CUYAHOGA VALLEY NATIONAL PARK
Environmental Assessment for Rockside Boarding Area Parking Expansion

Appendix E

Combined Statement of Findings

For

Executive Order 11988 "Floodplain Management"

And

Executive Order 11990 "Protection of Wetlands"

CUYAHOGA VALLEY NATIONAL PARK
Environmental Assessment for Rockside Station Boarding Area Parking Expansion
And Class 1 Connector Trail and Bridge from Lock 39 Trailhead

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Recommended: _____ 9-21-06
Superintendent, Cuyahoga Valley National Park **Date**

Concurred: _____ 10-13-06
Chief, Water Resources Division **Date**

Approved: _____ OCT 17 2006
Director, Midwest Region **Date**

1.0 INTRODUCTION

The NPS has implemented the requirements of Executive Order (EO) 11990, "Protection of Wetlands," in its Director's Order #77-1: Wetland Protection (DO #77-1), which applies to all NPS proposed actions that have the potential to adversely affect wetlands and wetland functions. The NPS has also implemented the requirements of EO 11988, "Floodplain Management," in its Director's Order #77-2 (DO #77-2), which applies to all NPS proposed actions that could adversely affect the natural resources and functions of floodplains, or increase flood risks.

A Statement of Findings (SOF) is required as a basis for management decision making for each of the executive orders, providing a rationale for the selection of the Preferred Alternative and the potential impacts on the wetland and floodplain areas. As provided in Section 3.3 of DO #77-1, a wetland SOF may be combined with a floodplain SOF. This combined SOF is being appended to the Environmental Assessment (EA) for the project and will be attached to the Finding of No Significant Impact (FONSI) of the EA.

1.1 Description of Proposed Action

One of the resources maintained at Cuyahoga Valley National Park (CVNP), is the Valley Railway through the Park, which is listed on the National Register of Historic Places and forms the Valley Railway Historic District. The Cuyahoga Valley Scenic Railroad (CVSR) is a not-for-profit organization that operates passenger excursion trains on the Valley Railway through a cooperative agreement. Annual ridership has steadily increased since 1990 and is expected to continue to expand with the recent connection to Canton, Ohio and the planned connection in downtown Cleveland, Ohio.

Among other locations, CVSR has a boarding site at the northern park boundary off Old Rockside Road and along the west side of the Cuyahoga River known as the Rockside Boarding Area (see location map in Appendix C). A gravel parking area that accommodates 149 vehicles currently serves this area. With the growth of the Valley Railway and in the services provided by CVSR, the parking area has experienced increased use resulting in increased demands on capacity, on operations, and on the quality of the user experience. The NPS also has a parking facility that accommodates 42 vehicles at the Lock 39 trailhead on the east side of the Cuyahoga River across from the Rockside Boarding Area which has also experienced increased use resulting in increased demands on capacity. The NPS seeks to accommodate the demand for additional parking, update the facilities for current and projected operations, and to improve the visitor experience at these facilities. A build alternative has been developed through the planning process to construct asphalt parking at the Rockside Boarding Area outside of the Cuyahoga River floodway which would connect to the Rockside Station. Additional parking would be provided to the south of this facility on stabilized turf. Lighting would be provided for the parking area. The loading platform at the Rockside Station would be extended 120 feet to the south. A Class I trail bridge would be constructed over the Cuyahoga River to connect the two parking facilities so that the Rockside Boarding Area facility could be better used as parking overflow for the Lock 39 Trailhead parking facility.

The Rockside Boarding Area exists to provide access for the public to the Valley Railway, which is one of the primary cultural resources and recreational opportunities provided by CVNP. The need for the project is to increase the parking capacity for the Rockside Boarding Area and for the Lock 39 Trailhead, and to improve the visitor experience at these facilities. The expansion of parking capacity at the Rockside Boarding Area is needed to serve present and future excursions, special events passenger trains and overflow parking for increasing use of the Lock 39 Trailhead parking area. Improvements of visitor experience at these facilities include lighting for use during night operations; a way to load longer trains without interfering with local traffic on Old Rockside Road; and safer transportation from the Rockside Boarding Area to the Towpath Trail for Lock 39 Trailhead overflow parkers.

The purpose of this project is to fulfill one of the purposes in Section 1 of PL 93-555**,** the 1974 enabling legislation for CVNP, for:

> *. . . preserving and protecting for public use and enjoyment the historic, scenic, natural, and recreational values of the Cuyahoga River and adjacent lands in the Cuyahoga Valley. . .*

It also fulfills one of the purposes of the NPS Organic Act (see Section 1.4) where the overall mission for areas managed by the NPS is to:

> *... promote and regulate the use of the Federal areas known as national parks ,... and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations.*

Increasing the parking capacity for the Rockside Boarding Area and for the Lock 39 Trailhead, and improving the visitor experience at these facilities will promote the public use and enjoyment of the Valley Railway, the Towpath Trail and other CVNP resources. There is also an opportunity to provide a multi-modal transportation link in bringing together transportation by train, automobile, bicycle and pedestrians.

A conceptual design was developed for the Preferred Alternative, known as Alternative 2 – Expansion & Improvement with Trail Bridge Over the Cuyahoga River, that would replace the existing gravel parking facility with a facility paved with asphalt to the north and covered with stabilized sod to the south. The asphalt portion would cover 58,520 square feet (1.3 acres) and have a capacity of 99, nine-foot parking spaces and four, 16-foot handicap parking spaces for a total of 103 parking spaces. The stabilized turf portion would cover 45,177 square feet (1.0 acres) and have a capacity of 116 nine-foot parking spaces. The total number of parking spaces on both the paved and stabilized turf would be 219 parking spaces.

The paved area section would be designed with a deepened crushed stone base and underlain with a geotextile bedding material to isolate the pavement structure from the underlying fine-grained soils. The stabilized turf area would be a mixture of 60 percent topsoil and 40 percent aggregate. Objectives in this design concept include the removal of parking area from the Cuyahoga River floodway and maximizing the riparian buffer area between the parking area and the river.

The improvement for the parking area in Alternative 2 would include lighting from 14 pole lights, with seven covering the asphalt area and seven covering the stabilized turf. The lights would only be used when needed. The lights would utilize the best available technology for energy efficiency and utilize minimal impact lighting techniques. The existing lights in the train station along the canopy would remain. These would be on a timer for regular use for security reason.

The parking area would be located in the floodplain of the Cuyahoga River. All of the facilities would therefore be designed to withstand inundation to comply with National Flood Insurance Program (NFIP) regulations. This alternative also includes provision of willow and/or cottonwood posts below the top of the left bank of the Cuyahoga River, and deeply rooted trees between the top of bank and edge of the parking area to improve bank stability and improve the riparian corridor.

A stormwater drainage scheme would be provided that incorporates permanent runoff controls with water quality enhancements. The design concept includes drainage islands to collect impervious sheet flows into concentrated grass-lined swales. Next, drainage culverts of sufficient slope and diameter would be used to convey flow from the drainage islands to the perimeter of the parking area. Outlet protection in the form of a rock or rip rap apron would be provided for the culverts. From each parking lot culvert outflow location and where sheet flow is allowed to directly run off from the parking lot, flow conveyance would continue in grass-lined channels. The channels would converge at the south end of the parking area and continue at a gradual slope along the existing topography to the south and east. The runoff control method would terminate by the use of an elevated grass level spreader that diffuses any concentrated flow into sheet flow. Any sheet flow that has not infiltrated would follow the existing topography to the Cuyahoga River.

Alternative 2 would also includes a Class 1 trail and trail bridge that would connect the east edge of the proposed parking area at the Rockside Boarding Area directly to the Lock 39 Trailhead by spanning the Cuyahoga River. Beginning at the edge of the proposed parking area expansion of the Rockside Boarding Area, a new trail, constructed of earthen embankment, would rise approximately 8 feet (to elevation 611.0) over a distance of 180 feet, at a grade not exceeding 5%, to the west abutment of the proposed trail bridge. The trail approach would be 8 feet wide with 2-foot wide grassed shoulders, and 2H:1V grassed side slopes. The trail surface would be composed of stone dust except where the slope is greater than 4%. In these areas, the surface would be composed of asphalt in order to avoid the potential for erosion. The trail bridge would have a clear span of 240 feet, spanning the floodway, a level deck (elevation 611.0) with clear inside width of 10 feet, and a structure depth of approximately 3 feet. From the east abutment, the trail (with typical section similar to the west approach) would continue east and rise another 2 feet over 165 feet to elevation 613.0 at the junction of the existing trails that connect the Lock 39 Trailhead parking area to the Towpath Trail.

Longer trains are being used than those envisioned when the existing timber platform was originally conceived and constructed in the mid-1990's. An unintended consequence of the current location of the platform and the longer trains is that trains that are boarding passengers at

Rockside Station occasionally block the existing vehicular crossing at Old Rockside Road (just north of the Rockside Station). The alternative therefore includes installation of another 120 feet of timber platform to eliminate the need for trains to block the crossing when they are boarding. This extension would span an existing wide and float drainage ditch adjacent to the tracks in the same manner as the existing platform area.

The Rockside Station Boarding Area Parking Expansion and Class 1 Connector Trail and Bridge from Lock 39 Trailhead is judged to be a Class I Action under DO 77-2 because it involves construction of man-made features that will perpetuate occupancy of the floodplain, and may potentially result in impacts to natural floodplain values.

1.2 Site Description

The Rockside Boarding Area site is located between the left bank of the Cuyahoga River and the Valley Railway, just south of Rockside Road. Access to the site is by means of a 20 foot wide paved access road, located adjacent to the left bank of the river. The access roadway passes under the Rockside Road bridge over the Cuyahoga River, and intersects with Old Rockside Road, located approximately 450 feet north of the north end of the parking area. The existing boarding area site includes approximately 75,235 square feet (1.7 acres) of gravel parking area, an open air station/waiting area with canopy located adjacent to the tracks, and walkways connecting the west edge of the parking lot, the station and boarding platform. The east edge of the parking area is located between 10 and 40 feet from the top of bank of the Cuyahoga River (Photo 3).

Lock 39 is located on the east side of the Cuyahoga River and is one of 44 locks along the Ohio & Erie Canal that lifted canal boats 395 feet in elevation between Cleveland and Akron. In operation from 1827 to 1913, this lock raised or lowered a canal boat about 9 feet. It is now the site of a trailhead for the multi-purpose "Towpath Trail," which follows the historic route of the Ohio & Erie Canal for 20 miles and serves as the major trail through CVNP. The trail continues to the north and is operated by Cleveland Metroparks. The Lock 39 parking facility has a capacity for 42 cars.

1.3 Alternatives Considered

The EA identified other alternatives that were considered but rejected. These included:

1.3.1 Use of Selected Green Techniques For Entire Parking Area. While some green techniques, such as stabilized turf, are included as part of Alternative 2, other green techniques and applications of green techniques to the entire parking area were considered but rejected. Using grass-pavers or open grass fields for parking was considered for the entire parking area. The special events occur into the early winter months and would require snow removal and use during inclement times of the year. Grass-pavers would be damaged by snowplows and the use of open grass fields would create muddy conditions during inclement weather. Semi-permeable pavement was also considered. The soils on the site are clay with poor permeability. A semi-permeable pavement would therefore require excavation of several feet of the clay base soil and

replacement with a permeable subbase. Such excavation was considered undue expense and disruption to the site.

1.3.2 Manage Existing Lot to Increase Capacity. Rather than adding parking capacity, the existing parking facility would be managed during higher usage to provide additional capacity. A "church parking lot" or "ferry approach" could be utilized for this purpose. It would require that individuals be present to help people park cars at the existing facility in lines, bumper-to-bumper, leaving lanes open for access and emergency vehicles. In this way, more cars could be packed into the same space. Although, this would provide more capacity for the existing parking area, it would also be confusing to the average visitor. Also, it would require that everyone arrive and leave at the same time since vehicles would be blocking each other in. However, different train programs leave on the same train but return at different times (See Train Schedule in Appendix F). It would also be difficult to incorporate those who may use the area as Lock 39 Trailhead overflow parking at the same time. The approach would also place additional logistics and manpower burdens on the CVSR, which has a limited number of staff and volunteers. It should be noted however, that this approach could work for special events where no other trips are being scheduled. Such techniques could still be used for such events in conjunction with either alternative.

1.3.3 Use of Overflow Parking. The nearest parking areas to the Rockside Boarding Area are the Lock 39 Trailhead parking area which has 42 parking spaces (located .5 miles away), and the Canal Visitor's Center, which has 89 parking spaces (located 2.25 miles away). These lots are often filled to capacity for their own uses, and would offer little in the way of overflow parking for the Rockside Boarding Area (as stated earlier, the Rockside Boarding Area is currently being used as overflow parking for the Lock 39 Trailhead parking). Furthermore, those using the railway are prepared to ride and not walk, and the trains run on a schedule. Neither of these areas is within easy walking distance of the Rockside Boarding Area. Those arriving later are the ones who would need to use overflow parking. They would therefore not have the extra time to walk to the station to catch the train. If the spaces in potential overflow areas were available at the time needed for the Rockside Boarding Area, shuttles would therefore be necessary to utilize them (see Section 1.3.4).

1.3.4 Use of Shuttles. There are no large lots in CVNP that are adequate to stage shuttle service. Arrangements could be made with facilities in nearby Valley View or Independence for parking space, and busses could be used to shuttle people to the boarding area. This type parking has been and would still be considered for special events that exceed the capacity of the Rockside Boarding Area parking lot. It requires a too much coordination and expense to be utilized on a regular, daily basis. Also, it does nothing to improve the surface, access, lighting, drainage or safety. It also does not address the overflow parking for the Lock 39 Trailhead.

1.3.5 Use of Other Boarding Areas. When the capacity of the parking lot is exceed, visitors would use other boarding areas. This would not be feasible for many schedules and special events because everyone boards at one location and the program begins. For other events, the last ones to the parking area, who would need an alternative boarding location, would likely not have enough time to travel to the next boarding area ahead of the train.

1.3.6 Expansion of Parking Area(s) in Other Locations. The location of the Rockside Boarding area and Lock 39 Trailhead precludes the expansion of parking facilities in other locations. Any expansion needs to serve those facilities. The Rockside Boarding Area is constrained to the north by Rockside Road and a drainage swale that serves it. It is constrained to the east by the Cuyahoga River and the river's floodway. It is constrained to the west by the railroad and a gas line that runs parallel to it, along the east side of the tracks. The Lock 39 Trailhead parking is constrained to the west and south by the Cuyahoga River and the river's floodway, to the north by Rockside Road, and to the east by the Towpath Trail and the canal.

1.3.7 Alternative 1 - No Action. The existing gravel parking area would be retained, maintained and utilized as it currently is. This does not meet the purpose and need for the project.

1.4 Flooding, Floodplain Values and Floodplain Processes

Flooding information used to perform this evaluation was drawn from the following sources:

1. U.S. Department of Housing and Urban Development, Flood Insurance Study, City of Independence, Ohio, Cuyahoga County, July 19, 2001(Revised) and HEC-RAS model. (Used to develop the water surface profiles, flooding limits, and includes modifications to determine the hydraulic effects of the proposed connector trail and river bridge.)

2. USGS Gauging Station 04208000 (72 years of record), Cuyahoga River at Independence, OH, located 240 feet downstream of Old Rockside Road, and approximately 600 feet downstream of the site.

3. Conditions Report and Alternatives Evaluation: Riverbank Stabilization at Station 515+00, Bergmann Associates and FIScH Engineering, March 31, 2001.

4. Programmatic Environmental Assessment for Riverbank Management of the Cuyahoga River, Cuyahoga Valley National Park; National Park Service, Bergmann Associates, FIScH Engineering, May 2003.

5. Field survey and mapping of the project area prepared by Bergmann Associates, dated May 2004 (under Task Order 32). This information was used to develop the parking area layout, connector trail and river bridge alignment and to model the effects of these changes in HEC-RAS.

Flooding of the site occurs when the Cuyahoga River overtops its banks. Most of the site is located within the 100-year floodplain, and the access drive is located within the floodway. The river is approximately 100 feet wide at this location and has a sinuosity of 1.15.

West of the river, the banks are 10 feet high, steep, and non-vegetated with the exception of willow and sycamore trees that are interspersed along the banks (Photos 1 and 2). Portions of the bank are naturally armored as a result of fluvial erosion and sorting (Photos 1 and 2). Photos 3 through 6 provide views of the existing riparian buffer, the existing parking area, a vernal pool

located to the south of the site and a view of the east bank of the river from the west bank, respectively. The floodplain is sloped between 1% and 4% towards the river. Other than the parking area, the floodplain consists of overgrown pasture, a drainage channel along the south side of Rockside Road, and seven wetlands (totaling 1.14 acres). A forested wetland with some vernal pools, located further to the south, will not be disturbed by the alternative being considered. In summary, the floodplain west of the river provides off-channel storage for Cuyahoga River flooding, however, the site exhibits rather low quality habitat and low quality floodplain values, primarily due to its existing use as a parking area and due to previous disturbance of the overall site.

The floodplain east of the river is significantly narrower due to high ground (above elevation 610) upon which the Lock 39 Trailhead parking lot is located. Most of this portion of the floodplain is covered with successional floodplain woods. Common species include cottonwood, box elder, Japanese knotweed and garlic mustard. The land between the floodplain and the Lock 39 Trailhead parking area is steeply sloped. There is one low quality wetland (0.01 acres) located near the Lot 39 Trailhead parking lot.

Photos 7, 8 and 9 show the approximate location of the proposed pedestrian bridge crossing from the east side, the Lock 39 Trailhead parking lot, and the eastern terminus of the proposed east approach trail, respectively.

1.5 Affected Wetlands

Many wetland areas exist in CVNP. A park-wide wetland inventory indicates that more than 1,200 wetland areas encompassing approximately 1,700 acres exist in CVNP (Davey Resource Group, 2001). Most CVNP wetlands are small, with only 190 greater than an acre in size and only 35 greater than 10 acres in size. Additional small wetlands may yet remain undetected.

Wetland types found in the Park include marshes, wet meadows, scrub/shrub wetlands and forested wetlands. Small emergent wetlands occurring in isolated depressions fed by surface water are most common. Small wetlands are also often found at the head of small, intermittent drainageways, adjacent to ponds or as hillside seeps where groundwater flows out of a hillside. Many wetlands are partially or completely forested or include a shrub component. The largest wetlands are located within the Cuyahoga River floodplain and include emergent, shrub, and forested areas. All ponds except one (Oxbow) are human-made (i.e., artificial), with many originally created to serve as small farm ponds. Long-abandoned ponds usually have reverted to a more natural state and now have wetland characteristics. Such ponds are treated as natural wetlands, assigned protective buffers and managed for natural resource values.

The CVNP inventory described above may be considered an “enhanced inventory” as described in Section 5.1 of Procedural Manual #77-1. The inventory does not show any wetlands in the study area. It does show a large wetland, Wetland Number 1140, just south of the site.

Wetlands on the 11.45-acre site were delineated and surveyed on June 20, 2005 by the Davey Resource Group (see Appendix D, Wetlands Delineation Report). The delineations were made utilizing the routine on-site determination method as published in the Corps of Engineers

Wetlands Delineation Manual (United States Army Engineer Waterways Experiment Station Environmental Laboratory, 1987). In addition, the methodology incorporated the procedures used by the NPS, the U.S. Fish and Wildlife Service system, *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin et al, 1979).

Seven wetland areas were mapped on the site as shown on Appendix M of the Wetlands Delineation Report (Appendix D). The areas of each wetland are shown on Table 4-1. Wetlands B, C, D and E are located on top of fill within slight depressions and areas of tire rutting and soil compaction. Wetlands B and G are dominated by the common reed (*Phragmites australis*), a non-native invasive species. Because of these characteristics, all of the wetlands identified on the site are rated by the Ohio Rapid Assessment Method (ORAM)[1] and placed in the Category 1 classification. Category 1 wetlands are the lowest quality wetlands. Wetlands A and F are palustrine forested wetlands. Wetland A is typical of small, roadside disturbed wetlands that are found along ditches and small streams and represents a recovered ecological state from past disturbances. Wetland F is the only wetland not likely to be regulated by the U. S. Army Corps of Engineers (USACE).

Table E-1. Wetlands Delineated on the Site.

Wetlands	Cowardin Type	Wetland Type	ORAM Category	Area (Acres)
A	Palustrine forested	USACE Jurisdictional	2	0.18
B	Palustrine emergent	USACE Jurisdictional	1	0.30
C	Palustrine emergent	USACE Jurisdictional	1	0.21
D	Palustrine emergent	USACE Jurisdictional	1	0.07
E	Palustrine emergent	USACE Jurisdictional	1	0.03
F	Palustrine forested	Cowardin only	Modified 2	0.35
G	Palustrine emergent	USACE Jurisdictional	1	0.01
Total				1.15

[1] The ORAM is a wetlands evaluation method developed and used by the Ohio EPA.

2.0 JUSTIFICATION FOR USE OF THE FLOODPLAIN

2.1 Why Proposed Action Must be Located in the Floodplain

The proposed action is an expansion of an existing facility already located within the floodplain with a trail connection over the river to the Towpath Trail. Whether or not the parking area is expanded, or just improved, the Valley Railway, the open-air station/waiting area with canopy located adjacent to the tracks, electrical service, the station and the boarding platform will remain in the floodplain.

The Rockside Boarding Area exists to provide access for the public to the Valley Railway, which is one of the primary cultural resources and recreational opportunities provided by CVNP. The need for the project is to increase the parking capacity for the Rockside Boarding Area and for the Lock 39 Trailhead, and to improve the visitor experience at these facilities. The expansion of parking capacity at the Rockside Boarding Area is needed to serve present and future excursions, special events passenger trains and overflow parking for increasing use of the Lock 39 Trailhead parking area. Improvements of visitor experience at these facilities include lighting for use during night operations; a way to load longer trains without interfering with local traffic on Old Rockside Road; and safer transportation from the Rockside Boarding Area to the Towpath Trail for Lock 39 Trailhead overflow parkers.

The purpose of this project is to fulfill one of the purposes in Section 1 of PL 93-555**,** the 1974 enabling legislation for CVNP, for:

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Increasing the parking capacity for the Rockside Boarding Area and for the Lock 39 Trailhead, and improving the visitor experience at these facilities will promote the public use and enjoyment of the Valley Railway, the Towpath Trail and other CVNP resources. There is also an opportunity to provide a multi-modal transportation link in bringing together transportation by train, automobile, bicycle and pedestrians.

2.2 Investigation of Alternative Sites

The Environmental Assessment for Rockside Station Boarding Area Parking Expansion and Class 1 Connector Trail From Lock 39 Trailhead, Cuyahoga Valley National Park, August 2005, prepared by the National Park Service and Bergmann Associates examined a full range of alternatives, based on the purpose and need. This SOF is an appendix to the EA. There are no alternatives in alternative locations outside the floodplain that could fulfill the purpose and need for the project.

