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Bridge Hydraulics Design Report
Proposed Ewing Young Park Footbridge Over Chehalem Creek
Yamhill County, Oregon

August 16, 2022

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1.0 INTRODUCTION

1.1 Overview

NV5, Inc. (NV5, formerly WHPacific, Inc.) is pleased to present to the Chehalem Park & Recreation District (District) this Bridge Hydraulics Report (Report) for the proposed footbridge over Chehalem Creek at the Ewing Young Park in Yamhill, County Oregon.

This Report describes the physical condition of the existing creek at the proposed bridge location; the regulatory flood management constraints imposed upon the proposed bridge site by the Federal Emergency Management Agency (FEMA); the proposed footbridge and associated site improvements that enable the proposed bridge to satisfy FEMA's requirements; and NV5's supporting hydraulic analyses of this proposed bridge crossing. This Report also confirms that the proposed bridge can be constructed such that the bridge does not increase the 100-year Base Flood Elevations (BFEs) in Chehalem Creek as identified by FEMA. This Report is supported by eight (8) appendices, which are referenced throughout the Report as necessary. **The signed/stamped No Rise Certificate in Appendix H certifies that the proposed bridge will not increase the BFEs previously identified by FEMA.**

It must be emphasized that the footbridge considered herein will be installed above Chehalem Creek's 10-year Water Surface Elevation (WSEL) but below the creek's 100-year BFE. Therefore, the bridge ultimately selected must consider the structural forces the flowing creek imposes upon the bridge structure. The structural design of the bridge and the geotechnical design of the abutments and footings are beyond the scope and context of this Bridge Hydraulic Design Report.

NV5 understands that the 95-foot-long footbridge proposed herein will be structurally designed and prefabricated "by others". In addition, the exact type and manufacturer of the footbridge have yet to be identified. Given this uncertainty, NV5 conservatively assumed a bridge girder depth of 18-inches and that the 42-inch-high bridge railing (parapet) would completely block the creek's 100-year flood (rather than having open spaces between the horizontal elements of the railing(s) that convey water.) This conservative approach provides the District greater flexibility in the selection of a specific bridge type and/or manufacturer. This conservative approach also likely eliminates the need for NV5 to refine the bridge's hydraulic design in the future.

1.2 Contract Authorization

NV5 has prepared this Report in general accordance with the Short Form Contract/Work Authorization for Ewing Young Park Trail Bridge Professional Services contract, dated 10/14/2021. ("Agreement")

1.3 Scope of Services

NV5 performed the services listed below in general accordance with the aforementioned Agreement. (Note, only the hydraulics-related services are referenced below. Reference should be made to the Agreement for great specificity regarding all of NV5's project-related services.)

- Locate the proposed bridge to:
    - Fully span FEMA's regulatory floodway (ie, the bridge approaches and abutments shall be installed beyond the floodway limits)
    - Be above the 10-year WSEL but below the 100-year WSEL
    - Maintain (or lower) the creek's BFEs
- Include in-stream or out-of-channel improvements (excavation) to offset the hydraulic blockage imposed upon the creek by the proposed bridge (to maintain the existing BFEs)
- Obtain from FEMA an electronic, executable copy of the hydraulic/computer model used to develop FEMA's BFEs. Once acquired, this model was to be refreshed with current topographic/bathymetric survey data and then rerun to confirm the model remains consistent with FEMA's published BFEs. Then, the refreshed (Existing Conditions) model was to be adjusted to reflect the proposed bridge crossing. (As discussed further below, FEMA was unable to locate and deliver the required hydraulic/computer model. This necessitated NV5 to develop an existing conditions model of the creek based solely on NV5's recent site/creek survey.)
- Adjust and refine the "Existing Conditions" hydraulic/computer model to reflect the proposed bridge crossing such that the proposed bridge does not increase the creek's BFEs
- Utilize the discharges identified by FEMA in our hydraulic modeling efforts
- Calculate channel scour at the proposed bridge crossing
- Assess the need for riprap scour countermeasures at the proposed bridge crossing
- Summarize our findings in a Technical Memo to support the bridge's conceptual level design
- Develop a Final Bridge Design and a Final Bridge Hydraulics Report based upon approvals of the conceptual design as described in the Technical Memo
- Provide a No Rise Certificate, signed and stamped by a Professional Engineer registered in the state of Oregon

Through our execution of the aforementioned scope - and by making the aforementioned conservative assumptions on the proposed bridge structure – it is NV5's opinion that the hydraulic design of the proposed bridge is advanced enough to constitute a final design. Therefore, this report is intended to replace the (conceptual level) Technical Memo and constitutes our Final Hydraulics Report.

1.4 Summary of Results

As described in this Report, the proposed 95-foot-long footbridge over Chehalem Creek:

- Achieves a No Rise condition
- Requires moderate bank grading at/near the southwestern abutment and pathway approach to achieve the No Rise condition

- Is estimated to realize 0.0-feet of channel scour at the proposed crossing during the 100-year flood event
- Does not require riprap scour countermeasures

2.0 PROJECT LOCATION AND EXISTING CONDITIONS

2.1 Project Location

As indicated on Figure 1 below, Yamhill County is located in Northwestern Oregon. As indicated in Figure 2 below, The Project Site (Ewing Young Park) is located near the Northeast corner of Yamhill County. Note, the "curvy" eastern boundary of Yamhill County corresponds with the Willamette River. Figure 3 below shows the location of the proposed project/bridge relative the boundaries of Ewing Young Park. The Project Site is presented in greater detail in **Appendix C: Existing and Proposed Plans.**

Figure 1: Location of Yamhill County, Oregon

Figure 2: Location of Site in Yamhill County, Oregon

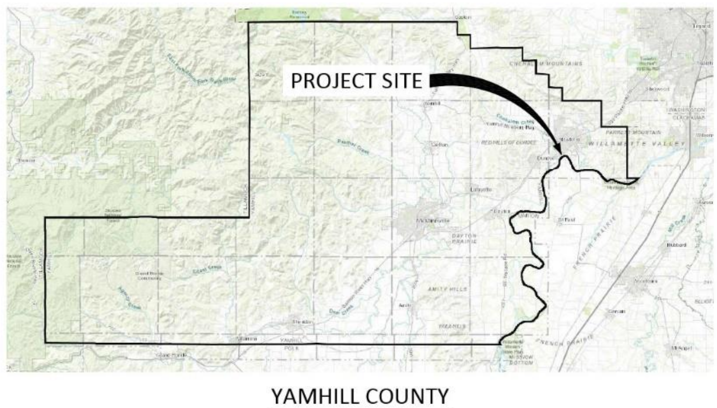
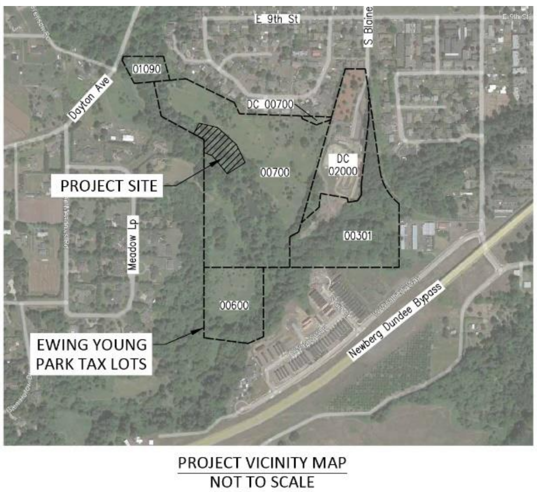


Figure 3: Project Vicinity Map (Ewing Young Park)



2.2 Existing Site and Stream Conditions

Chehalem Creek is an urbanized perennial tributary to the Willamette River. The stream banks are densely vegetated with a mixture of grasses, shrubs, and mature trees. Wetlands exist along the western streambank at the proposed bridge crossing. The channel bed is composed of relatively large and stable bed material, generally ranging in size from 3- to 6-inch diameter cobble-sized rocks up to 2- to 3-ft diameter rocks (small boulders). Interstitial voids between these larger bed materials are generally filled with large sand to small gravel. These smaller bed materials appear to have "cemented" the existing streambed. There were no obvious signs of either channel aggradation (sedimentation) or degradation (vertical erosion); thereby indicating the streambed is vertically stable. Similarly, there were no obvious signs of lateral bank erosion or lateral channel migration. Casual field observations suggest shallow bedrock lies beneath this bed material. **Appendix A, Photo Log of Existing Site**, depict the features described above.

As indicated on the stream/flood profile in **Appendix B, FEMA Documentation**, the proposed bridge site is approximately 1.65-miles upstream from Chehalem Creek's confluence with the Willamette River. Furthermore, and as indicated on FEMA's stream/flood profile, Chehalem Creek in the location of the proposed bridge is hydraulically influenced ("backwatered") by the Water Surface Elevations (WSELs) in the Willamette River. The channel bed in the vicinity of the proposed bridge crossing has a "mild" gradient of approximately 0.3%, whereas the water surface gradient at the crossing is near 0.0% during the 100-year flood event due to the Willamette River's backwater impacts.

2.3 Topographic/Bathymetric Survey

NV5's land surveyors performed a topographic/bathymetric survey of Chehalem Creek and the project site in October, 2021. **Appendix C, Existing and Proposed Plans**, present the results of this survey. It is important to note that NV5's survey was performed using the NGVD29 vertical datum, whereas the corresponding FEMA Flood Insurance Study (FIS) is based on the NAVD88 vertical datum. Note that 3.47-feet must be subtracted from FEMA's (NAVD88) elevations to convert the elevations to NV5's (NAVD29) datum.

2.4 FEMA Flood Zone

Appendix B, FEMA Documentation, includes excerpts from FEMA's Flood Insurance Study (FIS) for Yamhill County, Oregon and Incorporated Areas (FEMA, 2010a) and FEMA's corresponding Flood Insurance Rate Map (FIRM) (FEMA, 2010b). Both of these documents because "Effective" on March 2, 2010. Pertinent references are highlighted in these excerpts. As previously noted, NV5's survey was performed using the NGVD29 vertical datum, whereas the corresponding FEMA FIS is based on the NAVD88 vertical datum. Note that 3.47-feet must be subtracted from FEMA's (NAVD88) elevations to convert the elevations to NV5's (NAVD29) datum.

As indicated on the FEMA "FIRMette" included in **Appendix B, FEMA Documentation**, Chehalem Creek in the vicinity of the proposed footbridge is located within a FEMA-designated "AE" Flood Zone. This designation indicates that FEMA modeled Chehalem Creek with "detailed" hydraulic/computer modeling methods and that both BFEs and a Floodway were defined by FEMA. If the proposed bridge were to elevate FEMA's BFEs even as much as 0.01-feet, FEMA would likely require the District to apply for a Conditional Letter of Map Revision (CLOMR) in order construct the proposed bridge. CLOMRs are both time consuming and costly. Therefore, this proposed bridge – and its associated grading – were developed such that it will not elevate FEMA's BFEs. By maintaining FEMA's BFEs, this Project can utilize the appended (and less expensive) No Rise Certificate in lieu of a CLOMR.

NV5 first requested from FEMA FEMA's supporting documentation for the corresponding FIS and FIRM on December 20, 2021. This request, and NV5's follow-up email discussions with FEMA's representatives, are also included in Appendix B. As indicated therein, the supporting documentation and an executable version of the underlying hydraulic/computer model were not available from FEMA. NV5 subsequently developed a hydraulic/computer model of Chehalem Creek at the proposed bridge site in the absence of an executable model from FEMA. Specifics of this model are described below in the Hydraulic Modeling section of this report.

3.0 PROPOSED CONDITIONS

3.1 Overview

NV5's Project Manager engaged in discussions with representatives from several different manufacturers of prefabricated bridges. Based on these discussions – in addition to our understanding of the District's design preferences and budget limitations - NV5 developed the conceptual-level proposed bridge design as depicted in **Appendix C, Existing and Proposed Bridge Conditions.** As presented, this proposed bridge concept will not increase Chehalem Creek's BFEs. (ie, it achieves a No Rise condition.) Key parameters of this bridge include:

- 95-foot-long (open) span bridge (which fully spans FEMA's regulatory Floodway)
- 8-foot-wide bridge (this may be up to approximately 3-feet wider without impacting the hydraulics)
- 18-inch-deep girder depth (Possible girder depths for the various bridge types considered for a span this long ranged from 14 to 16-inches, so the 18-inch-deeper girder was conservatively deeper than necessary.)
- 42-inch-high, solid, bridge railing (aka, "parapet"). NV5 conservatively assumed the proposed bridge rail would be solid (in our hydraulic/computer model), rather than having open spaces between the rail members (as graphically depicted in Appendix C). This assumption:
    - Provides the District and selected bridge manufacturer flexibility in their forthcoming selection of a preferred bridge type.
    - Accounts for a full debris blockage against the bridge and rail during floods.

- Bridge deck elevations of 94.50 and 92.00 at the eastern and western bridge approaches, respectively. Note, the low chord of the proposed bridge shall be located above the 10-year flood WSEL of 87.13 as identified on FEMA's flood profile presented in **Appendix B, FEMA Documentation.** These elevations are also depicted on the proposed bridge cross-section presented in **Appendix C, Existing and Proposed Plans**.
- Shallow concrete footings setback into the existing banks as depicted in **Appendix C, Existing and Proposed Plans.** As indicated in NV5's January 18, 2022 *Report of Geotechnical Engineering Services* (NV5, 2022) Preliminary discussions between NV5's hydraulics engineers and geotechnical engineers indicate that the local soils have adequate stability and bearing capacity to accommodate this size bridge.
- Earthen "fill" pathway approaches
- Excavation of a 25-foot-wide (minimum) "cut area" at/near the western bridge approach. (This excavation offsets the hydraulic "conveyance" blocked by the girder, rail (parapet), abutments and filled approaches.)

It must be emphasized that this proposed bridge, as described above and graphically depicted in Appendix C, must be designed to accommodate the anticipated horizontal and vertical (both weight and floating) forces imposed upon the bridge by the flowing/flooding creek. It is suggested the bridge manufacturers/designers also consider additional forces potentially imposed upon the bridge by flood debris against the proposed bridge.

4.0 HYDRAULIC MODELING

4.1 Overview

NV5 utilized the United States Army Corps of Engineers (USACE), Hydrologic Engineering Center's River Analysis System (HEC-RAS) computer model (Version 6.0) (Brunner, 2010) to model the hydraulics of the existing and proposed creek/bridge conditions. Only the 100-year flood discharge was considered in this modeling exercise because the desired No Rise Certificate specifically addresses only the 100-year BFEs. The 100-year discharge of 2,760-cfs, as identified by FEMA and as highlighted in **Appendix B, FEMA Documentation**, was used in our modeling efforts.

4.2 Existing Conditions Model

NV5 developed an independent Existing Conditions hydraulic/computer model of Chehalem Creek at the proposed bridge crossing site because FEMA was unable to deliver either an executable copy of Chehalem Creek's "Effective" hydraulic/computer model or any other pertinent, useful, background information as requested. NV5 developed the "geometry" of this model using NV5's 2022 topographic/bathymetric survey for the creek, which is based on the NGVD29 vertical datum. NV5 also used the same Manning's Roughness Values that FEMA used in their "Effective" hydraulic model. The range of Manning's values used by FEMA are highlighted in **Appendix B, FEMA Documentation**.

The 100-year WSEL identified on FEMA's flood profile for Chehalem Creek was used as the downstream controlling boundary condition. As indicated on the "FIRMette" in **Appendix B, FEMA Documentation**, the proposed bridge will be located between FEMA cross-sections "B" and "C". As shown on the flood profile in Appendix B, the 100-year WSEL at these cross-sections is "backwatered" by the corresponding 100-year WSELs in the Willamette River further downstream. The 100-year WSEL at both of these cross-sections approximately equals 102.50 (NAVD88). FEMA's 100-year WSEL of 102.5 (NAVD88) was converted to elevation 99.03 (NGVD29) to maintain consistency with the NAVD29 vertical datum used in NV5's 2022 survey. (Specifically, the downstream WSEL at model station 0+00 was set to the 100-year WSEL of 90.03.)

NV5 refined the Manning's Roughness Values in our Existing Conditions Model such that the resulting WSELs essentially equaled those shown on the FEMA flood profile in Appendix B. The completed Existing Conditions Model developed by NV5 was used as the "Duplicate Effective" model in the absence of the executable model requested from FEMA. **Appendix D, Existing Conditions Hydraulic Model Results**, presents the input and output of this modeling effort.

4.3 Proposed Conditions Model and No Rise Certificate

NV5's Existing Conditions Model was then adjusted to represent the proposed bridge and channel conditions. Multiple bridge configurations and elevations, in addition to multiple channel and bank configurations (ie, excavation scenarios) were modeled to represent a design that resulted in the desired No Rise condition. It's important to emphasize that the Proposed Conditions Model is very "sensitive" to minor refinements to roughness values and the bridge/channel geometry because of the very "flat" or "level" backwater conditions imposed upon Chehalem Creek by the Willamette River.

Ultimately, the proposed bridge and channel/bank refinements, as described above in the Proposed Conditions section of this report, results in the desired No Rise condition. As previously noted, it is proposed to excavate the existing bank at/near the southwestern pathway approach of the bridge to offset the "conveyance blockage" the proposed bridge imposes upon the creek's 100-year floodwaters. The excavation proposed at the pathway approach was selected in lieu of in-stream excavation to eliminate potential environmental impacts the in-stream excavation would have caused to the existing wetlands beneath the proposed bridge. **Appendix E, Proposed Conditions Hydraulic Model Results**, presents the input and output of this modeling effort.

NV5 certifies the proposed bridge and site design will not increase the 100-year BFE in Chehalem Creek with the signed/stamped "No Rise Certificate" provided in **Appendix H, No Rise Certificate.**

5.0 SCOUR EVALUATION

5.1 Overview

NV5 evaluated the potential for channel scour at the proposed bridge crossing during the 100-year flood event using the scour analysis routines embedded in the HEC-RAS hydraulic/computer model. Scour was evaluated in accordance with the Oregon Department of Transportation's (ODOT) most current Hydraulic Design Manual (ODOT, 2014). The results of this evaluation are presented in **Appendix F, Scour Evaluation Results.**

5.2 Contraction Scour

As defined by the Oregon Department of Transportation (ODOT):

> *Contraction scour is general scour caused by increased flow velocities within the bridge opening in comparison to the slower velocities in the upstream and downstream waterway. Contraction scour can occur in the bridge opening due to the contraction caused by the bridge abutments and/or internal bents. (ODOT, 2014)*

In our scour evaluation, NV5 utilized a (conservatively small) median bed material size of 3.5-inches (88.9-mm) to represent the streambed material. As indicated in **Appendix F, Scour Evaluation Results,** the critical velocity for this sized bed material approximately ranges from 10.3- to 12.0-fps. Given that the average 100-year velocity through the bridge is approximately 2.2-fps, "clearwater" flow conditions prevail. Accordingly, clearwater contraction scour equations were used in this contraction scour evaluation. Clearwater contraction scour was subsequently calculated to be 0.00-feet deep. (ie, Contraction Scour is calculated not to occur at the proposed bridge.)

5.3 Abutment Scour

As defined by the Oregon Department of Transportation:

> *Abutment scour is local scour that occurs at the faces of abutments that project into the waterway or floodplain. The obstruction causes flow vortices to form at the toe of the abutment, and this turbulent flow scours away the underlying bed material. <u>At present, equations to predict abutment scour are mainly based on laboratory data and they tend to predict conservative scour depths. In other words, it is likely the actual abutment scour will be less than the predicted value, and unlikely the abutment scour will be greater than the prediction.</u>*
>
> *<u>ODOT recommended practice is to protect the toe of the abutment with revetment</u>* <u>(ie, riprap)</u> *<u>in lieu of including abutment scour in the predicted scour elevation.</u> An exception occurs when revetment protection is omitted from the face of the abutment and the toe of the abutment is not solidly keyed into non-erodible rock. In this case, abutment scour is calculated and included in the predicted total scour elevation.* (ODOT, 2014).

While not required by the ODOT criteria cited above, NV5 calculated the abutment scour depths at the bridge as a general check of the proposed bridge's vulnerability to abutment scour. NV5 estimated abutment scour using the abutment scour routine embedded in the HEC-RAS model. These results are presented in **Appendix F, Scour Evaluation Results.** As indicated in Appendix F, abutment scour was calculated to be over 10-feet deep at each abutment. In NV5's opinion, and as indicated in the ODOT literature cited above, the common abutment scour methods *"… tend to predict conservative scour depths"* and *"ODOT recommended practice is to protect the toe of the abutment with revetment* (ie, riprap) *in lieu of including abutment scour in the predicted scour elevation".*

Following ODOT's abutment scour guidance, NV5 "designed" riprap scour countermeasures for the creek banks beneath the proposed bridge. This riprap design is discussed in greater detail in the Report section immediately below. As indicated below, the largest riprap size required is less than 0.2-ft (2.4-inches). This required riprap size is less than the estimated median bed material size of 3.5-inches. Furthermore, the average and maximum 100-year flow velocities in the channel at the bridge crossing as calculated in the HEC-RAS model were estimated to be 2.4- and 3.5-fps, respectively. These velocities are relatively low and within the range of widely accepted maximum permissible velocities for well-vegetated (grassy) channel banks. Specifically, the maximum permissible velocity for "grass mixtures" on "easily erodible soils" is 4.0-fps. (USDA SCS, 1954)

5.4 TOTAL SCOUR

Total scour is defined as:

Total Scour = Contraction Scour + Abutment Scour + Pier Scour + Channel Degradation

In the case of this proposed bridge: abutment scour can be disregarded in lieu of abutment riprap (in accordance with the ODOT guidance cited above); and there is no pier, so pier scour equals 0.0-feet. In addition, Chehalem Creek exhibits no obvious signs of channel degradation, and the bed appears vertically stable. Therefore, channel degradation = 0.0-feet. Therefore, using the equation noted above:

Total Scour = 0.0 + 0.0 + 0.0 + 0.0 = 0.0-feet

This means, total scour is estimated to be non-existent at this proposed bridge crossing.

