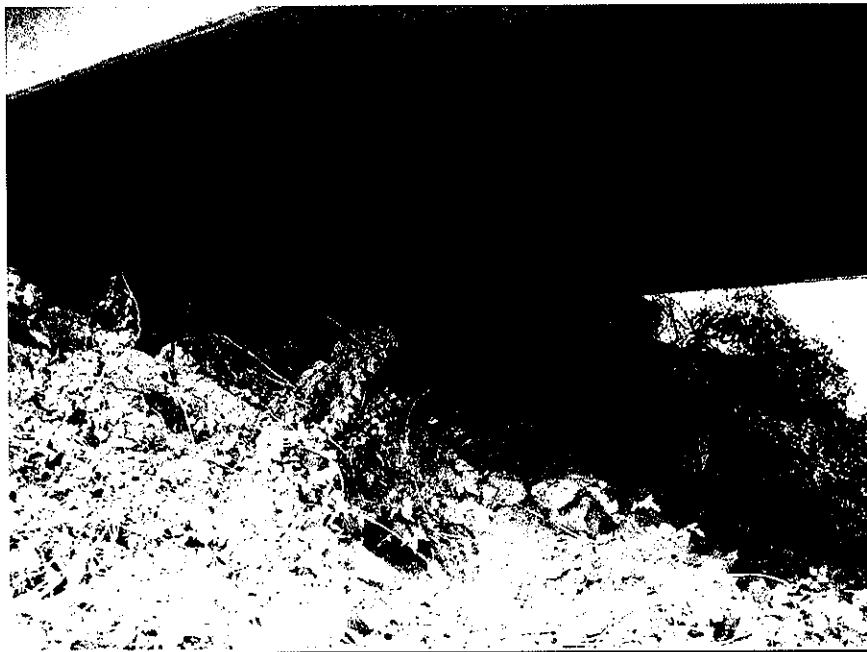
Photographs

Bridge ID#: 28SR0070007

Date: 11/13/2007



BRIDGE NUMBER



ABUTMENT

Photographs

Bridge ID#: 28SR0070007

Date: 11/13/2007



DOWNSTREAM



OUTLET ELEVATION



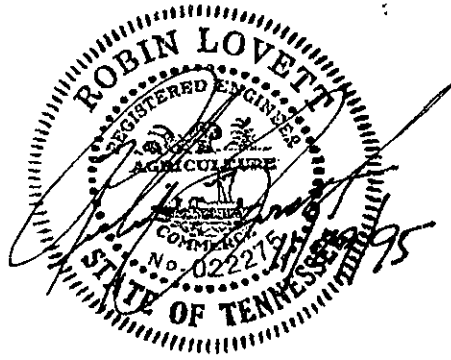
STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION

28SR070011

UNDERWATER
BRIDGE INSPECTION REPORT

COUNTY: GILES
ROUTE: STATE ROUTE 7
INSPECTED BY: HERB MURPHY (DIVER)
ROBIN LOVETT (ENGR.)

BRIDGE NO.: 28-SR7-5.45
CROSSING: ELK RIVER
REVIEWED BY: WIN PETRONE



ROBIN E. LOVETT, P.E.
PRINCIPLE INSPECTOR

SEPTEMBER 13, 1995

INSPECTION DATE



SITE PHOTOGRAPHS

STATE ROUTE 7 / ELK RIVER

FED. PROJ. NO.: BR-NBIS (28)