3.0 SITE-SPECIFIC FLOOD RISK

3.1 Increased Risk From Expansion and Use of Rockside Road Boarding Area Parking Area and Access Drive

3.1.1 Recurrence Interval of Flooding

A range of recurrence interval flooding was evaluated with HEC-RAS using flows obtained primarily from previous studies. In addition, Gumbel and Log Pearson III analyses were performed using the annual peak series from the gaging station (Figure 1) to obtain the 2.33- and 5-year recurrence interval flood peaks. The Gumbel results provided a better match for the lower recurrence interval events and thus were used in the analysis. The results of the analysis in terms of flooding depths and velocities in the existing parking area and access drive are summarized in Table E-2. Table E-2 shows that flooding of the parking lot occurs for storms with 5-year recurrence interval and greater. For the 500-year event, the lot floods to a depth of 9.5 feet. Table E-2 shows that flooding of the access drive, which has a minimum elevation 2 feet lower than the parking lot, occurs for storms with 2.33-year recurrence interval and greater. During the 500-year event, the access drive floods to a depth of 11.1 feet.

Table E-2. Rockside Road Boarding Area, Summary of Floodplain Information.

Flood Event	Flood Frequency (return period in yrs.)	Peak Flow (cfs)	Vel.Ch. (fps)	Vel. Left (ft/sec)	Peak Elevation (ft., MSL)	Water depth in Parking Lot / Access Drive[1]
Median	N/A	510	0.6	n/a	592.3	0 / 0
Average	N/A	900	0.9	n/a	3.1	0 / 0
Annual Flood	1	3,500	2.3	n/a	596.6	0 / 0
Dominant	1.5	6,300	3.0	n/a	599.6	0 / 0
2.33 - year	2.33	9,450	3.4	0.8	602.1	0 to 0.1 feet / up to 2.1 feet
5 - year	5	12,000	3.5	0.9	603.8	0 to 0.8 ft. / up to 3.8 feet
10 - year	10	14,300	3.3	1.0	605.5	0 to 3.5 ft. / up to 5.5 feet
50 - year	50	19,500	3.1	1.2	606.2	1.0 to 4.2 ft. / up to 6.2 feet
100 - year	100	21,900	2.9	1.2	609.2	4.0 to 7.2ft. / up to 9.2 feet
500 - year	500	27,800	2.7	1.3	611.6	6.4 to 9.6 ft. / up to 11.6 feet

[1]Parking lot minimum elevation = 602 / Access Drive minimum elevation = 600

Notes: Hydraulic data is based on the following:

- USGS Gaging Station 0408000, Cuyahoga River at Independence, OH, located approximately 600 feet downstream of the site.
- City of Independence, OH Flood Insurance Study, July 19, 2001 (for 10, 50, 100 & 500 yr.
- Conditions Report and Alternatives Evaluation – Riverbank Stabilization at Station 515+00, Bergmann Associates, March 30, 2001.
- Gumbel flood flow frequency analysis of annual peaks (73) to obtain 5-year, 2.33-year.
- Data presented in Table E-2 is obtained at Station 69552 of the HEC-RAS model.

Table E-2 also shows the average channel and left overbank velocities for all flood events. Although average velocities in the left overbank (where the parking lot and access drive are located) range from 0 to 1.3 ft./sec., velocities nearer to the edge of main channel will be closer to the

average main channel velocities. The main channel velocities range from 0.6 fps for the median discharge to 3.5 fps for the 5-year discharge.

The time required for flooding to occur varies depending upon the flood event. Discharge hydrographs from the gaging station records (Figure 2) provide an indication of the rate of change of flow with time. Figure 2 shows a one-year history of the fluctuation in daily mean discharge at the gage. Figure 3 shows the stage vs. discharge history for a one-month period. The slopes of the rising limbs of the individual stage hydrographs shown in Figure 3, indicating the rate of rise in the water surface, are close to being consistent from storm event to storm event. Figures 4 and 5 show the stage and discharge hydrographs for the May 31, 2003 flood event. The gage base elevation is 583.57. During this event, water level at the gage rose 8.5 feet in just under 9 hours, or approximately 1.0 feet per hour. This rate of rise is representative of region-wide precipitation. The rate of rise could be greater with snowmelt or thunderstorm conditions. Evacuation of the site can only be made via the access road that leads from the parking area to Old Rockside Road. The access road will become impassible prior the parking lot being flooded.

The fluvial geomorphology of the Cuyahoga River has been studied most recently as part of the Programmatic Environmental Assessment for Riverbank Management. The Cuyahoga River within the CVNP exhibits characteristics of a Rosgen C5 stream, which have a high potential for bank erosion (Photo 2). Typical bank failure mechanisms include erosion at the toe of the channel bank combined with translational failures of the upper bank. The study reach within which the Rockside Boarding Area is located, has an average channel slope of 4.9 ft./mi. and an average sinuosity of 1.3. In the immediate vicinity of the site the sinuosity is 1.15. Historic aerial photography from 1969 and 1999, used in connection with the Programmatic Environmental Assessment, shows that the left channel bank has remained relatively stable over the past 30 years. Portions of the river bank in close proximity to park resources or that exhibit significant bank loss, are regularly monitored by NPS staff. This area has not been included in the riverbank monitoring program, indicating that it is has not been found to be a significant risk to Park resources.

3.1.2 Flood Mitigation Plans

The preferred alternative will include measures to reduce hazards to human life and property, while minimizing impacts to the natural resources of the floodplain.

3.1.3 Operational Measures

The preferred alternative involves not only the expansion of an existing parking lot, but also new paving and other improvements such as lighting. This represents an increased investment of both government and personal property (privately owned vehicles) in a location that is subject to flooding risks. In addition, there is an increased risk to human life associated with the increase in parking spaces. To reduce the risk to human life and personal property damage, use of the

Rockside Boarding Area will be suspended whenever the Independence gage height exceeds 8.5 feet and is rising.[2]

Establishment of the 8.5 foot gage height is based on the following:

Initiation of access road flooding	=	600.0 feet, MSL
Freeboard (safety factor)	=	2.0 feet
Rate of river rise (from hydrographs)	=	1.0 feet / hour
Special train events trip duration	=	4 hours
River rise + Freeboard	=	6.0 feet
Max. water elevation at start of event	=	594.0 feet, MSL
Independence gage datum	=	583.57 feet, MSL
Max. gage height at start of event	=	10.43 feet, say 10.5 feet

3.2 Increased Risk From Trail Bridge and Approaches

3.2.1 Hydraulic Analysis of Trail Bridge

The FIS based HEC-RAS model was used with modifications that included adjustment of effective flow areas, and addition of new topography from the May 2004 site survey and mapping to assess the impacts of the proposed connector trail approaches and bridge. The existing ground surface above normal river level was determined using the May 2004 topography, and the below water portion was established using HEC-RAS interpolated cross sections.

The trail bridge and approaches were modeled into HEC-RAS using the layout presented in Exhibit 3. The trail bridge and approaches were projected normal to the cross section (see Figures 6 and 7). HEC-RAS was then run for existing and proposed conditions for a range of flows and the results are presented in Table E-3. Table E-3 shows that for the 5-year return period flood and lower, the proposed bridge has no effect on flood levels. For the 50 through 500-year floods, however, the maximum rise in water surface elevation is 0.1 feet. The peak water surface elevation for the 50, 100 and 500-year events will exceed the low chord elevation, possibly causing woody debris to be snagged by the bridge. Since the west approach embankment touches down quickly to match existing ground, the bridge is "perched," allowing a significant percentage of the flow to be conveyed in the left overbank.

Average velocities in the left overbank and main channel will increase slightly as shown in Table E-3, however, these velocities are not significant enough to cause any erosion of the proposed parking lot surface or of the channel banks.

[2] Real time gage height at the Independence gage can be monitored by the NPS and Scenic Valley Railway at http://waterdata.usgs.gov/nwis/uv/?site_no=04208000&agency_cd=USGS

Table E-3. Proposed Pedestrian Bridge, Summary of Floodplain Information.

Flood Event	Flood Frequency (return period in yrs.)	Peak Flow (cfs)	Existing Conditions			Proposed Conditions		
			Peak Elevation (ft., MSL)	Main Channel Avg. Vel. (fps)	Left Overbank Avg. Vel. (fps)	Peak Elevation (ft., MSL)	Main Channel Avg. Vel. (fps)	Left Overbank Avg. Vel. (fps)
Median	N/A	510	592.4	1.6	NA	592.4	1.6	NA
Average	N/A	900	593.3	2.0	NA	593.3	2.0	NA
Annual Flood	1	3,500	596.8	3.5	NA	596.8	3.5	NA
Dominant	1.5	6,300	599.8	4.0	NA	599.8	4.0	NA
2.33 - year	2.33	9,450	602.3	4.4	0.8	602.3	4.5	1.0
5 - year	5	12,000	604.0	4.6	1.1	604.0	4.7	1.0
10 - year	10	14,300	605.6	4.4	1.2	605.6	4.6	1.2
50 - year	50	19,500	608.2	4.1	1.3	608.3	3.8	1.8
100 - year	100	21,900	609.2	3.6	1.3	609.3	3.2	1.8
500 - year	500	27,800	611.6	3.3	1.4	611.7	2.3	2.1

Notes:

1. **Proposed Connector Trail Bridge low chord = 608.0**
2. **Proposed Connector Trail Bridge top of deck = 611.0**

3.2.2 Evaluation of Flooding Risk

The risk associated with construction of the connector trail approaches and pedestrian bridge primarily involves the increase in water surface elevation upstream of the trail bridge, and to a lesser extent, the increases in velocities in the vicinity of the bridge.

The maximum rise in water surface elevation for the 50- through 500-year floods is 0.1 feet. This rise diminishes to approximately 0.0 at a distance of 800 feet upstream of the bridge. National Flood Insurance Program (NFIP) regulations require that the maximum rise in water surface elevation for the base (100-year) flood not exceed 1.0 feet, so the proposed bridge complies with this requirement. The backwater from the proposed pedestrian bridge extends 800 feet upstream, however this portion of the floodplain has no structures.

3.2.3 Scour Design Recommendations for Pedestrian Bridge

In addition to compliance with the NFIP requirements utilization was made of highway bridge standards of the Ohio Department of Transportation (ODOT), contained in their Bridge Design Manual, Section 200. Section 203.3 of the Bridge Design Manual pertains to scour, and is intended to assure that the foundations of highway bridges are designed in compliance with Federal Highway Administration (FHWA) and ODOT bridge scour guidelines. Section 203.3 requires that:

- Bridge abutments be protected with rock channel protection underlain by a filter (either 6: crushed aggregate or appropriate geotextile). For this bridge, where the channel velocity is less than 8 feet/section for all flood conditions analyzed, a 2 foot thick layer of Type "C" stone would be adequate.

- Substructures for bridges over waterways be supported by piling or drilled shaft foundations unless the footings can be founded on bedrock.

- Scour calculations for bridges not supported on shale or bedrock should be performed in accordance with HEC-18. Such an analysis was performed for the 100- and 500-year floods and for a summary of the scour components provided in Table E-4. The calculations are provided in the Exhibits Section at the end of this report.

- Soil bearing conditions may also require that drilled shafts or piles be used to support the bridge foundations. The decision to use a deep spread footing that extends below the total estimated scour depth, or to support the bridge foundations or piles or drilled shafts, will be made based on the results of a geotechnical drilling investigation.

Table E-4. Scour Depths Summary Table

1 Percent Chance (100-year Flood)				
Element	Long-term (ft)	Contraction (ft)	Local (ft)	Total (ft)
Left Abutment	0.0	2.5	7.3	9.8
Right Abutment	0.0	2.5	5.6	8.1
0.2 Percent Chance (500-year Flood)				
Element	Long-term (ft)	Contraction (ft)	Local (ft)	Total (ft)
Left Abutment	0.0	0.0	8.5	8.5
Right Abutment	0.0	0.0	5.6	5.6

3.4 Facility Improvements and Environmental Mitigation Measures

The structures and facilities associated with the Rockside Boarding Area and the trail connector bridge and approaches will be designed to be consistent with the intent of the standards and criteria of the National Flood Insurance Program (44 CFR Part 60). To comply with the intent of these regulations, all new construction and substantial improvements will:

- Be designed (or modified) and adequately anchored to prevent floatation, collapse, or lateral movement of the structure resulting from hydrodynamic and hydrostatic loads, including the effects of buoyancy; [44 CFR Part 60.3(a) (3) (i)]

- Be constructed with materials resistant to flood damage; [44 CFR Part 60.3(a) (3) (ii)]

- Be constructed by methods and practices that minimize flood damages; [44 CFR Part 60.3(a) (3) (iii)];

- Be constructed with electrical, and other services facilities that are designed and/or located so as to prevent water from entering or accumulating within the components during conditions of flooding. [44 CFR Part 60.3(a) (3) (iv)]

- Prohibit encroachments, including fill, new construction, substantial improvements, and other development within the adopted regulatory floodway (the Preferred Alternative will remove approximately 5,300 square feet of the existing parking area from the floodway). [44 CFR Part 60.3(d) (3)];

- Not increase the base (100-year) flood elevation by more than 1.0 feet [44CFR Part 60.3 (c) (13)]; and

- Require that the minimum setback of the parking lot from the edge of the riverbank be increased from 10 to 30 feet, to allow the development of a vegetative buffer zone (Photo 4). Within this buffer, deep rooting trees will be planted at the top of bank, and posts (cottonwood and willow) will be driven between the top of bank and the water surface of the median discharge to ensure the long-term stabilization of the riverbank and develop a healthier riparian corridor. [44 CFR Part 60.5 (b) (2)]

4.0 WETLANDS

4.1 Impacts

In planning for specific site work, Procedural Manual #77-1 requires that onsite evaluations be conducted. Wetlands on the 11.45-acre site were delineated and surveyed on June 20, 2005 by Davey Resource Group.

Areas of potential impact were identified for each of the alternatives as shown on Table E-3.

Table E-3. Direct Impacts on Wetlands (in Acres).

Wetland	Total Area (Acres)	ORAM Category	Alternative 1	Alternative 2
A	0.18	2	0	0
B	0.30	1	0	0.30
C	0.21	1	0	0.21
D	0.07	1	0	0
E	1.03	1	0	0
F	0.35	Modified 2	0	0
G	0.01	1	0	0
Total	1.15	--	0	0.51

Under Alternative 2, the preferred alternative, there would be a total of 0.51 acres of impact to Wetlands B and C as shown on Drawing E-1 and enumerated in Table E-3. The area in Wetland B that is now shown to be covered by the proposed parking area would be removed in the construction process. The portion of Wetland C that is not shown under the stabilized turf would be disturbed during construction and what may remain of it would receive the stormwater runoff from the parking area, causing permanent impact. These wetland areas fall into Ohio EPA Category 1. The Wetland Delineation Report (Davey Resource Group, 2005) states that Wetland B is dominated by the common reed (*Phragmites australis*), a non-native, aggressively invasive species. Wetland C is a small palustrine emergent wetland with borderline hydric soils. Wetland C was formed in disturbed soils that appear to be low in organic matter as evidenced by weak plant growth, and are typical of wet meadow habitat that forms on disturbed soils.

4.2 Impact on Alternatives Considered

Table E-3 shows the potential impacts to the delineated wetlands for Alternative 1 - No Action.

4.3 Justification for Adverse Wetland Impacts

The two impacted wetlands fall into ORAM Category 1, the lowest quality wetlands. These wetlands are classified as Category 1 because of previous disturbance of the site and the presence of non-native, invasive species. The wetlands have formed on top of fill within slight depressions and areas of tier rutting and soil compaction.

Because of their low quality, the loss of any or all of these wetlands would not be significant. The loss of Wetland A may be more beneficial to surrounding wetlands because this area is

dominated completely by the aggressively invasive common reed (*Phragmites australis*). Also, the preferred alternative was designed to move the parking area out of the floodway area and increases the buffer area between the parking area and the river. The establishment of the riparian buffer in this area will contribute to the quality of the riverine wetland along the edges of the Cuyahoga River.

4.4 Proposed Compensation

According to Procedural Manual #77-1, compensation would be required for the wetland impacts since they are more than 0.1 acres. The manual provides that wetland compensation should be in the form of restoring wetland functions in degraded or former wetland habitats on NPS lands. Because of their low quality and domination of one by the common reed, the impacted wetland areas provide minimal beneficial wetland functions. Categories of the functions include sediment /toxicant retention and minimal flood storage.

To the south of the parking area is a forested wetland with some vernal pools that will not be affected by the project (see Figure 8 and Photo 5). This area includes debris piles covering an area of approximately 0.25 acres. It is proposed to restore this area by removing the debris piles as partial compensation for the removal of wetland areas under this alternative. Design would include consideration for protection of the existing wetland area during removal of the debris piles. This restoration of the vernal pools would add the function of wildlife habitat to those of sediment /toxicant retention and flood storage. Vernal pools are necessary for some species of amphibians and reptiles.

Additional compensation is proposed in the form of enhancement to a nearby Ohio Department of Transportation (ODOT) wetland mitigation site (see Figure 8). The ODOT is restoring a wetland for a nearby bridge replacement project on Interstate 271. It is scheduled for completion by May 2007. Areas immediately adjacent to this site are composed of a monoculture of the aggressively invasive common reed (*Phragmites australis*). The CVNP enhancement would include treatment of this infestation on 3.0 acres located adjacent and south of the ODOT mitigation project and would involve restoring native plant communities, planting native woody plants, and the control of the harmful non-native exotics. The *Phragmites* monoculture would be restored to a wet sedge meadow habitat. Other areas of the *Phragmites* monoculture along the east side of the ODOT mitigation site will be treated as part of the ODOT mitigation.

The proposed compensation for the 0.51 acres of wetland impact will therefore include 0.25 acres of restoration in the vernal pool area. Compensation for the remaining 0.26 will be compensated with the enhancement of 3.0 acres of an area of a *Phragmites* monoculture for an enhancement ratio of 12:1. The funding for this compensation will be included in the funding for the subject project, which has not yet been determined.

5.0 Summary

The preferred alternative will increase the monetary investment and the risk to both human life and property due to its location within the floodplain. However, the proposed mitigation measures will reduce this risk, provide compliance with the applicable provisions of 44 CFR Part 60, and restore and preserve some existing floodplain values.

Because of the proximity of the wetlands to the parking area, it is not possible to totally avoid impacts to wetlands. The preferred Alternative provides additional needed riparian buffer, while impacting 0.51 acres of Category 1 wetlands. This impact may be mitigated on nearby sites by the restoration of 0.25 acres in an existing forested wetland/vernal pool area. The remaining 0.26 acres will be compensated with the enhancement of 3.0 acres by treatment of a monoculture of *Phragmites australis* adjacent to a nearby ODOT wetland mitigation site for an enhancement ratio of 12:1.

CUYAHOGA VALLEY NATIONAL PARK
Environmental Assessment for Rockside Boarding Area Parking Expansion

Appendix E

Combined Statement of Findings
For
Executive Order 11988 "Floodplain Management"
And
Executive Order 11990 "Protection of Wetlands"

FIGURES

Figure 1: Annual Peak Discharges (cfs)

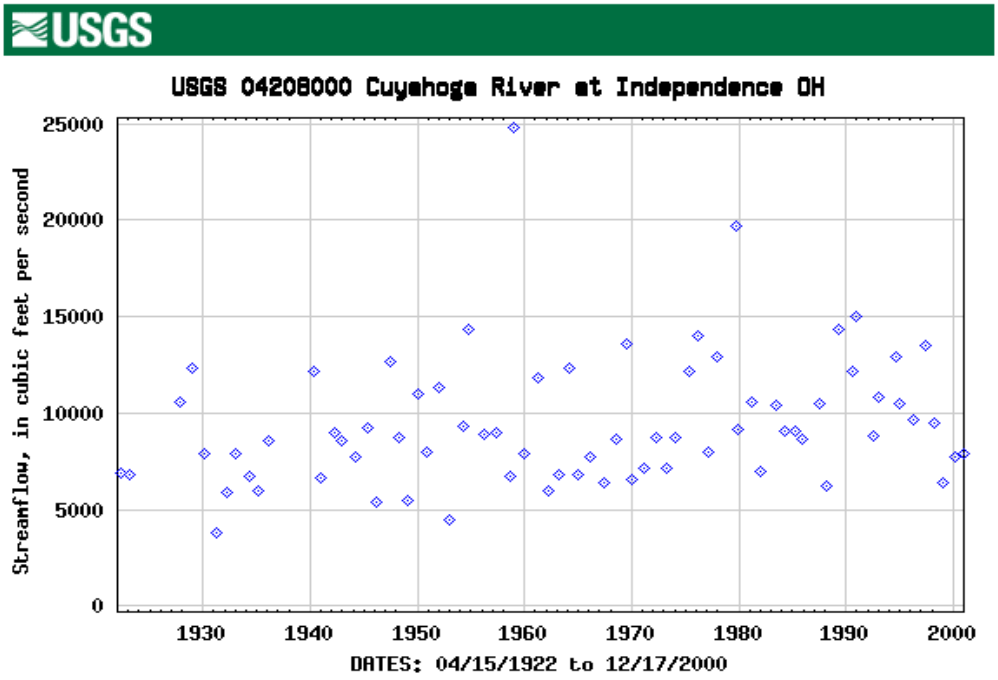
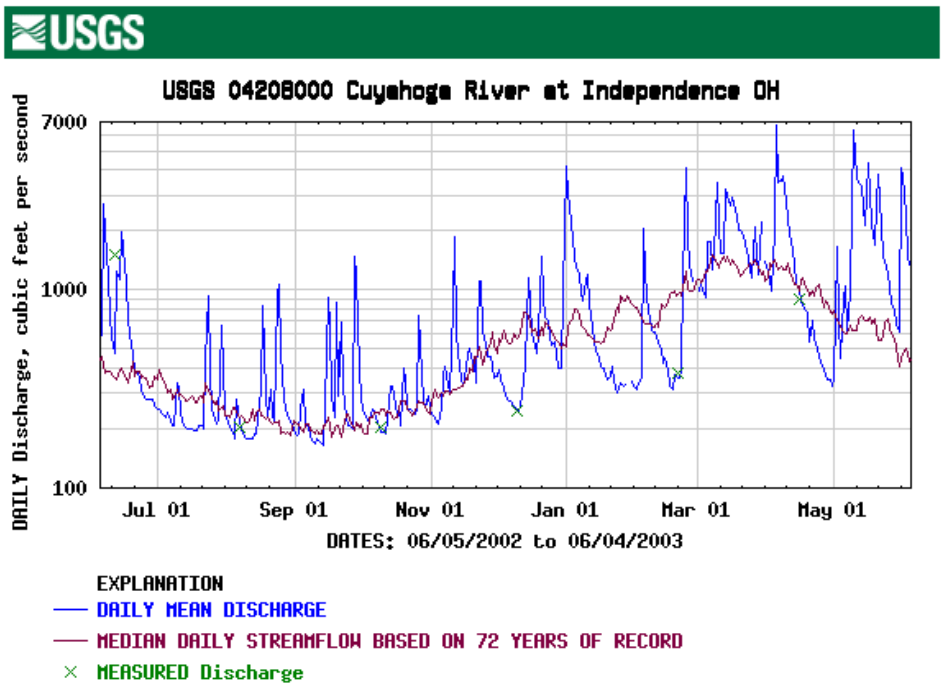


Figure 2: Daily Mean Discharge - June 5, 2002 to June 4, 2003



Provisional Data Subject to Revision

Figure 3: Stage vs. Discharge History - May 5 to June 5, 2003

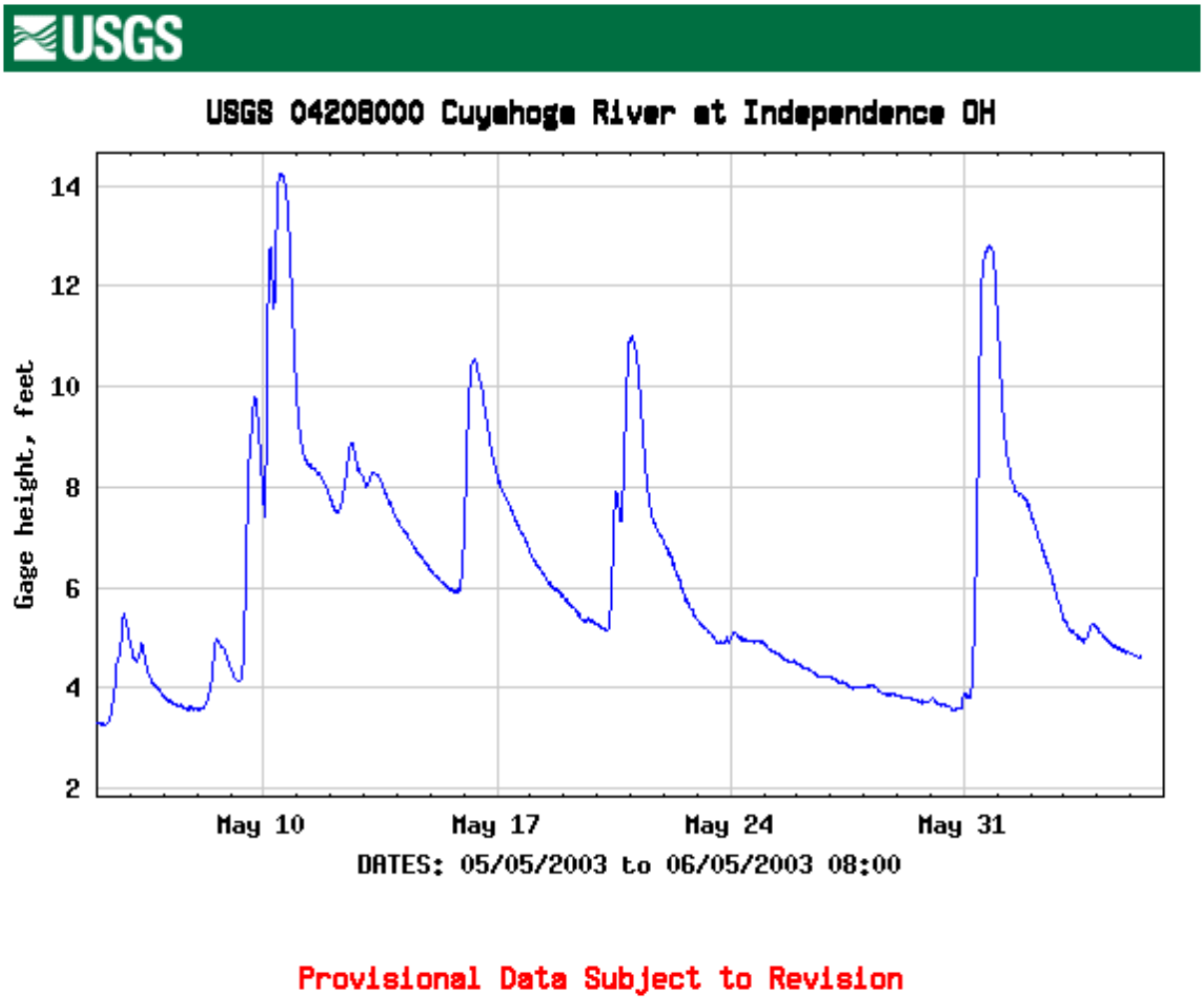


Figure 4: Stage Hydrograph - May 31, 2003 Flood Event

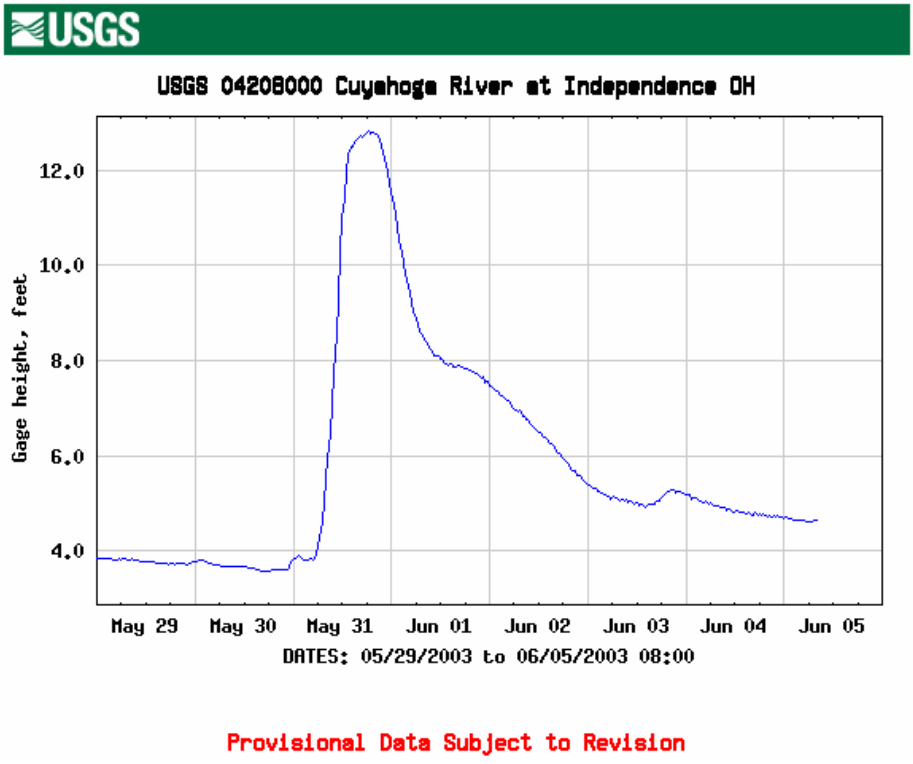


Figure 5: Discharge Hydrograph – May 31, 2003 Flood Event

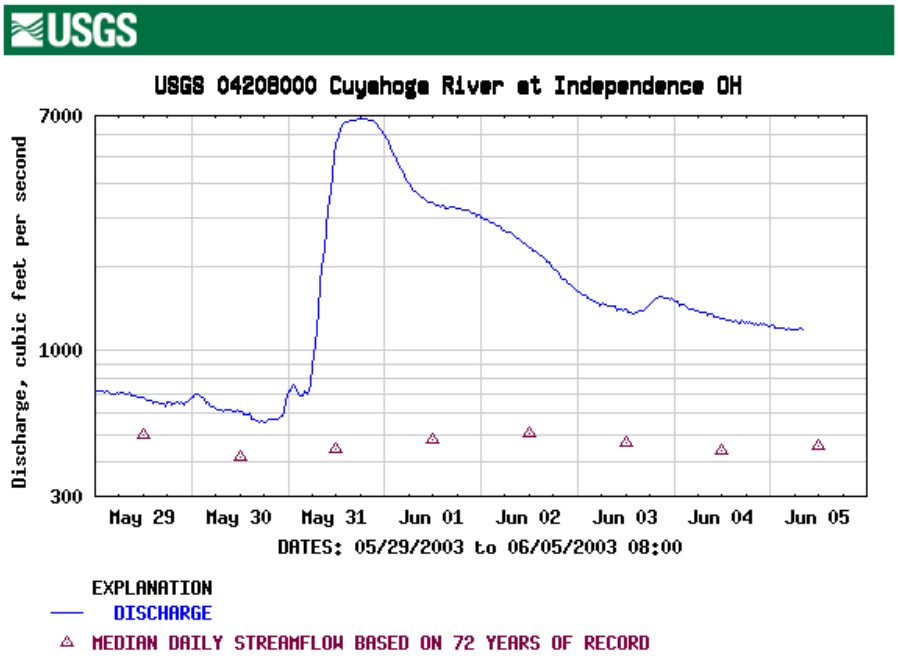


Figure 6: Existing Cross Section at Proposed Trail Bridge

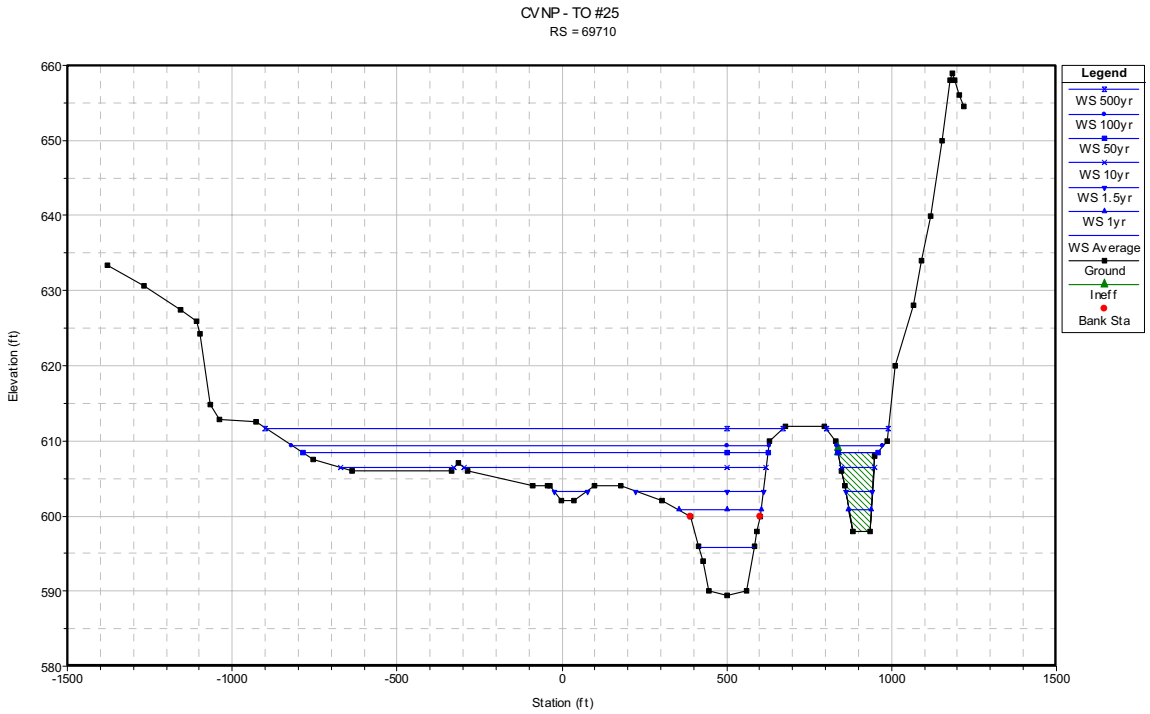
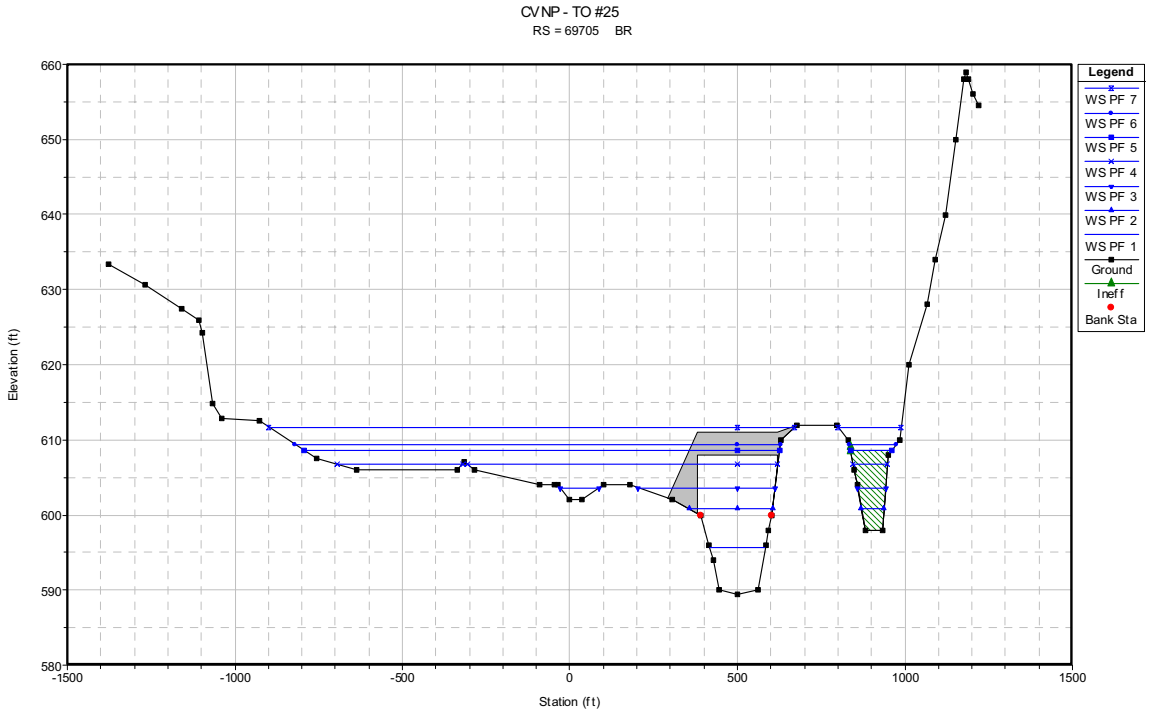
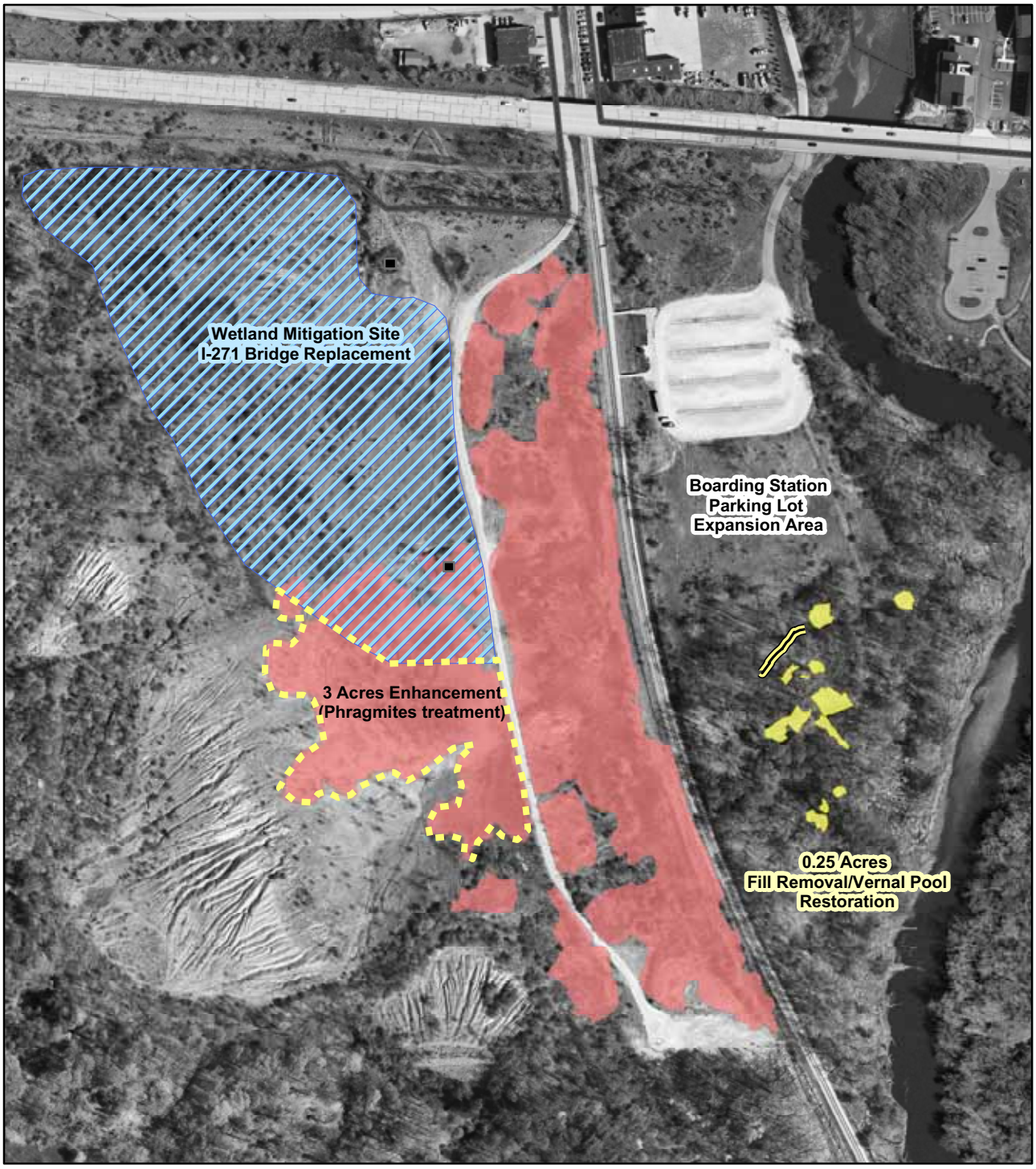


Figure 7: Proposed Cross Section at Proposed Trail Bridge



Proposed Wetland Mitigation Area: Rockside Road Boarding Station Parking Lot



Invasives (Phragmites australis monoculture)

Trash Removal Area

Fill Removal Area

Existing Wetland Mitigation Site

0 125 250 500 Feet

N

CUYAHOGA VALLEY NATIONAL PARK
Environmental Assessment for Rockside Boarding Area Parking Expansion

Appendix E

Combined Statement of Findings
For
Executive Order 11988 "Floodplain Management"
And
Executive Order 11990 "Protection of Wetlands"

PHOTOGRAPHS

Photo 1 - Cuyahoga River adjacent to existing parking area (looking upstream, parking area to right).

Photo 2 - Steep, unvegetated bank adjacent to Cuyahoga River, upstream of parking area.

Photo 3 - Existing buffer between parking area and Cuyahoga River

Photo 4 – South edge of proposed lot (located where person on the left is standing)

Photo 5 – Vernal Pool Area to South of Parking Facility

Photo 6 Proposed Pedestrian Crossing near Northeast Corner of Existing Parking Area Looking East

Photo 7 Proposed Pedestrian Crossing East Side of River Looking West Towards Boarding Area.

Photo 8 Entrance to Parking Area at Lock 39 Trailhead, Looking South

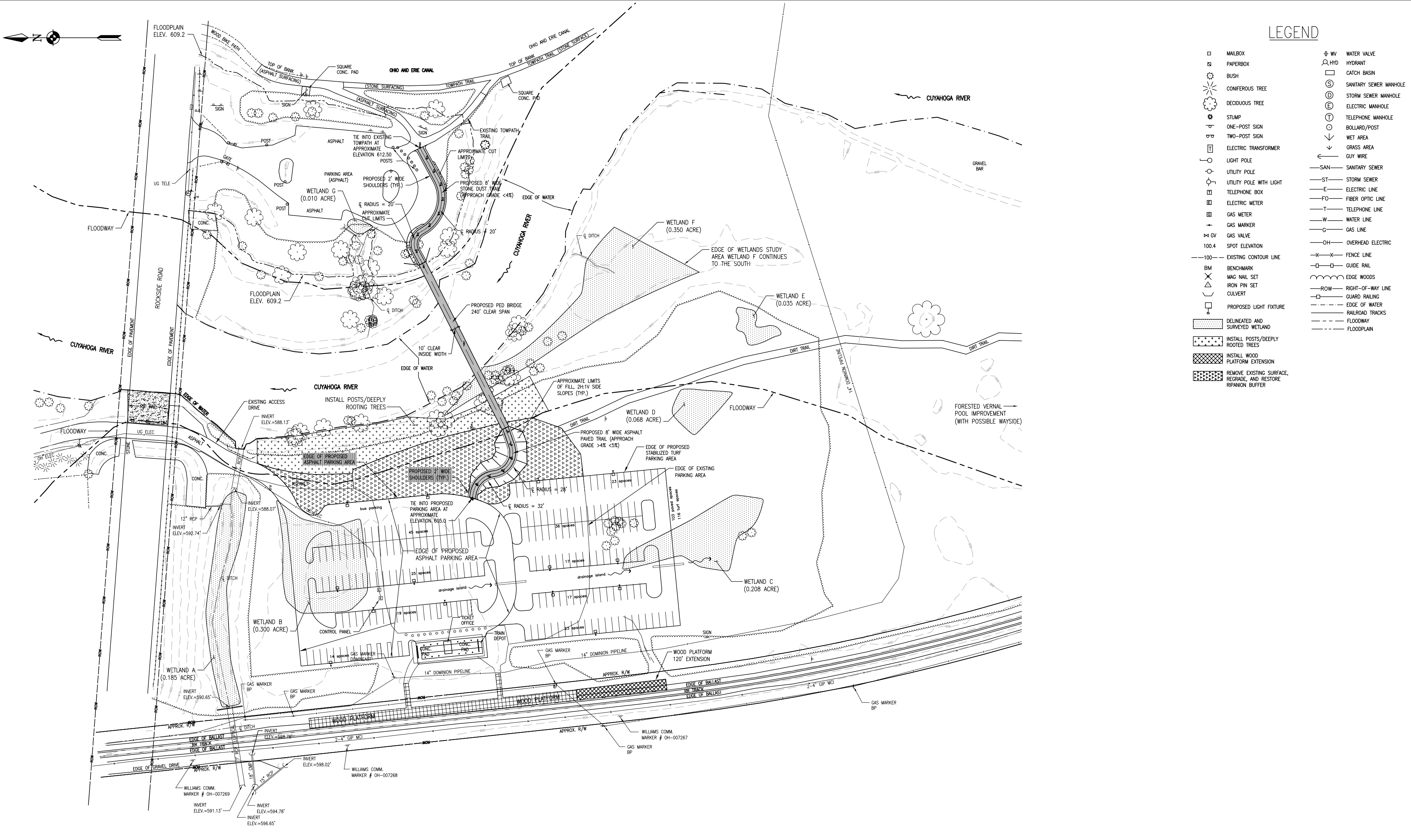
Photo 9 South End of Lock 39 Trailhead Parking Area Looking South Towards South Terminus of Proposed Connector Trail.

CUYAHOGA VALLEY NATIONAL PARK
Environmental Assessment for Rockside Station Boarding Area Parking Expansion
And Class 1 Connector Trail and Bridge From Lock 39 Trailhead

Appendix E

Combined Statement of Findings
For
Executive Order 11988 "Floodplain Management"
And
Executive Order 11990 "Protection of Wetlands"

DRAWING E-1



DESIGNED:	TITLE OF SHEET	DRAWING NO.
J.F.B.	SITE PLAN – E-1	
DRAWN: J.J.	CUYAHOGA VALLEY NATIONAL PARK	PKG. NO.
TECH REVIEW: K.R.A.	ENVIRONMENTAL ASSESSMENT FOR ROCKSIDE BOARDING AREA PARKING EXPANSION AND TRAIL BRIDGE OVER THE CUYAHOGA RIVER EXPANSION & IMPROVEMENT WITH TRAIL BRIDGE OVER CUYAHOGA RIVER	SHEET E-1
DATE: 8/05		OF

BERGMANN associates
Engineers / Architects / Surveyors
200 First Federal Plaza
28 East Main Street, Rochester, New York 14614
585.232.5135 / 585.232.4652 fax

NATIONAL PARK SERVICE

CUYAHOGA VALLEY NATIONAL PARK

Environmental Assessment for Rockside Station Boarding Area Parking Expansion
And Class 1 Connector Trail and Bridge From Lock 39 Trailhead

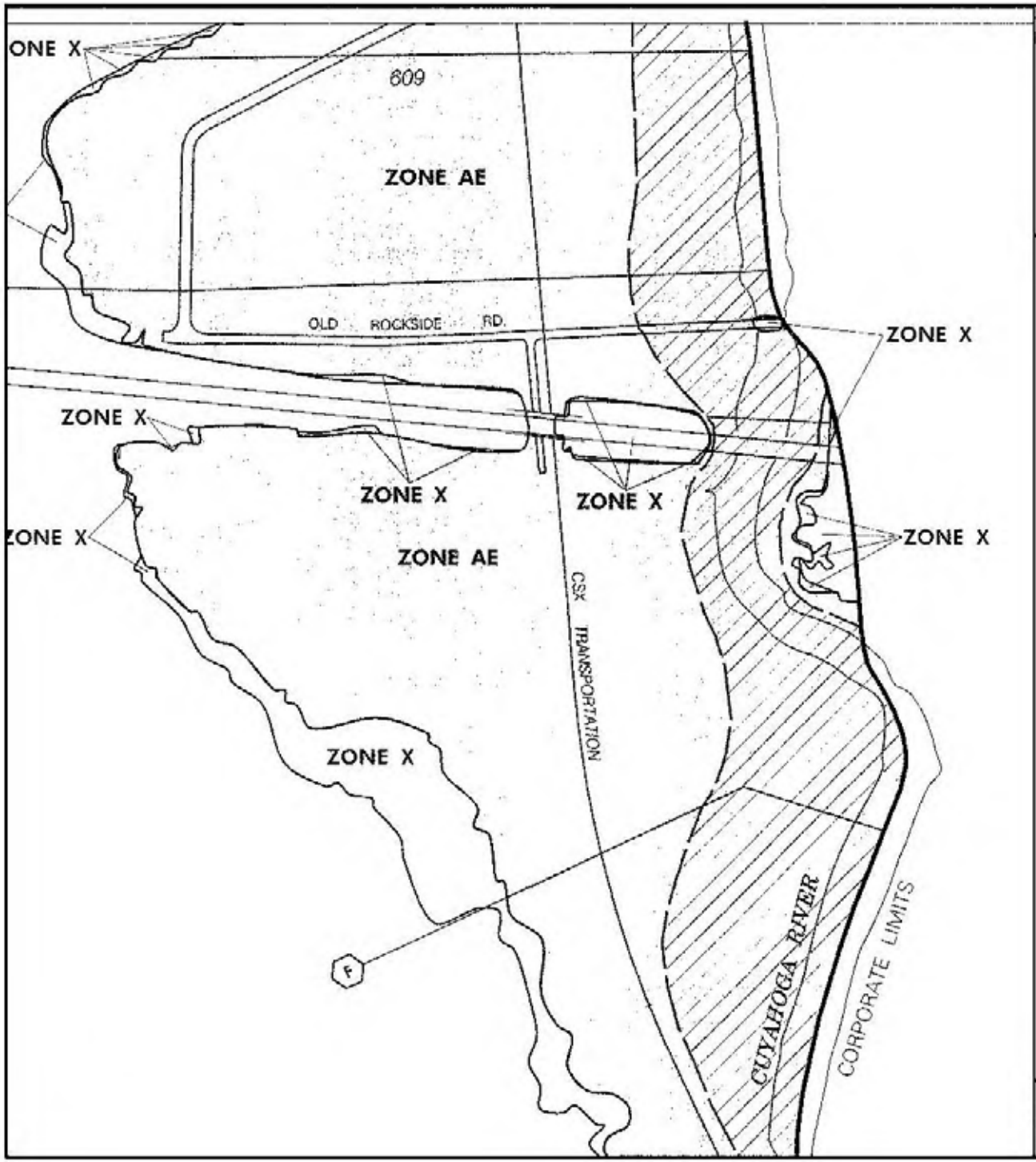
Appendix E

Combined Statement of Findings
For
Executive Order 11988 "Floodplain Management"
And
Executive Order 11990 "Protection of Wetlands"

EXHIBITS

1. Flood Insurance Rate Map
2. HEC-RAS Output, Cross Sections, Cross Section Location Plan
3. Bridge Scour Calculations
4. Detailed Topographic Map with Proposed Connector Trail and Pedestrian Bridge (in pocket)

Exhibit 1 - Flood Insurance Rate Map



To determine if flood insurance is available in this community, contact yo
insurance agent or call the National Flood Insurance Program at (800) 638-662

APPROXIMATE SCALE

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

CITY OF
INDEPENDENCE,
OHIO
CUYAHOGA COUNTY

PANEL 3 OF 5

(SEE MAP INDEX FOR PANELS NOT PRINTED)

COMMUNITY - PANEL NUMBER
390111 0003 C

MAP REVISED:
JULY 19, 2001

Federal Emergency Management Agency

Exhibit 2 - HEC-RAS Output, Cross Sections, Cross Section Location Plan

HEC-RAS River: RIVER-1 Reach: Reach-1

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach-1	84553	Median	ex	510.00	598.60	602.54		602.62	0.001593	2.20	232.05	106.85	0.26
Reach-1	84553	Median	prop 3ft	510.00	598.60	602.54		602.62	0.001593	2.20	232.05	106.85	0.26
Reach-1	84553	Average	ex	900.00	598.60	603.91		604.00	0.001036	2.34	384.89	116.56	0.23
Reach-1	84553	Average	prop 3ft	900.00	598.60	603.91		604.00	0.001036	2.34	384.89	116.56	0.23
Reach-1	84553	1yr	ex	3500.00	598.60	608.82		608.99	0.000784	3.34	1134.21	330.01	0.22
Reach-1	84553	1yr	prop 3ft	3500.00	598.60	608.82		608.99	0.000784	3.34	1134.21	330.01	0.22
Reach-1	84553	1.5yr	ex	6300.00	598.60	611.17		611.40	0.000799	4.06	2090.31	481.97	0.24
Reach-1	84553	1.5yr	prop 3ft	6300.00	598.60	611.17		611.40	0.000799	4.06	2090.31	481.97	0.24
Reach-1	84553	2.33yr	ex	9450.00	598.60	613.03		613.30	0.000813	4.63	3086.70	589.09	0.24
Reach-1	84553	2.33yr	prop 3ft	9450.00	598.60	613.03		613.30	0.000813	4.63	3086.74	589.09	0.24
Reach-1	84553	5yr	ex	12000.00	598.60	614.26		614.57	0.000825	5.00	3841.93	637.73	0.25
Reach-1	84553	5yr	prop 3ft	12000.00	598.60	614.26		614.57	0.000825	5.00	3841.97	637.73	0.25
Reach-1	84553	10yr	ex	14300.00	598.60	615.25		615.58	0.000835	5.29	4491.02	676.75	0.26
Reach-1	84553	10yr	prop 3ft	14300.00	598.60	615.25		615.58	0.000835	5.29	4491.15	676.75	0.26
Reach-1	84553	50yr	ex	19500.00	598.60	617.22		617.60	0.000849	5.85	5900.63	754.57	0.26
Reach-1	84553	50yr	prop 3ft	19500.00	598.60	617.22		617.60	0.000849	5.85	5901.64	754.62	0.26
Reach-1	84553	100yr	ex	21900.00	598.60	617.73		618.16	0.000928	6.25	6291.31	774.83	0.28
Reach-1	84553	100yr	prop 3ft	21900.00	598.60	617.73		618.16	0.000927	6.25	6292.31	774.88	0.28
Reach-1	84553	500yr	ex	27800.00	598.60	619.43		619.91	0.000951	6.78	7632.99	795.48	0.29
Reach-1	84553	500yr	prop 3ft	27800.00	598.60	619.43		619.91	0.000950	6.77	7635.37	795.50	0.29
Reach-1	83214	Median	ex	510.00	597.70	602.02		602.04	0.000186	0.96	529.41	133.66	0.09
Reach-1	83214	Median	prop 3ft	510.00	597.70	602.02		602.04	0.000186	0.96	529.41	133.66	0.09
Reach-1	83214	Average	ex	900.00	597.70	603.38		603.40	0.000229	1.26	715.94	141.31	0.10
Reach-1	83214	Average	prop 3ft	900.00	597.70	603.38		603.40	0.000229	1.26	715.94	141.31	0.10
Reach-1	83214	1yr	ex	3500.00	597.70	608.16		608.25	0.000384	2.38	1582.75	297.72	0.14
Reach-1	83214	1yr	prop 3ft	3500.00	597.70	608.16		608.25	0.000384	2.38	1582.75	297.72	0.14
Reach-1	83214	1.5yr	ex	6300.00	597.70	610.37		610.52	0.000515	3.20	2531.01	497.59	0.17
Reach-1	83214	1.5yr	prop 3ft	6300.00	597.70	610.37		610.52	0.000515	3.20	2531.01	497.59	0.17
Reach-1	83214	2.33yr	ex	9450.00	597.70	612.14		612.34	0.000607	3.82	3504.42	592.77	0.19
Reach-1	83214	2.33yr	prop 3ft	9450.00	597.70	612.14		612.34	0.000607	3.82	3504.45	592.77	0.19
Reach-1	83214	5yr	ex	12000.00	597.70	613.33		613.55	0.000654	4.21	4221.67	615.16	0.20
Reach-1	83214	5yr	prop 3ft	12000.00	597.70	613.33		613.55	0.000654	4.21	4221.75	615.16	0.20
Reach-1	83214	10yr	ex	14300.00	597.70	614.29		614.53	0.000687	4.50	4817.19	626.34	0.20
Reach-1	83214	10yr	prop 3ft	14300.00	597.70	614.29		614.53	0.000687	4.50	4817.38	626.34	0.20
Reach-1	83214	50yr	ex	19500.00	597.70	616.21		616.51	0.000739	5.06	6031.92	636.57	0.22
Reach-1	83214	50yr	prop 3ft	19500.00	597.70	616.21		616.51	0.000738	5.05	6033.05	636.58	0.22
Reach-1	83214	100yr	ex	21900.00	597.70	616.60		616.94	0.000841	5.48	6279.04	638.64	0.23
Reach-1	83214	100yr	prop 3ft	21900.00	597.70	616.60		616.94	0.000841	5.48	6280.17	638.64	0.23
Reach-1	83214	500yr	ex	27800.00	597.70	618.24		618.64	0.000907	6.04	7332.42	647.35	0.24
Reach-1	83214	500yr	prop 3ft	27800.00	597.70	618.24		618.64	0.000906	6.03	7335.03	647.38	0.24
Reach-1	81741	Median	ex	510.00	597.40	601.80	599.14	601.82	0.000126	0.99	517.24	172.05	0.10
Reach-1	81741	Median	prop 3ft	510.00	597.40	601.80	599.14	601.82	0.000126	0.99	517.24	172.05	0.10
Reach-1	81741	Average	ex	900.00	597.40	603.14	599.59	603.17	0.000119	1.20	753.10	178.95	0.10
Reach-1	81741	Average	prop 3ft	900.00	597.40	603.14	599.59	603.17	0.000119	1.20	753.10	178.95	0.10
Reach-1	81741	1yr	ex	3500.00	597.40	607.83	601.11	607.91	0.000149	2.15	1628.80	270.17	0.13
Reach-1	81741	1yr	prop 3ft	3500.00	597.40	607.83	601.11	607.91	0.000149	2.15	1628.80	270.17	0.13
Reach-1	81741	1.5yr	ex	6300.00	597.40	609.87	602.28	610.02	0.000238	3.13	2015.29	497.99	0.17
Reach-1	81741	1.5yr	prop 3ft	6300.00	597.40	609.87	602.28	610.02	0.000238	3.13	2015.29	497.99	0.17
Reach-1	81741	2.33yr	ex	9450.00	597.40	611.40	603.36	611.66	0.000342	4.10	2306.24	593.90	0.21
Reach-1	81741	2.33yr	prop 3ft	9450.00	597.40	611.40	603.36	611.66	0.000342	4.10	2306.25	593.90	0.21
Reach-1	81741	5yr	ex	12000.00	597.40	612.39	604.14	612.75	0.000425	4.81	2494.04	650.88	0.23
Reach-1	81741	5yr	prop 3ft	12000.00	597.40	612.39	604.14	612.75	0.000425	4.81	2494.06	650.89	0.23
Reach-1	81741	10yr	ex	14300.00	597.40	613.16	604.81	613.62	0.000498	5.41	2641.45	700.11	0.26
Reach-1	81741	10yr	prop 3ft	14300.00	597.40	613.16	604.81	613.62	0.000498	5.41	2641.53	700.15	0.26
Reach-1	81741	50yr	ex	19500.00	597.40	614.68	606.14	615.37	0.000656	6.66	2929.31	936.27	0.30
Reach-1	81741	50yr	prop 3ft	19500.00	597.40	614.68	606.14	615.37	0.000656	6.66	2929.77	936.62	0.30
Reach-1	81741	100yr	ex	21900.00	597.40	615.33	606.70	615.88	0.000559	6.32	4238.78	1024.87	0.28
Reach-1	81741	100yr	prop 3ft	21900.00	597.40	615.33	606.70	615.89	0.000558	6.31	4240.19	1025.28	0.28
Reach-1	81741	500yr	ex	27800.00	597.40	616.82	607.99	617.48	0.000614	7.03	5215.27	1245.88	0.30
Reach-1	81741	500yr	prop 3ft	27800.00	597.40	616.83	607.99	617.48	0.000613	7.02	5220.03	1247.11	0.30
Reach-1	81724.5			Bridge									
Reach-1	81708	Median	ex	510.00	597.40	601.80	599.14	601.81	0.000127	0.99	516.51	172.03	0.10
Reach-1	81708	Median	prop 3ft	510.00	597.40	601.80	599.14	601.81	0.000127	0.99	516.51	172.03	0.10
Reach-1	81708	Average	ex	900.00	597.40	603.14	599.59	603.16	0.000119	1.20	752.39	178.93	0.10
Reach-1	81708	Average	prop 3ft	900.00	597.40	603.14	599.59	603.16	0.000119	1.20	752.39	178.93	0.10
Reach-1	81708	1yr	ex	3500.00	597.40	607.83	601.11	607.90	0.000150	2.15	1627.81	269.95	0.13
Reach-1	81708	1yr	prop 3ft	3500.00	597.40	607.83	601.11	607.90	0.000150	2.15	1627.81	269.95	0.13
Reach-1	81708	1.5yr	ex	6300.00	597.40	609.86	602.28	610.01	0.000239	3.13	2013.65	497.33	0.17
Reach-1	81708	1.5yr	prop 3ft	6300.00	597.40	609.86	602.28	610.01	0.000239	3.13	2013.65	497.33	0.17
Reach-1	81708	2.33yr	ex	9450.00	597.40	611.39	603.36	611.65	0.000343	4.10	2303.78	593.15	0.21
Reach-1	81708	2.33yr	prop 3ft	9450.00	597.40	611.39	603.36	611.65	0.000343	4.10	2303.80	593.15	0.21
Reach-1	81708	5yr	ex	12000.00	597.40	612.37	604.14	612.73	0.000426	4.82	2490.89	649.92	0.23
Reach-1	81708	5yr	prop 3ft	12000.00	597.40	612.37	604.14	612.73	0.000426	4.82	2490.91	649.93	0.23
Reach-1	81708	10yr	ex	14300.00	597.40	613.14	604.81	613.60	0.000500	5.42	2637.68	698.53	0.26
Reach-1	81708	10yr	prop 3ft	14300.00	597.40	613.14	604.81	613.60	0.000500	5.42	2637.76	698.57	0.26
Reach-1	81708	50yr	ex	19500.00	597.40	614.65	606.14	615.34	0.000660	6.67	2924.02	932.26	0.30
Reach-1	81708	50yr	prop 3ft	19500.00	597.40	614.65	606.14	615.34	0.000660	6.67	2924.49	932.61	0.30
Reach-1	81708	100yr	ex	21900.00	597.40	615.29	606.70	615.85	0.000564	6.34	4217.30	1018.93	0.28
Reach-1	81708	100yr	prop 3ft	21900.00	597.40	615.29	606.70	615.85	0.000564	6.34	4218.66	1019.25	0.28
Reach-1	81708	500yr	ex	27800.00	597.40	616.74	607.99	617.41	0.000627	7.08	5159.15	1236.98	0.30

HEC-RAS River: RIVER-1 Reach: Reach-1 (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach-1	81708	500yr	prop 3ft	27800.00	597.40	616.75	607.99	617.42	0.000626	7.07	5163.67	1237.54	0.30
Reach-1	81535	Median	ex	510.00	597.30	601.73	599.44	601.76	0.000737	1.46	348.55	134.04	0.16
Reach-1	81535	Median	prop 3ft	510.00	597.30	601.73	599.44	601.76	0.000737	1.46	348.55	134.04	0.16
Reach-1	81535	Average	ex	900.00	597.30	603.07	599.98	603.12	0.000724	1.63	553.61	179.30	0.16
Reach-1	81535	Average	prop 3ft	900.00	597.30	603.07	599.98	603.12	0.000724	1.63	553.61	179.30	0.16
Reach-1	81535	1yr	ex	3500.00	597.30	607.78	601.89	607.85	0.000567	2.12	1652.75	399.00	0.16
Reach-1	81535	1yr	prop 3ft	3500.00	597.30	607.78	601.89	607.85	0.000567	2.12	1652.75	399.00	0.16
Reach-1	81535	1.5yr	ex	6300.00	597.30	609.81	603.39	609.93	0.000737	2.72	2313.56	800.91	0.19
Reach-1	81535	1.5yr	prop 3ft	6300.00	597.30	609.81	603.39	609.93	0.000737	2.72	2313.56	800.91	0.19
Reach-1	81535	2.33yr	ex	9450.00	597.30	611.34	604.54	611.51	0.000828	3.32	2850.19	993.77	0.20
Reach-1	81535	2.33yr	prop 3ft	9450.00	597.30	611.34	604.54	611.51	0.000828	3.32	2850.21	993.77	0.20
Reach-1	81535	5yr	ex	12000.00	597.30	612.34	605.36	612.56	0.000909	3.75	3198.16	1202.19	0.22
Reach-1	81535	5yr	prop 3ft	12000.00	597.30	612.34	605.36	612.56	0.000909	3.75	3198.22	1202.21	0.22
Reach-1	81535	10yr	ex	14300.00	597.30	613.12	606.00	613.39	0.000981	4.12	3472.68	1247.45	0.23
Reach-1	81535	10yr	prop 3ft	14300.00	597.30	613.12	606.00	613.39	0.000981	4.12	3472.85	1247.47	0.23
Reach-1	81535	50yr	ex	19500.00	597.30	614.67	607.24	615.03	0.001126	4.86	4013.02	1394.86	0.25
Reach-1	81535	50yr	prop 3ft	19500.00	597.30	614.67	607.24	615.04	0.001126	4.86	4013.90	1394.91	0.25
Reach-1	81535	100yr	ex	21900.00	597.30	615.31	607.73	615.59	0.000911	4.53	7086.26	1404.52	0.23
Reach-1	81535	100yr	prop 3ft	21900.00	597.30	615.31	607.73	615.59	0.000910	4.53	7088.45	1404.55	0.23
Reach-1	81535	500yr	ex	27800.00	597.30	616.78	608.87	617.11	0.000954	5.00	8350.54	1422.53	0.24
Reach-1	81535	500yr	prop 3ft	27800.00	597.30	616.78	608.87	617.12	0.000952	5.00	8355.82	1422.61	0.24
Reach-1	80001	Median	ex	510.00	597.00	601.18		601.20	0.000215	1.00	508.59	136.26	0.09
Reach-1	80001	Median	prop 3ft	510.00	597.00	601.18		601.20	0.000215	1.00	508.59	136.26	0.09
Reach-1	80001	Average	ex	900.00	597.00	602.45		602.47	0.000267	1.31	685.86	143.95	0.11
Reach-1	80001	Average	prop 3ft	900.00	597.00	602.45		602.47	0.000267	1.31	685.86	143.95	0.11
Reach-1	80001	1yr	ex	3500.00	597.00	607.14		607.20	0.000330	2.19	3132.02	1723.01	0.13
Reach-1	80001	1yr	prop 3ft	3500.00	597.00	607.14		607.20	0.000330	2.19	3132.02	1723.01	0.13
Reach-1	80001	1.5yr	ex	6300.00	597.00	609.16		609.22	0.000299	2.39	6748.55	1848.10	0.13
Reach-1	80001	1.5yr	prop 3ft	6300.00	597.00	609.16		609.22	0.000299	2.39	6748.55	1848.10	0.13
Reach-1	80001	2.33yr	ex	9450.00	597.00	610.69		610.75	0.000301	2.62	9634.11	1918.29	0.13
Reach-1	80001	2.33yr	prop 3ft	9450.00	597.00	610.69		610.75	0.000301	2.62	9634.23	1918.29	0.13
Reach-1	80001	5yr	ex	12000.00	597.00	611.67		611.74	0.000310	2.79	11524.82	1929.29	0.13
Reach-1	80001	5yr	prop 3ft	12000.00	597.00	611.67		611.74	0.000309	2.79	11525.29	1929.30	0.13
Reach-1	80001	10yr	ex	14300.00	597.00	612.45		612.51	0.000319	2.94	13019.53	1939.77	0.14
Reach-1	80001	10yr	prop 3ft	14300.00	597.00	612.45		612.51	0.000319	2.94	13020.83	1939.78	0.14
Reach-1	80001	50yr	ex	19500.00	597.00	613.98		614.05	0.000338	3.24	16002.24	1960.52	0.14
Reach-1	80001	50yr	prop 3ft	19500.00	597.00	613.98		614.05	0.000337	3.24	16008.70	1960.57	0.14
Reach-1	80001	100yr	ex	21900.00	597.00	614.61		614.69	0.000345	3.36	17257.62	1969.19	0.15
Reach-1	80001	100yr	prop 3ft	21900.00	597.00	614.62		614.70	0.000344	3.36	17263.99	1969.23	0.15
Reach-1	80001	500yr	ex	27800.00	597.00	616.08		616.17	0.000356	3.62	20162.92	1989.10	0.15
Reach-1	80001	500yr	prop 3ft	27800.00	597.00	616.09		616.18	0.000356	3.62	20178.21	1989.21	0.15
Reach-1	76605	Median	ex	510.00	596.20	598.03	598.03	598.54	0.044156	5.73	88.95	87.49	1.00
Reach-1	76605	Median	prop 3ft	510.00	596.20	598.03	598.03	598.54	0.044156	5.73	88.95	87.49	1.00
Reach-1	76605	Average	ex	900.00	596.20	598.51	598.51	599.24	0.039228	6.85	131.47	90.56	1.00
Reach-1	76605	Average	prop 3ft	900.00	596.20	598.51	598.51	599.24	0.039228	6.85	131.47	90.56	1.00
Reach-1	76605	1yr	ex	3500.00	596.20	604.43		604.73	0.002557	4.40	838.00	349.44	0.32
Reach-1	76605	1yr	prop 3ft	3500.00	596.20	604.43		604.73	0.002557	4.40	838.00	349.44	0.32
Reach-1	76605	1.5yr	ex	6300.00	596.20	606.78		607.08	0.001996	4.77	2133.83	915.24	0.30
Reach-1	76605	1.5yr	prop 3ft	6300.00	596.20	606.78		607.08	0.001996	4.77	2133.83	915.24	0.30
Reach-1	76605	2.33yr	ex	9450.00	596.20	608.57		608.81	0.001456	4.67	4400.34	1367.02	0.26
Reach-1	76605	2.33yr	prop 3ft	9450.00	596.20	608.57		608.81	0.001456	4.67	4400.51	1367.04	0.26
Reach-1	76605	5yr	ex	12000.00	596.20	609.62		609.83	0.001306	4.73	5893.81	1495.18	0.25
Reach-1	76605	5yr	prop 3ft	12000.00	596.20	609.62		609.83	0.001305	4.73	5894.82	1495.27	0.25
Reach-1	76605	10yr	ex	14300.00	596.20	610.39		610.60	0.001248	4.84	7088.70	1590.19	0.25
Reach-1	76605	10yr	prop 3ft	14300.00	596.20	610.39		610.60	0.001247	4.84	7091.42	1590.40	0.25
Reach-1	76605	50yr	ex	19500.00	596.20	611.92		612.13	0.001150	5.05	9686.16	1842.77	0.25
Reach-1	76605	50yr	prop 3ft	19500.00	596.20	611.93		612.13	0.001146	5.05	9699.89	1844.77	0.25
Reach-1	76605	100yr	ex	21900.00	596.20	612.58		612.77	0.001105	5.12	10906.98	1892.65	0.24
Reach-1	76605	100yr	prop 3ft	21900.00	596.20	612.58		612.78	0.001102	5.11	10920.15	1893.01	0.24
Reach-1	76605	500yr	ex	27800.00	596.20	614.10		614.29	0.000993	5.20	13857.77	1971.31	0.23
Reach-1	76605	500yr	prop 3ft	27800.00	596.20	614.12		614.30	0.000988	5.19	13886.89	1972.07	0.23
Reach-1	74478	Median	ex	510.00	583.10	594.65		594.68	0.000221	1.34	381.21	63.70	0.10
Reach-1	74478	Median	prop 3ft	510.00	583.10	594.65		594.68	0.000221	1.34	381.21	63.70	0.10
Reach-1	74478	Average	ex	900.00	583.10	595.61		595.68	0.000452	2.02	445.02	68.47	0.14
Reach-1	74478	Average	prop 3ft	900.00	583.10	595.61		595.68	0.000452	2.02	445.02	68.47	0.14
Reach-1	74478	1yr	ex	3500.00	583.10	599.52		599.80	0.002111	4.25	823.36	135.10	0.30
Reach-1	74478	1yr	prop 3ft	3500.00	583.10	599.52		599.80	0.002111	4.25	823.36	135.10	0.30
Reach-1	74478	1.5yr	ex	6300.00	583.10	602.29		602.70	0.002191	5.13	1227.69	156.13	0.32
Reach-1	74478	1.5yr	prop 3ft	6300.00	583.10	602.29		602.70	0.002191	5.13	1227.69	156.13	0.32
Reach-1	74478	2.33yr	ex	9450.00	583.10	604.44		604.99	0.002414	5.97	1624.25	374.08	0.35
Reach-1	74478	2.33yr	prop 3ft	9450.00	583.10	604.44		604.99	0.002413	5.97	1624.62	374.54	0.35
Reach-1	74478	5yr	ex	12000.00	583.10	605.84		606.39	0.002277	6.14	2290.44	560.95	0.34
Reach-1	74478	5yr	prop 3ft	12000.00	583.10	605.85		606.40	0.002268	6.13	2295.96	562.54	0.34
Reach-1	74478	10yr	ex	14300.00	583.10	607.16		607.62	0.001834	5.82	3113.86	671.67	0.31
Reach-1	74478	10yr	prop 3ft	14300.00	583.10	607.18		607.63	0.001821	5.80	3125.51	672.94	0.31
Reach-1	74478	50yr	ex	19500.00	583.10	609.49		609.83	0.001255	5.35	5126.53	1117.89	0.26
Reach-1	74478	50yr	prop 3ft	19500.00	583.10	609.53		609.86	0.001235	5.32	5165.80	1124.22	0.26
Reach-1	74478	100yr	ex	21900.00	583.10	610.40		610.71	0.001084	5.21	6226.30	1273.01	0.25
Reach-1	74478	100yr	prop 3ft	21900.00	583.10	610.43		610.73	0.001069	5.18	6263.02	1275.86	0.25
Reach-1	74478	500yr	ex	27800.00	583.10	612.63		612.83	0.000663	4.50	9624.09	1833.04	0.20

HEC-RAS River: RIVER-1 Reach: Reach-1 (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach-1	74478	500yr	prop 3ft	27800.00	583.10	612.66		612.86	0.000655	4.48	9678.48	1834.56	0.20
Reach-1	73329	Median	ex	510.00	589.50	594.50		594.50	0.000102	0.68	746.45	202.62	0.06
Reach-1	73329	Median	prop 3ft	510.00	589.50	594.50		594.50	0.000102	0.68	746.45	202.62	0.06
Reach-1	73329	Average	ex	900.00	589.50	595.35		595.37	0.000162	0.98	921.93	206.77	0.08
Reach-1	73329	Average	prop 3ft	900.00	589.50	595.35		595.37	0.000162	0.98	921.93	206.77	0.08
Reach-1	73329	1yr	ex	3500.00	589.50	598.77		598.83	0.000390	2.11	1655.84	223.59	0.14
Reach-1	73329	1yr	prop 3ft	3500.00	589.50	598.77		598.83	0.000390	2.11	1655.83	223.59	0.14
Reach-1	73329	1.5yr	ex	6300.00	589.50	601.42		601.54	0.000498	2.74	2473.16	507.14	0.16
Reach-1	73329	1.5yr	prop 3ft	6300.00	589.50	601.42		601.54	0.000498	2.74	2473.16	507.14	0.16
Reach-1	73329	2.33yr	ex	9450.00	589.50	603.71		603.83	0.000442	2.96	5272.68	1448.57	0.16
Reach-1	73329	2.33yr	prop 3ft	9450.00	589.50	603.71		603.83	0.000442	2.96	5274.80	1448.66	0.16
Reach-1	73329	5yr	ex	12000.00	589.50	605.24		605.36	0.000377	2.98	7553.52	1499.49	0.15
Reach-1	73329	5yr	prop 3ft	12000.00	589.50	605.26		605.37	0.000375	2.97	7573.10	1499.68	0.15
Reach-1	73329	10yr	ex	14300.00	589.50	606.68		606.78	0.000314	2.92	9716.51	1521.05	0.14
Reach-1	73329	10yr	prop 3ft	14300.00	589.50	606.70		606.80	0.000312	2.91	9748.63	1521.37	0.14
Reach-1	73329	50yr	ex	19500.00	589.50	609.08		609.18	0.000272	3.01	13427.43	1577.98	0.13
Reach-1	73329	50yr	prop 3ft	19500.00	589.50	609.12		609.22	0.000269	3.00	13490.54	1579.37	0.13
Reach-1	73329	100yr	ex	21900.00	589.50	610.01		610.11	0.000265	3.08	14907.19	1607.53	0.13
Reach-1	73329	100yr	prop 3ft	21900.00	589.50	610.04		610.14	0.000263	3.07	14959.49	1607.84	0.13
Reach-1	73329	500yr	ex	27800.00	589.50	612.29		612.38	0.000239	3.17	18595.91	1629.01	0.13
Reach-1	73329	500yr	prop 3ft	27800.00	589.50	612.32		612.42	0.000237	3.16	18648.81	1629.32	0.13
Reach-1	72143	Median	ex	510.00	591.50	594.26		594.28	0.000482	1.12	614.46	452.77	0.12
Reach-1	72143	Median	prop 3ft	510.00	591.50	594.26		594.28	0.000482	1.12	614.46	452.77	0.12
Reach-1	72143	Average	ex	900.00	591.50	595.05		595.07	0.000463	1.29	975.68	463.49	0.12
Reach-1	72143	Average	prop 3ft	900.00	591.50	595.05		595.07	0.000463	1.29	975.68	463.49	0.12
Reach-1	72143	1yr	ex	3500.00	591.50	598.31		598.35	0.000420	1.87	2529.92	502.01	0.13
Reach-1	72143	1yr	prop 3ft	3500.00	591.50	598.31		598.35	0.000420	1.87	2529.89	502.01	0.13
Reach-1	72143	1.5yr	ex	6300.00	591.50	600.97		601.02	0.000360	2.15	4130.26	752.61	0.13
Reach-1	72143	1.5yr	prop 3ft	6300.00	591.50	600.97		601.02	0.000360	2.15	4130.26	752.61	0.13
Reach-1	72143	2.33yr	ex	9450.00	591.50	603.32		603.37	0.000314	2.35	6652.85	1314.54	0.12
Reach-1	72143	2.33yr	prop 3ft	9450.00	591.50	603.32		603.38	0.000314	2.35	6655.18	1314.96	0.12
Reach-1	72143	5yr	ex	12000.00	591.50	604.91		604.96	0.000280	2.43	8859.29	1415.24	0.12
Reach-1	72143	5yr	prop 3ft	12000.00	591.50	604.92		604.98	0.000278	2.42	8880.37	1415.63	0.12
Reach-1	72143	10yr	ex	14300.00	591.50	606.39		606.44	0.000241	2.42	10988.80	1454.83	0.11
Reach-1	72143	10yr	prop 3ft	14300.00	591.50	606.42		606.47	0.000239	2.42	11022.64	1455.45	0.11
Reach-1	72143	50yr	ex	19500.00	591.50	608.83		608.88	0.000220	2.58	14611.26	1519.82	0.11
Reach-1	72143	50yr	prop 3ft	19500.00	591.50	608.87		608.93	0.000217	2.57	14676.49	1520.97	0.11
Reach-1	72143	100yr	ex	21900.00	591.50	609.76		609.82	0.000218	2.66	16040.93	1544.72	0.11
Reach-1	72143	100yr	prop 3ft	21900.00	591.50	609.80		609.85	0.000216	2.65	16094.59	1545.64	0.11
Reach-1	72143	500yr	ex	27800.00	591.50	612.06		612.12	0.000205	2.80	19662.57	1606.06	0.11
Reach-1	72143	500yr	prop 3ft	27800.00	591.50	612.09		612.15	0.000203	2.79	19717.58	1606.97	0.11
Reach-1	70519	Median	ex	510.00	590.90	592.96		593.00	0.001486	1.57	332.39	200.23	0.20
Reach-1	70519	Median	prop 3ft	510.00	590.90	592.96		593.00	0.001486	1.57	332.39	200.23	0.20
Reach-1	70519	Average	ex	900.00	590.90	593.87		593.92	0.001190	1.80	530.54	233.77	0.19
Reach-1	70519	Average	prop 3ft	900.00	590.90	593.87		593.92	0.001190	1.80	530.54	233.77	0.19
Reach-1	70519	1yr	ex	3500.00	590.90	597.49		597.55	0.000611	2.22	2237.78	650.99	0.16
Reach-1	70519	1yr	prop 3ft	3500.00	590.90	597.49		597.55	0.000611	2.22	2237.74	650.98	0.16
Reach-1	70519	1.5yr	ex	6300.00	590.90	600.42		600.47	0.000337	2.14	4670.59	1109.47	0.13
Reach-1	70519	1.5yr	prop 3ft	6300.00	590.90	600.42		600.47	0.000337	2.14	4670.59	1109.47	0.13
Reach-1	70519	2.33yr	ex	9450.00	590.90	602.89		602.93	0.000247	2.16	7650.89	1350.98	0.11
Reach-1	70519	2.33yr	prop 3ft	9450.00	590.90	602.89		602.94	0.000247	2.16	7653.78	1351.22	0.11
Reach-1	70519	5yr	ex	12000.00	590.90	604.54		604.58	0.000215	2.20	10024.36	1510.04	0.11
Reach-1	70519	5yr	prop 3ft	12000.00	590.90	604.55		604.59	0.000214	2.20	10050.08	1510.74	0.11
Reach-1	70519	10yr	ex	14300.00	590.90	606.08		606.12	0.000184	2.19	12397.23	1567.74	0.10
Reach-1	70519	10yr	prop 3ft	14300.00	590.90	606.10		606.14	0.000182	2.18	12437.52	1568.42	0.10
Reach-1	70519	50yr	ex	19500.00	590.90	608.54		608.58	0.000171	2.34	16383.38	1700.44	0.10
Reach-1	70519	50yr	prop 3ft	19500.00	590.90	608.59		608.63	0.000169	2.33	16462.21	1702.86	0.10
Reach-1	70519	100yr	ex	21900.00	590.90	609.48		609.52	0.000170	2.42	17997.69	1749.24	0.10
Reach-1	70519	100yr	prop 3ft	21900.00	590.90	609.51		609.56	0.000168	2.41	18062.96	1751.19	0.10
Reach-1	70519	500yr	ex	27800.00	590.90	611.79		611.84	0.000164	2.57	22193.09	1954.30	0.10
Reach-1	70519	500yr	prop 3ft	27800.00	590.90	611.83		611.87	0.000163	2.57	22263.67	1972.16	0.10
Reach-1	69710	Median	ex	510.00	589.50	592.38	590.59	592.42	0.000423	1.57	324.13	133.43	0.18
Reach-1	69710	Median	prop 3ft	510.00	589.50	592.38	590.59	592.42	0.000423	1.57	324.13	133.43	0.18
Reach-1	69710	Average	ex	900.00	589.50	593.27	590.99	593.33	0.000486	2.02	446.48	140.36	0.20
Reach-1	69710	Average	prop 3ft	900.00	589.50	593.27	590.99	593.33	0.000486	2.02	446.48	140.36	0.20
Reach-1	69710	1yr	ex	3500.00	589.50	596.82	592.74	597.00	0.000669	3.47	1007.30	177.38	0.26
Reach-1	69710	1yr	prop 3ft	3500.00	589.50	596.82	592.74	597.00	0.000669	3.47	1007.29	177.38	0.26
Reach-1	69710	1.5yr	ex	6300.00	589.50	599.83	594.10	600.08	0.000593	3.96	1590.72	273.10	0.25
Reach-1	69710	1.5yr	prop 3ft	6300.00	589.50	599.83	594.10	600.08	0.000593	3.96	1590.72	273.10	0.25
Reach-1	69710	2.33yr	ex	9450.00	589.50	602.31	595.41	602.61	0.000510	4.41	2250.57	449.77	0.25
Reach-1	69710	2.33yr	prop 3ft	9450.00	589.50	602.31	595.41	602.61	0.000509	4.41	2251.53	450.08	0.25
Reach-1	69710	5yr	ex	12000.00	589.50	603.97	596.31	604.28	0.000454	4.61	3028.90	650.12	0.24
Reach-1	69710	5yr	prop 3ft	12000.00	589.50	603.99	596.31	604.30	0.000451	4.60	3040.47	652.59	0.24
Reach-1	69710	10yr	ex	14300.00	589.50	605.60	597.03	605.87	0.000353	4.44	4303.22	960.28	0.21
Reach-1	69710	10yr	prop 3ft	14300.00	589.50	605.63	597.03	605.90	0.000349	4.42	4329.64	963.54	0.21
Reach-1	69710	50yr	ex	19500.00	589.50	608.20	598.52	608.40	0.000240	4.13	7578.22	1518.50	0.18
Reach-1	69710	50yr	prop 3ft	19500.00	589.50	608.25	598.52	608.45	0.000235	4.09	7653.26	1521.65	0.18
Reach-1	69710	100yr	ex	21900.00	589.50	609.24	599.14	609.37	0.000171	3.64	10013.93	1579.48	0.16
Reach-1	69710	100yr	prop 3ft	21900.00	589.50	609.28	599.14	609.41	0.000169	3.62	10078.47	1581.88	0.15
Reach-1	69710	500yr	ex	27800.00	589.50	611.62	600.51	611.72	0.000122	3.36	13969.27	1752.70	0.13

HEC-RAS River: RIVER-1 Reach: Reach-1 (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach-1	69710	500yr	prop 3ft	27800.00	589.50	611.66	600.51	611.76	0.000121	3.34	14036.08	1755.72	0.13
Reach-1	69700	Median	ex	510.00	589.50	592.31	590.59	592.35	0.000463	1.62	315.09	132.90	0.19
Reach-1	69700	Median	prop 3ft	510.00	589.50	592.31	590.59	592.35	0.000463	1.62	315.09	132.90	0.19
Reach-1	69700	Average	ex	900.00	589.50	593.19	590.99	593.26	0.000525	2.07	435.50	139.75	0.21
Reach-1	69700	Average	prop 3ft	900.00	589.50	593.19	590.99	593.26	0.000525	2.07	435.50	139.75	0.21
Reach-1	69700	1yr	ex	3500.00	589.50	596.71	592.74	596.90	0.000708	3.54	987.69	176.24	0.26
Reach-1	69700	1yr	prop 3ft	3500.00	589.50	596.71	592.74	596.90	0.000708	3.54	987.69	176.24	0.26
Reach-1	69700	1.5yr	ex	6300.00	589.50	599.74	594.10	599.99	0.000615	4.01	1570.38	271.48	0.26
Reach-1	69700	1.5yr	prop 3ft	6300.00	589.50	599.74	594.10	599.99	0.000615	4.01	1570.38	271.48	0.26
Reach-1	69700	2.33yr	ex	9450.00	589.50	602.23	595.41	602.53	0.000526	4.46	2219.82	439.69	0.25
Reach-1	69700	2.33yr	prop 3ft	9450.00	589.50	602.23	595.41	602.53	0.000526	4.46	2219.82	439.69	0.25
Reach-1	69700	5yr	ex	12000.00	589.50	603.90	596.31	604.22	0.000466	4.66	2987.48	641.20	0.24
Reach-1	69700	5yr	prop 3ft	12000.00	589.50	603.90	596.31	604.22	0.000466	4.66	2987.48	641.20	0.24
Reach-1	69700	10yr	ex	14300.00	589.50	605.55	597.03	605.82	0.000360	4.48	4255.80	954.40	0.22
Reach-1	69700	10yr	prop 3ft	14300.00	589.50	605.55	597.03	605.82	0.000360	4.48	4255.80	954.40	0.22
Reach-1	69700	50yr	ex	19500.00	589.50	608.17	598.52	608.37	0.000243	4.15	7532.13	1516.57	0.18
Reach-1	69700	50yr	prop 3ft	19500.00	589.50	608.17	598.52	608.37	0.000243	4.15	7532.13	1516.57	0.18
Reach-1	69700	100yr	ex	21900.00	589.50	609.21	599.14	609.35	0.000173	3.65	9979.43	1578.19	0.16
Reach-1	69700	100yr	prop 3ft	21900.00	589.50	609.21	599.14	609.35	0.000173	3.65	9979.43	1578.19	0.16
Reach-1	69700	500yr	ex	27800.00	589.50	611.60	600.51	611.71	0.000123	3.36	13944.78	1751.59	0.13
Reach-1	69700	500yr	prop 3ft	27800.00	589.50	611.60	600.51	611.71	0.000123	3.36	13944.78	1751.59	0.13
Reach-1	69553	Median	ex	510.00	582.00	592.27	583.51	592.28	0.000293	0.60	855.47	125.92	0.04
Reach-1	69553	Median	prop 3ft	510.00	582.00	592.27	583.51	592.28	0.000293	0.60	855.47	125.92	0.04
Reach-1	69553	Average	ex	900.00	582.00	593.13	584.18	593.15	0.000647	0.93	966.37	131.94	0.06
Reach-1	69553	Average	prop 3ft	900.00	582.00	593.13	584.18	593.15	0.000647	0.93	966.37	131.94	0.06
Reach-1	69553	1yr	ex	3500.00	582.00	596.58	587.04	596.66	0.002764	2.32	1505.75	185.94	0.14
Reach-1	69553	1yr	prop 3ft	3500.00	582.00	596.58	587.04	596.66	0.002764	2.32	1505.75	185.94	0.14
Reach-1	69553	1.5yr	ex	6300.00	582.00	599.61	589.16	599.75	0.003559	2.97	2124.00	275.39	0.17
Reach-1	69553	1.5yr	prop 3ft	6300.00	582.00	599.61	589.16	599.75	0.003559	2.97	2124.00	275.39	0.17
Reach-1	69553	2.33yr	ex	9450.00	582.00	602.12	590.88	602.30	0.004417	3.39	2958.43	510.23	0.19
Reach-1	69553	2.33yr	prop 3ft	9450.00	582.00	602.12	590.88	602.30	0.004417	3.39	2958.43	510.23	0.19
Reach-1	69553	5yr	ex	12000.00	582.00	603.82	592.02	604.00	0.003864	3.53	3984.46	832.48	0.18
Reach-1	69553	5yr	prop 3ft	12000.00	582.00	603.82	592.02	604.00	0.003864	3.53	3984.46	832.48	0.18
Reach-1	69553	10yr	ex	14300.00	582.00	605.51	592.94	605.66	0.002850	3.34	5858.05	1273.35	0.16
Reach-1	69553	10yr	prop 3ft	14300.00	582.00	605.51	592.94	605.66	0.002850	3.34	5858.05	1273.35	0.16
Reach-1	69553	50yr	ex	19500.00	582.00	608.15	595.01	608.26	0.001915	3.11	9322.83	1506.61	0.14
Reach-1	69553	50yr	prop 3ft	19500.00	582.00	608.15	595.01	608.26	0.001915	3.11	9322.83	1506.61	0.14
Reach-1	69553	100yr	ex	21900.00	582.00	609.19	595.88	609.28	0.001496	2.87	11694.40	1527.28	0.12
Reach-1	69553	100yr	prop 3ft	21900.00	582.00	609.19	595.88	609.28	0.001496	2.87	11694.40	1527.28	0.12
Reach-1	69553	500yr	ex	27800.00	582.00	611.59	597.47	611.66	0.001135	2.74	15419.45	1588.91	0.11
Reach-1	69553	500yr	prop 3ft	27800.00	582.00	611.59	597.47	611.66	0.001135	2.74	15419.45	1588.91	0.11
Reach-1	69334	Median	ex	510.00	589.50	592.16	590.50	592.20	0.000402	1.49	342.39	146.83	0.17
Reach-1	69334	Median	prop 3ft	510.00	589.50	592.16	590.50	592.20	0.000402	1.49	342.39	146.83	0.17
Reach-1	69334	Average	ex	900.00	589.50	592.95	590.84	593.01	0.000484	1.96	459.77	150.06	0.20
Reach-1	69334	Average	prop 3ft	900.00	589.50	592.95	590.84	593.01	0.000484	1.96	459.77	150.06	0.20
Reach-1	69334	1yr	ex	3500.00	589.50	596.14	592.42	596.35	0.000735	3.65	958.76	166.89	0.27
Reach-1	69334	1yr	prop 3ft	3500.00	589.50	596.14	592.42	596.35	0.000735	3.65	958.76	166.89	0.27
Reach-1	69334	1.5yr	ex	6300.00	589.50	599.17	593.70	599.41	0.000766	3.92	1608.97	301.89	0.28
Reach-1	69334	1.5yr	prop 3ft	6300.00	589.50	599.17	593.70	599.41	0.000766	3.92	1608.97	301.89	0.28
Reach-1	69334	2.33yr	ex	9450.00	589.50	601.75	594.91	602.01	0.000559	4.04	2345.46	346.78	0.25
Reach-1	69334	2.33yr	prop 3ft	9450.00	589.50	601.75	594.91	602.01	0.000559	4.04	2345.46	346.78	0.25
Reach-1	69334	5yr	ex	12000.00	589.50	603.48	595.76	603.75	0.000469	4.20	2935.30	418.98	0.24
Reach-1	69334	5yr	prop 3ft	12000.00	589.50	603.48	595.76	603.75	0.000469	4.20	2935.30	418.98	0.24
Reach-1	69334	10yr	ex	14300.00	589.50	605.17	596.68	605.44	0.000381	4.21	3583.35	463.98	0.22
Reach-1	69334	10yr	prop 3ft	14300.00	589.50	605.17	596.68	605.44	0.000381	4.21	3583.35	463.98	0.22
Reach-1	69334	50yr	ex	19500.00	589.50	607.74	598.37	608.05	0.000342	4.56	4634.33	498.04	0.21
Reach-1	69334	50yr	prop 3ft	19500.00	589.50	607.74	598.37	608.05	0.000342	4.56	4634.33	498.04	0.21
Reach-1	69334	100yr	ex	21900.00	589.50	608.84	598.97	609.10	0.000284	4.36	5742.41	512.56	0.20
Reach-1	69334	100yr	prop 3ft	21900.00	589.50	608.84	598.97	609.10	0.000284	4.36	5742.41	512.56	0.20
Reach-1	69334	500yr	ex	27800.00	589.50	611.19	600.24	611.48	0.000265	4.64	6988.55	547.05	0.19
Reach-1	69334	500yr	prop 3ft	27800.00	589.50	611.19	600.24	611.48	0.000265	4.64	6988.55	547.05	0.19
Reach-1	69301.5			Bridge									
Reach-1	69269	Median	ex	510.00	589.50	592.00	590.50	592.04	0.000511	1.60	317.97	146.15	0.19
Reach-1	69269	Median	prop 3ft	510.00	589.50	592.00	590.50	592.04	0.000511	1.60	317.97	146.15	0.19
Reach-1	69269	Average	ex	900.00	589.50	592.75	590.84	592.81	0.000605	2.10	428.91	149.21	0.22
Reach-1	69269	Average	prop 3ft	900.00	589.50	592.75	590.84	592.81	0.000605	2.10	428.91	149.21	0.22
Reach-1	69269	1yr	ex	3500.00	589.50	595.79	592.42	596.03	0.000862	3.88	902.30	161.65	0.29
Reach-1	69269	1yr	prop 3ft	3500.00	589.50	595.79	592.42	596.03	0.000862	3.88	902.30	161.65	0.29
Reach-1	69269	1.5yr	ex	6300.00	589.50	598.81	593.70	599.08	0.000881	4.15	1517.81	289.41	0.30
Reach-1	69269	1.5yr	prop 3ft	6300.00	589.50	598.81	593.70	599.08	0.000881	4.15	1517.81	289.41	0.30
Reach-1	69269	2.33yr	ex	9450.00	589.50	601.50	594.91	601.77	0.000622	4.17	2270.02	344.47	0.26
Reach-1	69269	2.33yr	prop 3ft	9450.00	589.50	601.50	594.91	601.77	0.000622	4.17	2270.02	344.47	0.26
Reach-1	69269	5yr	ex	12000.00	589.50	603.26	595.76	603.54	0.000506	4.30	2857.48	415.45	0.24
Reach-1	69269	5yr	prop 3ft	12000.00	589.50	603.26	595.76	603.54	0.000506	4.30	2857.48	415.45	0.24
Reach-1	69269	10yr	ex	14300.00	589.50	604.99	596.68	605.27	0.000403	4.28	3513.37	461.64	0.22
Reach-1	69269	10yr	prop 3ft	14300.00	589.50	604.99	596.68	605.27	0.000403	4.28	3513.37	461.64	0.22
Reach-1	69269	50yr	ex	19500.00	589.50	607.58	598.37	607.90	0.000356	4.62	4567.56	495.93	0.22
Reach-1	69269	50yr	prop 3ft	19500.00	589.50	607.58	598.37	607.90	0.000356	4.62	4567.56	495.93	0.22
Reach-1	69269	100yr	ex	21900.00	589.50	608.71	598.97	608.99	0.000293	4.41	5680.60	510.96	0.20

HEC-RAS River: RIVER-1 Reach: Reach-1 (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach-1	69269	100yr	prop 3ft	21900.00	589.50	608.71	598.97	608.99	0.000293	4.41	5680.60	510.96	0.20
Reach-1	69269	500yr	ex	27800.00	589.50	611.05	600.24	611.35	0.000273	4.69	6914.11	544.87	0.20
Reach-1	69269	500yr	prop 3ft	27800.00	589.50	611.05	600.24	611.35	0.000273	4.69	6914.11	544.87	0.20
Reach-1	68993	Median	ex	510.00	589.50	591.67	590.69	591.78	0.001689	2.61	195.28	105.95	0.34
Reach-1	68993	Median	prop 3ft	510.00	589.50	591.67	590.69	591.78	0.001689	2.61	195.28	105.95	0.34
Reach-1	68993	Average	ex	900.00	589.50	592.33	591.12	592.51	0.001973	3.39	265.36	109.05	0.38
Reach-1	68993	Average	prop 3ft	900.00	589.50	592.33	591.12	592.51	0.001973	3.39	265.36	109.05	0.38
Reach-1	68993	1yr	ex	3500.00	589.50	594.93	593.10	595.52	0.002800	6.19	565.07	121.41	0.51
Reach-1	68993	1yr	prop 3ft	3500.00	589.50	594.93	593.10	595.52	0.002800	6.19	565.07	121.41	0.51
Reach-1	68993	1.5yr	ex	6300.00	589.50	597.93	594.63	598.61	0.001872	6.62	951.26	135.68	0.44
Reach-1	68993	1.5yr	prop 3ft	6300.00	589.50	597.93	594.63	598.61	0.001872	6.62	951.26	135.68	0.44
Reach-1	68993	2.33yr	ex	9450.00	589.50	600.58	596.07	601.36	0.001560	7.09	1364.50	454.46	0.42
Reach-1	68993	2.33yr	prop 3ft	9450.00	589.50	600.58	596.07	601.36	0.001560	7.09	1364.50	454.46	0.42
Reach-1	68993	5yr	ex	12000.00	589.50	602.39	597.07	603.18	0.001365	7.24	1903.25	1271.85	0.40
Reach-1	68993	5yr	prop 3ft	12000.00	589.50	602.39	597.07	603.18	0.001365	7.24	1903.25	1271.85	0.40
Reach-1	68993	10yr	ex	14300.00	589.50	604.67	597.95	605.08	0.000744	5.75	3826.05	1937.36	0.30
Reach-1	68993	10yr	prop 3ft	14300.00	589.50	604.67	597.95	605.08	0.000744	5.75	3826.05	1937.36	0.30
Reach-1	68993	50yr	ex	19500.00	589.50	607.56	599.76	607.73	0.000340	4.21	7369.67	2123.31	0.21
Reach-1	68993	50yr	prop 3ft	19500.00	589.50	607.56	599.76	607.73	0.000340	4.21	7369.67	2123.31	0.21
Reach-1	68993	100yr	ex	21900.00	589.50	608.70	600.70	608.84	0.000260	3.88	8888.93	2174.16	0.18
Reach-1	68993	100yr	prop 3ft	21900.00	589.50	608.70	600.70	608.84	0.000260	3.88	8888.93	2174.16	0.18
Reach-1	68993	500yr	ex	27800.00	589.50	611.09	604.55	611.20	0.000173	3.52	12188.75	2508.94	0.15
Reach-1	68993	500yr	prop 3ft	27800.00	589.50	611.09	604.55	611.20	0.000173	3.52	12188.75	2508.94	0.15
Reach-1	68979.5			Bridge									
Reach-1	68966	Median	ex	510.00	589.50	590.69	590.69	591.15	0.018525	5.46	93.36	101.28	1.00
Reach-1	68966	Median	prop 3ft	510.00	589.50	590.69	590.69	591.15	0.018525	5.46	93.36	101.28	1.00
Reach-1	68966	Average	ex	900.00	589.50	591.12	591.12	591.79	0.016335	6.54	137.51	103.33	1.00
Reach-1	68966	Average	prop 3ft	900.00	589.50	591.12	591.12	591.79	0.016335	6.54	137.51	103.33	1.00
Reach-1	68966	1yr	ex	3500.00	589.50	593.46	593.10	594.70	0.008723	8.93	391.79	114.43	0.85
Reach-1	68966	1yr	prop 3ft	3500.00	589.50	593.46	593.10	594.70	0.008723	8.93	391.79	114.43	0.85
Reach-1	68966	1.5yr	ex	6300.00	589.50	597.53	594.63	598.30	0.002227	7.02	897.66	133.79	0.48
Reach-1	68966	1.5yr	prop 3ft	6300.00	589.50	597.53	594.63	598.30	0.002227	7.02	897.66	133.79	0.48
Reach-1	68966	2.33yr	ex	9450.00	589.50	600.26	596.07	601.10	0.001746	7.36	1301.06	371.87	0.44
Reach-1	68966	2.33yr	prop 3ft	9450.00	589.50	600.26	596.07	601.10	0.001746	7.36	1301.06	371.87	0.44
Reach-1	68966	5yr	ex	12000.00	589.50	602.07	597.07	602.95	0.001531	7.57	1759.71	1190.77	0.42
Reach-1	68966	5yr	prop 3ft	12000.00	589.50	602.07	597.07	602.95	0.001531	7.57	1759.71	1190.77	0.42
Reach-1	68966	10yr	ex	14300.00	589.50	604.49	597.95	604.91	0.000758	5.80	3904.10	1923.44	0.30
Reach-1	68966	10yr	prop 3ft	14300.00	589.50	604.49	597.95	604.91	0.000758	5.80	3904.10	1923.44	0.30
Reach-1	68966	50yr	ex	19500.00	589.50	607.48	599.76	607.63	0.000310	4.01	7871.70	2119.36	0.20
Reach-1	68966	50yr	prop 3ft	19500.00	589.50	607.48	599.76	607.63	0.000310	4.01	7871.70	2119.36	0.20
Reach-1	68966	100yr	ex	21900.00	589.50	608.65	600.70	608.77	0.000232	3.66	9547.53	2171.99	0.17
Reach-1	68966	100yr	prop 3ft	21900.00	589.50	608.65	600.70	608.77	0.000232	3.66	9547.53	2171.99	0.17
Reach-1	68966	500yr	ex	27800.00	589.50	611.06	604.51	611.16	0.000151	3.28	13145.54	2503.07	0.14
Reach-1	68966	500yr	prop 3ft	27800.00	589.50	611.06	604.51	611.16	0.000151	3.28	13145.54	2503.07	0.14
Reach-1	68844	Median	ex	510.00	582.00	586.74		586.75	0.000077	0.85	597.29	137.15	0.07
Reach-1	68844	Median	prop 3ft	510.00	582.00	586.74		586.75	0.000077	0.85	597.29	137.15	0.07
Reach-1	68844	Average	ex	900.00	582.00	588.20		588.22	0.000095	1.12	802.81	142.93	0.08
Reach-1	68844	Average	prop 3ft	900.00	582.00	588.20		588.22	0.000095	1.12	802.81	142.93	0.08
Reach-1	68844	1yr	ex	3500.00	582.00	593.99		594.05	0.000150	2.05	1709.18	171.93	0.11
Reach-1	68844	1yr	prop 3ft	3500.00	582.00	593.99		594.05	0.000150	2.05	1709.18	171.93	0.11
Reach-1	68844	1.5yr	ex	6300.00	582.00	597.81		597.92	0.000178	2.63	2395.07	186.92	0.13
Reach-1	68844	1.5yr	prop 3ft	6300.00	582.00	597.81		597.92	0.000178	2.63	2395.07	186.92	0.13
Reach-1	68844	2.33yr	ex	9450.00	582.00	600.54		600.70	0.000231	3.23	2930.79	217.14	0.15
Reach-1	68844	2.33yr	prop 3ft	9450.00	582.00	600.54		600.70	0.000231	3.23	2930.79	217.14	0.15
Reach-1	68844	5yr	ex	12000.00	582.00	602.35		602.55	0.000256	3.62	3401.61	338.78	0.16
Reach-1	68844	5yr	prop 3ft	12000.00	582.00	602.35		602.55	0.000256	3.62	3401.61	338.78	0.16
Reach-1	68844	10yr	ex	14300.00	582.00	604.55		604.76	0.000222	3.69	4568.67	810.90	0.15
Reach-1	68844	10yr	prop 3ft	14300.00	582.00	604.55		604.76	0.000222	3.69	4568.67	810.90	0.15
Reach-1	68844	50yr	ex	19500.00	582.00	607.40		607.59	0.000194	3.80	8256.42	1442.07	0.15
Reach-1	68844	50yr	prop 3ft	19500.00	582.00	607.40		607.59	0.000194	3.80	8256.42	1442.07	0.15
Reach-1	68844	100yr	ex	21900.00	582.00	608.55		608.73	0.000177	3.76	9947.25	1485.67	0.14
Reach-1	68844	100yr	prop 3ft	21900.00	582.00	608.55		608.73	0.000177	3.76	9947.25	1485.67	0.14
Reach-1	68844	500yr	ex	27800.00	582.00	610.97		611.12	0.000151	3.72	13676.43	1605.37	0.13
Reach-1	68844	500yr	prop 3ft	27800.00	582.00	610.97		611.12	0.000151	3.72	13676.43	1605.37	0.13
Reach-1	68529	Median	ex	510.00	580.70	586.69	582.76	586.71	0.000148	1.18	432.10	100.64	0.10
Reach-1	68529	Median	prop 3ft	510.00	580.70	586.69	582.76	586.71	0.000148	1.18	432.10	100.64	0.10
Reach-1	68529	Average	ex	900.00	580.70	588.14	583.28	588.18	0.000189	1.54	584.68	109.38	0.12
Reach-1	68529	Average	prop 3ft	900.00	580.70	588.14	583.28	588.18	0.000189	1.54	584.68	109.38	0.12
Reach-1	68529	1yr	ex	3500.00	580.70	593.87	585.63	593.98	0.000280	2.70	1297.13	138.84	0.16
Reach-1	68529	1yr	prop 3ft	3500.00	580.70	593.87	585.63	593.98	0.000280	2.70	1297.13	138.84	0.16
Reach-1	68529	1.5yr	ex	6300.00	580.70	597.66	587.39	597.83	0.000301	3.36	2206.47	522.32	0.17
Reach-1	68529	1.5yr	prop 3ft	6300.00	580.70	597.66	587.39	597.83	0.000301	3.36	2206.47	522.32	0.17
Reach-1	68529	2.33yr	ex	9450.00	580.70	600.39	589.00	600.60	0.000305	3.86	3883.91	657.49	0.18
Reach-1	68529	2.33yr	prop 3ft	9450.00	580.70	600.39	589.00	600.60	0.000305	3.86	3883.91	657.49	0.18
Reach-1	68529	5yr	ex	12000.00	580.70	602.22	590.11	602.46	0.000303	4.15	5173.48	768.50	0.18
Reach-1	68529	5yr	prop 3ft	12000.00	580.70	602.22	590.11	602.46	0.000303	4.15	5173.48	768.50	0.18
Reach-1	68529	10yr	ex	14300.00	580.70	604.47	591.05	604.68	0.000251	4.11	7382.87	1413.19	0.17
Reach-1	68529	10yr	prop 3ft	14300.00	580.70	604.47	591.05	604.68	0.000251	4.11	7382.87	1413.19	0.17
Reach-1	68529	50yr	ex	19500.00	580.70	607.34	592.88	607.52	0.000206	4.08	11608.02	1497.78	0.15

HEC-RAS River: RIVER-1 Reach: Reach-1 (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach-1	68529	50yr	prop 3ft	19500.00	580.70	607.34	592.88	607.52	0.000206	4.08	11608.02	1497.78	0.15
Reach-1	68529	100yr	ex	21900.00	580.70	608.50	593.66	608.67	0.000190	4.06	13353.07	1508.30	0.15
Reach-1	68529	100yr	prop 3ft	21900.00	580.70	608.50	593.66	608.67	0.000190	4.06	13353.07	1508.30	0.15
Reach-1	68529	500yr	ex	27800.00	580.70	610.92	595.41	611.07	0.000169	4.09	17021.99	1530.17	0.14
Reach-1	68529	500yr	prop 3ft	27800.00	580.70	610.92	595.41	611.07	0.000169	4.09	17021.99	1530.17	0.14

HEC-RAS Version 3.1.1 May 2003
U.S. Army Corp of Engineers
Hydrologic Engineering Center
609 Second Street, Suite D
Davis, California 95616-4687
(916) 756-1104

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X     X  XXXXXX    XXXX        XXXX       XX      XXXX
X     X  X        X    X       X   X     X  X    X
X     X  X        X            X   X    X    X   X
XXXXXXX  XXXX     X       XXX  XXXX     XXXXXX    XXXX
X     X  X        X            X  X     X    X        X
X     X  X        X    X       X   X    X    X        X
X     X  XXXXXX    XXXX        X    X   X    X   XXXXX
```

PROJECT DATA
Project Title: CVNP - TO #25
Project File : TO_25.prj
Run Date and Time: 7/18/2005 9:57:44 AM

Project in English units

Project Description:
National Parks Service - CVNRA Work Order #25

Hydraulic Model based on
Buffalo District USACE HEC-2 Model (1997)

Modified 3/01 by Bergmann
Associates using HEC-RAS 3.0 (beta)
Michael J McManus, P.E.

FLOW DATA

Flow Title: FIS Flows
Flow File : w:\Water Resources\jobs\CVNP\Task_Order #25\Flood\HEC RAS June 2005\TO_25.f02

Flow Data (cfs)

River	Reach	RS	Median	Average	
1yr	1.5yr	2.33yr	5yr	10yr	50yr
RIVER-1	Reach-1	84553	510	900	
3500	6300	9450	12000	14300	19500

River	Reach	RS	100yr	500yr
RIVER-1	Reach-1	84553	21900	27800

Boundary Conditions

River	Reach	Profile	Upstream	Downstream
RIVER-1	Reach-1	Median		
Known WS = 586.692				
RIVER-1	Reach-1	Average		
Known WS = 588.143				
RIVER-1	Reach-1	1yr		
Known WS = 593.867				
RIVER-1	Reach-1	1.5yr		
Known WS = 597.66				
RIVER-1	Reach-1	2.33yr		
Known WS = 600.39				
RIVER-1	Reach-1	5yr		
Known WS = 602.22				
RIVER-1	Reach-1	10yr		
Known WS = 604.465				
RIVER-1	Reach-1	50yr		
Known WS = 607.339				
RIVER-1	Reach-1	100yr		
Known WS = 608.5				
RIVER-1	Reach-1	500yr		
Known WS = 610.915				

GEOMETRY DATA

Geometry Title: BA Model - high flows run
Geometry File : w:\Water Resources\jobs\CVNP\Task_Order #25\Flood\HEC RAS June 2005\TO_25.g06

CROSS SECTION

RIVER: RIVER-1
REACH: Reach-1 RS: 84553

INPUT
Description:

Station Elevation Data num= 31

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
1000	700.1	1040	696.9	1120	666.9	1150	660.9	1170	654.5
1180	649.9	1200	631.3	1210	624.5	1260	613	1300	609.6
1310	604.1	1320	602	1415	598.6	1423	602	1430	605
1450	608	1610	608.5	1710	610	1960	617.9	1970	612.9
2000	610.7	2010	611.1	2020	617.7	2030	620	2100	620.4
2110	621.6	2120	624.7	2130	629.2	2230	644	2440	721.9
2443	722.3								

Manning's n Values num= 4

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val

1000	.15	1300	.045	1450	.08	1710	.15

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
1300	1450	1355	1339	1330	.2	.4

CROSS SECTION

RIVER: RIVER-1
REACH: Reach-1 RS: 83214

INPUT
Description:

Station Elevation Data num= 22

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
1000	659.2	1120	613.8	1190	609.3	1200	607	1210	602.5
1219	600	1220	597.7	1336	597.7	1340	600.2	1360	607
1410	606	1450	608	1610	608.6	1660	611.9	1710	609.5
1730	610.6	1740	612.4	1770	623.6	1780	625.9	1790	627.2
1900	649.6	1919	651						

Manning's n Values num= 5

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
1000	.15	1190	.08	1200	.052	1360	.08	1660	.15

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
1200	1360	1560	1473	1430	.3	.5

CROSS SECTION

RIVER: RIVER-1
REACH: Reach-1 RS: 81741

INPUT
Description: This is a REPEATED section.
US FACE HILLSIDE RD BRIDGE

Station Elevation Data num= 73

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
1000	687.4	1040	679.9	1050	678.9	1130	666.4	1140	667.5
1240	653.9	1284	651.3	1360	639.5	1380	639.2	1420	632.8
1430	633.3	1490	626.6	1500	626.6	1520	624.3	1530	622.2
1630	614	1770	608.4	1840	608.7	1860	607.1	1904	609.4
1910	609.4	1920	608.3	2010	613.3	2050	615	2060	614.1
2090	616	2100	606.8	2100.1	606.8	2110	601.4	2113	600
2274	597.4	2280	601.4	2289.9	604.4	2290	604.4	2300	616.3
2310	617.5	2342	615.3	2360	616.3	2380	613.2	2400	613.9
2410	613	2440	616.3	2460	613.5	2490	613.5	2500	615.1
2520	616.1	2560	613.7	2620	618	2650	615.6	2660	617.4
2690	616.8	2710	617.2	2730	616	2750	616	2760	614.8
2770	612.5	2790	604.6	2810	617.3	2820	605.1	2840	607.6
2850	614.2	2860	606.4	2870	604.9	2880	610.5	2890	609.3
2900	610	2920	614	2940	615.5	3060	637.8	3090	640
3130	652.1	3160	658.5	3215	676.6				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
1000	.04	2100	.035	2290	.04

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
2100	2290	33	33	.3	.5

Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
1000	2100	619.5	F
2290	3215	615.1	F

BRIDGE

RIVER: RIVER-1
REACH: Reach-1 RS: 81724.5

INPUT
Description: Bridge #11

Distance from Upstream XS = .1
Deck/Roadway Width = 32.8
Weir Coefficient = 2.6

Upstream Deck/Roadway Coordinates
num= 27

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
1530	622.2	622.2	1630	620	614	1770	619.5	608.4
1840	619.6	608.7	1860	619.6	607.1	1904	619.6	609.4
1920	619.7	608.3	2100	619.8	606.8	2100.1	619.8	615.5
2289.9	619.8	615.5	2290	619.8	604.4	2300	619.8	616.3
2310	619.7	617.5	2342	617.7	615.3	2360	617.6	616.2
2380	617.5	613.2	2400	615.6	613.9	2410	615.6	613
2440	616.3	616.3	2460	616.3	613.5	2500	615.1	615.1
2520	616.1	616.1	2560	616	613.7	2620	618	618
2650	615.6	615.6	2660	617.4	617.4	2710	617.2	617.2

Upstream Bridge Cross Section Data
Station Elevation Data num= 73

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
1000	687.4	1040	679.9	1050	678.9	1130	666.4	1140	667.5
1240	653.9	1284	651.3	1360	639.5	1380	639.2	1420	632.8
1430	633.3	1490	626.6	1500	626.6	1520	624.3	1530	622.2
1630	614	1770	608.4	1840	608.7	1860	607.1	1904	609.4
1910	609.4	1920	608.3	2010	613.3	2050	615	2060	614.1
2090	616	2100	606.8	2100.1	606.8	2110	601.4	2113	600
2274	597.4	2280	601.4	2289.9	604.4	2290	604.4	2300	616.3
2310	617.5	2342	615.3	2360	616.3	2380	613.2	2400	613.9
2410	613	2440	616.3	2460	613.5	2490	613.5	2500	615.1
2520	616.1	2560	613.7	2620	618	2650	615.6	2660	617.4
2690	616.8	2710	617.2	2730	616	2750	616	2760	614.8
2770	612.5	2790	604.6	2810	617.3	2820	605.1	2840	607.6
2850	614.2	2860	606.4	2870	604.9	2880	610.5	2890	609.3
2900	610	2920	614	2940	615.5	3060	637.8	3090	640
3130	652.1	3160	658.5	3215	676.6				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
1000	.04	2100	.035	2290	.04

Bank Sta: Left	Right	Coeff Contr.	Expan.
2100	2290	.3	.5

Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
1000	2100	619.5	F
2290	3215	615.1	F

Downstream Deck/Roadway Coordinates
num= 27

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
1530	622.2	622.2	1630	620	614	1770	619.5	608.4
1840	619.6	608.7	1860	619.6	607.1	1904	619.6	609.4
1920	619.7	608.3	2100	619.8	606.8	2100.1	619.8	615.5
2289.9	619.8	615.5	2290	619.8	604.4	2300	619.8	616.3
2310	619.7	617.5	2342	617.7	615.3	2360	617.6	616.2
2380	617.5	613.2	2400	615.6	613.9	2410	615.6	613
2440	616.3	616.3	2460	616.3	613.5	2500	615.1	615.1
2520	616.1	616.1	2560	616	613.7	2620	618	618
2650	615.6	615.6	2660	617.4	617.4	2710	617.2	617.2

Downstream Bridge Cross Section Data
Station Elevation Data num= 73

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
1000	687.4	1040	679.9	1050	678.9	1130	666.4	1140	667.5
1240	653.9	1284	651.3	1360	639.5	1380	639.2	1420	632.8
1430	633.3	1490	626.6	1500	626.6	1520	624.3	1530	622.2
1630	614	1770	608.4	1840	608.7	1860	607.1	1904	609.4
1910	609.4	1920	608.3	2010	613.3	2050	615	2060	614.1
2090	616	2100	606.8	2100.1	606.8	2110	601.4	2113	600
2274	597.4	2280	601.4	2289.9	604.4	2290	604.4	2300	616.3
2310	617.5	2342	615.3	2360	616.3	2380	613.2	2400	613.9
2410	613	2440	616.3	2460	613.5	2490	613.5	2500	615.1
2520	616.1	2560	613.7	2620	618	2650	615.6	2660	617.4
2690	616.8	2710	617.2	2730	616	2750	616	2760	614.8
2770	612.5	2790	604.6	2810	617.3	2820	605.1	2840	607.6
2850	614.2	2860	606.4	2870	604.9	2880	610.5	2890	609.3
2900	610	2920	614	2940	615.5	3060	637.8	3090	640
3130	652.1	3160	658.5	3215	676.6				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
1000	.04	2100	.035	2290	.04

Bank Sta: Left	Right	Coeff Contr.	Expan.
2100	2290	.3	.5

Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
1000	2100	617	F
2290	3215	615	F

Upstream Embankment side slope = 0 horiz. to 1.0 vertical
Downstream Embankment side slope = 0 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow = .95
Elevation at which weir flow begins = 615.7
Energy head used in spillway design =
Spillway height used in design =
Weir crest shape = Broad Crested

Number of Bridge Coefficient Sets = 1

Low Flow Methods and Data
Energy
Selected Low Flow Methods = Highest Energy Answer

High Flow Method
Pressure and Weir flow

Submerged Inlet Cd =
Submerged Inlet + Outlet Cd =.8006408
Max Low Cord = 615.5

Additional Bridge Parameters
Add Friction component to Momentum
Do not add Weight component to Momentum
Class B flow critical depth computations use critical depth inside the bridge at the upstream end
Criteria to check for pressure flow = Upstream energy grade line

CROSS SECTION

RIVER: RIVER-1
REACH: Reach-1 RS: 81708

INPUT
Description: DS FACE HILLSIDE RD BRIDGE

BRIDGE CENTERLINE AT STA. 817+50

LOW CHORD
ELEV. =615.5 TOP ROAD ELEV. =615.7

Station Elevation Data num= 73

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
1000	687.4	1040	679.9	1050	678.9	1130	666.4	1140	667.5
1240	653.9	1284	651.3	1360	639.5	1380	639.2	1420	632.8
1430	633.3	1490	626.6	1500	626.6	1520	624.3	1530	622.2
1630	614	1770	608.4	1840	608.7	1860	607.1	1904	609.4
1910	609.4	1920	608.3	2010	613.3	2050	615	2060	614.1
2090	616	2100	606.8	2100.1	606.8	2110	601.4	2113	600
2274	597.4	2280	601.4	2289.9	604.4	2290	604.4	2300	616.3
2310	617.5	2342	615.3	2360	616.3	2380	613.2	2400	613.9
2410	613	2440	616.3	2460	613.5	2490	613.5	2500	615.1
2520	616.1	2560	613.7	2620	618	2650	615.6	2660	617.4
2690	616.8	2710	617.2	2730	616	2750	616	2760	614.8
2770	612.5	2790	604.6	2810	617.3	2820	605.1	2840	607.6
2850	614.2	2860	606.4	2870	604.9	2880	610.5	2890	609.3
2900	610	2920	614	2940	615.5	3060	637.8	3090	640
3130	652.1	3160	658.5	3215	676.6				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
1000	.04	2100	.035	2290	.04

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
2100	2290	173	173	.3	.5

Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
1000	2100	617	F
2290	3215	615	F

CROSS SECTION

RIVER: RIVER-1
REACH: Reach-1 RS: 81535

INPUT
Description:

Station Elevation Data num= 39

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
1000	689.2	1340	626.8	1370	617.2	1380	615	1390	614
1500	613.5	1570	612.1	1700	611.4	1750	609.7	1820	609.1
1880	607	1890	607	1920	609.7	1930	609.7	2080	604
2110	600	2113	600.1	2200	597.3	2240	603	2259	602.3
2260	602.2	2270	603.6	2280	608	2330	611	2380	608.7
2500	609.4	2580	611.9	2610	608.5	2620	605.9	2650	604.1
2660	604.5	2680	610.2	2740	612	2760	612.3	2880	627.9
2920	637.6	2990	647	3060	660.1	3085	668.9		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
1000	.15	1930	.052	2280	.15

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
1930	2280	1500	1534	1600	.2	.4

Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
1000	1930	617	F
2280	3085	615	F

CROSS SECTION

RIVER: RIVER-1
REACH: Reach-1 RS: 80001

INPUT
Description:

Station Elevation Data num= 27

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
1000	653.7	1050	651.2	1070	651.3	1080	648.9	1120	632.3
1270	609.1	1390	606.2	1570	605.7	2000	606.4	2510	606
2580	606	2590	602.4	2600	600	2607	597	2714	597
2730	600.5	2740	605.6	2790	604.6	2820	606	3010	606
3060	610	3100	610	3130	604.7	3160	605.2	3180	611.3
3300	628.2	3405	660.7						

Manning's n Values num= 5

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
1000	.15	2510	.08	2580	.052	2740	.08	3060	.15

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
2580	2740	3159.94	3395.98 3385.06	.2	.4

CROSS SECTION

RIVER: RIVER-1
REACH: Reach-1 RS: 76605

INPUT
Description: DEC 90 HWM= 610.0 @ STA. 754+76

Station Elevation Data num= 26

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
1000	673.5	1020	665.8	1030	664	1140	626.1	1160	624.9
1190	619.4	1260	614.7	1270	614.8	1310	611.6	1440	608.4
1500	612	1600	611.5	1760	605.4	1780	601.6	1789	597.8
1850	596.2	1875	597.8	1890	601.5	1900	604	2090	604.5
2130	607	2260	604	2440	606.5	2980	607.2	3090	610
3480	620								

Manning's n Values num= 5

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
1000	.15	1600	.08	1760	.055	1900	.08	2130	.15

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
1760	1900	1535.04	2126.97 1559.97	.2	.4

CROSS SECTION

RIVER: RIVER-1
REACH: Reach-1 RS: 74478

INPUT
Description:

SECTION AT LOCATION OF FORMER STONE RD BRIDGE

Station Elevation Data num= 58

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
1000	620	1130	616	1220	615.2	1250	614	1500	608.3
1520	608.2	1540	607.2	1550	609.1	1560	608.6	1620	598.4
1663	597.5	1668	597.3	1693	589.6	1718	583.1	1736	592.1
1760	606.3	1770	609.6	1780	608.6	1800	609.9	1920	604
2140	604.5	2200	606	2210	605.8	2220	604.6	2370	608
2480	608.7	2510	610	2550	609.8	2580	608.2	2600	609
2610	608.9	2630	610	2640	609.2	2650	609.2	2690	611.8
2720	610.1	2760	611.9	2780	611.9	2790	611.1	2810	611.9
2870	612	2880	610.9	2920	612.4	2940	611.4	2960	612.6
2990	610.6	3050	611.9	3120	612	3140	612.2	3190	618.9
3250	649.1	3266	652.5	3270	655.4	3280	660.1	3350	676.3
3360	679.8	3440	714.5	3457	716				

Manning's n Values num= 5

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
1000	.15	1550	.05	1560	.052	1760	.05	2630	.15

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.

1560	1760	1140	1149	990	.2	.4

CROSS SECTION

RIVER: RIVER-1
REACH: Reach-1 RS: 73329

INPUT
Description:

Station Elevation Data num= 22

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
1000	681.3	1040	666.1	1080	660.2	1250	607.9	1305	602.2
1311	591.9	1412	589.5	1505	591.9	1510	594	1530	598.7
1560	602	1850	601.4	1950	600	2020	600.5	2140	601.9
2650	602	2770	604.3	2790	608	2850	609.9	2900	618
3130	697.8	3133	697.9						

Manning's n Values num= 5

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
1000	.15	1250	.08	1305	.052	1560	.08	1850	.15

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
1305	1560	1090	1186	1085	.2	.4

CROSS SECTION

RIVER: RIVER-1
REACH: Reach-1 RS: 72143

INPUT
Description:

Station Elevation Data num= 25

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
1000	641	1120	603.9	1130	601.9	1150	594.9	1160	594
1350	593.2	1462	593.5	1480	591.5	1540	591.5	1608	591.5
1610	594.4	1620	596.5	1630	600.3	1690	603.6	1820	602.9
1860	600.2	1870	601	1910	599.6	1940	602	2260	601.4
2370	598	2710	612.5	2780	626.4	2860	655.4	2919	665.7

Manning's n Values num= 5

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
1000	.15	1160	.08	1462	.055	1630	.08	1870	.15

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
1462	1630	1640	1624	1300	.2	.4

CROSS SECTION

RIVER: RIVER-1
REACH: Reach-1 RS: 70519

INPUT

Description:
Station Elevation Data num= 48

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
1000	701.3	1010	696.9	1020	693.7	1270	653.8	1350	630.4
1670	612	1850	611.6	2020	608.1	2090	607.5	2170	604
2240	603.4	2360	602.1	2460	601.5	2510	599.2	2520	599.2
2540	600.1	2640	599.6	2680	596	2840	596	2850	595.4
2860	592.2	2870	591.5	2874	591	2970	591	3018	590.9
3020	591	3030	592	3040	596	3110	595.6	3140	594
3230	594.2	3250	592.4	3260	592.5	3290	594	3330	599.7
3490	598.8	3530	598.1	3540	598.3	3580	605.7	3650	598.1
3670	600.4	3710	611.6	3780	613.1	3830	612.4	3850	612.5
4060	681.1	4100	698.3	4113	698.9				

Manning's n Values num= 5

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
1000	.15	2640	.08	2850	.055	3040	.08	3330	.15

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
2850	3040	623	809	833	.2	.4

CROSS SECTION

RIVER: RIVER-1
REACH: Reach-1 RS: 69710

INPUT
Description: This is a repeated section
Station Elevation Data num= 50

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-1377.88	633.4	-1267.88	630.7	-1157.88	627.5	-1107.88	626	-1097.88	624.2
-1067.88	614.9	-1037.88	612.9	-927.88	612.5	-755	607.5	-637	606
-335	606	-315	607	-285	606	-90	604	-45	604
-35	604	0	602	35	602	100	604	180	604
305	602	390	600	415	596	430	594	445	590
500	589.5	560	590	584	596	592	598	602	600
630	610	678	612	796	612	832	610	848	606
858	604	881	598	934	598	950	608	985	610
1012	620	1066	628	1090	634	1120	640	1152	650
1177	658	1183	659	1190	658	1204	656	1220	654.5

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-1377.88	.04	390	.035	602	.04

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
390	602	57	147	157	.3	.5

Ineffective Flow num= 1

Sta L	Sta R	Elev	Permanent
838	1220	609	F

BRIDGE

RIVER: RIVER-1
REACH: Reach-1 RS: 69705

INPUT
Description: Pedestrian Bridge
Distance from Upstream XS = .1
Deck/Roadway Width = 9.8
Weir Coefficient = 2.6

Upstream Deck/Roadway Coordinates
num= 6

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
288	602	602	380	611	600	380	611	608
620	611	608	620	611	600	680	612	598

Upstream Bridge Cross Section Data
Station Elevation Data num= 50

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-1377.88	633.4	-1267.88	630.7	-1157.88	627.5	-1107.88	626	-1097.88	624.2
-1067.88	614.9	-1037.88	612.9	-927.88	612.5	-755	607.5	-637	606
-335	606	-315	607	-285	606	-90	604	-45	604
-35	604	0	602	35	602	100	604	180	604
305	602	390	600	415	596	430	594	445	590
500	589.5	560	590	584	596	592	598	602	600
630	610	678	612	796	612	832	610	848	606
858	604	881	598	934	598	950	608	985	610
1012	620	1066	628	1090	634	1120	640	1152	650
1177	658	1183	659	1190	658	1204	656	1220	654.5

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-1377.88	.04	390	.035	602	.04

Bank Sta: Left Right Coeff Contr. Expan.
390 602 .3 .5
Ineffective Flow num= 1

Sta L	Sta R	Elev	Permanent
838	1220	609	F

Downstream Deck/Roadway Coordinates
num= 6

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
288	602	602	380	611	600	380	611	608
620	611	608	620	611	600	680	612	598

Downstream Bridge Cross Section Data
Station Elevation Data num= 50

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-1377.88	633.4	-1267.88	630.7	-1157.88	627.5	-1107.88	626	-1097.88	624.2
-1067.88	614.9	-1037.88	612.9	-927.88	612.5	-755	607.5	-637	606
-335	606	-315	607	-285	606	-90	604	-45	604
-35	604	0	602	35	602	100	604	180	604
305	602	390	600	415	596	430	594	445	590
500	589.5	560	590	584	596	592	598	602	600
630	610	678	612	796	612	832	610	848	606
858	604	881	598	934	598	950	608	985	610
1012	620	1066	628	1090	634	1120	640	1152	650
1177	658	1183	659	1190	658	1204	656	1220	654.5

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-1377.88	.04	390	.035	602	.04

Bank Sta: Left Right Coeff Contr. Expan.
390 602 .3 .5
Ineffective Flow num= 1

Sta L	Sta R	Elev	Permanent
838	1220	609	F

Upstream Embankment side slope = 0 horiz. to 1.0 vertical
Downstream Embankment side slope = 0 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow = .95

Elevation at which weir flow begins =
Energy head used in spillway design =
Spillway height used in design =
Weir crest shape = Broad Crested

Number of Bridge Coefficient Sets = 1

Low Flow Methods and Data
Energy
Selected Low Flow Methods = Highest Energy Answer

High Flow Method
Energy Only

Additional Bridge Parameters
Add Friction component to Momentum
Do not add Weight component to Momentum
Class B flow critical depth computations use critical depth
inside the bridge at the upstream end
Criteria to check for pressure flow = Upstream energy grade line

CROSS SECTION

RIVER: RIVER-1
REACH: Reach-1 RS: 69700

INPUT
Description: DS face ped bridge
Station Elevation Data num= 50

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-1377.88	633.4	-1267.88	630.7	-1157.88	627.5	-1107.88	626	-1097.88	624.2
-1067.88	614.9	-1037.88	612.9	-927.88	612.5	-755	607.5	-637	606
-335	606	-315	607	-285	606	-90	604	-45	604
-35	604	0	602	35	602	100	604	180	604
305	602	390	600	415	596	430	594	445	590
500	589.5	560	590	584	596	592	598	602	600
630	610	678	612	796	612	832	610	848	606
858	604	881	598	934	598	950	608	985	610
1012	620	1066	628	1090	634	1120	640	1152	650
1177	658	1183	659	1190	658	1204	656	1220	654.5

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-1377.88	.04	390	.035	602	.04

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
390	602	57	147	157	.3	.5

Ineffective Flow num= 1

Sta L	Sta R	Elev	Permanent
838	1220	609	F

CROSS SECTION

RIVER: RIVER-1
REACH: Reach-1 RS: 69553

INPUT
Description:
Station Elevation Data num= 106

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
1440	633.4	1550	630.7	1660	627.5	1710	626	1720	624.2

1750	614.9	1780	612.9	1890	612.5	1970	612.4	2080	612.3
2150	605.8	2224	606	2251	607	2275	606	2360	604
2412	602	2419	600	2429	600	2435	602	2482	604
2680	604	2798	602	2850	600	2860	600	2868	600
2886	600	2928	602	2940	604	3061	604	3201	602
3242	600	3258	598	3263	596	3268	594	3273	592
3278	590	3299	586.9	3304	582	3350	582	3375	586.9
3388	590	3397	592	3406	594	3442	596	3461	598
3467	600	3472	602	3476	604	3481	606	3485	608
3490	610	3515	612	3699	612	3707	610	3715	608
3724	606	3747	604	3751	602	3755	600	3759	598
3808	598	3811	600	3814	602	3817	604	3820	606
3860	608	3865	610	3868	612	3872	614	3877	616
3884	618	3903	620	3921	622	3933	624	3939	626
3948	628	3959	630	3969	632	3979	634	3983	636
3987	638	3993	640	3999	642	4006	644	4013	646
4022	648	4030	650	4038	652	4046	654	4055	655
4064	654	4070	652	4075	650	4079	648	4084	646
4088	644	4092	642	4096	640	4100	638	4104	636
4108	634	4112	632	4117	630	4123	628	4138	626
4143	625								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
1440	.15	3406	.08	3515	.15

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
3201	3472	265	219	215	.3	.5

Ineffective Flow num= 1

Sta L	Sta R	Elev	Permanent
3713	4143	609	F

CROSS SECTION

RIVER: RIVER-1
REACH: Reach-1 RS: 69334

INPUT
Description: This is a repeated section
BRIDGE CENTERLINE AT STA 693+01
Station Elevation Data num= 52

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
1870	630	2074	627.5	2129	626	2329	626	2454	628
2542	630	2606	630	2634	620	2652	610	2666	602
2712	602	2723	604	2725	604	2744	604	2759	610
2784	620	2806	630	2885	630	2939	628	3002	626
3074	624	3102	620	3124	610	3146	600	3192	598
3206	590	3274	589.5	3344	590	3358	596	3418	598
3432	600	3458	610	3467	614	3654	614	3667	610
3684	600	3689	598	3724	598	3729	600	3754	610
3762	612	4074	612	4150	614	4220	616	4264	618
4326	620	4370	622	4414	624	4454	626	4496	628
4534	630	4574	632						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
1870	.04	3146	.035	3432	.04

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
3146	3432	276	276	276	.3	.5

Ineffective Flow num= 1

Sta L	Sta R	Elev	Permanent

3664 4574 608 F

BRIDGE

RIVER: RIVER-1
REACH: Reach-1 RS: 69301.5

INPUT
Description: Bridge #10

Distance from Upstream XS = .1
Deck/Roadway Width = 64.7
Weir Coefficient = 2.6
Upstream Deck/Roadway Coordinates
num= 16

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
2840	627.2	627.2	3010	621.2	621.2	3020	621.7	621.7
3030	620.5	620.5	3050	620	600.3	3080	620	611.7
3090	620	613.8	3110	617	612	3465	617	612
3480	617	614	3550	614	614	3654	614	614
3654	614	611	3762	614	611	3762	614	612
4074	612	612						

Upstream Bridge Cross Section Data
Station Elevation Data num= 52

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
1870	630	2074	627.5	2129	626	2329	626	2454	628
2542	630	2606	630	2634	620	2652	610	2666	602
2712	602	2723	604	2725	604	2744	604	2759	610
2784	620	2806	630	2885	630	2939	628	3002	626
3074	624	3102	620	3124	610	3146	600	3192	598
3206	590	3274	589.5	3344	590	3358	596	3418	598
3432	600	3458	610	3467	614	3654	614	3667	610
3684	600	3689	598	3724	598	3729	600	3754	610
3762	612	4074	612	4150	614	4220	616	4264	618
4326	620	4370	622	4414	624	4454	626	4496	628
4534	630	4574	632						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
1870	.04	3146	.035	3432	.04

Bank Sta: Left Right Coeff Contr. Expan.
3146 3432 .3 .5
Ineffective Flow num= 1

Sta L	Sta R	Elev	Permanent
3664	4574	608	F

Downstream Deck/Roadway Coordinates
num= 16

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
2840	627.2	627.2	3010	621.2	621.2	3020	621.7	621.7
3030	620.5	620.5	3050	620	600.3	3080	620	611.7
3090	620	613.8	3110	617	612	3465	617	612
3480	617	614	3550	614	614	3654	614	614
3654	614	611	3762	614	611	3762	614	612
4074	612	612						

Downstream Bridge Cross Section Data
Station Elevation Data num= 52

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
1870	630	2074	627.5	2129	626	2329	626	2454	628

2542	630	2606	630	2634	620	2652	610	2666	602
2712	602	2723	604	2725	604	2744	604	2759	610
2784	620	2806	630	2885	630	2939	628	3002	626
3074	624	3102	620	3124	610	3146	600	3192	598
3206	590	3274	589.5	3344	590	3358	596	3418	598
3432	600	3458	610	3467	614	3654	614	3667	610
3684	600	3689	598	3724	598	3729	600	3754	610
3762	612	4074	612	4150	614	4220	616	4264	618
4326	620	4370	622	4414	624	4454	626	4496	628
4534	630	4574	632						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
1870	.04	3146	.035	3432	.04

Bank Sta: Left	Right	Coeff Contr.	Expan.
3146	3432	.3	.5

Ineffective Flow num= 1

Sta L	Sta R	Elev	Permanent
3664	4574	608	F

Upstream Embankment side slope = 0 horiz. to 1.0 vertical
Downstream Embankment side slope = 0 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow = .95
Elevation at which weir flow begins = 617
Energy head used in spillway design =
Spillway height used in design =
Weir crest shape = Broad Crested

Number of Piers = 1

Pier Data
Pier Station Upstream= 3287.5 Downstream= 3287.5
Upstream num= 2

Width	Elev	Width	Elev
16	582.5	16	612

Downstream num= 2

Width	Elev	Width	Elev
16	582.5	16	612

Number of Bridge Coefficient Sets = 1

Low Flow Methods and Data
Energy
Yarnell KVal = .9
Selected Low Flow Methods = Highest Energy Answer

High Flow Method
Pressure and Weir flow
Submerged Inlet Cd =
Submerged Inlet + Outlet Cd =.8006408
Max Low Cord = 612

Additional Bridge Parameters
Add Friction component to Momentum
Do not add Weight component to Momentum
Class B flow critical depth computations use critical depth inside the bridge at the upstream end
Criteria to check for pressure flow = Upstream energy grade line

CROSS SECTION

RIVER: RIVER-1
REACH: Reach-1 RS: 69269

INPUT
Description: DS FACE ROCKSIDE RD BRIDGE

BRIDGE
CENTERLINE AT STA 693+01

Station Elevation Data num= 52

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
1870	630	2074	627.5	2129	626	2329	626	2454	628
2542	630	2606	630	2634	620	2652	610	2666	602
2712	602	2723	604	2725	604	2744	604	2759	610
2784	620	2806	630	2885	630	2939	628	3002	626
3074	624	3102	620	3124	610	3146	600	3192	598
3206	590	3274	589.5	3344	590	3358	596	3418	598
3432	600	3458	610	3467	614	3654	614	3667	610
3684	600	3689	598	3724	598	3729	600	3754	610
3762	612	4074	612	4150	614	4220	616	4264	618
4326	620	4370	622	4414	624	4454	626	4496	628
4534	630	4574	632						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
1870	.04	3146	.035	3432	.04

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
3146	3432	276	276	.3	.5

Ineffective Flow num= 1

Sta L	Sta R	Elev	Permanent
3664	4574	608	F

CROSS SECTION

RIVER: RIVER-1
REACH: Reach-1 RS: 68993

INPUT
Description: This is a repeated section

BRIDGE CENTERLINE AT
STA. 689+79

Station Elevation Data num= 52

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
1420	637.8	1590	618	1620	617.8	1640	615.6	1670	615.4
1680	613.9	1810	611	1910	611	1920	611	2030	611
2150	612	2170	612	2270	612	2340	602	2590	600
2665	599.5	2725	600	2865	602	2948	604	2988	604
3022	604	3145	602	3395	602	3442	604	3478	606
3499	604	3504	600	3508	598	3530	590	3580	589.5
3628	590	3644	598	3674	608	3712	606	3745	604
3974	603	4083	602	4187	602	4260	600	4272	599
4285	600	4325	602	4350	604	4400	606	4444	608
4510	610	4584	612	4761	614	4778	616	4810	618
4849	620	4887	622						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val

1420	.04	3478	.035	3674	.04

Bank Sta: Left 3478 Right 3674 Lengths: Left Channel 122 Right 122 Coeff Contr. .3 Expan. .5

Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
1680	2915	612	F
3145	3355	612	F

BRIDGE

RIVER: RIVER-1
REACH: Reach-1 RS: 68979.5

INPUT
Description: Bridge #9

Distance from Upstream XS = .1
Deck/Roadway Width = 26.7
Weir Coefficient = 2.6

Upstream Deck/Roadway Coordinates num= 12

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
3395	602	602	3442	604	602	3465	606	604
3493.5	608	603.8	3495	608	603.8	3527	610	605.8
3580	611	606.8	3606	610	605.8	3665.5	608	603.5
3674	608	608	3705	606	606	3744	604	604

Upstream Bridge Cross Section Data
Station Elevation Data num= 52

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
1420	637.8	1590	618	1620	617.8	1640	615.6	1670	615.4
1680	613.9	1810	611	1910	611	1920	611	2030	611
2150	612	2170	612	2270	612	2340	602	2590	600
2665	599.5	2725	600	2865	602	2948	604	2988	604
3022	604	3145	602	3395	602	3442	604	3478	606
3499	604	3504	600	3508	598	3530	590	3580	589.5
3628	590	3644	598	3674	608	3712	606	3745	604
3974	603	4083	602	4187	602	4260	600	4272	599
4285	600	4325	602	4350	604	4400	606	4444	608
4510	610	4584	612	4761	614	4778	616	4810	618
4849	620	4887	622						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
1420	.04	3478	.035	3674	.04

Bank Sta: Left 3478 Right 3674 Coeff Contr. .3 Expan. .5

Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
1680	2915	612	F
3145	3355	612	F

Downstream Deck/Roadway Coordinates num= 12

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
3395	602	602	3442	604	602	3465	606	604
3493.5	608	603.8	3495	608	603.8	3527	610	605.8
3580	611	606.8	3606	610	605.8	3665.5	608	603.5
3674	608	608	3705	606	606	3744	604	604

Downstream Bridge Cross Section Data
Station Elevation Data num= 52

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
1420	637.8	1590	618	1620	617.8	1640	615.6	1670	615.4
1680	613.9	1810	611	1910	611	1920	611	2030	611
2150	612	2170	612	2270	612	2340	602	2590	600
2665	599.5	2725	600	2865	602	2948	604	2988	604
3022	604	3145	602	3395	602	3442	604	3478	606
3499	604	3504	600	3508	598	3530	590	3580	589.5
3628	590	3644	598	3674	608	3712	606	3745	604
3974	603	4083	602	4187	602	4260	600	4272	599
4285	600	4325	602	4350	604	4400	606	4444	608
4510	610	4584	612	4761	614	4778	616	4810	618
4849	620	4887	622						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
1420	.04	3478	.035	3674	.04

Bank Sta: Left	Right	Coeff Contr.	Expan.
3478	3674	.3	.5

Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
1680	2915	612	F
3145	3245	612	F

Upstream Embankment side slope = 0 horiz. to 1.0 vertical
Downstream Embankment side slope = 0 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow = .95
Elevation at which weir flow begins = 608.5
Energy head used in spillway design =
Spillway height used in design =
Weir crest shape = Broad Crested

Number of Piers = 1

Pier Data
Pier Station Upstream= 3580 Downstream= 3580
Upstream num= 2

Width	Elev	Width	Elev
3	582.4	3	606.8

Downstream num= 2

Width	Elev	Width	Elev
3	582.4	3	606.8

Number of Bridge Coefficient Sets = 1

Low Flow Methods and Data
Energy
Yarnell KVal = 1.25
Selected Low Flow Methods = Highest Energy Answer

High Flow Method
Pressure and Weir flow
Submerged Inlet Cd =
Submerged Inlet + Outlet Cd =.8006408
Max Low Cord = 606.7

Additional Bridge Parameters
Add Friction component to Momentum
Do not add Weight component to Momentum
Class B flow critical depth computations use critical depth
inside the bridge at the upstream end

Criteria to check for pressure flow = Upstream energy grade line

CROSS SECTION

RIVER: RIVER-1
REACH: Reach-1 RS: 68966

INPUT
Description: DS FACE OLD ROCKSIDE RD BRIDGE

BRIDGE
CENTERLINE AT STA. 689+79

Station Elevation Data num= 52

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
1420	637.8	1590	618	1620	617.8	1640	615.6	1670	615.4
1680	613.9	1810	611	1910	611	1920	611	2030	611
2150	612	2170	612	2270	612	2340	602	2590	600
2665	599.5	2725	600	2865	602	2948	604	2988	604
3022	604	3145	602	3395	602	3442	604	3478	606
3499	604	3504	600	3508	598	3530	590	3580	589.5
3628	590	3644	598	3674	608	3712	606	3745	604
3974	603	4083	602	4187	602	4260	600	4272	599
4285	600	4325	602	4350	604	4400	606	4444	608
4510	610	4584	612	4761	614	4778	616	4810	618
4849	620	4887	622						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
1420	.04	3478	.035	3674	.04

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
3478	3674	122	122	.3	.5

Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
1680	2915	612	F
3145	3245	612	F

CROSS SECTION

RIVER: RIVER-1
REACH: Reach-1 RS: 68844

INPUT
Description:

DEC
90 HWM = 605.3 @ STA. 685+96

Station Elevation Data num= 78

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
1290	639.2	1300	638	1310	637.9	1420	635	1520	628.4
1560	620.5	1580	614	1690	612.3	1800	612	1810	612
1900	612	1910	612	1950	612	2000	612	2110	612
2180	612	2270	612	2370	612	2460	612	2570	612

2590	612	2660	612	2770	612	2880	612	2990	603.5
3040	603.7	3050	603.5	3060	604	3170	604	3270	604
3380	602.6	3420	602	3430	598.9	3440	593.7	3450	590
3458	586.7	3478	582	3593	582	3595	586.7	3600	590
3610	593.3	3620	598.3	3630	600.2	3690	601.9	3730	602.1
3800	605.1	3910	605.1	4020	605.1	4050	605.1	4350	605.1
4390	608	4500	611	4610	612.6	4720	615.1	4830	619.3
4860	620	4870	619.9	4878	619.9	4890	619.8	4900	619.5
4940	616	4970	621.5	4990	622	5000	622	5010	621.6
5030	622	5050	622	5080	620.5	5090	620.9	5110	620.3
5120	620.3	5130	620.1	5140	620.1	5150	620.2	5160	620
5270	628	5350	636	5390	646.8				

Manning's n Values num= 5

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
1290	.15	1800	.06	3420	.04	3630	.06	4500	.15

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
3420	3630	300	315	315	.2 .4

CROSS SECTION

RIVER: RIVER-1
REACH: Reach-1 RS: 68529

INPUT
Description:

SURVEYED SECTION #25

Station Elevation Data num= 79

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
1370	648.1	1380	648.3	1410	648.3	1460	645.2	1470	645.1
1490	645.5	1500	644.7	1610	618.1	1620	616.2	1710	612
1720	612	1730	612	1840	612	1900	612	1910	612
2800	612	2820	604	2930	602.8	2990	601.9	3000	599.3
3030	598.2	3070	598.2	3130	597.4	3240	596.9	3310	596.6
3320	596.7	3330	595.9	3360	596.7	3370	595.9	3390	596.7
3400	596.7	3450	596	3480	596	3490	592.8	3508	587.7
3528	580.7	3548	581.7	3568	581.2	3588	582.7	3590	582.2
3595	581.9	3615	587.7	3620	590.4	3630	596.7	3640	600.1
3750	602.5	3810	604	3990	604	4100	604	4160	604
4210	604	4300	605.9	4340	612	4360	612	4440	612
4510	612	4520	612	4550	612	4580	612	4830	612
4940	612	5042	612	5060	612	5160	613.7	5180	616
5290	618	5330	618	5350	618.5	5360	616.5	5400	616.4
5410	616.1	5420	617.5	5430	621.8	5460	623	5490	620.3
5500	621.4	5550	630.6	5660	672.6	5732	695.7		

Manning's n Values num= 5

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
1370	.15	3450	.06	3480	.04	3630	.06	4300	.15

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
3480	3630	0	0	0	.2 .4

Exhibit 3 - Bridge Scour Calculations

Scour Calculations

Contraction Scour

Avg. D50= 0.46 mm From field inspection visit

Determine if live bed scour occurs (V > Vc)

$$V_c = 11.17 \cdot \left(y_1\right)^{\frac{1}{6}} \cdot \left(D_{50}\right)^{\frac{1}{3}}$$

EVENT	AREA (chnl)	TOP W (chnl)	AVG DEPTH	D50 (ft)	Vc	V (Vch)	**TRANSP. MODE**
100-Year	3447.5	190.0	18.1	0.00151	2.1	2.4	**Live Bed**
500-Year	3886.9	212.0	18.3	0.00151	2.1	2.6	**Live Bed**

If Vc < V, use Laursen's Live-Bed contraction scour
If Vc > V, use Laursen's Clear-Water contraction scour

Area, Top width, and Velocity are taken at the upstream main channel

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Fall Velocity Chart, used for Live Bed Calculation

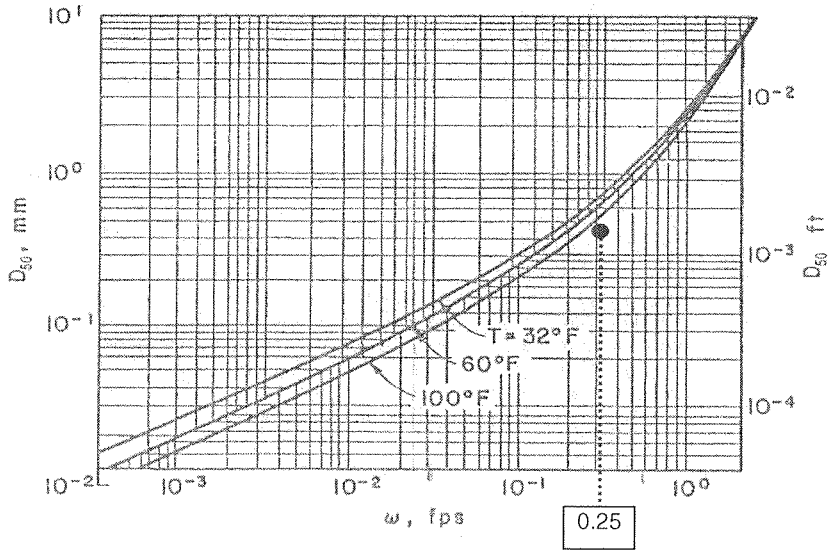

Figure 6-4 Fall Velocity of Sand-Sized Particles

LIVE BED CONTRACTION SCOUR

$$y_s = \left[\left(\frac{Q_2}{Q_1} \right)^{\frac{6}{7}} \cdot \left(\frac{W_1}{W_2} \right)^{k_1} \cdot y_1 \right] - y_1$$

(HEC 18 {2001} Eqns. 5.2; 5.3, Page 5.10)

First Solve for k1:

V_* = shear velocity $\left(g \cdot y_1 \cdot S_1\right)^{0.5}$

w = fall velocity(ft/s) at 20° C, from Fig. 5.8, Page 5.12 (HEC-18, {2001})

g = gravity acceleration constant

S1 = slope energy grade line of main channel

V_*/w = ratio shear velocity to fall velocity for k1

V_*/w < 0.5	k1 = 0.59
0.5 <= V_*/w <= 2.0	k1 = 0.64
2.0 < V_*/w	k1 = 0.69

EVENT	g (ft/s^2)	Y1 (ft)	S1 (ft/ft)	V_* (ft/s)	w (ft/s)	**k1**
100-Year	32.2	18.1	0.000168	0.313	0.25	**0.64**
500-Year	32.2	18.3	0.000163	0.310	0.25	**0.64**

Y1 = Avg. depth of the main channel

W1 = Top width (ft) of the upstream main channel

W2 = Top width (ft) of the contracted (bridge) section

Q1 = flow (cfs) in the upstream main channel (sediment)

Q2 = flow (cfs) in the contracted channel

EVENT	Q2 (Qch)	Q1 (Qch)	W1 (top w ch)	W2 (top w ch)	Y1	K1	**Ys (ft)**
100-Year	10480	8306	190.0	212.0	18.1	0.64	**2.5**
500-Year	7817	9973	190.0	212.0	18.3	0.64	**0.0**

LOCAL SCOUR - ABUTMENTS - 100 YEAR

Froelich's live-bed scour equation: $Y_s/Y_a = (2.27*k1*k2(L'/Y_a)^{.43})*(Fr)^{0.61} + 1$

Q_e = flow obstructed by approach embankment and abutment, (cfs)
A_e = flow area (ft^2) obstructed by embankment
$V_e = Q_e/A_e$, ft/sec
Y_a = average depth (ft) of floodplain flow at the abutment (Area/Top Width)

EVENT	Q_e (left)	A_e (left)	V_e (left)	Y_a (left)	Q_e (right)	A_e (right)	V_e (right)	Y_a (right)
100-year	600.0	300.0	2.00	3.0	2549.0	1055.0	2.42	1.6
	Left Top Width (ft) = {effective length}		100.00		Right Top Width (ft) = {effective length}		680.5	

EVENT	Fr (left)	Fr (right)
100-year	0.2035	0.3425

$$Fr = \frac{Ve}{\sqrt{g \cdot y_a}}$$

Embankment angle = 90 (Angle of embankment to flow)

(coefficient of abutment shape) k1 = 1.00

Vertical wall abut. k1=1.00
Vertical wall abut. w/wingwalls k1=0.82
Spill-through abut. k1=0.55

Coefficent for angle of embankment to flow
k2 (Right)= 1.00
k2 (Left)= 1.00

EVENT	RT/LT	k1	k2	L'	Y_a	Fr	**Y_s**
100-year	LEFT	1.00	1.00	10.0	3.0	0.2035	**7.3**
100-Year	RIGHT	1.00	1.00	10.0	1.6	0.3425	**5.6**

L' = length (ft) of abutment projected normal to flow
Y_s = Scour depth (ft)

LOCAL SCOUR - ABUTMENTS - 500 YEAR

Froelich's live-bed scour equation: $Y_s/Y_a = (2.27*k1*k2(L'/Y_a)^{.43})*(Fr)^{0.61} + 1$

Q_e = flow obstructed by approach embankment and abutment, (cfs)
A_e = flow area (ft^2) obstructed by embankment
$V_e = Q_e/A_e$, ft/sec
Y_a = average depth (ft) of floodplain flow at the abutment (Area/Top Width)

EVENT	Q_e (left)	A_e (left)	V_e (left)	Y_a (left)	Q_e (right)	A_e (right)	V_e (right)	Y_a (right)
500-year	900.0	300.0	3.00	3.0	2549.0	1055.0	2.42	1.6
	Left Top Width (ft) = {effective length}		100.00		Right Top Width (ft) = {effective length}		680.5	

EVENT	Fr (left)	Fr (right)
500-year	0.3052	0.3425

$$Fr = \frac{Ve}{\sqrt{g \cdot y_a}}$$

Embankment angle = 90 (Angle of embankment to flow)

(coefficient of abutment shape) k1 = 1.00

Vertical wall abut. k1=1.00
Vertical wall abut. w/wingwalls k1=0.82
Spill-through abut. k1=0.55

Coefficent for angle of embankment to flow: k2 (Right)= 1.00, k2 (Left)= 1.00

EVENT	RT/LT	k1	k2	L'	Y_a	Fr	**Y_s**
500-year	LEFT	1.00	1.00	10.0	3.0	0.3052	**8.5**
500-Year	RIGHT	1.00	1.00	10.0	1.6	0.3425	**5.6**

L' = length (ft) of abutment projected normal to flow
Y_s = Scour depth (ft)