Hydrologic and Geomorphic Evaluation & Alternatives Analysis

For Stream Rehabilitation for East Valley Reservoir Tributary Alluvial Fan on Jordan Creek, Juneau, Alaska

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Abstract

The East Valley Reservoir (EVR) Tributary to Jordan Creek is located in the Mendenhall Valley, Juneau, Alaska. The EVR Tributary flows from Thunder Mountain forming an alluvial fan through a lower gradient reach along the lower 800 ft of the tributary. Sediment deposition forming the fan has encroached into the Jordan Creek flood plain and stream channel. The alluvial fan has created a sediment wedge and plume along 640 ft of Jordan Creek that has raised the stream bed by up to 2 to 2.5 ft and pushed the stream towards the west bank. This stream bed aggradation has increased upstream water surface elevations. Stream channel and flood plain habitats have been covered by sediment deposits. This study investigated site conditions to understand the stream processes along the EVR Tributary and Jordan Creek. Discussions were conducted with project stakeholders, CBJ maintenance staff and the landowner immediately affected by the fan to further understand conditions at the project site and identify goals for addressing the site conditions. An alternatives analysis was conducted to develop conceptual remedies for restoring flood conveyance and enhancing aquatic/riparian habitats along Jordan Creek; and, to slow the rate of sediment delivery from the EVR Tributary and the growth of the fan.

Introduction

This study investigates the cause of sediment deposition forming an alluvial fan at the mouth of the East Valley Reservoir (EVR) Tributary. Growth of the fan has encroached into the Jordan Creek flood plain and channel; raising the stream bed elevation, negatively impacting aquatic and riparian habitats and upstream flood elevations. Along the west bank of Jordan Creek is a residential area which is at risk of flooding from continued growth of the fan. Alternative remedies to limit flood risk and remediate aquatic and riparian habitats were developed to a conceptual level.

The project site is located in the Mendenhall Valley, approximately 8.5-miles north of downtown Juneau. The East Valley Reservoir water tank is accessed via Amalga Street. The EVR Tributary flows into Jordan Creek immediately upstream of the Jennifer Drive foot bridge. The project location is shown on Sheet 1.

This Study is funded by a grant to the Juneau Watershed Partnership (JWP) from the Alaska Department of Environmental Conservation (Alaska DEC). JWP has contracted Inter-Fluve, Inc. (Inter-Fluve) to conduct the study. In addition to JWP and Alaska DEC, stakeholders include the City and Borough of Juneau (CBJ), U.S. Fish and Wildlife Service (USFWS) and the U.S. Geologic Survey (USGS). Representatives from these stakeholders have been invited to participate in the development of the study and have provided valuable input and comment. University of Alaska Southeast (UAS) has donated use of lab equipment for analyzing stream bed sediment samples. During field investigations, the Landowner at the fan was met with to discuss the stream conditions and possible remedies. The local residents were invited to a public presentation of this study.

Background

The East Valley Reservoir is a 2.0 million gallon water tank constructed by CBJ in 1985 on the flank of Thunder Mountain. An access road was constructed to the tank from the end of Amalga Drive. Near the water tank, the access road runs along the right (looking downstream) bank of the tributary and crosses at two locations. Each crossing is comprised of two large culverts. A gravel berm extends upstream beyond the upper crossing along the right bank. Prior to construction of the access road and berm, the EVR Tributary had access to spill flood flows onto a fan surface roughly 15 to 20 acres in size (based on approximate measurements from GPS waypoints, topographic mapping and aerial imagery). An unintended consequence of the access road and gravel berm along the north edge of the stream is channelized flow and sediments discharging below the lower access road to a smaller fan area approximately 4.5-acres in size. An apparent result is an increase in the rate of growth of the fan surface and outward extents.

According to CBJ Water Department staff (D. Crabtree, personal communication, January 2008), three sediment traps above and one trap below the lower access road were operated until a flood in the fall of 1995 blocked the culverts causing tributary flow to spill on to the fan surface and run through Coho Apartments. CBJ maintenance crews spent that night bailing sediment from the tributary to control flood conditions. Following the flood, larger HDPE culverts were installed which have been effective in passing stream sediments past the crossings. Following the new culvert installations, the sediment traps were no longer actively maintained.

Approximately 280 lineal feet of the east flood plain of Jordan Creek is entirely covered by sediments deposited by the EVR Tributary fan. Sediment deposition into the Jordan Creek stream bed has caused the channel bed to aggrade to a depth of up to 2 to 2.5 feet and pushed the active channel towards residences along the west side of the creek. This channel aggradation has caused an increase in upstream flood elevations as demonstrated in the hydraulic modeling discussed later.

Purpose and Scope

The purpose of this study is twofold. The first component is to investigate the EVR Tributary and Jordan Creek hydrology, hydraulics, geomorphology and sediment transport to determine the cause of sediment deposition. The second component is development of alternative remedies to a conceptual level to reduce flood elevations and enhance aquatic and riparian habitats along Jordan Creek; and, to slow the rate of growth of the EVR Tributary fan. Project Stakeholders were actively involved in this process to identify goals for the study and discuss potential remedies. The study investigates potential remedies and their respective pros, cons, feasibility and planning level construction costs. A recommendation is made for an alternative which best meets the project goals. Through active participation in this study and discussion, the stakeholders have selected a preferred alternative for design and construction during a later phase of the project.

Project Goals

Through discussion with Stakeholders, a number of goals for the project were identified. These include:

- Reduce impacts to Jordan Creek flooding locally and upstream of the fan.
- The remedy should account for and be sensitive to stream geomorphic and environmental conditions of Jordan Creek by working with and addressing natural stream processes.
- The remedy should enhance aquatic and riparian habitats.
- The remedy is a sustainable solution to the degree possible.
- The remedy is cost effective and constructible.

Existing information

Existing information for Jordan Creek and the EVR Tributary includes:

The report *Baseline Characteristics of Jordan Creek, Juneau, Alaska* was prepared by the USGS (Host and Neal, 2004). This report describes the climatic and physical setting of Jordan Creek, summarizes flow and water quality conditions. Of particular value to the current study is physical characteristics of Jordan Creek USGS study reaches including near Nancy Street and Thunder Mountain Park. These two reaches are respectively below and above the EVR Tributary fan and provide valuable reference reach information for Jordan Creek cross sections and stream profiles.

The report *Hydrology and Flood Profiles of Duck Creek and Jordan Creek Downstream from Egan Drive, Juneau, Alaska* was prepared by the USGS (Curran, 2006). This report is the most current hydrologic and hydraulic analyses along Duck and Jordan Creeks. These analyses were conducted to help CBJ update flood plain maps. Of particular value to the current study is the updated flood flow hydrology along Jordan Creek at the USGS study's upstream limit near Egan Drive. The flows estimated by USGS were interpolated to the project location using a ratio of drainage area tributary to the two locations.

Topographic survey of the EVR Tributary and areas surrounding the reservoir tank were collected by R&M Engineering (R&M) in 2005. The survey includes topography in the vicinity of the tank with stream profile and cross section data collected along the EVR Tributary to the confluence with Jordan Creek. Inter-Fluve identified additional survey needs along Jordan Creek for this study. That data was collected by R&M in late November 2007. This survey data was used as the basis for conceptual drawings. R&M survey mapping is included in Appendix 1.

GIS and aerial imagery were provided by JWP. Aerial photographs, provided by JWP, from 1962 and 1984 cover the Jordan Creek watershed. These photographs are not spatially registered. ADF&G provided various GIS layers for Jordan Creek including a shapefile delineating the 4.2 sq. mi. Jordan Creek watershed, five lakes within the Jordan Creek watershed, a stream line of the mainstem Jordan Creek delineated into reaches with surveyed habitat information including bed substrate and bank vegetation, unsurveyed stream lines of the tributaries and the mainstem below the airport, and GPS points of features, photo locations and fish observations along Jordan Creek.

Geology maps of the Mendenhall Valley were prepared by Barnwell and Boning (1968) and Miller (1975). These maps show surficial geology of the valley and the historic limits of the Mendenhall Glacier. From these maps, Jordan Creek lies within colluvial deposits (materials delivered by hillslope processes – e.g. landslides and talus slopes) and abandoned outwash channel deposits (e.g. relic of Mendenhall Glacier retreat).

FEMA flood plain boundaries exist for Jordan Creek at the project site. Existing FEMA information is documented in the Flood Insurance Study (FEMA, 1980) and Flood Insurance Rate Map (FIRM, FEMA, 1990). Jordan Creek is listed as Zone A1 on the FIRM. Note that flood flows as updated by the USGS (Curran 2006) were used in this study.

Field work

On November 6, 2007 Inter-Fluve staff conducted field observations focused on stream processes along the EVR Tributary and Jordan Creek in the vicinity of the fan. In addition, Jordan Creek conditions near Thunder Mountain Park and Nancy Street were viewed on November 5, 2007. Field notes of observations, GPS waypoints (Appendix 5) and digital photographs (log and contact sheet Appendix 6) were collected during field investigations. Electronic copies of digital photograph files are submitted to JWP on CD.

Three soils pits were excavated in the fan by SOURCE, LLC at locations identified by Inter-Fluve. Generally, the pits had consistent size material through the depth and exhibited layering at 12 to 18 inch thicknesses between zones of roots, organic matter or other discernable features. Following general notes of the soil profile and photos, the pits were back filled and the site restored to its original contour. Samples were collected from the stock pile of materials excavated from soil pits 1 and 2. The sample from soil pit 1 was lost during site restoration. Details of each soil pit follows:

- Soil pit 1 was excavated in the fan 10 ft to the right (looking downstream) of the EVR Tributary channel to a depth of 6.5 ft below grade (BG) at GPS waypoint 229 approximately 625 ft upstream of Jordan Creek. Soil pit 1 had a layer of small roots at 1.25 ft BG; tree roots 2 to 2.8 ft BG; and, a thin layer of duff and sticks at 4.5 ft BG. No water was observed in the pit which was open for about 20 minutes.
- Soil pit 2 was excavated in the fan approximately 85 ft to the left of the EVR Tributary channel to a depth of 7.0 ft BG at GPS waypoint 230 approximately 355 ft upstream of Jordan Creek. Soil pit 2 had a layer of fine roots at 0.7 ft BG; medium sized roots at 1.7 ft BG; the main root layer was at 4.0 ft BG and a silt layer at 6.5 ft BG. Water was first noticed at 6.5 ft BG and rose to 6.0 ft BG during the 20 minutes that the pit was open.
- Soil pit 3 was excavated in the marshy zone near the base of the fan near the active channel to a depth of 6.0 ft BG at GPS waypoint 231 approximately 150 ft upstream of Jordan Creek. Soil pit 3 had a layer of roots at 0.9 ft BG; an iron layer at 2.2 to 2.7 ft BG. Water was intercepted at about 3.0 ft BG. The

equipment operator, Dave Hanna, said the materials excavated below water portion of the pit felt similar through the depth of the pit with the exception of a firmer layer at 3.5 ft BG. The water level continued to rise while the pit was open. Adjacent areas were wet suggesting the water table was at or near the land surface.

Nine sediment samples were collected from the EVR Tributary channel, Jordan Creek channel and soil pit 2 in the fan. Samples were collected by hand, placed in a one gallon zip lock bag, labeled, the location photographed, noted and GPS waypoint recorded. Samples were delivered to JWP for sieve analysis by JWP staff using equipment provided by UAS. Results of the sieve analysis are included in Appendix 4. Discussion of sediment samples is included in the Sediment Transport section later in this report.

Additional survey data of Jordan Creek through the fan area was requested by Inter-Fluve for hydraulic modeling. These data were collected under separate contract by R&M Engineering. The R&M survey includes channel cross sections and profile of the stream thalweg (lowest point in cross section). R&M survey mapping is included in Appendix 1. The Jordan Creek thalweg profile summarized on Sheet 3 clearly shows sediment deposition forming a wedge in the profile up 2 to 2.5 feet thick in the area of the fan and a sediment plume extending downstream about 150 yards. This sediment wedge has caused ponding upstream with higher water surface elevations. Along the stream thalweg profile, the upstream ponded area channel bottom is less clearly defined due to difficult access from water depth and bed sediments.

Interviews:

CBJ Water Department maintenance staff was interviewed about past maintenance performed on the EVR Tributary and sedimentation traps (D. Crabtree, personal communication, January 2008). From this recounting, three sediment traps were located immediately upstream from the lower access road crossing; a fourth was located immediately downstream of the crossing. The traps were inline ponds with dimensions of roughly 20 ft by 20 ft by maximum depth of 6 ft. These traps were generally full of sediment and cleaned by excavation on an annual basis. A flood in 1995 was reported to have blocked the access road culverts causing the flow along the EVR Tributary to overflow its banks, flow through the forest and the Coho Park Apartments. CBJ maintenance crews responding to flooding reports discovered that the EVR access road culverts were plugged and spent the night bailing debris to keep the culverts open and limit flood damage. The primary stockpile described from that nights maintenance work was roughly 175 ft long by 12 ft high by 30 ft wide at the base, or slightly more than 1,000 cubic yards of material. Following this flood, the culverts were changed to a larger size and a smoother (HDPE) material to pass sediment. Following culvert work, sediment did not build up at the culverts and maintenance of the sediment traps was not continued.

Louie Rogers has lived immediately opposite the fan for nearly eleven years. Mr. Rogers recounted that the stream channel has migrated upwards of 10 ft towards the west bank. He also recalled that the pond level upstream of the fan has increased between two and three feet based on his observations of a timber retaining wall along the bank. (L. Rogers, personal communication, November, 2007; February 2008).

Dave Hanna recounted his observations that the EVR Tributary has head cut along a reach from below the lower crossing to about 70 yards upstream of the upper crossing. This head cut has lowered the stream bed and eroded the stream banks. Using the 2005 R&M survey and observations, Dave estimates that approximately 5,000-cy of material has eroded from the channel from below the lower crossing to above the upper crossing (Dave Hanna letter to Mendenhall Watershed Partnership, undated). Dave is concerned that continued bank erosion is entraining gravels, including those placed into the berm above the upper crossing, into the tributary system. While the portion of this eroded material which contributes to total deposition within the fan is not known, this eroded volume could be significant and warrants considering erosion protection along the EVR Tributary. In discussion on thoughts for remedies, Dave suggested considering an overflow option to disperse some of the flow and sediment during flooding onto the fan in areas near the upper access road crossing and agreed that impacts to downstream properties needs to be considered. Dave suggested that remedies should remove sufficient amount of sediment including fine material that contributes to degradation of Jordan Creek habitats and suggested considering settling ponds, wide meandering channels below the lower crossing to improve water quality. He also mentioned that the non-profit group Trail Mix has proposed construction of a trail through the forested portion of the fan parallel and just uphill from Jordan Creek. The trail would be a maintainable bike path which could be constructed as an elevated embankment. The trail embankment located along a contour with a number of flow conveyance points may provide a valuable opportunity to pool EVR Tributary flows in order to deposit sediments and improve the water quality of flows entering Jordan Creek (D. Hanna personal communication February 4, 2008).

Site Characterization

In order to develop a sustainable and appropriate remedy, an understanding of stream processes along the EVR Tributary and Jordan Creek are necessary. The following discussion is based on observations, interviews, existing data and conceptual level analysis.

Geomorphic conditions

EVR Tributary and fan

The EVR Tributary is a steep gradient channel discharging from Thunder Mountain. The R&M survey includes channel profile data which shows the tributary exiting Thunder Mountain at approximately 12 percent slope to the location of the lower crossing. From the lower crossing to Jordan Creek the EVR Tributary channel has a lower gradient, averaging 4.4 percent through the forested area and further reducing to 3.3 percent as it approaches Jordan Creek. EVR Tributary profile plots are included in Appendix 2. As the gradient decreases, the tributary flow loses energy and sediments deposit. This creates an alluvial fan. Under current conditions, the upstream end of active sediment deposition in the channel and fan area is evident approximately 650 ft below the lower access road and 800 ft upstream of Jordan Creek. The depth and lateral extent of recent deposition continually increases as the tributary approaches Jordan Creek. Stream flows infiltrate into the fan sediments with the channel completely dewatered about 200 ft upstream of Jordan Creek during the field investigation. Flow was seen to reemerge along a broad front about 130 ft upstream of Jordan Creek as the fan progressed into a marshy area with broad areas of sediment deposition and an undefined network of channels before entering Jordan Creek and floodplain

By their nature, alluvial fans grow as sediments deposit along the fan surface, the channel fills, loses capacity and changes course to a lower topographic area. Over a long period of time, the channel will move across the face of the fan, bounded by the valley walls, raising the elevation of the fan surface and extending the distal end outward. This is a continual process with growth dependent on flood conditions. From the available information and site observations it is likely the area of fan accessible to the EVR Tributary flow and sediment was reduced through containment by the access road and upstream berm. Since the delivery of sediment and flow from Thunder Mountain has likely remained unchanged but the available fan area has decreased, the rate of depositional depth and outward encroachment of the distal end of the fan would increase.

Sediment deposition is actively encroaching into Jordan Creek. In considering remedies for Jordan Creek, it will be necessary to manage the sediments delivered by the EVR Tributary to slow the rate of growth of the active fan. Management options include source control and interception by trapping.

Sources of sediment include hill slope processes upstream from the reservoir and local erosion along the tributary. Hill slope processes deliver sediment to the tributary where the steep gradient is capable of delivering sediments downstream. Local erosion of the stream channel is another potential source of sediment, including the reach near the water tank that has been estimated at approximately 5,000 c.y. of material (D. Hanna). The relative amounts of sediment delivered by upstream hill slope processes and local stream erosion is not known. The volume and size of sediment delivered by various flow and flood events is not known. In considering erosion control of sediment sources, upstream hill slope processes happen on a scale too large to effectively control at the source and management would need to rely on interception. Local erosion might be controlled at the source through bank and bed hardening and by interception. The cost of stream bed and bank erosion control along the head cut reach versus the benefit from a sediment management standpoint is uncertain at this time. The rate of erosion along the tributary near the EVR tank can only be known with certainty through monitoring or comparison of current to historic survey data. If local erosion proves to be a small percentage of the overall sediment delivered by the tributary stream then the cost to implement bed and bank erosion protection may not be warranted. If it proves to be an actively eroding stream reach and a significant source of sediment, then the cost to implement erosion protection may be warranted. This would lend itself to a monitoring program with erosion protection implemented as a second phase of construction if necessary.

Sediment interception by trapping will prevent some percentage of transported sediments from reaching Jordan Creek and accumulating. Sediment trapping is achieved by providing an area along the stream where flow energy is reduced causing sediment to deposit into a volume where it is stored and periodically removed. The size and volume of sediment delivered by floods is not known and are important trap design factors. Coarser sediments are more effectively trapped than finer materials. Sediments sufficiently small are expected to pass through the trap. As the trap fills and the available volume decreases, the trapping efficiency decreases. Monitoring and routine removal of sediment from the trap will be necessary. Additional discussion of a sediment trap is included in Alternative 4.

Jordan Creek

Physical conditions of Jordan Creek are well documented in the USGS report Baseline Characteristics of Jordan Creek, Juneau, Alaska (Host and Neal, 2004). This report is recommended reading. Jordan Creek reaches near Thunder Mountain Park and Nancy Street are included in the USGS report. These reaches are upstream and downstream, respectively, of this project and have similar characteristics of stream bed, bank and channel slope. Jordan Creek has an average slope of about 0.002-ft/ft slope regionally (USGS, 2004) and 0.0017 ft/ft locally below the fan (R&M survey). Data collected by the USGS along these reaches were used as reference conditions for the channel rehabilitation. In summary, Jordan Creek is a single thread meandering channel with average slope of 0.002 ft/ft and typical section 20 to 25 ft wide and bank full depth of 1.5 to 2 ft deep.

A number of anecdotal accountings recall that Jordan Creek had been a gravel bedded stream in the mid 1900's. During field investigations, Jordan Creek was observed to be predominately a sand to silt bedded stream near Thunder Mountain Park, Jennifer Drive below the EVR Tributary fan and at Nancy Street. USGS staff' observations along Jordan Creek indicate the stream is now predominately sand or silt bedded (E. Neal, personal communication). The cause for this change in stream regime is uncertain and assessment is beyond the scope of this study. Discussions of potential contributing factors included isostatic rebound; changes in tidal elevations; changes in land use/sediment budgets; and, changes in Jordan Creek stream hydrology including possible loss of glacial outwash flows as the Mendenhall Glacier has retreated.

The EVR Tributary channel and fan enter Jordan Creek approximately 150 feet upstream of the Jennifer Drive footbridge. Sediment deposition in the alluvial fan has created a sediment wedge within Jordan Creek. In addition, encroachment of the fan has pushed the Jordan Creek channel toward the west; well established riparian vegetation appears to be effective at limiting bank erosion. This sediment wedge has aggraded (raised) the stream bed by up to 2 to 2.5 feet (as shown on Sheet 3) causing upstream ponding with increased upstream water surface elevations. Jordan Creek is locally steeper at approximately 0.007 ft/ft through the fan portion of the sediment wedge which moves some sediment downstream forming a sediment plume downstream of the fan. The sediment plume portion of the sediment wedge has a stream gradient of about 0.005 ft/ft and extends about 150 yards downstream. Approximately 375 ft downstream of the fan, at XS-1 (as shown on Sheet 2) the channel has a sand bed and appears to be the downstream limit of the sediment plume.

Jordan Creek is unable to move the majority of sediments delivered by the EVR Tributary sufficiently to establish a stream channel similar in character to upstream and downstream reaches as documented by the USGS (2004). As a result of this transport limited condition, the channel bed becomes wide and shallow, unless channel width is confined by vegetation or structure such as large woody debris. A good example of this transport limited condition is 100 ft upstream of the Jennifer Drive foot bridge (Appendix 3.2: HEC-RAS cross section 7, Appendix 6: photo "IMG_0559.jpg") where the channel has a mid channel bar. One consequence of wide shallow channel conditions is degraded aquatic habitat.

Jordan Creek is not capable of passing sediments delivered from the EVR Tributary. Thus, in considering stream rehabilitation it will be necessary to physically remove sediments from the channel and flood plain and physically create an appropriate geomorphic form and aquatic/riparian habitats. To provide a sustainable solution to the degree possible it will be necessary to manage sediments along the EVR Tributary to slow or stop growth of the fan in order to limit the degree of alluvial fan encroachment into Jordan Creek.

Sediment Analysis

Existing conditions of sediment transport were evaluated through a suite of sediment samples collected from the stream bed, bars and soil pits. Nine samples were collected and analyzed. Collection of samples focused on mobile gravels and were taken from the bed and bars from upstream of the gravel berm above the upper access road crossing along the EVR Tributary and along Jordan Creek to the downstream limit of the apparent sediment plume. An additional sample was collected from the soil pit 2 stockpile. The samples were collected from the surface by hand, placed in a labeled gallon ziplock bag, location noted, photographed and GPS waypoint recorded. The samples were then delivered to JWP for analysis by JWP staff using equipment generously provided by University of Alaska Southeast (UAS). The samples were dried, weighed, passed through a stack of sieves with progressively smaller openings. The fractions of each sample retained on each sieve were weighed. The result was a grain size distribution (GSD) for each sample characterized by percent of material finer than a certain sieve size based on weight. Results of the sieve analyses are shown in Appendix 4.

From the plot in Appendix 4, there is definitive reduction in size of sediments sampled in the downstream direction. The soil pit sample is consistent in size with the adjacent stream samples. Some variation of sizes in the downstream direction is evident depending on whether the sample was taken from the bed (coarser) versus bars (finer). This downstream fining is evidence that larger size particles deposit as the slope reduces and that Jordan Creek is not capable of moving the size of sediment delivered by the EVR Tributary. Sediments delivered to Jordan Creek that are larger than Jordan Creek is able mobilize will deposit and remain in place. Progressive encroachment of sediments from the EVR Tributary will continue to aggrade (build up) the fan surface and Jordan Creek channel and flood plain.

Hydrology

Flood flows along Jordan Creek for the 2-, 5-, 10-, 25-, 50-, 100-, 200- and 500-year events were estimated by the USGS based on stream flow data and regional regression equations below Egan Drive (Curran, 2006). The 2- through 100-year event flows were used in the hydraulic modeling for this study. USGS flood flows for these events were interpolated to the project site through a flow reduction based on the ratio of drainage areas at the site and below Egan Drive. A summary of the flows at Egan Drive and estimates of flows at the project site follows.

Tr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Q(cfs) USGS DA = 2.6 sq. mi.	98.6	155	202	273	329	389
Q(cfs) project site DA = 2.3 sq. mi.	87	137	179	242	291	344

Hydraulic Conditions

EVR Tributary and fan

Hydraulic conditions were analyzed along the EVR Tributary at a number of sections between the lower crossing and Jordan Creek. These sections encompassed incised transport reaches, relatively intact channel and depositional sections as observed in the field. Given the relatively steep profile along the EVR Tributary each section was analyzed individually using normal depth, at-a-section methods. Cross sections and local profile were obtained from the R&M 2005 survey. The section was imported into WinXSPro for normal depth analysis. Flow depth, velocity and shear were generated for a range of flow depths. The output for each section was imported into Excel for plotting and summarization. The upstream section is incised and contains more flow than lower reaches where flow spreads onto the fan surface. Results of the hydraulic modeling along the EVR Tributary are summarized in Appendix 3.1.

Jordan Creek

Hydraulic conditions along Jordan Creek through the project reach were modeled at a conceptual level using the U.S. Army Corps of Engineers (USCOE) HEC-RAS River Analysis System version 3.1.3 for Jordan Creek. HEC-RAS is a one-dimensional open channel hydraulic model used in steady state for this analysis. Channel geometry is represented in the model by stream cross sections and distances between sections. The model was developed representing existing conditions based on November 2007 survey data collected by R&M at locations requested by Inter-Fluve. The locations of these model cross sections are shown on Sheet 2. It is important to note that these sections extend only partially across the flood plain and do not contain all of the flood flows. This is acceptable at the conceptual planning level phase. Detailed flood modeling is beyond the scope of this study and would require additional detail by extending the cross sections to contain flood flows. Channel and flood plain Manning's n roughness coefficients for channel and flood plain were estimated based on professional experience and judgment. Channel coefficients were assumed to be 0.033 to 0.038 for sand and fine gravel bedded streams obstructed by vegetation and minor-moderate degree of irregularity. Flood plain roughness coefficients were assumed to be 0.05 to 0.06 for vegetated conditions. The model was run in mixed mode to account for subcritical and possible super critical hydraulic conditions. Model boundary conditions were approximated as normal depth starting water elevations based on the slope of the surveyed profile at upstream and downstream ends of the model. Results of the hydraulic modeling along Jordan Creek are summarized in Appendix 3.2.