6.0 RIPRAP PROTECTION

6.1 Riprap Design

In accordance with the ODOT abutment scour guideline cited above (ODOT, 2014), NV5 "designed" riprap protection beneath the bridge along each abutment. Specifically, NV5 used a proprietary Microsoft Excel workbook to design the proposed riprap protection. This workbook, a copy of which in included in **Appendix G, Riprap Workbook,** was developed to design riprap for a total of six (6) different design methods. This multiple-method approach provides an objective comparative analysis of the various methods and allows the user to select the most appropriate method for the project in question.

As evidenced by the riprap design calculations included as **Appendix G, Riprap Workbook,** the "abutment sideslopes" (ie, the existing streambanks beneath the bridge adjacent to the two proposed abutments) would only require a maximum riprap size of 0.2-feet (2.4-inces), which is smaller than the local, median bed material size of 3.5-inches. And as noted above, the 100-year flow velocities beneath the bridge are within the acceptable range of widely accepted maximum permissible velocities for well vegetated, highly erodible soils. Therefore, riprap protection is not required along the abutments beneath the proposed bridge.

7.0 SUMMARY

NV5 performed the Scope of Services noted above in accordance with the Agreement noted above. Services included the development of a hydraulic/computer model to represent both the existing and proposed site/bridge conditions described in detail above. It is important to note that the Proposed Conditions hydraulic/computer model is very sensitive to even the slightest refinements to the bridge, hydraulic friction values, and proposed grading due to the very "flat" or "level" "backwater conditions" imposed upon this reach of Chehalem Creek by the Willamette River. This means any adjustments to the proposed design may compromise the "No Rise" condition certified herein.

The proposed creek/bridge crossing has been assessed for bridge/channel scour using commonly accepted practices and techniques. Channel scour at the proposed bridge was calculated to equal 0.0-feet (ie, scour is non-existent.) In addition, the need to protect the channel banks beneath the proposed bridge with riprap was considered. Results from the hydraulic model and riprap analysis indicate the existing channel banks are stable under the 100-year flood condition and that riprap is not required at the proposed bridge.

It is NV5's opinion that this Report and the finding provided herein are sufficiently detailed to constitute a Final Bridge Hydraulics Report, in lieu of the interim Technical Memo initially envisioned on our proposed scope of services. This opinion is based upon:

- The conservatively deep (18-inch) bridge girder depth considered herein
- The conservative assumption that the proposed bridge rail will be "solid" rather than constructed of thinner rail elements that can pass flow in between the rail elements
- The finding that bridge scour is non-existent
- The finding that riprap scour countermeasures and/or abutment protection is not required

8.0 LIMITATIONS

NV5, Inc. has prepared this report and design exclusively for the Chehalem Park and Recreation District and their authorized agents and regulatory agencies for this specific Ewing Young Park Footbridge Project. Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in the field of bridge hydraulic engineering design in this area at the time this report was prepared. The conclusions, recommendations, and opinions presented in this report are based on our professional knowledge, judgment, and experience. No warranty or other conditions, expressed or implied, should be understood.

9.0 REFERENCES

Brunner G.W., 2010. *HEC-RAS River Analysis System Hydraulic Reference Manual*. U.S. Army Corps of Engineers' Hydraulic Engineering Center.

FEMA, 2010a. Federal Emergency Management Agency, *Flood Insurance Study, Yamhill County, Oregon and Incorporated Areas*, Effective March 2, 2010

FEMA, 2010b. Federal Emergency Management Agency, *Flood Insurance Rate Map, Panel 236 of 675, Yamhill County, Oregon and Incorporated Areas*, Effective March 2, 2010

NV5, January 18, 2022. *Report of Geotechnical Engineering Services, Pedestrian Bridge – Ewing Young Park, Newberg, Oregon*

Oregon Department of Transportation Highway Division, April 2014, *Hydraulics Design Manual*

U.S. Department of Agriculture, Soil Conservation Service (SCS) 1954, *SCS-TP-61, Handbook of Channel Design for Soil and Water Conservation*

APPENDIX A: PHOTO LOG OF EXISTING SITE

Photo 1

Facing southeasterly (downstream) on existing trail at/near bridge site. Chehalem Creek is (barely visible) in photo to right. (Photo taken 5/17/2022)

Photo 2

Facing southwesterly across creek at/near proposed bridge crossing. Creek flows from right to left in photo. (5/17/2022)

Photo 3

Facing southeasterly (downstream) across creek at/near proposed bridge crossing. Creek flows from right to left in photo. (5-17-2022)

Photo 4

Facing southwesterly across creek at/near proposed bridge crossing. Creek flows from right to left in photo. (5-17-2022)

Photo 5

Facing southwesterly across creek at/near proposed bridge crossing. Creek flows from right to left in photo. (5-17-2022)

Photo 6

Facing westerly across creek at/near proposed bridge crossing. Creek flows from right to left in photo. (5-17-2022)

Photo 7

Facing westerly across creek at/near proposed bridge crossing. Creek flows from right to left in photo. Note large bed material. (7-13-2022)

Photo 8

Facing southeasterly (downstream) at/near proposed bridge crossing. Note large bed material. (7-13-2022)

Photo 9

Facing northwesterly (upstream) at/near proposed bridge crossing. Note large bed material. (7-13-2022)

Photo 10

Representative streambed material at/near proposed bridge crossing. (7-14-2022)

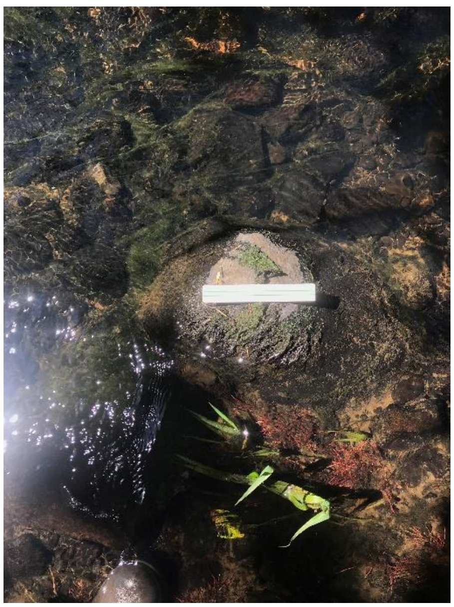


Photo 11

Representative streambed material at/near proposed bridge crossing. (Scale shown is approximately 6-inches-long.) (7-14-2022)

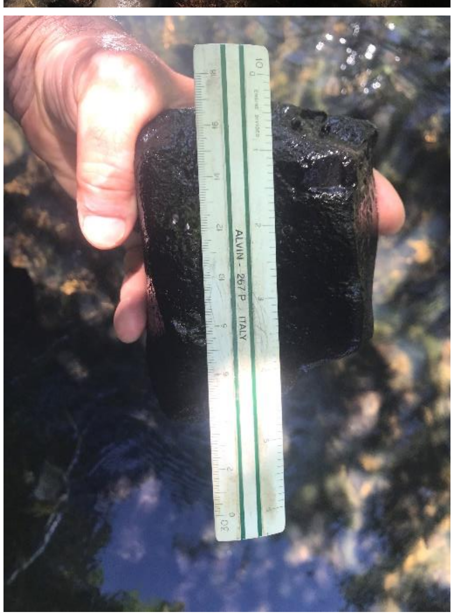


Photo 12

Representative streambed material at/near proposed bridge crossing. (Scale shown is approximately 6-inches-long.) (7-14-2022)

Photo 13

Representative streambed material at/near proposed bridge crossing. (Scale shown is approximately 6-inches-long.) (7-14-2022)

Photo 14

Representative streambed material at/near proposed bridge crossing. (7-14-2022)

Photo 15

Representative streambed material taken from in between relatively larger bed cobbles/rocks at/near proposed bridge crossing. (Scale shown is approximately 6-inches-long.) (7-14-2022)

APPENDIX B: FEMA DOCUMENTATION

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) Report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS Report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study Report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study Report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) zone 10. The **horizontal datum** was NAD 83, GRS 1980 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at **(301) 713- 3242**, or visit its website at http://www.ngs.noaa.gov.

Base map information shown on this FIRM was derived from multiple sources. Base map files were provided in digital format by the State of Oregon. This information was compiled from the U.S. Geological Survey (2007), Oregon Department of Transportation (2007), OR/WA Bureau of Land Management (2005), Oregon Department of Forestry (2003), NGS (2007), and USDA-FSA (2006) at a scale of 1:24,000.

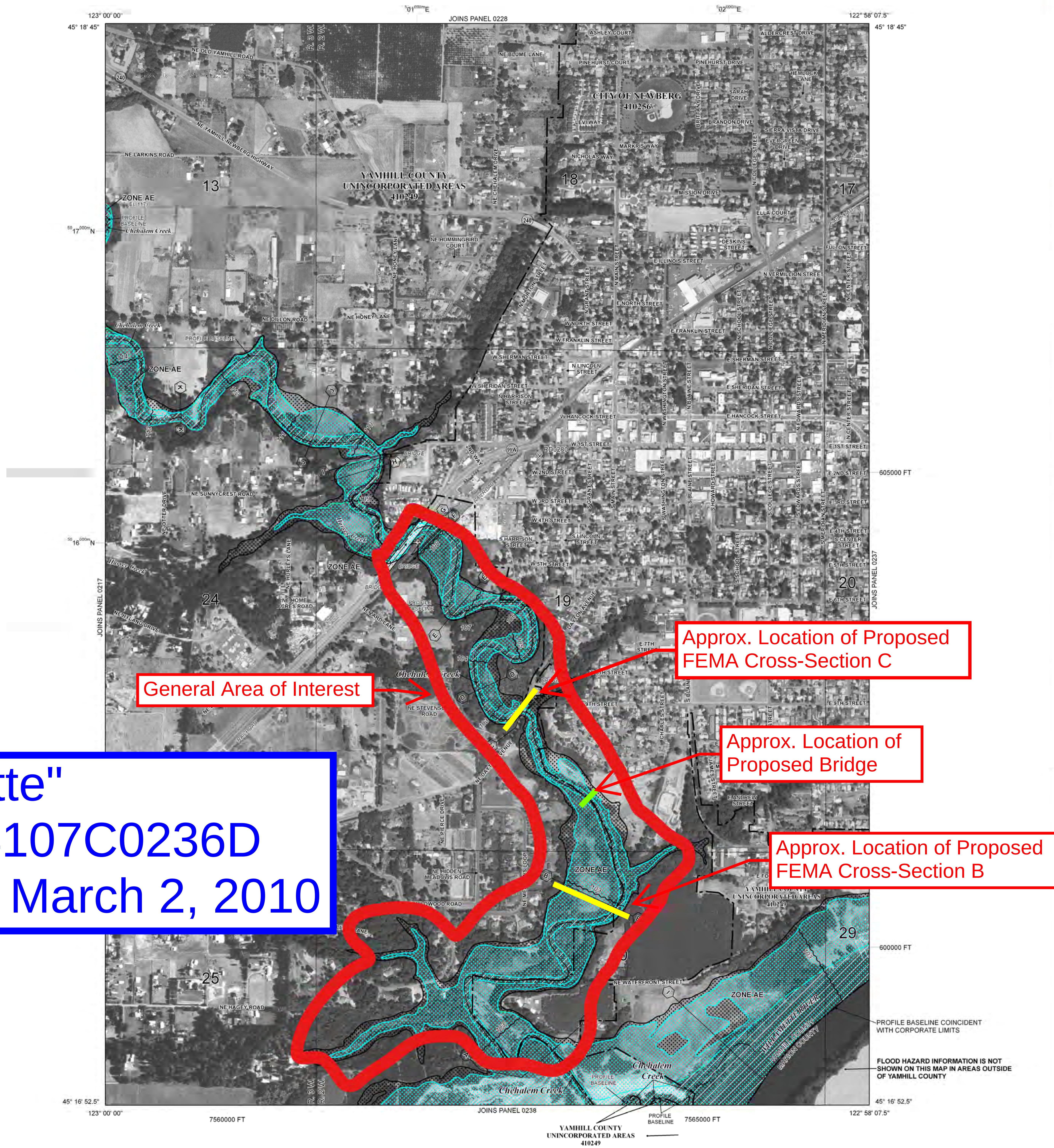
The **profile baselines** depicted on this map represent the hydraulic modeling baselines that match the flood profiles in the FIS report. As a result of improved topographic data, the **profile baseline**, in some cases, may deviate significantly from the channel centerline or appear outside the SFHA.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

Contact the **FEMA Map Service Center** at 1-800-358-9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1-800-358-9620 and its website at http://msc.fema.gov.

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1- 877- FEMA MAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/business/nfip/.



LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A No Base Flood Elevations determined.

ZONE AE Base Flood Elevations determined.

ZONE AH Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.

ZONE AO Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.

ZONE AR Special Flood Hazard Areas formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.

ZONE A99 Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.

ZONE V Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.

ZONE VE Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X Areas determined to be outside the 0.2% annual chance floodplain.

ZONE D Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

1% Annual Chance Floodplain Boundary
0.2% Annual Chance Floodplain Boundary
Floodway boundary
Zone D boundary
CBRS and OPA boundary
Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.

~~ 513 ~~~	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

*Referenced to the North American Vertical Datum of 1988

(A)———(A)	Cross section line
(23) - - - - - (23)	Transect line
45° 02' 08", 93° 02' 12'	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83) Western Hemisphere
3100000 FT	5000-foot ticks: Oregon State Plane North Zone (FIPS Zone 3601), Lambert Conformal Conic projection
4989000m N	1000-meter Universal Transverse Mercator grid values, zone 10N
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
March 2, 2010
EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 500'

250 0 500 1000 FEET
150 0 150 300 METERS

NFIP
NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0236D

FIRM
FLOOD INSURANCE RATE MAP
YAMHILL COUNTY, OREGON
AND INCORPORATED AREAS

PANEL 236 OF 675
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
NEWBERG, CITY OF	410256	0236	D
YAMHILL COUNTY	410249	0236	D

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
41071C0236D

EFFECTIVE DATE
MARCH 2, 2010

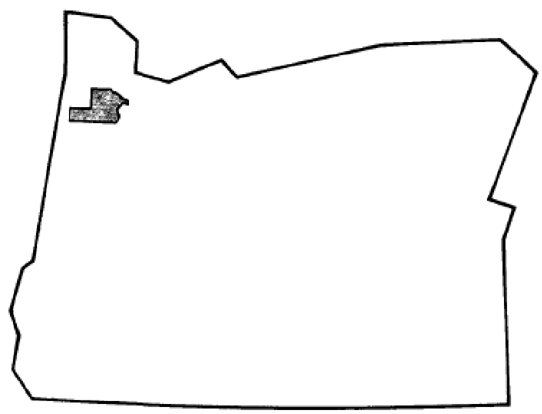
Federal Emergency Management Agency

Excerpts From

FLOOD INSURANCE STUDY

YAMHILL COUNTY, OREGON AND INCORPORATED AREAS

COMMUNITY NAME	COMMUNITY NUMBER
AMITY, CITY OF	410250
CARLTON, CITY OF	410251
DAYTON, CITY OF	410252
DUNDEE, CITY OF	410253
LAFAYETTE, CITY OF	410254
MCMINNVILLE, CITY OF	410255
NEWBERG, CITY OF	410256
SHERIDAN, CITY OF	410257
WILLAMINA, CITY OF	410258
YAMHILL, CITY OF	410259
YAMHILL COUNTY UNINCORPORATED AREAS	410249



Effective Date: March 2, 2010

Federal Emergency Management Agency
Flood Insurance Study Number
41071CV000A

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EXHIBITS

Exhibit 1 – Flood Profiles

Agency Creek	Panels 01P-02P
Ash Swale	Panel 03P
Baker Creek	Panels 04P-05P
Chehalem Creek	Panels 06P-09P
Cozine Creek	Panels 10P-13P
North Fork Cozine Creek	Panel 14P
Hess Creek	Panels 15P-19P
Palmer Creek	Panel 20P
West Fork Palmer Creek	Panel 21P
Panther Creek	Panel 22P
Salt Creek	Panels 23P-24P
Willamette River	Panels 25P-37P
Willamina Creek	Panels 38P-39P
Yamhill Creek	Panels 40P-42P
Yamhill River	Panels 43P-44P
North Yamhill River	Panels 45P-46P
South Yamhill River	Panels 47P-50P

PUBLISHED SEPARATELY

Flood Insurance Rate Map Index

Flood Insurance Rate Map

Table 4. Summary of Discharges

Flooding Source and Location	Drainage Area (square miles)	Peak Discharges (cfs) 10-percent-annual-chance	2-percent-annual-chance	1-percent-annual-chance	0.2-percent-annual-chance
Agency Creek	25	2,130	3,430	4,080	5,090
Ash Swale	43	2,150	2,880	3,180	3,760
Baker Creek	26	1,320	1,780	2,030	2,400
Chehalem Creek					
at mouth	41	1,650	2,450	2,760	3,490
below Harvey Creek (River Mile 2.8)	39	1,600	2,380	2,680	3,390
at State Highway 240	27	1,330	1,950	2,190	2,750
Cozine Creek	11	600	830	940	1,230
North Fork Cozine Creek	2	196	270	309	399
West Fork Cozine Creek	0.6	109	150	170	221
Hess Creek					
at Wynoski Street	3.8	290	350	400	440
at U.S. Highway 99W (River Mile 3.4)	3.0	220	270	310	350
at Fulton Avenue (River Mile 4.0)	2.3	170	210	240	260
upstream of Mountain View Drive (River Mile 5.3)	1.7	140	180	210	230
Palmer Creek	31.3	3,210	4,020	4,360	5,260

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals. Users should be aware that flood elevations shown on the FIRM represent rounded whole foot elevations and may not exactly reflect the elevations shown on the Flood Profiles or in the Floodway Data tables in the FIS report. Flood elevations shown on the FIRM are primarily intended for flood insurance rating purposes. For construction and/or floodplain management purposes, users are cautioned to use the flood elevation data presented in this FIS in conjunction with the data shown on the FIRM.

Cross sections for streams were field surveyed by the USACE, determined from detailed USGS topographic maps, or obtained from aerial photography (References 24, 25, 26, and 27). All bridges, dams, and culverts were field checked to obtain elevation data and structural geometry.

Cross sections for the Willamette River in the vicinity of Dundee were based on condition surveys taken from 1973 to 1976 and topographic maps dated April 1973 (Reference 28). Cross sections for Hess Creek in the vicinity of Newberg were based on USACE orthophoto topographic maps (Reference 29) and field channel surveys. Those field surveys were made in February and March 1978. Topographic maps were used for a few photographic control points to supplement the field-surveyed control points (Reference 30).

Cross sections for the Yamhill River, North Yamhill River, South Yamhill River, and Willamina Creek were based on orthophoto topographic maps (References 19 and 31) and field channel surveys. Topographic maps were used for a few photographic control points to supplement the field-surveyed control points (Reference 32).

Cross section data for Yamhill Creek were based on a USACE orthophoto topographic map, dated April 1977 (Reference 26), and June 1979 field channel surveys. Topographic maps were used for a few photographic control points to supplement the field-surveyed control points (Reference 32).

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway was computed (Section 4.2), selected cross section locations are also shown on the FIRM.

Channel roughness factors (Manning's "n") used in the hydraulic computations for the channel and overbanks were chosen by engineering judgment based on field observations. The values were then adjusted to match high-water marks where available. The range of roughness values used for all flooding sources are shown in Table 5.

Table 5. Range of Manning's Roughness Values

Flood Source	Main Channel	Floodplain
Agency Creek	0.060-0.300	0.120
Ash Swale	0.030-0.650	0.120-0.300
Baker Creek	0.070-0.300	0.080
Chehalem Creek	0.050-0.060	0.080-0.120
Cozine Creek	0.030-0.130	0.030-0.150

Table 5. Range of Manning's Roughness Values (continued)

Flood Source	Main Channel	Floodplain
North Fork Cozine Creek	0.030-0.130	0.030-0.150
West Fork Cozine Creek	0.030-0.130	0.035-0.150
Hess Creek	0.035-0.055	0.070-0.100
Palmer Creek	0.050	0.070
West Fork Palmer Creek	0.050	0.070
Panther Creek	0.070	0.080
Salt Creek	0.030-0.065	0.120-0.300
Willamette River	0.028-0.029	0.077-.0150
Willamina Creek	0.045-0.050	0.070
Yamhill Creek	0.035-0.050	0.070-0.150
Yamhill River	0.033-0.042	0.075-0.090
North Yamhill River	0.035-0.500	0.070-0.100

Water-surface elevations of floods of the selected recurrence intervals were computed through use of the USACE HEC-2 step-backwater computer program for all streams studied in detail except Cozine Creek, North Fork Cozine Creek, and West Fork Cozine Creek (Reference 33). Cozine Creek, North Fork Cozine Creek, and West Fork Cozine Creek were analyzed using the U.S. Soil Conservation Service WSP-2 backwater computer program (Reference 34). North Yamhill River starting water-surface elevations were calculated considering Yamhill River elevations when North Yamhill River is at peak flow. Starting water-surface elevations for Yamhill River, South Yamhill River, Hess Creek, Cozine Creek, and Willamina Creek were calculated using normal depth computations. North Fork Cozine Creek starting water-surface elevations were calculated using critical depth. Starting water-surface elevations for Chehalem Creek, Palmer Creek, West Fork Palmer Creek, Panther Creek, Baker Creek, Yamhill Creek, Salt Creek, Ash Swale, and Agency Creek were determined using slope-area method. Starting water-surface elevations for the Willamette River were taken from the Clackamas County Flood Insurance Study (Reference 35).