T.D.O.T. PROJECT NO. 99103-5266-94

County: GILES

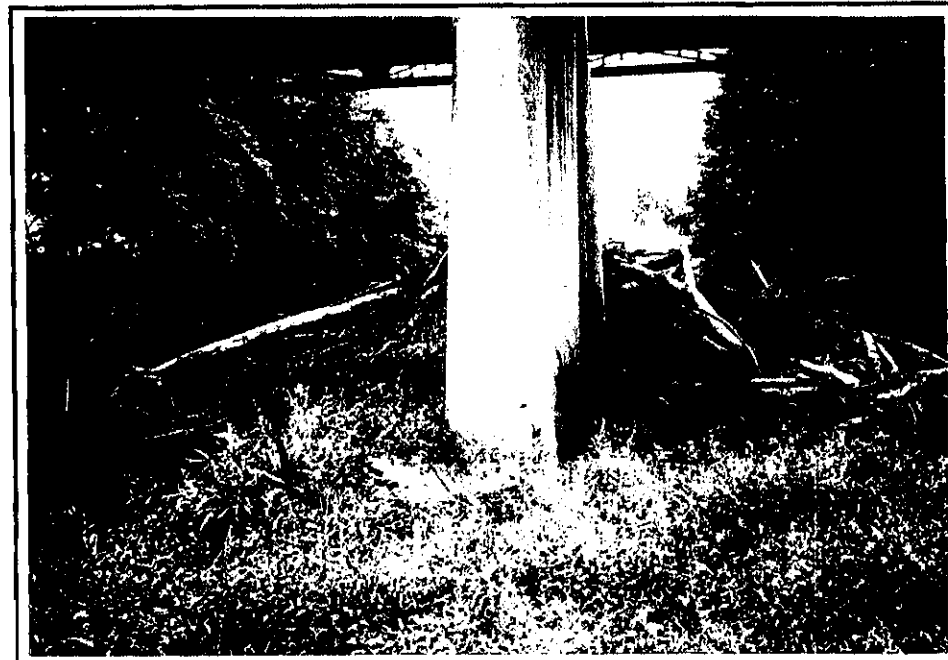
Inspected by: ROBIN LOVETT

Bridge No.: 28-SR7-5.45

Inspection Date: 09/13/95



PIER NO. 1 (LOOKING BACK ON SURVEY)



PIER NO. 2 LOOKING UPSTREAM

SITE PHOTOGRAPHS

STATE ROUTE 7/ELK RIVER

FED. PROJ. NO.: BR-NBIS (28)

T.D.O.T. PROJECT NO. 99103-5266-94

County: GILES

Inspected by: ROBIN LOVETT

Bridge No.: 28-SR7-545

Inspection Date: 09/13/95



PIER NO. 3 (LOOKING FORWARD ON SURVEY)



PIER NO. 4 (LOOKING FORWARD ON SURVEY)

Site # 6

**STREAM RECONNAISSANCE
For Debris Accumulation at Bridges**

SECTION 1 - SITE DESCRIPTION

ROAD NAME/NUMBER

SR 274

DATE

3/12/2008

BRIDGE NUMBER

52-SR274-10-03

STREAM NAME

Elk River

GPS COORDINATES

N 35° 07.370' +/- 16 feet

W 86° 43.064' **SECTION 2 - REGION AND VALLEY DESCRIPTION**

PART 1: WATERSHED

Land Use

- Natural
- Agricultural
- Urban
- Suburban
- Rural
- Industrial
- Cattle grazing

Vegetation

- None
- Grass
- Pasture
- Crops
- Shrubs
- Deciduous Forest/trees
- Coniferous Forest/trees

PART 2: RIVER VALLEY CONDITION

Valley Side Failures

- None
- Occasional
- Frequent

Failure Locations

- None
- Away from river
- Along river

PART 3: FLOODPLAIN

Floodplain Width

- None
- <1 river width
- 1-5 river widths
- 5-10 river widths
- >10 river widths

Land Use

- Natural
- Agricultural
- Urban
- Suburban
- Rural
- Industrial
- Mining
- Cattle grazing

Vegetation

- None
- Grass
- Pasture
- Orchards
- Crops
- Shrubs
- Deciduous Forest/trees
- Coniferous Forest/trees

Riparian Buffer Strip

- None
- <1 river width
- 1-5 river widths
- >5 river widths

- 1) debris on pier 2 from left bank
- 2) upstream, from deck (note submerged bars upstream of bridge)
- 3) downstream, from deck

- 4) Debris and upstream face of bridge, from hill on left bank

PART 4: VERTICAL CONFINEMENT

Terraces

- None
- Left bank
- Right bank

Levees

- None
- Natural
- Constructed

Levee Location

- Along channel bank
- Set back <1 river width
- Set back >1 river width

PART 5: LATERAL RELATION OF CHANNEL TO VALLEY

Planform

- Straight
- Meandering
- Braided
- Anastomosed
- Engineered

Meander Characteristics

- Mild bends
- Moderate bends
- Tight bends

SECTION 3 - CHANNEL DESCRIPTION

PART 6: CHANNEL DESCRIPTION (select all that apply)

Bed Controls

- None
- Occasional
- Frequent
- Confined

Control Types

- None
- Bedrock
- Boulders
- Gravel armor
- Bridge protection
- Grade control
- Debris
- Dams (beaver, engineered)