To illustrate the best estimate of pre-fan conditions along Jordan Creek, hydraulic modeling for Alternative 4 were generated from the existing conditions HEC-RAS parent model modified to represent conditions with a stream channel and flood plain exhumed from the fan. Using information in the USGS study of baseline characteristics for Jordan Creek, a typical reference channel is 20 to 25 ft wide by 1.5 to 2.0 ft deep with a slope of approximately 0.002 ft/ft. The conceptual design channel thalweg profile and channel/flood plain cross section are shown on Sheet 3 and essentially exhumes the Jordan Creek channel and flood plain from fan sediments. The results of this project conditions model were used to conceptually evaluate changes in flood water surface elevations, velocity and energy along the restored stream reach. This information will be valuable during the later design phase for design of stream stability, channel features and LWD fish habitats. Results of the hydraulic modeling for project conditions along Jordan Creek are summarized in Appendix 3.2.

Stream Channel rehabilitation and flood risk abatement

Alternatives

A number of alternatives were considered through discussion with Stakeholders and conceptual level analysis. Some alternatives are not considered feasible for various reasons but are included here for sake of discussion. A narrative of each alternative follows.

Alternative 1 – Do nothing

The Do Nothing Alternative provides a baseline of existing conditions. As described above the EVR Tributary is delivering sediment from uphill steeper gradient reaches which deposit along the lower gradient reach near the confluence with Jordan Creek. This alluvial fan is actively encroaching into the Jordan Creek flood plain and channel. Aggradation (raising) of the streambed and flood plain has increased upstream water surface elevations causing ponding upstream. Encroachment of the fan into the channel has pushed the channel towards the west. Fan growth is expected to continue, exacerbating these conditions. The rate of growth is dependent on sediment and flow on a flooding basis.

Pros:

- No in stream construction disturbance.

Cons:

- Stream bed aggradation and associated rise of flood water surface elevations is expected to continue from fan growth.
- Aquatic and riparian habitats lost to sediment inundation will not be restored.
- Individual landowners may act in response to flood damage or to mitigate flood risk.

Construction costs:

- No construction costs would be incurred.
- Flood damages to Jordan Creek, properties and structures are to be expected.

Construction:

- No immediate construction.

Alternative 2 - Buy out affected properties

One option commonly considered in flood impact alternatives analysis is buy out of affected properties. Under this alternative, properties which are impacted by the fan would be purchased through some manner of Willing Seller program allowing the resident to relocate to an area not at risk of flood. It must be stressed that this is a voluntary option and property owners would not be pressured or forced to sell. Titles to these properties would then be encumbered to prevent future occupancy in the area at risk of flooding. Commonly, structures are removed and the property placed into green space. As the fan grows with the potential to expand the flood area into the relatively flat western flood plain, additional properties may be impacted. This alternative does not address continued fan growth nor restoration/enhancement of aquatic/riparian habitats.

Pros:

- Allows Willing Sellers to relocate to non-flood zones.
- Establishes zone where EVR Tributary and Jordan Creek stream processes are allowed to occur.

Cons:

- Can be a costly and complicated process that has not yet been investigated.
- In other applications of this approach it is common that not all impacted landowners opt to relocate and flood impacts to residents would continue.
- Does not address impacts to habitats.
- Fan growth could be expected to expand flood area towards the west and further upstream.

Construction costs:

- Construction costs would include removal of structures.
- Program costs generally include property acquisitions at fair market value plus administrative expenses. Costs have not been estimated.

Construction:

- None.

Alternative 3 - Spread flow across fan

This alternative would spill flood flows and attendant sediment from the tributary to distribute onto other areas of the fan. This has the intent of slowing the growth rate of the fan by distributing sediment over a larger area of fan and reducing the flow along the EVR Tributary below the access road crossings to reduce the sediment transport capacity. Two relic channels were evident near the upper crossing and between the crossings during field investigations. The relic channel located above the upper crossing may be suited for connecting as an overflow from the tributary without impacting access road function. However, this relic channel is uphill of the Coho Apartments. To establish if this is feasible, it will be necessary to determine if sending flows across the fan will impact any properties (e.g. Coho Apartments or the new structure upstream of Jennifer Drive. This alternative does not address restoration or enhancement of aquatic/riparian habitats.

Pros:

- May reduce rate of deposition along lower fan area.

Cons:

- Potential impact to properties needs to be evaluated.
- Risk of blockage by debris or sediment causing more flow than desired onto the larger fan area above Coho Apartments.
- Does not address impacts to habitats.

Construction costs (Appendix 7):

- Construction costs would be limited to installation of a riprap weir flow control and grading of the gravel berm to spill flood flows onto the fan surface near the upper crossing.
- Conceptual level cost is roughly $20,000.

Construction:

- Construction would be relatively straightforward as access is readily available and equipment can reach the stream from the bank.

Alternative 4 - Multi-faceted approach:

This alternative is comprised of a number of aspects. The first aspect is to remove the fan sediments from Jordan Creek channel and flood plain to restore flood conveyance and local geomorphic function. This includes enhancement of vegetation and aquatic and riparian habitats. The second aspect is to limit the risk of continued growth and potential encroachment of the fan into Jordan Creek. The third aspect is to monitor local EVR Tributary bed and bank erosion near the water tank and implement a second phase of construction if necessary to provide local erosion protection.

Jordan Creek does not have sufficient flow energy to move sediments delivered by the EVR Tributary. It will be necessary to mechanically remove the fan sediments to exhume the Jordan Creek channel and flood plain. The reference reach data collected by the USGS (2004) provides a conceptual design template for channel slope and cross section. As noted above, this design template is a cross section 20 to 25 ft wide by 1.5 to

2 ft deep at a slope of about 0.002 ft/ft. Sediments inundating the Jordan Creek flood plain should also be removed to establish the appropriate hydrologic connection of channel to flood plain.

The establishment of a new channel for Jordan Creek will require the planting of riparian vegetation to stabilize the constructed banks, and will also provide the opportunity to accelerate the development of vegetation that will contribute to the productivity and habitat diversity of the stream. Excavation should preserve as many of the higher value trees as feasible. It is recommended that the excavation process minimizes disturbance to existing vegetation and salvage quality vegetation that otherwise would be destroyed through the careful relocation of minimally disturbed vegetation. Moving entire assemblages of the existing plant community will aid in establishment of a diverse and stable habitat.

The selection of specific plant species for the revegetation will be dependent primarily on the soils and hydrologic regime of the area in question. Areas that are subject to strong subsurface flows will require the planting of vegetation known to thrive in these conditions, such as Barclay willow or Red Osier Dogwood. Wetland plants such as sedges may also be suitable to establish in wet areas protected from the scouring effects of flood flows. On drier banks it is recommended that the planting of young conifers, such as Sitka Spruce or Western Hemlock, be considered in conjunction with the establishment of willow, alder and dogwood. It is recommended that the ADF&G publication, Streambank Revegetation and Protection, A Guide for Alaska, 2005, be utilized to provide primary recommendations for species selection and planting methodology. The density of the plantings will depend on the specific species and methodology selected. Detailed planting plans would be developed during a later design phase.

Aquatic habitat enhancement is proposed through construction of large woody debris (LWD) as single pieces and logjams to create scour holes and cover. Logjams are also conceptually included below the foot bridge to limit flows along the right bank near residences. Design details for size, placement and ballasting would be prepared during a later design phase. Side sloughs entering from the east above and below the footbridge may be opportunities to create side channel rearing habitats for juvenile Coho.

Construction challenges will include access, maneuvering along potentially unconsolidated fan sediments, hauling of materials and sediment control. Access from Jennifer Drive may be the least invasive option and would require passing through private property. Construction with small equipment using low ground pressure tracks operating off pads may be necessary to avoid sinking into the fan sediments. Use of low ground pressure small equipment or conveyors may be the least impact method to remove sediment from the work site. Depending on the in stream work window it may be possible to construct during low flows or dry periods. Further, a creek diversion and construction dewatering plan will be necessary to separate construction disturbances from live stream flows.

Sediment traps located along the EVR Tributary immediately above the lower access road crossing are proposed to intercept at least a portion of sediment. Routine monitoring and maintenance cleaning will be necessary. Existing access at the lower crossing is sufficient for construction and maintenance. From interviews and discussions, there is a commercial value of the sediments removed. Through discussion, sediment traps located upstream and downstream of the lower access road that are comprised of inline ponds with concrete and rock outlet structures may provide the most trapping volume for the available area. Grade controls at the upstream end of the ponds will be necessary to prevent a head cut from migrating upstream. Concepts are shown on Sheet 4.

Given the volume of sediment in the fan and removed during the 1995 flood, the traps may not have sufficient volume to remove adequate volumes of sediment during large floods. Further, the stream is steep in this reach and the traps will likely be inefficient in trapping finer sized particles. There is a proposal by the non profit group Trail Mix to construct a bike path through the forest (D. Hanna personal communication). Construction of an elevated embankment with controlled through flow could provide an effective sediment trap and polishing pond/wetland area for flows discharging to Jordan Creek.

Erosion control of the bed and banks of the EVR Tributary from the lower crossing to above the upper crossing may be warranted to reduce the volume of sediment locally entrained into the stream. The volume of material that currently is sourced from this reach is unknown. It is recommended that the reach be monitored through observations and periodic cross sectional surveys. If it is determined that the volume of erosion is a significant portion of material removed from the sediment traps, a second phase of construction to place erosion protection along this reach is recommended.

Pros:

- Restores flood conveyance.
- Restores/enhances local geomorphic function.
- Enhances riparian vegetation.
- Enhances aquatic/riparian habitat.
- Limits risk or rate of fan growth and encroachment into Jordan Creek increasing sustainability of Jordan Creek work.
- Sediment trap is in an accessible location along a non-fish bearing stream.
- Commercial market exists for sediments cleaned from the traps.

Cons:

- Though of a short duration, construction disturbance will require careful management to limit impacts.
- Construction access and materials handling may be challenging.
- May not be able to intercept or manage sufficient volume/size of sediments from the EVR Tributary requiring monitoring and adaptive management.
- Insufficient trapping or transport of sediments from downstream of proposed traps may encroach into Jordan Creek.

Construction costs (Appendix 7):

- Jordan Creek restoration/enhancement is roughly $160,000.

- EVR Tributary sediment trap is roughly $125,000.

Construction along Jordan Creek:

- Access to the Jordan Creek site will be challenging and may require crossing private property.
- Operation of equipment along the stream and unconsolidated fan sediments may require special means and methods.
- Excavation and hauling from the fan, across the channel through the access area to Jennifer Drive will need to minimize impacts.
- Best management practices must be implemented for sediment control.
- In exhuming relic channel bed and flood plain existing vegetation would be preserved to the degree possible.
- Revegetation may be possible using local volunteer groups.

Construction of sediment traps:

- Construction would be relatively straightforward as access is readily available and equipment can reach the stream from the bank.

Recommendation

No action will result in increasing flood risk as the fan continues to encroach in to Jordan Creek.

Alternative 4 satisfies the majority of the project goals. The sediment trap near the lower access road crossing should be constructed first. This will reduce the risk of the sediment deposition causing the fan to encroach into the Jordan Creek work area. The second priority is implementing Jordan Creek work including exhuming the channel and flood plain from fan sediments and enhancement of riparian vegetation and aquatic/riparian habitats. To determine the necessity of installing bed and bank erosion control along the EVR Tributary head cut reach (from the lower crossing to above the upper crossing) a monitoring program to estimate the volume of material eroded into the tributary is recommended. If bed and bank erosion is a significant volume a later phase construction to provide erosion protection is recommended.

Additional sediment trapping opportunities need to be explored. The bike trail concept put forth by Trail Mix may be an opportunity to further manage sediments and improve water quality. With an elevated embankment and controlled through flow this may present an opportunity to settle out additional volume of sediment including fine sediments thereby improving the water quality delivered to Jordan Creek.

Alternative 4 was selected by the stakeholders as the preferred alternative. The next phases of the project will be administered by CBJ for design, permitting and construction. Recommended steps to be included in the next phase for preparation of designs, permits and construction documents include:

- Survey of high value trees and utilities. Additional survey if needed for flood no-rise certification.

- Review of access routes to determine safe working load limitations of roads and bridges, available area for staging and stockpiling, and utilities.
- Design EVR Tributary sediment trap through estimation of sediment volume, hydraulic design of weir spillways, stilling basin and trapping efficiency. Hydraulic design of channel stability and structure erosion protection. Design of civil infrastructure including geotechnical stability, seepage and structural elements.
- Design Jordan Creek restoration considering stream hydrology, site hydraulics, geomorphic conditions, sediment transport/channel stability, aquatic habitat (e.g. side sloughs, LWD), and revegetation.
- Identify and address construction logistics, sequencing, and means and methods.
- Prepare quantities/cost estimate and construction documents including drawings and special specifications.
- Permitting including preparation of applications and supporting technical information.
- Begin monitoring of erosion potential along the head cut reach of the EVR Tributary through observation, photographs and cross sectional survey.

References

ADF&G, 2005. Streambank Revegetation and Protection, a Guide for Alaska.

Barnwell, William W. and Charles W. Boning. 1968. Water Resources and Surficial Geology of the Mendenhall Valley, Alaska. USGS Hydrologic Investigations Atlas HA-259.

Curran, J.H., 2007, Hydrology and Flood Profiles of Duck Creek and Jordan Creek Downstream from Egan Drive, Juneau, Alaska: U.S. Geological Survey Scientific Investigations Report 2006-5323, 35 p.

FEMA National Flood Insurance program Flood Insurance Rate Map, City and Borough of Juneau, Alaska. Panel 880 of 1050, Community Panel number 020009 0880 C. Map Revised September 28, 1990.

FEMA Flood Insurance Study, City and Borough of Juneau, Alaska. August 4, 1980.

Host, R.H. and E.G. Neal, 2004, Baseline Characteristics of Jordan Creek, Juneau, Alaska: U.S. Geological Survey Open-File Report 2004-1220.

Miller, Robert D. 1975. Surficial Geologic Map of the Juneau Urban Area and Vicinity, Alaska. USGS Miscellaneous Investigation Series.

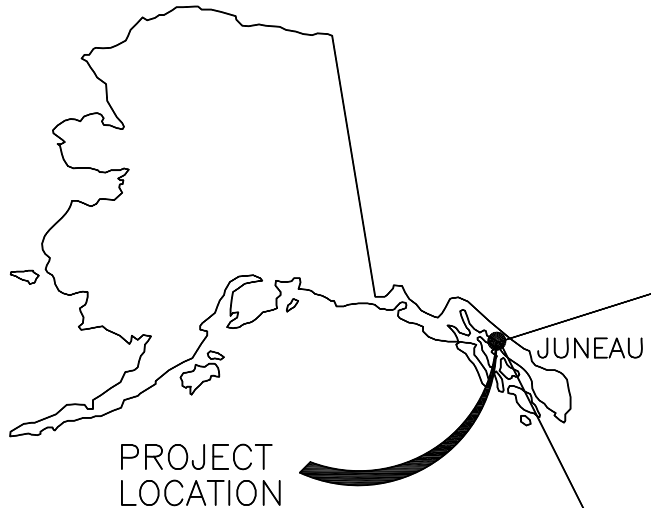
R&M Engineering, 2005 and 2007 site survey.

U.S. Army Corps of Engineers. HEC-RAS River Analysis System, version 3.1.3, May 2005.

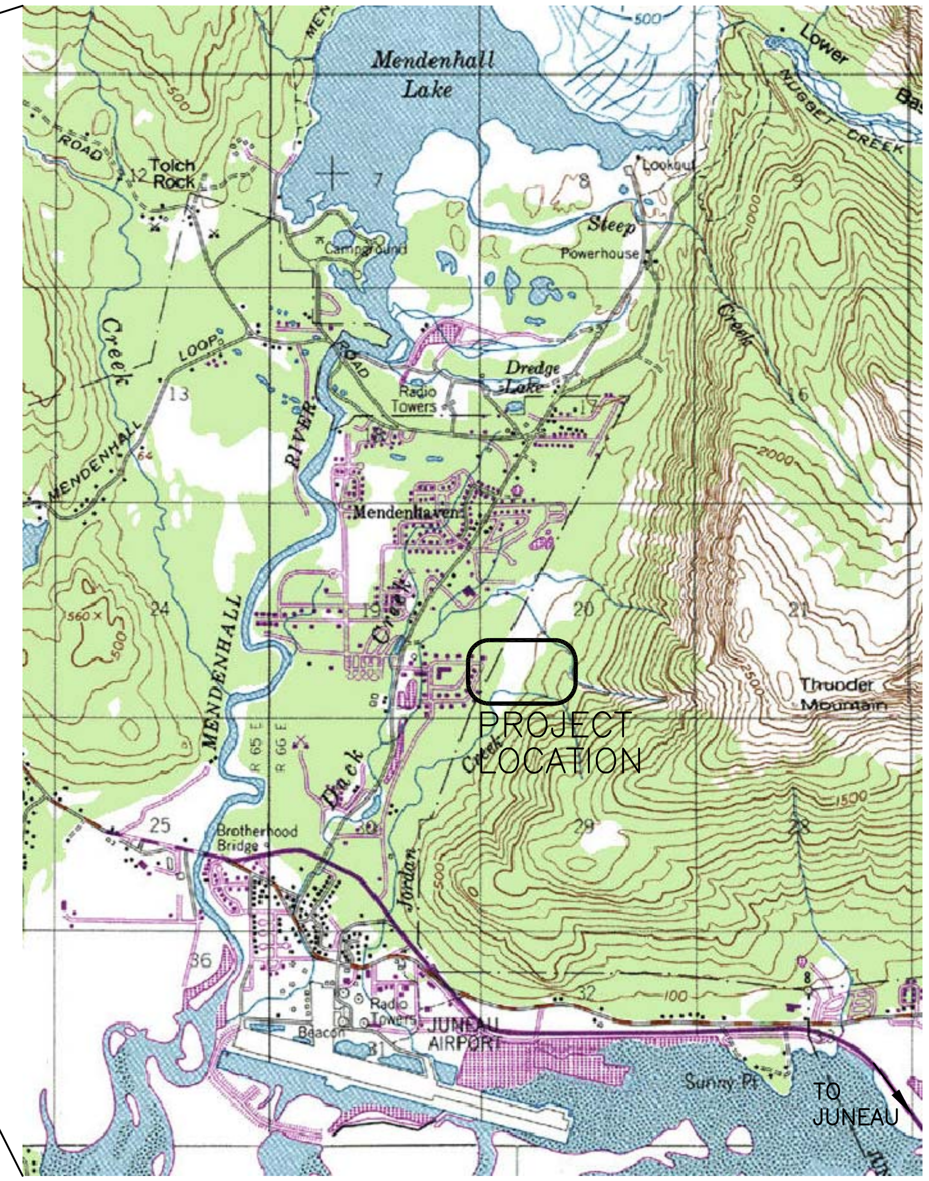
USDA Forest Service, Stream Systems Technology Center. WinXSPRO, version 3.0.

JORDAN CREEK CHANNEL REHABILITATION

JUNEAU, AK



STATE OF ALASKA VICINITY MAP



USGS VICINITY MAP
NOT TO SCALE

SHEET INDEX

1	COVER, VICINITY MAP AND SHEET INDEX
2	JORDAN CREEK CONCEPTUAL DESIGN PLAN
3	JORDAN CREEK CONCEPTUAL DESIGN PROFILE AND SECTION
4	EVR TRIBUTARY SEDIMENT RETENTION PONDS CONCEPTS
5	WATER RESERVOIR – R&M ENGINEERING SURVEY

inter·fluve inc.
1020 Wasco Street, Suite I
Hood River, OR 97031
541.386.9003
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Jordan Creek
Juneau, AK
Channel Rehabilitation

Cover, Vicinity Map and Sheet Index

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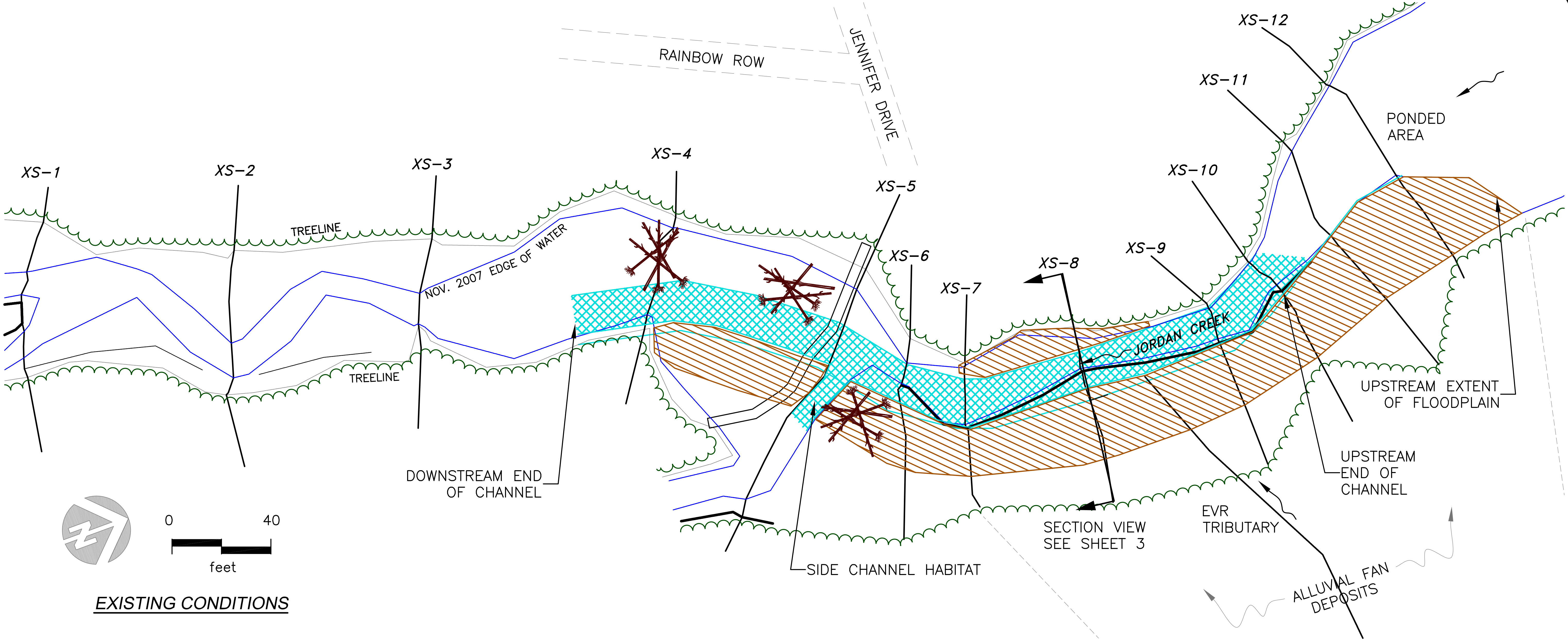
DM	DM
DRAWN BY	DATE APPD.
NS	Feb 2008



NOTES:

- EXHUME JORDAN CREEK CHANNEL AND FLOODPLAIN
- REHABILITATE CHANNEL BASED ON REFERENCE REACH (SLOPE~0.2%, W~20FT, D~2FT
- PROVIDE CONNECTED FLOODPLAIN
- LIMIT EXCAVATION TO RELIC SURFACES
- ENHANCE STREAMBANK AND FLOODPLAIN WITH NATIVE RIPARIAN PLANT SPECIES
- PROVIDE AQUATIC HABITAT USING LARGE WOODY DEBRIS ELEMENTS TO CREATE SCOUR POOLS AND COVER
- EVALUATE SIDE CHANNEL OPPORTUNITIES
- INTERCEPT EVR TRIBUTARY SEDIMENTS TO CONTROL EXCESSIVE DEPOSITION

SURVEY DATA COLLECTED BY R&M ENGINEERING, JUNEAU, AK

LEGEND

- RESTORED CHANNEL
- RESTORED FLOODPLAIN
- LARGE WOODY DEBRIS HABITAT ELEMENT
- XS-2 HEC-RAS CROSS SECTION

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Jordan Creek
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Jordan Creek
Conceptual Design Plan