Flooding on Salt Creek through the City of Amity is influenced by the South Yamhill River; thus, the elevations used in this study are based on a hydraulic analysis of South Yamhill River (Reference 36). Elevations on Ash Swale through the study area are controlled by Salt Creek backwater. Water-surface elevations on Palmer Creek are controlled by backwater from Yamhill River. On West Fork Cozine Creek, it was determined that flooding was due to backwater from Cozine Creek; therefore no profile is shown.

Base flood elevations shown on the Floodway Data Table (Table 6) for cross sections BF, BG, and BH on South Yamhill River are not representative for the entire cross section width across the floodplain. Orientation of base flood elevations shown on the Flood Insurance Rate Map (FIRM) (published separately) was determined through a combination of computed elevations on the South Yamhill and historical high-water marks along the floodplain.

The hydraulic analyses for this study were based on unobstructed flow. The flood elevations shown on the profiles are thus considered valid only if hydraulic structures remain unobstructed and operate properly, and do not fail.

Approximate study areas were analyzed using slope-area method, field reconnaissance, engineering judgment, and available topographic information (References 32 and 37). Approximate study areas within the City of Amity were analyzed using the Federal Insurance Administration Flood Hazard Boundary Map for the City of Amity (Reference 38), information from city officials, field inspection, engineering judgment, and topographic maps at a scale of 1:4800, with a contour interval of 5 feet (Reference 26). Approximate water-surface elevations for the unnamed tributary to the Yamhill River in the vicinity of the City of Dayton were determined using Yamhill River backwater elevation and adding a small surcharge.

For the approximate studies of an unnamed tributary to Yamhill Creek through the eastern part of the City of Yamhill, and a short reach of Rowland Creek upstream and downstream of Moores Valley Road near the western corporate limits, the 1-percent-annual-chance flood elevations were prepared from information furnished by the City of Yamhill and local residents; and by using aerial photographs, field observations, and limited hydraulic computations.

3.3 Vertical Datum

All FIS reports and FIRMs are referenced to a specific vertical datum. The vertical datum provides a starting point against which flood, ground, and structure elevations can be referenced and compared. Until recently, the standard vertical datum used for newly created or revised FIS reports and FIRMs was the National Geodetic Vertical Datum of 1929 (NGVD 29). With the completion of the North American Vertical Datum of 1988 (NAVD 88), many FIS reports and FIRMs are now prepared using NAVD 88 as the referenced vertical datum.

Flood elevations shown in this FIS report and on the FIRMs are referenced to NAVD 88. These flood elevations must be compared to structure and ground elevations referenced to the same vertical datum. For information regarding conversion between the NGVD and the NAVD, visit the National Geodetic Survey website at www.ngs.noaa.gov, or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242
(301) 713-4172 (fax)

The conversion factor from NGVD to NAVD for all flooding sources in this report is +3.47 feet.

Temporary vertical monuments are often established during the preparation of a flood hazard analysis for the purpose of establishing local vertical control. Although these monuments are not shown on the FIRM, they may be found in the Technical Support Data Notebook associated with the FIS report and the FIRMs for this community. Interested individuals may contact FEMA to access these data.

To obtain current elevation, description and/or location information for benchmarks

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
Chehalem Creek								
A	0.61	60	663	4.2	102.5	75.8[2]	76.3[2]	0.5
B	1.39	50	461	6.0	102.5	84.7[2]	84.9[2]	0.2
C	1.86	48	223	12.4	102.5	98.9[2]	98.9[2]	0.0
D	1.99	55	531	5.2	103.5	103.5	103.7	0.2
E	2.45	148	1,010	2.7	107.3	107.3	108.0	0.7
F	2.64	105	1,175	2.3	108.0	108.0	108.8	0.8
G	2.66	75	138	2.6	108.2	108.2	109.0	0.8
H	3.02	67	551	4.9	109.3	109.3	109.9	0.6
I	3.04	51	553	4.8	109.6	109.6	110.3	0.7
J	3.20	130	1,111	2.4	110.8	110.8	111.5	0.7
K	3.68	85	772	3.5	112.6	112.6	113.4	0.8
L	4.21	75	736	3.3	116.2	116.2	116.7	0.5
M	4.70	61	642	3.8	119.0	119.0	119.8	0.8
N	4.99	140	855	2.6	121.0	121.0	121.8	0.8
O	5.36	85	442	5.0	124.7	124.7	125.0	0.3
P	5.37	78	421	5.2	125.2	125.2	125.5	0.3
Q	5.42	160	631	3.5	126.4	126.4	126.7	0.3
R	6.05	110	486	4.5	135.1	135.1	135.6	0.5
S	6.29	95	321	6.2	141.0	141.0	141.3	0.3
T	6.61	250	655	3.0	148.7	148.7	149.5	0.8
U	6.69	130	494	4.0	150.2	150.2	151.0	0.8
V	6.71	75	596	3.3	151.1	151.1	151.8	0.7
W	6.97	200	571	3.0	155.4	155.4	156.1	0.7
X	7.24	512	1,131	1.5	159.7	159.7	160.1	0.4

Elevation in NAVD88 and Survey in NGVD29 (See Construction Plans for NGVD29 Control)

[1]Miles above mouth

[2]Elevation computed without consideration of backwater effects from Willamette River

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

YAMHILL COUNTY, OREGON AND INCORPORATED AREAS

FLOODWAY DATA

CHEHALEM CREEK

102.5' - 3.47' = 99.03'
See this document for conversion from 88 to 29

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
Chehalem Creek (continued)								
Y	7.45[1]	410	2,192	0.8	160.2	160.2	160.6	0.4
Z	7.81[1]	550	2,353	0.5	160.4	160.4	161.0	0.6
AA	8.13[1]	440	1,361	0.9	160.7	160.7	161.5	0.8
AB	8.46[1]	37	227	5.2	162.8	162.8	163.5	0.7
AC	8.47[1]	22	125	9.4	163.0	163.0	163.3	0.3
AD	8.60[1]	200	832	1.4	165.1	165.1	165.8	0.7
Cozine Creek								
A	84[3]	25	253	3.7	122.3	88.3[2]	89.3[2]	1.0
B	1,184[3]	42	337	2.9	122.3	91.5[2]	92.5[2]	1.0
C	1,404[3]	37	245	4.0	122.3	92.9[2]	93.9[2]	1.0
D	1,534[3]	27	219	4.5	122.3	93.2[2]	94.2[2]	1.0
E	1,834[3]	82	819	1.2	122.3	101.5[2]	102.5[2]	1.0
F	2,484[3]	92	795	1.2	122.3	101.7[2]	102.7[2]	1.0
G	2,714[3]	179	3,179	0.3	122.3	112.4[2]	113.4[2]	1.0
H	3,579[3]	214	2,051	5.4	122.3	112.5[2]	113.5[2]	1.0
I	4,134[3]	171	2,376	0.5	122.3	112.5[2]	113.5[2]	1.0
J	4,559[3]	123	1,608	0.7	122.3	114.1[2]	115.1[2]	1.0
K	5,564[3]	187	2,343	0.5	122.3	114.1[2]	115.1[2]	1.0
L	6,314[3]	170	1,397	0.8	122.3	114.2[2]	115.2[2]	1.0
M	6,414[3]	92	527	2.0	122.3	114.3[2]	115.3[2]	1.0
N	6,635[3]	132	1,348	0.9	122.3	114.4[2]	115.4[2]	1.0
O	6,935[3]	115	1,159	0.8	122.3	114.4[2]	115.4[2]	1.0

[1]Miles above mouth
[2]Elevation computed without consideration of backwater effects from South Yamhill River
[3]Feet above mouth

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

YAMHILL COUNTY, OREGON AND INCORPORATED AREAS

FLOODWAY DATA

CHEHALEM CREEK, COZINE CREEK

5.0 INSURANCE APPLICATION

For flood insurance rating purposes, flood insurance zone designations are assigned to the community based on the results of the engineering analyses. These zones are as follows:

Zone A

Zone A is the flood insurance rate zone that corresponds to the 1-percent-annual-chance floodplains that are determined in the Flood Insurance Study by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no base (1-percent-annual-chance) flood elevations (BFEs) or depths are shown within this zone.

Zone AE

Zone AE is the flood insurance rate zone that corresponds to the 1-percent-annual-chance floodplains that are determined in the Flood Insurance Study by detailed methods. BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone X

Zone X is the flood insurance rate zone that corresponds to areas outside the 0.2-percent-annual-chance floodplain, areas within the 0.2-percent-annual-chance floodplain, areas of 1-percent-annual-chance flooding where average depths are less than one foot, areas of 1-percent-annual-chance flooding where the contributing drainage area is less than one square mile, and areas protected from the 1-percent-annual-chance flood by levees. No BFEs or depths are shown within this zone.

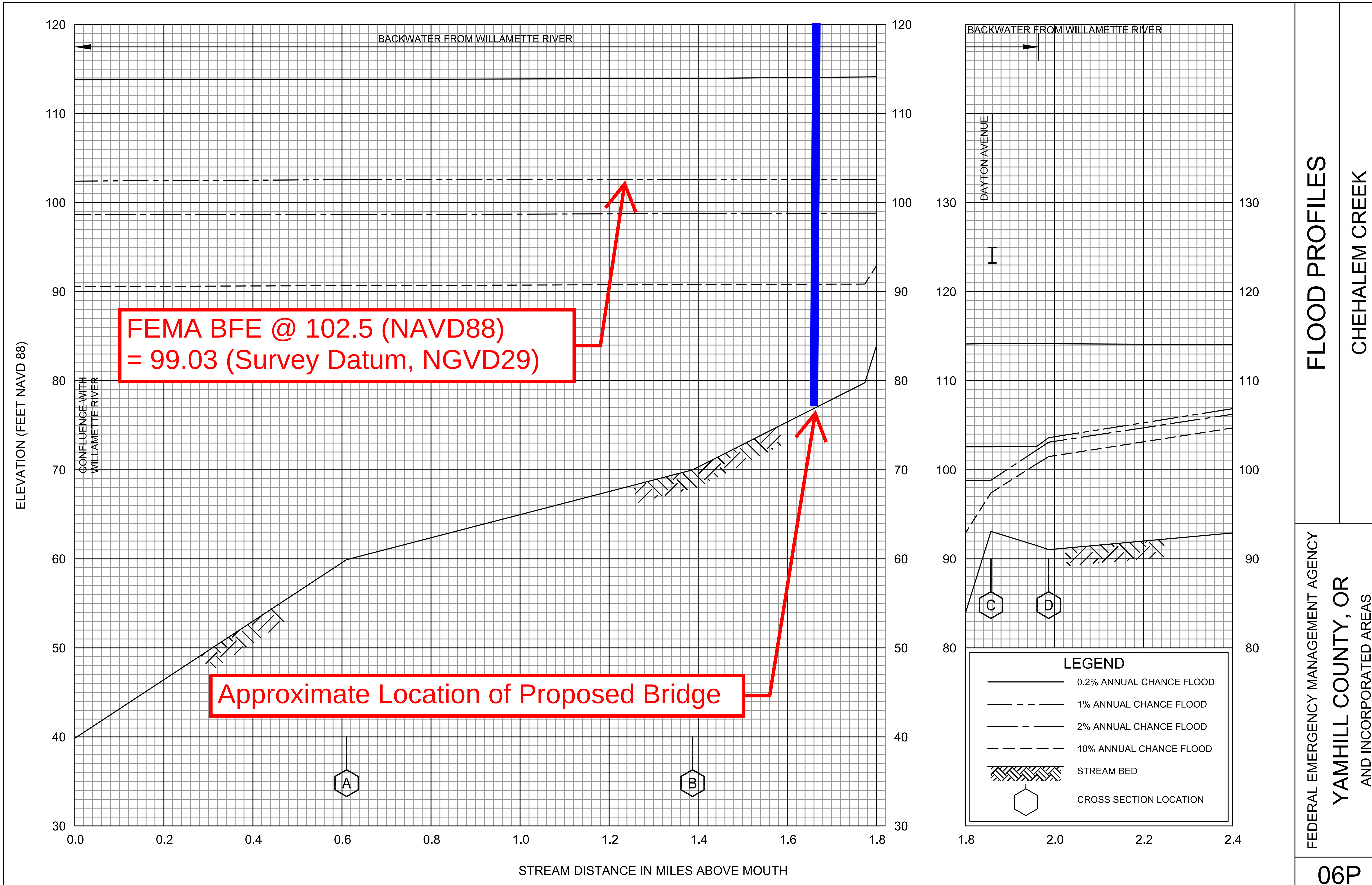
Table 7 lists the flood insurance zones that each community is responsible for regulating.

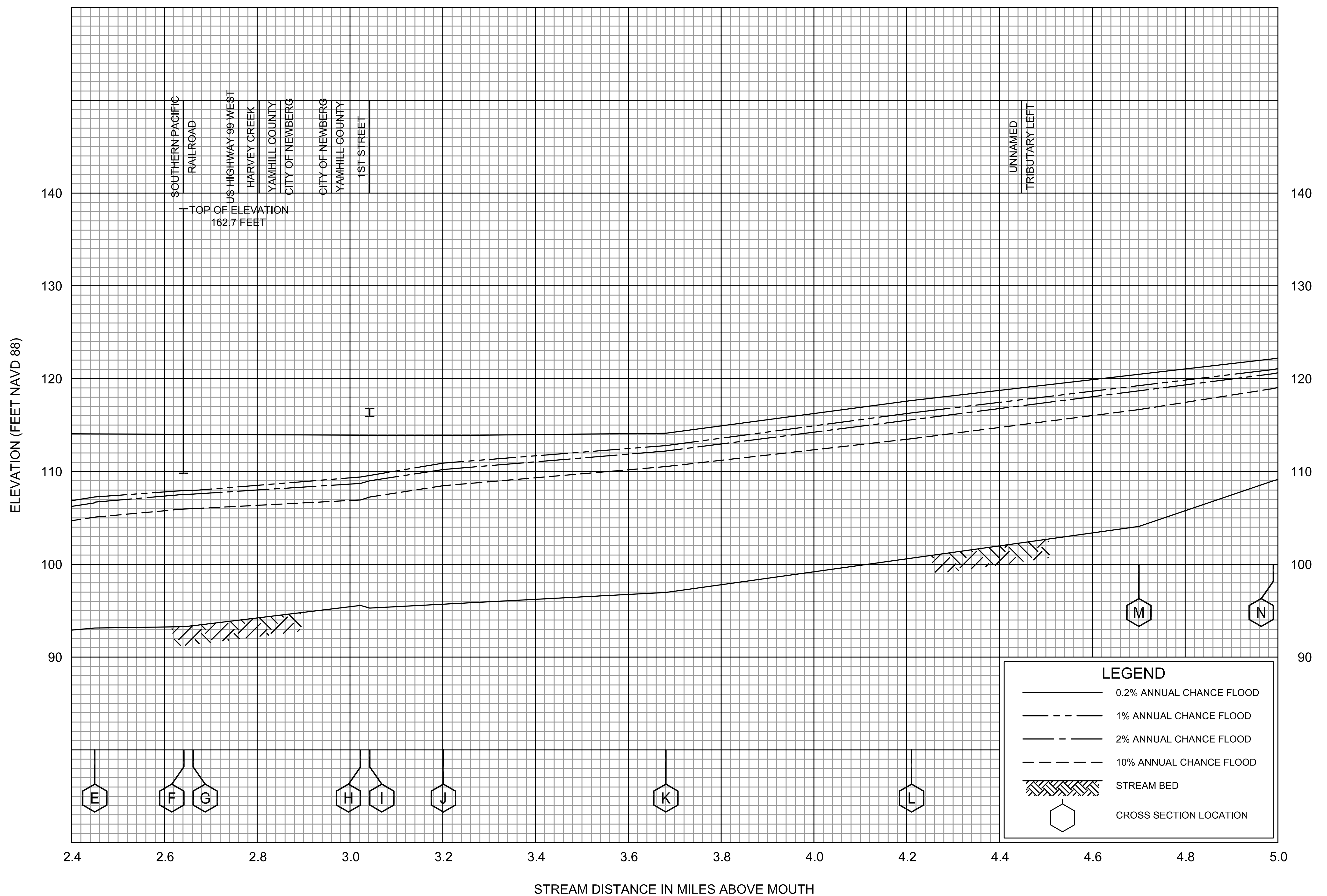
Table 7. Flood Insurance Zones within Each Community

Community	Flood Zone(s)
Amity, City of	A, AE, X
Carlton, City of	A, AE, X
Dayton, City of	A, AE, X
Dundee, City of	AE, X
Lafayette, City of	A, AE, X
McMinnville, City of	A, AE, X
Newberg, City of	A, AE, X
Sheridan, City of	AE, X
Willamina, City of	AE, X
Yamhill, City of	A, AE, X
Yamhill County, Unincorporated Areas	A, AE, X

6.0 FLOOD INSURANCE RATE MAP

The Flood Insurance Rate Map is designed for flood insurance and floodplain management applications.


BACKWATER FROM WILLAMETTE RIVER
CONFLUENCE WITH WILLAMETTE RIVER
ELEVATION (FEET NAVD 88)
FEMA BFE @ 102.5 (NAVD88)
= 99.03 (Survey Datum, NGVD29)
Approximate Location of Proposed Bridge
A
B
C
D
DAYTON AVENUE
STREAM DISTANCE IN MILES ABOVE MOUTH
LEGEND
0.2% ANNUAL CHANCE FLOOD
1% ANNUAL CHANCE FLOOD
2% ANNUAL CHANCE FLOOD
10% ANNUAL CHANCE FLOOD
STREAM BED
CROSS SECTION LOCATION
FLOOD PROFILES
CHEHALEM CREEK
FEDERAL EMERGENCY MANAGEMENT AGENCY
YAMHILL COUNTY, OR
AND INCORPORATED AREAS
06P