Width Controls

- None
- Occasional
- Frequent
- Confined

Control Types

- None
- Bedrock
- Boulders
- Gravel armor
- Bridge protection
- Bridge abutments
- Bank stabilization
- Debris

Other

- Debris
- Mining
- Reservoir
- Knickpoint

M-B classification

- Cascade or step-pool
- Plane, pool-riffle, dune-ripple
- Braided

Corps classification (other)

- Modified (engineered)
- Regulated
- Arroyo

Flow Habit

- Perennial
- Flashy perennial
- Intermittent
- Ephemeral

Channel width = _____

PART 7: BED SEDIMENT DESCRIPTION (select all that apply)

Bed Material

- Clay
- Silt
- Sand
- Gravel
- Cobbles
- Boulders

Bar Types

- None
- Alternate bars
- Point bars
- Mid-channel bars
- Diagonal bars
- Irregular/combination

Bar Material

- Silt
- Sand
- Gravel
- Cobbles

Bar Vegetation

- None
- Grasses
- Reeds/shrubs
- Trees

Bar Width

- None
- Narrow
- Moderate
- Wide

SECTION 4 - BANK SURVEY (select all that apply)

Bank Characteristic	Left Bank	Right Bank
Bank material	<input type="checkbox"/> clay <input checked="" type="checkbox"/> silt <input checked="" type="checkbox"/> sand <input checked="" type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders <input type="checkbox"/> bedrock	<input type="checkbox"/> clay <input checked="" type="checkbox"/> silt <input checked="" type="checkbox"/> sand <input checked="" type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders <input type="checkbox"/> bedrock
Layer material	<input checked="" type="checkbox"/> no layers <input type="checkbox"/> cohesive <input type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders	<input checked="" type="checkbox"/> no layers <input type="checkbox"/> cohesive <input type="checkbox"/> sand <input type="checkbox"/> gravel <input type="checkbox"/> cobbles <input type="checkbox"/> boulders
Bank height	6-12 feet	6-12 feet
Bank slope	<input checked="" type="checkbox"/> steep <input type="checkbox"/> moderate <input type="checkbox"/> shallow	<input checked="" type="checkbox"/> steep <input type="checkbox"/> moderate <input type="checkbox"/> shallow
Bank vegetation	<input type="checkbox"/> none <input checked="" type="checkbox"/> grasses/annuals <input checked="" type="checkbox"/> reeds/shrubs <input checked="" type="checkbox"/> trees falling trees? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no tree density: <input type="checkbox"/> sparse <input checked="" type="checkbox"/> dense tree health: <input checked="" type="checkbox"/> good <input type="checkbox"/> poor tree ages: <input type="checkbox"/> young <input checked="" type="checkbox"/> mature <input type="checkbox"/> old tree diversity? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no	<input type="checkbox"/> none <input checked="" type="checkbox"/> grasses/annuals <input checked="" type="checkbox"/> reeds/shrubs <input checked="" type="checkbox"/> trees falling trees? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no tree density: <input type="checkbox"/> sparse <input checked="" type="checkbox"/> dense tree health: <input checked="" type="checkbox"/> good <input type="checkbox"/> poor tree ages: <input type="checkbox"/> young <input checked="" type="checkbox"/> mature <input type="checkbox"/> old tree diversity? <input checked="" type="checkbox"/> yes <input type="checkbox"/> no
Bank erosion and failure location	location of erosion: <input type="checkbox"/> outside meander bend <input type="checkbox"/> inside meander bend <input type="checkbox"/> opposite bar or obstruction <input checked="" type="checkbox"/> general type of erosion: <input checked="" type="checkbox"/> fluvial <input type="checkbox"/> geotechnical	location of erosion: <input type="checkbox"/> outside meander bend <input type="checkbox"/> inside meander bend <input type="checkbox"/> opposite bar or obstruction <input checked="" type="checkbox"/> general type of erosion: <input checked="" type="checkbox"/> fluvial <input type="checkbox"/> geotechnical

SECTION 5 – DEBRIS CHARACTERISTICS

PART 8: EVIDENCE OF HIGH DEBRIS DELIVERY POTENTIAL

- Presence of debris at bridge (See Part 9)
- Presence of debris at upstream sites
- Documented need for debris removal at bridge (Contact: _____)
- Evidence of bank erosion