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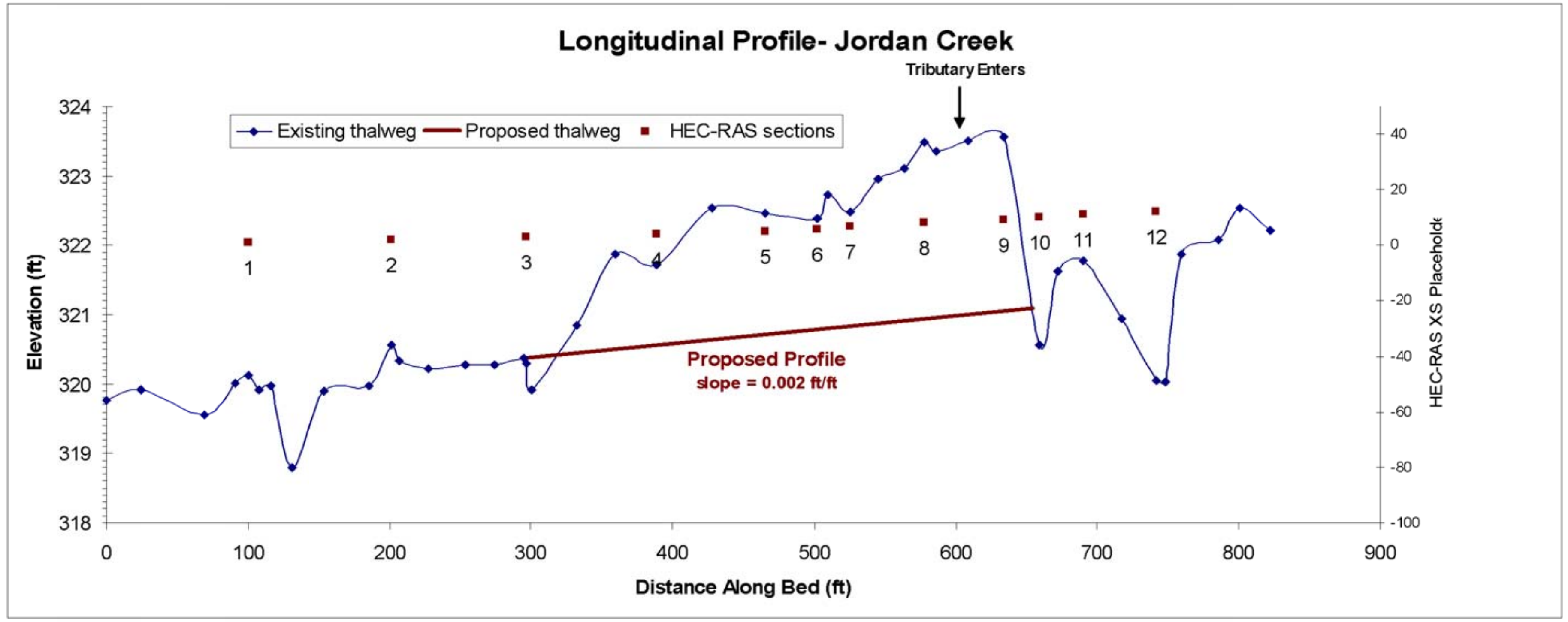
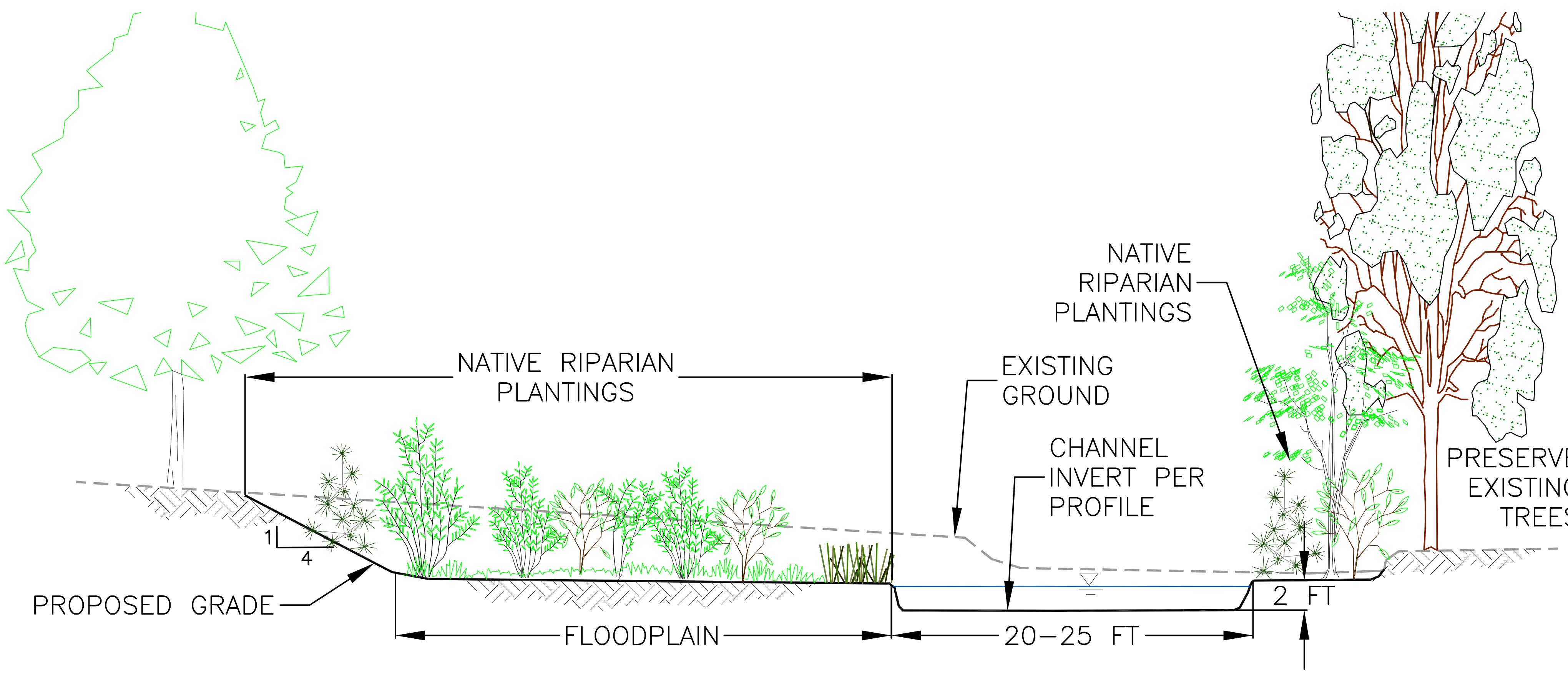
NS	Feb 2008



JORDAN CREEK THALWEG PROFILE IS BASED ON SURVEY DATA COLLECTED BY R&M ENGINEERING NOVEMBER 2007 AS REQUESTED BY INTER–FLUVE, INC



CONCEPTUAL CROSS SECTION

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Jordan Creek
Juneau, AK
Channel Rehabilitation

Jordan Creek
Conceptual Design
Profile and Section

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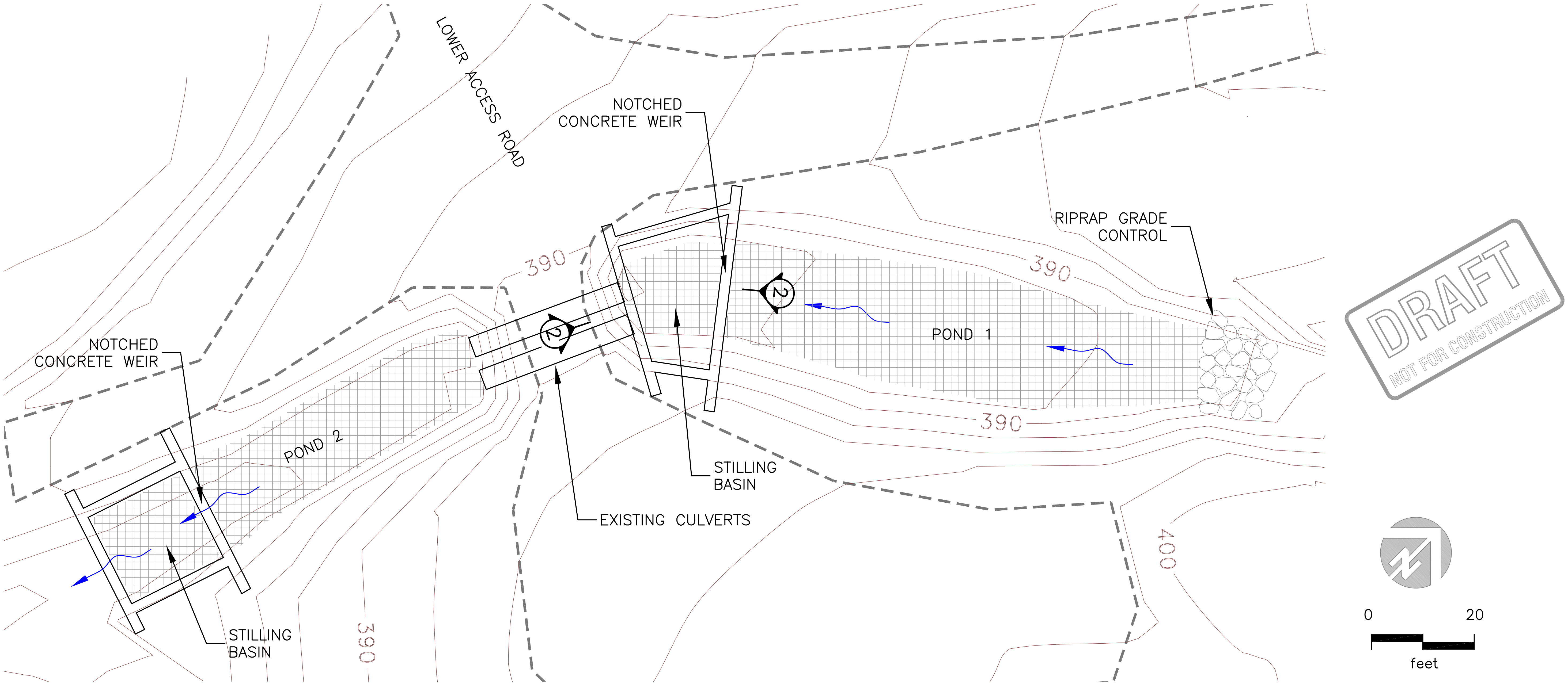
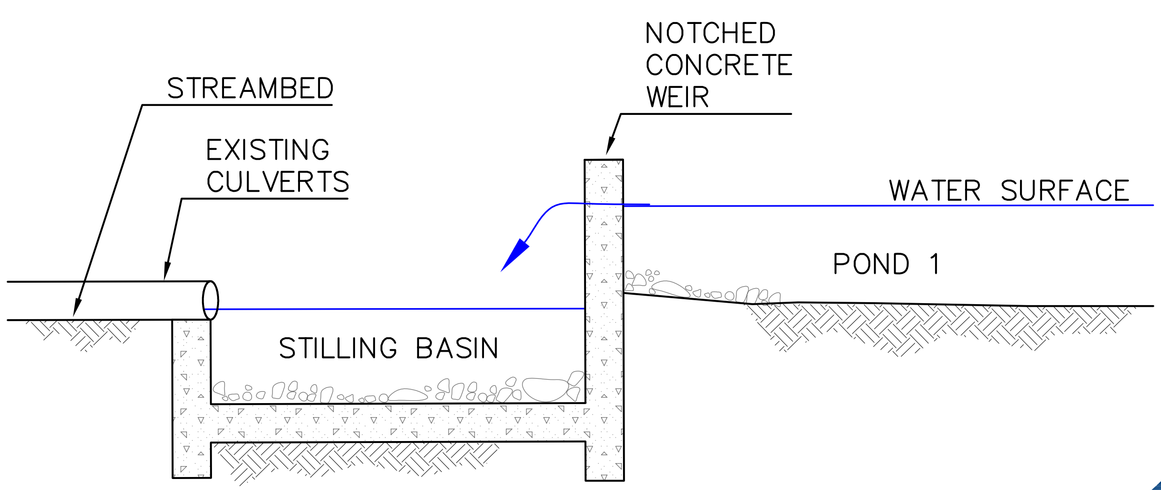
NS	Feb 2008



1. SEDIMENT RETENTION PONDS
AT LOWER EVR ACCESS ROAD
SURVEY DATA COLLECTED BY R&M ENGINEERING, JUNEAU, AK



2. SEDIMENT RETENTION PONDS
PROFILE VIEW
NOT TO SCALE

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Jordan Creek
Juneau, AK
Channel Rehabilitation

EVR Tributary
Sediment Retention
Ponds Concepts

DESIGNED BY	CHECKED BY
DM	DM
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NS	Feb 2008

4

Appendix 1

R&M Engineering Site Survey Maps

GENERAL NOTES

1. THE BASIS OF BEARING UTILIZED TO CONDUCT THIS SURVEY WAS BETWEEN A RECOVERED G.L.O./B.L.M. BRASS CAP MONUMENT FOR C–4, LOT 6, U.S.S. 2084, IDENTICAL TO A ½ MILE POST, U.S.S. 1535 AND A 7712–S PRIMARY MONUMENT FOR C–4, LOT 1, U.S.S. 2084, HAVING A RECORD BEARING OF S 26°41'00" W PER OFFICIAL RECORD OF U.S. SURVEY 5504.
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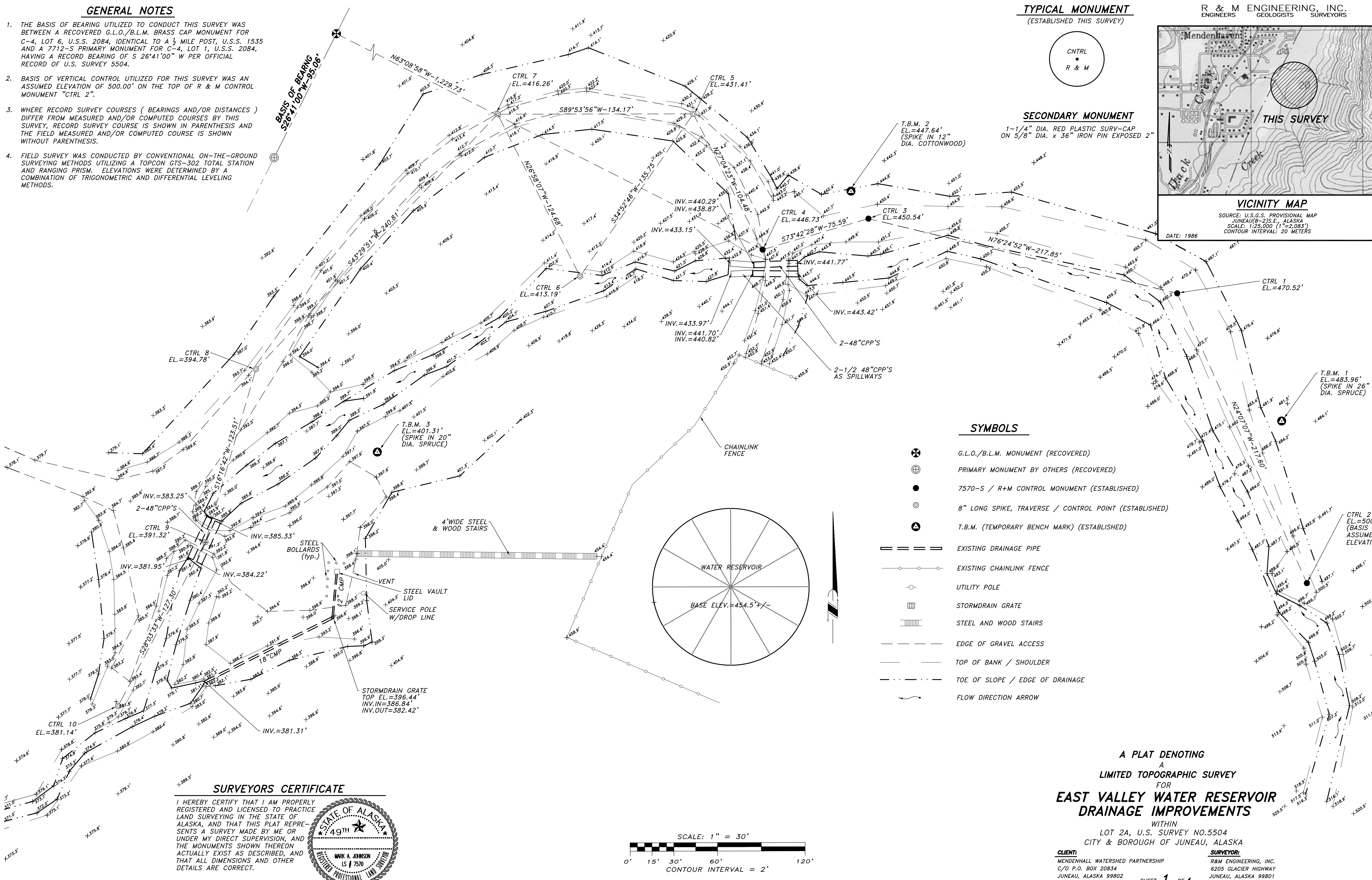

SYMBOLS

Symbol	Description
⊕	G.L.O./B.L.M. MONUMENT (RECOVERED)
⊕	PRIMARY MONUMENT BY OTHERS (RECOVERED)
●	7570–S / R+M CONTROL MONUMENT (ESTABLISHED)
◎	8" LONG SPIKE, TRAVERSE / CONTROL POINT (ESTABLISHED)
▲	T.B.M. (TEMPORARY BENCH MARK) (ESTABLISHED)
═ ═ ═	EXISTING DRAINAGE PIPE
–o–o–	EXISTING CHAINLINK FENCE
–o–	UTILITY POLE
▥	STORMDRAIN GRATE
▥▥	STEEL AND WOOD STAIRS
— — —	EDGE OF GRAVEL ACCESS
—— · ——	TOP OF BANK / SHOULDER
– · · –	TOE OF SLOPE / EDGE OF DRAINAGE
~	FLOW DIRECTION ARROW

SURVEYORS CERTIFICATE

I HEREBY CERTIFY THAT I AM PROPERLY REGISTERED AND LICENSED TO PRACTICE LAND SURVEYING IN THE STATE OF ALASKA, AND THAT THIS PLAT REPRESENTS A SURVEY MADE BY ME OR UNDER MY DIRECT SUPERVISION, AND THE MONUMENTS SHOWN THEREON ACTUALLY EXIST AS DESCRIBED, AND THAT ALL DIMENSIONS AND OTHER DETAILS ARE CORRECT.

STATE OF ALASKA 49TH MARK A. JOHNSON LS # 7570 REGISTERED PROFESSIONAL LAND SURVEYOR

R & M ENGINEERING, INC.
ENGINEERS GEOLOGISTS SURVEYORS

A PLAT DENOTING
A
LIMITED TOPOGRAPHIC SURVEY
FOR

EAST VALLEY WATER RESERVOIR DRAINAGE IMPROVEMENTS

WITHIN
LOT 2A, U.S. SURVEY NO.5504
CITY & BOROUGH OF JUNEAU, ALASKA

CLIENT:
MENDENHALL WATERSHED PARTNERSHIP
C/O P.O. BOX 20834
JUNEAU, ALASKA 99802
DATE: DEC. 27, 2005

SHEET 1 OF 4

SURVEYOR:
R&M ENGINEERING, INC.
6205 GLACIER HIGHWAY
JUNEAU, ALASKA 99801
R&M PROJ. NO. 051831

FILE:# L–923

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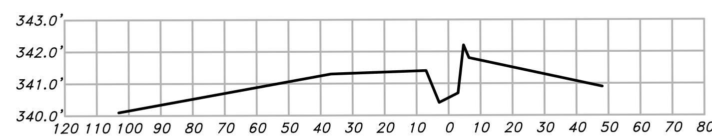

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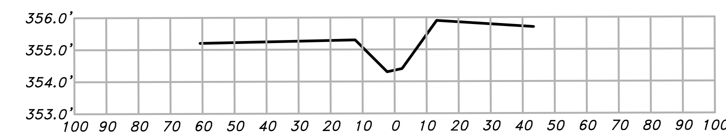

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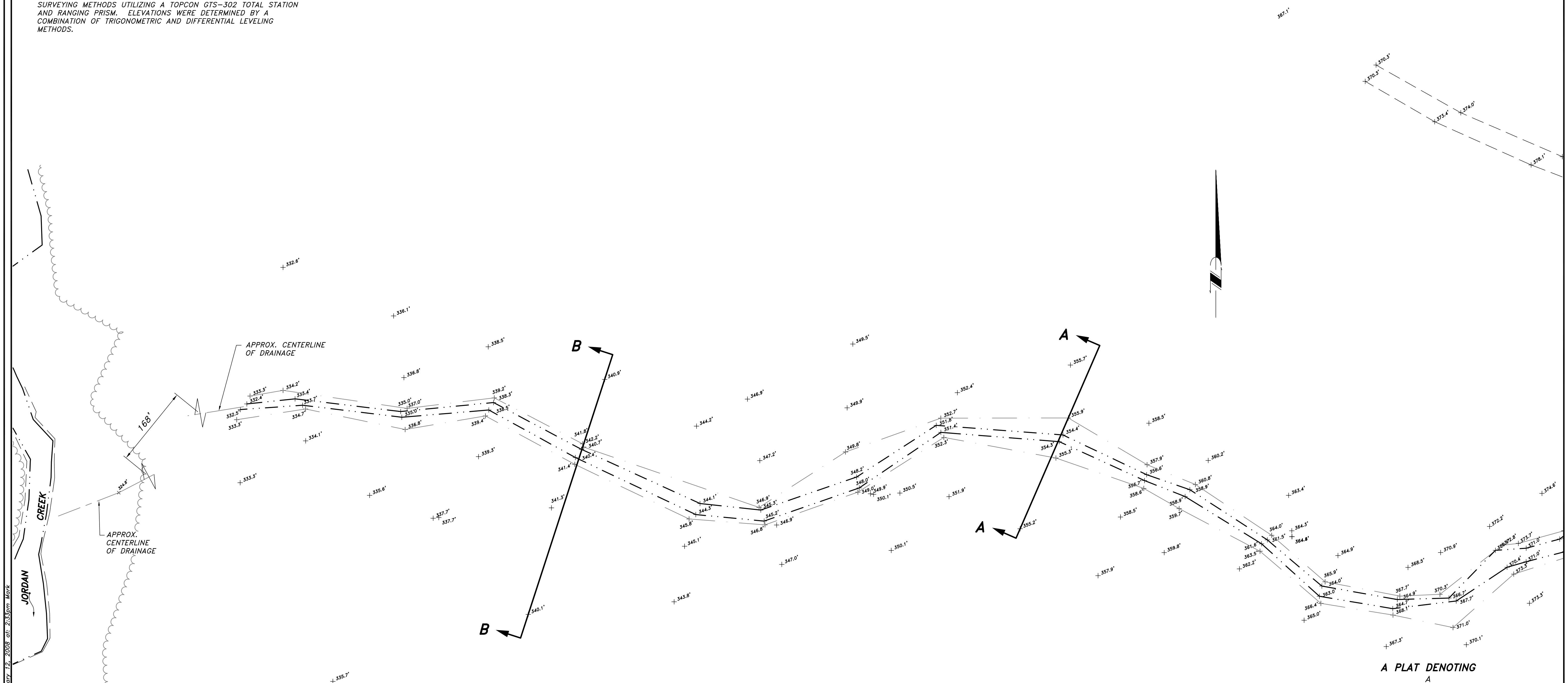

SCALE: 1" = 30'
0' 15' 30' 60' 120'

A PLAT DENOTING
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SHEET 2 OF 4

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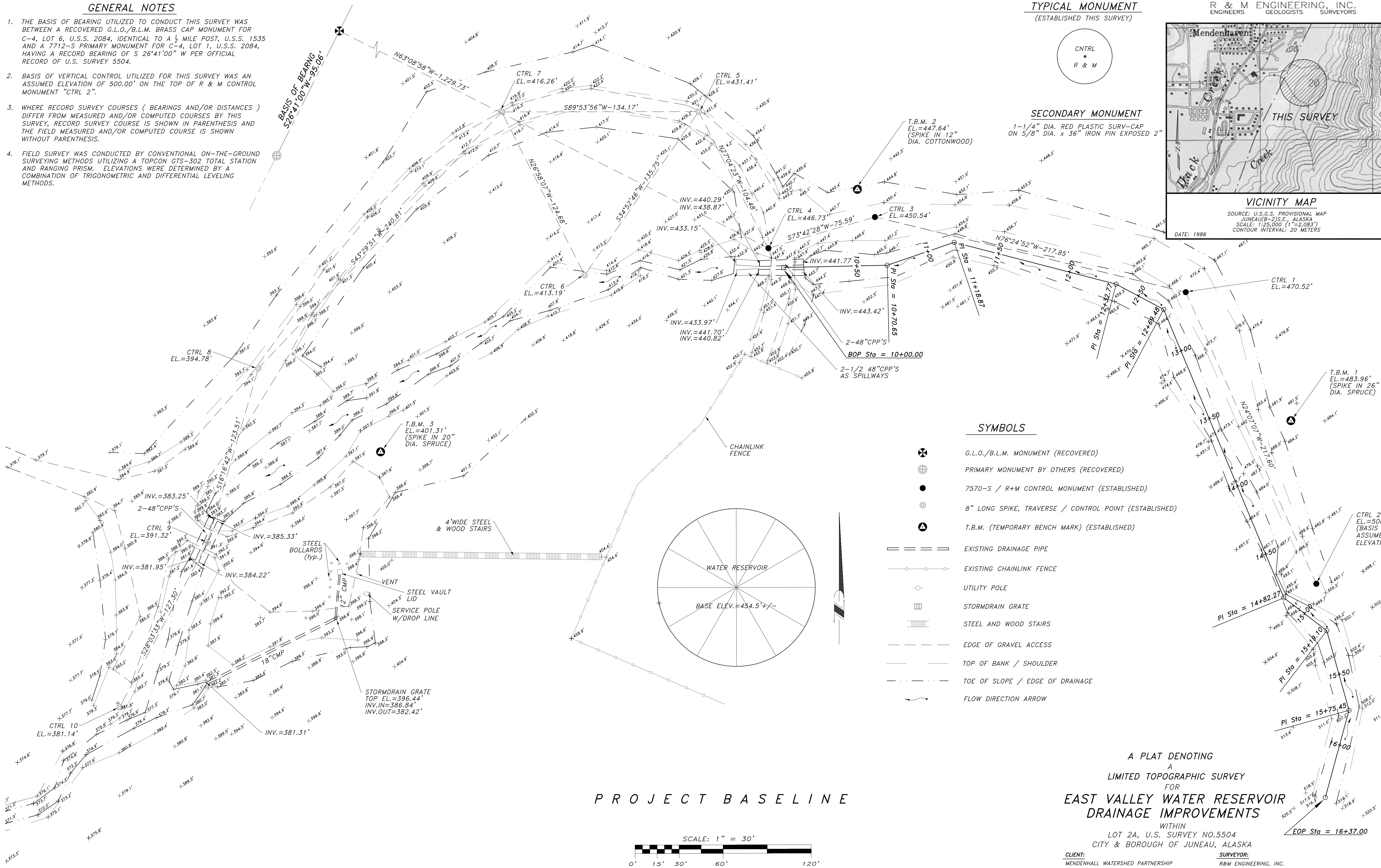

TYPICAL MONUMENT
(ESTABLISHED THIS SURVEY)

CNTRL
R & M

SECONDARY MONUMENT
1-1/4" DIA. RED PLASTIC SURV-CAP ON 5/8" DIA. x 36" IRON PIN EXPOSED 2"

VICINITY MAP
SOURCE: U.S.G.S. PROVISIONAL MAP
JUNEAU(B-2)S.E., ALASKA
SCALE: 1:25,000 (1"=2,083')
CONTOUR INTERVAL: 20 METERS
DATE: 1986