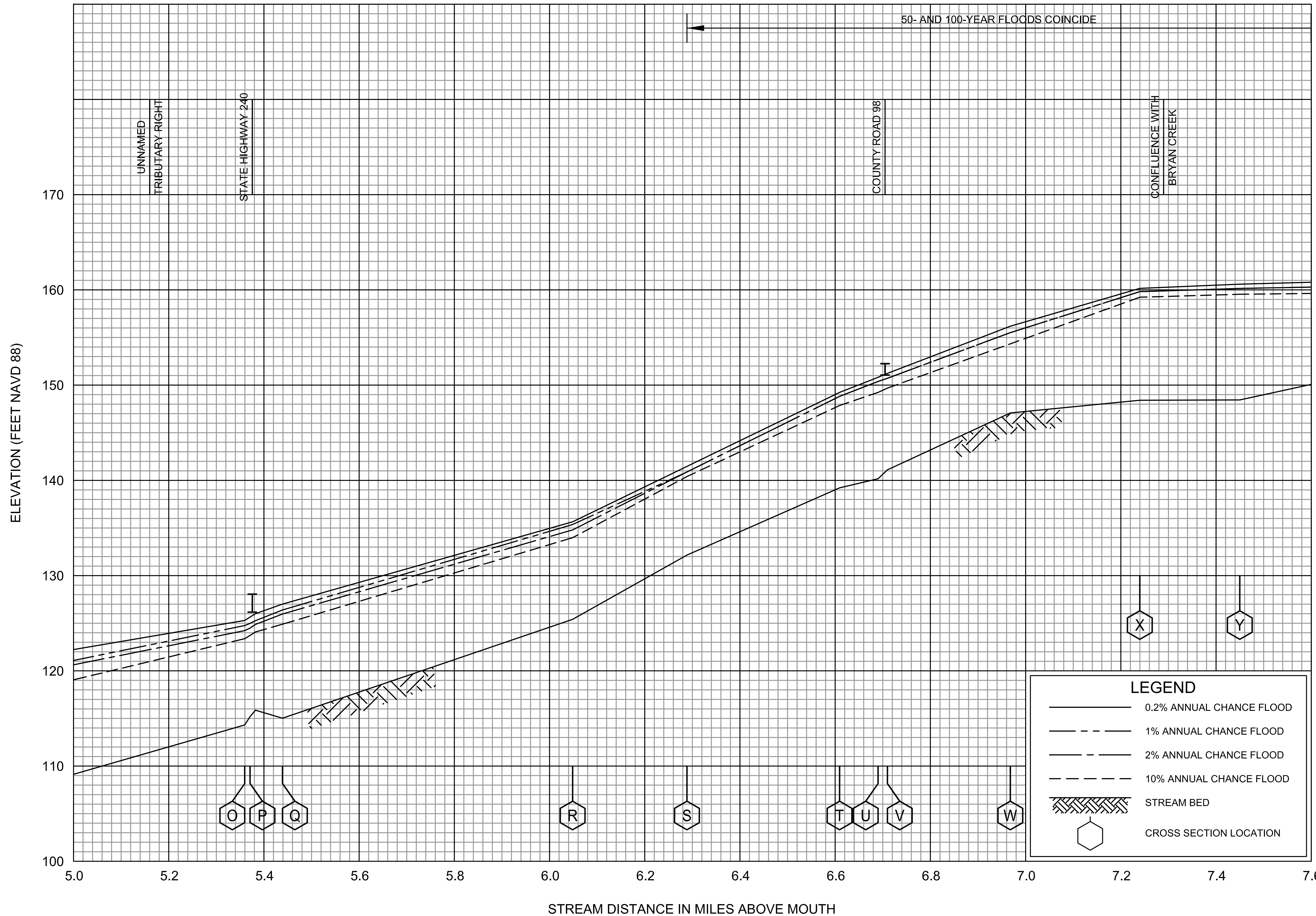
FLOOD PROFILES

CHEHALEM CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

YAMHILL COUNTY, OR
AND INCORPORATED AREAS

07P



FLOOD PROFILES

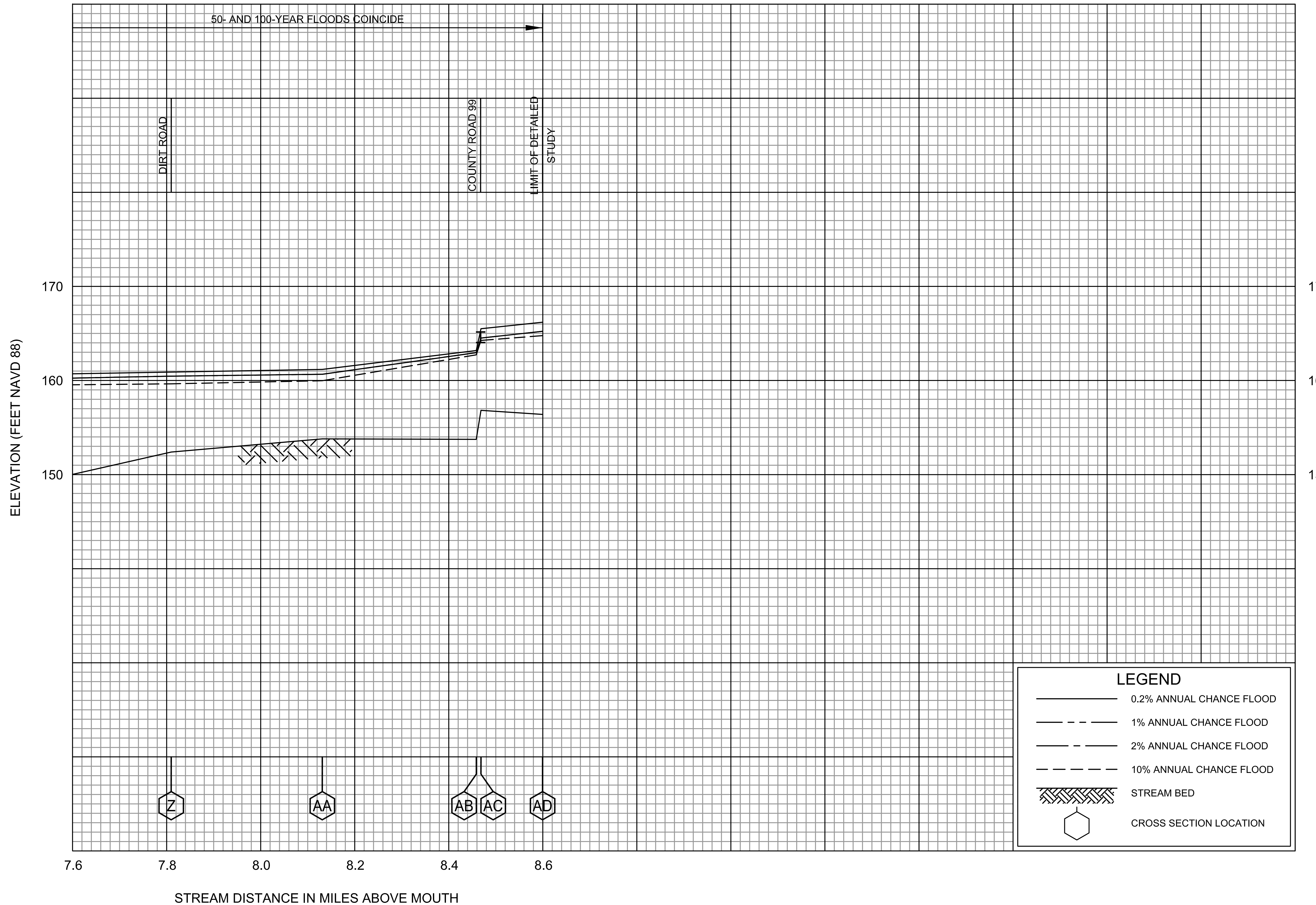
CHEHALEM CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

YAMHILL COUNTY, OR

AND INCORPORATED AREAS

08P



FLOOD PROFILES

CHEHALEM CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

YAMHILL COUNTY, OR

AND INCORPORATED AREAS

09P

Request Sent 12/20/2021

Federal Emergency Management Agency

Washington, D.C. 20472

Flood Insurance Study (FIS) Data Request

Please provide the following information as applicable for the area where you require data:

- Complete community name (including county and state):

  City of Newberg, Yamhill County, Oregon

- Community identification number, if known:

  410256

- Name(s) of flooding source(s) and specific location(s) for which data are needed (Attach FIRM panel showing subject area if available):

  Chehalem Creek between Pacific Hwy W and Newberg Dundee Bypass. See attached annotated copy of FIRM Panel.

- Specific data needed (see list of available categories on page 1):

  Category 1: Portable Document Format (PDF) or Diskettes of hydrologic and hydraulic backup data for current or historical FISs.
  Specifically the Executable HEC-RAS model and readily available supporting data.

- Effective date of FIRM for which data are requested (enclose an annotated copy of FIRM/FBFM, if available, identifying area of interest):

  March 2, 2010, see attached annotated copy of FIRM Panel.

- Contact person's name:
  Craig Tom

- Firm Name:
  NV5, Inc

- Email Address:
  craig.tom@nv5.com

- Daytime Phone/fax number

  Phone #: 505-348-5212

  Fax #:

- Mailing Address:
  6501 Americas Pkwy NE, Ste 400
  Albuquerque, NM 87110

- I am employed by (choose one):

■ Private Firm ☐ State Agency ☐ Federal Agency ☐ Local Gov't ☐ FEMA Study Contractor* ☐ Other

* Please provide contract number

From: Greene, Susan <Susan.Greene@mbakerintl.com>
Sent: Thursday, May 12, 2022 6:43 AM
To: Craig Tom
Subject: RE: EXTERNAL: RE: FEMA Data Request

The microfiche is not any better, unfortunately they should have saved this in hard copy but didn't. Please let me know if you have any additional questions.

Thank you,
Susan

From: Craig Tom <Craig.Tom@nv5.com>
Sent: Wednesday, May 11, 2022 1:08 PM
To: Greene, Susan <Susan.Greene@mbakerintl.com>
Cc: Jon Champlin <Jon.Champlin@nv5.com>; Michael Homza <Michael.Homza@nv5.com>
Subject: RE: EXTERNAL: RE: FEMA Data Request

Thank you Susan for your attention on my FEMA Request.

Have you had any luck finding a better copy of the model? It sounds like delivery of my request will be hardcopy information on the model rather than an executable copy of the model itself? Is the model in the old HEC-2 format?

Craig Tom, PE (NM) | Staff Engineer | **NV5**
6501 Americas Pkwy NE, Ste 400 | Albuquerque, NM 87110 | P: 505.348.5212 | F: 505.242.4845 | Craig.Tom@NV5.com

---

From: Greene, Susan <Susan.Greene@mbakerintl.com>
Sent: Wednesday, May 4, 2022 8:41 AM
To: Craig Tom <Craig.Tom@nv5.com>
Subject: RE: EXTERNAL: RE: FEMA Data Request

I am sending you the model that was archived , it is a very poor copy. Tomorrow morning I will go into the office and see if I can get a better copy from the microfiche. It will depend on the original that was scanned to the microfiche.

Thank you,
Susan

From: Craig Tom <Craig.Tom@nv5.com>
Sent: Thursday, April 28, 2022 12:02 PM
To: Greene, Susan <Susan.Greene@mbakerintl.com>
Cc: Jon Champlin <Jon.Champlin@nv5.com>; Michael Homza <Michael.Homza@nv5.com>
Subject: EXTERNAL: RE: FEMA Data Request

Good morning,

See the attached PDFs for the initial request.
Thank you for your initial response back regarding my data request and I am checking in again on the status of my request.

It has been four (4) months since we made our initial request for this information. This design project is highly dependent upon this FEMA information, and we cannot make any design advancements until we have the information we requested from FEMA.

Our client is becoming extremely impatient with us and our only reply to-date has been "We are waiting on FEMA". This excuse is no longer valid.

Can you please provide us an update on the requested documentation as soon as possible?

Your immediate attention to this request will be appreciated.

Thank you very much.

Craig Tom, PE (NM) | Staff Engineer | **NV5**
6501 Americas Pkwy NE, Ste 400 | Albuquerque, NM 87110 | P: 505.348.5212 | F: 505.242.4845 | Craig.Tom@NV5.com

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From: Craig Tom
Sent: Wednesday, April 13, 2022 9:53 AM
To: 'Greene, Susan' <Susan.Greene@mbakerintl.com>
Cc: Jon Champlin <Jon.Champlin@nv5.com>; Michael Homza <Michael.Homza@nv5.com>
Subject: RE: FEMA Data Request

Hello,

I am just checking in if you have what you needed and a possible timeframe for the requested information.
The data request is for the Chehalem Creek between Pacific Hwy W and Newberg Dundee Bypass in City of Newberg, Yamhill County, Oregon.

Thank you,

Craig Tom, PE (NM) | Staff Engineer | **NV5**
6501 Americas Pkwy NE, Ste 400 | Albuquerque, NM 87110 | P: 505.348.5212 | F: 505.242.4845 | Craig.Tom@NV5.com

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From: Craig Tom
Sent: Thursday, March 24, 2022 11:19 AM
To: Greene, Susan <Susan.Greene@mbakerintl.com>
Subject: RE: FEMA Data Request

Hello,

Here is the original data request.

Craig Tom, PE (NM) | Staff Engineer | **NV5**
6501 Americas Pkwy NE, Ste 400 | Albuquerque, NM 87110 | P: 505.348.5212 | F: 505.242.4845 | Craig.Tom@NV5.com

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From: Greene, Susan <Susan.Greene@mbakerintl.com>
Sent: Thursday, March 24, 2022 8:13 AM
To: Craig Tom <craig.tom@nv5.com>
Subject: FEMA Data Request

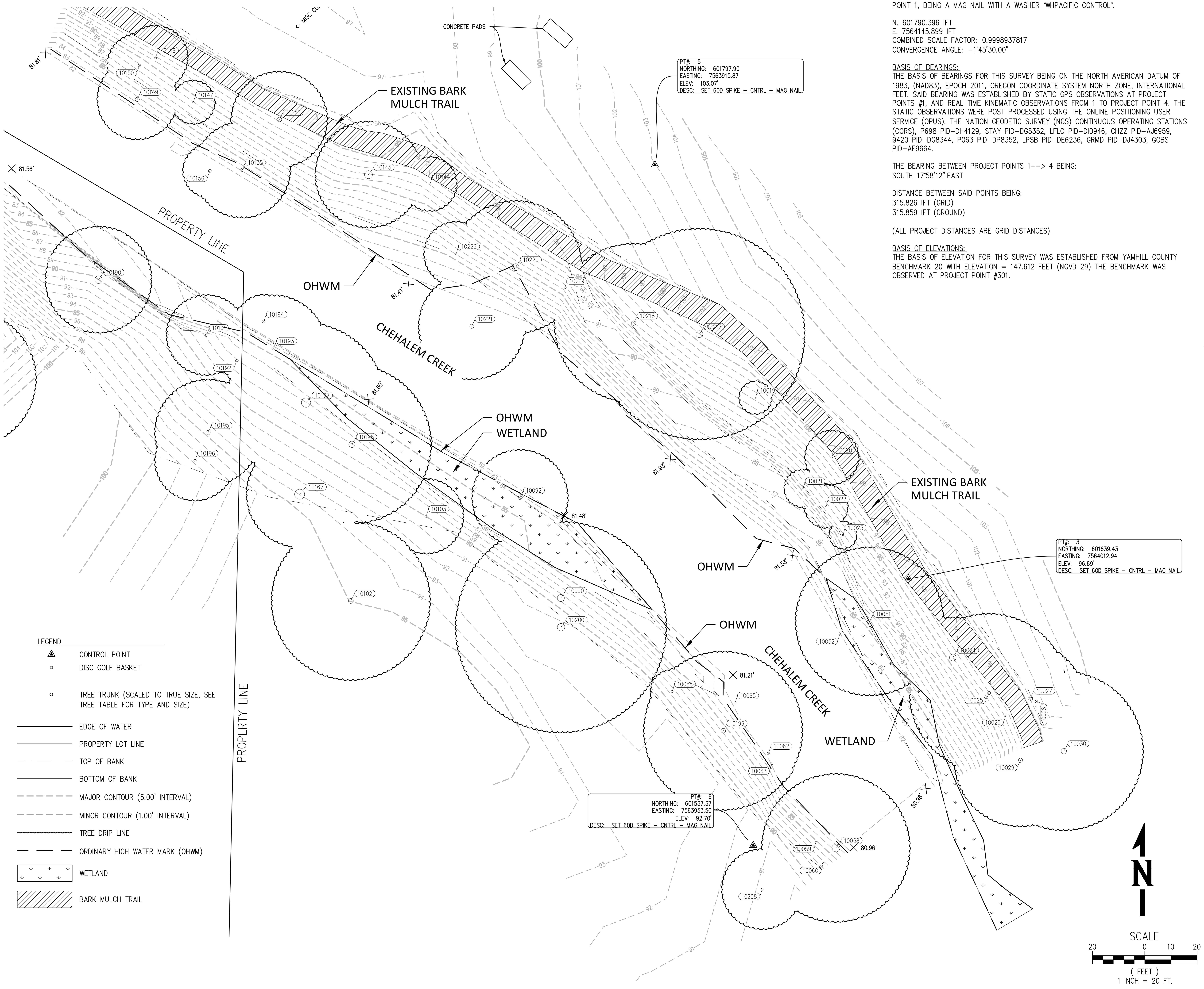
We would have assigned this request by now. Do you mind sending a copy of the original data request directly to me at this email. I will make sure that it is assigned right away.

Thank you,
Susan

Susan Greene | Associate/Document Control Supervisor
3601 Eisenhower Ave, Suite 600 | Alexandria, VA 22304 | [O] 571-357-6053
susan.greene@mbakerintl.com | www.mbakerintl.com

Michael Baker INTERNATIONAL 80 YEARS *Making a Difference*

APPENDIX C: EXISTING AND PROPOSED PLANS



LEGEND

- CONTROL POINT
- DISC GOLF BASKET
- TREE TRUNK (SCALED TO TRUE SIZE, SEE TREE TABLE FOR TYPE AND SIZE)
- EDGE OF WATER
- PROPERTY LOT LINE
- TOP OF BANK
- BOTTOM OF BANK
- MAJOR CONTOUR (5.00' INTERVAL)
- MINOR CONTOUR (1.00' INTERVAL)
- TREE DRIP LINE
- ORDINARY HIGH WATER MARK (OHWM)
- WETLAND
- BARK MULCH TRAIL

BASIS OF SURVEY

BASIS OF COORDINATES:
NORTH AMERICAN DATUM OF 1983, (NAD83), EPOCH 2011, OREGON COORDINATE SYSTEM NORTH ZONE, INTERNATIONAL FEET,

THE BASIS OF COORDINATES FOR THIS SURVEY WAS ESTABLISHED AT PROJECT POINT 1, BEING A MAG NAIL WITH A WASHER "WHPACIFIC CONTROL".

N. 601790.396 IFT
E. 7564145.899 IFT
COMBINED SCALE FACTOR: 0.9998937817
CONVERGENCE ANGLE: –1°45'30.00"

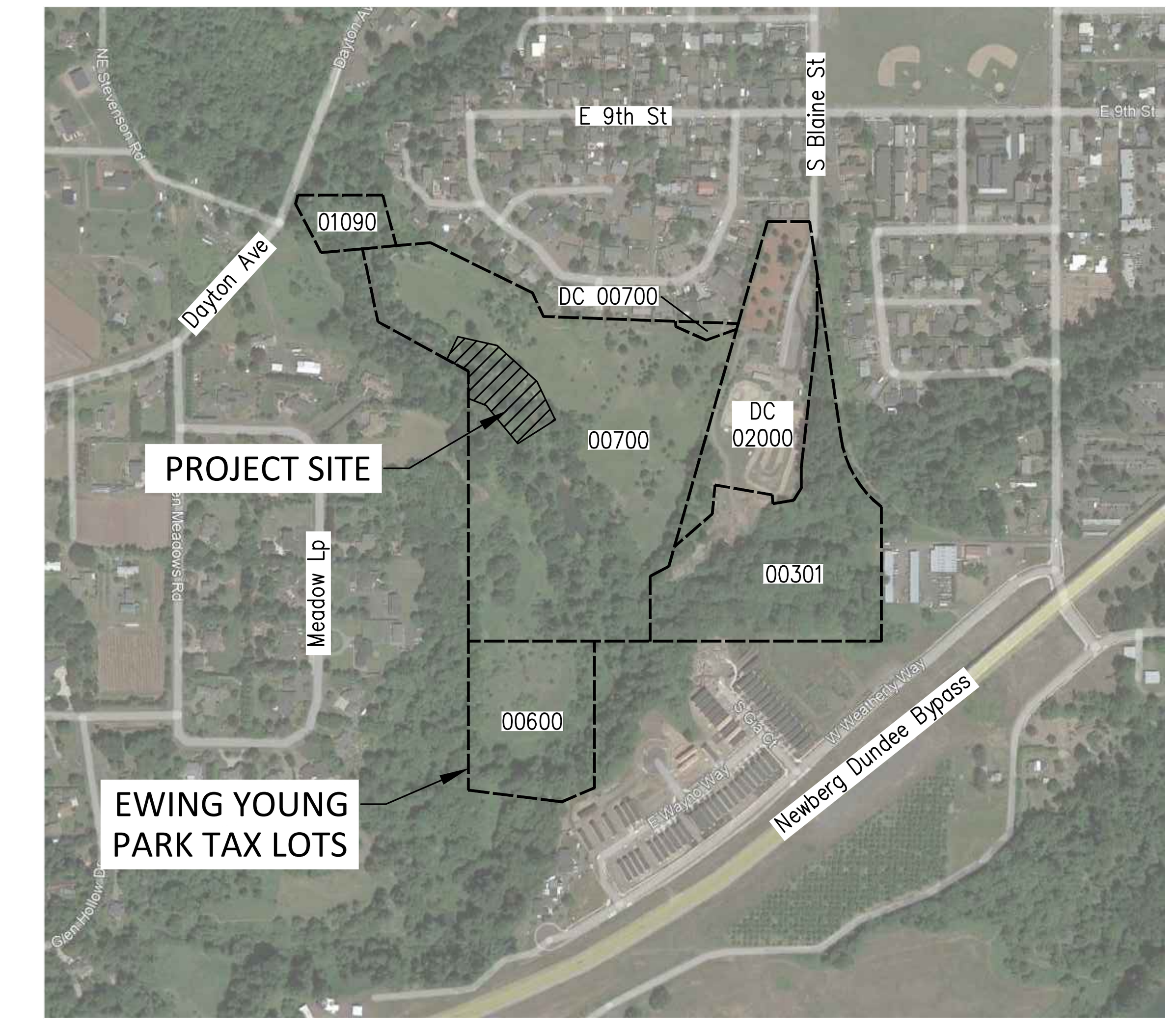
BASIS OF BEARINGS:
THE BASIS OF BEARINGS FOR THIS SURVEY BEING ON THE NORTH AMERICAN DATUM OF 1983, (NAD83), EPOCH 2011, OREGON COORDINATE SYSTEM NORTH ZONE, INTERNATIONAL FEET. SAID BEARING WAS ESTABLISHED BY STATIC GPS OBSERVATIONS AT PROJECT POINTS #1, AND REAL TIME KINEMATIC OBSERVATIONS FROM 1 TO PROJECT POINT 4. THE STATIC OBSERVATIONS WERE POST PROCESSED USING THE ONLINE POSITIONING USER SERVICE (OPUS). THE NATION GEODETIC SURVEY (NGS) CONTINUOUS OPERATING STATIONS (CORS), P698 PID–DH4129, STAY PID–DG5352, LFLO PID–DI0946, CHZZ PID–AJ6959, 9420 PID–DG8344, P063 PID–DP8352, LPSB PID–DE6236, GRMD PID–DJ4303, GOBS PID–AF9664.

THE BEARING BETWEEN PROJECT POINTS 1--> 4 BEING:
SOUTH 17°58'12" EAST

DISTANCE BETWEEN SAID POINTS BEING:
315.826 IFT (GRID)
315.859 IFT (GROUND)

(ALL PROJECT DISTANCES ARE GRID DISTANCES)

BASIS OF ELEVATIONS:
THE BASIS OF ELEVATION FOR THIS SURVEY WAS ESTABLISHED FROM YAMHILL COUNTY BENCHMARK 20 WITH ELEVATION = 147.612 FEET (NGVD 29) THE BENCHMARK WAS OBSERVED AT PROJECT POINT #301.



VICINITY MAP
NOT TO SCALE

NOTE:
1. PROPERTY LINES SHOWN HERE ON ARE BASED ON GIS DATA FROM THE YAMHILL COUNTY DATA SOURCES. ADDITIONAL RESOLUTION WILL REQUIRE MONUMENT RECOVERY.
2. TOPOGRAPHY OF CREEK MEASURED TO HIGH WATER MARK DUE TO UNSAFELY HIGH WATER IN CREEK. ESTIMATE 4-5 FEET DEPTH OF WATER AT WORSE SPOTS.