PART 9: DEBRIS TYPE / QUANTITY

- | | | | | |
|--|-----------|--|--|---------|
| <input type="checkbox"/> None | Percent | | <input type="checkbox"/> Fine detritus | Percent |
| <input checked="" type="checkbox"/> Small floating debris | <u>50</u> | | <input type="checkbox"/> Coarse detritus | _____ |
| <input checked="" type="checkbox"/> Medium floating debris | <u>50</u> | | <input type="checkbox"/> Boulders | _____ |
| <input type="checkbox"/> Large floating debris | _____ | | | |

SECTION 6 - BRIDGE CHARACTERISTICS

PART 10: PIER MEASUREMENTS

Number of piers: 3

Width measurements:

Left bank or abutment to pier: ¹10 ft Right bank or abutment to pier: ³10 ft

Width between piers:

Piers	1 - 2	2 - 3	3 - 4	4 - 5	5 - 6
Width (ft)					

Height of low chord above stream bed: see plans

PART 11: PIER CHARACTERISTICS

- Single, solid piers
- Multiple, closely spaced pier or pile groups
- Exposed pier footing piles
- Multiple piles, or row of pier columns skewed to approaching flow

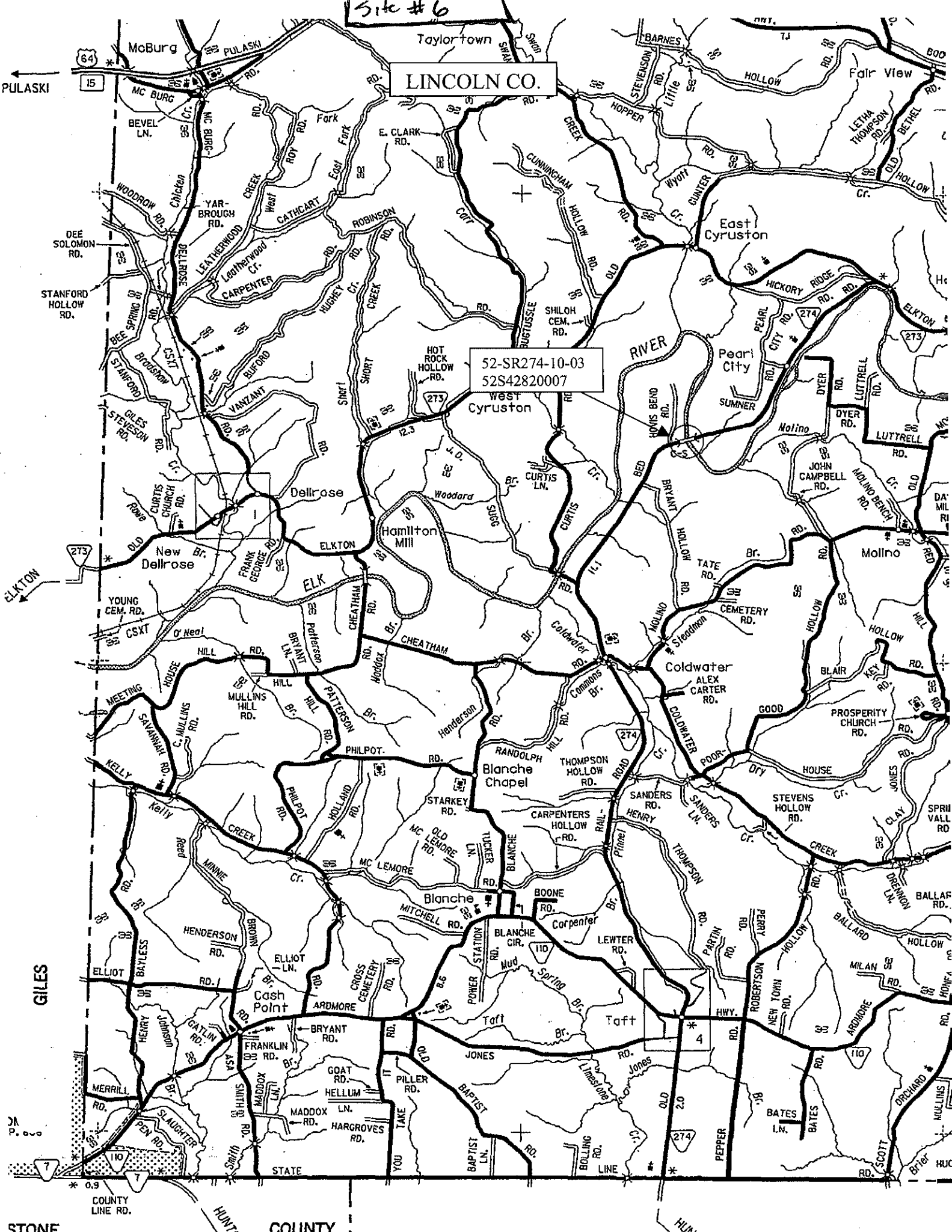