SYMBOLS

G.L.O./B.L.M. MONUMENT (RECOVERED)
PRIMARY MONUMENT BY OTHERS (RECOVERED)
7570-S / R+M CONTROL MONUMENT (ESTABLISHED)
8" LONG SPIKE, TRAVERSE / CONTROL POINT (ESTABLISHED)
T.B.M. (TEMPORARY BENCH MARK) (ESTABLISHED)
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EXISTING CHAINLINK FENCE
UTILITY POLE
STORMDRAIN GRATE
STEEL AND WOOD STAIRS
EDGE OF GRAVEL ACCESS
TOP OF BANK / SHOULDER
TOE OF SLOPE / EDGE OF DRAINAGE
FLOW DIRECTION ARROW

SCALE: 1" = 30'
0' 15' 30' 60' 120'
CONTOUR INTERVAL = 2'

A PLAT DENOTING
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SHEET 3 OF 4

SURVEYOR:
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FILE:# L-923

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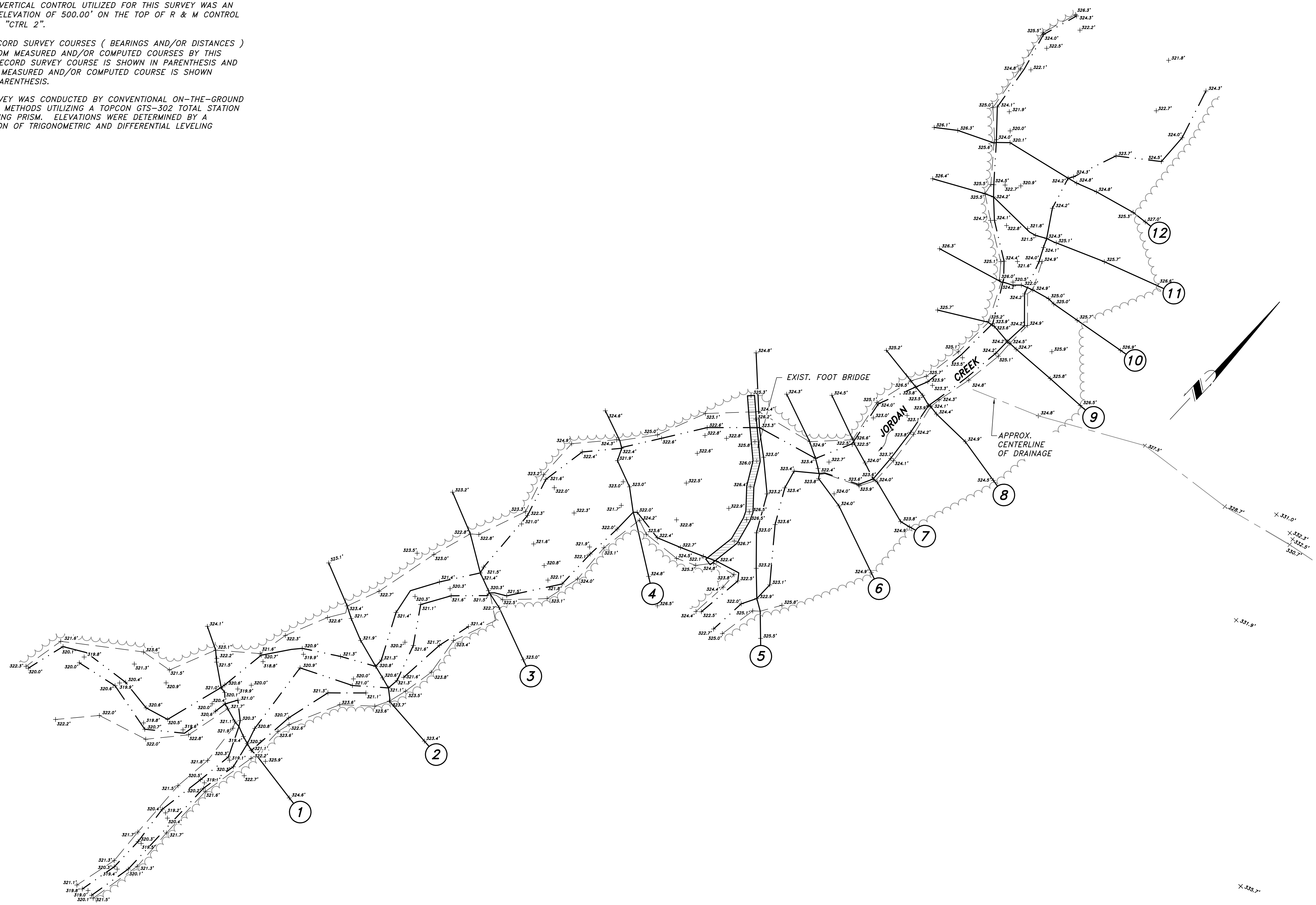
R & M ENGINEERING, INC.
ENGINEERS GEOLOGISTS SURVEYORS

SYMBOLS

EXISTING FOOT BRIDGE
EDGE OF WATER
TOP OF BANK
TOE OF SLOPE
TREE LINE
SPOT ELEVATION
FLOW DIRECTION ARROW
CROSS SECTIONS



SCALE: 1" = 30'
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SHEET 4 OF 4

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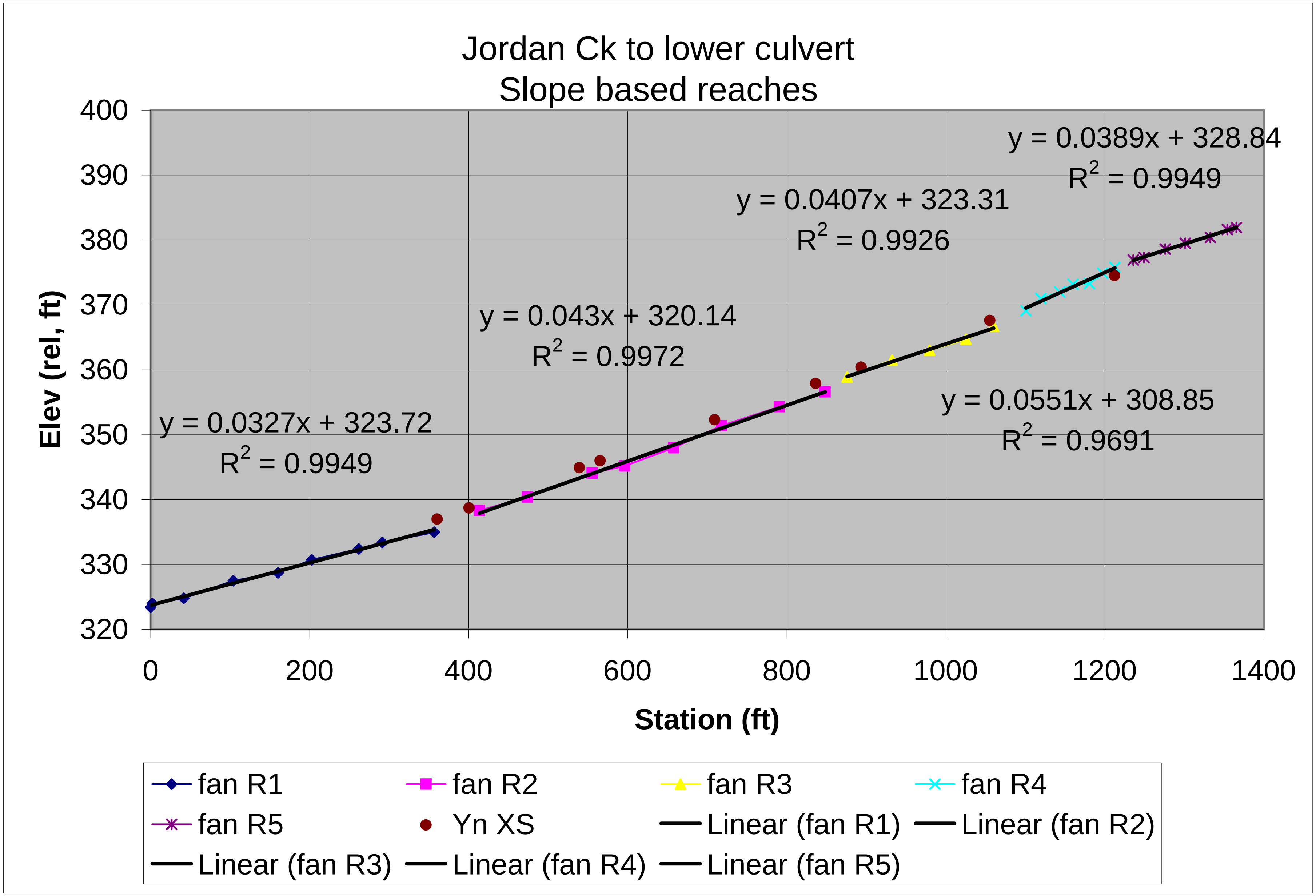
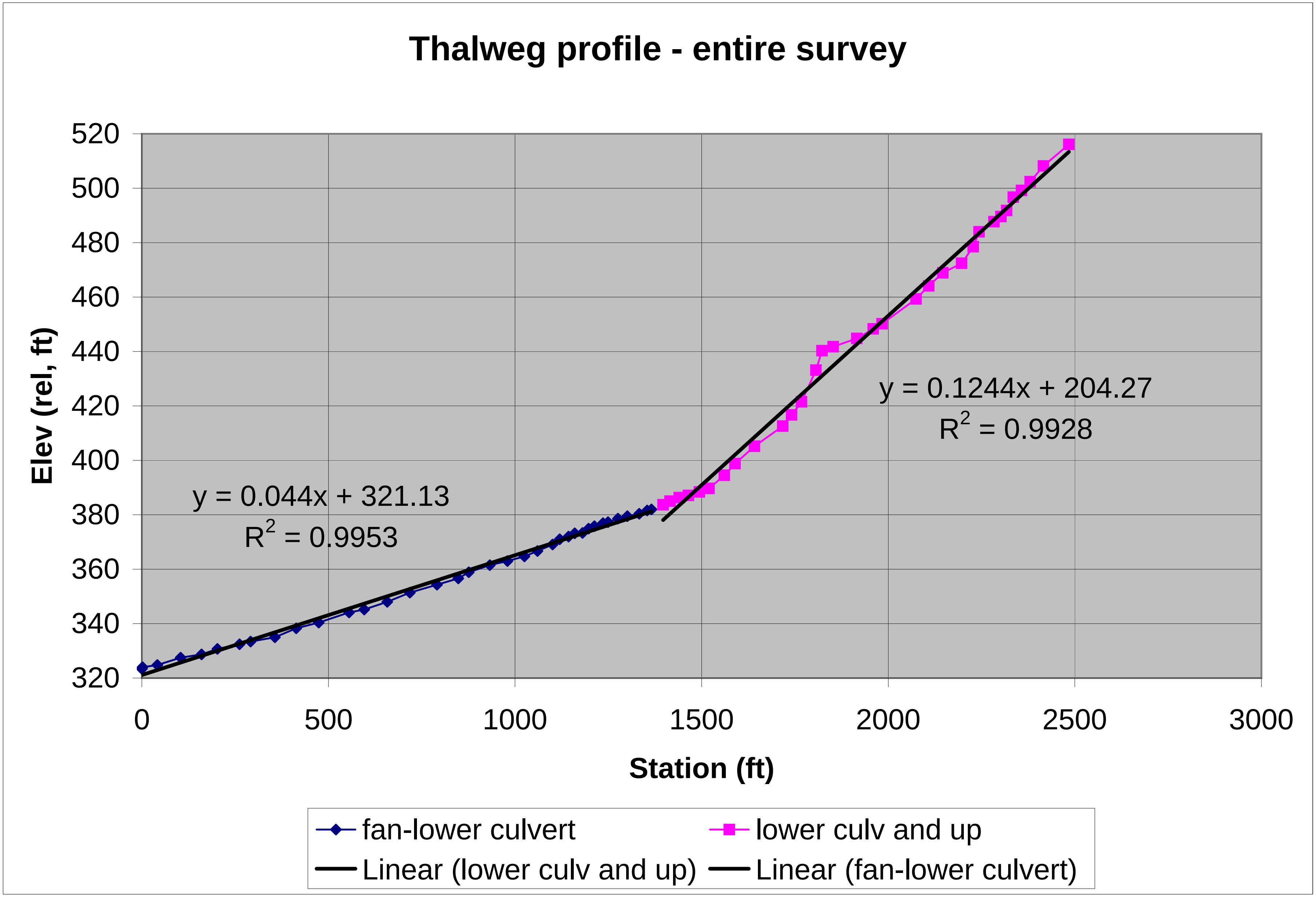
FILE:#

Appendix 2

EVR Tributary Profile
(Based on 2005 survey by R&M Engineering)



Jordan Ck to lower culvert
Slope based reaches
y = 0.0327x + 323.72
R2 = 0.9949
y = 0.043x + 320.14
R2 = 0.9972
y = 0.0407x + 323.31
R2 = 0.9926
y = 0.0389x + 328.84
R2 = 0.9949
y = 0.0551x + 308.85
R2 = 0.9691
Elev (rel, ft)
Station (ft)
400
390
380
370
360
350
340
330
320
0
200
400
600
800
1000
1200
1400
fan R1
fan R2
fan R3
fan R4
fan R5
Yn XS
Linear (fan R1)
Linear (fan R2)
Linear (fan R3)
Linear (fan R4)
Linear (fan R5)



Thalweg profile - entire survey
520
500
480
460
440
420
400
380
360
340
320
Elev (rel, ft)
0
500
1000
1500
2000
2500
3000
Station (ft)
y = 0.044x + 321.13
R^2 = 0.9953
y = 0.1244x + 204.27
R^2 = 0.9928
fan-lower culvert
lower culv and up
Linear (lower culv and up)
Linear (fan-lower culvert)

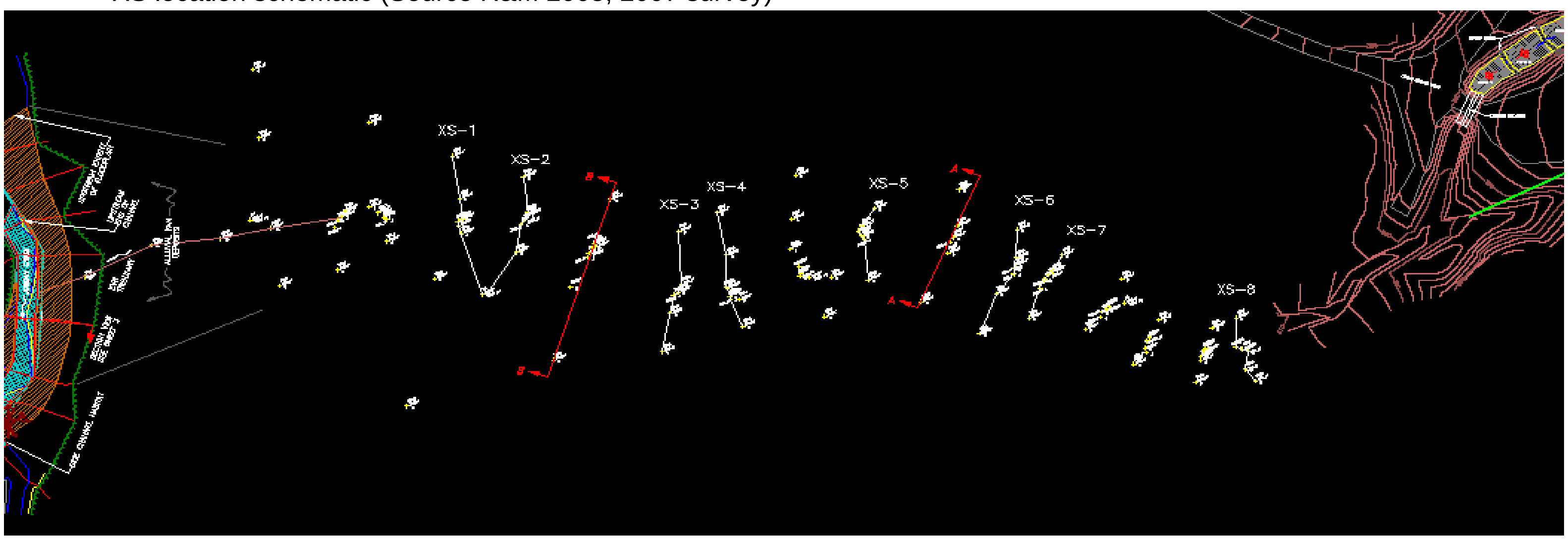
Appendix 3.1

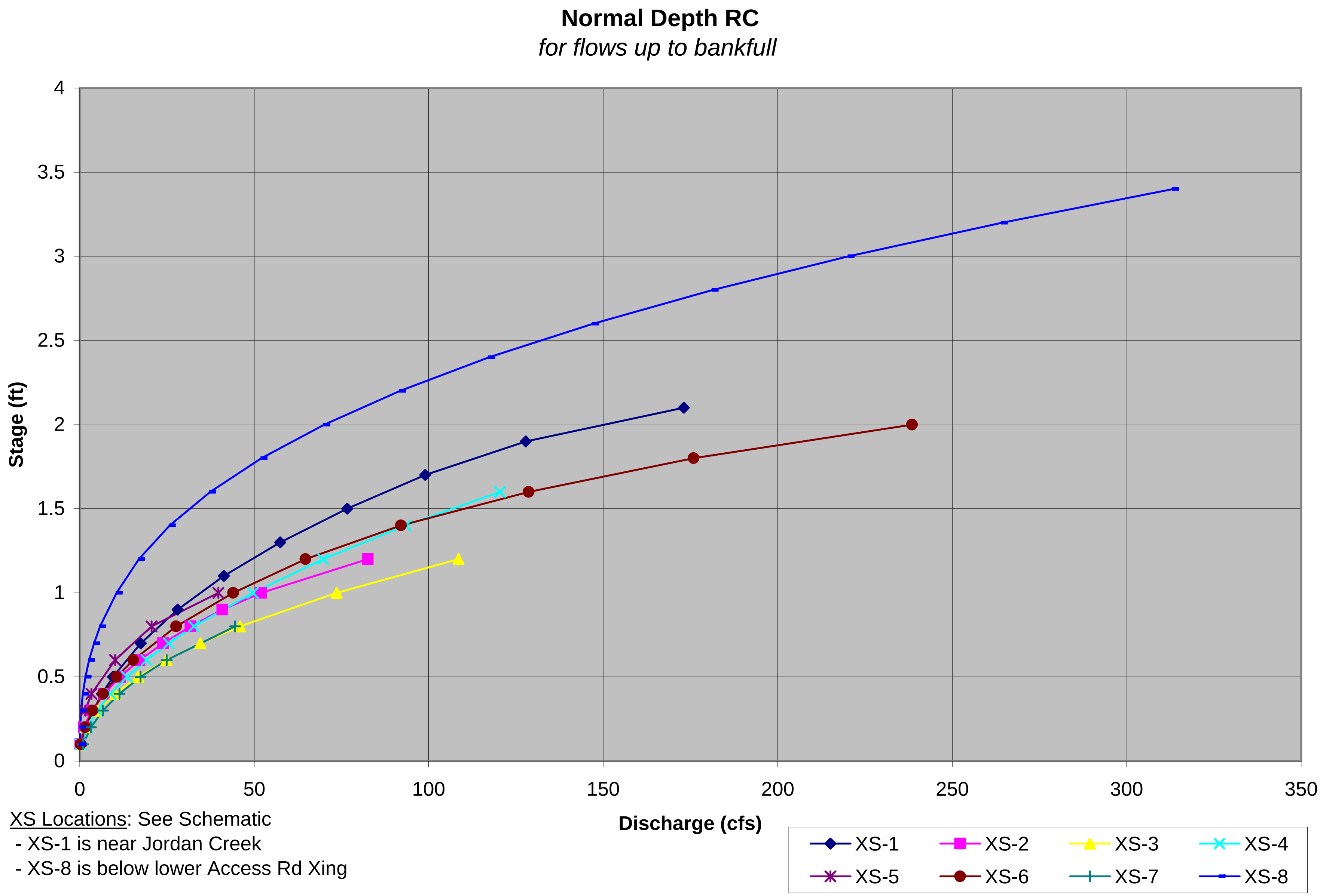
EVR Tributary Hydraulics

EVR Tributary at-a-section Hydraulic analysis - location of sections

Section ID	distance below lower Xing (ft)	Photo (filename no.)	GPS waypoint	Description
1	1005	518-519	216	broad shallow channel downcut into prior deposits
2	965	515	215	broad shallow channel downcut into prior deposits
3	826	509	--	extensive flood plain sediment deposits
4	800	499	213	extensive flood plain sediment deposits
	Note: 670 ft below lower crossing is approximate apex of current active alluvial fan			
5	656	495	--	channel downcut into prior deposits
6	529	484	211	broad shallow channel - depositional
7	376	472	--	broad section - sediment appears contained
8	310	467	--	incised section - transport

XS location schematic (Source R&M 2005, 2007 survey)





XS Locations: See Schematic

- XS-1 is near Jordan Creek
- XS-8 is below lower Access Rd Xing

XS - 1 EVR Tributary WinXSPro summary output

*******************************WinXSPRO********************************
*
I:\I-L\Jordan Creek Tributary_JWP_070245\Hydraulics\WinXSPro\SECTION1.out
Input File: I:\I-L\Jordan Creek Tributary_JWP_070245\Hydraulics\WinXSPro\SECTION1.DAT
Run Date: 01/28/08
Analysis Procedure: Hydraulics
Cross Section Number: 1
Survey Date: 01/25/08

Subsections/Dividing positions

Resistance Method: Manning's n

SECTION	A
Low Stage n	0.035
High Stage n	0.035

Unadjusted horizontal distances used

STAGE	#SEC	AREA	PERIM	WIDTH	R	DHYD	SLOPE	n	VAVG	Q	SHEAR
(ft)		(sq ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)		(ft/s)	(cfs)	(psf)
0.10	T	0.38	4.10	4.02	0.09	0.09	0.0330	0.035	1.58	0.60	0.19
0.20	T	0.80	4.65	4.49	0.17	0.18	0.0330	0.035	2.40	1.93	0.36
0.30	T	1.28	5.20	4.96	0.25	0.26	0.0330	0.035	3.03	3.87	0.51
0.40	T	1.80	5.75	5.43	0.31	0.33	0.0330	0.035	3.56	6.40	0.64
0.50	T	2.36	6.30	5.91	0.38	0.40	0.0330	0.035	4.02	9.51	0.77

STAGE	ALPHA	FROUDE
0.10	1.000000	0.907287
0.20	1.000000	0.999766
0.30	1.000000	1.053537
0.40	1.000000	1.091304
0.50	1.000000	1.120449

XS - 2 EVR Tributary WinXSPro summary output

*****************************WinXSPRO*******************************

I:\I-L\Jordan Creek Tributary_JWP_070245\Hydraulics\WinXSPro\SECTION2.OUT
Input File: I:\I-L\Jordan Creek Tributary_JWP_070245\Hydraulics\WinXSPro\SECTION2.DAT
Run Date: 01/28/08
Analysis Procedure: Hydraulics
Cross Section Number: 1
Survey Date: 01/25/08

Subsections/Dividing positions

Resistance Method: Manning's n

SECTION	A
Low Stage n	0.035
High Stage n	0.035

Unadjusted horizontal distances used

STAGE (ft)	#SEC	AREA (sq ft)	PERIM (ft)	WIDTH (ft)	R (ft)	DHYD (ft)	SLOPE (ft/ft)	n	VAVG (ft/s)	Q (cfs)	SHEAR (psf)
0.10	T	0.15	3.02	3.00	0.05	0.05	0.0430	0.035	1.19	0.18	0.13
0.20	T	0.60	6.04	6.01	0.10	0.10	0.0430	0.035	1.89	1.14	0.27
0.30	T	1.24	6.84	6.78	0.18	0.18	0.0430	0.035	2.83	3.51	0.49
0.40	T	1.96	7.64	7.55	0.26	0.26	0.0430	0.035	3.56	6.97	0.69
0.50	T	2.75	8.43	8.32	0.33	0.33	0.0430	0.035	4.18	11.50	0.87
0.60	T	3.62	9.23	9.09	0.39	0.40	0.0430	0.035	4.73	17.12	1.05
0.70	T	4.57	10.03	9.86	0.46	0.46	0.0430	0.035	5.23	23.87	1.22
0.80	T	5.59	10.83	10.63	0.52	0.53	0.0430	0.035	5.68	31.79	1.39
0.90	T	6.69	11.62	11.40	0.58	0.59	0.0430	0.035	6.11	40.91	1.55

STAGE	ALPHA	FROUDE
0.10	1.000000	0.940578
0.20	1.000000	1.055763
0.30	1.000000	1.165071
0.40	1.000000	1.232596
0.50	1.000000	1.281812
0.60	1.000000	1.320750
0.70	1.000000	1.353127
0.80	1.000000	1.380964
0.90	1.000000	1.405461

XS - 3 EVR Tributary WinXSPro summary output

******************************WinXSPRO********************************
*
I:\I-L\Jordan Creek
Tributary_JWP_070245\Hydraulics\WinXSPro\SECTION3.OUT
Input File: I:\I-L\Jordan Creek
Tributary_JWP_070245\Hydraulics\WinXSPro\SECTION3.DAT
Run Date: 01/28/08
Analysis Procedure: Hydraulics
Cross Section Number: 1
Survey Date: 01/25/08

Subsections/Dividing positions

Resistance Method: Manning's n

SECTION	A
Low Stage n	0.035
High Stage n	0.035

Unadjusted horizontal distances used

STAGE (ft)	#SEC	AREA (sq ft)	PERIM (ft)	WIDTH (ft)	R (ft)	DHYD (ft)	SLOPE (ft/ft)	n	VAVG (ft/s)	Q (cfs)	SHEAR (psf)
0.10	T	0.22	4.38	4.37	0.05	0.05	0.0430	0.035	1.20	0.26	0.13
0.20	T	0.87	8.75	8.73	0.10	0.10	0.0430	0.035	1.90	1.66	0.27
0.30	T	1.80	9.79	9.75	0.18	0.18	0.0430	0.035	2.85	5.13	0.49
0.40	T	2.82	10.84	10.77	0.26	0.26	0.0430	0.035	3.60	10.17	0.70
0.50	T	3.95	11.88	11.78	0.33	0.34	0.0430	0.035	4.24	16.75	0.89
0.60	T	5.18	12.92	12.80	0.40	0.40	0.0430	0.035	4.80	24.87	1.08
0.70	T	6.51	13.96	13.81	0.47	0.47	0.0430	0.035	5.31	34.56	1.25
0.80	T	7.94	15.01	14.83	0.53	0.54	0.0430	0.035	5.78	45.88	1.42

STAGE	ALPHA	FROUDE
0.10	1.000000	0.943142
0.20	1.000000	1.058661
0.30	1.000000	1.170287
0.40	1.000000	1.239352
0.50	1.000000	1.289699
0.60	1.000000	1.329499
0.70	1.000000	1.362548
0.80	1.000000	1.390898

XS - 4 EVR Tributary WinXSPro summary output

******************************WinXSPRO*******************************
*
I:\I-L\Jordan Creek Tributary_JWP_070245\Hydraulics\WinXSPro\SECTION4.OUT
Input File: I:\I-L\Jordan Creek Tributary_JWP_070245\Hydraulics\WinXSPro\SECTION4.DAT
Run Date: 01/28/08
Analysis Procedure: Hydraulics
Cross Section Number: 1
Survey Date: 01/25/08

Subsections/Dividing positions

Resistance Method: Manning's n

SECTION	A
Low Stage n	0.035
High Stage n	0.035

Unadjusted horizontal distances used

STAGE (ft)	SLOPE (ft/ft)	#SEC	AREA (sq ft)	n	PERIM (ft)	VAVG (ft/s)	WIDTH (ft)	Q (cfs)	R (ft)	SHEAR (psf)	DHYD (ft)
0.10	0.0430	T	0.29	0.035	5.83	1.19	5.79	0.35	0.05	0.13	0.05
0.20	0.0430	T	0.89	0.035	6.23	2.41	6.14	2.13	0.14	0.38	0.14
0.30	0.0430	T	1.52	0.035	6.63	3.30	6.49	5.02	0.23	0.61	0.23
0.40	0.0430	T	2.19	0.035	7.04	4.05	6.84	8.85	0.31	0.83	0.32
0.50	0.0430	T	2.89	0.035	7.44	4.70	7.19	13.56	0.39	1.04	0.40
0.60	0.0430	T	3.62	0.035	7.84	5.28	7.54	19.11	0.46	1.24	0.48
0.70	0.0430	T	4.39	0.035	8.25	5.80	7.89	25.50	0.53	1.43	0.56
0.80	0.0430	T	5.20	0.035	8.65	6.29	8.24	32.70	0.60	1.61	0.63

STAGE	ALPHA	FROUDE
0.10	1.000000	0.940826
0.20	1.000000	1.116281
0.30	1.000000	1.203777
0.40	1.000000	1.262320
0.50	1.000000	1.306134
0.60	1.000000	1.341035
0.70	1.000000	1.369986
0.80	1.000000	1.394692

XS - 5 EVR Tributary WinXSPro summary output

******************************WinXSPRO********************************
*

I:\I-L\Jordan Creek
Tributary_JWP_070245\Hydraulics\WinXSPro\SECTION5.OUT
Input File: I:\I-L\Jordan Creek
Tributary_JWP_070245\Hydraulics\WinXSPro\SECTION5.DAT
Run Date: 01/28/08
Analysis Procedure: Hydraulics
Cross Section Number: 1
Survey Date: 01/25/08

Subsections/Dividing positions

Resistance Method: Manning's n

SECTION	A
Low Stage n	0.035
High Stage n	0.035

Unadjusted horizontal distances used

STAGE (ft)	#SEC	AREA (sq ft)	PERIM (ft)	WIDTH (ft)	R (ft)	DHYD (ft)	SLOPE (ft/ft)	n	VAVG (ft/s)	Q (cfs)	SHEAR (psf)
0.10	T	0.07	1.43	1.41	0.05	0.05	0.0430	0.035	1.19	0.08	0.13
0.20	T	0.28	2.85	2.81	0.10	0.10	0.0430	0.035	1.88	0.53	0.26
0.30	T	0.63	4.28	4.22	0.15	0.15	0.0430	0.035	2.47	1.56	0.40
0.40	T	1.12	5.70	5.62	0.20	0.20	0.0430	0.035	2.99	3.36	0.53

STAGE	ALPHA	FROUDE
0.10	1.000000	0.935623
0.20	1.000000	1.050201
0.30	1.000000	1.123624
0.40	1.000000	1.178795

XS - 6 EVR Tributary WinXSPro summary output

******************************WinXSPRO*******************************

I:\I-L\Jordan Creek Tributary_JWP_070245\Hydraulics\WinXSPro
\SECTION6.OUT

Input File: I:\I-L\Jordan Creek Tributary_JWP_070245
\Hydraulics\WinXSPro\SECTION6.DAT

Run Date: 01/28/08

Analysis Procedure: Hydraulics

Cross Section Number: 1

Survey Date: 01/25/08

Subsections/Dividing positions

Resistance Method: Manning's n

SECTION	A
Low Stage n	0.035
High Stage n	0.035

Unadjusted horizontal distances used

STAGE (ft)	#SEC	AREA (sq ft)	PERIM (ft)	WIDTH (ft)	R (ft)	DHYD (ft)	SLOPE (ft/ft)	n	VAVG (ft/s)	Q (cfs)	SHEAR (psf)
0.10	T	0.21	4.24	4.22	0.05	0.05	0.0430	0.035	1.20	0.25	0.13
0.20	T	0.67	4.94	4.90	0.14	0.14	0.0430	0.035	2.32	1.55	0.36
0.30	T	1.19	5.64	5.57	0.21	0.21	0.0430	0.035	3.13	3.72	0.57
0.40	T	1.78	6.34	6.24	0.28	0.29	0.0430	0.035	3.78	6.74	0.75
0.50	T	2.44	7.05	6.91	0.35	0.35	0.0430	0.035	4.35	10.60	0.93

STAGE	ALPHA	FROUDE
0.10	1.000000	0.942374
0.20	1.000000	1.109343
0.30	1.000000	1.192208
0.40	1.000000	1.248054
0.50	1.000000	1.290479

XS - 7 EVR Tributary WinXSPro summary output

```
*****************************WinXSPRO*******************************
I:\I-L\Jordan Creek Tributary_JWP_070245\Hydraulics\WinXSPro
\SECTION7.OUT
Input File:             I:\I-L\Jordan Creek Tributary_JWP_070245
\Hydraulics\WinXSPro\SECTION7.DAT
Run Date:               01/28/08
Analysis Procedure:     Hydraulics
Cross Section Number:  1
Survey Date:            01/25/08


Subsections/Dividing positions


Resistance Method:       Manning's n
            SECTION          A
      Low Stage n          0.035
      High Stage n         0.035

Unadjusted horizontal distances used
```

STAGE (ft)	#SEC	AREA (sq ft)	PERIM (ft)	WIDTH (ft)	R (ft)	DHYD (ft)	SLOPE (ft/ft)	n	VAVG (ft/s)	Q (cfs)	SHEAR (psf)
0.10	T	0.56	6.20	6.18	0.09	0.09	0.0410	0.035	1.72	0.96	0.23
0.20	T	1.24	7.48	7.42	0.17	0.17	0.0410	0.035	2.60	3.21	0.42
0.30	T	2.04	8.75	8.67	0.23	0.24	0.0410	0.035	3.27	6.66	0.60
0.40	T	2.97	10.02	9.92	0.30	0.30	0.0410	0.035	3.83	11.38	0.76
0.50	T	4.02	11.30	11.16	0.36	0.36	0.0410	0.035	4.33	17.43	0.91

STAGE	ALPHA	FROUDE
0.10	1.000000	1.013831
0.20	1.000000	1.121335
0.30	1.000000	1.186413
0.40	1.000000	1.233831
0.50	1.000000	1.271560

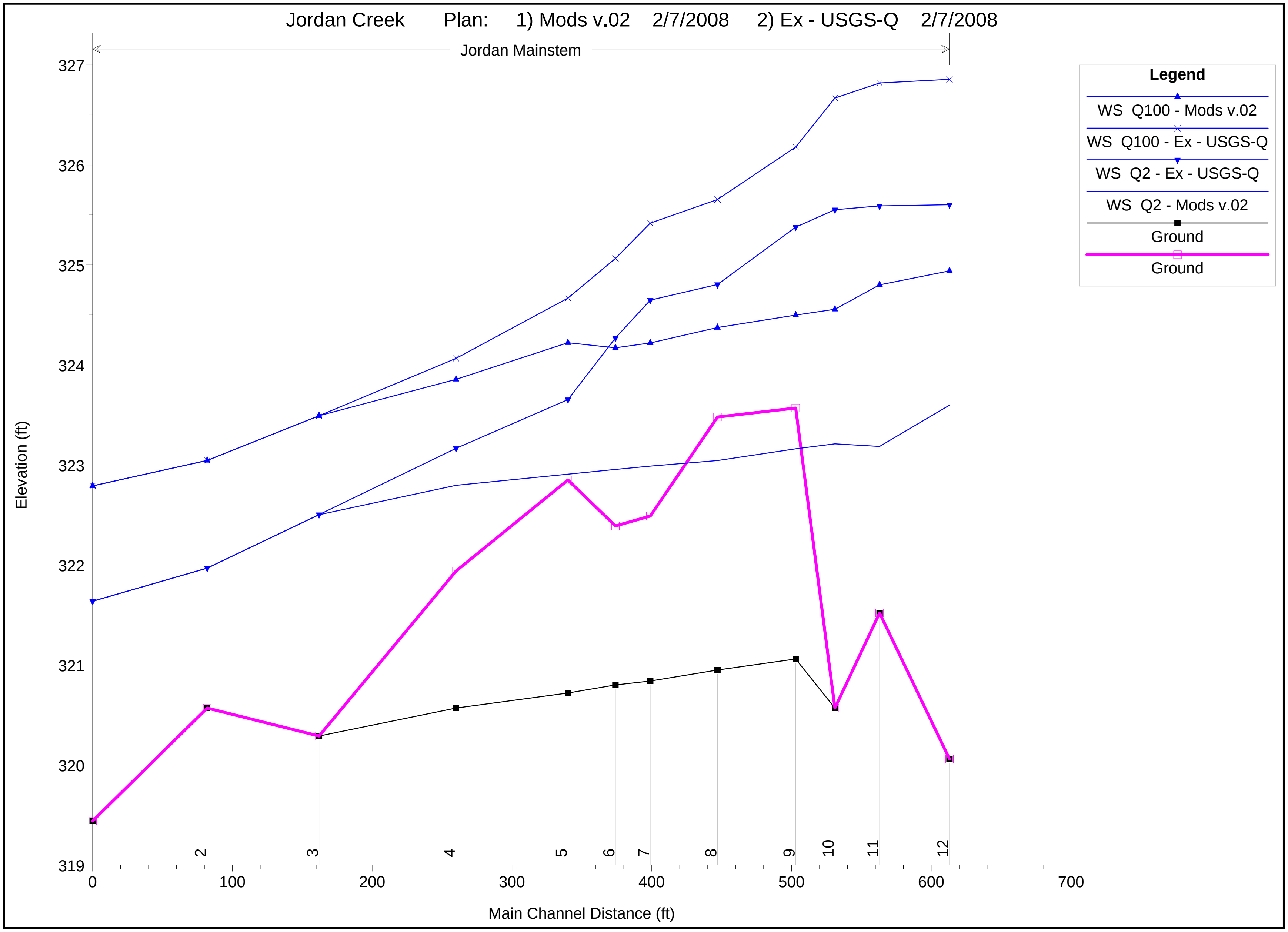
XS - 8 EVR Tributary WinXSPro summary output

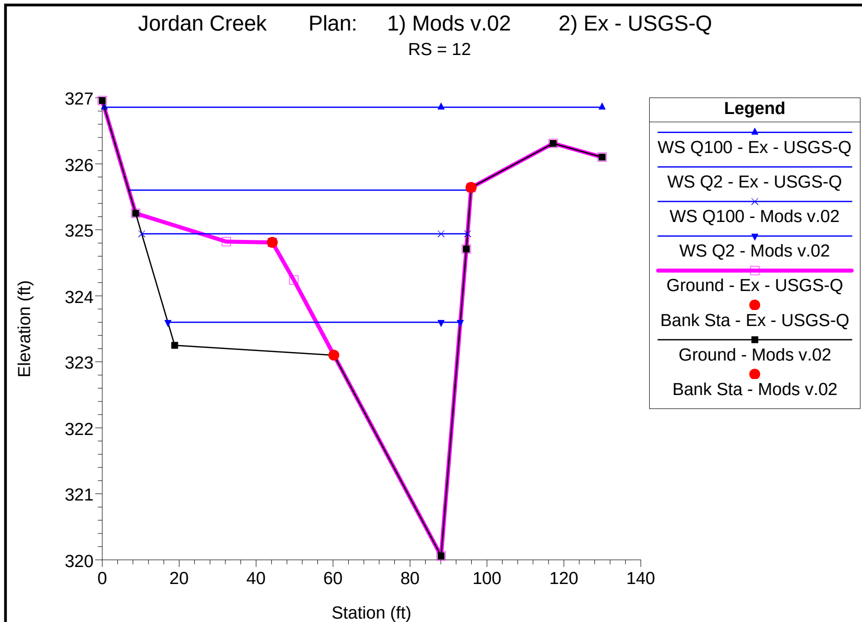
```
*****************************WinXSPRO******************************
I:\I-L\Jordan Creek Tributary_JWP_070245\Hydraulics\WinXSPro
\SECTION8.OUT
Input File:            I:\I-L\Jordan Creek Tributary_JWP_070245
\Hydraulics\WinXSPro\SECTION8.DAT
Run Date:              01/28/08
Analysis Procedure:    Hydraulics
Cross Section Number:  1
Survey Date:           01/25/08


Subsections/Dividing positions


Resistance Method:      Manning's n
            SECTION          A
      Low Stage n          0.035
      High Stage n         0.035

Unadjusted horizontal distances used


 STAGE      #SEC    AREA        PERIM       WIDTH        R     DHYD
      SLOPE           n    VAVG           Q              SHEAR
  (ft)             (sq ft)   (ft)     (ft)        (ft)          (ft)
      (ft/ft)                   (ft/s)    (cfs)   (psf)
  0.10         T     0.02         0.47        0.42       0.04   0.05
      0.0410         0.035       1.08            0.02     0.11
  0.20         T     0.08         0.95        0.84       0.09   0.10
      0.0410         0.035       1.72            0.14     0.23
  0.30         T     0.19         1.42        1.27       0.13   0.15
      0.0410         0.035       2.25            0.43     0.34
  0.40         T     0.34         1.90        1.69       0.18   0.20
      0.0410         0.035       2.73            0.92     0.46
  0.50         T     0.53         2.37        2.11       0.22   0.25
      0.0410         0.035       3.16            1.67     0.57
  0.60         T     0.76         2.84        2.53       0.27   0.30
      0.0410         0.035       3.57            2.71     0.68
  0.70         T     1.03         3.32        2.95       0.31   0.35
      0.0410         0.035       3.96            4.09     0.80
  0.80         T     1.35         3.79        3.37       0.36   0.40
      0.0410         0.035       4.33            5.84     0.91

 STAGE        ALPHA    FROUDE
  0.10     1.000000       0.853035
  0.20     1.000000       0.957500
  0.30     1.000000       1.024442
  0.40     1.000000       1.074758
  0.50     1.000000       1.115481
  0.60     1.000000       1.149898
  0.70     1.000000       1.179824
  0.80     1.000000       1.206360
```

Appendix 3.2

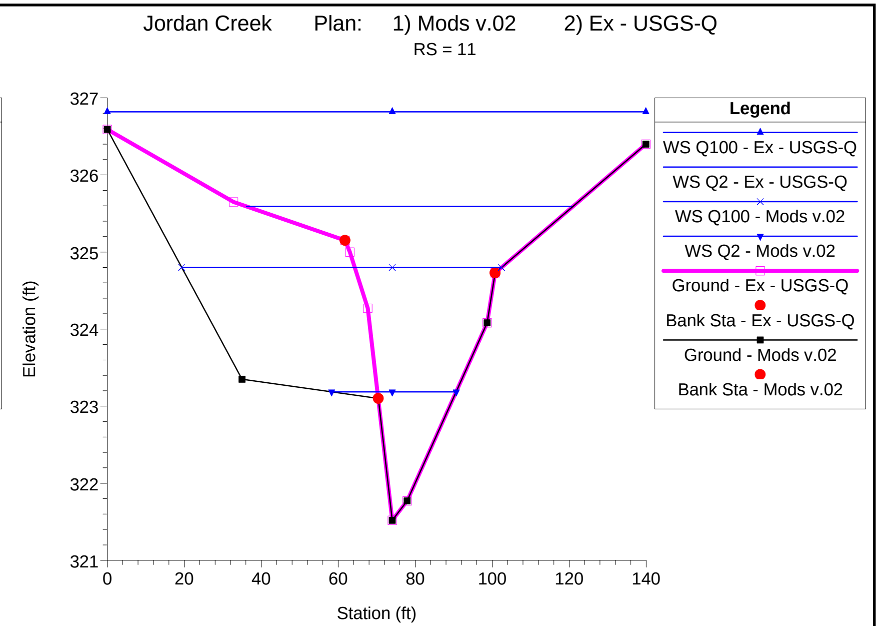
Jordan Creek – HEC-RAS hydraulic analysis
Existing and Alternative 4 conditions

(Note: HEC-RAS cross section locations are shown on Sheet 2)

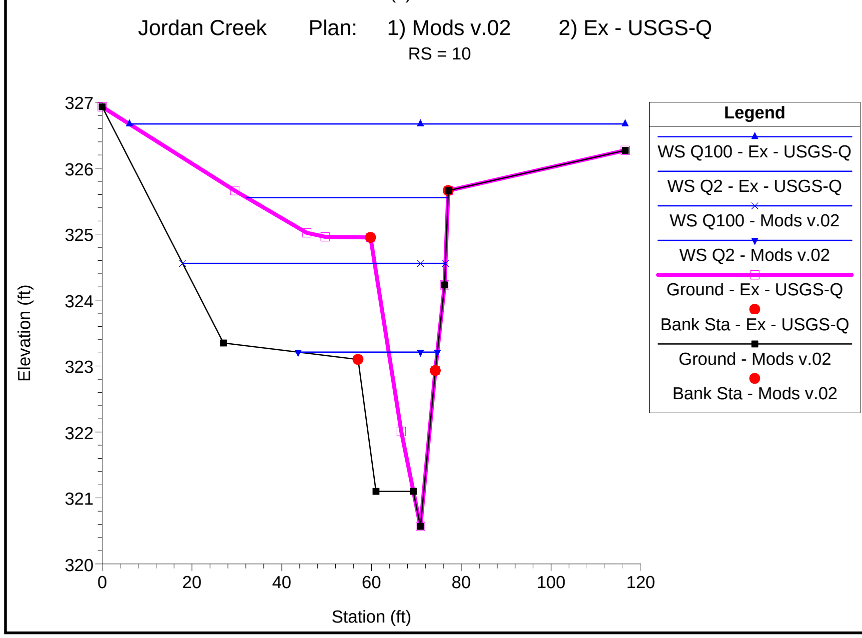

Jordan Creek Plan: 1) Mods v.02 2/7/2008 2) Ex - USGS-Q 2/7/2008
Jordan Mainstem
Legend
WS Q100 - Mods v.02
WS Q100 - Ex - USGS-Q
WS Q2 - Ex - USGS-Q
WS Q2 - Mods v.02
Ground
Ground
Elevation (ft)
Main Channel Distance (ft)
319
320
321
322
323
324
325
326
327
0
100
200
300
400
500
600
700
2
3
4
5
6
7
8
9
10
11
12



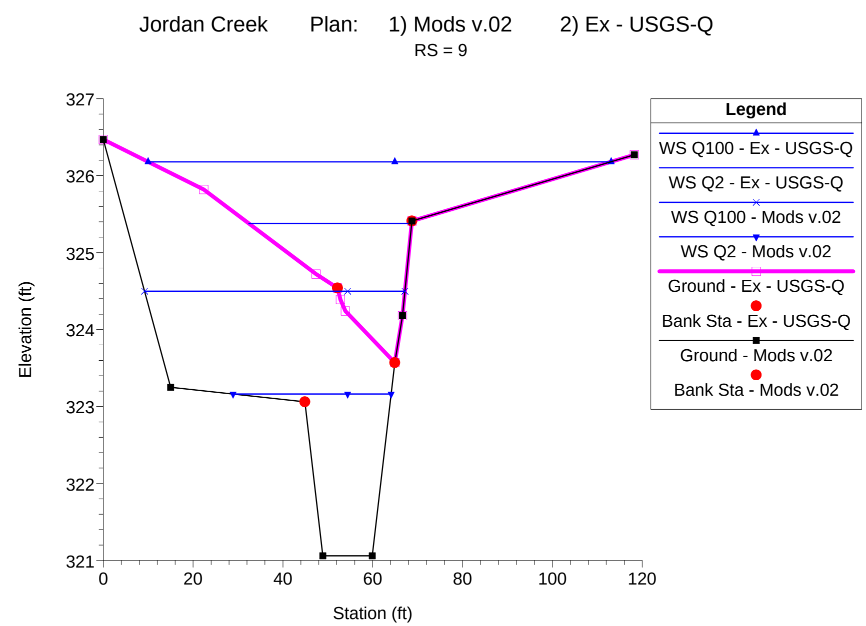
Jordan Creek Plan: 1) Mods v.02 2) Ex - USGS-Q
RS = 12
Elevation (ft)
Station (ft)
Legend
WS Q100 - Ex - USGS-Q
WS Q2 - Ex - USGS-Q
WS Q100 - Mods v.02
WS Q2 - Mods v.02
Ground - Ex - USGS-Q
Bank Sta - Ex - USGS-Q
Ground - Mods v.02
Bank Sta - Mods v.02



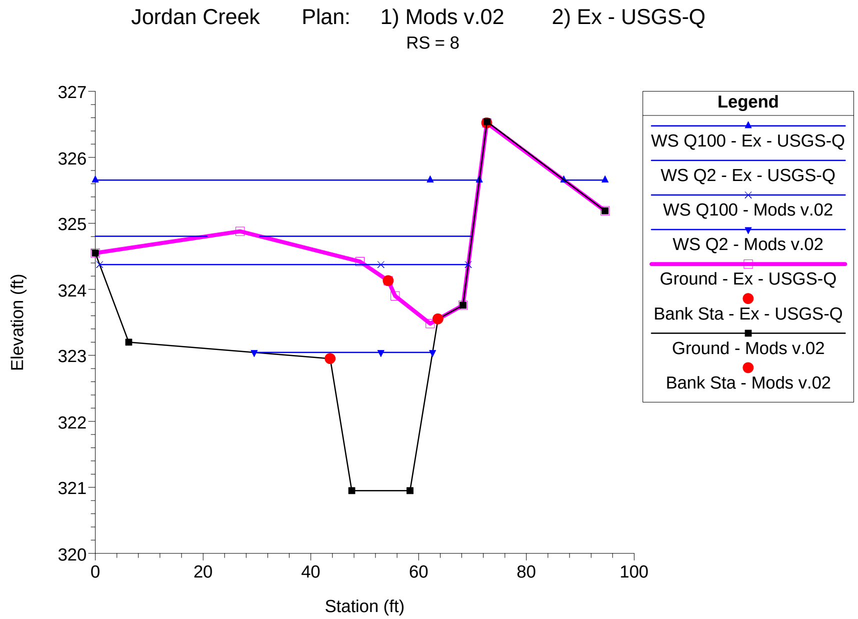
Jordan Creek Plan: 1) Mods v.02 2) Ex - USGS-Q
RS = 11
Elevation (ft)
Station (ft)
Legend
WS Q100 - Ex - USGS-Q
WS Q2 - Ex - USGS-Q
WS Q100 - Mods v.02
WS Q2 - Mods v.02
Ground - Ex - USGS-Q
Bank Sta - Ex - USGS-Q
Ground - Mods v.02
Bank Sta - Mods v.02

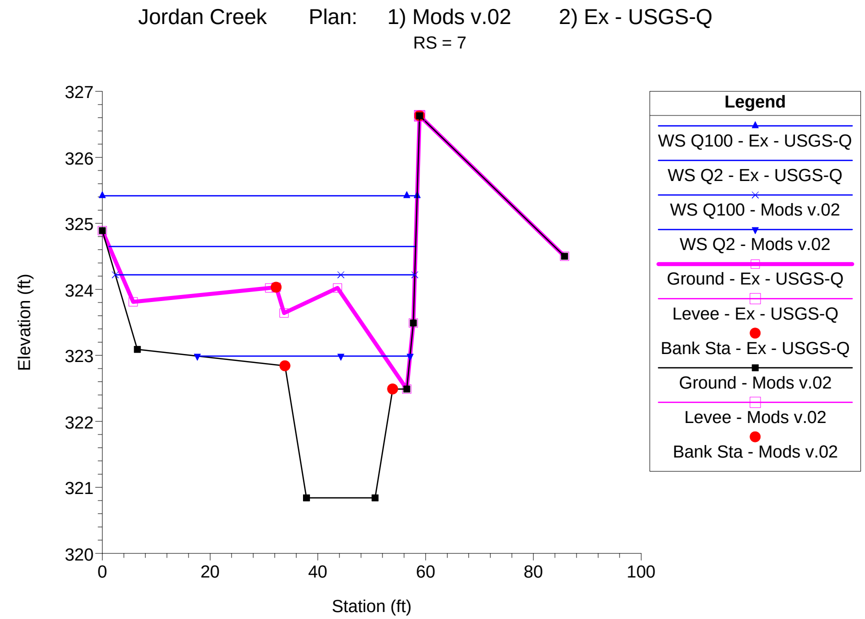


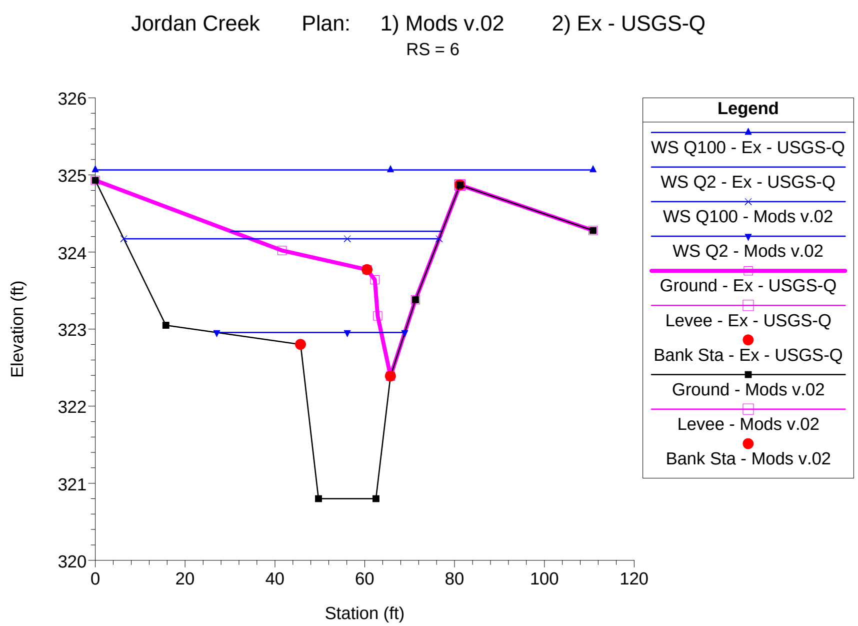
Jordan Creek Plan: 1) Mods v.02 2) Ex - USGS-Q
RS = 10
Elevation (ft)
Station (ft)
Legend
WS Q100 - Ex - USGS-Q
WS Q2 - Ex - USGS-Q
WS Q100 - Mods v.02
WS Q2 - Mods v.02
Ground - Ex - USGS-Q
Bank Sta - Ex - USGS-Q
Ground - Mods v.02
Bank Sta - Mods v.02

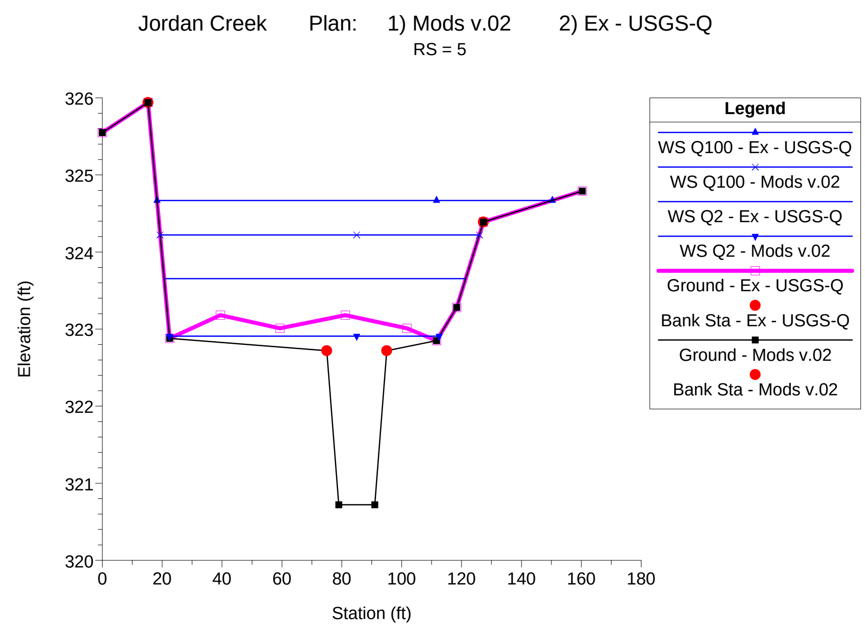


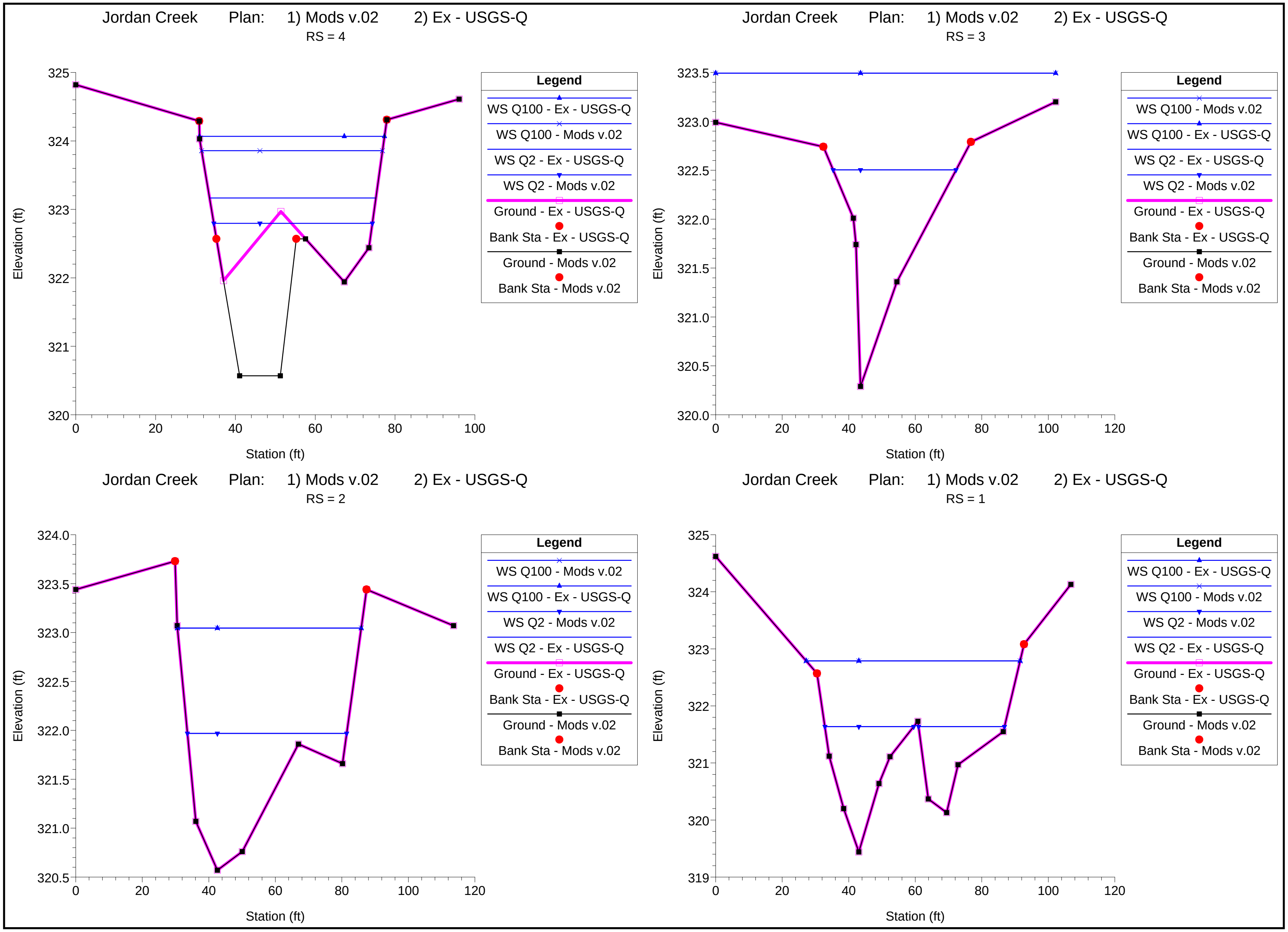
Jordan Creek Plan: 1) Mods v.02 2) Ex - USGS-Q
RS = 9
Elevation (ft)
Station (ft)
Legend
WS Q100 - Ex - USGS-Q
WS Q2 - Ex - USGS-Q
WS Q100 - Mods v.02
WS Q2 - Mods v.02
Ground - Ex - USGS-Q
Bank Sta - Ex - USGS-Q
Ground - Mods v.02
Bank Sta - Mods v.02


Jordan Creek Plan: 1) Mods v.02 2) Ex - USGS-Q
RS = 8
Elevation (ft)
Station (ft)
Legend
WS Q100 - Ex - USGS-Q
WS Q2 - Ex - USGS-Q
WS Q100 - Mods v.02
WS Q2 - Mods v.02
Ground - Ex - USGS-Q
Bank Sta - Ex - USGS-Q
Ground - Mods v.02
Bank Sta - Mods v.02


Jordan Creek Plan: 1) Mods v.02 2) Ex - USGS-Q
RS = 7
Elevation (ft)
Station (ft)
Legend
WS Q100 - Ex - USGS-Q
WS Q2 - Ex - USGS-Q
WS Q100 - Mods v.02
WS Q2 - Mods v.02
Ground - Ex - USGS-Q
Levee - Ex - USGS-Q
Bank Sta - Ex - USGS-Q
Ground - Mods v.02
Levee - Mods v.02
Bank Sta - Mods v.02


Jordan Creek Plan: 1) Mods v.02 2) Ex - USGS-Q
RS = 6
Elevation (ft)
Station (ft)
Legend
WS Q100 - Ex - USGS-Q
WS Q2 - Ex - USGS-Q
WS Q100 - Mods v.02
WS Q2 - Mods v.02
Ground - Ex - USGS-Q
Levee - Ex - USGS-Q
Bank Sta - Ex - USGS-Q
Ground - Mods v.02
Levee - Mods v.02
Bank Sta - Mods v.02


Jordan Creek Plan: 1) Mods v.02 2) Ex - USGS-Q
RS = 5
Elevation (ft)
Station (ft)
Legend
WS Q100 - Ex - USGS-Q
WS Q100 - Mods v.02
WS Q2 - Ex - USGS-Q
WS Q2 - Mods v.02
Ground - Ex - USGS-Q
Bank Sta - Ex - USGS-Q
Ground - Mods v.02
Bank Sta - Mods v.02


Jordan Creek Plan: 1) Mods v.02 2) Ex - USGS-Q
RS = 4
Legend
WS Q100 - Ex - USGS-Q
WS Q100 - Mods v.02
WS Q2 - Ex - USGS-Q
WS Q2 - Mods v.02
Ground - Ex - USGS-Q
Bank Sta - Ex - USGS-Q
Ground - Mods v.02
Bank Sta - Mods v.02
Elevation (ft)
325
324
323
322
321
320
0
20
40
60
80
100
Station (ft)
Jordan Creek Plan: 1) Mods v.02 2) Ex - USGS-Q
RS = 3
Legend
WS Q100 - Mods v.02
WS Q100 - Ex - USGS-Q
WS Q2 - Ex - USGS-Q
WS Q2 - Mods v.02
Ground - Ex - USGS-Q
Bank Sta - Ex - USGS-Q
Ground - Mods v.02
Bank Sta - Mods v.02
Elevation (ft)
323.5
323.0
322.5
322.0
321.5
321.0
320.5
320.0
0
20
40
60
80
100
120
Station (ft)
Jordan Creek Plan: 1) Mods v.02 2) Ex - USGS-Q
RS = 2
Legend
WS Q100 - Mods v.02
WS Q100 - Ex - USGS-Q
WS Q2 - Mods v.02
WS Q2 - Ex - USGS-Q
Ground - Ex - USGS-Q
Bank Sta - Ex - USGS-Q
Ground - Mods v.02
Bank Sta - Mods v.02
Elevation (ft)
324.0
323.5
323.0
322.5
322.0
321.5
321.0
320.5
0
20
40
60
80
100
120
Station (ft)
Jordan Creek Plan: 1) Mods v.02 2) Ex - USGS-Q
RS = 1
Legend
WS Q100 - Ex - USGS-Q
WS Q100 - Mods v.02
WS Q2 - Mods v.02
WS Q2 - Ex - USGS-Q
Ground - Ex - USGS-Q
Bank Sta - Ex - USGS-Q
Ground - Mods v.02
Bank Sta - Mods v.02
Elevation (ft)
325
324
323
322
321
320
319
0
20
40
60
80
100
120
Station (ft)

HEC-RAS River: Jordan Reach: Mainstem

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)	
Mainstem	12	10-cfs	Mods v.02	10.00	320.06	322.34	320.80	322.34	0.000057	0.36	27.53	24.13	0.06
Mainstem	12	10-cfs	Ex - USGS-Q	10.00	320.06	324.46	320.80	324.46	0.000002	0.10	102.47	46.68	0.01
Mainstem	12	25-cfs	Mods v.02	25.00	320.06	322.75	321.12	322.75	0.000149	0.65	38.21	28.43	0.10
Mainstem	12	25-cfs	Ex - USGS-Q	25.00	320.06	324.80	321.12	324.80	0.000007	0.21	119.05	50.47	0.02
Mainstem	12	50-cfs	Mods v.02	50.00	320.06	323.17	321.47	323.19	0.000265	0.98	51.96	52.41	0.14
Mainstem	12	50-cfs	Ex - USGS-Q	50.00	320.06	325.23	321.46	325.24	0.000017	0.35	150.72	85.82	0.04
Mainstem	12	75-cfs	Mods v.02	75.00	320.06	323.48	321.71	323.50	0.000314	1.18	73.60	75.21	0.15
Mainstem	12	75-cfs	Ex - USGS-Q	75.00	320.06	325.50	321.71	325.50	0.000027	0.47	173.67	88.26	0.05
Mainstem	12	Q2	Mods v.02	87.00	320.06	323.60	321.81	323.62	0.000329	1.26	82.90	76.01	0.16
Mainstem	12	Q2	Ex - USGS-Q	87.00	320.06	325.60	321.81	325.61	0.000032	0.53	182.98	88.93	0.05
Mainstem	12	Q5	Mods v.02	137.00	320.06	323.93	322.16	323.96	0.000441	1.59	108.09	78.13	0.19
Mainstem	12	Q5	Ex - USGS-Q	137.00	320.06	325.94	322.16	325.95	0.000053	0.73	215.00	100.34	0.07
Mainstem	12	Q10	Mods v.02	179.00	320.06	324.17	322.39	324.22	0.000497	1.80	127.71	79.74	0.20
Mainstem	12	Q10	Ex - USGS-Q	179.00	320.06	326.18	322.39	326.20	0.000070	0.88	240.54	114.37	0.08
Mainstem	12	Q25	Mods v.02	242.00	320.06	324.50	322.71	324.55	0.000559	2.05	153.78	81.84	0.22
Mainstem	12	Q25	Ex - USGS-Q	242.00	320.06	326.49	322.69	326.50	0.000094	1.07	277.97	127.53	0.09
Mainstem	12	Q50	Mods v.02	291.00	320.06	324.72	322.89	324.78	0.000599	2.21	172.11	83.28	0.23
Mainstem	12	Q50	Ex - USGS-Q	291.00	320.06	326.68	322.90	326.70	0.000112	1.20	302.74	128.51	0.10
Mainstem	12	Q100	Mods v.02	344.00	320.06	324.94	323.10	325.01	0.000632	2.37	190.76	84.70	0.23
Mainstem	12	Q100	Ex - USGS-Q	344.00	320.06	326.86	323.11	326.88	0.000132	1.34	325.73	129.42	0.11
Mainstem	11	10-cfs	Mods v.02	10.00	321.52	322.14	322.14	322.32	0.023199	3.34	2.99	8.65	1.00
Mainstem	11	10-cfs	Ex - USGS-Q	10.00	321.52	324.46		324.46	0.000010	0.19	53.11	33.43	0.03
Mainstem	11	25-cfs	Mods v.02	25.00	321.52	322.44	322.44	322.70	0.020971	4.09	6.11	12.05	1.01
Mainstem	11	25-cfs	Ex - USGS-Q	25.00	321.52	324.80		324.80	0.000035	0.38	65.06	38.10	0.05
Mainstem	11	50-cfs	Mods v.02	50.00	321.52	322.77	322.77	323.11	0.018750	4.69	10.66	15.76	1.00
Mainstem	11	50-cfs	Ex - USGS-Q	50.00	321.52	325.23		325.23	0.000072	0.61	84.32	55.23	0.07
Mainstem	11	75-cfs	Mods v.02	75.00	321.52	323.04	323.00	323.41	0.016022	4.90	15.30	18.79	0.96
Mainstem	11	75-cfs	Ex - USGS-Q	75.00	321.52	325.49		325.50	0.000107	0.81	101.34	76.31	0.09
Mainstem	11	Q2	Mods v.02	87.00	321.52	323.19	323.11	323.54	0.013397	4.78	18.67	32.36	0.89
Mainstem	11	Q2	Ex - USGS-Q	87.00	321.52	325.59		325.60	0.000122	0.89	109.65	84.72	0.10
Mainstem	11	Q5	Mods v.02	137.00	321.52	323.70		323.89	0.005871	3.84	47.07	64.01	0.62
Mainstem	11	Q5	Ex - USGS-Q	137.00	321.52	325.92		325.94	0.000185	1.19	141.48	105.49	0.13
Mainstem	11	Q10	Mods v.02	179.00	321.52	324.00		324.15	0.004249	3.57	67.12	69.94	0.54
Mainstem	11	Q10	Ex - USGS-Q	179.00	321.52	326.16		326.19	0.000226	1.39	168.08	119.30	0.14
Mainstem	11	Q25	Mods v.02	242.00	321.52	324.34		324.49	0.003271	3.52	92.33	75.26	0.49
Mainstem	11	Q25	Ex - USGS-Q	242.00	321.52	326.46		326.49	0.000278	1.64	205.75	135.20	0.16
Mainstem	11	Q50	Mods v.02	291.00	321.52	324.57		324.72	0.002898	3.56	110.01	78.46	0.47
Mainstem	11	Q50	Ex - USGS-Q	291.00	321.52	326.64		326.69	0.000312	1.81	231.97	139.90	0.17
Mainstem	11	Q100	Mods v.02	344.00	321.52	324.80		324.95	0.002618	3.63	128.28	83.07	0.45
Mainstem	11	Q100	Ex - USGS-Q	344.00	321.52	326.82		326.87	0.000346	1.97	256.44	139.90	0.18

HEC-RAS River: Jordan Reach: Mainstem (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)	
Mainstem	10	10-cfs	Mods v.02	10.00	320.57	321.79	321.34	321.81	0.001159	1.14	8.76	13.00	0.24
Mainstem	10	10-cfs	Ex - USGS-Q	10.00	320.57	324.46		324.46	0.000023	0.32	31.44	15.52	0.04
Mainstem	10	25-cfs	Mods v.02	25.00	320.57	322.26	321.58	322.30	0.001343	1.63	15.29	14.61	0.28
Mainstem	10	25-cfs	Ex - USGS-Q	25.00	320.57	324.79		324.80	0.000093	0.68	36.78	16.48	0.08
Mainstem	10	50-cfs	Mods v.02	50.00	320.57	322.75	321.88	322.82	0.001657	2.19	22.81	16.27	0.33
Mainstem	10	50-cfs	Ex - USGS-Q	50.00	320.57	325.21		325.23	0.000215	1.13	47.75	36.02	0.12
Mainstem	10	75-cfs	Mods v.02	75.00	320.57	323.09		323.20	0.001909	2.63	28.58	17.46	0.36
Mainstem	10	75-cfs	Ex - USGS-Q	75.00	320.57	325.46		325.49	0.000346	1.51	57.36	42.31	0.16
Mainstem	10	Q2	Mods v.02	87.00	320.57	323.21		323.34	0.002026	2.83	31.45	31.04	0.37
Mainstem	10	Q2	Ex - USGS-Q	87.00	320.57	325.55		325.59	0.000408	1.67	61.57	44.78	0.17
Mainstem	10	Q5	Mods v.02	137.00	320.57	323.60		323.77	0.002292	3.44	49.24	50.19	0.41
Mainstem	10	Q5	Ex - USGS-Q	137.00	320.57	325.86		325.93	0.000669	2.28	77.51	64.70	0.23
Mainstem	10	Q10	Mods v.02	179.00	320.57	323.84		324.05	0.002450	3.82	61.73	52.42	0.43
Mainstem	10	Q10	Ex - USGS-Q	179.00	320.57	326.07		326.17	0.000848	2.68	93.42	83.57	0.26
Mainstem	10	Q25	Mods v.02	242.00	320.57	324.14		324.39	0.002650	4.29	77.84	55.15	0.46
Mainstem	10	Q25	Ex - USGS-Q	242.00	320.57	326.34		326.47	0.001061	3.15	118.87	102.74	0.29
Mainstem	10	Q50	Mods v.02	291.00	320.57	324.35		324.62	0.002760	4.60	89.33	56.90	0.47
Mainstem	10	Q50	Ex - USGS-Q	291.00	320.57	326.51		326.66	0.001197	3.45	137.04	106.77	0.31
Mainstem	10	Q100	Mods v.02	344.00	320.57	324.56		324.85	0.002832	4.88	101.32	58.58	0.49
Mainstem	10	Q100	Ex - USGS-Q	344.00	320.57	326.67		326.84	0.001342	3.75	154.15	110.44	0.33
Mainstem	9	10-cfs	Mods v.02	10.00	321.06	321.75		321.77	0.001300	1.17	8.58	13.76	0.26
Mainstem	9	10-cfs	Ex - USGS-Q	10.00	323.57	324.42		324.46	0.003331	1.47	6.79	14.38	0.38
Mainstem	9	25-cfs	Mods v.02	25.00	321.06	322.22		322.26	0.001358	1.61	15.51	15.65	0.29
Mainstem	9	25-cfs	Ex - USGS-Q	25.00	323.57	324.71		324.79	0.004421	2.24	11.46	19.81	0.47
Mainstem	9	50-cfs	Mods v.02	50.00	321.06	322.71		322.78	0.001605	2.13	23.50	17.57	0.32
Mainstem	9	50-cfs	Ex - USGS-Q	50.00	323.57	325.10	324.68	325.20	0.003912	2.73	20.98	29.32	0.47
Mainstem	9	75-cfs	Mods v.02	75.00	321.06	323.04		323.14	0.001847	2.53	29.65	18.91	0.36
Mainstem	9	75-cfs	Ex - USGS-Q	75.00	323.57	325.30	324.92	325.45	0.004620	3.29	27.52	34.35	0.52
Mainstem	9	Q2	Mods v.02	87.00	321.06	323.16		323.28	0.001977	2.72	32.74	35.20	0.37
Mainstem	9	Q2	Ex - USGS-Q	87.00	323.57	325.38		325.55	0.004965	3.53	30.27	36.26	0.54
Mainstem	9	Q5	Mods v.02	137.00	321.06	323.55		323.70	0.002231	3.24	51.57	51.27	0.41
Mainstem	9	Q5	Ex - USGS-Q	137.00	323.57	325.58	325.34	325.86	0.007041	4.61	38.80	50.57	0.66
Mainstem	9	Q10	Mods v.02	179.00	321.06	323.79		323.97	0.002333	3.57	64.21	53.06	0.42
Mainstem	9	Q10	Ex - USGS-Q	179.00	323.57	325.73	325.57	326.09	0.008054	5.25	47.38	62.74	0.72
Mainstem	9	Q25	Mods v.02	242.00	321.06	324.09		324.30	0.002485	4.01	80.28	55.28	0.45
Mainstem	9	Q25	Ex - USGS-Q	242.00	323.57	325.93	325.84	326.37	0.008918	5.96	61.77	80.28	0.77
Mainstem	9	Q50	Mods v.02	291.00	321.06	324.29		324.53	0.002574	4.30	91.65	56.67	0.46
Mainstem	9	Q50	Ex - USGS-Q	291.00	323.57	326.05	326.04	326.55	0.009634	6.47	72.27	91.53	0.81
Mainstem	9	Q100	Mods v.02	344.00	321.06	324.50		324.76	0.002629	4.56	103.46	57.98	0.47
Mainstem	9	Q100	Ex - USGS-Q	344.00	323.57	326.18		326.72	0.010024	6.87	84.52	103.12	0.83

HEC-RAS River: Jordan Reach: Mainstem (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)	
Mainstem	8	10-cfs	Mods v.02	10.00	320.95	321.69		321.71	0.001084	1.10	9.06	13.75	0.24
Mainstem	8	10-cfs	Ex - USGS-Q	10.00	323.48	323.94	323.93	324.06	0.023709	2.76	3.62	13.11	0.93
Mainstem	8	25-cfs	Mods v.02	25.00	320.95	322.15		322.19	0.001254	1.57	15.88	15.61	0.28
Mainstem	8	25-cfs	Ex - USGS-Q	25.00	323.48	324.28		324.41	0.010667	2.98	8.55	17.34	0.70
Mainstem	8	50-cfs	Mods v.02	50.00	320.95	322.62		322.69	0.001583	2.12	23.55	17.46	0.32
Mainstem	8	50-cfs	Ex - USGS-Q	50.00	323.48	324.42	324.42	324.76	0.020012	4.70	11.25	20.17	0.99
Mainstem	8	75-cfs	Mods v.02	75.00	320.95	322.94		323.04	0.001896	2.56	29.32	18.74	0.36
Mainstem	8	75-cfs	Ex - USGS-Q	75.00	323.48	324.71	324.71	325.03	0.013184	4.70	20.22	47.64	0.84
Mainstem	8	Q2	Mods v.02	87.00	320.95	323.04		323.16	0.002067	2.77	32.05	33.11	0.38
Mainstem	8	Q2	Ex - USGS-Q	87.00	323.48	324.80	324.80	325.12	0.012174	4.77	25.32	60.08	0.82
Mainstem	8	Q5	Mods v.02	137.00	320.95	323.41		323.57	0.002392	3.32	51.31	58.11	0.42
Mainstem	8	Q5	Ex - USGS-Q	137.00	323.48	325.07	325.07	325.38	0.010609	5.08	43.49	70.32	0.79
Mainstem	8	Q10	Mods v.02	179.00	320.95	323.66		323.84	0.002450	3.61	65.85	61.90	0.43
Mainstem	8	Q10	Ex - USGS-Q	179.00	323.48	325.20	325.20	325.55	0.011506	5.58	52.50	70.64	0.83
Mainstem	8	Q25	Mods v.02	242.00	320.95	323.96		324.16	0.002497	3.97	85.13	65.82	0.44
Mainstem	8	Q25	Ex - USGS-Q	242.00	323.48	325.36		325.77	0.012578	6.21	64.26	73.59	0.88
Mainstem	8	Q50	Mods v.02	291.00	320.95	324.16		324.38	0.002511	4.20	98.79	67.10	0.45
Mainstem	8	Q50	Ex - USGS-Q	291.00	323.48	325.51		325.93	0.011935	6.37	75.50	76.31	0.87
Mainstem	8	Q100	Mods v.02	344.00	320.95	324.38		324.61	0.002486	4.39	113.16	68.41	0.46
Mainstem	8	Q100	Ex - USGS-Q	344.00	323.48	325.65		326.08	0.011546	6.56	86.72	78.93	0.87
Mainstem	7	10-cfs	Mods v.02	10.00	320.84	321.66	321.11	321.67	0.000561	0.85	11.71	15.97	0.18
Mainstem	7	10-cfs	Ex - USGS-Q	10.00	322.49	323.54	323.26	323.60	0.004888	1.88	5.31	10.07	0.46
Mainstem	7	25-cfs	Mods v.02	25.00	320.84	322.12	321.32	322.14	0.000756	1.28	19.46	17.80	0.22
Mainstem	7	25-cfs	Ex - USGS-Q	25.00	322.49	324.00	323.60	324.06	0.004823	1.85	15.31	49.56	0.45
Mainstem	7	50-cfs	Mods v.02	50.00	320.84	322.57	321.59	322.62	0.001025	1.79	28.17	22.17	0.26
Mainstem	7	50-cfs	Ex - USGS-Q	50.00	322.49	324.36	324.02	324.40	0.002348	1.80	34.60	55.24	0.34
Mainstem	7	75-cfs	Mods v.02	75.00	320.84	322.88	321.81	322.96	0.001218	2.18	35.36	27.79	0.29
Mainstem	7	75-cfs	Ex - USGS-Q	75.00	322.49	324.57	324.15	324.62	0.002278	2.04	46.10	56.41	0.35
Mainstem	7	Q2	Mods v.02	87.00	320.84	322.99	321.91	323.08	0.001329	2.37	38.92	39.49	0.31
Mainstem	7	Q2	Ex - USGS-Q	87.00	322.49	324.65	324.20	324.71	0.002311	2.15	50.69	56.87	0.36
Mainstem	7	Q5	Mods v.02	137.00	320.84	323.34	322.26	323.47	0.001638	2.97	56.43	51.96	0.36
Mainstem	7	Q5	Ex - USGS-Q	137.00	322.49	324.91	324.37	325.00	0.002605	2.61	65.89	58.25	0.39
Mainstem	7	Q10	Mods v.02	179.00	320.84	323.57	322.51	323.73	0.001833	3.35	68.41	52.99	0.38
Mainstem	7	Q10	Ex - USGS-Q	179.00	322.49	325.08	324.49	325.19	0.002886	2.95	75.77	58.31	0.42
Mainstem	7	Q25	Mods v.02	242.00	320.84	323.85	322.85	324.05	0.002097	3.86	83.29	54.10	0.42
Mainstem	7	Q25	Ex - USGS-Q	242.00	322.49	325.23	324.66	325.38	0.003798	3.58	84.20	58.37	0.48
Mainstem	7	Q50	Mods v.02	291.00	320.84	324.03	323.25	324.27	0.002276	4.21	93.40	54.84	0.44
Mainstem	7	Q50	Ex - USGS-Q	291.00	322.49	325.33	324.78	325.52	0.004457	4.02	90.01	58.40	0.53
Mainstem	7	Q100	Mods v.02	344.00	320.84	324.22	323.45	324.48	0.002430	4.53	103.71	55.58	0.46
Mainstem	7	Q100	Ex - USGS-Q	344.00	322.49	325.42	324.91	325.66	0.005187	4.47	95.42	58.44	0.57

HEC-RAS River: Jordan Reach: Mainstem (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)	
Mainstem	6	10-cfs	Mods v.02	10.00	320.80	321.64	321.07	321.65	0.000495	0.82	12.23	16.19	0.17
Mainstem	6	10-cfs	Ex - USGS-Q	10.00	322.39	323.35	323.17	323.44	0.008185	2.37	4.22	8.48	0.59
Mainstem	6	25-cfs	Mods v.02	25.00	320.80	322.10	321.28	322.12	0.000702	1.25	19.99	18.02	0.21
Mainstem	6	25-cfs	Ex - USGS-Q	25.00	322.39	323.52	323.52	323.81	0.022112	4.34	5.76	9.79	1.00
Mainstem	6	50-cfs	Mods v.02	50.00	320.80	322.55	321.55	322.59	0.000971	1.76	28.51	20.39	0.26
Mainstem	6	50-cfs	Ex - USGS-Q	50.00	322.39	323.95	323.95	324.25	0.016360	4.45	12.22	27.87	0.90
Mainstem	6	75-cfs	Mods v.02	75.00	320.80	322.85	321.77	322.93	0.001182	2.17	35.30	29.04	0.29
Mainstem	6	75-cfs	Ex - USGS-Q	75.00	322.39	324.19	324.19	324.48	0.013070	4.51	21.15	43.00	0.83
Mainstem	6	Q2	Mods v.02	87.00	320.80	322.96	321.86	323.04	0.001301	2.36	38.92	41.86	0.31
Mainstem	6	Q2	Ex - USGS-Q	87.00	322.39	324.27	324.27	324.56	0.012921	4.64	24.63	47.06	0.83
Mainstem	6	Q5	Mods v.02	137.00	320.80	323.30	322.21	323.43	0.001621	2.96	57.37	57.24	0.35
Mainstem	6	Q5	Ex - USGS-Q	137.00	322.39	324.52	324.52	324.84	0.012808	5.09	37.95	60.07	0.85
Mainstem	6	Q10	Mods v.02	179.00	320.80	323.53	322.46	323.68	0.001811	3.34	70.57	60.53	0.38
Mainstem	6	Q10	Ex - USGS-Q	179.00	322.39	324.67	324.67	325.02	0.013229	5.44	47.58	67.94	0.87
Mainstem	6	Q25	Mods v.02	242.00	320.80	323.80	322.80	323.99	0.002053	3.82	87.72	64.64	0.41
Mainstem	6	Q25	Ex - USGS-Q	242.00	322.39	324.87	324.87	325.19	0.011943	5.50	71.06	108.12	0.84
Mainstem	6	Q50	Mods v.02	291.00	320.80	323.98	323.23	324.21	0.002205	4.14	99.90	67.41	0.43
Mainstem	6	Q50	Ex - USGS-Q	291.00	322.39	324.98	324.98	325.32	0.011703	5.75	83.11	110.85	0.85
Mainstem	6	Q100	Mods v.02	344.00	320.80	324.17	323.43	324.42	0.002320	4.43	112.79	70.22	0.45
Mainstem	6	Q100	Ex - USGS-Q	344.00	322.39	325.07	325.07	325.43	0.012152	6.09	92.69	110.85	0.87
Mainstem	5	10-cfs	Mods v.02	10.00	320.72	321.63		321.64	0.000490	0.80	12.54	15.63	0.16
Mainstem	5	10-cfs	Ex - USGS-Q	10.00	322.85	323.21	323.12	323.22	0.004190	0.71	14.13	95.56	0.32
Mainstem	5	25-cfs	Mods v.02	25.00	320.72	322.07		322.10	0.000770	1.26	19.89	17.41	0.21
Mainstem	5	25-cfs	Ex - USGS-Q	25.00	322.85	323.33	323.19	323.35	0.003565	0.97	25.90	97.36	0.33
Mainstem	5	50-cfs	Mods v.02	50.00	320.72	322.51		322.56	0.001150	1.80	27.85	19.15	0.26
Mainstem	5	50-cfs	Ex - USGS-Q	50.00	322.85	323.47	323.27	323.49	0.003705	1.28	39.04	98.76	0.36
Mainstem	5	75-cfs	Mods v.02	75.00	320.72	322.81		322.88	0.001447	2.22	35.36	58.89	0.30
Mainstem	5	75-cfs	Ex - USGS-Q	75.00	322.85	323.60	323.33	323.63	0.003271	1.44	51.98	100.11	0.35
Mainstem	5	Q2	Mods v.02	87.00	320.72	322.91		322.99	0.001523	2.37	43.55	90.14	0.31
Mainstem	5	Q2	Ex - USGS-Q	87.00	322.85	323.65	323.36	323.69	0.003121	1.51	57.77	100.71	0.35
Mainstem	5	Q5	Mods v.02	137.00	320.72	323.28		323.36	0.001401	2.57	78.25	96.81	0.31
Mainstem	5	Q5	Ex - USGS-Q	137.00	322.85	323.90	323.46	323.94	0.002420	1.66	82.72	103.27	0.33
Mainstem	5	Q10	Mods v.02	179.00	320.72	323.52		323.61	0.001312	2.68	102.19	99.36	0.30
Mainstem	5	Q10	Ex - USGS-Q	179.00	322.85	324.08	323.54	324.13	0.002115	1.76	101.89	105.19	0.31
Mainstem	5	Q25	Mods v.02	242.00	320.72	323.82		323.91	0.001260	2.83	132.19	102.46	0.30
Mainstem	5	Q25	Ex - USGS-Q	242.00	322.85	324.33	323.64	324.38	0.001870	1.89	127.93	107.74	0.31
Mainstem	5	Q50	Mods v.02	291.00	320.72	324.02		324.11	0.001241	2.95	152.85	104.54	0.31
Mainstem	5	Q50	Ex - USGS-Q	291.00	322.85	324.50	323.72	324.56	0.001742	1.99	146.93	117.54	0.30
Mainstem	5	Q100	Mods v.02	344.00	320.72	324.22		324.32	0.001217	3.06	174.15	106.65	0.31
Mainstem	5	Q100	Ex - USGS-Q	344.00	322.85	324.67	323.79	324.74	0.001635	2.08	168.30	132.06	0.30

HEC-RAS River: Jordan Reach: Mainstem (Continued)

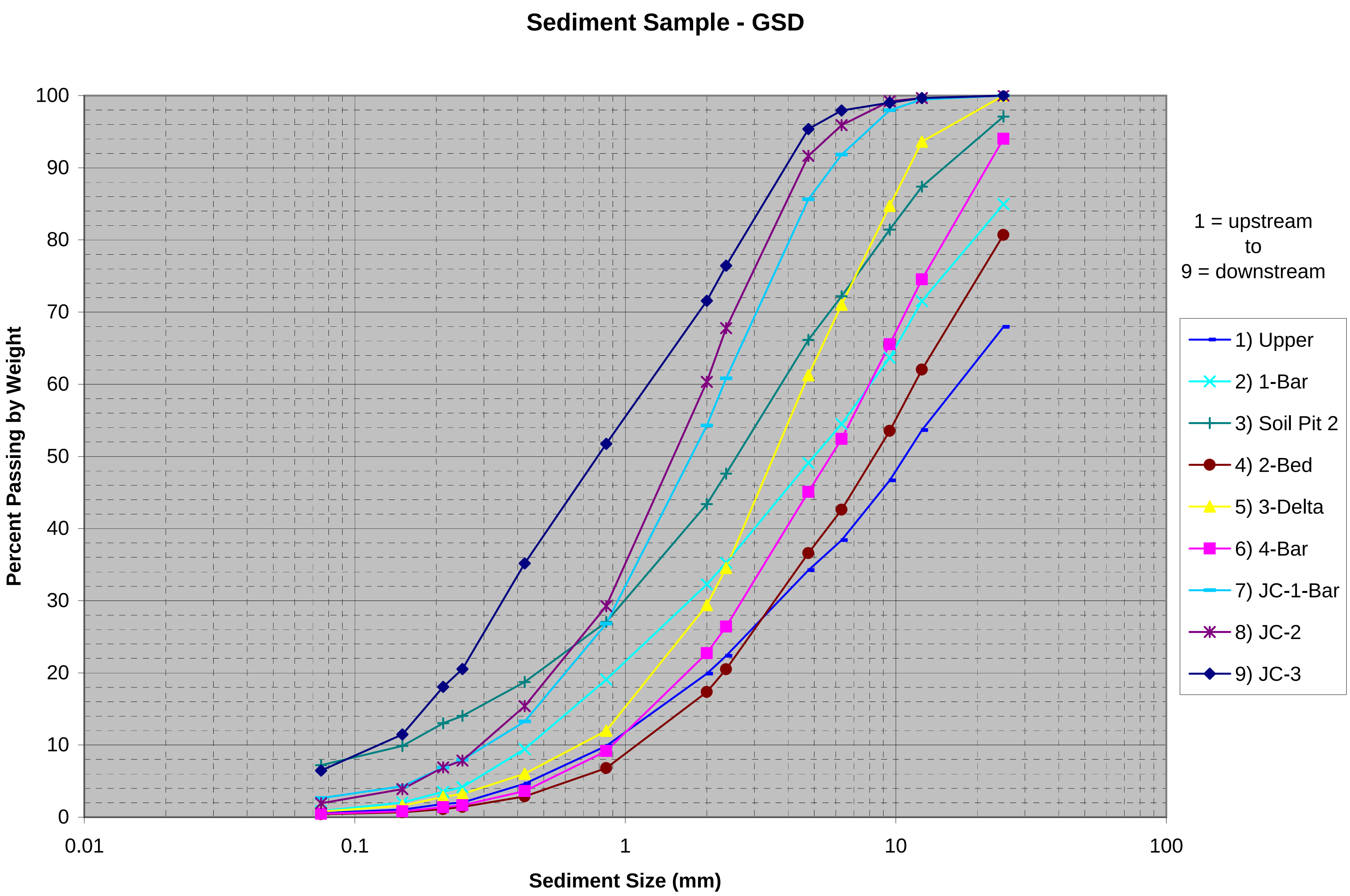
Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Mainstem	4	10-cfs	Mods v.02	10.00	320.57	321.59		321.60	0.000421	0.77	12.98	15.21	0.15
Mainstem	4	10-cfs	Ex - USGS-Q	10.00	321.94	322.36	322.36	322.47	0.035944	2.59	3.86	18.63	1.00
Mainstem	4	25-cfs	Mods v.02	25.00	320.57	322.01		322.04	0.000772	1.26	19.85	19.23	0.21
Mainstem	4	25-cfs	Ex - USGS-Q	25.00	321.94	322.55	322.54	322.70	0.030959	3.13	7.98	25.81	0.99
Mainstem	4	50-cfs	Mods v.02	50.00	320.57	322.42		322.46	0.001179	1.79	30.33	32.47	0.27
Mainstem	4	50-cfs	Ex - USGS-Q	50.00	321.94	322.88		322.99	0.012549	2.72	18.40	37.34	0.68
Mainstem	4	75-cfs	Mods v.02	75.00	320.57	322.70		322.77	0.001360	2.12	40.70	39.21	0.29
Mainstem	4	75-cfs	Ex - USGS-Q	75.00	321.94	323.08		323.21	0.009368	2.81	26.67	41.23	0.62
Mainstem	4	Q2	Mods v.02	87.00	320.57	322.80		322.87	0.001454	2.28	44.50	39.72	0.30
Mainstem	4	Q2	Ex - USGS-Q	87.00	321.94	323.17		323.30	0.008509	2.89	30.14	41.67	0.60
Mainstem	4	Q5	Mods v.02	137.00	320.57	323.13		323.24	0.001782	2.83	57.90	41.46	0.35
Mainstem	4	Q5	Ex - USGS-Q	137.00	321.94	323.45		323.61	0.007209	3.24	42.23	43.18	0.58
Mainstem	4	Q10	Mods v.02	179.00	320.57	323.33		323.47	0.002086	3.26	66.37	42.53	0.38
Mainstem	4	Q10	Ex - USGS-Q	179.00	321.94	323.62		323.82	0.007344	3.60	49.74	44.09	0.60
Mainstem	4	Q25	Mods v.02	242.00	320.57	323.56		323.76	0.002575	3.87	76.37	43.76	0.43
Mainstem	4	Q25	Ex - USGS-Q	242.00	321.94	323.82		324.09	0.007998	4.12	58.68	45.15	0.64
Mainstem	4	Q50	Mods v.02	291.00	320.57	323.71		323.95	0.002955	4.30	82.90	44.54	0.47
Mainstem	4	Q50	Ex - USGS-Q	291.00	321.94	323.95		324.27	0.008665	4.52	64.39	45.81	0.67
Mainstem	4	Q100	Mods v.02	344.00	320.57	323.86		324.14	0.003320	4.73	89.57	45.32	0.50
Mainstem	4	Q100	Ex - USGS-Q	344.00	321.94	324.07		324.44	0.009411	4.93	69.80	46.34	0.71
Mainstem	3	10-cfs	Mods v.02	10.00	320.29	321.50		321.52	0.002164	1.23	8.16	14.18	0.28
Mainstem	3	10-cfs	Ex - USGS-Q	10.00	320.29	321.50	321.01	321.52	0.002164	1.23	8.16	14.18	0.28
Mainstem	3	25-cfs	Mods v.02	25.00	320.29	321.84		321.89	0.003461	1.77	14.10	20.12	0.37
Mainstem	3	25-cfs	Ex - USGS-Q	25.00	320.29	321.83		321.88	0.003597	1.80	13.88	19.92	0.38
Mainstem	3	50-cfs	Mods v.02	50.00	320.29	322.17		322.25	0.004919	2.30	21.77	27.66	0.46
Mainstem	3	50-cfs	Ex - USGS-Q	50.00	320.29	322.17		322.25	0.004917	2.30	21.78	27.67	0.46
Mainstem	3	75-cfs	Mods v.02	75.00	320.29	322.43		322.53	0.005209	2.51	29.90	34.91	0.48
Mainstem	3	75-cfs	Ex - USGS-Q	75.00	320.29	322.43		322.53	0.005209	2.51	29.90	34.91	0.48
Mainstem	3	Q2	Mods v.02	87.00	320.29	322.50		322.61	0.005700	2.67	32.53	36.95	0.50
Mainstem	3	Q2	Ex - USGS-Q	87.00	320.29	322.50		322.61	0.005698	2.67	32.54	36.95	0.50
Mainstem	3	Q5	Mods v.02	137.00	320.29	322.77		322.92	0.006830	3.16	43.40	47.80	0.56
Mainstem	3	Q5	Ex - USGS-Q	137.00	320.29	322.77		322.92	0.006830	3.16	43.40	47.80	0.56
Mainstem	3	Q10	Mods v.02	179.00	320.29	322.94		323.12	0.006877	3.50	53.83	78.69	0.58
Mainstem	3	Q10	Ex - USGS-Q	179.00	320.29	322.94		323.12	0.006877	3.50	53.83	78.69	0.58
Mainstem	3	Q25	Mods v.02	242.00	320.29	323.16		323.38	0.006351	3.80	74.68	99.85	0.57
Mainstem	3	Q25	Ex - USGS-Q	242.00	320.29	323.16		323.38	0.006355	3.80	74.66	99.84	0.57
Mainstem	3	Q50	Mods v.02	291.00	320.29	323.32		323.54	0.005883	3.94	90.96	102.21	0.56
Mainstem	3	Q50	Ex - USGS-Q	291.00	320.29	323.32		323.54	0.005885	3.94	90.95	102.21	0.56
Mainstem	3	Q100	Mods v.02	344.00	320.29	323.49		323.72	0.005333	4.02	108.38	102.21	0.54
Mainstem	3	Q100	Ex - USGS-Q	344.00	320.29	323.49		323.72	0.005334	4.02	108.37	102.21	0.54

HEC-RAS River: Jordan Reach: Mainstem (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)	
Mainstem	2	10-cfs	Mods v.02	10.00	320.57	320.99	320.97	321.09	0.028432	2.54	3.93	16.38	0.92
Mainstem	2	10-cfs	Ex - USGS-Q	10.00	320.57	320.99	320.97	321.09	0.028432	2.54	3.93	16.38	0.92
Mainstem	2	25-cfs	Mods v.02	25.00	320.57	321.27		321.38	0.014662	2.66	9.40	22.28	0.72
Mainstem	2	25-cfs	Ex - USGS-Q	25.00	320.57	321.27		321.38	0.014246	2.63	9.50	22.36	0.71
Mainstem	2	50-cfs	Mods v.02	50.00	320.57	321.61		321.73	0.008950	2.74	18.28	28.60	0.60
Mainstem	2	50-cfs	Ex - USGS-Q	50.00	320.57	321.61		321.73	0.008981	2.74	18.25	28.58	0.60
Mainstem	2	75-cfs	Mods v.02	75.00	320.57	321.89		322.00	0.008823	2.62	28.64	47.33	0.59
Mainstem	2	75-cfs	Ex - USGS-Q	75.00	320.57	321.89		322.00	0.008823	2.62	28.64	47.33	0.59
Mainstem	2	Q2	Mods v.02	87.00	320.57	321.97		322.08	0.007955	2.68	32.45	47.88	0.57
Mainstem	2	Q2	Ex - USGS-Q	87.00	320.57	321.97		322.08	0.007972	2.68	32.43	47.88	0.57
Mainstem	2	Q5	Mods v.02	137.00	320.57	322.24		322.38	0.006701	3.01	45.57	49.72	0.55
Mainstem	2	Q5	Ex - USGS-Q	137.00	320.57	322.24		322.38	0.006701	3.01	45.57	49.72	0.55
Mainstem	2	Q10	Mods v.02	179.00	320.57	322.43		322.59	0.006251	3.24	55.22	51.04	0.55
Mainstem	2	Q10	Ex - USGS-Q	179.00	320.57	322.43		322.59	0.006233	3.24	55.27	51.04	0.55
Mainstem	2	Q25	Mods v.02	242.00	320.57	322.69		322.88	0.005796	3.53	68.65	52.81	0.54
Mainstem	2	Q25	Ex - USGS-Q	242.00	320.57	322.69		322.88	0.005812	3.53	68.59	52.80	0.55
Mainstem	2	Q50	Mods v.02	291.00	320.57	322.87		323.08	0.005581	3.72	78.30	54.05	0.54
Mainstem	2	Q50	Ex - USGS-Q	291.00	320.57	322.87		323.08	0.005586	3.72	78.28	54.04	0.54
Mainstem	2	Q100	Mods v.02	344.00	320.57	323.05		323.28	0.005456	3.91	87.96	55.26	0.55
Mainstem	2	Q100	Ex - USGS-Q	344.00	320.57	323.05		323.28	0.005459	3.91	87.95	55.26	0.55
Mainstem	1	10-cfs	Mods v.02	10.00	319.44	320.49	320.19	320.52	0.002903	1.32	7.60	18.44	0.36
Mainstem	1	10-cfs	Ex - USGS-Q	10.00	319.44	320.49	320.19	320.52	0.002903	1.32	7.60	18.44	0.36
Mainstem	1	25-cfs	Mods v.02	25.00	319.44	320.86	320.45	320.90	0.002902	1.59	15.70	24.94	0.35
Mainstem	1	25-cfs	Ex - USGS-Q	25.00	319.44	320.86	320.45	320.90	0.002902	1.59	15.70	24.94	0.35
Mainstem	1	50-cfs	Mods v.02	50.00	319.44	321.27	320.70	321.32	0.002904	1.76	28.43	39.04	0.36
Mainstem	1	50-cfs	Ex - USGS-Q	50.00	319.44	321.27	320.70	321.32	0.002904	1.76	28.43	39.04	0.36
Mainstem	1	75-cfs	Mods v.02	75.00	319.44	321.54	320.89	321.60	0.002905	1.86	40.36	50.22	0.37
Mainstem	1	75-cfs	Ex - USGS-Q	75.00	319.44	321.54	320.89	321.60	0.002905	1.86	40.36	50.22	0.37
Mainstem	1	Q2	Mods v.02	87.00	319.44	321.64	320.96	321.69	0.002901	1.92	45.29	52.53	0.36
Mainstem	1	Q2	Ex - USGS-Q	87.00	319.44	321.64	320.96	321.69	0.002901	1.92	45.29	52.53	0.36
Mainstem	1	Q5	Mods v.02	137.00	319.44	321.94	321.26	322.01	0.002901	2.22	61.66	55.97	0.37
Mainstem	1	Q5	Ex - USGS-Q	137.00	319.44	321.94	321.26	322.01	0.002901	2.22	61.66	55.97	0.37
Mainstem	1	Q10	Mods v.02	179.00	319.44	322.14	321.44	322.23	0.002904	2.44	73.31	57.33	0.38
Mainstem	1	Q10	Ex - USGS-Q	179.00	319.44	322.14	321.44	322.23	0.002904	2.44	73.31	57.33	0.38
Mainstem	1	Q25	Mods v.02	242.00	319.44	322.42	321.63	322.53	0.002901	2.71	89.27	59.14	0.39
Mainstem	1	Q25	Ex - USGS-Q	242.00	319.44	322.42	321.64	322.53	0.002906	2.71	89.22	59.14	0.39
Mainstem	1	Q50	Mods v.02	291.00	319.44	322.61	321.78	322.74	0.002901	2.89	100.65	60.85	0.39
Mainstem	1	Q50	Ex - USGS-Q	291.00	319.44	322.61	321.78	322.74	0.002901	2.89	100.65	60.85	0.39
Mainstem	1	Q100	Mods v.02	344.00	319.44	322.79	321.88	322.94	0.002905	3.08	112.16	64.33	0.40
Mainstem	1	Q100	Ex - USGS-Q	344.00	319.44	322.79	321.90	322.94	0.002905	3.08	112.16	64.33	0.40

Appendix 4

Sediment Sample plots and data


Sediment Sample - GSD
Percent Passing by Weight
Sediment Size (mm)
0
10
20
30
40
50
60
70
80
90
100
0.01
0.1
1
10
100
1 = upstream
to
9 = downstream
1) Upper
2) 1-Bar
3) Soil Pit 2
4) 2-Bed
5) 3-Delta
6) 4-Bar
7) JC-1-Bar
8) JC-2
9) JC-3

Jordan Creek and EVR Tributary summary of sediment sample Grain Size Distribution analysis

GPS Waypoint Location u/s to d/s		213 1		217 2		222 3		228 4		230 5		232 6		234 7		235 8		236 9	
Sieve Size	**Sieve mesh size (mm)**	**IF1-1-BAR Weight Retained**	**IF1-1-BAR Percent Passing**	**IF2-2-BED Weight Retained**	**IF-2-BED Percent Passing**	**IF1-3-DELTA Weight Retained**	**IF1-3-DELTA Percent Passing**	**IF1-4-BAR Weight Retained**	**IF1-4-BAR Percent Passing**	**IF1-SOIL PIT-2 Weight**	**IF1 SOIL PIT-2 Percent Passing**	**IF1-JC-1-BAR Weight Retained**	**IF1-JC-1-BAR Percent Passing**	**IF1-JC2 Weight Retained**	**IF1-JC2 Percent Passing**	**IF1-JC-3 Weight Retained**	**IF1-JC-3 Percent Passing**	**IF1-UPPER Weight Retained**	**IF1-UPPER Percent Passing**
1"	**25**	0.521	84.9565443	0.71	80.6786949	0	100	0.273	94.0148642	0.087	97.0786743	0	100	0	100	0	100	1.197	67.9552391
1/2"	**12.5**	0.465	71.5300436	0.685	62.0377174	0.234	93.5955333	0.889	74.5248065	0.289	87.3745005	0.016	99.4742204	0.011	99.6758413	0.003	99.676933	0.535	53.6328104
3/8"	**9.5**	0.272	63.6762625	0.313	53.5200152	0.324	84.7278102	0.41	65.536141	0.177	81.4311138	0.046	97.9626039	0.015	99.2338068	0.006	99.0307991	0.26	46.6723778
1/4"	**6.3**	0.319	54.4653943	0.401	42.6075598	0.501	71.0156827	0.599	52.4039199	0.275	72.1970384	0.187	91.8175545	0.113	95.9038133	0.01	97.9539091	0.309	38.4001713
#4	**4.75**	0.186	49.094794	0.221	36.5934634	0.357	61.2447656	0.334	45.0814461	0.18	66.1529163	0.188	85.6396438	0.144	91.6602817	0.024	95.3693733	0.156	34.2239118
#8	**2.36**	0.48	35.2351803	0.591	20.5105179	0.976	34.5321181	0.852	26.4025607	0.552	47.6176085	0.756	60.7965561	0.811	67.7609477	0.176	76.4161103	0.443	22.3644054
#10	**2**	0.103	32.2611382	0.116	17.3537976	0.188	29.3866492	0.168	22.7194002	0.126	43.3867231	0.198	54.2900332	0.252	60.3347675	0.045	71.5701055	0.093	19.8747122
#20	**0.85**	0.457	19.065631	0.388	6.79511253	0.636	11.9796371	0.618	9.17063118	0.486	27.0675934	0.836	26.8180474	1.055	29.245005	0.184	51.7553306	0.373	9.8891685
#40	**0.425**	0.333	9.45052407	0.144	2.87642529	0.218	6.01308263	0.253	3.62396685	0.248	18.7401363	0.413	13.2463606	0.47	15.3945895	0.154	35.1712255	0.196	4.64207314
#60	**0.25**	0.183	4.16654636	0.054	1.40691757	0.102	3.22139201	0.09	1.65084515	0.14	14.0391525	0.161	7.95570307	0.256	7.85053339	0.136	20.5255223	0.097	2.04529635
#70	**0.212**	0.022	3.53131406	0.011	1.10757341	0.015	2.81084928	0.012	1.38776226	0.03	13.0317988	0.033	6.87128257	0.032	6.90752637	0.023	18.0486754	0.008	1.8311292
#100	**0.15**	0.0516	2.0414056	0.0162	0.66672109	0.0452	1.57374716	0.0262	0.81336461	0.0937	9.88549746	0.0781	4.30482074	0.1029	3.87516945	0.0611	11.4688779	0.0298	1.03335653
#200	**0.075**	0.0418	0.83446424	0.0102	0.38914741	0.0287	0.78824206	0.0153	0.47793392	0.08	7.19922098	0.0512	2.62232592	0.0664	1.91842989	0.0465	6.46133965	0.0173	0.57022006
Pan #2		0.0289		0.0143		0.0288		0.0218		0.2144		0.0798		0.0651		0.06		0.0213	
Total Sample Weight		**3.4633**		**3.6747**		**3.6537**		**4.5613**		**2.9781**		**3.0431**		**3.3934**		**0.9286**		**3.7354**	

Appendix 5

GPS Waypoints – plot and log

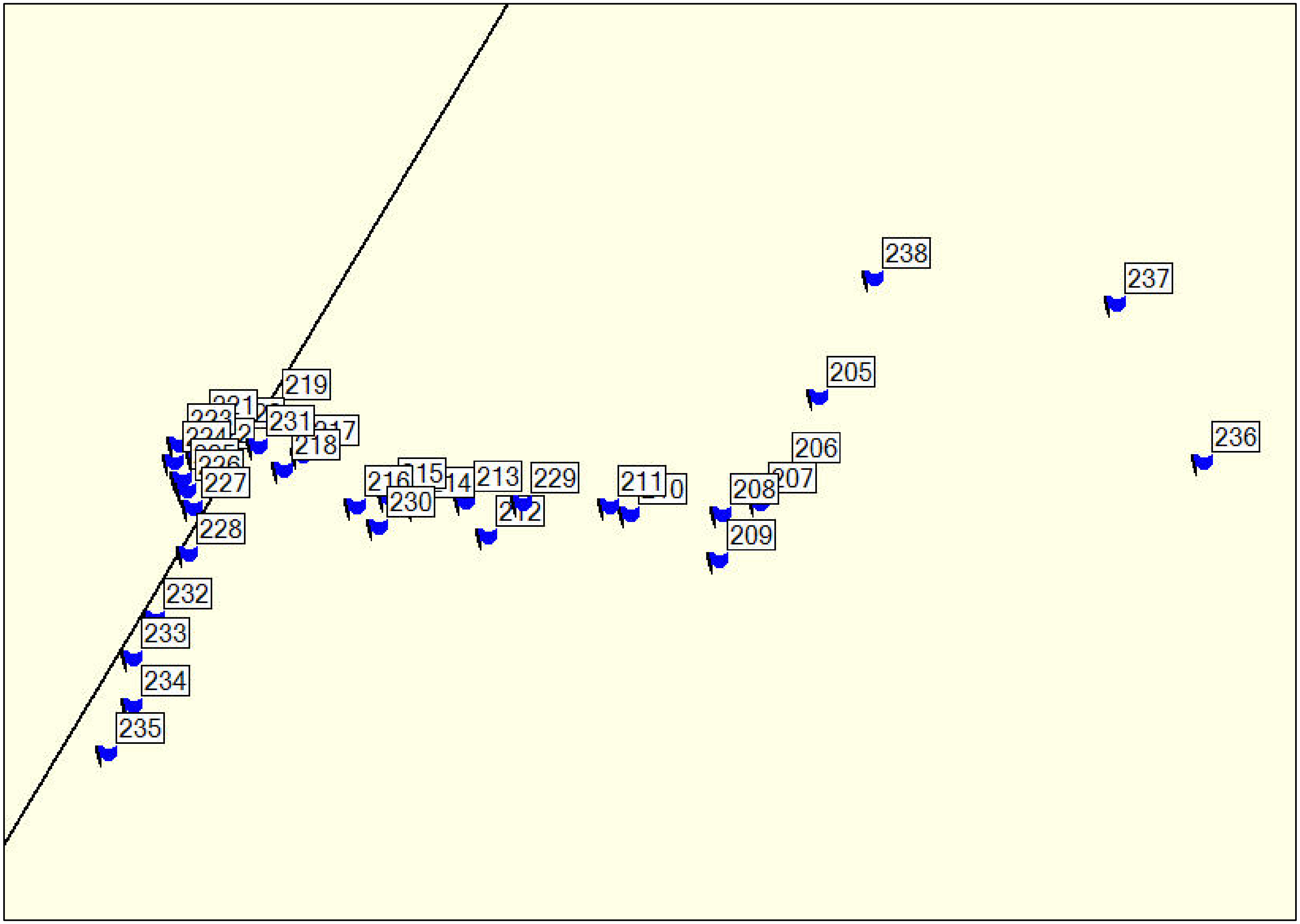
Jordan Creek and EVR Tributary Fan

Inter-Fluve field work on 11/6/2007

Datum WGS 84
GPS Unit: Garmin GPSMap 76Cx
(accuracy no better than 10-ft, see field notes for accuracy indicated on GPS unit)
distance below lower access road crossing was measured with a hip chain (string machine) while walking downstream along the EVR Trib

Waypoint	Position (hddd.ddddd)		Description	sample	indicated error	Photo No.	
	Latitude	Longitude			(ft)	field	filename
205	N58.38409	W134.55826	lower access road Crossing (Xing)		38	15	439
206	N58.38370	W134.55861	confluence EVR Trib and Tank storm drain		27	18-22	442-446
207	N58.38355	W134.55884	153 ft downstream (d/s) from lower access road Xing		26	23-25	447-449
208	N58.38349	W134.55921	205 ft d/s from lower access road Xing		27	26-30	450-454
209	N58.38325	W134.55925	288 ft d/s from lower access road Xing		29	37-41	461-465
210	N58.38349	W134.56012	461 ft d/s from lower access road Xing		26	54-57	478-481
211	N58.38353	W134.56034	529 ft d/s from lower access road Xing		26	59	483
			Note: deposition begins at 541 ft d/s from lower access road Xing				
212	N58.38337	W134.56154	775 ft d/s from lower access road Xing		22	73-74	497-498
213	N58.38356	W134.56176	800 ft d/s from lower access road Xing	IFI-1-Bar	22	75-80	499-504
214	N58.38353	W134.56223	914 ft d/s from lower access road Xing		26	87	511
215	N58.38357	W134.56251	965 ft d/s from lower access road Xing		26	90-93	514-517
216	N58.38353	W134.56284	1005 ft d/s from lower access road Xing		24	94-95	518-519
217	N58.38380	W134.56336	1100 ft d/s from lower access road Xing, dewatered	IFI-2-Bed	23	98-100	522-524
218	N58.38372	W134.56355	1151 ft d/s from lower access road Xing		25	101-102	525-526
219	N58.38404	W134.56366	1240 ft d/s from lower access road Xing, rewatered 40' u/s		24	105-106	529-530
220	N58.38388	W134.56411	1301 ft d/s from lower access road Xing, witness post		24	107-109	531-533
221	N58.38392	W134.56438	1375 ft d/s from lower access road Xing, Confluence with Jordan Creek, at Lath: "lot 2A/lot 2B"		21		
222	N58.38378	W134.56440	Delta at "relic" bank at entry into Jordan Ck flood plain	IFI-3-Delta	22	120-121	544-545
223	N58.38385	W134.56460	distal end of fan		16		
224	N58.38376	W134.56463	distal end of fan		~16		
225	N58.38367	W134.56455	distal end of fan		~16		
226	N58.38362	W134.56452	distal end of fan - hydraulic control of backwater (XS-10)		~16	122-125	546-549
227	N58.38352	W134.56445	hydraulic control of backwater - crest of riffle at sediment wedge (XS-9)		17		
228	N58.38329	W134.56450	Jordan Creek (XS-7)	IFI-4-Bar	16	133-136	557-560
229	N58.38355	W134.56118	soil pit #1		22	137-140	561-564
230	N58.38343	W134.56261	soil pit #2	soil pit 2	24	142-145	566-569
231	N58.38384	W134.56381	soil pit #3		23	147-149	571-573
232	N58.38294	W134.56482	Jordan Creek (XS-4)	IFI-JC-1	17	155-156	579-580
233	N58.38274	W134.56504	Jordan Creek (XS-3)		17		
234	N58.38249	W134.56505	Jordan Creek (XS-2)	IFI-JC-2	21	157-158	
235	N58.38225	W134.56530	Jordan Creek (XS-1)	IFI-JC-3	21	159-161	583-585
236	N58.38376	W134.55446	EVR Tributary - upper end of gravel berm	IFI-Upper	28	169-171	593-595
237	N58.38458	W134.55532	Relic fan channel downhill from berm/access road		--	172	596
238	N58.38471	W134.55771	Relic fan channel downhill from berm/access road		--	173-174	597-598

GPS Waypoint Skematic.



Appendix 6

Site Photographs – log and contact sheets
(Note: electronic files are submitted to JWP on CD)

Jordan Creek & East Valley Reservoir Tributary photo numbers

photo # in notes	photo file number	Sample Id	Location	EVR Trib Dist below lower Xing (ft)	GPS waypoint	Description
1	425		Jordan Creek			below Thunder Mtn Park ditch
2	426		Jordan Creek			below Jennifer Drive Bridge
3	427		Jordan Creek			along left channel at island below XS-1
4	428		Jordan Creek			along left channel at island below XS-1
5	429		Jordan Creek			along left channel at island below XS-1
6	430		Jordan Creek			at left-right channel bifurcation at island at XS-1
7	431		Jordan Creek			below Jennifer Drive Bridge
8	432		Jordan Creek			below Jennifer Drive Bridge near XS-4
9	433		Jordan Creek			below Jennifer Drive Bridge
15	439		East Valley Reservoir Tributary (EVR Trib)	0	205	looking downstream (d/s) from lower access road crossing (Xing)
16	440		EVR Trib	17		bed material
17	441		EVR Trib	35		looking upstream (u/s) at lower Xing
18	442		EVR Trib	94	206	looking d/s
19	443		EVR Trib	94	206	confluence with tank storm drain channel
20	444			94	206	looking d/s
21	445			94	206	bed material
22	446			94	206	looking u/s at confluence with tank storm drain
23	447			153	207	looking u/s
24	448			153	207	looking d/s
25	449			153	207	bed material
26	450			205	208	looking u/s
27	451			205	208	looking d/s
28	452			205	208	bank condition
29	453			205	208	bed material
30	454			205	208	bed material
31	455			245		looking d/s
32	456			245		bank material
33	457			267		bank material
34	458			267		bed material
35	459			267		bank condition - tree roots
36	460			267		looking d/s
37	461			288	209	looking d/s
38	462			288	209	looking d/s
39	463			288	209	bed material
40	464			288	209	looking d/s
41	465			288	209	bed material
42	466			310		looking u/s - log sills and channel boundary
43	467			310		looking d/s - log sills and channel boundary
44	468			329		bed material
45	469			329		bank condition - tree with sediment deposition
46	470			329		bank condition - tree with sediment deposition
47	471			329		bank material

Jordan Creek & East Valley Reservoir Tributary photo numbers

photo # in notes	photo file number	Sample Id	Location	EVR Trib Dist below lower Xing (ft)	GPS waypoint	Description
48	472			376		looking d/s
49	473			402		bank condition - secondary tree roots from trunk buried in sediment
50	474			402		looking d/s
51	475			402		bimodal cobble - gravel bed material
52	476			430		looking d/s - wide depositional bed with bank erosion
53	477			430		bank material
54	478			461	210	bank condition - tree buried in sediment deposits
55	479			461	210	bank condition - tree buried in sediment deposits
56	480			461	210	bank condition - tree buried in sediment deposits
57	481			461	210	bank condition - secondary tree roots from trunk buried in sediment
58	482					looking d/s
59	483			529	211	looking u/s - vegetative controls & log sills, cobble & gravel bed substrate
60	484			529	211	looking d/s - broad shallow section deposition becoming apparent on fan surfaces
61	485			529	211	tree trunk with secondary roots in sediment deposits
62	486			529	211	? - bank condition
			Begin depositional reach at 541 ft below Lower Xing			
63	487			541		looking d/s - broad shallow section deposition on fan surfaces
64	488			541		bed material - bimodel cobble and gravel
65	489			550		sediment deposition on fan surface
66	490			577		bed material
67	491			605		sediment deposition in channel and fan surface - channel has downcut into deposits
68	492			605		sediment deposition in channel and fan surface - channel has downcut into deposits
69	493			605		sediment deposition in channel and fan surface - channel has downcut into deposits
70	494			605		channel migrated w/ sediment deposits on tree trunk, moss stripped ~12inches up trunk
71	495			656		channel downcut through prior sediment deposits
72	496			691		sediment deposits at tree trunk burying roots
73	497			775	212	looking d/s sediment deposition throughout adjacent fan surface
74	498			775	212	looking u/s - tree roots arrest u/s migration of downcutting
75	499			800	213	1 of 2: looking u/s - channel cutting throug prior sediment deposition
76	500			800	213	2 of 2: looking u/s - channel cutting throug prior sediment deposition
77	501			800	213	looking d/s - sediment deposition and headcut arrested by root system
78	502			800	213	bed material
79	503			800	213	bed material
80	504	IFI-1-bar		800	213	bed material sample
81	505			826		looking u/s channel downcutting through prior sediment deposits
82	506			826		bank material
83	507			826		bed material
84	508			826		channel forming in sediment deposits through channel and on fan surface
85	509			826		extensive sediment deposits through forested fan surface
86	510			868		channel downcutting arrested by logs and roots
87	511			914	214	channel condition
88	512			933		bed material
89	513			933		channel condition u/s of grade break to low gradient
90	514			965	215	looking u/s channel downcutting through prior sediment deposits
91	515			965	215	extensive sediment deposits through channel and forested fan

Jordan Creek & East Valley Reservoir Tributary photo numbers

photo # in notes	photo file number	Sample Id	Location	EVR Trib Dist below lower Xing (ft)	GPS waypoint	Description
92	516			965	215	bed material
93	517			965	215	bed material
94	518			1005	216	channel condition along lower gradient reach
95	519			1005	216	channel condition
96	520			1005		bank material
97	521			1005		bed material
98	522			1100	217	channel formed in sediment deposits. Channel dewatered completely during field visit
99	523			1100	217	dewatered channel formed in sediment deposits, sample IFI-2-Bed taken at bend
100	524	IFI-2-bed		1100	217	sediment sample of sediment deposit at bed of channel
101	525			1151	218	channel formed in extensive sediment deposits
102	526			1151	218	bed material
103	527			1200		water beginning to resurface - entering upper elevations of marshy zone parallel to Jordan Creek
104	528			1200		broad areas of sediment deposition, re-watering of channel and upper elevations of marshy zone.
105	529			1240	219	bed material
106	530			1240	219	broad areas of sediment deposition, re-watering of channel and marshy zone.
107	531			1301	220	witness post - broad areas of sediment deposition, re-watering of channel and marshy zone.
108	532			1301	220	bed material
109	533			1301	220	marshy zone parallel to Jordan Creek
110	534			1320		sediment deposits
111	535			1320		sediment deposits entering Jordan Creek floodplain - marsh
112	536		Jordan Creek			submerged Jordan Creek flood plain forest u/s of fan
113	537					distal end of fan u/s in backwatered reach
114	538					submerged Jordan Creek flood plain forest u/s of fan
115	539					distal end of fan u/s in backwatered reach
116	540					distal end of fan u/s in backwatered reach
117	541					sediment deposition encroaching into edge of Jordan Creek flood plain
118	542					looking u/s - sediment deposition encroaching into edge of Jordan Creek flood plain
119	543					looking d/s along Jordan Creek at fan surface
120	544				222	sediment deposition at fan entry into Jordan Creek flood plain
121	545	IFI-3-Delta			222	sample of fan deposits at entry into Jordan Creek flood plain
122	546				226	backwatered reach of Jordan Creek upstream of fan - distal end of fan evident to viewer's right. Submerged grasses along Jordan Creek flood plain
123	547				226	looking d/s at riffle crest formed in sediment wedge from fan deposits.
124	548				226	looking u/s from riffle crest at backwatered reach
125	549				226	backwatered reach of Jordan Creek upstream of fan - distal end of fan evident to viewer's right. Submerged grasses along Jordan Creek flood plain
126	550					broad shallow Jordan Creek stream channel through sediment wedge of fan deposits
127	551					broad shallow Jordan Creek stream channel through sediment wedge of fan deposits
128	552					broad shallow Jordan Creek stream channel through sediment wedge of fan deposits
129	553					Fan encroaching into Jordan Creek stream channel
130	554					Fan encroaching into Jordan Creek stream channel
131	555					broad shallow Jordan Creek stream channel through sediment wedge of fan deposits
132	556					broad shallow Jordan Creek stream channel - beginning to braid - through sediment wedge of fan deposits
133	557				228	bar material
134	558				228	looking d/s from bar

Jordan Creek & East Valley Reservoir Tributary photo numbers

photo # in notes	photo file number	Sample Id	Location	EVR Trib Dist below lower Xing (ft)	GPS waypoint	Description
135	559	IFI-4-Bar			228	1 of 2: sample taken from Jordan Creek bar near d/s end of fan
136	560				228	2 of 2: sample taken from Jordan Creek bar near d/s end of fan
137	561		soil pit in fan		229	soil pit #1
138	562				229	soil pit #1
139	563				229	soil pit #1
140	564				229	soil pit #1
141	565					soil pit #1
142	566				230	soil pit #2
143	567				230	soil pit #2
144	568				230	soil pit #2
145	569				230	soil pit #2
146	570					nurse stump on fan surface near soil pit #2
147	571				231	soil pit #3
148	572				231	soil pit #3
149	573		soil pit in fan		231	soil pit #3
150	574		Jordan Creek			looking d/s towards Jennifer Dr bridge
151	575					looking u/s from just above Jennifer Dr bridge
152	576					looking at river-left side above Jennifer Dr bridge
153	577					looking at river-left side below Jennifer Dr bridge
154	578					looking d/s from below Jennifer Dr Bridge
155	579	IFI-JC-1			232	sample of fan sediment plume in bar below Jennifer Dr bridge (XS-4)
156	580	IFI-JC-1			232	sample of fan sediment plume in bar below Jennifer Dr bridge (XS-4)
157	581				234	d/s from Jennifer Dr bridge near XS-3
158	582	IFI-JC-2			234	XS-2, sample taken from below water near waters edge on far side of photo
159	583	IFI-JC-3			235	looking d/s along left channel of island below XS-1 (sample taken from bed of left channel at XS-1)
160	584				235	? - looking u/s from XS-1
161	585				235	looking d/s along right channel of island below XS-1
162	586		EVR Trib			looking u/s from lower access road Xing
163	587					looking d/s from upper access road Xing
164	588					looking u/s from upper access road Xing
165	589					looking u/s above upper access road Xing
166	590					looking d/s towards upper access road Xing
167	591					looking u/s above upper access road Xing
168	592					looking u/s near u/s end of gravel berm
169	593				236	looking u/s from u/s end of gravel berm
170	594	Upper			236	looking u/s approximately 40 ft u/s from end of gravel berm
171	595				236	looking u/s approximately 40 ft u/s from end of gravel berm
172	596		EVR fan		237	relic channel near upper access road Xing
173	597				238	1 of 2: relic channel between upper and lower access road Xings
174	598				238	2 of 2: relic channel between upper and lower access road Xings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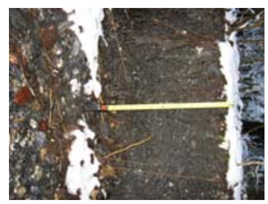
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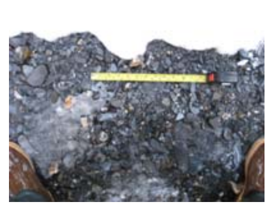
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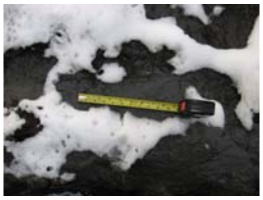
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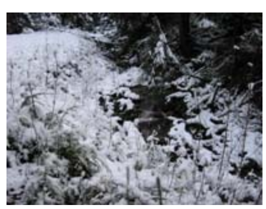
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Appendix 7

Planning level estimate of construction quantities and costs

Jordan Creek Rehabilitation at EVR Tributary Fan

Feature	task	quantity	units	unit cost	cost	assumption
Alternative 4 - Jordan Creek restoration						
	excavate alluvial fan sediments from floodplain and channel	1300	CY	$ 12	$ 15,600	excavated, preserving existing trees as possible
	haul/dispose excavated material	1300	CY	$ 25	$ 32,500	haul/stock pile off site
	place erosion control fabric	1100	SY	$ 3	$ 3,300	non-woven on excavated surface
	native riparian plantings	1100	ea	$ 10	$ 11,000	3 ft on center
	logjams - materials (logs, ballast boulders)	1	LS	$ 6,000	$ 6,000	one log truck, one day for placement, two days for ballasting
	logjams - excavator/operator	16	hr	$ 200	$ 3,200	place logs and boulders
	logjams - 2-laborers ballast/cable	48	hr	$ 60	$ 2,900	ballast logs
	access/staging restoration	1	LS	$ 5,000	$ 5,000	one day equipment/operator, laborer, miscellaneous materials (seed, fabric)
	flow diversion/construction dewatering	1	LS	$ 20,000	$ 20,000	assumed
				Subtotal =	$ 99,500	
	contingency				$ 49,750	**50-percent**
	mobilization				9,950.0	10-percent
				Total =	**$ 159,000**	
Alternative 4 - EVR Tributary sediment traps						
	excavate footprint of traps 3-ft for volume & riprap liner	600	CY	$ 16	$ 9,600	excavate trap and weirs
	excavate for concrete flow control/stilling basin	90	CY	$ 16	$ 1,400	excavate subgrade for liner
	Concrete weir and basin sides (assumed ~8' retaining wall)	160	l.f.	$ 220	$ 35,200	R.S. Means 2006 Heavy Construction Cost Data pg 389 G2040-210-3400
	Concrete basin end sill (assumed ~4' retaining wall)	65	l.f.	$ 115	$ 7,500	R.S. Means 2006 Heavy Construction Cost Data pg 389 G2040-210-3000
	Concrete basin slab (assumed ~15" thick slab on grade)	800	s.f.	$ 6	$ 5,000	R.S. Means 2006 Heavy Construction Cost Data pg 158 03310-240-4950
	place riprap liner	250	CY	$ 75	$ 18,800	approximated - bed and at concrete
	place riprap grade control	65	CY	$ 75	$ 4,900	
	flow diversion/construction dewatering	1	LS	$ 5,000	$ 5,000	assumed
				Subtotal =	$ 87,400	
	contingency				$ 26,220	**30-percent**
	mobilization				8,740.0	10-percent
				Total =	**$ 122,000**	
Alternative 3 - EVR Tributary spill control to upper fan area						
	excavate for riprap weir & spillway	100	CY	$ 16	$ 1,600	assumed 2x trap weir
	place riprap weir & spillway	80	CY	$ 75	$ 6,000	assumed
	flow diversion/construction dewatering	1	LS	$ 5,000	$ 5,000	assumed
				Subtotal =	$ 12,600	
	contingency				$ 6,300	**50-percent**
	mobilization				1,260.0	10-percent
				Total =	**$ 20,000**	

Jordan Creek - estimate volume of alluvial fan removal to restore channel & flood plain

Cross Section	cut volume (sf)	spacing (ft)	Volume (cy)	
			incremental	cumulative
		0		0
12	66.1445			
		43	138.86	138.86
11	108.2349			
		32	134.41	273.27
10	118.5802			
		30	145.3	418.57
9	142.9616			
		56	271.42	689.99
8	118.7667			
		50	183.81	873.8
7	79.7475			
		29	98.98	972.78
6	104.5663			
		34	101.51	1074.29
5	56.6556			
		80	127.53	1201.82
4	29.4278			
		49	53.41	1255.23

method:

Copy HEC-RAS XS plot with existing & Alt 4 sections into AutoCAD
Scale each section to 1:1
Snap polyline around existing-alt 4 divergence
List closed polyline and extract area
Spacing between sections estimated from HEC-RAS XS spacing
Volume calculated using average end method