TREE TABLE

POINT NUMBER	TREE TYPE	TRUNK DIAMETER	DRIP LINE DIAMETER
10019	TRDE	6	6
10020	TRDE	7	10
10021	TRDE	6	7
10022	TRDE	6	8
10023	TRDE X2	7	5
10024	TRCO	32	15
10025	TRCO	16	30
10026	TRDE	11	20
10027	TRDE	21	20
10028	TRDE	13	16
10029	TRDE	20	25
10030	TRDE	26	30
10051	TRDE	23	28
10052	TRDE	10	12
10058	TRDE	38	28
10059	TRDE	6	8
10060	TRDE	8	8
10062	TRDE	12	8
10063	TRDE	10	8
10065	TRDE	12	16
10088	TRDE	10	8
10090	TRDE	34	18
10092	TRDE	19	18
10102	TRCO	24	30
10103	TRDE	11	14
10144	TRDE	10	10
10145	TRCO	38	20
10146	TRDE	22	18
10147	TRDE	8	8
10148	TRDE	10	12
10149	TRDE	20	15
10150	TRDE	12	12
10155	TRDE	16	18
10156	TRDE	14	10
10167	TRCO	48	20
10188	TRCO	55	26
10189	TRDE	9	12
10190	TRDE	36	20
10191	TRDE X2	13	15
10192	TRDE	12	6
10193	TRDE	16	20
10194	TRDE	14	10
10195	TRDE	21	20
10196	TRDE	12	15
10197	TRCO	45	30
10198	TRCO	30	30
10199	TRDE	22	30
10200	TRDE	36	40
10208	TRDE	10	15
10217	TRDE	33	40
10218	TRDE	22	30
10219	TRDE	6	10
10221	TRDE	20	20
10222	TRDE	10	12
10023	TRDE X2	7	5
10191	TRDE X2	13	15

NV5
9450 SW Commerce Circle, Ste 300
Wilsonville, OR 97070
503-626-0455 www.NV5.com

REVISIONS			
NO.	BY	DATE	REMARKS

SHEET INFO	
DRAWN	JC
CHECKED	MS
APPROVED	JC
LAST EDIT	3/2/2022
PLOT DATE	5/12/2022
SUBMITTAL	

EXISTING CONDITIONS PLAN
CHEHALEM PARK AND RECREATION DISTRICT
SE 1/4, SEC 19, T. 3 S., R. 2 W., W.M.
YAMHILL COUNTY, OREGON

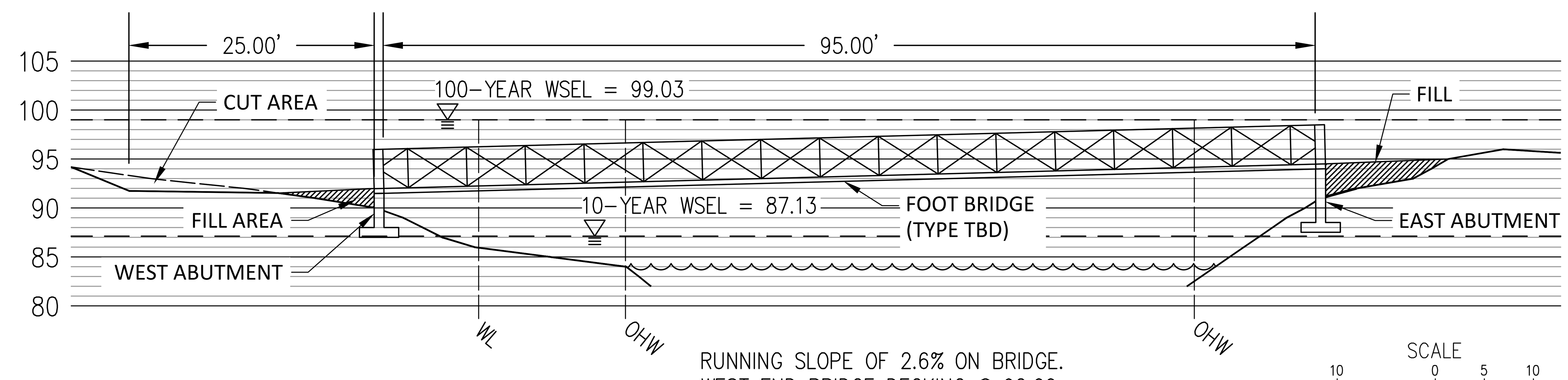
SCALE 1" = 20'

PROJECT NUMBER C000191.00

DRAWING FILE NAME C000191.00-LA01_L1.10-EX

SHEET NUMBER

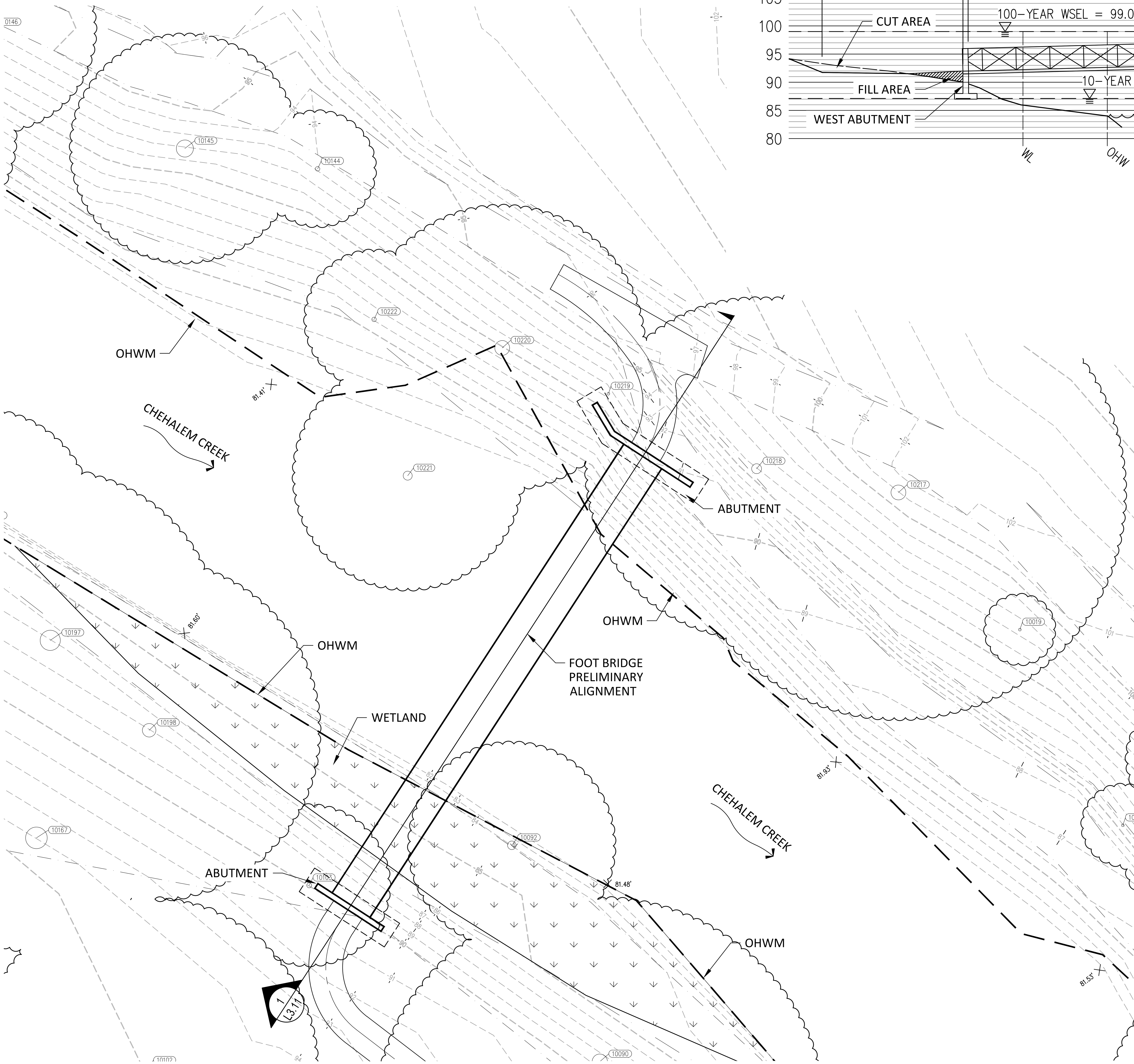
L1.10



RUNNING SLOPE OF 2.6% ON BRIDGE.
WEST END BRIDGE DECKING @ 92.00
EAST END BRIDGE DECKING @ 94.50

SCALE 10 0 5 10 (FEET) 1 INCH = 10 FT.

FOOT BRIDGE PROFILE (1 / L3.11)
SCALE: 1" = 10'



SCALE 10 0 5 10 (FEET) 1 INCH = 10 FT.

LEGEND

- CONTROL POINT
- DISC GOLF BASKET
- TREE TRUNK (SCALED TO TRUE SIZE, SEE TREE TABLE FOR TYPE AND SIZE)
- EDGE OF WATER
- PROPERTY LOT LINE
- TOP OF BANK
- BOTTOM OF BANK
- MAJOR CONTOUR (5.00' INTERVAL)
- MINOR CONTOUR (1.00' INTERVAL)
- TREE DRIP LINE
- ORDINARY HIGH WATER MARK (OHWM)
- WETLAND

SURVEY INFORMATION
HORIZONTAL DATUM = NAD83, EPOCH 2011, OREGON COORDINATE SYSTEM NORTH ZONE, INTERNATIONAL FEET.

VERTICAL DATUM = NGVD29

NOTE: ELEVATIONS SHOWN ARE ON NGVD29 DATUM.

HYDRAULIC DATA		
RETURN PERIOD (YEARS)	WATER SURFACE ELEVATION (FT)	MAXIMUM VELOCITY (FPS)
10	87.13	N/A
100	99.03	3.5

BRIDGE DESIGN PARAMETERS	
BRIDGE (OPEN) SPAN	95.00 FT
WESTERN BRIDGE DECK ELEVATION	92.00
EASTERN BRIDGE DECK ELEVATION	94.50
ASSUMED GIRDER DEPTH	18 INCHES
ASSUMED RAIL (PARAPET) HEIGHT	42 INCHES

NV5
9450 SW Commerce Circle, Ste 300
Wilsonville, OR 97070
503-626-0455 www.NV5.com

REVISIONS			
NO.	BY	DATE	REMARKS

SHEET INFO	
DRAWN	JC
CHECKED	MS
APPROVED	JC
LAST EDIT	8/8/2022
PLOT DATE	8/9/2022
SUBMITTAL	

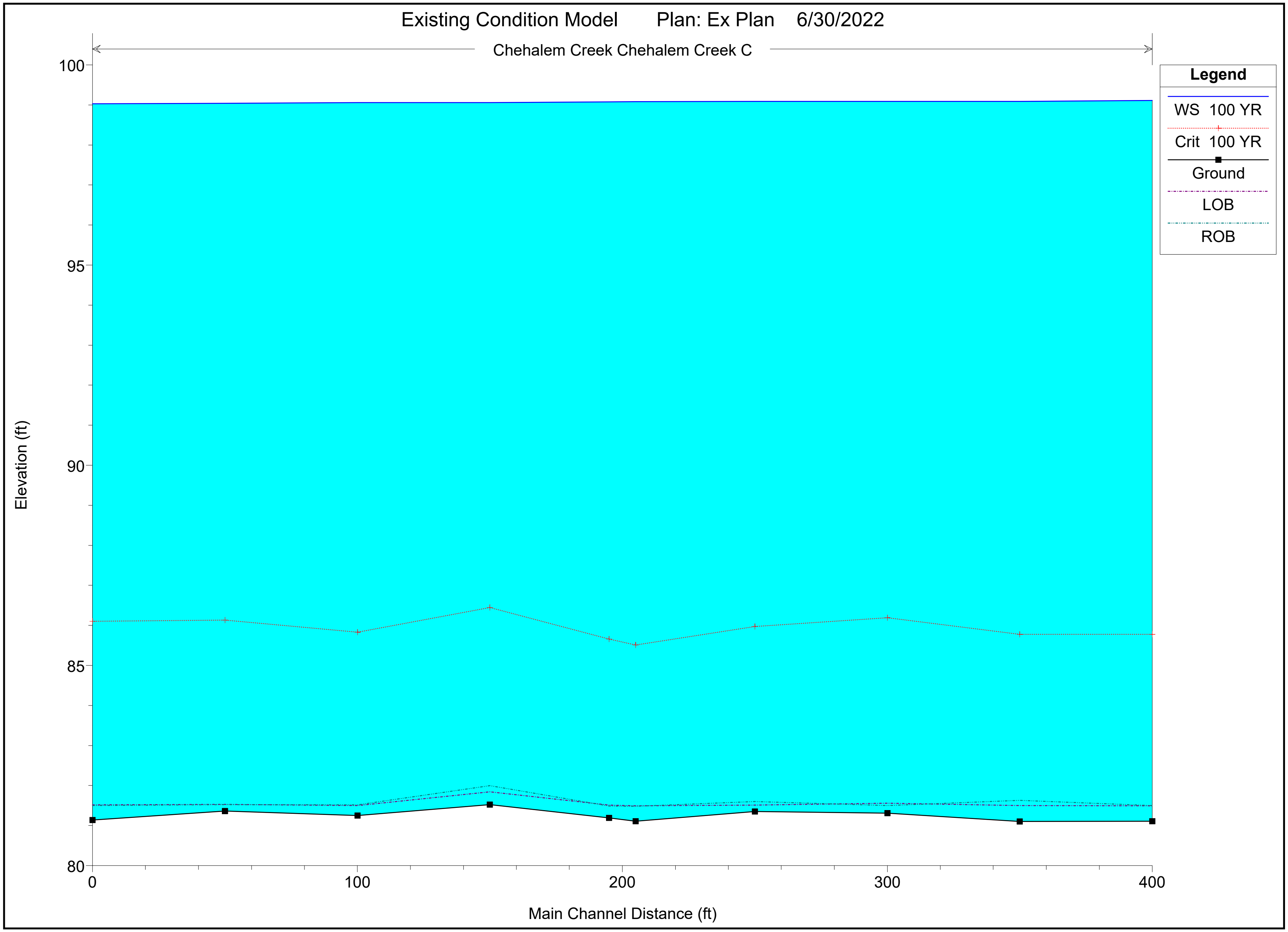
BRIDGE ENLARGEMENT PLAN
EWING YOUNG PARK FOOTBRIDGE
CHEHALEM PARK AND RECREATION DISTRICT

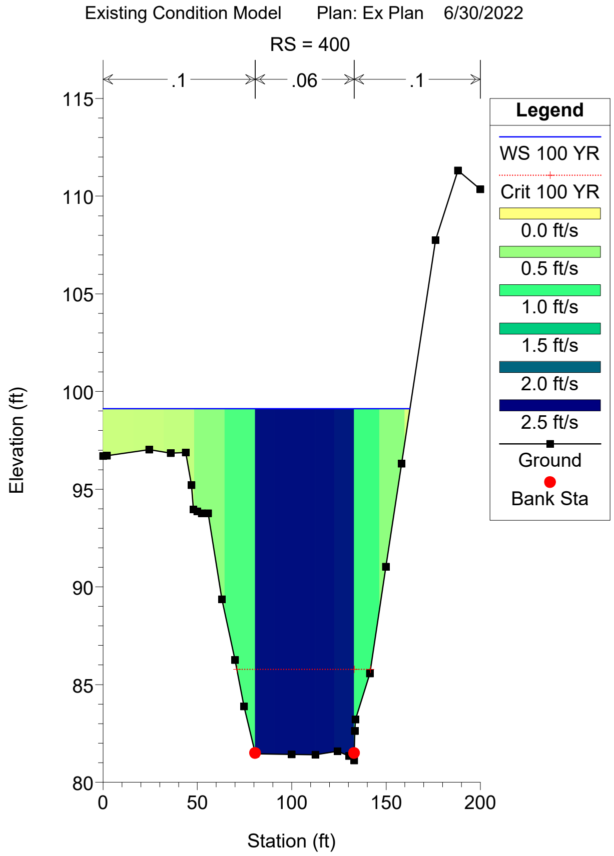
SCALE 1" = 20'
DRAWING FILE NAME C000191.00-LA01_L3.11-BR.0
PROJECT NUMBER C000191.00

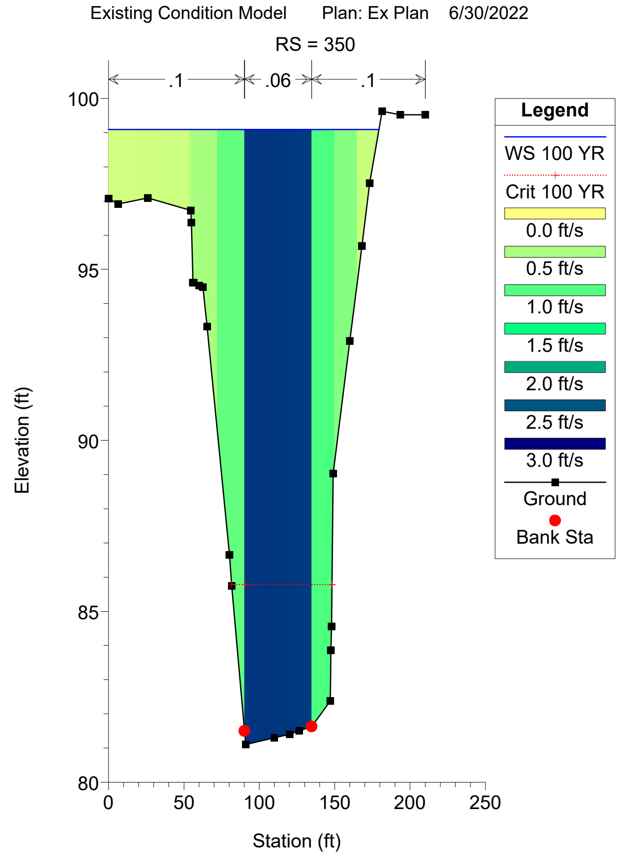
SHEET NUMBER
L3.11

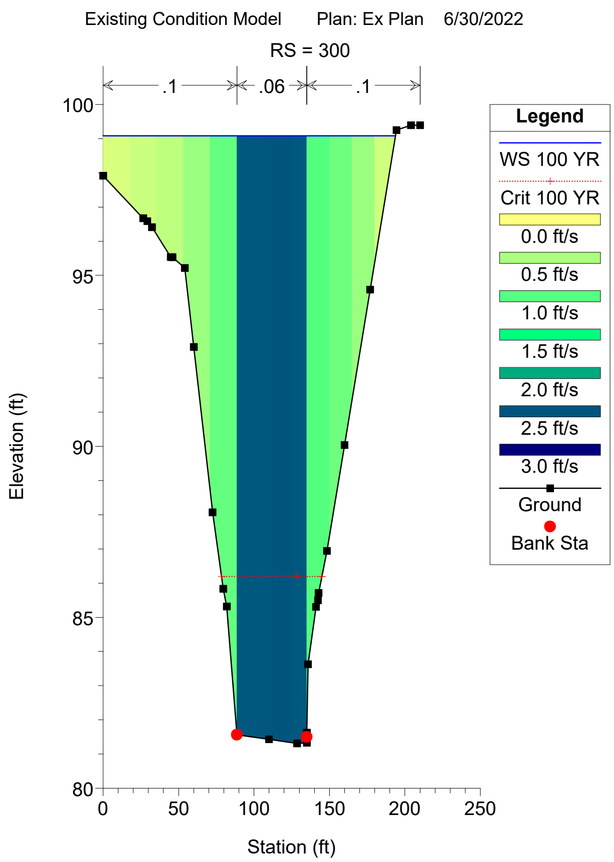
APPENDIX D: EXISTING CONDITIONS HYDRAULIC MODEL RESULTS

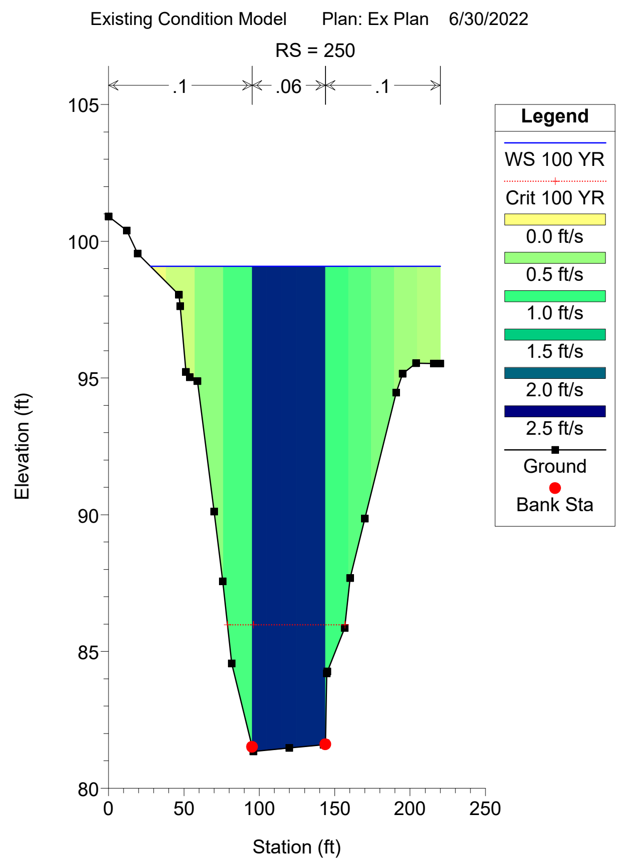
Ewing Young Park Trail Bridge HEC-RAS 100 YR Existing Conditions Plan View

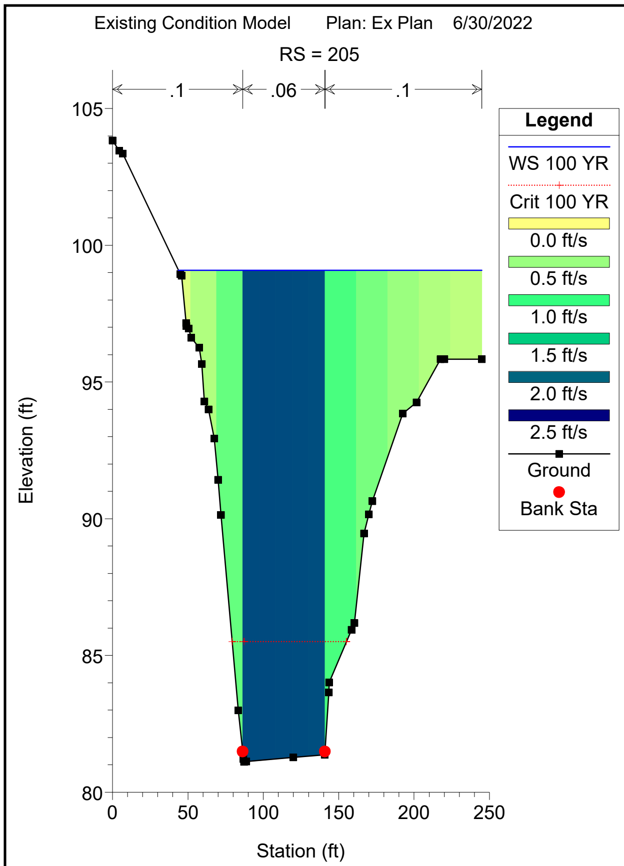

Existing Condition Model Plan: Ex Plan 6/30/2022
Chehalem Creek Chehalem Creek C
Legend
WS 100 YR
Crit 100 YR
Ground
LOB
ROB
Elevation (ft)
100
95
90
85
80
0
100
200
300
400
Main Channel Distance (ft)