PART 12: PIER LOCATION

- Sheltered location (Piers 1, 3)
- Bank/floodplain (Piers _____)
- In the channel (Piers 1, 2, 3)
- In the path of debris flow (Piers 2)

Site #6

LINCOLN CO.

52-SR274-10-03
52S42820007



STONE COUNTY HUN. COUNTY

PHOTOGRAPHS

Page No. _____

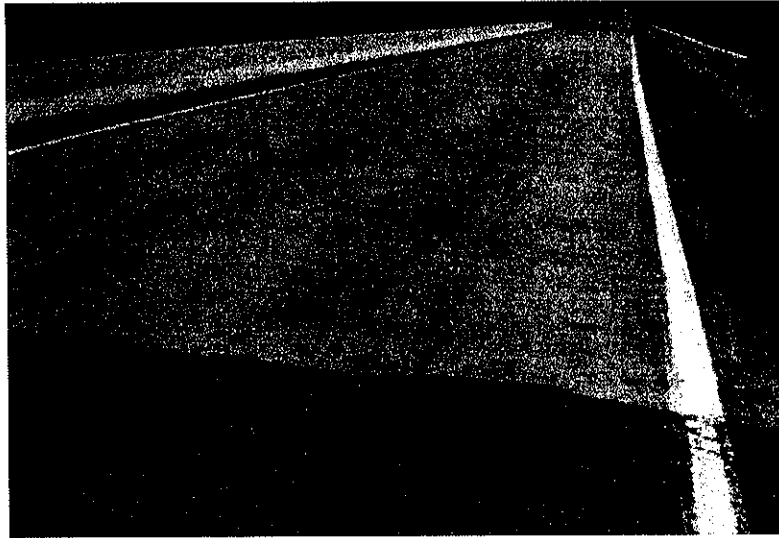
Bridge No.: 52 - SR274 - 1003

Crossing:: ELK RIVER

Federal No.: 52S42820007

Date: October 24, 2005

PIC1



WEARING SURFACE

PIC2



#1 END LOOKING BACK

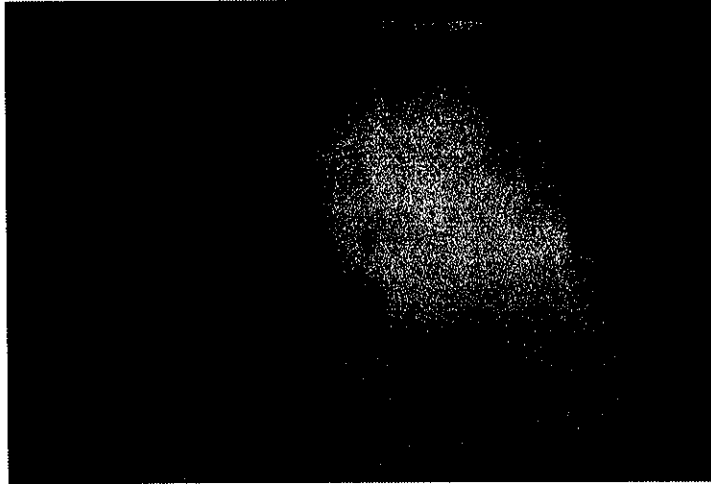
PHOTOGRAPHS

Page No. _____

Bridge No.: 52 - SR274 - 1003
Crossing:: ELK RIVER
Federal No.: 52S42820007

Date: October 24, 2005

PIC5



DOWNSTREAM

PIC6



BRIDGE NUMBER

PHOTOGRAPHS

Page No. _____

Bridge No.: 52 - SR274 - 1003
Crossing:: ELK RIVER
Federal No.: 52S42820007

Date: October 24, 2005

PIC 9



PIER

PIC 10



INLET

BRIDGE INSPECTION REPORT

Page No. _____

Form BIR 3.0
(Rev. 9-22-98)
DT-0069

Field Report No. 17 Date 10/24/2005
Previous Report No. 16 Date 10/22/2003
Plans: DESIGN

Bridge No. 52S42820007
Eleven Digit No.