Existing Condition Model Plan: Ex Plan 6/30/2022
RS = 400
.1
.06
.1
Elevation (ft)
Station (ft)
Legend
WS 100 YR
Crit 100 YR
0.0 ft/s
0.5 ft/s
1.0 ft/s
1.5 ft/s
2.0 ft/s
2.5 ft/s
Ground
Bank Sta

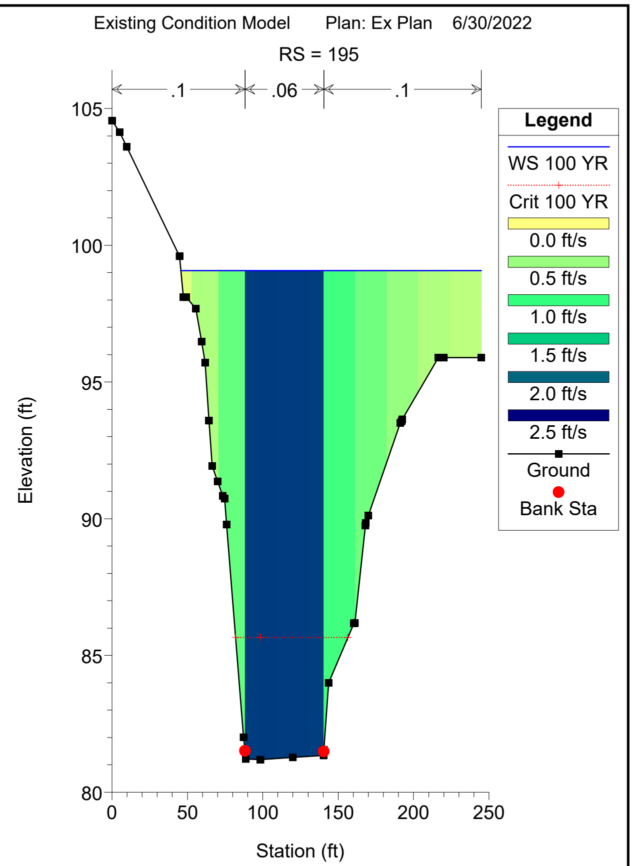

Existing Condition Model Plan: Ex Plan 6/30/2022
RS = 350
.1
.06
.1
Elevation (ft)
Station (ft)
Legend
WS 100 YR
Crit 100 YR
0.0 ft/s
0.5 ft/s
1.0 ft/s
1.5 ft/s
2.0 ft/s
2.5 ft/s
3.0 ft/s
Ground
Bank Sta


Existing Condition Model Plan: Ex Plan 6/30/2022
RS = 300
.1
.06
.1
Elevation (ft)
Station (ft)
Legend
WS 100 YR
Crit 100 YR
0.0 ft/s
0.5 ft/s
1.0 ft/s
1.5 ft/s
2.0 ft/s
2.5 ft/s
3.0 ft/s
Ground
Bank Sta

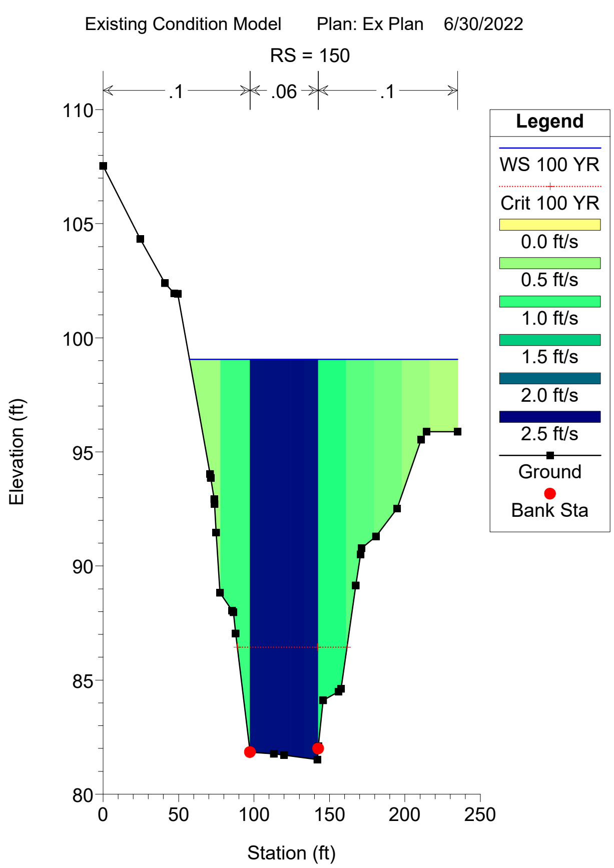

Existing Condition Model Plan: Ex Plan 6/30/2022
RS = 250
.1
.06
.1
Elevation (ft)
Station (ft)
Legend
WS 100 YR
Crit 100 YR
0.0 ft/s
0.5 ft/s
1.0 ft/s
1.5 ft/s
2.0 ft/s
2.5 ft/s
Ground
Bank Sta



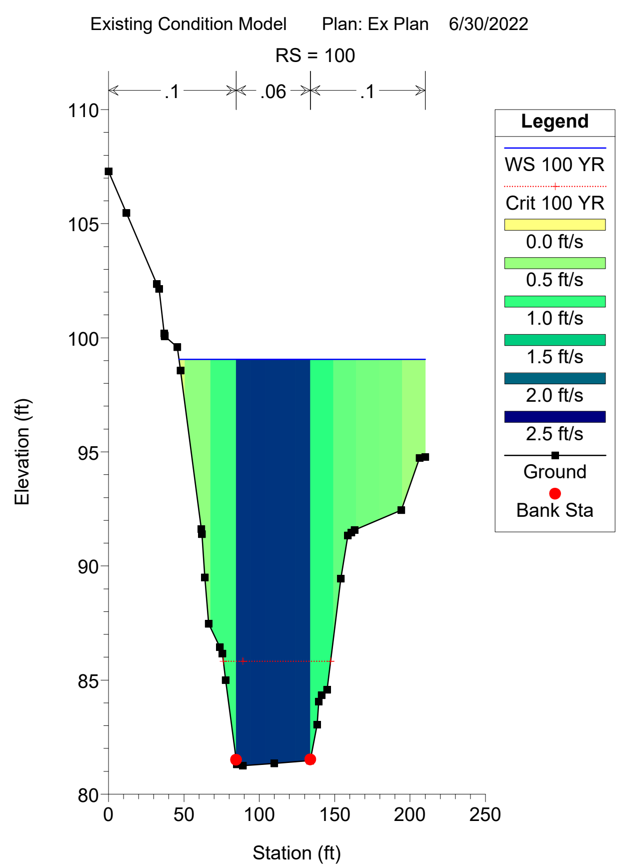
Existing Condition Model Plan: Ex Plan 6/30/2022
RS = 205
.1
.06
.1
Legend
WS 100 YR
Crit 100 YR
0.0 ft/s
0.5 ft/s
1.0 ft/s
1.5 ft/s
2.0 ft/s
2.5 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)



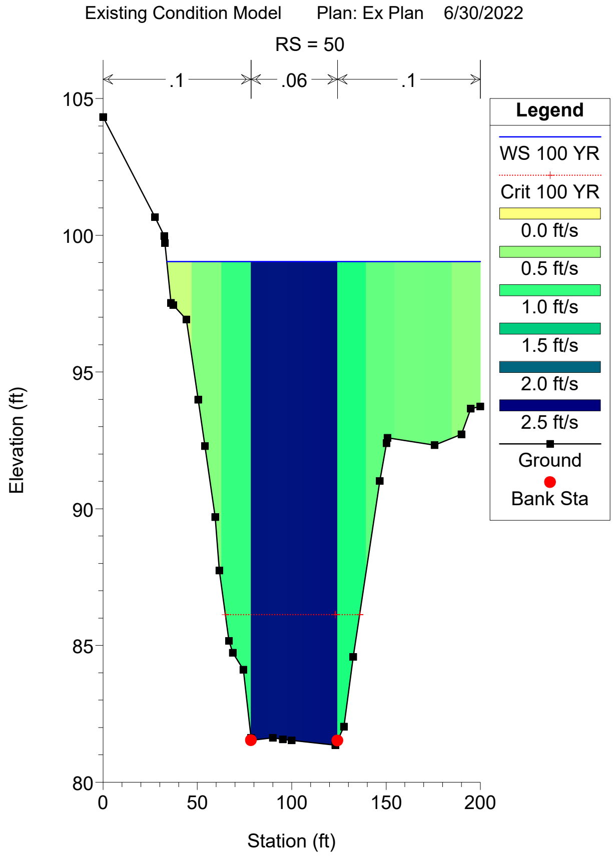
Existing Condition Model Plan: Ex Plan 6/30/2022
RS = 195
.1
.06
.1
Legend
WS 100 YR
Crit 100 YR
0.0 ft/s
0.5 ft/s
1.0 ft/s
1.5 ft/s
2.0 ft/s
2.5 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)

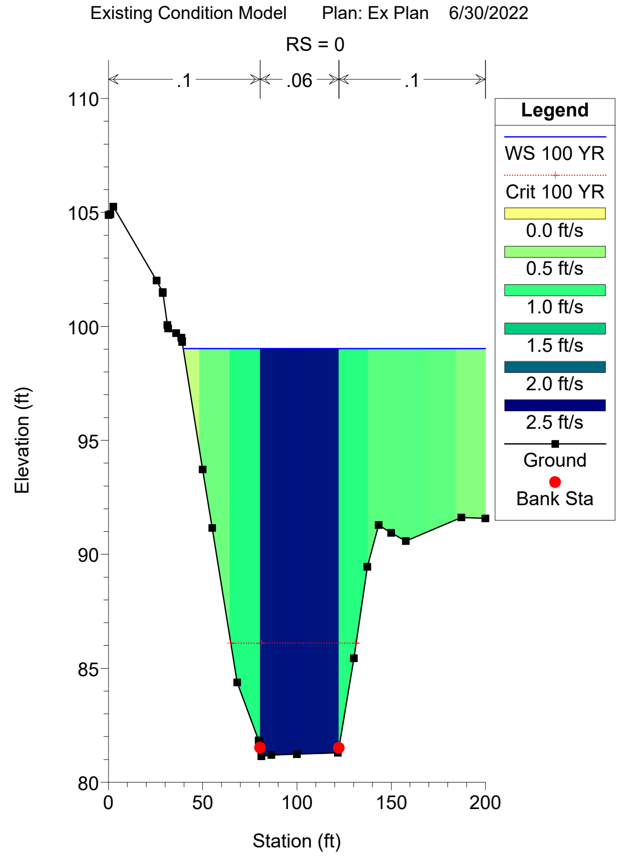


Existing Condition Model Plan: Ex Plan 6/30/2022
RS = 150
.1
.06
.1
Legend
WS 100 YR
Crit 100 YR
0.0 ft/s
0.5 ft/s
1.0 ft/s
1.5 ft/s
2.0 ft/s
2.5 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)



Existing Condition Model Plan: Ex Plan 6/30/2022
RS = 100
.1
.06
.1
Legend
WS 100 YR
Crit 100 YR
0.0 ft/s
0.5 ft/s
1.0 ft/s
1.5 ft/s
2.0 ft/s
2.5 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)


Existing Condition Model Plan: Ex Plan 6/30/2022
RS = 50
.1
.06
.1
Legend
WS 100 YR
Crit 100 YR
0.0 ft/s
0.5 ft/s
1.0 ft/s
1.5 ft/s
2.0 ft/s
2.5 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)
105
100
95
90
85
80
0
50
100
150
200

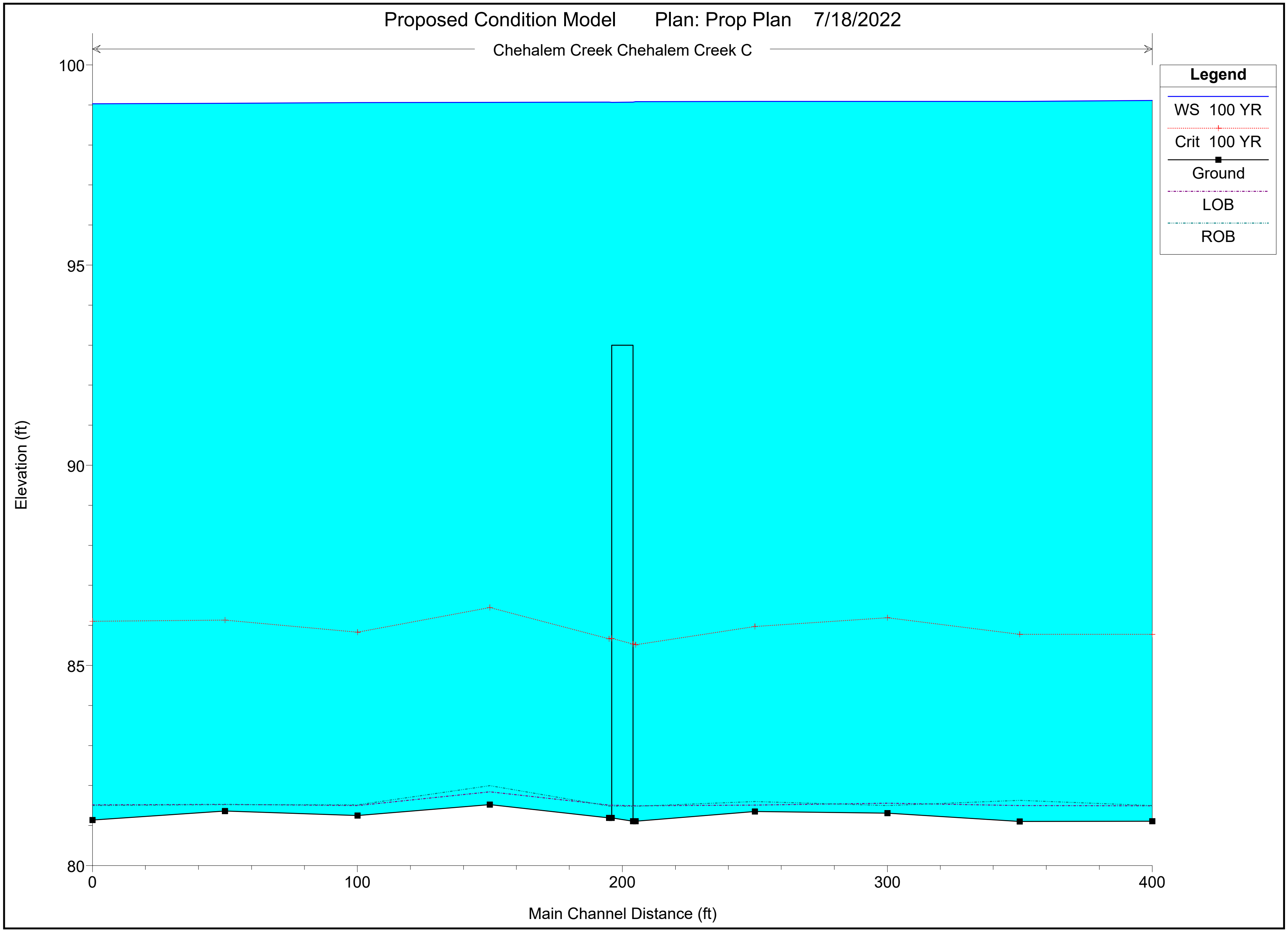

Existing Condition Model Plan: Ex Plan 6/30/2022
RS = 0
.1
.06
.1
Legend
WS 100 YR
Crit 100 YR
0.0 ft/s
0.5 ft/s
1.0 ft/s
1.5 ft/s
2.0 ft/s
2.5 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)
110
105
100
95
90
85
80
0
50
100
150
200

HEC-RAS Plan: Ex Plan River: Chehalem Creek Reach: Chehalem Creek C Profile: 100 YR

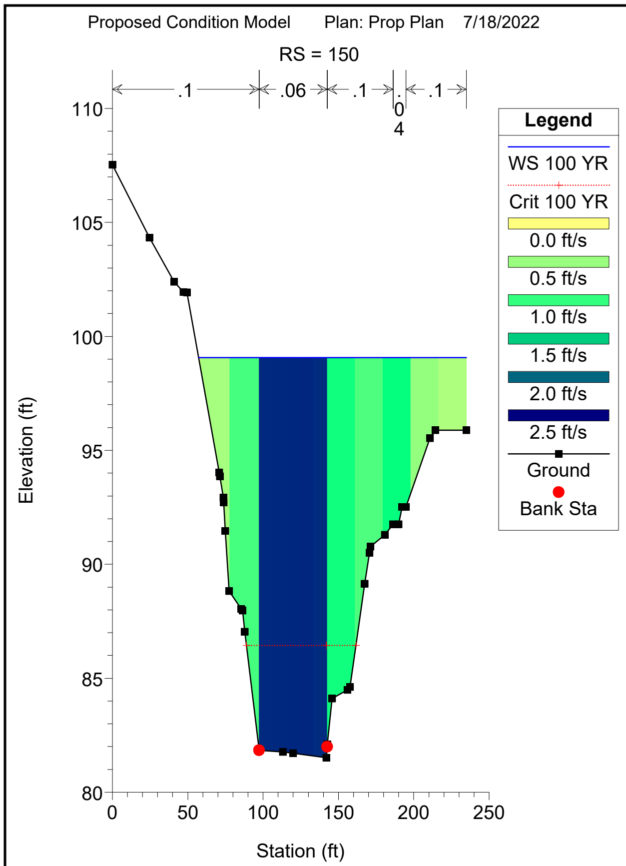
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Chehalem Creek C	400	100 YR	2760.00	81.11	99.11	85.78	99.19	0.000209	2.42	1647.32	162.69	0.10
Chehalem Creek C	350	100 YR	2760.00	81.10	99.09	85.78	99.18	0.000254	2.68	1624.23	179.40	0.11
Chehalem Creek C	300	100 YR	2760.00	81.31	99.09	86.19	99.16	0.000221	2.49	1775.27	193.86	0.10
Chehalem Creek C	250	100 YR	2760.00	81.35	99.09	85.97	99.15	0.000190	2.31	1913.64	192.21	0.10
Chehalem Creek C	205	100 YR	2760.00	81.11	99.08	85.51	99.14	0.000159	2.13	2010.94	201.25	0.09
Chehalem Creek C	195	100 YR	2760.00	81.19	99.08	85.66	99.14	0.000171	2.20	1967.44	199.31	0.09
Chehalem Creek C	150	100 YR	2760.00	81.52	99.06	86.45	99.13	0.000215	2.43	1831.93	177.82	0.10
Chehalem Creek C	100	100 YR	2760.00	81.25	99.06	85.83	99.11	0.000178	2.24	1881.31	163.25	0.09
Chehalem Creek C	50	100 YR	2760.00	81.36	99.04	86.13	99.10	0.000207	2.41	1807.37	166.21	0.10
Chehalem Creek C	0	100 YR	2760.00	81.14	99.03	86.10	99.09	0.000204	2.40	1852.05	160.36	0.10

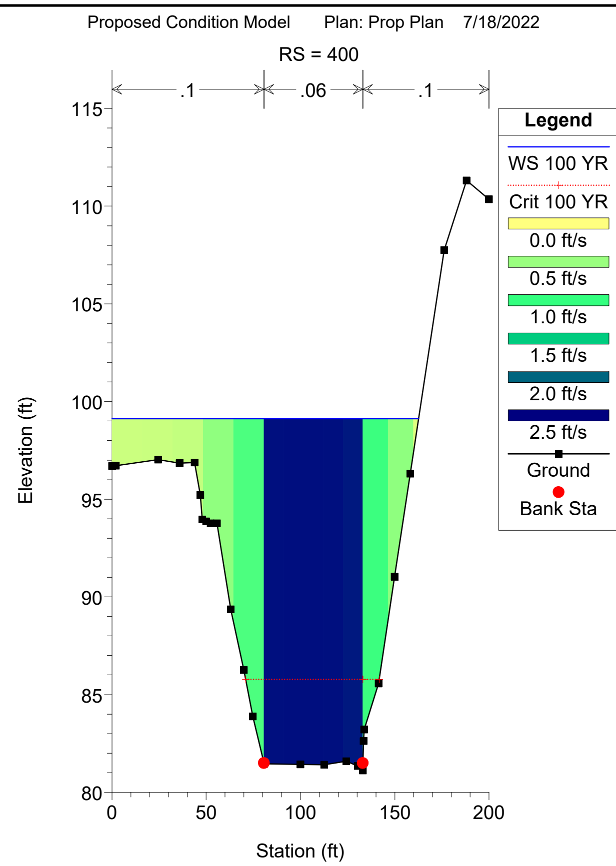
APPENDIX E: PROPOSED CONDITIONS HYDRAULIC MODEL RESULTS

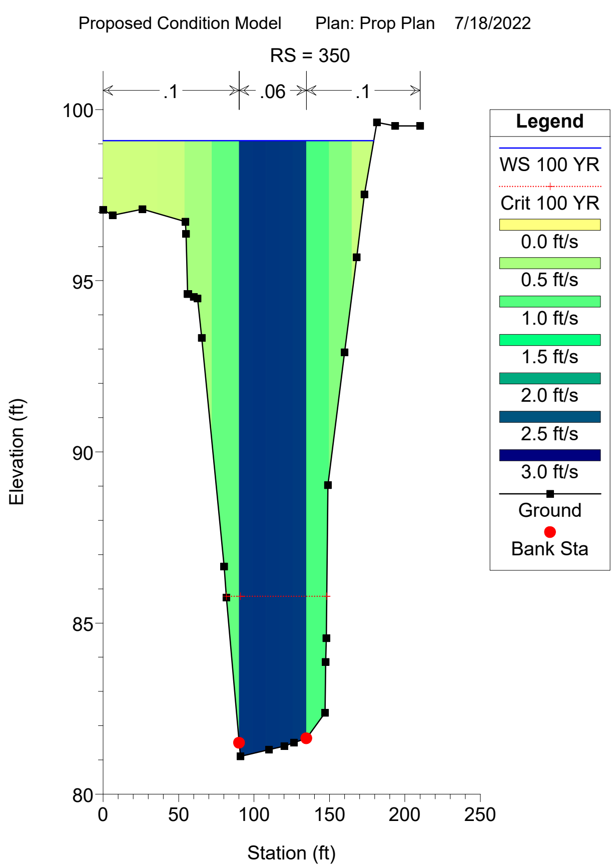
Ewing Young Park Trail Bridge HEC-RAS 100 YR Proposed Conditions Plan View

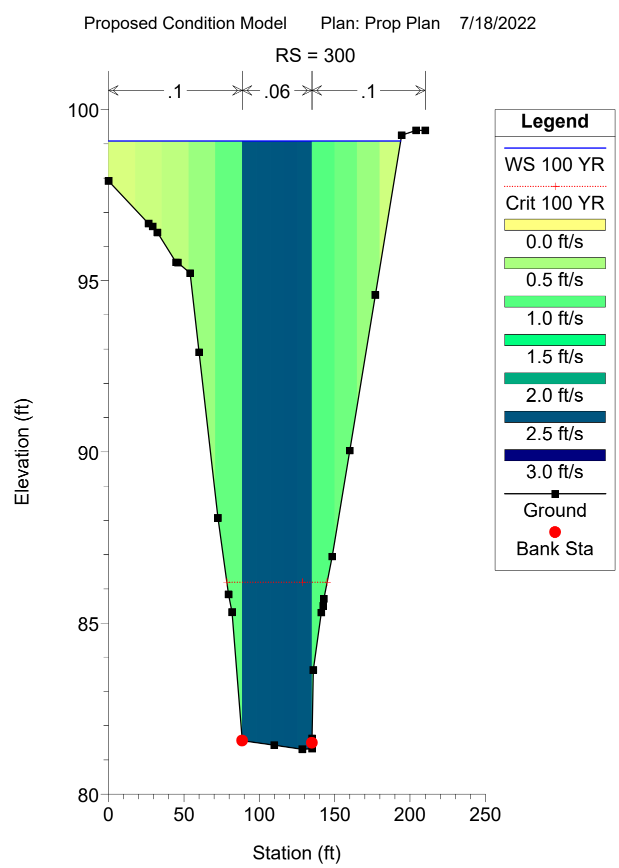


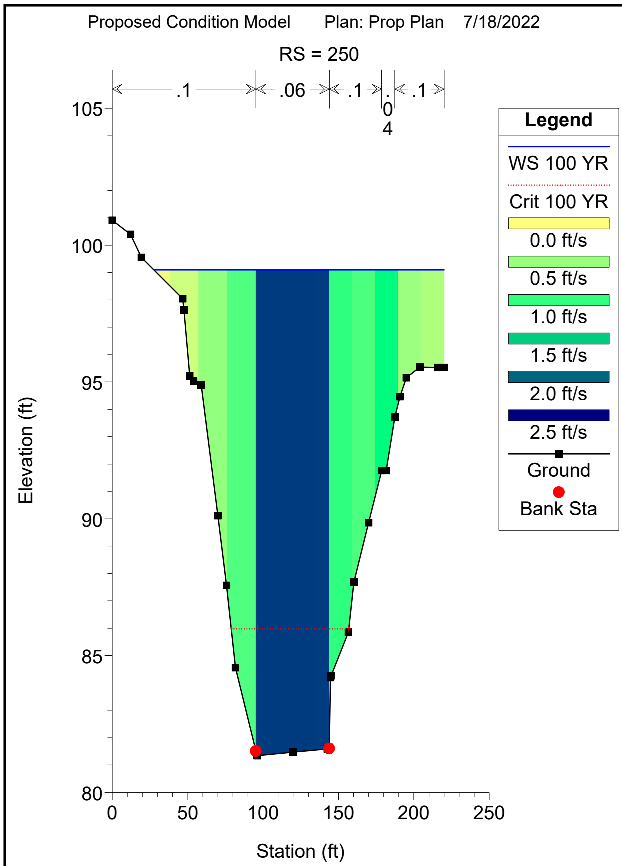
Proposed Condition Model Plan: Prop Plan 7/18/2022
Chehalem Creek Chehalem Creek C
Legend
WS 100 YR
Crit 100 YR
Ground
LOB
ROB
Elevation (ft)
100
95
90
85
80
0
100
200
300
400
Main Channel Distance (ft)

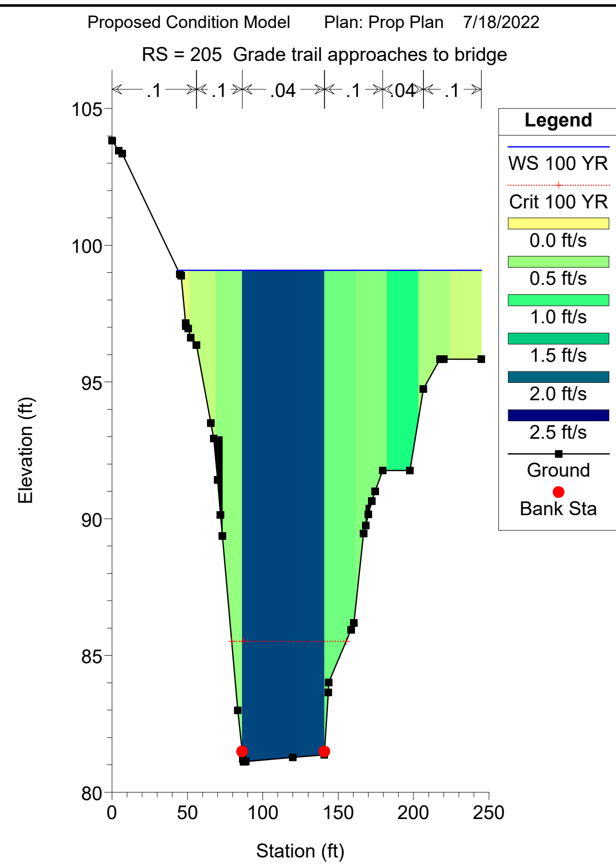

Proposed Condition Model Plan: Prop Plan 7/18/2022
RS = 150
.1
.06
.1
.04
.1
Legend
WS 100 YR
Crit 100 YR
0.0 ft/s
0.5 ft/s
1.0 ft/s
1.5 ft/s
2.0 ft/s
2.5 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)

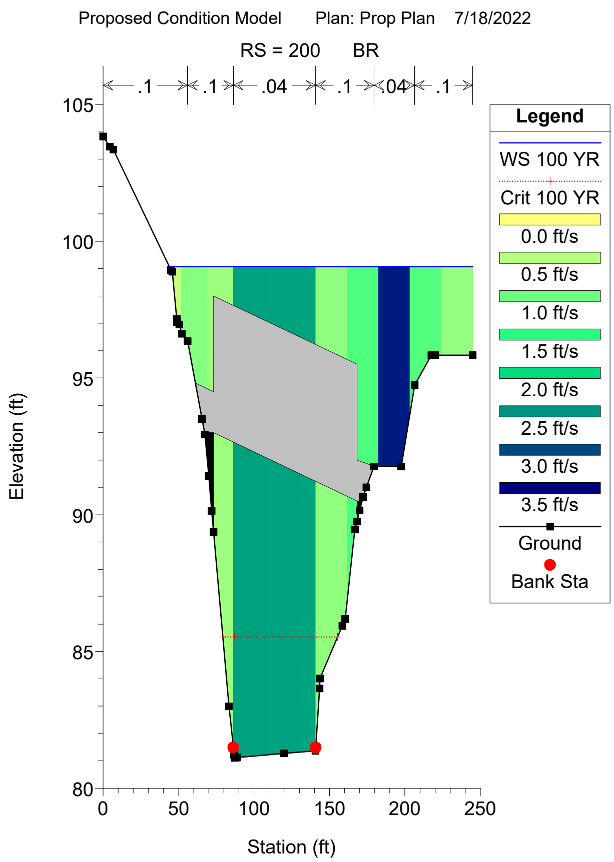

Proposed Condition Model Plan: Prop Plan 7/18/2022
RS = 400
.1
.06
.1
Legend
WS 100 YR
Crit 100 YR
0.0 ft/s
0.5 ft/s
1.0 ft/s
1.5 ft/s
2.0 ft/s
2.5 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)

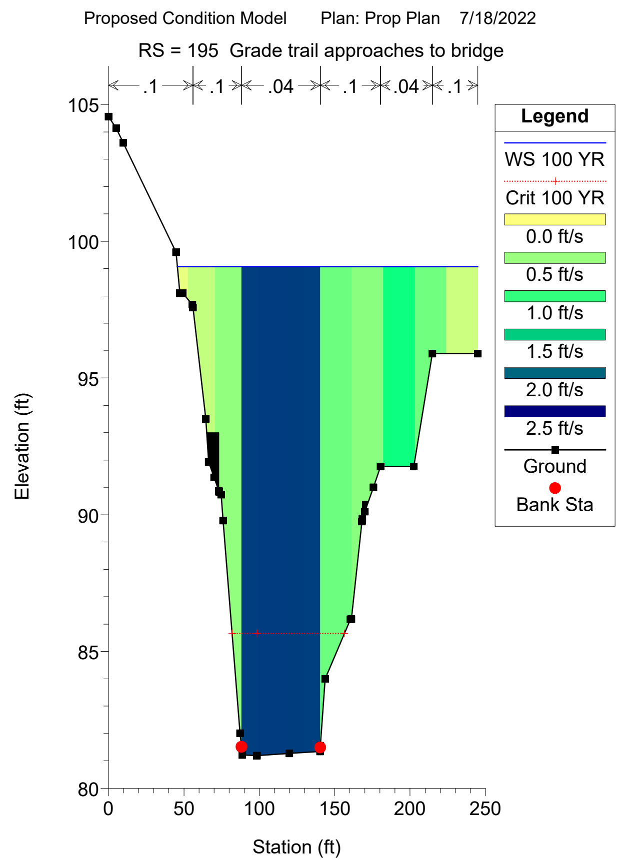

Proposed Condition Model Plan: Prop Plan 7/18/2022
RS = 350
.1
.06
.1
Legend
WS 100 YR
Crit 100 YR
0.0 ft/s
0.5 ft/s
1.0 ft/s
1.5 ft/s
2.0 ft/s
2.5 ft/s
3.0 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)


Proposed Condition Model Plan: Prop Plan 7/18/2022
RS = 300
.1
.06
.1
Legend
WS 100 YR
Crit 100 YR
0.0 ft/s
0.5 ft/s
1.0 ft/s
1.5 ft/s
2.0 ft/s
2.5 ft/s
3.0 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)


Proposed Condition Model Plan: Prop Plan 7/18/2022
RS = 250
.1
.06
.1
.04
.1
Legend
WS 100 YR
Crit 100 YR
0.0 ft/s
0.5 ft/s
1.0 ft/s
1.5 ft/s
2.0 ft/s
2.5 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)
80
85
90
95
100
105
0
50
100
150
200
250

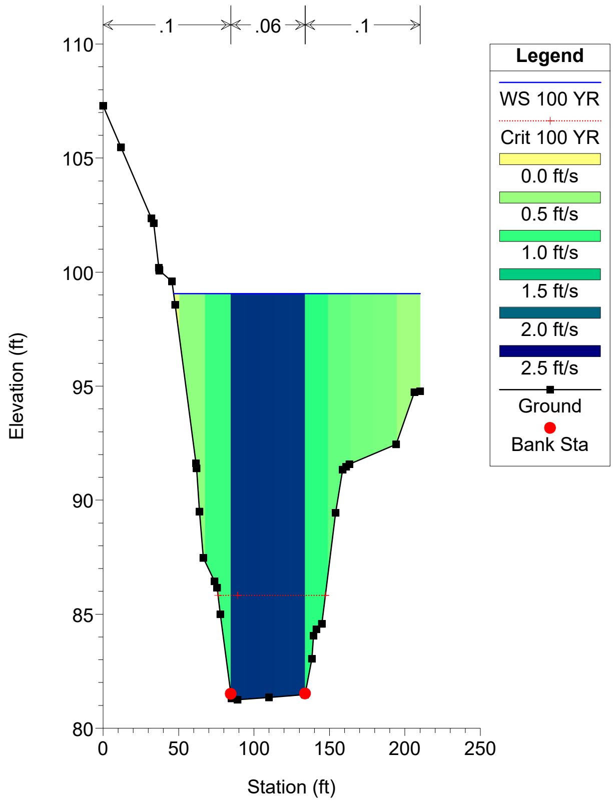

Proposed Condition Model Plan: Prop Plan 7/18/2022
RS = 205 Grade trail approaches to bridge
.1
.1
.04
.1
.04
.1
Legend
WS 100 YR
Crit 100 YR
0.0 ft/s
0.5 ft/s
1.0 ft/s
1.5 ft/s
2.0 ft/s
2.5 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)
80
85
90
95
100
105
0
50
100
150
200
250


Proposed Condition Model Plan: Prop Plan 7/18/2022
RS = 200 BR
.1
.1
.04
.1
.04
.1
Legend
WS 100 YR
Crit 100 YR
0.0 ft/s
0.5 ft/s
1.0 ft/s
1.5 ft/s
2.0 ft/s
2.5 ft/s
3.0 ft/s
3.5 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)
80
85
90
95
100
105
0
50
100
150
200
250


Proposed Condition Model Plan: Prop Plan 7/18/2022
RS = 195 Grade trail approaches to bridge
.1
.1
.04
.1
.04
.1
Legend
WS 100 YR
Crit 100 YR
0.0 ft/s
0.5 ft/s
1.0 ft/s
1.5 ft/s
2.0 ft/s
2.5 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)
80
85
90
95
100
105
0
50
100
150
200
250

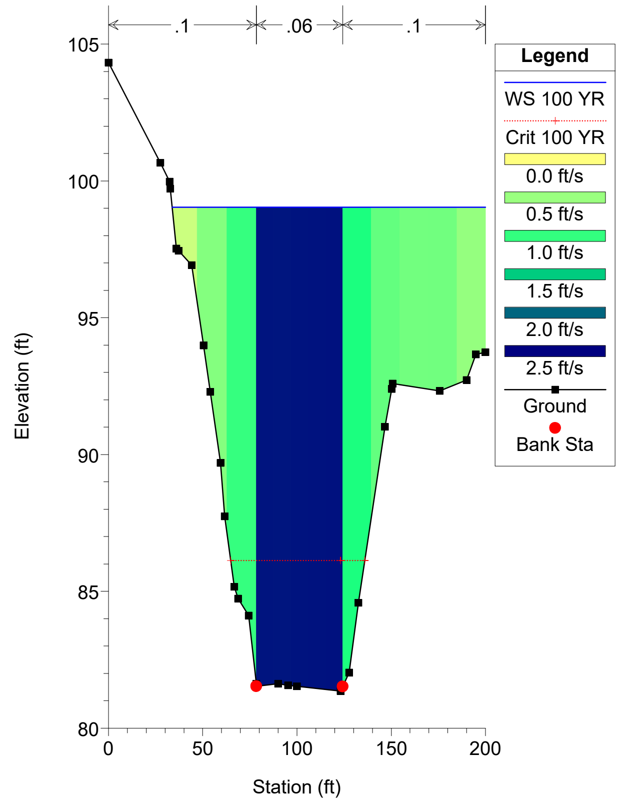
Proposed Condition Model Plan: Prop Plan 7/18/2022

RS = 100



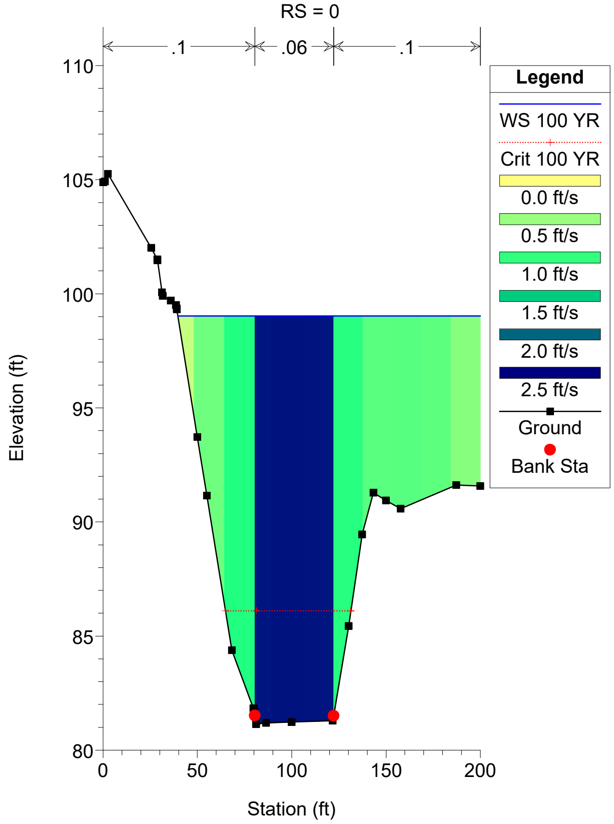
Proposed Condition Model Plan: Prop Plan 7/18/2022

RS = 50



Proposed Condition Model Plan: Prop Plan 7/18/2022

RS = 0



HEC-RAS Plan: Prop Plan River: Chehalem Creek Reach: Chehalem Creek C Profile: 100 YR

Reach	River Sta	Profile	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)	
Chehalem Creek C	400	100 YR	2760.00	81.11	99.11	85.78	99.19	0.000209	2.42	1647.36	162.69	0.10
Chehalem Creek C	350	100 YR	2760.00	81.10	99.09	85.78	99.18	0.000254	2.68	1624.27	179.40	0.11
Chehalem Creek C	300	100 YR	2760.00	81.31	99.09	86.19	99.16	0.000221	2.49	1775.31	193.86	0.10
Chehalem Creek C	250	100 YR	2760.00	81.35	99.09	85.97	99.15	0.000174	2.21	1917.59	192.30	0.09
Chehalem Creek C	205	100 YR	2760.00	81.11	99.08	85.52	99.14	0.000072	2.16	2033.74	201.27	0.09
Chehalem Creek C	200		Bridge									
Chehalem Creek C	195	100 YR	2760.00	81.19	99.07	85.67	99.13	0.000076	2.20	2008.24	199.30	0.09
Chehalem Creek C	150	100 YR	2760.00	81.52	99.06	86.45	99.12	0.000193	2.30	1833.26	177.84	0.10
Chehalem Creek C	100	100 YR	2760.00	81.25	99.06	85.83	99.11	0.000178	2.24	1881.31	163.25	0.09
Chehalem Creek C	50	100 YR	2760.00	81.36	99.04	86.13	99.10	0.000207	2.41	1807.37	166.21	0.10
Chehalem Creek C	0	100 YR	2760.00	81.14	99.03	86.10	99.09	0.000204	2.40	1852.05	160.36	0.10

HEC-RAS Plan: Prop Plan River: Chehalem Creek Reach: Chehalem Creek C Profile: 100 YR

Reach	River Sta	Profile	E.G. Elev	W.S. Elev	Crit W.S.	Frctn Loss	C & E Loss	Top Width	Q Left	Q Channel	Q Right	Vel Chnl
			(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(cfs)	(ft/s)
Chehalem Creek C	250	100 YR	99.15	99.09	85.97	0.00	0.00	192.30	336.74	1890.20	533.06	2.21
Chehalem Creek C	205	100 YR	99.14	99.08	85.52	0.00	0.00	201.27	129.86	2100.85	529.29	2.16
Chehalem Creek C	200 BR U	100 YR	99.14	99.07	85.53	0.00	0.00	201.16	146.00	1670.10	943.90	2.38
Chehalem Creek C	200 BR D	100 YR	99.13	99.07	85.68	0.00	0.00	199.30	127.16	1591.36	1041.47	2.38
Chehalem Creek C	195	100 YR	99.13	99.07	85.67	0.01	0.00	199.30	130.91	2047.42	581.68	2.20
Chehalem Creek C	150	100 YR	99.12	99.06	86.45	0.01	0.00	177.84	264.09	1800.67	695.25	2.30

APPENDIX F: SCOUR EVALUATION RESULTS

Channel/Bridge Scour Calculations

From HEC-RAS Model

Proposed Ewing Young Park Bridge

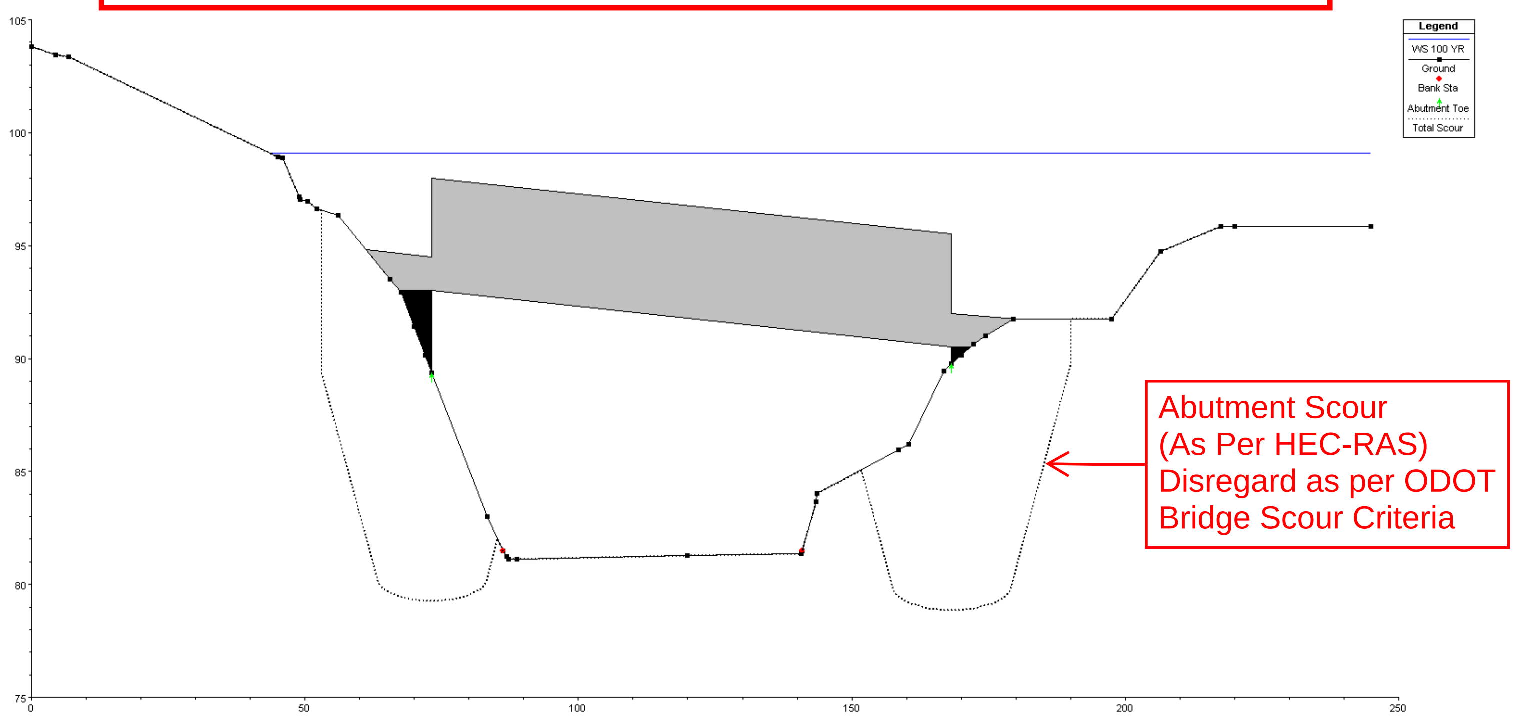
Contraction Scour

		Left	Channel	Right
Input Data				
	Average Depth (ft):	7.10	17.62	7.65
	Approach Velocity (ft/s):	0.70	2.21	0.91
	Br Average Depth (ft):	4.86	12.83	6.00
	BR Opening Flow (cfs):	146.00	1670.10	943.90
	BR Top WD (ft):	42.44	54.61	104.11
	Grain Size D50 (mm):	88.90	88.90	88.90
	Approach Flow (cfs):	336.74	1890.20	533.06
	Approach Top WD (ft):	67.64	48.49	76.17
	K1 Coefficient:	0.590	0.590	0.590
Results				
	Scour Depth Ys (ft):	0.00	0.00	0.00
	Critical Velocity (ft/s):	10.28	11.96	10.41
	Equation:	Clear	Clear	Clear

Abutment Scour

		Left	Right
Input Data			
	Station at Toe (ft):	73.24	168.24
	Toe Sta at appr (ft):	82.30	171.18
	Abutment Length (ft):	54.60	48.82
	Depth at Toe (ft):	9.72	9.33
	K1 Shape Coef:	1.00 - Vertical abutment	
	Degree of Skew (degrees):	90.00	90.00
	K2 Skew Coef:	1.00	1.00
	Projected Length L' (ft):	54.60	48.82
	Avg Depth Obstructed Ya (ft):	5.16	5.10
	Flow Obstructed Qe (cfs):	166.12	208.64
	Area Obstructed Ae (sq ft):	281.79	249.22
Results			
	Scour Depth Ys (ft):	10.08	10.89
	Qe/Ae = Ve:	0.59	0.84
	Froude #:	0.05	0.07
	Equation:	Froehlich	Froehlich

Abutment Scour
(As Per HEC-RAS)
Disregard as per ODOT
Bridge Scour Criteria



APPENDIX G: RIPRAP WORKBOOK

Riprap Design Workbook

Project:	CPRD Ewing Young Park Trail Bridge	**Site:**	Proposed 95-ft Bridge
Project Number:	229221-C000191.00	**Analyst:**	M.K. Homza. PE
Watercourse:	Chehalem Creek	**Latest Revision:**	8/2/2022

Workbook Description

- This workbook contains spreadsheets that facilitate the analysis and/or design of riprap.
- This spreadsheet lists the General Project and Workbook Information that is consistent throughout the workbook.
- It also lists the titles of the spreadsheets contained in this workbook. (Only relevant spreadsheets will be submitted.)
- Only input data into the SHADED CELLS.
- Th*is workbook is intended for use with ENGLISH UNITS.*

Filename: *I:\Proposals\Chehalem Park and Rec Dist Bridge 2021\Temp Report Working Folder mkh 8-2022\Riprap Design\[Riprap Design Workbook Ewing Yound Park Bridge 8-2-2022.xlsx]Intro*

Sheet Titles:

Riprap Design Workbook
Design Assumptions
Abutment Input Data
HEC-23 (HEC-18) Riprap Design Method
HEC-11 Riprap Design Method
Four Riprap Design Methods
Comparison of Riprap Design Methods

Design Assumptions

Project: CPRD Ewing Young Park Trail Bridge
Project Number: 229221-C000191.00
Watercourse: Chehalem Creek

Road or Bridge: Proposed 95-ft Bridge
Analyst: M.K. Homza. PE
Latest Revision: 08/02/22

Assumptions

GENERAL:

- This workbook calculates and compares the sizes and extents of riprap using six (6) different riprap design methods.
- The applicability of the various methods differ.
- The user of this workbook should be familiar with the application of the various methods and should only use the methods/resu lts that apply to each individual project.
- Information is input into only the "Piers" and "Abutment" sheets as applicable.
- It is not necessary to input data into the "Piers" spreadsheet if piers are not considered for this specific project. (The Piers spreadsheet has been removed from this entire workbook because the proposed bridge does not have piers.)

PROJECT SPECIFICS:

- This project involves the hydraulic design of a footbridge for the Chehalem Parks and Recreation District across Chehalem Cre ek, in Yamhill County, Oregon.
- The proposed footbridge is approximately 95-ft long and has been developed such that the bridge itself does not cause an increase in the creek's Baseflood Elevation (BFEs) as previously identified by FEMA.
- Note that as proposed, the proposed bridge:
  a) Will be installed above the 10-year flood elevation, and
  b) Will be fully innudated (overtopped) with water durinhg the 100-year flood event.
- Ths specific workbook supports the design of the proposed riprap along the abutments of the proposed footbridge.
- The hydraulic information used in this workbook was obtained from the Proposed Conditions Hydraulic Model (HEC -RAS Model) as developed by NV5.
- The hydraulics pertain to the 100-year flood event, the discharge of which was obtained directly from effective FEMA documentation.

Abutment Input Data

Project: CPRD Ewing Young Park Trail Bridge
Project Number: 229221-C000191.00
Watercourse: Chehalem Creek

Road or Bridge: Proposed 95-ft Bridge
Analyst: M.K. Homza. PE
Latest Revision: 8/2/22

General Comments

- This spreadsheet lists the input required for the riprap design methodologies noted below.
- The individual riprap design methodologies and associated calculations are included on the following spreadsheets.
- **Only input data into this sheet to design the riprap sizes.**
- **Only input data into the SHADED CELLS.**
- Refer to the Summary Table and Curve at the end of this workbook.

Variable	Variable Value	Units	Variable Description	HEC-23	HEC-11	ASCE	USBR	USGS	Isbash
Va	2.40	fps	Average Velocity	X	X	X	X	X	X
Gs	2.65	-----	Specific Gravity of Riprap (Normally 2.65)	X	X	X			X
g	32.20	ft/sec^2	Acceleration due to Gravity	X					X
d	17.97	ft	Average Flow Depth	X	X				
-----	S	-----	Type of Abutment S = Spill through, V = Vertical	X					
R	100000.0	ft	Radius of Curvature		X				
W	52.0	ft	Channel Width		X				
Z	1.25	ft	Sideslope (_H/V)		X	X			
Theta	41.00	Degrees	Angle of Repose (HEC-23, Pg DG12.5)		X				
SF	1.20	units	Stability Factor **(See note on HEC-11 Page)**		X				
Gamma	165	lbs/sf	Unit weight of stone (Usually 165)			X			
C	1.2	-----	0.86 for High Turbulence, 1.2 for Low Turbulence						X

HEC-23 (HEC-18) Riprap Design Method

Project: CPRD Ewing Young Park Trail Bridge
Project Number: 229221-C000191.00
Watercourse: Chehalem Creek

Road or Bridge: Proposed 95-ft Bridge
Analyst: M.K. Homza. PE
Latest Revision: 8/2/22

General Comments

- This spreadsheet calculates riprap in accordance with the 3rd edition of HEC-23 "Bridge Scour and Stream Instability Countermeasures". FHWA NHI 09-112, September 2009. Equations 14.1 and 14.2. (Page DG14.6) (This is the same as the HEC-18 method.)
- Refer to the Summary Table and Curve at the end of this workbook for a comparison of the methods analyzed.
- **The input for this sheet is input in the "Abutment Scour Input Data" sheet. No input is required on this sheet.**

Input

2.40 = Va = Characteristic Average Velocity (fps)

2.65 = Gs = Specific Gravity of riprap (Normally 2.65)

32.20 = g = Acceleration due to Gravity (32.2 ft/s^2)

17.97 = d = Depth of Flow Adjacent to Abutment

S = Type of Abutment (S = Spill Through, V = Vertical Wall)

K Coefficient Table		
	Fr < 0.8	**Fr > 0.8**
Spill Through	0.89	0.61
Vertical Wall	1.02	0.69

Output

0.1 = Fr = Froude Number

0.89 = K = Appropriate K Coefficient

0.1 = D_{50} = Median Stone Diameter (ft)

0.2 = D_{100} = Largest Stone Diameter (ft)

0.2 = T = Thickness of Riprap Layer (Double if placed under water) (ft)

35.9 = H = Lateral Extent of Riprap from toe into the Channel

HEC-11 Riprap Design Method

Project:	CPRD Ewing Young Park T	**Road or Bridge:**	Proposed 95-ft Bridge
Project Number:	229221-C000191.00	**Analyst:**	M.K. Homza. PE
Watercourse:	Chehalem Creek	**Latest Revision:**	08/02/22

General Comments

- This spreadsheet sizes riprap using the methodology set forth in the March, 1989 issue of HEC-11, FHWA-IP-89-016, "Design Of Riprap Revetment". (Also found in HEC-23 under "Design Guideline 12".)
- Refer to the Summary Table and Curve at the end of this workbook for a comparison of the methods analyzed.
- **The input for this sheet is input in the "Abutment Scour Input Data" sheet. No input is required on this sheet.**

Input

100000	= R = Curve Radius (ft)[1]
52	= W = Channel Width (ft)[1]
1.3	= Z = Sideslope, (H:1'V)[1]
2.4	= $V_{a\,=}$ Average Velocity (fps)[2]
18.0	= d = Average Depth (ft)[2]
41	= Theta = Angle Of Repose (degrees)[3]
2.65	= $G_{s\,=}$ Specific Gravity[4]
1.2	= SF Stability Factor[5]
NA	Is Riprap At Abutment Or Pier? ("Y" or "N") [6]

Output

1923.08	= R/W, Radius/Width Ratio
38.66	= θ, Bank Angle (degrees)
0.31	= K1, Bank Angle Correction Factor
0.02	= D_{50}, Median Stone Size (ft)
1.00	= C, SF & S_s Correction Factor
1.00	= $C_{p/a}$, Pier/Abutment Correction Factor
0.02	= D'_{50}, Corrected Median Stone Size (ft)
0.03	= D_{100}, Maximum Stone Size (ft)
0.03	= T = Thickness of Riprap Layer (Double if placed under water) (ft)

Footnotes

1. Input based on field observations, measurements and estimates.
2. Input derived from hydraulic model.
3. Angle of Repose obtained from Chart 4, page 129, HEC-11.
4. Specific Gravity is assumed to be 2.65.
5. See Stability Factor information below.
6. HEC-11 specifies that a multiplier of 3.38 be used if the riprap is at an abutment or pier. This spreadsheet does not use this factor since it is generally considered too conservative.

Stability Factor

1.0 - 1.2	Uniform flow; Straight or mildly curving reach (R/W > 30); Impact from wave action and floating debris is minimal; Little or no uncertainty in design parameters.
1.3 - 1.6	Gradually varying flow; Moderate bend curvature (30 > R/W > 10); Impact from waves and/or floating debris moderate.
1.6 - 2.0	Approaching rapidly varying flow; Sharp bend curvature (10 > R/W); Significant impact potential from floating debris and/or ice; Significant wind and/or boat generated waves (1' -2'); High flow turbulence; Significant uncertainty in design parameters.

Four Riprap Design Methods

Project:	CPRD Ewing Young Park Trail I	**Road or Bridge:**	Proposed 95-ft Bridge
Project Number:	229221-C000191.00	**Analyst:**	M.K. Homza. PE
Watercourse:	Chehalem Creek	**Latest Revision:**	8/2/22

General Comments

- This spreadsheet calculates the riprap required for the following methods:
- American Society of Civil Engineers (ASCE), Vanoni, 1977.
- U.S. Bureau of Reclamiation (USBR), (USBR EM-25, Peterka, 1958)
- U.S. Geological Survey (USGS), Blodgett, 1981)
- Isbash, Isbash, 1936; USCOE, 1971.
- Only input data into the SHADED CELLS.
- Refer to the Summary Table and Curve at the end of this workbook for a comparison of the methods analyzed.
- **The input for this sheet is input in the "Abutment Scour Input Data" sheet. No input is required on this sheet.**

ASCE Method

Input

2.65 = Gs = Specific Gravity of riprap (Normally 2.65)

2.4 = V_a = Average Velocity (fps)

1.25 = Z = Sideslope (ft) (H:1'V)

165 = gamma = Unit weight of Stone (lbs/sf) (Usually 165 lbs/sf)

Output

38.7 = θ = Bank Angle (degrees)

0.0 = W = Stone Weight (lbs)

0.0 = D_{50} = Median Stone Diameter (ft)

0.1 = T = Thickness of Riprap Layer (Double if placed under water) (ft)

USBR Method

Input

2.4 = V_a = Average Velocity (fps)

Output

0.1 = D_{50} = Median Stone Diameter (ft)

0.1 = T = Thickness of Riprap Layer (Double if placed under water) (ft)

USGS Method

Input

2.4 = V_a = Average Velocity (fps)

Output

0.1 = D_{50} = Median Stone Diameter (ft)

0.2 = T = Thickness of Riprap Layer (Double if placed under water) (ft)

Isbash Method

Input

2.4 = V_a = Average Velocity (fps)

2.65 = Gs = Specific Gravity of riprap (Normally 2.65)

32.2 = g = Acceleration due to Gravity (32.2 ft/s^2)

1.2 = C = 0.86 for High Turbulence, 1.2 for Low Turbulence

Output

0.0 = D_{50} = Median Stone Diameter (ft)

0.1 = T = Thickness of Riprap Layer (Double if placed under water) (ft)

Comparison of Riprap Design Methods

Project:	CPRD Ewing Young Park Trail Bridge	**Road or Bridge:**	Proposed 95-ft Bridge
Project Number:	229221-C000191.00	**Analyst:**	M.K. Homza. PE
Watercourse:	Chehalem Creek	**Latest Revision:**	8/2/22

General Comments

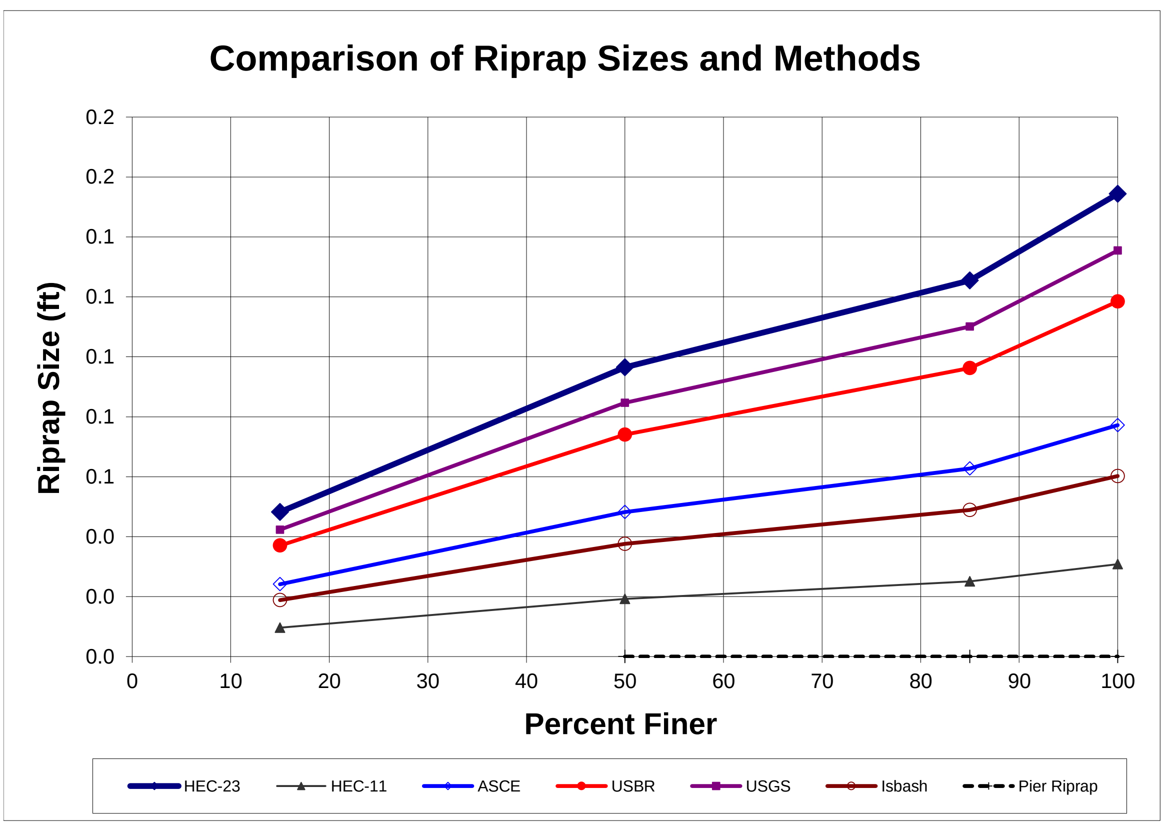
- This spreadsheet compares the riprap sizes calculated using the methods noted.
- The gradations are based upon the AASHTO Method as presented in HEC-23, page DG12.7.
- The data in the table is calculated in previous sheets.
- **No input is required on this spreadseheet.**

- **As indicated in the table below, the hydraulic conditions at the bridge DO NOT REQUIRE RIPRAP PROTECTION.**

No Riprap Required **= Riprap design method recommended for this project.**

Comparison of Riprap Sizes (in Feet) and Methods							
Riprap Size (Percent Finer)	**HEC-23**	**HEC-11**	**ASCE**	**USBR**	**USGS**	**Isbash**	**Pier Riprap**
15	0.0	0.0	0.0	0.0	0.0	0.0	
50	0.1	0.0	0.0	0.1	0.1	0.0	#REF!
85	0.1	0.0	0.1	0.1	0.1	0.0	#REF!
100	0.2	0.0	0.1	0.1	0.1	0.1	#REF!
Layer Thickness (ft)	0.2	0.0	0.1	0.1	0.2	0.1	#REF!

25 = Horizontal extent of riprap from abutment toe (ft) (= 2 x depth, not to Exceed 25-ft)



APPENDIX H: NO RISE CERTIFICATE

ENGINEERING "NO-RISE" CERTIFICATION

This is to certify that I am a duly qualified engineer licensed to practice in the State of Oregon.

It is to further certify that the attached technical data supports the fact that proposed Ewing Young Park Footbridge will
(Name of Development)
not impact the 100-year flood elevations, floodway elevations and floodway widths on Chehalem Creek at published sections
(Name of Stream)
in the Flood Insurance Study for Yamhill County, Oregon (Community No. 410259),
(Name of Community)
dated March 2, 2010 and will not impact the 100-year flood elevations, floodway elevations, and floodway widths at unpublished cross-sections in the vicinity of the proposed development.

Attached are the following documents that support my findings:

Bridge Hydraulics Design Report
Proposed Ewing Young Park Footbridge Over Chehalem Creek

For: Yamhill County, Oregon
By: NV5, Inc.
Date: August 16, 2022

(Date) August 16, 2022

(Signature) M Homza

(Title) Professional Engineer

Michael K. Homza, PE

Director of Water Resources
NV5, Inc.
690 S. Industry Way
Suite #10
Meridian, Idaho 83642

(Seal)

REGISTERED PROFESSIONAL ENGINEER
62799PE
OREGON
JAN. 11, 2000
MICHAEL K. HOMZA
Expires: 6.30.2023

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