Bridge Location No. 52 - SR274 - 10.03 N
Co. Route Log Mile

ST RTE 274 over ELK RIVER NA
Road Name Crossing Structure Name (If Named)
Year Constructed 1974 Actual County Lincoln Maintenance District 34
Year Widened NA NA Year Rehabilitated NA NA

FEATURES

Wearing Surface CONCRETE Depth NA (in.)
Flared Width No Median Width NONE
Navigational Control No Bridge Skew 90° NA
Structure Type (Main Span) P.P.C.
Structure Type (Appr.Spans) NA
No. Main Spans 4 No. Approach Spans NA
Maximum Span Length 71.3' (**.* ft.)
Total Length 284.3' (**.* ft.)

INSPECTORS

- 1. LAFLEUR
- 2. Nix
- 3. Stahl
- 4. _____
- 5. _____
- 6. _____
- 7. _____
- 8. _____

WIDTHS (*.* ft.)

Deck Out-to-Out 35.0'
Roadway Curb/Curb 30.0'
Roadway Rail/Rail 30.0'
Sidewalk Rt. NA Lt. NA
*Approach Roadway 22.0'
*(Does Not Include Shoulders)
Approach Shoulder Rt. 3'
Lt. 3'

CLEARANCES

Min. Vertical Clearance over Deck 99 (ft.-in.)
Min. Vertical Under Clearance 99 (ft.-in.)
Min. Lateral Under Clearance Rt. NA (*.* ft.)
Min. Lateral Under Clearance Lt. NA (*.* ft.)

FRACTURE CRITICAL: NO
(If Yes, Include BIR 3.9)

NBIS Bridge Length (<25 ft.) >25' (ft.-in.)

UNDERWATER INSPECTION

To Be Performed By: CONTRACT DIVER Date _____

Change in Structural Condition: No Major Repairs Made: No BRIDGE is: OPEN

COMMENTS:

Water is coming off of the # 2 end and draining down between the road way and bridge, causing embankment erosion

Supervising Bridge Inspector: JEFF SCOTT

BRIDGE RATING: GOOD

STREAM CHANNEL DATA AND CONDITIONS

Stream Crossing: ELK RIVER

- I. 1. Type of bed material? Unknown
2. Has channel shifted? No (Yes/ No/ Not Apparent)
3. Condition of rip-rap? Good Est. % failed 0 %
4. Overall condition of channel? Good
5. Item 61 - Code values 0 thru 9 according to the recording and coding guide currently in effect: 7
6. Underwater diver inspection recommended? Yes
If yes, why? Deep Water
- II. Channel and bank stability conditions: (yes if applicable)
1. Steep bank conditions: Failures upstream _____ Failures downstream _____
2. Moderate bank erosion _____
3. Bank vegetation: a. low growth Yes b. large timber Yes c. clear banks _____
d. dead trees upstream Yes e. dead trees downstream Yes
4. Sediment or gravel accumulation: Yes (Yes/ No/ Unknown)
5. Channel altered or straightened: No (Yes/ No/ Unknown)
6. Stable conditions: a. live growth Yes b. bedrock _____
c. boulders _____ d. flat slopes (<=2:1) _____
- III. Waterway adequacy and debris characteristics: (yes if applicable)
1. Bridge deck elevations:
a. level with approach roadway. Yes
b. higher than approach roadway. _____
c. roadway approach >= 2 ft. above natural ground line. _____
2. Abutment encroaches into channel. _____
3. Large scour (blowhole) under bridge. _____
4. Indications that flood waters overtop bridge: No (Yes/No)
If YES, Answer: Occasionally, Frequently, or Unknown _____
5. Debris characteristics:
a. debris/drift present Yes
b. debris/drift likely to accumulate Yes
c. dead trees upstream Yes dead trees downstream Yes
- IV. Comments: NO CHANGE

SPECIAL INSPECTION DATA - FOR REASONS OTHER THAN FC OR SCOUR

- I. Does this bridge need a special inspection? No
II. Reason for special inspection: