FINAL DRAINAGE REPORT
FOR
REDTAIL RIDGE SUBDIVISION PHASE 1

CITY OF LOUISVILLE
BOULDER COUNTY
STATE OF COLORADO

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ENGINEER CERTIFICATION

“I hereby certify that this Phase 1 Final Drainage Report for the final drainage design of the Redtail Ridge project was prepared by me (or under my direct supervision) in accordance with the provisions of the City of Louisville Storm Drainage Design and Technical Criteria for the owners thereof.”

_____

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Licensed Professional Engineer
State of Colorado
No. 38561
On behalf of Harris Kocher Smith

I. EXECUTIVE SUMMARY

A. PHASE 1 FINAL DRAINAGE REPORT FOR REDTAIL RIDGE

The purpose of this report is to outline the proposed stormwater and drainage characteristics for the sustainable redevelopment of the former Storage Tek and ConocoPhillips property. All proposed development within Phase 1 follows the guidelines set forth in the Final Master Drainage Report for Redtail Ridge or provides design alternatives or improvements that do not cause adverse impact to adjacent facilities, downstream entities, or property owners.

This report provides design information for the Phase 1 stormwater and drainage infrastructure to support the proposed major roadways of Campus Drive, Rockcress Drive (formerly Tape Dr.), and Sorrel Avenue as well as utility infrastructure to create developable parcels within the overall Site.

Phase 1 shall include the construction of all of Campus Drive and associated storm sewer, Sorrel Avenue, the east segment of Rockcress Drive (From the Northwest Parkway to Sorrel Avenue), Tributary I, the Goodhue Ditch crossing, and Full Spectrum Detention Ponds C-1, C-2 and B. With Phase 1, all runoff from developed infrastructure was routed to either Pond C-1 or C-2.

Phase 2 is currently proposed to include the construction of the west segment of Rockcress Drive (from Sorrell Avenue to S. 88th Street), and the associated storm network.

A Phasing line displaying the construction phases of the overall Site is included in the drainage plan for the project, located in Appendix D.

For the purposes of this report, the analysis, computations, and design procedure will focus solely on Phase 1 of the Redtail Ridge Project. For full details related to the Redtail Ridge project, refer to the Master Drainage Report or Phase 2 Drainage report.

II. GENERAL LOCATION AND DESCRIPTION

A. Location

The proposed Redtail Ridge Phase 1 development by Brue Baukol Capital Partners on the former Storage Tek / ConocoPhillips Site property (hereinafter referred to as "Site" or "Project") is situated in the City of Louisville (hereinafter referred to as "City"); specifically the Northeast ½ and South ½ of Section 20, the North ½ of Section 29, and the Northwest ¼ of Section 28, Township 1 South, Range 69 West of the 6th P.M. Counties of Boulder and Broomfield, State of Colorado.

The Project is located east of S. 88th Street, South of Campus Drive, West of S. 96th Street and Northwest Parkway, and Northeast of Highway 36. A Vicinity Map is included in Appendix A for reference.

There is an existing Outfall System Plan which was used as reference for the Site. The City of Louisville/Boulder County Outfall System Plan (hereinafter referred to as "Louisville OSP") dated November 1982 indicates that there are several existing ponds at low points throughout the Site. Excerpts from this report are included in Appendix B.

The adjoining parcels include the Monarch K-8 School campuses north of Campus Drive, the Health Park complex west of S. 88th Street and northwest of the Site, and the Parkway Circle development east of S. 96th Street.

B. Description of Property

The Site is approximately 389 acres and was formerly a developed office campus that has been demolished and removed from the Site. The Site is currently covered with grass vegetation, remnants of building slabs, and several private roadways. A ridge bisects the Site approximately along the alignment of the existing Tape Drive.

To the north, existing runoff flows from the ridge north and east towards S. 96th Street at slopes approximately ranging from 2-3%. To the South, existing runoff flows from the ridge south and east towards Highway 36 at slopes approximately ranging from 2-45%.

The Site is shown to be in a Zone X Flood Area according to FIRM map 08013C0584K, Boulder County, Colorado, and Incorporated Areas, August 15, 2019. Zone X is described on this map as areas outside the 0.2% annual chance of flood. Runoff from the northwest portion of the Site generally flows into the existing Tributary I at slopes ranging from 5-10%. Tributary I is not a FEMA regulated floodplain. Tributary I is, and will remain, a natural channel terminating on-site into a roadway culvert at S. 96th Street, that will be replaced with proposed construction on S. 96th Street. See Section IV for specific details about the Tributary I. A copy of the FIRM map is included in Appendix A for reference.

The Louisville OSP also describes several irrigation swales traversing the Site, specifically Goodhue Ditch (hereinafter referred to as “Ditch”) in the northeast corner of the Site and Tributary I along the Site’s northern property boundary. Specific details on the Ditch culvert crossing are provided in Section IV of this report.

According to the Request for Approved Jurisdictional Determination for Phillips 66 Site Boulder and Broomfield Counties, Colorado issued on January 24, 2019, by ERO Resources Corp., none of the existing drainage features within the Project area are jurisdictional except for the Ditch and Rock Creek. Development is not planned in the vicinity of Rock Creek, and no modifications to Rock Creek are proposed.

According to the Phillips 66 Site – Delineation of the Ditch and Rock Creek issued on September 23, 2019, by ERO Resources Corp., there are wetlands abutting the Ditch. ERO mapped approximately 0.428 acres of open water along the Ditch and approximately 0.121 acres of wetlands abutting the Ditch within the Project area during a 2019 Site visit. A copy of this report can be found in Appendix B for reference.

According to soils information provided by CTL|Thompson for the project, the soil borings for the Site consist of existing fill and/or natural sandy clay with fewer amounts of sand, gravel and cobble, which overlie claystone and interbedded claystone/sandstone bedrock of the Laramie Formation. A majority of the soils on the Site are Type C soils. A copy of the geologic, bedrock, and groundwater maps is included in Appendix B for reference.

According to the Boulder Valley School District (hereinafter referred to as “BVSD”) Louisville Campus PUD Drainage Report (hereinafter referred to as “School Report”), there is an existing pond at the northwest corner of the Site (hereinafter referred to as “School Pond”), that is a part of the Monarch K-8 school’s drainage system. According to the School Report, the pond collects runoff from an off-site basin tributary to the school’s site. This runoff is detained in the pond at the northwest corner of the Site and then released into a drainage swale that drains to a culvert under Campus Drive and outfalls into the Bus Loop Pond on the school’s site. The School Report specifies that this runoff was detained off-site because the engineer was concerned that peak flows from this basin would increase the size of the on-site systems and the size of Bus Loop Pond. A copy of the Master Drainage Plan for the BVSD Monarch School Campus is included in Appendix B for reference.

C. Historic Drainage

1. Major Basin Description

The Site is located within Basins 4-I, 5-I, 6-I, 2-J, and 10-H of the Louisville OSP. The north portion of the Site is tributary to Rock Creek Tributary I, and the balance of the Site is tributary to the Rock Creek main channel. Rock Creek eventually combines with Coal Creek and is tributary to Boulder Creek. The following is how the Louisville OSP describes the Rock Creek and Coal Creek basins:

> *"The Rock Creek basin has a northeast aspect with the high point of the basin (elevation 5560) just southwest of U.S. 36. The upper section of the basin has slopes that range from 5 to 10% and then level out to an average of 1.5% in the lower reaches of the basin."*

> *"The Coal Creek basin has a West to East aspect with the high point (elevation 5670) of the basin on the Davidson Mesa. The slopes on top of the mesa are very mild, but rapidly approach 6 to 7% upon decent from the mesa. The terrain then levels out to an average grade of 2% for the remaining portion of the basin."*

The Site contains several irrigation swales and ditches that were utilized with the previous land uses but are no longer in service. The only active and defined irrigation ditch is located in the far northeast corner of the Site and is owned by the Goodhue Ditch & Reservoir Company (hereinafter referred to as "Ditch Company"). All other irrigation swales and ditches are non–binding and will be routed on a Site level basis per development plans for individual parcels.

2. Sub-Basin Description

Basin delineation, areas, and flows for the Existing Drainage Plan were derived from the Louisville OSP as the existing condition. The Site design maintains the historical drainage patterns and the allowable flow at S. 96th Street (specified by the Louisville OSP) will not be exceeded with the proposed development.

Runoff flows from the northern portion of the Site (Louisville OSP Basins 4-I and 5-I) historically drains to the existing Rock Creek Tributary I channel, which contains two existing in line ponds. The central portion of the Site (Louisville OSP Basin 6-I) historically drains from southwest to northeast into a channel on the eastern side of the Site which conveys flows from South to North along the Northwest Parkway. The southern portion of the Site (Louisville OSP Basin 2-J) historically flows from west to east across the Site to the Northwest Parkway. As shown in the Louisville OSP, approximately half of basins 4-I and 5-I drain on-site from off-site. The flows from these basins, as well as portions of basin 10-H, are accounted for in the design of Rock Creek Tributary I. See Appendix D to reference the Existing Drainage Plan.

The historic basin 2-J of the Louisville OSP located in the southeast portion of the site drains to an existing 48" HDPE culvert located at the East side of the basin that conveys flows offsite underneath Northwest Parkway where it joins an existing "Northern" storm sewer that discharges flows to the Northeast. Historical records indicate that it conveys a flow of 39.17 CFS and 80.5 CFS for the 5- and 100-year storm respectively. Additional Information and flows can be found in Appendix B of the Via Varra & West Midway Improvements construction documents prepared by Drexel Barrel & CO (December 4, 2002), included in Appendix B.

Off the northeast corner of the Site, at the Tributary I crossing, the Northwest Parkway Toll Authority installed the existing dual (2) 10' x 6' Reinforced Concrete Box Culvert (hereinafter referred to as "RCBC") at the intersection of the Northwest Parkway and S. 96th Street. The existing culvert under the Northwest Parkway will be maintained as the outfall for the Site flows. Per Table 4 of this report, peak flows to this culvert are lower than historic in the developed condition.

III. DRAINAGE DESIGN CRITERIA

A. Regulations

The Site will comply with the City's and Mile High Flood District's, formerly known as Urban Drainage Flood Control District (hereinafter referred to as "MHFD"), requirements. The Site will comply with current City and MHFD criteria, including runoff reduction, water quality capture volume, stabilizing drainageways and source control BMPs, as applicable. The Site will also comply with the Louisville OSP as it relates to the extents of the Site.

B. Development Criteria References and Constraints

The principal design guidelines that will be sourced for this Site development are the City of Louisville Storm Drainage & Technical Criteria Manual (hereinafter referred to as "Louisville Criteria") and the current version of the MHFD Urban Storm Drainage Criteria Manual (hereinafter referred to as "District Manual").

The existing conditions of the adjacent properties and those relevant drainage studies that affect the Site in that the existing conditions were analyzed, and the appropriate measures taken to maintain historic runoff as it relates to the Site. The drainage design will be affected by the proposed grading, building outline and legal boundaries of the Site. These existing basins encompass the entirety of the Site and represent the previous drainage study the Site will be modifying per the proposed developments.

Existing Site constraints include Rock Creek Tributary I, the Goodhue Ditch, and various irrigation ditches or swales throughout the Site, existing structural building pads, and an overhead electric line and easement. Please see Appendix D for existing drainage. See Section IV of this report for a discussion on how the Site will take into consideration Rock Creek Tributary I and the Goodhue Ditch.

C. Hydrologic Criteria

On a regional basis for the channel design, a hydrologic stormwater routing analysis for the watershed was completed using a combination of the Colorado Urban Hydrograph Procedure (CUHP) v. 2.0.0 and the US Environmental Protection Agency Storm Water Management Model (EPA SWMM) v. 5.1. To create the Tributary I regional model, storm hydrographs produced by CUHP were integrated into EPA SWMM for routing and flood risk analysis.

The following formula, from the District Manual, was used to determine rainfall intensities:

$$I = \frac{28.5 P_1}{(10 + T_C)^{0.786}}$$

For this report, the 5-year and 100-year storm events have been analyzed. The 5-year storm is considered the minor event and the 100-year storm is considered the major event. One-hour rainfall P_1 values were taken from NOAA Atlas 14, Volume 8, and Version 2 for the Site. The P_1 values for the 5-year and 100-year storms are 1.08 inches and 2.50 inches, respectively.

CUHP and EPA SWMM were used in conjunction to analyze peak flows for the proposed roadway storm sewer analysis. While the Rational Method is often used for runoff analyses totaling under 90 acres, the CUHP method is more accurate and exceeds the minimum criteria set by the City. Utilizing catchment area, rainfall data, an assumed imperviousness for all development parcels, and infiltration parameters based on Horton's Infiltration Model, the CUHP workbook calculates hydrographs to determine the basin time to peak flow and peak runoff rate, in additional to other parameters. As a conservative approach, to accommodate future developments, most parcel areas are assumed to have between 75-85% imperviousness to account for future development. Most roadway basins were set at 75%, to account for pervious landscaping. Roadway basins containing roundabouts were assumed to be 80% to account for the increased amount of pavement. The following basins were assumed to have a lower percentage of impervious surfaces, between 2-9%, as limited development is predicted in these areas: A-1, A-2-1, D-2, F, OS-1, OS-2, and OS-3. The results from these calculations can be found in Appendix C, for reference. The CUHP results are linked to the EPA SWMM model in order to assess the proposed storm drain system.

As these criteria represent all required information for development of Project hydrology, other criteria or calculation methods outside of Louisville Criteria and the District Manual were not used in the hydrologic design for the Site.

D. Hydraulic Criteria

Storm sewer pipes and inlets were sized for the 100-yr major storm event throughout all phases of the Site; supporting calculations can be found in Appendix C. Storm sewers were evaluated using EPA SWMM 5.1. With EPA SWMM having limited capabilities to account for bypass runoff from street inlets, the MHFD-Inlet v5.02 workbook was utilized to evaluate each inlet's size and capacity. Computations from the MHFD-Inlet workbook can be found in Appendix C, showing that bypass flows were accounted for in the hydraulic analysis of all inlets.

For the proposed Site Full Spectrum Detention Facilities, the District Manual MHFD-Detention_v4.03 workbooks were used to determine required volumes and release rates for each design storm.

Per Chapter 3.0 of the District Manual; calculation of the Water Quality Capture Volume (hereinafter referred to as "WQCV") in watershed inches is given as:

$$WQCV = a (0.91 I^3 – 1.19 I^2 + 0.78 I)$$ Equation 3-1

where:
- a = 1.0 for a 40-hour drain time for extended detention.
- I = Contributing Basin Imperviousness

$$V = (WQCV * A) / 12$$ Equation 3-2

where:
- V = required storage volume (acre-feet)
- A = watershed tributary area upstream (acres)
- WQCV = Water Quality Capture Volume (watershed-inches)

The proposed storm sewer design adheres to the City of Louisville's Storm Drainage and Technical Criteria Manual (August 2013). For further details regarding the storm sewer design and computations, refer to Appendix C.

Other criteria or calculation methods outside of Louisville Criteria and the District Manual were not used in the hydraulic design for the Site.

E. Waivers from Criteria

No waivers were requested or granted. All aspects of design are intended to meet or exceed criteria.

IV. DRAINAGE FACILITY DESIGN

A. General Concept

The general drainage concept for the Site is to capture storm water runoff from the Site and roadway drainage basins and route the runoff through proposed storm sewer infrastructure to existing and proposed Full Spectrum Detention Facilities. Detained runoff will be released at specified rates through outlet structures to existing or proposed drainage infrastructure. Runoff from Basins D-2 and C-6-3 will flow off the Site per historic conditions into the drainage system associated with U.S. Highway 36. This is referenced in Appendix D.

The north portion of the Site releases per historical conditions and as shown on the Existing Drainage Plan at 96th Street. From this point, Tributary I releases to the existing dual 10'(W) x 6'(H) RCBC under the Northwest Parkway. Per the Louisville OSP, the peak discharge at this location is 842 cfs for the 100-year storm event. Proposed Site releases, as described below, will not exceed the allowable 842 cfs through the existing dual 10' x 6' RCBC in the 100-year storm event.

SWMM element Out1 represents all the Site flows contributing to Tributary I. The OSP shows a flow of 842 cfs discharging from the Site through Tributary I, but Site detention meeting MHFD standards have decreased this to below pre-developed site conditions. The SWMM model 100-year storm event flows at element Out1 were found to be 441 cfs in the pre-developed condition and 373.68 cfs in the developed condition. This shows the Site is meeting the design criteria of MHFD to release 100-year storm events at or below the pre-developed flows from the basin.

SWMM element Out2 represents all the flows contributing to the 48" RCP shown on the Grading Plan and Basin Delineation from the Via Varra & West Midway Improvements construction documents prepared by Drexell Barrell & company which are provided in Appendix B. This report calculates that off-site basin DA-1C contributes 80.5 cfs to the Northern Storm System which is the existing 48" HDPE culvert. The SWMM model 100-year storm event flows at element Out2 were found to be 65.26 cfs in the developed condition.

The aforementioned report additionally calculates that off-site basins DA-1A and DA-1B contribute 19.5 cfs to the Southern Storm System at the existing 36" HDPE storm sewer in Via Varra Road. Most of these flows from this area will be routed to the on-site pond C-2 and the only flow contributing to the Southern Storm System will be from sub-basin C-6-3 with a developed flow of 1.59 CFS. These flows are not represented in the SWMM model. See appendix B for existing offsite basins.

SWMM nodes were created corresponding to the proposed layout of the complete storm sewer system. The full SWMM modeling inputs and results can be found in Appendix C.

B. Specific Details

The following section describes in detail the proposed major drainage basins for the Phase 1 Redtail Ridge Site. See Appendix D for a detailed layout of all major basins.

Minor basins within the roadway areas are shown in the drainage plan and included in the CUHP/SWMM calculations found in Appendix C.

Calculations for all proposed Ponds as well as their respective outlet structure design can also be found in Appendix C.

Basin A is in the northwest corner of the Site located to the north of Rockcress Drive, to the east of South 88th Street, and to the south of Campus Drive, Tributary I splits the parcel from southwest to northeast dividing Sub-Basins A-1 and A-2-1. Flows from A-1 historically flow from northwest to southeast into Tributary I and flows from Sub-Basin A-2-2 historically flow from southwest to northeast into Tributary I. Sub-Basin A-3 consists of a portion of Rockcress Drive which must be discharged into Basin A.

Sub-Basin A-1 (37.99 acres, 2% imperviousness) is northwest of Tributary I. Sub-Basin A-1 is proposed to be an open space area dedicated to the City of Louisville. Stormwater runoff from Sub-Basin A-1 will continue to sheet flow as it historically does into Tributary I. Water quality should be considered for any future hardscape improvements (such as parking lots) that may be proposed in this basin.

Sub-Basin A-2-1 (14.64 acres, 2% imperviousness) is south of Tributary I. Sub-Basin A-2-1 is proposed as an undeveloped parcel where stormwater runoff will drain as it has historically and will release directly to Tributary I.

Sub-Basin A-2-2 (34.10 acres, 85% imperviousness) is southeast of Tributary I. Sub-Basin A-2-2 is proposed to be a mixed land use including parking, buildings, sidewalks, and landscaped areas. Stormwater runoff from Sub-Basin A-2 is proposed to drain to future curb, gutter, inlet, and storm sewer system that will release to the proposed full spectrum detention Pond B at a location in the downgradient area of the basin. Pond B is proposed to release flows to Tributary I.

Sub-Basin A-3 (0.62 acres, 75% imperviousness) is along the western extents of Rockcress Drive. Sub-Bain A-3 consists of roadway and detached sidewalk. Stormwater runoff from Sub-Basin A-3 is proposed to drain to future curb, gutter, inlet, and storm sewer system along Rockcress Drive that will release to a Barracuda Hydrodynamic Separator water quality device, location in the southwestern corner of Sub-Basin A-3. The flow is proposed to be released to the Rock Creek Tributary I channel after receiving water quality treatment.

In the pre-developed condition, the Health Park subdivision and the S. 88th Street roadway west of Basin A contribute 84 cfs to the School Pond at the northwest corner of Basin A.

The School Pond then releases up to a maximum of 56 cfs north into the school site through a 30" RCP storm sewer pipe north to the Bus Loop Pond, as shown on the BVSD Drainage plan provided in Appendix B. With the development of Campus Drive, the school pond will be removed and these flows are proposed to be captured at the 88th and Campus Drive intersection and will then routed to the proposed storm sewer in Campus Drive.

A 30" RCP will outlet from a manhole in the proposed Campus Drive storm sewer and release flows at an equivalent rate as the existing culvert into the Bus Loop Pond. The balance of flow not released to the Bus Loop Pond will overtop the 30" RCP in the manhole and continue east through the proposed Campus Drive storm sewer system to Pond C-1.

In the existing condition, flows from the offsite School Site Basin contribute 1.9 cfs in the 10-year event and 4.2 cfs in the 100-year event to Sub-Basin A-1. The School Site Detention Pond D releases 1.1 cfs in the 10-year event and 4.8 cfs in the 100-year event into Sub-Basin A-1 as well. With the construction of Campus Drive, these flows will be collected by the proposed storm sewer main in Campus Drive. These flows will be routed to the storm sewer in Campus drive beginning at the existing flared end section at the northwest corner of the parcel and be released into Pond C-1.

Basin B is in the central portion of the Site located to the north of Rockcress Drive, to the east of Basin A-1, to the south of Campus Drive, and to the west of Sorrel Avenue. A natural ridge in the southern portion of the parcel splits the basin into Sub-Basins B-1 draining north and B-2 draining south.

Sub-Basin B-1 (79.46 acres, 85% imperviousness) consists of buildings, roadways, sidewalks, and landscaped areas. Runoff will drain to curb, gutter, inlet, and storm sewer system that will release to a proposed Full Spectrum Detention Facility Pond B (hereinafter referred to as "Pond B") located at the northeast corner of Basin B. Pond B is planned to release north into Tributary I. Calculations for the design of Pond B as well as outlet structure design are included in Appendix C.

Sub-Basin B-2 (30.37 acres, 85% imperviousness) consists of buildings, roadways, sidewalks, and landscaped areas. Runoff will be conveyed by curb and gutter to storm inlets and drain south to proposed Full Spectrum Detention Facility Pond C-2. A storm sewer outfall stub is provided to the southeast corner of Basin B-2 to collect developed stormwater runoff from Basin B-2 and route to Pond C-2.

Basin C is in the eastern portion of the Site and generally lies east of Sorrel Avenue and west of S. 96th Street. A natural ridge in the south portion of the parcel splits the basin into Sub-Basins C-1 draining north and C-2 draining south. Basin C Sub-Basins include the portions of Campus Drive, Rockcress Drive, and Sorrel Avenue which are Tributary to Ponds C-1 and C-2.

Sub-Basin C-1 (53.21 acres, 80% imperviousness) is in the northeastern portion of Basin C between Sorrel Avenue and S. 96th Street. This Sub-Basin is proposed to be developed at 80% Imperviousness. Sub-Basin C-1 contains the Full Spectrum Detention Facility Pond C-1 (hereinafter referred to as "Pond C-1"). Basin C-1 will be developed to drain to a curb, gutter, inlet and storm sewer system that will release to Pond C-1, located at the northeast corner of the basin. Pond C-1 is a planned permanent water surface facility with stormwater detention provided above the permanent water surface. This pond will follow state permit procedure for permanent water surface facilities. The outlet of Pond C-1 will release east into Tributary I.

Sub-Basin C-2 (19.63 acres, 80% imperviousness) is the southeastern portion of Basin C between Sorrel Avenue and Northwest Parkway. This Sub-Basin is proposed to be developed at 80% Imperviousness. Runoff from Sub-Basin C-2 will be routed south through a proposed curb, gutter, inlet, and storm sewer system to Pond C-2 where it will be combined with flows from Sub-Basin C-5. The combined flows will then be detained for both the WQCV event and the major storm event. The outfall for Pond C-2 will be routed to the existing 48" RCP storm sewer releasing east under the Northwest Parkway.

Sub-Basin C-3 (14.17 acres, 79% imperviousness) is composed of the area routed to Basin C from Campus Drive and Sorrel Avenue. Stormwater runoff in Sub-Basin C-3 will be developed to drain to a curb, gutter, inlet, and storm sewer system that will release to Pond C-1.

Sub-Basin C-3-1 (1.34 acres, 80% imperviousness) is located on the west section of Campus Drive near S 88th Street. The Sub-Basin consists of roadway and detached sidewalk. Stormwater runoff in this Sub-basin is routed by proposed curb and gutter to a 15' Type R inlet (on-grade) and conveyed east through the proposed storm network to Pond C-1.

Sub-Basin C-3-2 (1.30 acres, 80% imperviousness) is located on the west section of Campus Drive near S 88th Street. The Sub-Basin consists of roadway and detached sidewalk. Stormwater runoff in this Sub-basin is routed by proposed curb and gutter to a 15' Type R inlet (on-grade) and conveyed east through the proposed storm network to Pond C-1.

Sub-Basin C-3-3 (0.42 acres, 75% imperviousness) is located on the west section of Campus Drive. The Sub-Basin consists of roadway and detached sidewalk. Stormwater runoff in this Sub-basin is routed by proposed curb and gutter to a 5' Type inlet (on-grade) and conveyed east through the proposed storm network to Pond C-1.

Sub-Basin C-3-4 (0.44 acres, 75% imperviousness) is located on the west section of Campus Drive. The Sub-Basin consists of roadway and detached sidewalk. Stormwater runoff in this Sub-Basin is routed by proposed curb and

gutter to a 5’ Type inlet (on-grade) and conveyed east through the proposed storm network to Pond C-1.

Sub-Basin C-3-5 (0.73 acres, 80% imperviousness) is located on the west section of Campus Drive. The Sub-Basin consists of roadway, a roundabout and detached sidewalk. Stormwater runoff in this Sub-Basin is routed by proposed curb and gutter to a 10’ Type inlet (on-grade) and conveyed east through the proposed storm network to Pond C-1.

Sub-Basin C-3-6 (0.76 acres, 80% imperviousness) is located on the west section of Campus Drive. The Sub-Basin consists of roadway, a roundabout and detached sidewalk. Stormwater runoff in this Sub-Basin is routed by proposed curb and gutter to a 10’ Type inlet (on-grade) and conveyed east through the proposed storm network to Pond C-1.

Sub-Basin C-3-7 (0.95 acres, 80% imperviousness) is located on the west section of Campus Drive. The Sub-Basin consists of roadway, a roundabout and detached sidewalk. Stormwater runoff in this Sub-Basin is routed by proposed curb and gutter to a 10’ Type inlet (on-grade) and conveyed east through the proposed storm network to Pond C-1.

Sub-Basin C-3-8 (0.95 acres, 80% imperviousness) is located on the west section of Campus Drive. The Sub-Basin consists of roadway, a roundabout and detached sidewalk. Stormwater runoff in this Sub-Basin is routed by proposed curb and gutter to a 10’ Type inlet and conveyed east through the proposed storm network to Pond C-1.

Sub-Basin C-3-15 (0.65 acres, 75% imperviousness) is located near the middle of Campus Drive. The Sub-Basin consists of roadway and detached sidewalk. Stormwater runoff in this Sub-Basin is routed by proposed curb and gutter to a 15’ Type inlet (on-grade) and conveyed east through the proposed storm network to Pond C-1.

Sub-Basin C-3-16 (0.67 acres, 75% imperviousness) is located near the middle of Campus Drive. The Sub-Basin consists of roadway and detached sidewalk. Stormwater runoff in this Sub-Basin is routed by proposed curb and gutter to a 15’ Type inlet (on-grade) and conveyed east through the proposed storm network to Pond C-1.

Sub-Basin C-3-17 (0.52 acres, 80% imperviousness) is located on the east section of Campus Drive. The Sub-Basin consists of roadway and detached sidewalk. Stormwater runoff in this Sub-Basin is routed by proposed curb and gutter to a 10’ Type inlet (on-grade) and conveyed east through the proposed storm network to Pond C-1.

Sub-Basin C-3-18 (0.56 acres, 80% imperviousness) is located on the east section of Campus Drive. The Sub-Basin consists of roadway and detached sidewalk. Stormwater runoff in this Sub-Basin is routed by proposed curb and gutter to a 10' Type inlet (on-grade) and conveyed east through the proposed storm network to Pond C-1.

Sub-Basin C-3-19 (0.89 acres, 80% imperviousness) is located at the intersection of Campus Drive and Sorrell Ave. The Sub-Basin consists of roadway, a roundabout, and detached sidewalk. Stormwater runoff in this Sub-Basin is routed by proposed curb and gutter to a 10' Type inlet (on-grade) and conveyed south then east through the proposed storm network to Pond C-1.

Sub-Basin C-3-20 (1.97 acres, 80% imperviousness) is located on the north section of Sorrell Ave. The Sub-Basin consists of roadway and detached sidewalk. Stormwater runoff in this Sub-Basin is routed by proposed curb and gutter to a 10' Type R inlet (sump) and conveyed east through the proposed storm network to Pond C-1.

Sub-Basin C-3-21 (2.02 acres, 80% imperviousness) is located on the north section of Sorrell Ave. The Sub-Basin consists of roadway and detached sidewalk. Stormwater runoff in this Sub-Basin is routed by proposed curb and gutter to a 10' Type R inlet (sump) and conveyed east through the proposed storm network to Pond C-1.

Sub-Basin C-4 (2.78 acres, 75% imperviousness) is composed of the northeastern portion of Campus Drive which grades preclude from being routed to Pond C-1. Stormwater runoff in Sub-Basin C-4 is to be collected by proposed curb, gutter, inlets, and storm sewer which will be treated by a Barracuda Hydrodynamic Stormwater Separator to provide water quality and then routed to Tributary I. A BMP agreement will be put together for this stormwater facility this will be finalized along with the civil construction documents for this facility.

Sub-Basin C-4-1 (1.16 acres, 75% imperviousness) is located at the northeast corner of the site near the intersection of Campus Drive and S 96th Street. The Sub-Basin consists of roadway and detached sidewalk. Stormwater runoff in this Sub-Basin is routed by proposed curb and gutter to a 10' Type R inlet (on-grade) and conveyed south through the proposed storm network to a Barracuda Hydrodynamic Stormwater Separator for water quality treatment before being released to Tributary I.

Sub-Basin C-4-2 (1.62 acres, 75% imperviousness) is located at the northeast corner of the site near the intersection of Campus Drive and S 96th Street. The Sub-Basin consists of roadway and detached sidewalk. Stormwater runoff in this Sub-Basin is routed by proposed curb and gutter to a 10' Type R inlet (on-grade) and conveyed south through the proposed storm network to a Barracuda

Hydrodynamic Stormwater Separator for water quality treatment before being released to Tributary I.

Sub-Basin C-5 (10.69 acres, 76% imperviousness) is composed of the area routed to Basin C from Rockcress Drive and Sorrel Avenue. Stormwater runoff in Sub-Basin C-5 will be developed to drain to a curb, gutter, inlet, and storm sewer system that will release to Pond C-2. For more detailed information pertaining to Sub-Basins C-5-1 through C-5-8 refer to the Redtail Ridge Phase 2 Drainage Report.

Sub-Basin C-5-9 (0.37 acres, 75% imperviousness) is located at the intersection of Rockcress Drive and Sorrell Ave. The Sub-Basin consists of roadway, a roundabout, and detached sidewalk. Stormwater runoff in this Sub-Basin is routed by proposed curb and gutter to a 5’ Type R inlet (sump) and conveyed east through the proposed storm network to Pond C-2.

Sub-Basin C-5-10 (0.71 acres, 75% imperviousness) is located north of the intersection of Rockcress Drive and Sorrell Ave. The Sub-Basin consists of roadway and detached sidewalk. Stormwater runoff in this Sub-Basin is routed by proposed curb and gutter to a 10’ Type R inlet (on-grade) and conveyed south then east through the proposed storm network to Pond C-2.

Sub-Basin C-5-11 (0.71 acres, 75% imperviousness) is located north of the intersection of Rockcress Drive and Sorrell Ave. The Sub-Basin consists of roadway and detached sidewalk. Stormwater runoff in this Sub-Basin is routed by proposed curb and gutter to a 10’ Type R inlet (on-grade) and conveyed south then east through the proposed storm network to Pond C-2.

Sub-Basin C-5-12 (0.97 acres, 80% imperviousness) is located at the intersection of Rockcress Drive and Sorrell Ave. The Sub-Basin consists of roadway, a roundabout, and detached sidewalk. Stormwater runoff in this Sub-Basin is routed by proposed curb and gutter to a 10’ Type R inlet (on-grade) and conveyed east through the proposed storm network to Pond C-2.

Sub-Basin C-5-13 (0.96 acres, 80% imperviousness) is located at the intersection of Rockcress Drive and Sorrell Ave. The Sub-Basin consists of roadway, a roundabout, and detached sidewalk. Stormwater runoff in this Sub-Basin is routed by proposed curb and gutter to a 15’ Type R inlet (on-grade) and conveyed east through the proposed storm network to Pond C-2.

Sub-Basin C-6 (1.82 acres, 75% imperviousness) is composed of the southeastern portion of Rockcress Drive which at portion of its grades preclude from being routed to Pond C-2. Stormwater runoff in Sub-Basin C-6-1 and C-6-2 is to be collected by proposed curb, gutter, inlets, and storm sewer and will be routed to pond C-2. Sub basin C-6-3 will sheet flow off site and will then be routed to the existing 36” HDPE storm sewer releasing east in Via Varra Road.

Sub-Basin C-6-1 (0.67 acres, 75% imperviousness) is located at the southeast portion of the Site near the intersection of Rockcress Drive and Northwest Parkway. The Sub-Basin consists of roadway and detached sidewalk. Stormwater runoff in this Sub-Basin is routed by proposed curb and gutter to a 10' Type R inlet (on-grade) and conveyed north through the proposed storm network to Pond C-2.

Sub-Basin C-6-2 (0.81 acres, 75% imperviousness) is located at the southeast portion of the Site near the intersection of Rockcress Drive and Northwest Parkway. The Sub-Basin consists of roadway and detached sidewalk. Stormwater runoff in this Sub-Basin is routed by proposed curb and gutter to a 10' Type R inlet (on-grade) and conveyed north through the proposed storm network to Pond C-2.

Sub-Bains C-6-3 (0.34 acres, 75% imperviousness) is located at the southeast portion of the Site near the intersection of Rockcress Drive and Northwest Parkway. The Sub-Basin consists of roadway and detached sidewalk. Stormwater runoff in this Sub-Basin is sheet flows to an existing 36" HDPE storm sewer before releasing east in Via Varra Road.

Basin D is in the southern portion of the Site and generally lies south of Rockcress Drive and Basin E. Extents of proposed development and an existing ridge in Parcel E split Sub-Basins D-1, D-2, and E. Sub-Basin D-1 drains from both northwest and southeast to meet approximately in the center of the sub-basin. Sub-Basin D-2 generally drains along the existing ridge in Parcel E from northeast to southwest.

Sub-Basin D-1 (14.55 acres) contains the southeast corner of the Site, an area bounded by Rockcress Drive to the north, by property boundary to the south and by an existing ridge to the west. Flows from Sub-Basin D-1 shall be routed to storm sewer east of the intersection of Rockcress Drive and Sorrel Avenue through curb, gutter, inlets, and storm sewer. Flows will then be routed to the Full Spectrum Detention Facility Pond C-2, where flows will be detained for both the WQCV event and the major storm event. In order for the parcel to drain to Pond C-2 fill is required to be placed on the Site. If alternate parcel development plans are desired, this area may be released south to Rock Creek with the proper Jurisdictional approvals.

Sub-Basin D-2 (19.40 acres, 2% imperviousness) is proposed as open space and will drain as it does historically. The historical flows for Basin D-2 generally flow from northeast to southwest into an empty field within the City and County of Broomfield. There appears to be an outfall crossing Northwest Parkway and Storage Tek Drive approximately 800' south from the southeast corner of the Site where runoff from D-2 eventually ends and continues downstream.

Sub-Basin D-3 (11.26 acres) contains the southeast corner of the Site, an area bounded by Rockcress Drive to the north, by property boundary to the south and Northwest Parkway to the west. Flows from Sub-Basin D-3 shall be routed to storm sewer east of the intersection of Rockcress Drive and Northwest Parkway via a stub out for future connection. Flows will then be routed to the Full Spectrum Detention Facility Pond C-2, where flows will be detained for both the WQCV event and the major storm event. In order for the parcel to drain to Pond C-2 fill is required to be placed on the Site. If alternate parcel development plans are desired, this area may be released south to Rock Creek with the proper Jurisdictional approvals.

Basin E (34.33 acres, 75% imperviousness) is in the southwest portion of the Site and generally lies south of Basin A and west of Sub-Basin D-2. Stormwater runoff in Basin E is proposed to drain to a curb, gutter, inlet, and storm sewer system that will release to a proposed Full Spectrum Detention Facility Pond E located in the downgradient portion of Basin E. Pond E is planned for future construction in the development of PUD-8. For more detailed information pertaining to Sub-Basins E and Pond E, refer to the Redtail Ridge Master Drainage Report.

Basin F (17.05 acres, 2% imperviousness) is in the northern portion of the Site and is existing open space and will drain as it does historically. Basin F is bound on the north by the property line and on the east, west, and south by Campus Drive. The historical flows for Basin F generally flow from the extents of the basin to the center where they meet Tributary I. Two reinforced concrete box culverts with headwalls and riprap aprons at the inlet and outlet locations are proposed for construction where Tributary I intersects Campus Drive. Both crossings are composed of a dual box system which includes one lower structure solely for flow conveyance and another raised structure which doubles as a trail underpass for maintenance vehicle and pedestrian access up to the 10-year event. The lower RCBC will have a span of 8’ with a rise of 5’ and the raised trail underpass RCBC will have a span of 10’ and rise of 8’. A trail is proposed within Basin F spanning from east to west to allow access for pedestrians and maintenance vehicles.

Basin OS-1 (77.43 acres, 9% imperviousness) is located generally west of the Site and is existing open space and roadway areas. Basin OS-1 will drain as it does historically. The historical flows for Basin OS-1 generally flow east to S. 88th Street. Flows are conveyed under 88th St. to Tributary I in Basin A via an existing 36” RCP culvert and two 18” CMP.

Basin OS-2 (33.32 acres, 6% imperviousness) is located generally north of the Site and is existing farm and residential land. Basin OS-2 will be left to drain as it does historically. The historical flows for Basin OS-2 generally flow southeast into Basin F and then Tributary I.

Basin OS-3 (19.51 acres, 5% imperviousness) is located generally north of the Site, east of OS-2, and is existing farm and residential land. Basin OS-3 will also be left to drain as it does historically, into Basin F and then Tributary I.

Table 1 below summarizes the basin and direct runoff information for both Phase 1 and Phase 2.

Table 1: Basin and Direct Runoff Summary Table

BASIN	AREA (AC)	IMP. (%)	Q2 (CFS)	Q10 (CFS)	Q100 (CFS)
A-1	37.99	2	0.24	6.87	37.40
A-2-1	18.42	2	0.08	2.19	12.21
A-2-2	30.37	85	31.92	56.46	120.74
A-3	0.62	75	0.24	0.46	1.09
B-1	78.76	85	82.82	145.97	309.64
B-2	31.01	85	33.22	59.73	123.28
C-1	53.21	80	45.87	83.88	183.61
C-2	19.63	80	22.10	41.84	88.58
C-3	14.17	79	5.22	9.54	22.53
C-4	2.78	75	1.69	1.10	7.26
C-5	10.69	76	11.41	22.05	47.94
C-6	1.82	75	1.23	2.31	5.22
D-1	25.82	70	19.16	36.96	85.60
D-2	19.40	2	0.12	3.41	18.55
E	34.33	75	28.67	53.52	120.26
F	17.05	2	0.11	3.06	16.59
OS-1	77.43	9	8.78	21.66	99.62
OS-2	32.32	6	0.71	7.20	40.72
OS-3	19.51	5	0.36	4.36	25.31

C. Goodhue Ditch

The Ditch traverses the far northeast corner of the Site and is owned by the Ditch Company. The Ditch contains a defined bed and bank with fringe wetlands along portions of the banks. The Ditch is shown on the United States Geological Survey (USGS) Louisville topographic quadrangle and on the National Hydrography Dataset (NHD) as a canal/ditch and intermittent stream.

A crossing of the Ditch by Campus Drive is planned, subject to Ditch Company's approval, with the proposed development. The Ditch will continue to outfall per historic conditions at the existing location on northeast property boundary. The Ditch Company has been contacted regarding the requirements of the proposed Ditch revisions. The proposed Ditch crossing has been designed and included in a separate plan set for approval by the Ditch Company according to the Ditch Company requirements.

Decreed flows in this section of the Ditch range between 30 cfs and 40 cfs. We have requested additional information on the specific decreed flow from the Ditch Company. Based on the Ditch crossing at the intersection of Via Varra and Northwest Parkway just

north of the Broomfield Business center, a 54" RCP has been sized for the Ditch crossing. Preliminary calculations indicate that a 54" RCP conveys 50 cfs, which was used for design on the Site. A maintenance road with a minimum 15' wide easement is required, and the roadway crossing will also incorporate the ability for maintenance equipment to cross.

As the Ditch crossing will disturb waters of the US, the Project team has engaged the services of ERO Resources Corporation to assist in obtaining the required permitting. A copy of ERO's Preconstruction Notification (hereinafter referred to as "PCN") can be found in Appendix B. Per correspondence with the Army Corps of Engineers, the Goodhue Ditch Crossing, (NWO-2020-00467-DEN) will be issued an exemption for this project. It will be considered construction of an irrigation ditch, which is exempt under Section 404(f), and does not require a permit, which is referenced in Regulatory Guidance Letter 07-02.

The Site contains several other minor irrigation swales and ditches that are internal to the Site and do not flow off-site. All other irrigation swales and ditches in the Project are non–binding and will be routed on a Site level basis per development plans for individual parcels. See Appendix D for the Existing Drainage Plan sheet.

D. Stormwater Detention and Water Quality

All on-site Detention and water quality ponds are designed to be Full Spectrum Extended Detention Basins (EDBs) per the Criteria of the District Manual Volume 3. Ponds B and C-1 are designed as permanent wet bottom EDBs, and Pond C-2 is designed as a dry bottom EDB. For detailed information about Pond C-2, refer to the Phase 2 Drainage Report. Construction Documents detail the required forebay, upper stage area, lower stage area and micro-pool area of these EDBs. Each EDB design will incorporate an outlet feature that is intended to delay the release of the WQCV over a 40-hour period. This outlet feature will also allow the major 100-year storm event to be detained and released through the top of the outlet feature. The overflow has been designed with 1.0' of freeboard to the top of the detention berm. The spillway is sized to accommodate the 100-year event total inflows to the pond and incorporate Type L buried soil riprap as the outlet protection. The three EDBs will serve as permanent, post-construction BMP to treat the WQCV in accordance with Louisville Criteria for the ponds' tributary area.

Pond B is designed with a permanent water surface elevation per the Criteria of the District Manual Volume 3. Pond B will capture the runoff from future PUDs 1 through 4, or Basins A-2-2, and B-1. Individual drainage conformance reports for the PUDs will be provided in the future adhering to design laid out in this report. Conservative estimates were made in the design process for Pond B, assuming 85% imperviousness for the 113.55 acres of contributing area to ensure the pond provides adequate storage while the PUDs' designs are finalized. Refer to the Internal Roads Drainage Report for a more detailed analysis of the contributing areas to Pond B. Aqua Engineering performed hydrologic calculations estimating the peak summertime evaporation rates and the required flowrate to replenish the pond to the permanent water surface elevations within

a given time frame. In addition to designing the domestic water tap system detailing the tap size, system function, and how the shutoff functioning operates. For detailed information about the domestic water tap system to replenish Pond B, refer to the Aqua Engineering Report. Pond B will outfall through a storm sewer system to Tributary I, just upstream of the proposed culvert under S 96th Street.

Pond C-1 is designed with a permanent water surface elevation per the Criteria of the District Manual Volume 3. Pond C-1 will capture runoff from Basins C-1 and C-3, which includes the 88th Street Culvert, West BVSD Culvert, and the BVSD Pond Bypass. Refer to the Off-Site Flows section of this report for more information pertaining to the BVSD and 88th Street culvert flows. An impervious value of 79.84% was calculated for the 67.38 acres of contributing area as design parameters for Pond C-1. Aqua Engineering performed hydrologic calculations estimating the peak summertime evaporation rates and the required flowrate to replenish the pond to the permanent water surface elevations within a given time frame. In addition to designing the domestic water tap system detailing the tap size, system function, and how the shutoff functioning operates. For detailed information about the domestic water tap system to replenish Pond B, refer to the Aqua Engineering Report. Pond C-1 will outfall through a storm sewer to Tributary I, just upstream of the location of the proposed culvert under S. 96th Street.

Pond C-2 is designed as a full spectrum EDB per the Criteria of the district Manual Volume 3. Pond C-2 will capture runoff from Basins B-2 (PUD 1), C-2, C-5, C-6-1, C-6-2, and D-1. Conservative estimates were made in the design process for Pond C-2, assuming 80% imperviousness for the 87.99 acres of contributing area to ensure the pond provides adequate storage while PUD 1's design is finalized. Pond C-2 will outfall through an existing 48" HDPE storm sewer under Northwest Parkway that flows to the Via Varra subdivision east of the Site.

Table 2 below summarizes the on-site detention for Phase 1.

Table 2: Site Detention Summary

Pond	Contributing Area (ac)	Max 100-YR Depth (ft)	Design % Imp.	WQCV (ac-ft)	EURV (ac-ft)	Required Volume (ac-ft)			Provided Volume (ac-ft)	Allowable Release Rate (cfs)			Design Release Rate (cfs)		
						2-YR	10-YR	100-YR		2-YR	10-YR	100-YR	2-YR	10-YR	100-YR
B	113.56	6.27	85.00%	3.44	9.54	5.44	10.28	16.71	19.711	N/A	34.20	176.8	5.32	8.70	86.84
C-1	67.38	3.61	79.84%	1.86	5.31	3.03	5.75	9.23	9.617	N/A	9.09	52.70	2.38	4.69	47.39
C-2	87.98	8.47	79.42%	2.35	6.76	4.11	7.35	10.93	12.758	N/A	19.89	105.7	1.39	11.5	74.27

*Allowable release rate is 90% of the predevelopment 100-yr peak runoff rate per USDCM criteria.

An ADS Barracuda Max S4 in an HP manhole is proposed in Basin C4 to provide water quality treatment for surface runoff that is not routed to a detention facility prior to releasing into Tributary I. Refer to Appendix C for construction details.

To further the MHFD goal of watershed level runoff control, this Final Master Drainage Report encourages the implementation of Low Impact Development practices and alternative water quality features per the District Manual Volume 3, Chapter 4.

The WQCV treatment system and release rate will be designed in accordance with Volume 3 of the District Manual and Chapter 6 of Louisville Criteria. The Full Spectrum Detention Facilities are designed as permanent, post-construction Best Management Practice (BMP) to treat the WQCV in accordance with Louisville Criteria for each of the facilities' tributary areas.

E. Off-site Flows

Basin D-2, which is to be left undeveloped, is the only on-site basin which will be left to flow freely off-site. This basin contains primarily landscaped areas and will continue to flow off-site per historical conditions.

Off-site Basins OS-1,OS-2, and OS-3 will be left to drain freely on-site as they do historically. OS-1 drains into Tributary I, while OS-2 and OS-3 generally drains east. A portion of the runoff from OS-2 splits to Tributary I at the southeast boundary between OS-2 and OS-3. Using HY-8 Culvert Hydraulic Analysis Program v7.3, it was confirmed that the 36" RCP and two 18" CMP culverts have capacity to convey the 100-year storm from Basin OS-1 under S. 88th St. without overtopping the road. These calculations have been included in Appendix C.

The existing pond in the northwest corner of Parcel A, known as the "School Pond", is associated with BVSD Monarch School Campuses. This pond will be removed at the time that the Campus Drive storm sewer is installed. Contributing flows to the School Pond will be rerouted from the existing flared end section and into the proposed storm sewer in Campus Drive. Currently a 30" RCP releases a maximum flow of 56 cfs (maximum pipe capacity) from the School Pond into the BVSD Monarch School Site to the north. In the proposed condition, this pipe will connect the storm sewer main in Campus Drive to the Bus Loop Pond on the School Site. The invert of the 30" RCP to the Bus Loop Pond is set lower than the invert of the main, ensuring that the 30" continues to release 56 cfs north matching the existing condition.

Currently there are two storm sewer pipes that release historical flow into vacant land south of Campus Drive. These pipes release 4.2 cfs in the 100-year event and Pond D releases 4.8 cfs in the 100-year event. Both of these pipes will be connected to the storm sewer main in the proposed condition of Campus Drive.

The existing inlets at the intersection of Rockcress Drive and Via Varra Road are contributory to the storm sewer system in Via Varra Road. This system connects to storm sewer in West Midway Blvd and ultimately releases south of Rock Creek. The proposed development will not add additional flows to this intersection, and the existing inlets are to be reset at the new curb locations in the intersection.

Stormwater drainage in Sub-Basin C-4 at the eastern section of Campus Drive will be routed by a curb, gutter, inlet, and storm sewer system south to Tributary I. Flows at and

near the intersection of Campus Drive and S. 96th Street will release into the roadside ditch fronting Fire Station 67, and travel southeast within the roadside ditch ultimately discharge into Tributary I.

Pond C-2 and Sub-Basin C-6-3 release flows to the Via Varra subdivision east of the Site. Pond C-2 releases to an existing 48" HDPE storm sewer discharging east under Northwest Parkway. In the Final Drainage Report for Parkway Circle, 96th Street & Carbon Road, the Existing Off-site Facilities Section delineates Basin DA-1C tributary to the 48" HDPE with a peak flow of 80.5 cfs. This report also indicates that the 48" HDPE is routed within the North Storm System which runs north and then east at Carbon Drive. Basins DA-1A, DA-1B release into the existing 36" HDPE system in Via Varra Road with a peak flow of 19.5 cfs. The grading plan with the storm sewer plan and a drainage basin map from this report can be found in Appendix B.

No other minor or major flows besides those listed above are anticipated to enter or exit the Site boundary. All flows exiting the Site, with the exception of the Sub-Basins D-2 and C-6-3, will be routed through proposed drainage infrastructure to existing drainage infrastructure which has the capacity available to convey these flows.

Additional roadway improvements have been proposed off-site, along S. 96th Street, Northwest Parkway, and W. Dillion Road, and are being reviewed by the City separately from this filing. An addendum to this report has been submitted for these off-site improvements, more detailed information can be found in the Redtail Ridge Off-site Roadway Improvements Drainage Report or the Master Drainage Report.

F. Rock Creek Tributary I

1. Tributary Watershed

The Tributary I Watershed is approximately 586 acres. Tributary I drains the area along U.S. Highway 36 from just West of U.S. Highway 36 to S. 96th Street, then through a narrow section from S. 96th Street to Rock Creek. The watercourse throughout consists of a well-defined channel.

The majority of the channel has a relatively wide and shallow floodplain with bank slopes which are densely vegetated with native grasses that provide significantly increased channel stability. Soils within the upper watershed vary but are considered Hydrologic soil group C.

2. CUHP and SWMM

The hydrologic stormwater routing analysis for the watershed was completed using a combination of the Colorado Urban Hydrograph Procedure (CUHP) v. 2.0.1 and the US Environmental Protection Agency Storm Water Management Model (EPA SWMM) v. 5.1. To create the Tributary I Basin regional model, storm hydrographs produced by CUHP

were integrated into EPA SWMM for routing and flood risk analysis. The SWMM has been developed utilizing the proposed Site development planning areas routed to respective full-spectrum water quality and detention facilities. In general, Site areas drain to full spectrum detention facilities, which then release flows at rates that mimic historic flows into Tributary I.

The outlet structures from the regional detention facilities are designed to be concrete structures with weir controls and an outfall pipe sized to accommodate the 100-year release rate. The outlet structures will be designed per MHFD criteria. The spillway weir overflow was sized to route pond overflows. The overflow has been designed with 1.0' of freeboard to the top of the detention berm. The spillway is sized to accommodate the 100-year event total inflows to the pond and will be protected with Type L buried soil riprap outlet protection.

To understand the effects that the proposed development and private detention ponds have on the overall Tributary I flood control system, hydrographs were compared at several locations within the Project. A summary of SWMM Hydrographs results were compared at specific nodes for the 2, 10, and 100-year events and have been included in Appendix C. Results shown in these hydrographs indicate closely matched peaks and timing for all events.

3. Hydrology Data

A detailed analysis of the OSP basin delineation was conducted in order to make comparisons of proposed to historical flow conditions. This analysis indicated a discrepancy in the Area of Basin 6-I (148-acres to 184-acres). Additionally, Basin 2-J in the OSP contained areas of the Northwest Parkway which no longer drain in the manner described in the OSP (23 acres).

Due to the discrepancies in the OSP, a pre-developed CUHP/SWMM model was created to create a more accurate representation of the Site-specific historical flow conditions. The creation of this model provides a more direct comparison for acceptable release rates of developed flows from the Site's proposed detention structures, and was the hydrologic flow condition selected to represent existing conditions for the design of Tributary I.

A summary table detailing these changes and a comparison of the 100-year pre-developed flows from these basins to existing conditions from the Louisville OSP can be found in Table 3 below.

Table 3: Existing Basin Summary Table

BASIN	OSP AREA (AC)	PRE-DEVELOPED BASIN DELINEATION AREA (AC)	OSP EXISTING PERCENT IMPERVIOUS	PRE-DEVELOPED PERCENT IMPERVIOUS	OSP EXISTING Q100 (CFS)	PRE-DEVELOPED BASIN Q100 (CFS)
4 - I	110	110	13	2	213	128
5 - I	142	142	3	2	235	126
6 - I	148	184	57	2	382	176
2 - J	104	81	44	2	306	96

See Appendix D for the Louisville OSP Existing Drainage Plan sheet.

4. Channel Geometry

Tributary I as it exists within the Site extends from the existing culvert at S. 88th Street to the downstream culvert at S. 96th Street. The proposed design for Tributary I is broken into three reaches. Tributary I will conform to a high functioning low maintenance (HFLM) stream design approach and will seek to armor the bankfull portion of the channel as needed to protect against long term erosion concerns while keeping a wide, vegetated, and shallow floodplain for larger flooding events. The design of the typical sections of this HFLM was based on MHFD criteria for natural streams.

Three typical channel sections for Tributary I were identified within the existing and proposed Project extents and titled Reach 1, Reach 2, and Reach 3. Reach 1 will be left undisturbed in the existing channel condition. Reach 2 will seek to maintain the existing channel's planform geometry and alignment but will incorporate a new typical section with an armored bankfull channel and minimal grading. Reach 3 will be realigned to mimic a portion of Reach 2's planform geometry and will incorporate a new proposed cross section with an armored bankfull channel and a wide and shallow floodplain. Details of Tributary I typical sections are included in the construction documents for Redtail Ridge Phase 1. Calculations and design of each Typical Section was performed using Hydraflow Express Extension for Autodesk AutoCAD Civil 3D Ver. 2018.3.

Reach 1 is to be left in existing conditions because low velocities and shear stresses were evaluated within this reach. With the available spread for flow through this section it was determined that native grasses would be sufficient to maintain stability of the channel following development.
Reach 2 is proposed to include four typical sections between the West Campus Dr. Culvert and the East Campus Dr. Culvert. These are broken into separate typical sections to deal with different longitudinal slopes and flow rates. All four typical sections are designed to carry the 10% 100-year flow within an armored bankfull channel and allow larger events to spread out on the adjacent floodplain up to the 100-year event. The four reaches are broken out as follows below:

- Reach 2 IN 0.2% is designed convey flows of SWMM node Reach 2 IN with a 0.2% longitudinal slope along the existing alignment of the channel.
- Reach 2 IN 1.3% is designed to convey flows of SWMM node Reach 2 IN with a 1.3% longitudinal slope along the existing alignment of the channel.
- Reach 2 Armored Bankfull is designed to convey flows of SWMM node Reach 2 IN. This section will take advantage of the existing floodplain grades and grades. It will only disturb the existing ground to establish the Bankfull channel.
- Reach 2 OUT is designed to convey flows of the SWMM node Reach 3 OUT at 1.0% longitudinal slope. The alignment of the channel will be changed here but is designed to have a similar sinuosity of the existing channel.

Reach 3 is a proposed channel between the eastern culvert under Campus Drive and the culvert under S. 96th Street. Reach 3 is similar to Reach 2 OUT but is designed to convey the SWMM flows of Reach 3 at a slope of 1.6% longitudinal slope.

Flow values in the table below are taken from the SWMM model prepared for Tributary I.

Table 4: SWMM Tributary I Reach Flows – Pre-Development (CFS)

Rock Creek Tributary I Reach	2 YR Pre -Developed Flows (CFS)	10 YR Pre -Developed Flows (CFS)	100 YR Pre -Developed Flows (CFS)	100 YR OSP Flows* (CFS)
Reach 1	0.52	20.67	124.43	170
Reach 2 In	0.84	38.19	239.44	345
Reach 2 Out	0.84	38.19	239.44	345
Reach 3	1.93	67.96	441.42	842**

*OSP values are approximate from Design Peak Flow Diagrams Drawing 6 of the OSP
**Flow includes portions of Northwest Parkway and Via Varra Subdivision

Table 5: SWMM Tributary I Reach Flows – Developed With and Without Detention (CFS)

Rock Creek Tributary I Reach	10% 100 YR With Detention Flows (CFS)	10% 100 YR Without Detention Flows (CFS)	10 YR With Detention Flows (CFS)	10 YR Without Detention Flows (CFS)	100 YR With Detention Flows (CFS)	100 YR Without Detention Flows (CFS)	100 YR OSP Flows* (CFS)
Reach 1	9.97	10.26	21.69	22.99	99.68	102.60	170
Reach 2 In	15.00	15.31	27.67	29.00	150.01	153.06	345
Reach 2 Out	20.25	20.56	34.63	35.83	202.46	205.59	345
Reach 3	32.34	69.31	38.07	301.25	323.35	693.06	842**

*OSP values are approximate from Design Peak Flow Diagrams Drawing 6 of the OSP
**Flow includes portions of Northwest Parkway and Via Varra Subdivision

Flows in the table below represent the 100-year developed site flows at each release point into the channel and the corresponding channel flow at each release/outfall point.

Table 6: Site Release/Outfall Points

Developed Site Release Point	Channel Station	Release Point Flow (CFS)	Channel Flow (CFS)
Pond B	5+00	71.6	418.9
Pond C-1	3+00	48.2	418.9

5. HEC-RAS Modeling

One-dimensional steady flow models were prepared for existing and proposed Tributary I configurations using a series of input parameters including flowrate, channel cross-section geometry, roughness coefficients, and main channel bank stations.

Cross-sections were sampled in regular intervals (roughly every 50') and at areas that were determined to have complex or important geometry. The geometry of the existing channel was modeled using topography extracted from ground survey provided by LIDAR data that was collected for the Site. Cross-sections were created in AutoCAD, which were then exported into HEC-RAS for analysis. The Manning's n roughness was chosen based on MHFD suggested values for native grasses and to represent the existing topography of natural grasses within Tributary I.

The following Manning's n values were used for native grasses within the channel:

- 0.032 when assessing Velocity, Froude No., Shear Stress
- 0.050 when assessing Water Surface Elevation and Water Depth

The following Manning's n values were used for sections where the channel bottom would be considered sand/clay:

- 0.030 when assessing Velocity, Froude No., Shear Stress
- 0.040 when assessing Water Surface Elevation and Water Depth

The following Manning's n values were used for channel bottom would be considered cobbles or riprap lined:

- 0.035 when assessing Velocity, Froude No., Shear Stress
- 0.070 when assessing Water Surface Elevation and Water Depth

The development does not plan to introduce new or different vegetative communities that would alter these coefficients.

Table 7 provides the calculated hydraulic parameters for the three proposed reaches indicating low velocities and shear stress.

Flow for the major storm event was quantified within the CUHP/EPASWMM model. Flows as listed in Table 4 of this report were used as input values within the model as steady-state flow to represent the 100-year event within Tributary I.

Boundary conditions of the HEC-RAS model were based on normal depth and the average slope of the channel. A mixed-flow analysis was performed based on the mild slopes within the existing channel geometry that are expected to have sub-critical flow and the proposed drop structure where super critical flow and hydraulic jumps are predicted to occur.

The results of the model were used to represent the proposed and existing flooding extents of the 2-year, the 10-year, and 100-year events, flooding depths, and flow velocities to determine channel stability. A Floodplain Workmap indicating cross-section locations and proposed floodplain limits as well as a copy of the HEC-RAS model results are included in Appendix E. It is noted that the resulting flow velocities and depths indicated a stable stream section except within the bankfull channel. A natural stream design, while accounting for higher velocities and shear stresses in the bankfull section will be used to mimic the current stream conditions.

6. Revegetation

The disturbed areas of Tributary I will be seeded with a seeding plan consisting of two main seed mixes, an Upland Seed Mix and a Riparian Seed Mix.

To further encourage the development of well-established vegetation, soil amendments may be incorporated along Tributary I channel slopes. Depending on growing conditions, a temporary irrigation system may be needed.

Details on the percentage of each grass in each mix, locations, and areas where the different seed mixes are to be applied will be included in the Rock Creek Tributary I Channel and Detention Pond Seeding and Vegetation Management Plan to be submitted and approved by the City prior to construction.

7. MHFD Maintenance Eligibility

The Tributary I improvements and all drainage improvements impacting Tributary I have been designed to meet MHFD maintenance eligibility requirements, as demonstrated by the hydraulic modeling results in Table 7 below. Eligibility requirements are given below as well in Tables 7 and 8.

Table 7: Tributary I Typical Channel Section Hydraulic Results Summary

REACH 1	10% Q100	Q10	Q100
Discharge (cfs)	9.97	21.69	99.68
Total Depth (ft)	0.21	0.24	0.58
Area (sf)	9.76	11.31	30.08
Slope (ft/ft)	0.013	0.013	0.013
Velocity (ft/s)	1.02	1.92	3.31

Wp (wetted perimeter - ft)	50.95	51.61	58.91
Top Width (ft)	50.94	51.59	58.86
Hydraulic Radius (A / Wp)	0.19	0.22	0.51
Shear Stress (lb/sf)	0.16	0.18	0.41

REACH 2 IN, 0.2%	**10% Q100**	**Q10**	**Q100**
Discharge (cfs)	15.00	27.67	150.01
Total Depth (ft)	0.92	1.38	2.14
Area (sf)	9.90	23.44	91.00
Slope (ft/ft)	0.002	0.002	0.002
Velocity (ft/s)	1.52	1.18	1.65
Wp (wetted perimeter - ft)	13.82	51.78	126.70
Top Width (ft)	13.52	51.45	126.35
Hydraulic Radius (A / Wp)	0.72	0.45	0.72
Shear Stress (lb/sf)	0.09	0.06	0.09

REACH 2 IN, 1.3%	**10% Q100**	**Q10**	**Q100**
Discharge (cfs)	15.00	27.67	150.01
Total Depth (ft)	0.66	0.99	1.54
Area (sf)	5.04	11.52	45.89
Slope (ft/ft)	0.013	0.013	0.013
Velocity (ft/s)	2.97	2.40	3.27
Wp (wetted perimeter - ft)	10.44	35.19	90.20
Top Width (ft)	10.28	35.00	90.00
Hydraulic Radius (A / Wp)	0.48	0.33	0.51
Shear Stress (lb/sf)	0.39	0.27	0.41

REACH 2 IN, ARMORED	**10% Q100**	**Q10**	**Q100**
Discharge (cfs)	15.00	27.67	150.01
Total Depth (ft)	1.33	1.37	1.84
Area (sf)	10.81	12.59	44.02
Slope (ft/ft)	0.014	0.014	0.014
Velocity (ft/s)	1.39	2.20	3.41
Wp (wetted perimeter - ft)	43.12	46.64	87.96
Top Width (ft)	42.74	46.26	87.57
Hydraulic Radius (A / Wp)	0.25	0.27	0.50
Shear Stress (lb/sf)	0.22	0.24	0.44

REACH 2 OUT	10% Q100	Q10	Q100
Discharge (cfs)	20.25	34.63	202.46
Total Depth (ft)	0.80	1.22	1.88
Area (sf)	5.92	12.86	56.68
Slope (ft/ft)	0.013	0.013	0.013
Velocity (ft/s)	3.42	2.69	3.57
Wp (wetted perimeter - ft)	10.06	33.49	99.98
Top Width (ft)	9.80	33.16	99.64
Hydraulic Radius (A / Wp)	0.59	0.38	0.57
Shear Stress (lb/sf)	0.48	0.32	0.47

REACH 3	10% Q100	Q10	Q100
Discharge (cfs)	32.34	38.07	323.35
Total Depth (ft)	0.87	0.95	1.89
Area (sf)	8.25	9.31	71.30
Slope (ft/ft)	0.016	0.016	0.016
Velocity (ft/s)	3.92	4.09	4.53
Wp (wetted perimeter - ft)	13.17	13.83	102.93
Top Width (ft)	12.96	13.60	102.67
Hydraulic Radius (A / Wp)	0.63	0.67	0.69
Shear Stress (lb/sf)	0.63	0.67	0.69

Table 8: MHFD Table 8-3: Design Parameters for Naturalized Channels

Design Parameters for Naturalized Channels					
Design Parameter	**MHFD Recommended Value**	**Rock Creek Tributary I Design Value**			**Comment**
Maximum 100-year Depth Outside of Bankfull Channel	5 ft	4.66 ft			Meets Criteria
Roughness Values	Per Table 8-5	Flooding Extents - n = 0.05 overbanks, n = 0.04 channel; Velocity/Shear Stress/Froude - n = 0.03 overbanks, n - 0.035 main channel			Meets Criteria
Maximum 5-year Velocity, Main Channel (Within Bankfull Channel Width) (ft./s)	5 ft/s	**Reach 1**	**Reach 2**	**Reach 3**	Channel is Lined in Reach 2 & 3 to Account for Excess Velocity
		2.98 ft/s (10-YR)	5.05 ft/s (10-YR)	4.8 ft/s (10-YR)	
Maximum 100-year Velocity, Main Channel (Within	7 ft/s	4.34 ft/s	7.69 ft/s	7.60 ft/s	Channel is Lined in Reach 2 & 3 to

Design Parameters for Naturalized Channels					
Bankfull Channel Width) (ft./s)					Account for Excess Velocity
Froude No., 5-year, Main Channel (Within Bankfull Channel Width)	0.7	0.99 (10-YR)	0.94 (10-YR)	0.92 (10-YR)	Channel is lined in Reach 2 & # to Account for Excess Froude #
Froude No., 100-year, Main Channel (Within Bankfull Channel Width)	0.8	1.3	1.14	1.05	Channel is Generally Stable in Existing Condition
Maximum Shear Stress, 100-year, Main Channel (Within Bankfull Channel Width)	1.2 lb/sf	0.78 lb/sf	2.15 lb/sf	1.96 lb/sf	Channel is Lined in Reach 2 & 3 to Account for Excess Shear Stress
Minimum Bankfull Capacity of Bankfull Channel (Based on Future Development Conditions)	70% of 2-year discharge or 10% of 100-yr discharge, whichever is greater (see above)	100% 2-year discharge	100% 2-year discharge	100% 2-year discharge	Does not meet 100-yr criteria, but designed to mimic existing geometry.

Table 9: MHFD Table 8-4: Design Parameters for Naturalized Channels Cont.

Design Parameters for Naturalized Channels					
Minimum Bankfull Channel Geometry	Per Table 8-2	Depth = 0.1', Width = 47', Terrace = 51'	Depth = 1', Width = 9', Terrace = 70'	Depth = 1', Width = 10', Terrace = 70'	Meets Criteria
Minimum Bankfull Channel Width/Depth Ratio (Equation 8-3)	9	470.0	9.3	12.5	Meets Criteria
Minimum Entrenchment Ratio (Equation 8-4)	3	3.2	16.7	15.0	Meets Criteria
Maximum Longitudinal Slope of Low Flow Channel (Assuming	0.2 percent	1.68%	2.07%	1.59%	Low Flow Channel is Lined and Vegetated

Unlined, Unvegetated Low Flow Channel)					
Bankfull Channel Sinuosity (Equation 8-5)	1.1 to 1.3	1.02	1.04	1.05	Designed to Match Existing Channel Sinuosity
Maximum Overbank Side Slope	4(H):1(V)	10(H):1(V)	33(H):1(V)	33(H):1(V)	Meets Criteria
Maximum Bankfull Side Slope	2.5(H):1(V)	100(H):1(V)	3(H):1(V)	4(H):1(V)	Meets Criteria
Minimum Radius of Curvature	2.5 times top width, Reach 1 = 100', Reach 2 = 22.5', Reach 3 = 25'	161' = 3.4x	65' = 7.2x	65' = 6.5x	Meets Criteria

- Manning's n=0.032 When Assessing Velocity, Froude No., Shear Stress
- Manning's n=0.050 When Assessing Water Surface Elevation and Water Depth

8. Culverts

Several culverts are proposed with the Project and the culvert calculating program HY-8 was used to analyze these culverts. In HY-8 the tailwater was determined through a normal depth calculation based on downstream channel geometry inputs.

Two culverts have been designed for crossing the proposed Campus Drive at Tributary I reach stations 30+00 and 7+00.

Both crossings are composed of a dual box system which includes one lower structure solely for flow conveyance and another raised structure which doubles as a trail underpass for vehicle and pedestrian access during storms up to the 10-year event. The lower RCBC will have a span of 8' with a rise of 5' and the raised trail underpass RCBC will have a span of 10' and rise of 8'.

A culvert is proposed to cross under S. 96th Street on the downstream end of Tributary I project extents. The culvert is proposed as a dual barrel RCBC running approximately 80' long with geometry of 7' (span) x 5' (rise). This culvert does not include a trail underpass.

G. Site Phasing

The overall Site storm sewer and detention pond improvement phasing is broken out by Phase below:

Redtail Ridge Subdivision Phase 1 – Parcels B, C, and F

- Campus Drive storm sewer in its entirety
- Rockcress Drive storm sewer built from Via Varra to Sorrel Avenue
- Sorrel Avenue storm sewer
- Pond C-1, Pond C-2, and Pond B
- Rock Creek Tributary I in its entirety

Redtail Ridge Subdivision Phase 2 – Parcels A, D, and E

- West extension of Rockcress Drive and the entirely of the associated storm sewer.

H. Construction Best Management Practices (BMP) Plan

Erosion and Sediment Control Measures Discussion

All areas considered for development and any disturbed areas will be included in the Stormwater Management Plan (SWMP) design. The proposed grading design for this Site will consist of both cut and fill. The predominant Construction BMP (CBMP) control measure will be several sedimentation basins located throughout the Project area to be installed as the Project phasing occurs. These basins have been sized to account for sediment yield from the basins adjacent to that area.

Initial SWMP ~ Utilizes a combination of the following:

- Stabilized staging area (SSA)
- Construction Entrance and Vehicle Tracking Control (CE) (VTC)
- Concrete Washout Area (CWA)
- Silt fence (SF) installation on the downstream portions of the Site
- Inlet protection (IP) for the existing storm drain system located adjacent to the Site
- Check Dam (CD) for open channels
- Temporary Stream Crossing (SC)
- Temporary Sediment Basin (TSB)
- Sediment Control Log (SCL)
- Project phasing to minimize the amount of open acreage.

Interim SWMP ~ Within phasing limits utilizes a combination of the following:

- Stabilized staging area (SSA)
- Construction Entrance and Vehicle Tracking Control (CE) (VTC)

- Concrete Washout Area (CWA)
- Surface roughening (SR)
- Temporary Stream Crossing (SC)
- Inlet protection (IP) for the existing storm drain system located adjacent to the Site
- Sediment Control Log (SCL)
- Silt fence (SF) installation on the downstream portions of the Site
- Maintenance of the previously installed measures

Interim SWMP ~ Utilizes a combination of sediment control measures, after the storm system has been installed, of the following:

- On-site Inlet Protection (IP)
- Check Dams within swales (CD)
- Additional Silt Fencing (SF)
- Surface roughening (SR)
- Outlet Protection (OP) for newly installed storm drain system
- Sediment Control Log (SCL)
- Maintenance of all new and previously installed measures.

Final SWMP ~ Utilizes a combination of sediment control measures, after the storm system has been installed, of the following:

- On-site Inlet Protection (IP) to remain until all disturbed areas have been re-established with 80% vegetation.
- Outlet Protection (OP)
- Erosion Control Blanket (ECB) on slopes greater than 4:1
- Seeding, Mulching, and Crimping (SMC)
- Surface Roughening (SF)
- Temporary Irrigation (TI)
- Silt Fence (SF) to remain until all disturbed areas have been re-established with 80% vegetation.
- Maintenance of all installed measures.
- Upon acceptance by the City, all temporary measures are to be removed and any disturbance caused by these removals shall be brought into compliance to achieve restoration of the area.

I. Project Schedule

The start of the project schedule is determined on the approval of the project Grading, Erosion and Sediment Control plan and supportive construction documents. At the time of approval, it is anticipated that the Initial SWMP measures will be implemented within one week. The timeline of events is determined by the date of issuance of the Grading

Permit. A pre-construction meeting will be necessary to adequately establish the final phasing areas and implementation of the SWMP measures. At the pre-construction meeting the final schedule will be determined. It is anticipated that the grading operations for the entire disturbed area will take approximately six months, weather permitting.

J. BMP Maintenance

The General Contractor will designate an on-site SWMP Manager at the time of permit issuance. The Contractor's SWMP Manager will be the responsible party for ensuring that the Site remains in compliance with the SWMP and will be the Contractor's contact person with the permitting agency for all matters pertaining to the permit. Paved areas, including streets, will be kept clean throughout build-out and will be cleaned at first notice of accidental tracking. At a minimum, the SWMP Manager will inspect all BMP's weekly and after runoff events. All necessary maintenance and repair activities will be performed within 24-hours or as directed by the permitting agency.

V. CONCLUSIONS

A. Compliance with Standards

Drainage design for the Site was performed in accordance with Louisville and MHFD Criteria. The District Manual was used for the design of the Site only when instructed to by Louisville Criteria. The control measures identified in this report are in compliance with part I.E.4.a.iv of the CDPHE Municipal Storm Sewer Systems General permit.

It is the intent of this Final Master Drainage Report to act as the master report for the entire Site. Future Development's preliminary plats, final plats, and individual Site Plans shall be required to submit their own Preliminary and Final Drainage Reports, as applicable, with subsequent development applications.

B. Drainage Concept

The proposed drainage design for the Site will effectively control and minimize any damage from storm runoff associated with the design storms. As stated, runoff will be routed through proposed curb and gutter within roadways, to proposed storm sewer inlets and pipes, and then to one of six Full Spectrum Detention Facilities. All these systems will be adequately sized for the flows associated with the Site and off-site discharges will be managed in a manner which causes no negative effects downstream.

VI. REFERENCES

1. *Boulder Valley School District Louisville Campus PUD Drainage Report*, Charles Keim & Associates, May 31, 1996
2. *City of Louisville/Bounder County Outfall System Plan*, Water Resources Consultants, INC. November 1982
3. *Executive Summary of Previous Investigations, Former ConocoPhillips Site (Storage Tek Campus),* CTL|Thompson, April 19, 2019.
4. *Flood Insurance Rate Map*, Boulder County, Colorado, Map #08013C0584J, FEMA, revised December 18, 2012.
5. Storm Drainage Design & Technical Criteria Manual, City of Louisville, August 2013
6. *Phase I Environmental Site Assessment Former Conoco Phillips Site*, CTL|Thompson, February 25, 2019.
7. MHFD / Urban Storm Drainage Criteria Manual, Volumes 1, 2, and 3 by Urban Drainage and Flood Control District, Current Version.

APPENDIX A – Vicinity Map, FIRM Map, and NRCS Web Soil Survey

Louisville Drainage Report Submittal Checklist
Vicinity Map
FIRM
NRCS WSS

CITY OF LOUISVILLE
DRAINAGE REPORT SUBMITTAL CHECKLIST

PREPARED BY: Mark A. West DATE: 2024-02-07

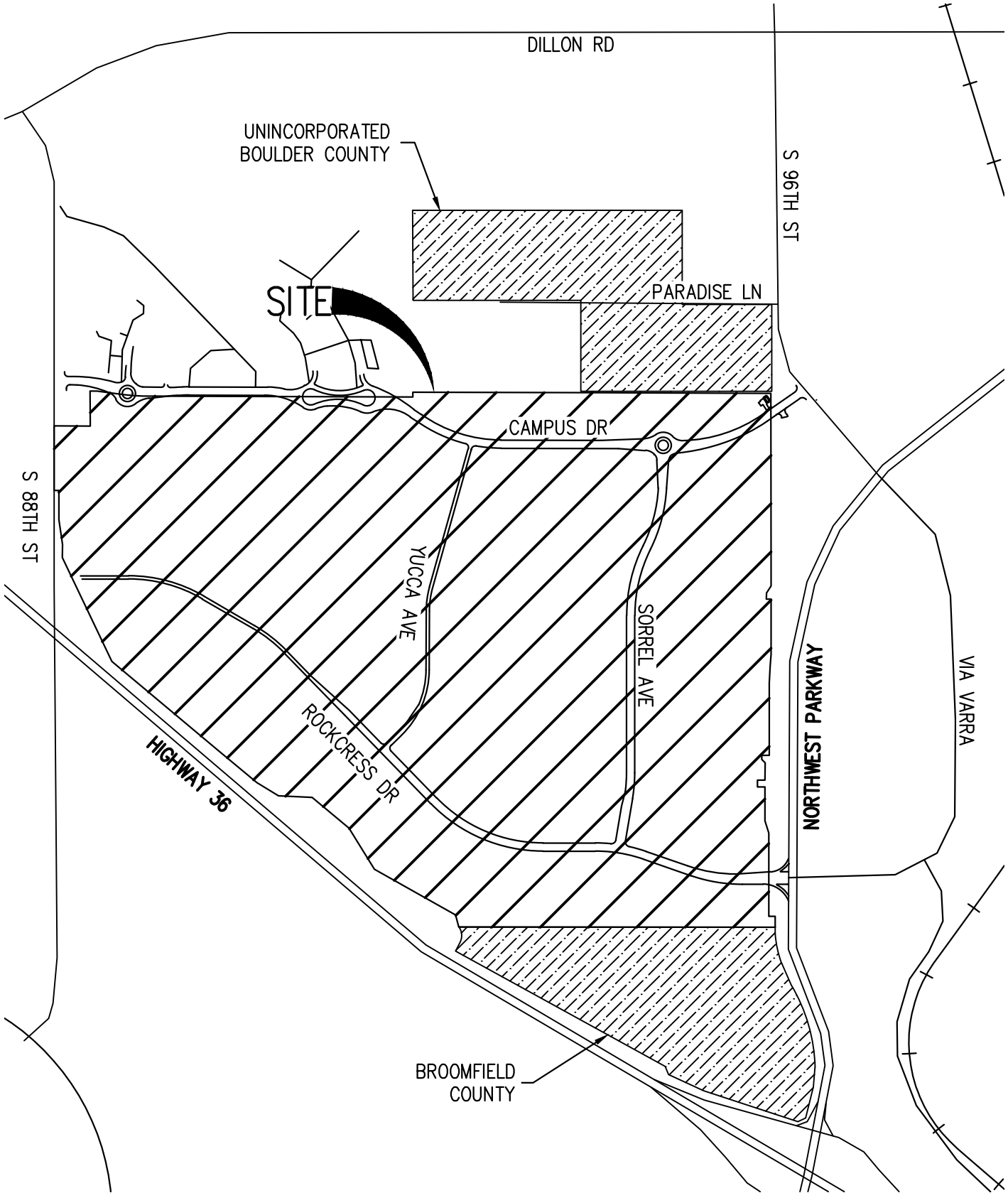
The drainage report for the development as noted below has been received and found to lack the information noted. This information must be submitted before the report will be accepted for review. Please provide the required information.

DEVELOPMENT: Redtail Ridge
LOCATION: S OF CAMPUS DR, W OF 96TH, N OF HWY 36
DATE SUBMITTED: 2024-02-07
SUBMITTED BY: FIRM Harris Kocher Smith
CONTACT Mark A. West
PHONE 303-623-6300 FAX

☐ Preliminary Report ☒ Final Report

CHECKLIST

ITEM	DESCRIPTION	RECEIVED OR NOT APPLICABLE	TO BE SUBMITTED
1.	Typed, Bound Report with Cover Letter	X (ALL)	
2.	Professional Engineer's Certificate		
3.	General Location and Description		
	(a) Location Map		
	(b) Existing Site Description		
	(c) Description of Existing Drainage Patterns and Facilities		
4.	Drainage Basins and Sub-Basins		
	(a) Major Basin Description		
	(b) Sub-Basin Description		
5.	Design Criteria		
	(a) Discussion of Basinwide Planning Studies		
	(b) Hydrologic Criteria Discussion		
	(c) Hydraulic Criteria Discussion		
	(d) Hydrologic/Hydraulic Computations		
6.	Drainage Facility Design		
	(a) Discussion of proposed Facilities		
	(b) Discussion of Drainage Patterns		
	(c) Impact on Offsite Facilities		
	(d) Impact on Master Plan		
7.	Drainage Plan		
	(a) Topographic Contours		
	(b) ROW and Easements		
	(c) Delineation of Basin and Sub-Basins		
	(d) Existing Drainage Patterns and Facilities		
	(e) Proposed Drainage Patterns and Facilities		
	(f) Proposed Outfall Points		
	(g) Routing of Offsite Drainage		
8.	Other As Stated:		



Plotted: MON 06/08/20 3:04:34P By: Michael Walton Filepath: p:\190108\engineering\xref\vic map.dwg Layout: layout1

NO CHANGES ARE TO BE MADE TO THIS DRAWING WITHOUT WRITTEN PERMISSION OF HARRIS KOCHER SMITH.

ISSUE DATE: 06-06-2019	PROJECT #: 190108
DATE	REVISION COMMENTS

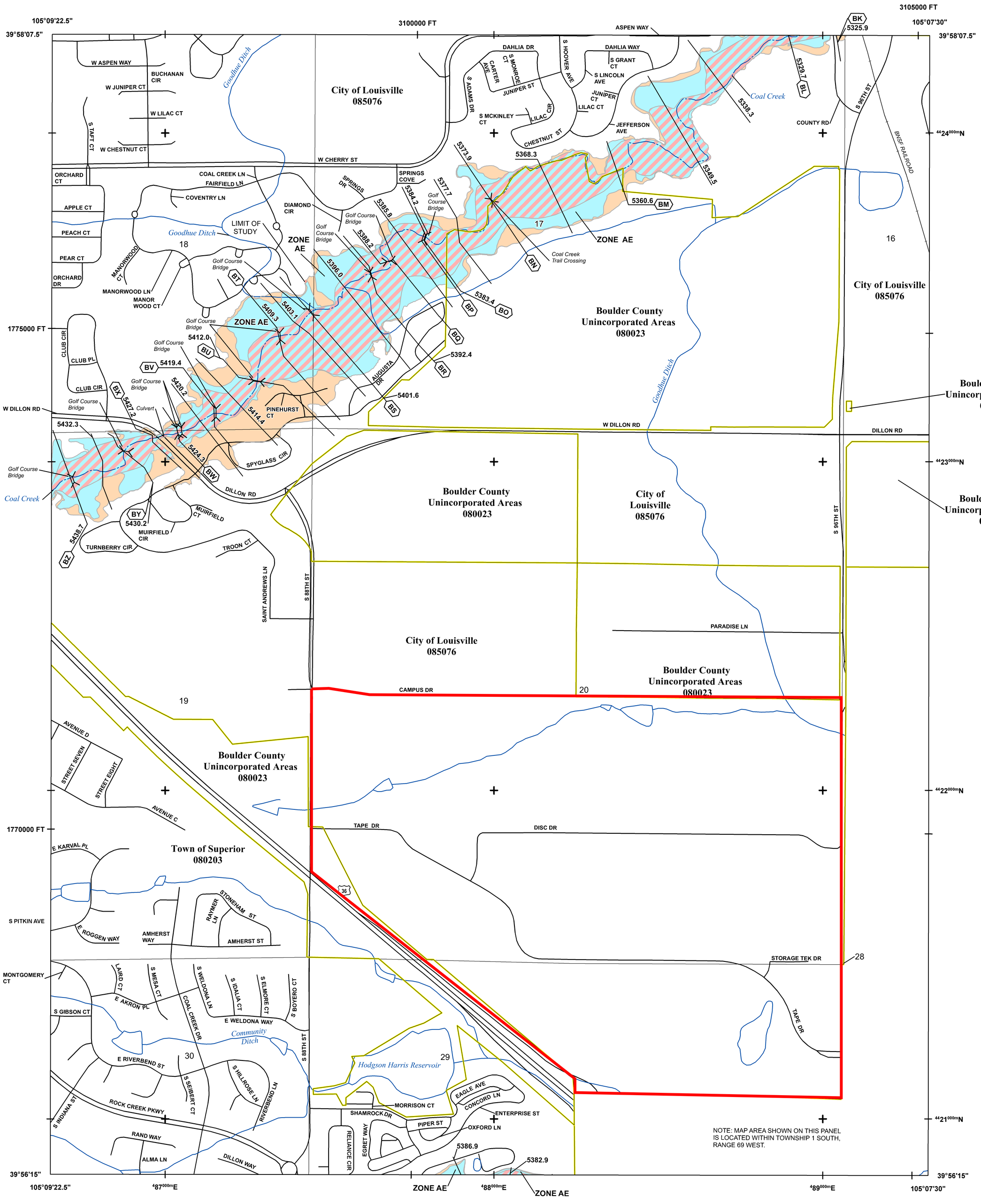
BRUE BAUKOL PARTNERS

REDTAIL RIDGE
VICINITY MAP

HARRIS KOCHER SMITH
1120 Lincoln Street, Suite 1000
Denver, Colorado 80203
P: 303.623.6300 F: 303.623.6311
HarrisKocherSmith.com

DSN'D BY: TJS
CHK'D BY: TJS
DRAWN BY: SJA

SHEET NO.
1
1 OF 1



FLOOD HAZARD INFORMATION

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

THE INFORMATION DEPICTED ON THIS MAP AND SUPPORTING DOCUMENTATION ARE ALSO AVAILABLE IN DIGITAL FORMAT AT

HTTPS://MSC.FEMA.GOV

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A,V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN — Area of Minimal Flood Hazard *Zone X*
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- E 18.2 / 17.5 — Cross Sections with 1% Annual Chance Water Surface Elevation
- 8 — Coastal Transect
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature
- 513 — Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary

NOTES TO USERS

For information and questions about this Flood Insurance Rate Map (FIRM), available products associated with this FIRM, including historic versions, the current map date for each FIRM panel, how to order products, or the National Flood Insurance Program (NFIP) in general, please call the FEMA Map Information eXchange at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA Flood Map Service Center website at https://msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the website.

Communities annexing land on adjacent FIRM panels must obtain a current copy of the adjacent panel as well as the current FIRM Index. These may be ordered directly from the Flood Map Service Center at the number listed above.

For community and countywide map dates refer to 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.

Base map information shown on the FIRM was provided by the FEMA Map Service Center, the Bureau of Land Management and Boulder County.

SCALE

N

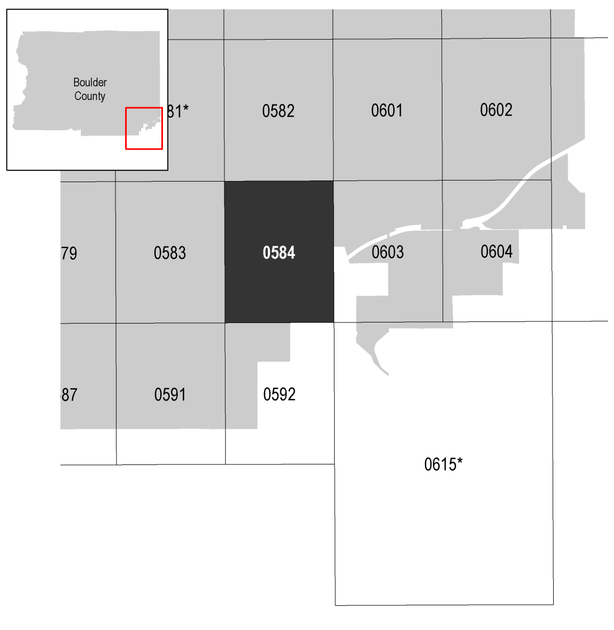
Map Projection:
Universal Transverse Mercator Zone 13 North, Meters;
North American Datum 1983; Vertical Datum: NAVD 88

1 inch = 500 feet 1:6,000

0 250 500 750 1,000 2,000 feet

0 125 250 500 meters

PANEL LOCATOR



*PANEL NOT PRINTED

FEMA National Flood Insurance Program

NATIONAL FLOOD INSURANCE PROGRAM

FLOOD INSURANCE RATE MAP

BOULDER COUNTY, COLORADO
and Incorporated Areas

PANEL 584 OF 615

Panel Contains:

COMMUNITY	NUMBER	PANEL	SUFFIX
BOULDER COUNTY	080023	0584	K
LOUISVILLE, CITY OF	085076	0584	K
SUPERIOR, TOWN OF	080203	0584	K

Notice: This map was reissued on 8/26/2019 to make a correction. This version replaces any previous versions. See the Notice-to-User Letter that accompanied this correction for details.

VERSION NUMBER
2.3.3.0

MAP NUMBER
08013C0584K

MAP REVISED
AUGUST 15, 2019

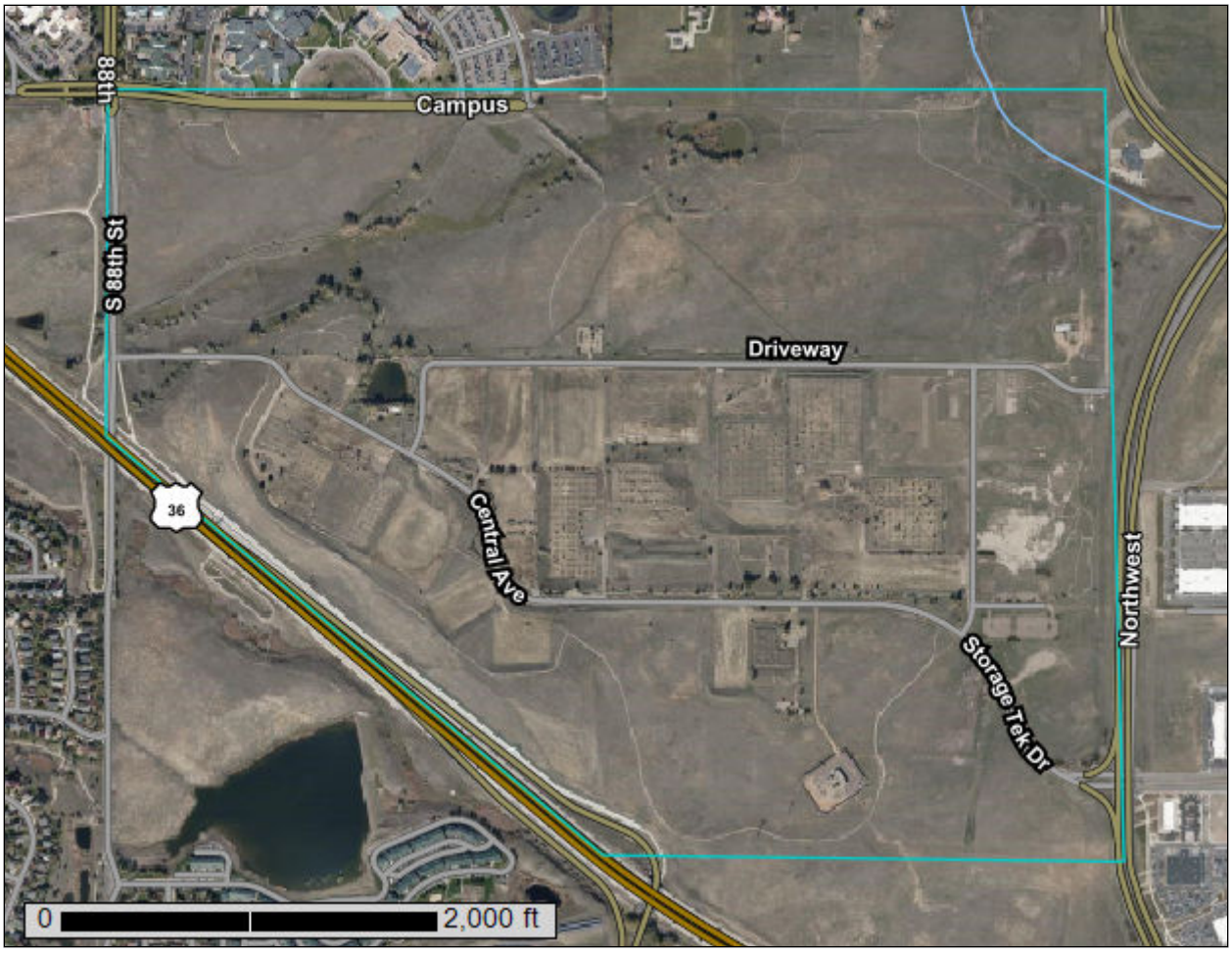
United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Boulder County Area, Colorado



January 6, 2020

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

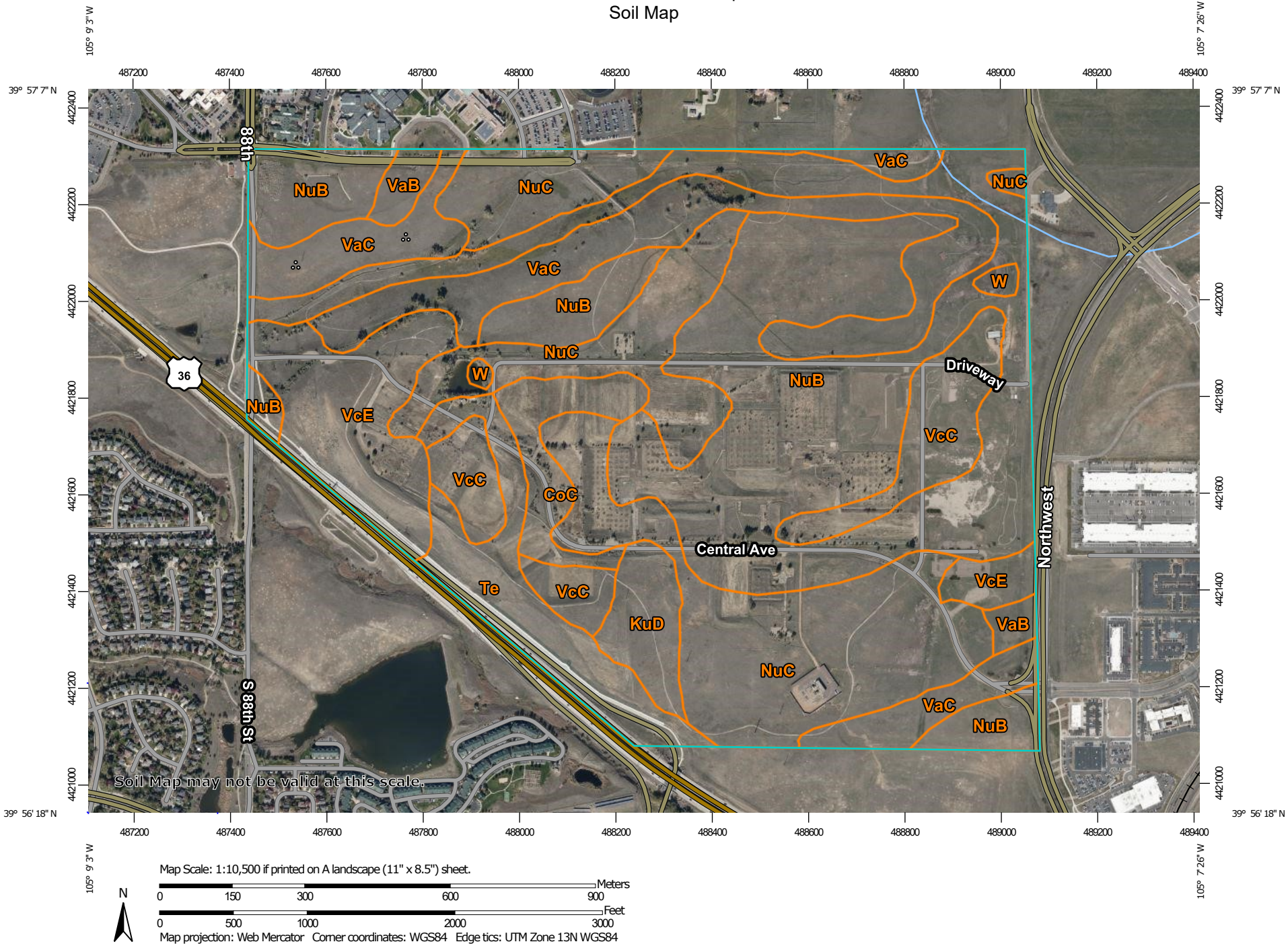
After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map



MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Boulder County Area, Colorado
Survey Area Data: Version 16, Sep 13, 2019

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Sep 25, 2018—Apr 9, 2019

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
CoC	Colby silty clay loam, 3 to 5 percent slopes	12.7	2.9%
KuD	Kutch clay loam, 3 to 9 percent slopes	10.6	2.4%
NuB	Nunn clay loam, 1 to 3 percent slopes	154.9	35.8%
NuC	Nunn clay loam, 3 to 5 percent slopes	97.4	22.5%
Te	Terrace escarpments	25.3	5.8%
VaB	Valmont clay loam, 1 to 3 percent slopes	5.7	1.3%
VaC	Valmont clay loam, 3 to 5 percent slopes	62.6	14.5%
VcC	Valmont cobbly clay loam, 1 to 5 percent slopes	27.7	6.4%
VcE	Valmont cobbly clay loam, 5 to 25 percent slopes	34.3	7.9%
W	Water	1.7	0.4%
Totals for Area of Interest		**432.9**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They

generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Boulder County Area, Colorado

CoC—Colby silty clay loam, 3 to 5 percent slopes

Map Unit Setting

National map unit symbol: jprf
Elevation: 4,900 to 5,500 feet
Mean annual precipitation: 14 to 18 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 140 to 155 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Colby and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Colby

Setting

Landform: Upland slopes
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Uniform eolian deposits

Typical profile

H1 - 0 to 12 inches: silty clay loam
H2 - 12 to 43 inches: silty clay loam
H3 - 43 to 60 inches: clay loam

Properties and qualities

Slope: 3 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent
Available water storage in profile: High (about 11.4 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: C
Ecological site: Loamy Plains (R067BY002CO)
Hydric soil rating: No

Minor Components

Gaynor

Percent of map unit: 5 percent
Hydric soil rating: No

Weld

Percent of map unit: 5 percent
Hydric soil rating: No

KuD—Kutch clay loam, 3 to 9 percent slopes

Map Unit Setting

National map unit symbol: jprx
Elevation: 4,900 to 5,500 feet
Mean annual precipitation: 12 to 18 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 140 to 155 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Kutch and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kutch

Setting

Landform: Valley sides
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Clayey residuum weathered from sedimentary rock

Typical profile

H1 - 0 to 7 inches: clay loam
H2 - 7 to 22 inches: clay
H3 - 22 to 30 inches: clay
H4 - 30 to 34 inches: unweathered bedrock

Properties and qualities

Slope: 3 to 9 percent
Depth to restrictive feature: 20 to 40 inches to paralithic bedrock
Natural drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Available water storage in profile: Low (about 4.8 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 4e

Hydrologic Soil Group: D
Ecological site: Clayey Foothill (R049BY208CO)
Hydric soil rating: No

Minor Components

Renohill
Percent of map unit: 6 percent
Hydric soil rating: No

Nunn
Percent of map unit: 5 percent
Hydric soil rating: No

Samsil
Percent of map unit: 2 percent
Hydric soil rating: No

Shingle
Percent of map unit: 2 percent
Hydric soil rating: No

NuB—Nunn clay loam, 1 to 3 percent slopes

Map Unit Setting
National map unit symbol: 2tlpl
Elevation: 3,900 to 5,840 feet
Mean annual precipitation: 13 to 17 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 135 to 160 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition
Nunn and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Nunn

Setting
Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Pleistocene aged alluvium and/or eolian deposits

Typical profile
Ap - 0 to 9 inches: clay loam
Bt - 9 to 13 inches: clay loam
Btk - 13 to 25 inches: clay loam
Bk1 - 25 to 38 inches: clay loam
Bk2 - 38 to 80 inches: clay loam

Properties and qualities

Slope: 1 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 7 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.1 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 0.5
Available water storage in profile: High (about 9.9 inches)

Interpretive groups

Land capability classification (irrigated): 2e
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C
Ecological site: Clayey Plains (R067BY042CO)
Hydric soil rating: No

Minor Components

Heldt

Percent of map unit: 10 percent
Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: Clayey Plains (R067BY042CO)
Hydric soil rating: No

Satanta

Percent of map unit: 5 percent
Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: Loamy Plains (R067BY002CO)
Hydric soil rating: No

NuC—Nunn clay loam, 3 to 5 percent slopes

Map Unit Setting

National map unit symbol: 2tlpm
Elevation: 5,000 to 5,750 feet
Mean annual precipitation: 12 to 17 inches
Mean annual air temperature: 46 to 54 degrees F

Frost-free period: 100 to 160 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Nunn and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Nunn

Setting

Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Pleistocene aged alluvium and/or eolian deposits

Typical profile

A - 0 to 6 inches: clay loam
Bt - 6 to 18 inches: clay
Btk - 18 to 30 inches: clay
Bk - 30 to 47 inches: clay loam
BCk - 47 to 80 inches: clay loam

Properties and qualities

Slope: 3 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 7 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.1 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 0.5
Available water storage in profile: High (about 9.6 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C
Ecological site: Clayey Plains (R067BY042CO)
Hydric soil rating: No

Minor Components

Satanta

Percent of map unit: 10 percent
Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: Loamy Plains (R067BY002CO)
Hydric soil rating: No

Te—Terrace escarpments

Map Unit Setting

National map unit symbol: jpsv
Elevation: 4,400 to 5,500 feet
Mean annual precipitation: 10 to 16 inches
Mean annual air temperature: 46 to 54 degrees F
Frost-free period: 120 to 160 days
Farmland classification: Not prime farmland

Map Unit Composition

Terrace escarpments: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Terrace Escarpments

Setting

Landform: Paleoterraces, fan remnants
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Base slope, riser
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Cobbly and stony colluvium over sandstone and shale

Typical profile

H1 - 0 to 6 inches: gravelly sand
H2 - 6 to 60 inches: gravelly sand, very gravelly sand, gravelly coarse sand
H2 - 6 to 60 inches:
H2 - 6 to 60 inches:

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: A
Hydric soil rating: No

VaB—Valmont clay loam, 1 to 3 percent slopes

Map Unit Setting

National map unit symbol: jpsw
Elevation: 4,900 to 5,500 feet
Mean annual precipitation: 12 to 18 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 140 to 155 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Valmont and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Valmont

Setting

Landform: Terraces, fan remnants
Landform position (three-dimensional): Base slope, tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Gravelly and cobbly loamy alluvium

Typical profile

H1 - 0 to 9 inches: clay loam
H2 - 9 to 29 inches: clay loam, clay
H2 - 9 to 29 inches: very gravelly loam, very gravelly sandy loam
H3 - 29 to 60 inches:
H3 - 29 to 60 inches:

Properties and qualities

Slope: 1 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Very high (about 12.4 inches)

Interpretive groups

Land capability classification (irrigated): 2e
Land capability classification (nonirrigated): 3s
Hydrologic Soil Group: C
Ecological site: Clayey Foothill (R049BY208CO)
Hydric soil rating: No

Minor Components

Nunn

Percent of map unit: 8 percent
Hydric soil rating: No

Fluventic haplaquolls

Percent of map unit: 4 percent
Landform: Terraces
Hydric soil rating: Yes

Heldt

Percent of map unit: 3 percent
Hydric soil rating: No

VaC—Valmont clay loam, 3 to 5 percent slopes

Map Unit Setting

National map unit symbol: jpsx
Elevation: 4,900 to 5,500 feet
Mean annual precipitation: 12 to 18 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 140 to 155 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Valmont and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Valmont

Setting

Landform: Terraces, fan remnants
Landform position (three-dimensional): Base slope, tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Gravelly and cobbly loamy alluvium

Typical profile

H1 - 0 to 7 inches: clay loam
H2 - 7 to 24 inches: clay loam, clay
H2 - 7 to 24 inches: very gravelly loam, very gravelly sandy loam
H3 - 24 to 60 inches:
H3 - 24 to 60 inches:

Properties and qualities

Slope: 3 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 11.8 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C

Ecological site: Clayey Foothill (R049BY208CO)
Hydric soil rating: No

Minor Components

Nunn
Percent of map unit: 8 percent
Hydric soil rating: No

Heldt
Percent of map unit: 5 percent
Hydric soil rating: No

Fluventic haplaquolls
Percent of map unit: 2 percent
Landform: Flood plains
Hydric soil rating: Yes

VcC—Valmont cobbly clay loam, 1 to 5 percent slopes

Map Unit Setting
National map unit symbol: jpsy
Elevation: 4,900 to 5,500 feet
Mean annual precipitation: 12 to 18 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 140 to 155 days
Farmland classification: Not prime farmland

Map Unit Composition
Valmont and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Valmont

Setting
Landform: Terraces, fan remnants
Landform position (three-dimensional): Base slope, tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Gravelly and cobbly loamy alluvium

Typical profile
H1 - 0 to 8 inches: cobbly clay loam
H2 - 8 to 22 inches: clay loam, clay
H2 - 8 to 22 inches: very gravelly loam, very gravelly sandy loam
H3 - 22 to 60 inches:
H3 - 22 to 60 inches:

Properties and qualities
Slope: 1 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained

Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 11.0 inches)

Interpretive groups
Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C
Ecological site: Cobbly Foothills (R048AY346CO)
Hydric soil rating: No

VcE—Valmont cobbly clay loam, 5 to 25 percent slopes

Map Unit Setting
National map unit symbol: jpsz
Elevation: 4,900 to 5,500 feet
Mean annual precipitation: 12 to 18 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 140 to 155 days
Farmland classification: Not prime farmland

Map Unit Composition
Valmont and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Valmont

Setting
Landform: Terraces, fan remnants
Landform position (three-dimensional): Base slope, riser
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Gravelly and cobbly loamy alluvium

Typical profile
H1 - 0 to 6 inches: cobbly clay loam
H2 - 6 to 18 inches: clay loam, clay
H2 - 6 to 18 inches: very gravelly loam, very gravelly sandy loam
H3 - 18 to 60 inches:
H3 - 18 to 60 inches:

Properties and qualities
Slope: 5 to 10 percent
Depth to restrictive feature: More than 80 inches

Natural drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 10.6 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: C
Ecological site: Cobbly Foothills (R048AY346CO)
Hydric soil rating: No

Minor Components

Dacono

Percent of map unit: 9 percent
Hydric soil rating: No

Fluventic haplaquolls

Percent of map unit: 1 percent
Landform: Flood plains
Hydric soil rating: Yes

W—Water

Map Unit Composition

Water: 95 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Minor Components

Aquolls

Percent of map unit: 5 percent
Landform: Marshes
Hydric soil rating: Yes

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APPENDIX B – Reference Material and Supporting Documents

CTL Geotechnical Bedrock and Groundwater Figures
Phillips 66 Site Wetlands Delineation Memo
Phillips 66 Site PNC
ACOE Email
Louisville and Boulder County Outfall Systems Plan Excerpts
Boulder Valley School District Louisville Campus PUD Drainage Report Excerpts
Drexel, Barrell, & Co. 48” RCP Plans
Drexel, Barrell, & Co. FDP for Parkway Circle BYOT

TH–1
TH–2
TH–3
TH–4
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TH–10
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Qca
Qp
Af
Qls
Kl

US 36–DENVER–BOULDER TURNPIKE

STORAGE TEK DR.

0 250 500
SCALE: 1" = 500'

LEGEND:

TH–1 — INDICATES APPROXIMATE LOCATION OF EXPLORATORY BORING

5365 — INDICATES EXISTING GROUND SURFACE ELEVATION (FEET)

Af — LARGER DEPOSITS OF MAN–PLACED FILL, LIKELY PLACED DURING DEVELOPMENT OF SITE; ALSO POND EMBANKMENTS.

UNSTABLE AND POTENTIALLY UNSTABLE SLOPES; INCLUDES POSSIBLE LANDSLIDES. GENERALLY CLASSIFIED DUE TO STEEPNESS OF ABOUT 25 PERCENT OR MORE.

Qls — POSSIBLE OLD, RELICT LANDSLIDES, MAY CONTAIN SEASONAL SEEPS.

Qp — PINEY CREEK AND YOUNGER ALLUVIUM DEPOSITS OF SAND AND CLAY.

Qca — COLLUVIUM (SLOPEWASH, WIND AND GRAVITY DEPOSITS) GENERALLY OVERLYING OLDER ALLUVIUAL SAND WITH GRAVEL.

Kl — CRETACEOUS–AGE LARAMIE FORMATION; CLAYSTONE AND FINE–GRAINED SANDSTONE.

CONTACT BETWEEN GEOLOGIC UNITS, APPROXIMATELY SHOWN.

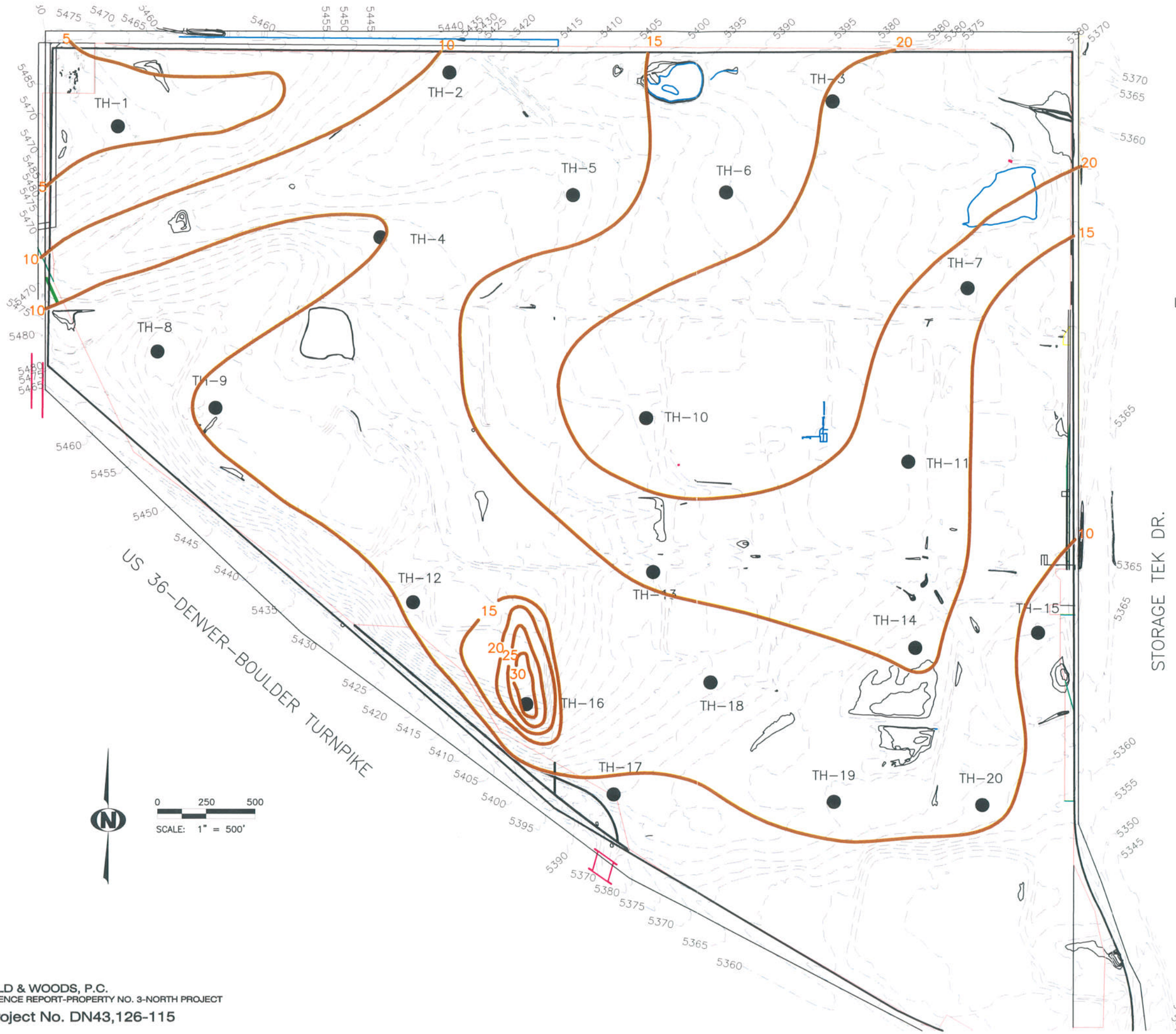
APPROXIMATE LOCATION OF ANCIENT, INACTIVE FAULT TRACE

Geologic Map

FAIRFIELD & WOODS, P.C.
DUE DILIGENCE REPORT-PROPERTY NO. 3-NORTH PROJECT
CTL Project No. DN43,126-115

Fig. 4-2

S:\PROJECTS\DN43126-115\2. Reports\R1\DN43126-115-R1-D1.dwg, FIG. 4-2, 11/9/2007 9:02:04 AM



LEGEND:

TH-1 — INDICATES APPROXIMATE LOCATION OF EXPLORATORY BORING

5365 — INDICATES EXISTING GROUND SURFACE ELEVATION (FEET)

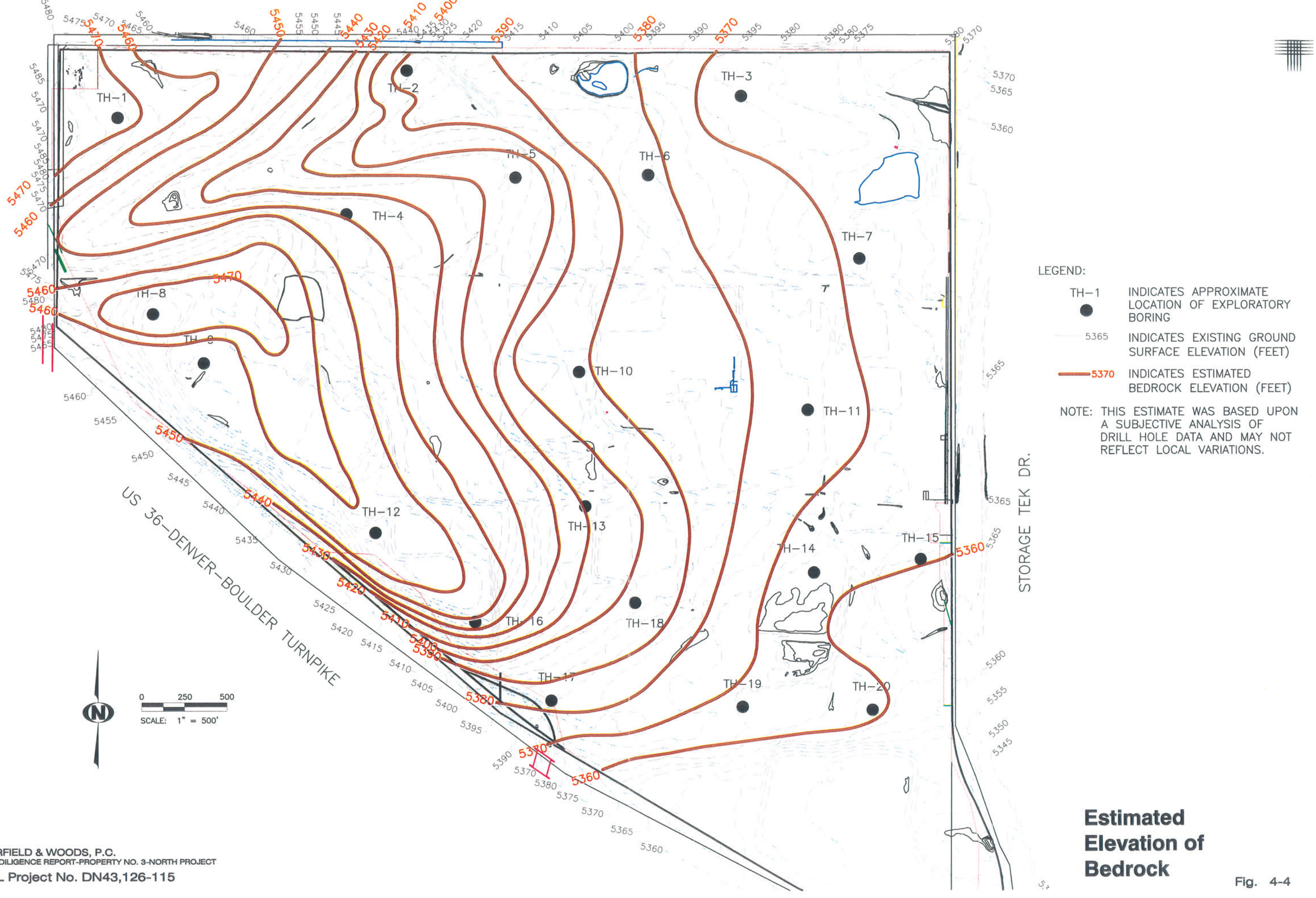
10 — INDICATES ESTIMATED DEPTH TO BEDROCK (FEET)

NOTE: THIS ESTIMATE WAS BASED UPON A SUBJECTIVE ANALYSIS OF DRILL HOLE DATA AND MAY NOT REFLECT LOCAL VARIATIONS.

FAIRFIELD & WOODS, P.C.
DUE DILIGENCE REPORT-PROPERTY NO. 3-NORTH PROJECT
CTL Project No. DN43,126-115

Estimated Depth to Bedrock

Fig. 4-3



FAIRFIELD & WOODS, P.C.
DUE DILIGENCE REPORT-PROPERTY NO. 3-NORTH PROJECT
CTL Project No. DN43,126-115

Estimated Elevation of Bedrock

Fig. 4-4

S:\PROJECTS\DN431 115\2. Reports\R1\DN43126-115-R1-D1.dwg, FIG. 4-4, 11/9/2007 6:52:29 AM

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TH–19
TH–20

US 36–DENVER–BOULDER TURNPIKE

STORAGE TEK DR.

LEGEND:

TH–1 — INDICATES APPROXIMATE LOCATION OF EXPLORATORY BORING

5365 — INDICATES EXISTING GROUND SURFACE ELEVATION (FEET)

20 — INDICATES ESTIMATED DEPTH TO GROUND WATER (FEET)

NOTE: THIS ESTIMATE WAS BASED UPON A SUBJECTIVE ANALYSIS OF DRILL HOLE DATA AND MAY NOT REFLECT LOCAL VARIATIONS AND SEASONAL FLUCTUATIONS.

APPROXIMATE AREA OF SHALLOW GROUND WATER (LESS THAN 10')

N

0 250 500

SCALE: 1" = 500'

FAIRFIELD & WOODS, P.C.
DUE DILIGENCE REPORT-PROPERTY NO. 3-NORTH PROJECT
CTL Project No. DN43,126-115

Estimated Depth to Ground Water

Fig. 4-5

S:\PROJECTS\DN4312 :15\2. Reports\R1\DN43126-115-R1-D1.dwg, FIG. 4-5, 11/9/2007 6:52:38 AM

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TH-19
TH-20

US 36-DENVER-BOULDER TURNPIKE

STORAGE TEK DR.

LEGEND:

TH-1 — INDICATES APPROXIMATE LOCATION OF EXPLORATORY BORING

5365 — INDICATES EXISTING GROUND SURFACE ELEVATION (FEET)

5350 — INDICATES ESTIMATED DEPTH TO GROUND WATER (FEET)

NOTE: THIS ESTIMATE WAS BASED UPON A SUBJECTIVE ANALYSIS OF DRILL HOLE DATA AND MAY NOT REFLECT LOCAL VARIATIONS AND SEASONAL FLUCTUATIONS.

0 250 500
SCALE: 1" = 500'

FAIRFIELD & WOODS, P.C.
DUE DILIGENCE REPORT-PROPERTY NO. 3-NORTH PROJECT
CTL Project No. DN43,126-115

Estimated Elevation of Ground Water

Fig. 4-6

S:\PROJECTS\DN4312\ 152. Reports\R1\DN43126-115-R1-D1.dwg, FIG. 4-6, 11/9/2007 6:52:45 AM

ERO Resources Corp.

September 23, 2019

To: Mrs. Jordan Swisher, Brue Baukol Capital Partners

From: Heidi Gerstung, ERO Resources Corporation

Re: Phillips 66 Site – Delineation of the Goodhue Ditch and Rock Creek

Background

Brue Baukol Capital Partners retained ERO Resources Corporation (ERO) to conduct a wetland delineation along the Goodhue Ditch and Rock Creek within portions of the Phillips 66 Site (property) in Boulder and Broomfield Counties, Colorado (project area; Figure 1). ERO reviewed the entirety of the property on January 17 and 21, 2019 to determine if any areas within the property had characteristics of a water of the U.S. (WUS) and had a defined surface connection to the South Platte River, the closest traditionally navigable water. An approved Jurisdictional Determination was subsequently completed for the property, and the U.S. Army Corps of Engineers (Corps) determined that portions of the property (the Goodhue Ditch and its abutting wetlands and Rock Creek and its abutting wetlands) were jurisdictional (Corps File No. NWO-2019-00148-DEN, attached).

On August 23, 2019, Heidi Gerstung and Anna Wistrom with ERO surveyed the project area for wetlands, streambeds, and open water (2019 site visit).

The natural resources and associated regulations described in this memo are valid as of the date of this memo and may be relied upon for the specific use for which it was prepared by ERO under contract to Brue Baukol Capital Partners. Because of their dynamic natures, site conditions and regulations should be reconfirmed by a qualified consultant before relying on this memo for a use other than that for which ERO was contracted. ERO assumes the landowner or municipality is responsible for obtaining all federal, state, and local permits for construction of the project.

General Description of Project Area

Project Location

The project area is along the Goodhue Ditch and Rock Creek within the Phillips 66 Site (property) located northwest of U.S. Highway 36 and 96th Street (Northwest Parkway) in Sections 20, 21, and 29, Township 1 South, Range 69 West of the 6th Principal Meridian in Boulder and Broomfield Counties, Colorado. The UTM coordinates for the approximate center of the property are Zone 13 488402mE and 4421737mN (Figure 1). The

Denver
1842 Clarkson Street
Denver, CO 80218
303.830.1188

Durango
1015 ½ Main Avenue
Durango, CO 81301
970.422.2136

Hotchkiss
P.O. Box 932
161 South 2nd Street
Hotchkiss, CO 81419
970.872.3020

Idaho
4001 East Main Street
Emmett, ID 83617
208.365.7684

www.eroresources.com

longitude/latitude of the property is 105.135760°W/39.945675°N. The elevation of the property ranges from 5,330 to 5,490 feet above sea level.

Site Description

The project area consists of the Goodhue Ditch and Rock Creek within the property (Figure 2a and Figure 2b). The Goodhue Ditch is approximately 2 to 6 feet wide within the project area and flows generally southeast (Photo 1; Figure 2a). Wetlands occur along the southern portion of the Goodhue Ditch (Photo 2). Vegetation along the banks of the Goodhue Ditch consists primarily of smooth brome (*Bromus inermis*) and plains cottonwood (*Populus deltoides*) with abutting wetlands dominated by peachleaf willow (*Salix amygdaloides*), sandbar willow (*Salix exigua*), reed canarygrass (*Phalaris arundinacea*), and marshpepper knotweed (*Polygonum hydropiper*) (Photo 2). Rock Creek is an intermittent drainage, is approximately 6 to 8 feet wide within the project area and flows generally northeast (Figure 2b). Wetlands occur along much of Rock Creek within the project area (Photos 3 and 4). Vegetation along Rock Creek consists primarily of plains cottonwood, peachleaf willow, sandbar willow, narrowleaf cattail (*Typha angustifolia*), Emory's sedge (*Carex emoryi*), and softstem bulrush (*Schoenoplectus tabernaemontani*).

Methods

ERO conducted the wetland delineation following the methods for routine on-site wetland determinations in areas less than 5 acres as described in the 1987 *Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory 1987) and used methods in the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Great Plains Region (Version 2.0)* (Corps 2010) to record data on vegetation, soils, and hydrology on routine determination forms. The Corps defines wetlands as "areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas" (33 Code of Federal Regulations (CFR) 328.3(c)). Wetland boundaries were determined by a visible change in vegetation community, soils, topographic changes, and other visible distinctions between wetlands and uplands.

The wetland indicator status of plant species was identified using the *National Wetland Plant List* (Lichvar et al. 2016), taxonomy was determined using *Colorado Flora: Eastern Slope* (Weber and Wittmann 2012), and nomenclature was determined using *The PLANTS Database* (U.S. Department of Agriculture, Natural Resources Conservation Service 2019). If present, hydric soils were identified using field observation for hydric soil indicators accepted by the Corps. Soil data were not always collected if hydrophytic vegetation and hydrology were present and did not appear altered (Environmental Laboratory 1987). In addition, soil data were not collected in conditions where there was a clear lack of hydrology and hydrophytic vegetation indicators. Where soil data were collected, a Munsell soil color chart was used to determine soil color.

Intermittent, ephemeral, and perennial drainages with characteristics of a defined streambed, streambank, ordinary high water mark (OHWM), and other erosional features also were identified. The OHWM identifies the lateral jurisdictional limits of nonwetland WUS. Federal jurisdiction over nonwetland WUS extends to the OHWM, defined in 33 CFR 328.3 as "the line on the shore established by fluctuations of water and indicated by physical characteristics such as a clear, natural line impressed on the bank, shelving, changes in the character of the soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas." The Corps defines "stream bed" as "the substrate of the stream channel between the OHWMs. The substrate may be bedrock or inorganic particles that range in size from clay to boulders."

Project Area Conditions

ERO mapped approximately 0.635 acre of open water and 0.357 acre of wetlands along the Goodhue Ditch and Rock Creek in the project area during the 2019 site visit (Figure 2a and Figure 2b). The project area conditions along the Goodhue Ditch and Rock Creek are discussed individually in more detail below.

Goodhue Ditch

Streams and Open Water

The Goodhue Ditch is in the northeast corner of the property and contains a defined bed and bank with fringe wetlands along portions of the banks. The Goodhue Ditch is shown on the U.S. Geological Survey (USGS) Louisville topographic quadrangle and on the National Hydrography Dataset (NHD) as a canal/ditch and intermittent stream (Figure 1 and Figure 2a). ERO mapped approximately 0.428 acre of open water along the Goodhue Ditch in the project area during the 2019 site visit.

Wetlands

During the 2019 site visit, ERO mapped approximately 0.121 acre of wetlands abutting the Goodhue Ditch within the project area. ERO collected data from three data points (DP) near the Goodhue Ditch (DP1, DP2, and DP3).

Vegetation

The wetland fringe vegetation within the Goodhue Ditch is dominated by sandbar willow (facultative wetland (FACW)), peachleaf willow (FACW), marshpepper knotweed (obligate (OBL)), and reed canary grass (FACW). Upland vegetation is dominated by smooth brome, Canada thistle (*Cirsium arvense*), and Scotch thistle (*Onopordum acanthium*). At DP1 and DP2, the vegetation met the rapid test for hydrophytic vegetation. DP3 consisted primarily of smooth brome (upland (UPL)) and did not meet the dominance test or prevalence index for hydrophytic vegetation.

Soils

Soil data were collected from two locations in the Goodhue Ditch portion of the project area (DP1 and DP2) (Figure 2a). Soils at DP1 had a matrix color of 10YR 3/2 from 0 to 2 inches with no redox features observed and a matrix color of 10YR 4/2 from 2 to 12 inches with 10 percent faint redox features of 7.5YR 4/4. No hydric soils were observed at DP1. Soils at DP2 had a matrix color of 10YR 4/2 from 0 to 6 inches with 5 percent prominent redox features of 7.5YR 4/6 observed and a matrix color of 10YR 3/2 from 6 to 12 inches with 5 percent distinct redox features of 7.5YR 4/4 observed. The hydric soil indicator at DP2 was depleted matrix. Soils were not collected within the adjacent upland (DP3) due to the lack of hydrophytic vegetation and hydrologic indicators.

Hydrology

Hydrologic indicators observed at DP1 and DP2 included the presence of surface water, saturation, geomorphic position, and the FAC-Neutral test. No hydrologic indicators were observed at DP3.

Rock Creek

Streams and Open Water

Rock Creek, shown on the USGS topographic quadrangle and on the NHD as an intermittent stream, occurs within the project area (Figure 1 and Figure 2b). ERO mapped approximately 0.207 acre of open water along Rock Creek in the project area during the 2019 site visit.

Wetlands

During the 2019 site visit, ERO mapped approximately 0.236 acre of wetlands abutting Rock Creek within the project area. ERO collected data from four DPs near Rock Creek (DP4, DP5, DP6, and DP7).

Vegetation

Wetland vegetation along Rock Creek is dominated by plains cottonwood (FAC), peachleaf willow (FACW), sandbar willow (FACW), narrowleaf cattail (OBL), Emory's sedge (OBL), watercress (*Nasturtium officinale* - OBL)), curlytop knotweed (*Polygonum lapathifolium* - OBL), and common spikerush (*Eleocharis palustris* - OBL). Vegetation at DP4 met the rapid test for hydrophytic vegetation, and vegetation at DP5 met the dominance test for hydrophytic vegetation. Vegetation at DP5 and DP7 consisted primarily of the upland species including smooth brome (UPL) and Canada thistle (facultative upland (FACU)), with an overstory of plains cottonwood (facultative (FAC)), and did not meet the dominance test or prevalence index for hydrophytic vegetation.

Soils

Soil data were collected from two locations in the Rock Creek portion of project area (DP4 and DP6) (Figure 2b). Soils at DP4 had a matrix color of 10YR 4/2 from 0 to 6 inches with 15 percent prominent redox features of 7.5YR 4/6 and 7 percent depletion of Gley 1 2.5/N

observed. From 6 to 12 inches, soils at DP4 had a matrix color of 10YR 4/1 with 10 percent prominent redox features of 7.5YR 4/4 and 20 percent depletions of Gley 1 2.5/N observed. The hydric soil indicator met at DP4 was depleted matrix. Soils at DP6 had a matrix color of 10YR 4/2 from 0 to 3 inches with 25 percent depletions of Gley 1 2.5/N observed. DP6 is located within a wetland mitigation site and met the criteria for problematic hydric soils due to recently developed wetlands. Soils were not collected within the adjacent uplands (DP5 and DP7) due to the lack of hydrophytic vegetation and hydrologic indicators.

Hydrology

Hydrologic indicators observed at DP4 included high water table, saturation, oxidized rhizospheres on living roots, geomorphic position, and the FAC-Neutral test. Hydrologic indicators observed at DP6 included surface water, high water table, saturation, geomorphic position, and the FAC-Neutral test. No hydrologic indicators were observed at DP5 or DP7.

Recommendations

The Goodhue Ditch and its abutting wetlands and Rock Creek and its abutting wetlands were previously determined jurisdictional (Corps 2019). If work is planned within these areas, a Section 404 permit would be required for the placement of dredged or fill material below the OHWM. If no work is planned within these areas, no action would be necessary.

References

Environmental Laboratory. 1987. *Corps of Engineers Wetland Delineation Manual*. Technical Report 7-87-1, U.S. Army Engineer Waterways Experiment Station. Vicksburg, MS.

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U.S. Army Corps of Engineers (Corps). 2019. NWO-2019-00148-DEN, Phillips 66 Site (JD). April 4.

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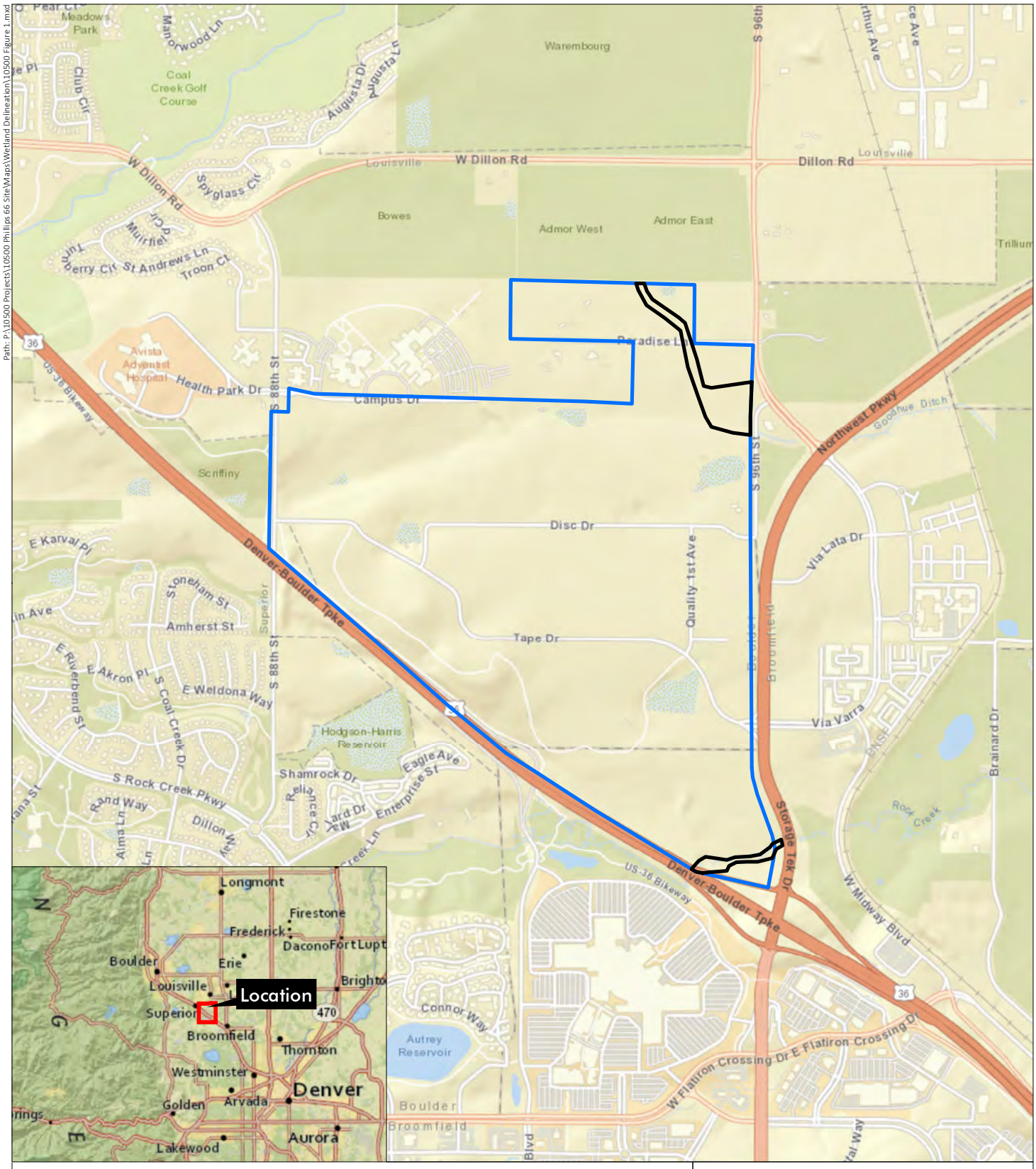
Attachments

Figure 1 – Vicinity Map
Figure 2a – Goodhue Ditch Existing Conditions
Figure 2b – Rock Creek Existing Conditions
Photo log
Wetland delineation datasheets
Jurisdictional Determination



Phillips 66 Site Delineation

Sections 20, 21, and 29, T1S, R69W; 6th PM

UTM NAD 83: Zone 13N; 488402mE, 4421737mN

Longitude 105.135760°W, Latitude 39.945675°N

USGS Louisville, CO Quadrangle

Boulder and Broomfield Counties, Colorado

Project Area

Property Boundary

N

0 750 1,500 Feet

Figure 1
Vicinity Map

Prepared for: Brue Baukol

File: 10500 Figure 1.mxd (GS)

September 19, 2019

ERO Resources Corp.

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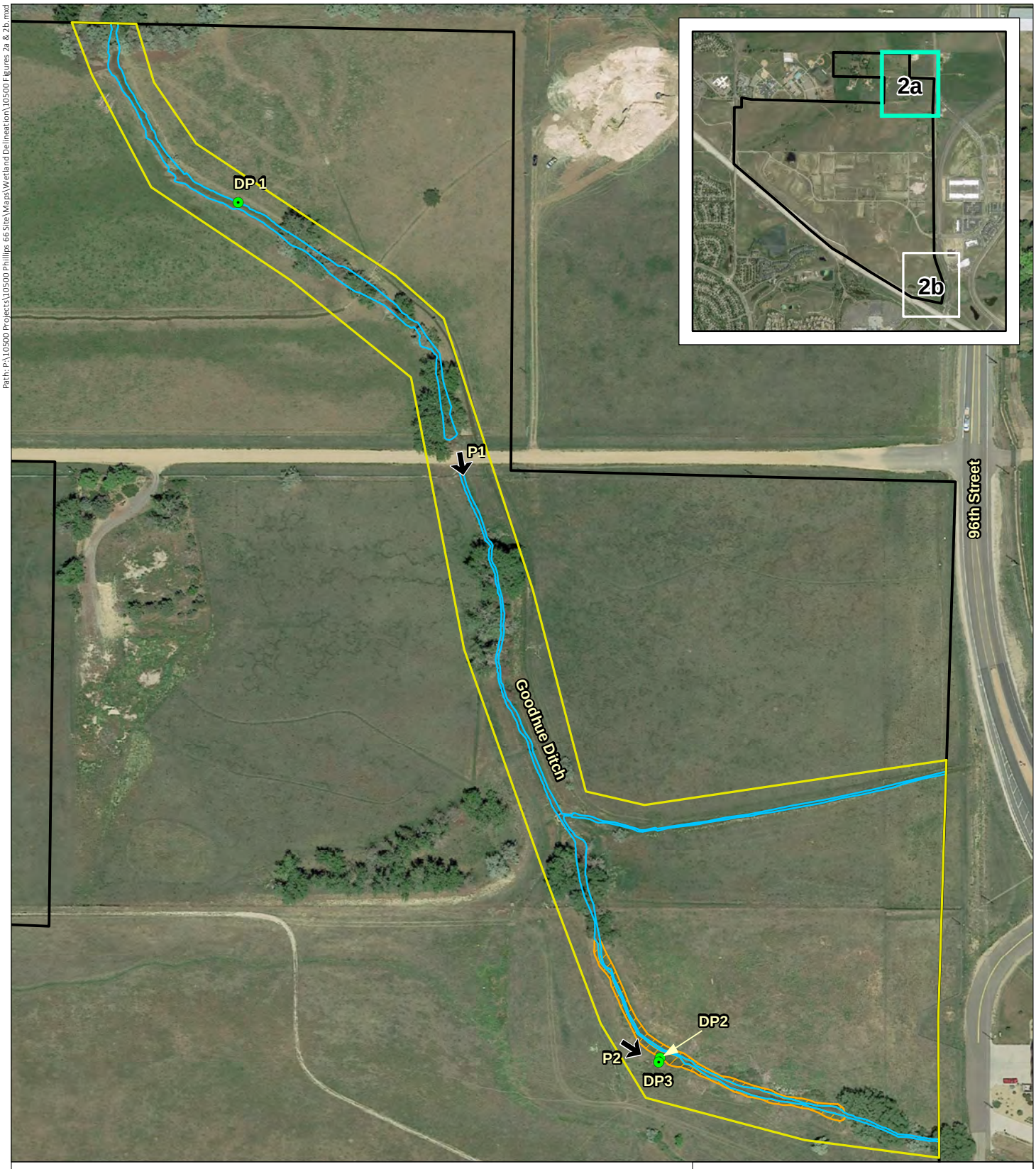


Phillips 66 Site Delineation

- Data Point
- Photo Point
- Ordinary High Water Mark (0.635 ac)
- Wetland (0.357 ac)
- Property Boundary
- Project Area

0 100 200 Feet

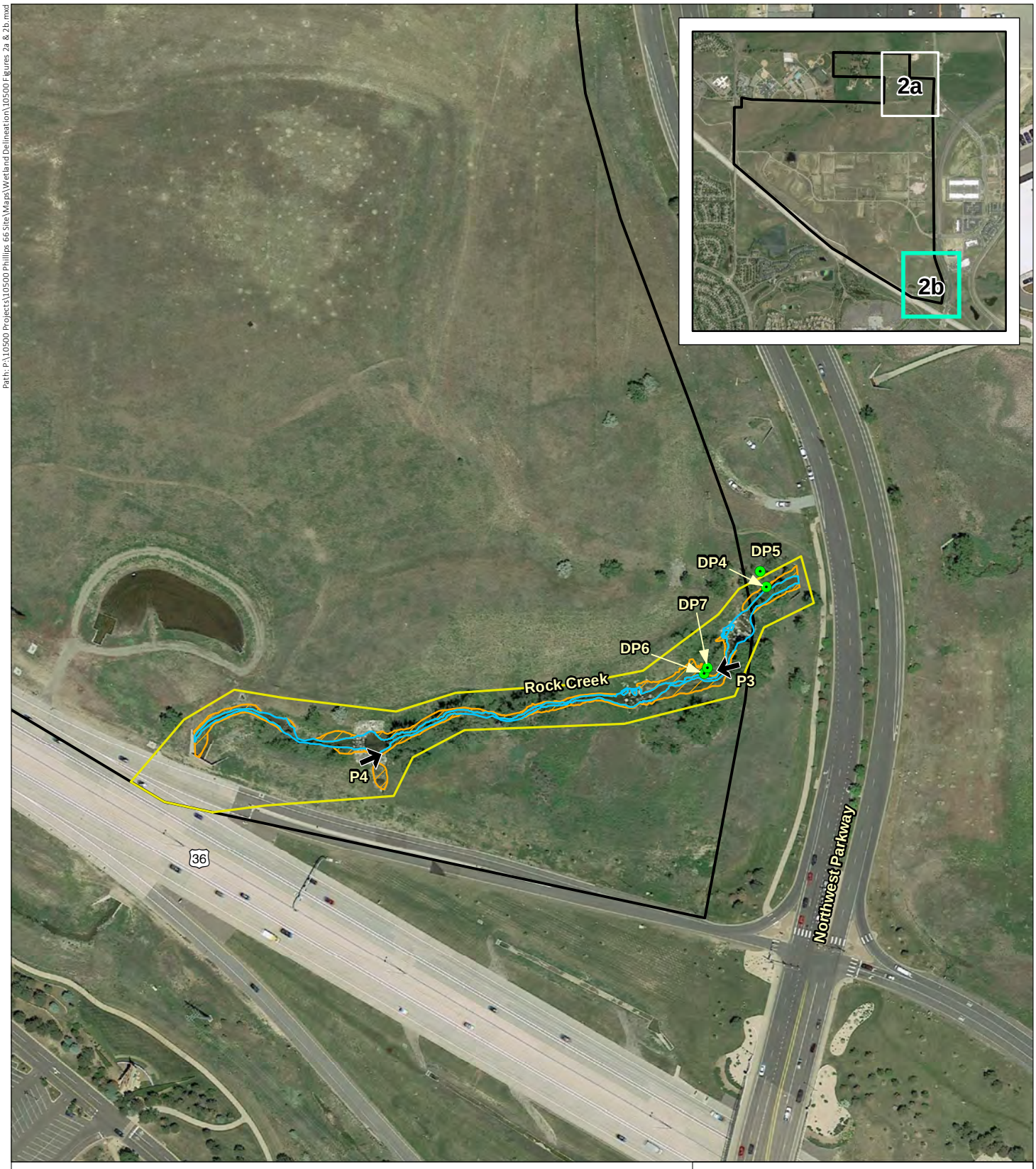
N

Image Source: Google Earth©, May 2018

Figure 2a
Goodhue Ditch Existing Conditions

Prepared for: Brue Baukol
File: 10500 Figures 2a & 2b.mxd (GS)
September 19, 2019

ERO Resources Corp.



Phillips 66 Site Delineation

- Data Point
- Photo Point
- Ordinary High Water Mark (0.635 ac)
- Wetland (0.357 ac)
- Property Boundary
- Project Area

0 100 200 Feet

N

Image Source: Google Earth©, May 2018

Figure 2b
Rock Creek Existing Conditions

Prepared for: Brue Baukol
File: 10500 Figures 2a & 2b.mxd (GS)
September 19, 2019

ERO Resources Corp.

Path: P:\10500 Projects\10500 Phillips 66 Site\Maps\Wetland Delineation\10500 Figures 2a & 2b.mxd

Photo 1 - Overview of Goodhue Ditch. View is to the southeast.

Photo 2 - Overview of wetlands abutting Goodhue Ditch. View is to the southeast.

Photo 3 - Overview of Rock Creek and abutting wetlands. View is to the southwest.

Photo 4 - Overview of Rock Creek and abutting wetlands. View is to the northeast.

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: Phillips 66 Site City/County: Louisville/Broomfield &Boul Sampling Date: 8/23/2019

Applicant/Owner: Brue Baukol Capital Partners State: CO Sampling Point: DP1

Investigator(s): H.Gerstung, A.Wistrom Section, Township, Range: 20, 21, and 29, T1S, R69W

Landform (hillslope, terrace, etc.): drainageway Local relief (concave, convex, none): concave Slope (%): <1

Subregion (LRR): G Lat: 39.953435°N Long: 105.131959°W Datum: NAD83

Soil Map Unit Name: Nunn clay loam, 1 to 3 percent slopes NWI classification: R5UBFx

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ☒ No ☐ (If no, explain in Remarks.)

Are Vegetation N, Soil N, or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes ☒ No ☐

Are Vegetation N, Soil N, or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ☒ No ☐	**Is the Sampled Area within a Wetland?** Yes ☐ No ☒
Hydric Soil Present?	Yes ☐ No ☒	
Wetland Hydrology Present?	Yes ☒ No ☐	

Remarks:

within Goodhue Ditch

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: 30')			
1.			
2.			
3.			
4.			
	= Total Cover		
Sapling/Shrub Stratum (Plot size: 15')			
1.			
2.			
3.			
4.			
5.			
	= Total Cover		
Herb Stratum (Plot size: 5')			
1. Carex emoryi	20	Yes	OBL
2. Polygonum hydropiper	12	Yes	OBL
3. Cirsium arvense	1	No	FACU
4. Pascopyrum smithii	4	No	FACU
5. Amorpha fruticosa	3	No	FACW
6.			
7.			
8.			
9.			
10.			
	40 = Total Cover		
Woody Vine Stratum (Plot size:)			
1.			
2.			
	= Total Cover		

% Bare Ground in Herb Stratum 60

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC−): 2 (A)

Total Number of Dominant Species Across All Strata: 2 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	
FACW species		x 2 =	
FAC species		x 3 =	
FACU species		x 4 =	
UPL species		x 5 =	
Column Totals:	(A)		(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

☒ 1 - Rapid Test for Hydrophytic Vegetation

☐ 2 - Dominance Test is >50%

☐ 3 - Prevalence Index is ≤3.0[1]

☐ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

☐ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ☒ No ☐

Remarks:

SOIL

Sampling Point: DP1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-2	10YR 3/2	100	-	0	-	-	clay loam	
2-12	10YR 4/2	90	7.5YR 4/3	10	C	M	clay loam	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5) (**LRR F**)
- ☐ 1 cm Muck (A9) (**LRR F, G, H**)
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1)
- ☐ 2.5 cm Mucky Peat or Peat (S2) (**LRR G, H**)
- ☐ 5 cm Mucky Peat or Peat (S3) (**LRR F**)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1)
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ High Plains Depressions (F16) (**MLRA 72 & 73 of LRR H**)

Indicators for Problematic Hydric Soils[3]:

- ☐ 1 cm Muck (A9) (**LRR I, J**)
- ☐ Coast Prairie Redox (A16) (**LRR F, G, H**)
- ☐ Dark Surface (S7) (**LRR G**)
- ☐ High Plains Depressions (F16) (**LRR H outside of MLRA 72 & 73**)
- ☐ Reduced Vertic (F18)
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (inches): _____

Hydric Soil Present? Yes ☐ No ☒

Remarks:

refusal after 12"; faint redox observed

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ☒ Surface Water (A1)
- ☐ High Water Table (A2)
- ☒ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Salt Crust (B11)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Dry-Season Water Table (C2)
- ☐ Oxidized Rhizospheres on Living Roots (C3) (**where not tilled**)
- ☐ Presence of Reduced Iron (C4)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ☐ Surface Soil Cracks (B6)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Drainage Patterns (B10)
- ☐ Oxidized Rhizospheres on Living Roots (C3) (**where tilled**)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☒ Geomorphic Position (D2)
- ☒ FAC-Neutral Test (D5)
- ☐ Frost-Heave Hummocks (D7) (**LRR F**)

Field Observations:

Surface Water Present? Yes ☒ No ☐ Depth (inches): Surface

Water Table Present? Yes ☐ No ☒ Depth (inches): _____

Saturation Present? (includes capillary fringe) Yes ☒ No ☐ Depth (inches): Surface

Wetland Hydrology Present? Yes ☒ No ☐

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: Phillips 66 Site City/County: Louisville/Broomfield &Boul Sampling Date: 8/23/2019

Applicant/Owner: Brue Baukol Capital Partners State: CO Sampling Point: DP2

Investigator(s): H.Gerstung, A,Wistrom Section, Township, Range: 20, 21, and 29, T1S, R69W

Landform (hillslope, terrace, etc.): drainageway Local relief (concave, convex, none): concave Slope (%): <1

Subregion (LRR): G Lat: 39.949979°N Long: 105.129768°W Datum: NAD83

Soil Map Unit Name: Nunn clay loam, 1 to 3 percent slopes NWI classification: R4SBC

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ☒ No ☐ (If no, explain in Remarks.)

Are Vegetation N, Soil N, or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes ☒ No ☐

Are Vegetation N, Soil N, or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ☒ No ☐	**Is the Sampled Area within a Wetland?** Yes ☒ No ☐
Hydric Soil Present?	Yes ☒ No ☐	
Wetland Hydrology Present?	Yes ☒ No ☐	

Remarks:

In drainageway

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
	0	= Total Cover	
Sapling/Shrub Stratum (Plot size: 15')			
1. Populus angustifolia	20	Yes	FACW
2. Salix exigua	30	Yes	FACW
3.			
4.			
5.			
	50	= Total Cover	
Herb Stratum (Plot size: 5')			
1. Phalaris arundinacea	25	Yes	FACW
2. Polygonum hydropiper	10	Yes	OBL
3. Dipsacus fullonum	5	No	FACU
4. Echinochloa crus-galli	2	No	FAC
5.			
6.			
7.			
8.			
9.			
10.			
	42	= Total Cover	
Woody Vine Stratum (Plot size:)			
1.			
2.			
	0	= Total Cover	

% Bare Ground in Herb Stratum 58

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC−): 4 (A)

Total Number of Dominant Species Across All Strata: 4 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	(A)	(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

☒ 1 - Rapid Test for Hydrophytic Vegetation

☐ 2 - Dominance Test is >50%

☐ 3 - Prevalence Index is ≤3.0[1]

☐ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

☐ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ☒ No ☐

Remarks:

SOIL

Sampling Point: DP2

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-6	10YR 4/2	95	7.5YR 4/6	5	C	M	SCL	
6-12	10YR 3/2	95	7.5YR 4/4	5	C	M	SCL	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5) (**LRR F**)
- ☐ 1 cm Muck (A9) (**LRR F, G, H**)
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1)
- ☐ 2.5 cm Mucky Peat or Peat (S2) (**LRR G, H**)
- ☐ 5 cm Mucky Peat or Peat (S3) (**LRR F**)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1)
- ☐ Loamy Gleyed Matrix (F2)
- ☒ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ High Plains Depressions (F16) (**MLRA 72 & 73 of LRR H**)

Indicators for Problematic Hydric Soils[3]:

- ☐ 1 cm Muck (A9) (**LRR I, J**)
- ☐ Coast Prairie Redox (A16) (**LRR F, G, H**)
- ☐ Dark Surface (S7) (**LRR G**)
- ☐ High Plains Depressions (F16) (**LRR H outside of MLRA 72 & 73**)
- ☐ Reduced Vertic (F18)
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (inches): _____

Hydric Soil Present? Yes ☒ No ☐

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ☒ Surface Water (A1)
- ☐ High Water Table (A2)
- ☒ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Salt Crust (B11)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Dry-Season Water Table (C2)
- ☐ Oxidized Rhizospheres on Living Roots (C3) (**where not tilled**)
- ☐ Presence of Reduced Iron (C4)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ☐ Surface Soil Cracks (B6)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Drainage Patterns (B10)
- ☐ Oxidized Rhizospheres on Living Roots (C3) (**where tilled**)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☒ Geomorphic Position (D2)
- ☒ FAC-Neutral Test (D5)
- ☐ Frost-Heave Hummocks (D7) (**LRR F**)

Field Observations:

Surface Water Present? Yes ☒ No ☐ Depth (inches): Surface

Water Table Present? Yes ☐ No ☒ Depth (inches): _____

Saturation Present? (includes capillary fringe) Yes ☒ No ☐ Depth (inches): Surface

Wetland Hydrology Present? Yes ☒ No ☐

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: Phillips 66 Site City/County: Louisville/Broomfield &Boul Sampling Date: 8/23/2019

Applicant/Owner: Brue Baukol Capital Partners State: CO Sampling Point: DP3

Investigator(s): H. Gerstung, A. Wistrom Section, Township, Range: 20, 21, and 29, T1S, R69W

Landform (hillslope, terrace, etc.): terrace Local relief (concave, convex, none): nonr Slope (%): 1

Subregion (LRR): G Lat: 39.949960°N Long: 105.129775°W Datum: NAD83

Soil Map Unit Name: Nunn clay loam, 1 to 3 percent slopes NWI classification: R4SBC

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ☒ No ☐ (If no, explain in Remarks.)

Are Vegetation N, Soil N, or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes ☐ No ☒

Are Vegetation N, Soil N, or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ☐ No ☒	**Is the Sampled Area within a Wetland?** Yes ☐ No ☒
Hydric Soil Present?	Yes ☐ No ☒	
Wetland Hydrology Present?	Yes ☐ No ☒	

Remarks:

Terrace above drainage

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
	= Total Cover		
Sapling/Shrub Stratum (Plot size: 15')			
1. Salix exigua	10	Yes	FACW
2.			
3.			
4.			
5.			
	10 = Total Cover		
Herb Stratum (Plot size: 5')			
1. Onopordum acanthium	20	Yes	UPL
2. Bromus inermis	35	Yes	UPL
3. Cirsium arvense	20	Yes	FACU
4. Dipsacus fullonum	10	No	FACU
5.			
6.			
7.			
8.			
9.			
10.			
	85 = Total Cover		
Woody Vine Stratum (Plot size:)			
1.			
2.			
	= Total Cover		

% Bare Ground in Herb Stratum 15

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC−): 1 (A)

Total Number of Dominant Species Across All Strata: 4 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 25 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	
FACW species	10	x 2 =	20
FAC species		x 3 =	
FACU species	30	x 4 =	120
UPL species	55	x 5 =	275
Column Totals:	95 (A)		415 (B)

Prevalence Index = B/A = 4.37

Hydrophytic Vegetation Indicators:

☐ 1 - Rapid Test for Hydrophytic Vegetation

☐ 2 - Dominance Test is >50%

☐ 3 - Prevalence Index is ≤3.0[1]

☐ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

☐ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ☐ No ☒

Remarks:

SOIL

Sampling Point: DP3

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5) (**LRR F**)
- ☐ 1 cm Muck (A9) (**LRR F, G, H**)
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1)
- ☐ 2.5 cm Mucky Peat or Peat (S2) (**LRR G, H**)
- ☐ 5 cm Mucky Peat or Peat (S3) (**LRR F**)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1)
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ High Plains Depressions (F16) (**MLRA 72 & 73 of LRR H**)

Indicators for Problematic Hydric Soils[3]:

- ☐ 1 cm Muck (A9) (**LRR I, J**)
- ☐ Coast Prairie Redox (A16) (**LRR F, G, H**)
- ☐ Dark Surface (S7) (**LRR G**)
- ☐ High Plains Depressions (F16) (**LRR H outside of MLRA 72 & 73**)
- ☐ Reduced Vertic (F18)
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (inches): _____

Hydric Soil Present? Yes ☐ No ☒

Remarks:

Soil not sampled due to upland vegetation and lack of hydrology indicators.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Salt Crust (B11)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Dry-Season Water Table (C2)
- ☐ Oxidized Rhizospheres on Living Roots (C3) (**where not tilled**)
- ☐ Presence of Reduced Iron (C4)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ☐ Surface Soil Cracks (B6)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Drainage Patterns (B10)
- ☐ Oxidized Rhizospheres on Living Roots (C3) (**where tilled**)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ FAC-Neutral Test (D5)
- ☐ Frost-Heave Hummocks (D7) (**LRR F**)

Field Observations:

Surface Water Present? Yes ☐ No ☒ Depth (inches): _____

Water Table Present? Yes ☐ No ☒ Depth (inches): _____

Saturation Present? (includes capillary fringe) Yes ☐ No ☒ Depth (inches): _____

Wetland Hydrology Present? Yes ☐ No ☒

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

no wetland hydrology indicators observed

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: Phillips 66 Site City/County: Broomfield &Boulder Sampling Date: 8/23/2019

Applicant/Owner: Brue Baukol Capital Partners State: CO Sampling Point: DP4

Investigator(s): H. Gerstung, A. Wistrom Section, Township, Range: 20, 21, and 29, T1S, R69W

Landform (hillslope, terrace, etc.): bench Local relief (concave, convex, none): none Slope (%): <1

Subregion (LRR): G Lat: 39.937224°N Long: 105.127267°W Datum: NAD83

Soil Map Unit Name: Heldt clay, 0 to 3 percent slopes NWI classification: R4SBC

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ☒ No ☐ (If no, explain in Remarks.)

Are Vegetation N, Soil N, or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes ☒ No ☐

Are Vegetation N, Soil N, or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ☒ No ☐	**Is the Sampled Area within a Wetland?** Yes ☒ No ☐
Hydric Soil Present?	Yes ☒ No ☐	
Wetland Hydrology Present?	Yes ☒ No ☐	

Remarks:

Wetland fringe abutting Rock Creek

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1. Populus deltoides	30	Yes	FAC
2. Salix amygdaloides	20	Yes	FACW
3.			
4.			
	50	= Total Cover	
Sapling/Shrub Stratum (Plot size: 15')			
1. Salix exigua	20	Yes	FACW
2. Salix amygdaloides	30	Yes	FACW
3. Ribes aureum	2	No	FACU
4.			
5.			
	52	= Total Cover	
Herb Stratum (Plot size: 5')			
1. Poa palustris	3	No	FACW
2. Typha angustifolia	20	Yes	OBL
3. Cirsium arvense	10	No	FACU
4. Chenopodium album	2	No	FACU
5. Carex emoryi	40	Yes	OBL
6. Bromus inermis	15	No	UPL
7.			
8.			
9.			
10.			
	90	= Total Cover	
Woody Vine Stratum (Plot size:)			
1.			
2.			
		= Total Cover	

% Bare Ground in Herb Stratum 10

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC−): 6 (A)

Total Number of Dominant Species Across All Strata: 6 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	
FACW species		x 2 =	
FAC species		x 3 =	
FACU species		x 4 =	
UPL species		x 5 =	
Column Totals:	(A)		(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

- ☐ 1 - Rapid Test for Hydrophytic Vegetation
- ☒ 2 - Dominance Test is >50%
- ☐ 3 - Prevalence Index is ≤3.0[1]
- ☐ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ☐ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ☒ No ☐

Remarks:

SOIL

Sampling Point: DP4

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-6	10YR 4/2	78	7.5YR 4/6	15	C	M&PL	CL	prominent
	10YR 4/2	-	Gley1 2.5/N	7	D	PL	CL	
6-12	10YR 4/1	70	7.5YR 4/4	10	C	M	CL	
	10YR 4/1	-	Gley1 2.5/N	20	D	M	CL	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5) (**LRR F**)
- ☐ 1 cm Muck (A9) (**LRR F, G, H**)
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1)
- ☐ 2.5 cm Mucky Peat or Peat (S2) (**LRR G, H**)
- ☐ 5 cm Mucky Peat or Peat (S3) (**LRR F**)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1)
- ☐ Loamy Gleyed Matrix (F2)
- ☒ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ High Plains Depressions (F16) (**MLRA 72 & 73 of LRR H**)

Indicators for Problematic Hydric Soils[3]:

- ☐ 1 cm Muck (A9) (**LRR I, J**)
- ☐ Coast Prairie Redox (A16) (**LRR F, G, H**)
- ☐ Dark Surface (S7) (**LRR G**)
- ☐ High Plains Depressions (F16) (**LRR H outside of MLRA 72 & 73**)
- ☐ Reduced Vertic (F18)
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (inches): _____

Hydric Soil Present? Yes ☒ No ☐

Remarks:

Depleted matrix

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ☐ Surface Water (A1)
- ☒ High Water Table (A2)
- ☒ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Salt Crust (B11)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Dry-Season Water Table (C2)
- ☒ Oxidized Rhizospheres on Living Roots (C3) (**where not tilled**)
- ☐ Presence of Reduced Iron (C4)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ☐ Surface Soil Cracks (B6)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Drainage Patterns (B10)
- ☐ Oxidized Rhizospheres on Living Roots (C3) (**where tilled**)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☒ Geomorphic Position (D2)
- ☒ FAC-Neutral Test (D5)
- ☐ Frost-Heave Hummocks (D7) (**LRR F**)

Field Observations:

Surface Water Present? Yes ☐ No ☒ Depth (inches): _____

Water Table Present? Yes ☒ No ☐ Depth (inches): 6

Saturation Present? (includes capillary fringe) Yes ☒ No ☐ Depth (inches): Surface

Wetland Hydrology Present? Yes ☒ No ☐

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: Phillips 66 Site | City/County: Broomfield &Boulder | Sampling Date: 8/23/2019

Applicant/Owner: Brue Baukol Capital Partners | State: CO | Sampling Point: DP5

Investigator(s): H. Gerstung, A. Wistrom | Section, Township, Range: 20, 21, and 29, T1S, R69W

Landform (hillslope, terrace, etc.): hillslope | Local relief (concave, convex, none): none | Slope (%): 2

Subregion (LRR): G | Lat: 39.937287°N | Long: 105.127300°W | Datum: NAD83

Soil Map Unit Name: Heldt clay, 0 to 3 percent slopes | NWI classification: none

Are climatic / hydrologic conditions on the site typical for this time of year? Yes [X] No [ ] (If no, explain in Remarks.)

Are Vegetation N, Soil N, or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes [X] No [ ]

Are Vegetation N, Soil N, or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes [ ]	No [X]	**Is the Sampled Area within a Wetland?** Yes [ ] No [X]
Hydric Soil Present?	Yes [ ]	No [X]	
Wetland Hydrology Present?	Yes [ ]	No [X]	

Remarks:

Upland adjacent to wetland bench on Rock Creek.

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1. Populus deltoides	30	Yes	FAC
2. Salix amygdaloides	10	Yes	FACW
3.			
4.			
	40	= Total Cover	
Sapling/Shrub Stratum (Plot size: 15')			
1. Populus deltoides	5	Yes	FAC
2.			
3.			
4.			
5.			
	5	= Total Cover	
Herb Stratum (Plot size: 5')			
1. Bromus inermis	85	Yes	UPL
2. Lactuca serriola	5	No	FAC
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
	90	= Total Cover	
Woody Vine Stratum (Plot size:)			
1.			
2.			
	0	= Total Cover	

% Bare Ground in Herb Stratum 10

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC−): 3 (A)

Total Number of Dominant Species Across All Strata: 4 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 75 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	0	x 1 =	0
FACW species	10	x 2 =	20
FAC species	40	x 3 =	120
FACU species	0	x 4 =	0
UPL species	85	x 5 =	425
Column Totals:	135 (A)		565 (B)

Prevalence Index = B/A = 4.19

Hydrophytic Vegetation Indicators:

- [ ] 1 - Rapid Test for Hydrophytic Vegetation
- [ ] 2 - Dominance Test is >50%
- [ ] 3 - Prevalence Index is ≤3.0[1]
- [ ] 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- [ ] Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes [ ] No [X]

Remarks:

SOIL

Sampling Point: DP5

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5) (**LRR F**)
- ☐ 1 cm Muck (A9) (**LRR F, G, H**)
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1)
- ☐ 2.5 cm Mucky Peat or Peat (S2) (**LRR G, H**)
- ☐ 5 cm Mucky Peat or Peat (S3) (**LRR F**)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1)
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ High Plains Depressions (F16) (**MLRA 72 & 73 of LRR H**)

Indicators for Problematic Hydric Soils[3]:

- ☐ 1 cm Muck (A9) (**LRR I, J**)
- ☐ Coast Prairie Redox (A16) (**LRR F, G, H**)
- ☐ Dark Surface (S7) (**LRR G**)
- ☐ High Plains Depressions (F16) (**LRR H outside of MLRA 72 & 73**)
- ☐ Reduced Vertic (F18)
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (inches): _____

Hydric Soil Present? Yes ☐ No ☒

Remarks:

Soil not sampled due to upland vegetation and lack of hydrological indicators.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Salt Crust (B11)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Dry-Season Water Table (C2)
- ☐ Oxidized Rhizospheres on Living Roots (C3) (**where not tilled**)
- ☐ Presence of Reduced Iron (C4)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ☐ Surface Soil Cracks (B6)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Drainage Patterns (B10)
- ☐ Oxidized Rhizospheres on Living Roots (C3) (**where tilled**)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ FAC-Neutral Test (D5)
- ☐ Frost-Heave Hummocks (D7) (**LRR F**)

Field Observations:

Surface Water Present? Yes ☐ No ☒ Depth (inches): _____

Water Table Present? Yes ☐ No ☒ Depth (inches): _____

Saturation Present? (includes capillary fringe) Yes ☐ No ☒ Depth (inches): _____

Wetland Hydrology Present? Yes ☐ No ☒

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

No indicators observed.

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: Phillips 66 Site City/County: Broomfield &Boulder Sampling Date: 8/23/2019

Applicant/Owner: Brue Baukol Capital Partners State: CO Sampling Point: DP6

Investigator(s): H. Gerstung, A. Wistrom Section, Township, Range: 20, 21, and 29, T1S, R69W

Landform (hillslope, terrace, etc.): drainageway Local relief (concave, convex, none): none Slope (%): ,1

Subregion (LRR): G Lat: 39.936876°N Long: 105.127595°W Datum: NAD83

Soil Map Unit Name: Heldt clay, 0 to 3 percent slopes NWI classification: R4SBC

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ☒ No ☐ (If no, explain in Remarks.)

Are Vegetation N, Soil N, or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes ☒ No ☐

Are Vegetation N, Soil Y, or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ☒ No ☐	**Is the Sampled Area within a Wetland?** Yes ☒ No ☐
Hydric Soil Present?	Yes ☒ No ☐	
Wetland Hydrology Present?	Yes ☒ No ☐	

Remarks:

wetland mitigation area within Rock Creek drainageway

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: 30')			
1. Populus deltoides	10	Yes	FAC
2.			
3.			
4.			
	10 = Total Cover		
Sapling/Shrub Stratum (Plot size: 15')			
1. Salix exigua	2	Yes	FACW
2.			
3.			
4.			
5.			
	2 = Total Cover		
Herb Stratum (Plot size: 5')			
1. Typha angustifolia	15	No	OBL
2. Schoenoplectus tabernaemontani	8	No	OBL
3. Polypogon monspeliensis	2	No	FACW
4. Nasturtium officinale	20	Yes	OBL
5. Epilobium ciliatum	3	No	FACW
6. Cirsium arvense	1	No	FACU
7. Polygonum lapathifolium	20	Yes	OBL
8. Eleocharis palustris	20	Yes	OBL
9. Echinochloa crus-galli	1	No	FAC
10.			
	90 = Total Cover		
Woody Vine Stratum (Plot size:)			
1.			
2.			
	= Total Cover		

% Bare Ground in Herb Stratum 10

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC−): 5 (A)

Total Number of Dominant Species Across All Strata: 5 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	
FACW species		x 2 =	
FAC species		x 3 =	
FACU species		x 4 =	
UPL species		x 5 =	
Column Totals:	(A)		(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

- ☐ 1 - Rapid Test for Hydrophytic Vegetation
- ☒ 2 - Dominance Test is >50%
- ☐ 3 - Prevalence Index is ≤3.0[1]
- ☐ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ☐ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ☒ No ☐

Remarks:

SOIL

Sampling Point: DP6

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-3	10YR 4/2	75	Gley1 2.5/N	25	D	M	Cobble	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5) (**LRR F**)
- ☐ 1 cm Muck (A9) (**LRR F, G, H**)
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1)
- ☐ 2.5 cm Mucky Peat or Peat (S2) (**LRR G, H**)
- ☐ 5 cm Mucky Peat or Peat (S3) (**LRR F**)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1)
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ High Plains Depressions (F16) (**MLRA 72 & 73 of LRR H**)

Indicators for Problematic Hydric Soils[3]:

- ☐ 1 cm Muck (A9) (**LRR I, J**)
- ☐ Coast Prairie Redox (A16) (**LRR F, G, H**)
- ☐ Dark Surface (S7) (**LRR G**)
- ☐ High Plains Depressions (F16) (**LRR H outside of MLRA 72 & 73**)
- ☐ Reduced Vertic (F18)
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☒ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (inches): _____

Hydric Soil Present? Yes ☒ No ☐

Remarks:

Unable to dig past 2";Problematic soils - recently developed alluvium in floodplain. Restoration project work apparent.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ☒ Surface Water (A1)
- ☒ High Water Table (A2)
- ☒ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Salt Crust (B11)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Dry-Season Water Table (C2)
- ☐ Oxidized Rhizospheres on Living Roots (C3) (**where not tilled**)
- ☐ Presence of Reduced Iron (C4)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ☐ Surface Soil Cracks (B6)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Drainage Patterns (B10)
- ☐ Oxidized Rhizospheres on Living Roots (C3) (**where tilled**)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☒ Geomorphic Position (D2)
- ☒ FAC-Neutral Test (D5)
- ☐ Frost-Heave Hummocks (D7) (**LRR F**)

Field Observations:

Surface Water Present? Yes ☒ No ☐ Depth (inches): 0

Water Table Present? Yes ☒ No ☐ Depth (inches): 0

Saturation Present? (includes capillary fringe) Yes ☒ No ☐ Depth (inches): 0

Wetland Hydrology Present? Yes ☒ No ☐

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: Phillips 66 Site | City/County: Broomfield &Boulder | Sampling Date: 8/23/2019

Applicant/Owner: Brue Baukol Capital Partners | State: CO | Sampling Point: DP7

Investigator(s): H. Gerstung, A. Wistrom | Section, Township, Range: 20, 21, and 29, T1S, R69W

Landform (hillslope, terrace, etc.): upland | Local relief (concave, convex, none): none | Slope (%): 1

Subregion (LRR): G | Lat: 39.936900°N | Long: 105.127579°W | Datum: NAD83

Soil Map Unit Name: Heldt clay, 0 to 3 percent slopes | NWI classification: none

Are climatic / hydrologic conditions on the site typical for this time of year? Yes [X] No [ ] (If no, explain in Remarks.)

Are Vegetation N, Soil N, or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes [X] No [ ]

Are Vegetation N, Soil N, or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes [ ] No [X]	**Is the Sampled Area within a Wetland?** Yes [ ] No [X]
Hydric Soil Present?	Yes [ ] No [X]	
Wetland Hydrology Present?	Yes [ ] No [X]	

Remarks:

Upland adjacent to wetland bench.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: 30')			
1. Populus deltoides	12	Yes	FAC
2.			
3.			
4.			
	12	= Total Cover	
Sapling/Shrub Stratum (Plot size: 15')			
1. Salix exigua	10	Yes	FACW
2.			
3.			
4.			
5.			
	10	= Total Cover	
Herb Stratum (Plot size: 5')			
1. Cirsium arvense	30	Yes	FACU
2. Rumex crispus	5	No	FAC
3. Conium maculatum	5	No	FACW
4. Conyza canadensis	10	Yes	FACU
5. Chenopodium album	5	No	FACU
6. Pascopyrum smithii	5	No	FACU
7. Dipsacus fullonum	10	Yes	FACU
8.			
9.			
10.			
	70	= Total Cover	
Woody Vine Stratum (Plot size:)			
1.			
2.			
		= Total Cover	

% Bare Ground in Herb Stratum 30

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC−): 2 (A)

Total Number of Dominant Species Across All Strata: 5 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 40 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	0	x 1 =	0
FACW species	15	x 2 =	30
FAC species	17	x 3 =	51
FACU species	60	x 4 =	240
UPL species	0	x 5 =	0
Column Totals:	92 (A)		321 (B)

Prevalence Index = B/A = 3.5

Hydrophytic Vegetation Indicators:

- [ ] 1 - Rapid Test for Hydrophytic Vegetation
- [ ] 2 - Dominance Test is >50%
- [ ] 3 - Prevalence Index is ≤3.0[1]
- [ ] 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- [ ] Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes [ ] No [X]

Remarks:

SOIL

Sampling Point: DP7

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5) (**LRR F**)
- ☐ 1 cm Muck (A9) (**LRR F, G, H**)
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1)
- ☐ 2.5 cm Mucky Peat or Peat (S2) (**LRR G, H**)
- ☐ 5 cm Mucky Peat or Peat (S3) (**LRR F**)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1)
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ High Plains Depressions (F16) (**MLRA 72 & 73 of LRR H**)

Indicators for Problematic Hydric Soils[3]:

- ☐ 1 cm Muck (A9) (**LRR I, J**)
- ☐ Coast Prairie Redox (A16) (**LRR F, G, H**)
- ☐ Dark Surface (S7) (**LRR G**)
- ☐ High Plains Depressions (F16) (**LRR H outside of MLRA 72 & 73**)
- ☐ Reduced Vertic (F18)
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (inches): _____

Hydric Soil Present? Yes ☐ No ☒

Remarks:

Soil not sampled due to upland vegetation and lack of hydrological indicators.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Salt Crust (B11)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Dry-Season Water Table (C2)
- ☐ Oxidized Rhizospheres on Living Roots (C3) (**where not tilled**)
- ☐ Presence of Reduced Iron (C4)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ☐ Surface Soil Cracks (B6)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Drainage Patterns (B10)
- ☐ Oxidized Rhizospheres on Living Roots (C3) (**where tilled**)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ FAC-Neutral Test (D5)
- ☐ Frost-Heave Hummocks (D7) (**LRR F**)

Field Observations:

Surface Water Present? Yes ☐ No ☒ Depth (inches): _____

Water Table Present? Yes ☐ No ☒ Depth (inches): _____

Saturation Present? (includes capillary fringe) Yes ☐ No ☒ Depth (inches): _____

Wetland Hydrology Present? Yes ☐ No ☒

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

no hydrology indicators observed

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, OMAHA DISTRICT
DENVER REGULATORY OFFICE, 9307 SOUTH WADSWORTH BOULEVARD
LITTLETON, COLORADO 80128-6901

April 4, 2019

SUBJECT: Approved Jurisdictional Determination, Phillips 66 Site, Corps File No. NWO-2019-00148-DEN, Broomfield City/County, CO

Ms. Jordan Swisher
Brue Baukol Capital Partners
1555 Blake Street, Suite 210
Denver, CO 80202

Dear Ms. Swisher:

Reference is made to the above-mentioned project centered at approximately 39.945675°N, -105.135760°W, in the City and County of Broomfield, Colorado. You have requested an Approved Jurisdictional Determination (JD) for all aquatic resources found at the project location.

The project area has been reviewed in accordance with Section 404 of the Clean Water Act under which the U.S. Army Corps of Engineers regulates the discharge of dredged and fill material, and any excavation activity associated with a dredge and fill project in waters of the United States.

We have determined that the following aquatic resources are jurisdictional waters of the U.S., and a Department of the Army permit will be required for any work that impacts these resources:

- Goodhue Ditch and its abutting wetlands
- Rock Creek and its abutting wetlands

We have determined the following aquatic resources are *not* jurisdictional waters of the U.S.:

- Community Ditch Lateral
- South Boulder Coal Creek First Extension Lateral
- Stock Ponds 1, 2, 3, and 4, and their abutting wetlands
- Detention Ponds 1 and 2, and their abutting wetlands
- Duck Pond
- Ephemeral Drainage 1 Wetlands
- Ephemeral Drainage 2 Wetlands

At your request, an approved JD has been completed for two aquatic resources in this area. The approved JD is attached to this letter. If you are not in agreement with the JD decision, you may request an administrative appeal under regulation 33 CFR 331, by using the attached Appeal Form and Administrative Appeal Process form. The request for appeal must be received within 60 days from the date of this letter. If you would like more information on the jurisdictional appeal process, contact this office. It is not necessary to submit a Request for Appeal if you do not object to the JD.

This JD is valid for a period of five years from the date of this letter, unless new information warrants revisions of the JDs before the expiration date, or unless the Corps has identified, after a possible public notice and comment, that specific geographic areas with rapidly changing environmental conditions merit re-verification on a more frequent basis.

If there are any additional questions or concerns, please contact **Mr. Nicholas Franke** of my office at **303-979-4120** or by email at Nicholas.A.Franke@usace.army.mil and reference **Corps File No. NWO-2019-00148-DEN**.

Sincerely,

John Urbanic
Chief, Denver Regulatory Office

Attachments:

Approved Jurisdictional Determination (April 4, 2019)
Approved Jurisdictional Determination Appeal Form
Approved Jurisdictional Determination Appeal Form Instruction Sheet

Copies Furnished:
Heidi Gerstung, ERO Resources Corp., 1842 Clarkson Street, Denver, CO/80218

ERO Resources Corp.

February 24, 2020

Mr. Kiel Downing
U.S. Army Corps of Engineers
Denver Regulatory Office
9307 South Wadsworth Boulevard
Littleton, CO 80128-6901

RE: Preconstruction Notification Redtail Ridge Development Goodhue Ditch Crossing
Boulder County, Colorado

Dear Mr. Downing:

On behalf of Brue Baukol Capital Partners, ERO Resources Corporation (ERO) is requesting authorization for impacts on waters of the U.S. and abutting wetlands that would result from construction of a road crossing over the Goodhue Ditch in Boulder County, Colorado. ERO believes the project meets the criteria for authorization under the Nationwide Permit (NWP) system (33 CFR 330.6) – specifically, NWP 14 for Linear Transportation Projects and/or NWP 46 for Discharges in Ditches.

The attached Preconstruction Notification includes a description of the proposed project and associated impacts, along with figures, photos of the site, and plan sheets. If you have any questions or need further information, please do not hesitate to call. I look forward to hearing from you.

Sincerely,

Heidi Gerstung
Natural Resources Specialist

Attachments

cc via email: Jordan Swisher – Brue Baukol Capital Partners
Mark West – Harris Kocher Smith

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ERO

Consultants in Natural Resources and the Environment

Preconstruction Notification

Redtail Ridge Development – Goodhue Ditch Crossing

Boulder County, Colorado

Prepared for—

Brue Baukol Capital Partners
1555 Blake Street, Suite 210
Denver, Colorado 80202

Prepared by—

ERO Resources Corporation
1842 Clarkson Street
Denver, Colorado 80218
(303) 830-1188
ERO Project #10500

February 24, 2020

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Preconstruction Notification
Redtail Ridge Development – Goodhue Ditch Crossing

Boulder County, Colorado

February 24, 2020

Project Description

Brue Baukol Capital Partners (BBCP) is proposing to construct a road crossing over the Goodhue Ditch in Boulder County, Colorado (project area; Figure 1). The proposed road crossing is associated with Campus Drive and the Redtail Ridge residential development located in Boulder County, Colorado. The crossing over the Goodhue Ditch would provide road access to the proposed development, and project activities would include the installation of a culvert constructed of approximately 400 linear feet of reinforced concrete pipe. BBCP retained ERO Resources Corporation (ERO) to assist in requesting authorization for the project under Nationwide Permit (NWP) 14 for Linear Transportation or NWP 46 for Discharges in Diches.

Location

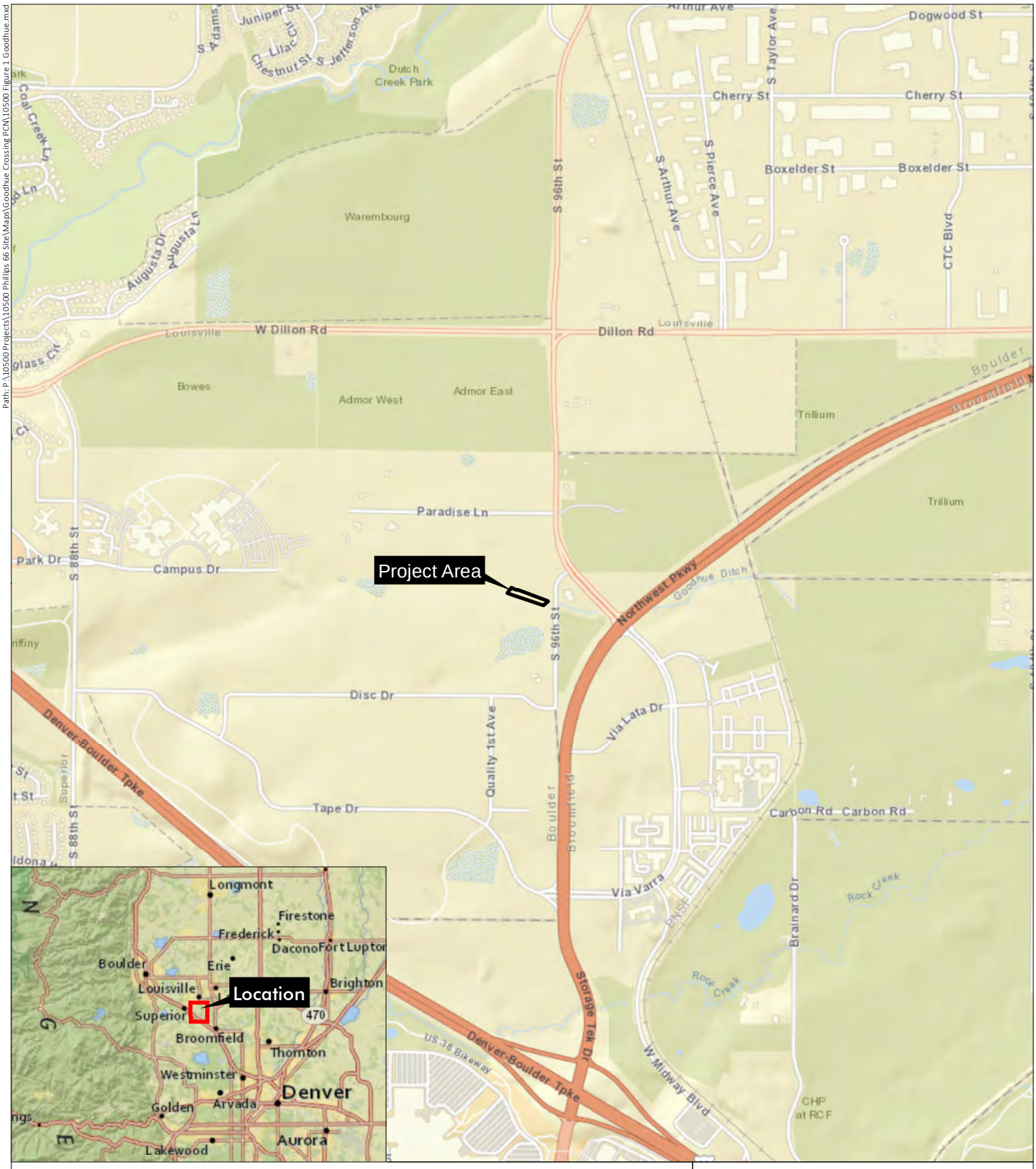
The project area is generally southwest of the intersection of Paradise Lane and South 96th Street in Boulder County, Colorado. The legal description of the project area is Section 20, Township 1 South, Range 69 West of the 6th Principal Meridian in Boulder County, Colorado (Figure 1). The UTM coordinates for the approximate center of the project area are 488963mE, 4422198mN, Zone 13 North. The longitude/latitude of the project area is 105.129202°W/39.949841°N. The elevation of the project area is approximately 5,391 feet above sea level. Photo points of the project area are shown on Figure 2, and the photo log is in Appendix A.

Site Description

Land Use and Vegetation

The project area is southwest of the intersection of Paradise Lane and South 96th Street in Boulder County, Colorado (Figure 1). The project area is surrounded by agricultural lands to the north, undeveloped grazed lands to the south and west that were part of the former StorageTek campus, and South 96th Street and the North Metro Fire Station 67 to the east. The Goodhue Ditch generally flows north to southeast in the project area.

Path: P:\10500 Projects\10500 Phillips 66 Site\Maps\Goodhue Crossing PCN\10500 Figure 1 Goodhue.mxd



Goodhue Ditch Crossing PCN

Section 20, T1S, R69W; 6th PM

UTM NAD 83: Zone 13N; 488963mE, 4422198mN

Longitude 105.129202°W, Latitude 39.949841°N

USGS Louisville, CO Quadrangle

Boulder and Broomfield Counties, Colorado

0 750 1,500 Feet

N

Figure 1
Vicinity Map

Prepared for: Brue Baukol
Capital Partners
File: 10500 Figure 1 Goodhue.mxd (GS)
January 31, 2020

ERO Resources Corp.

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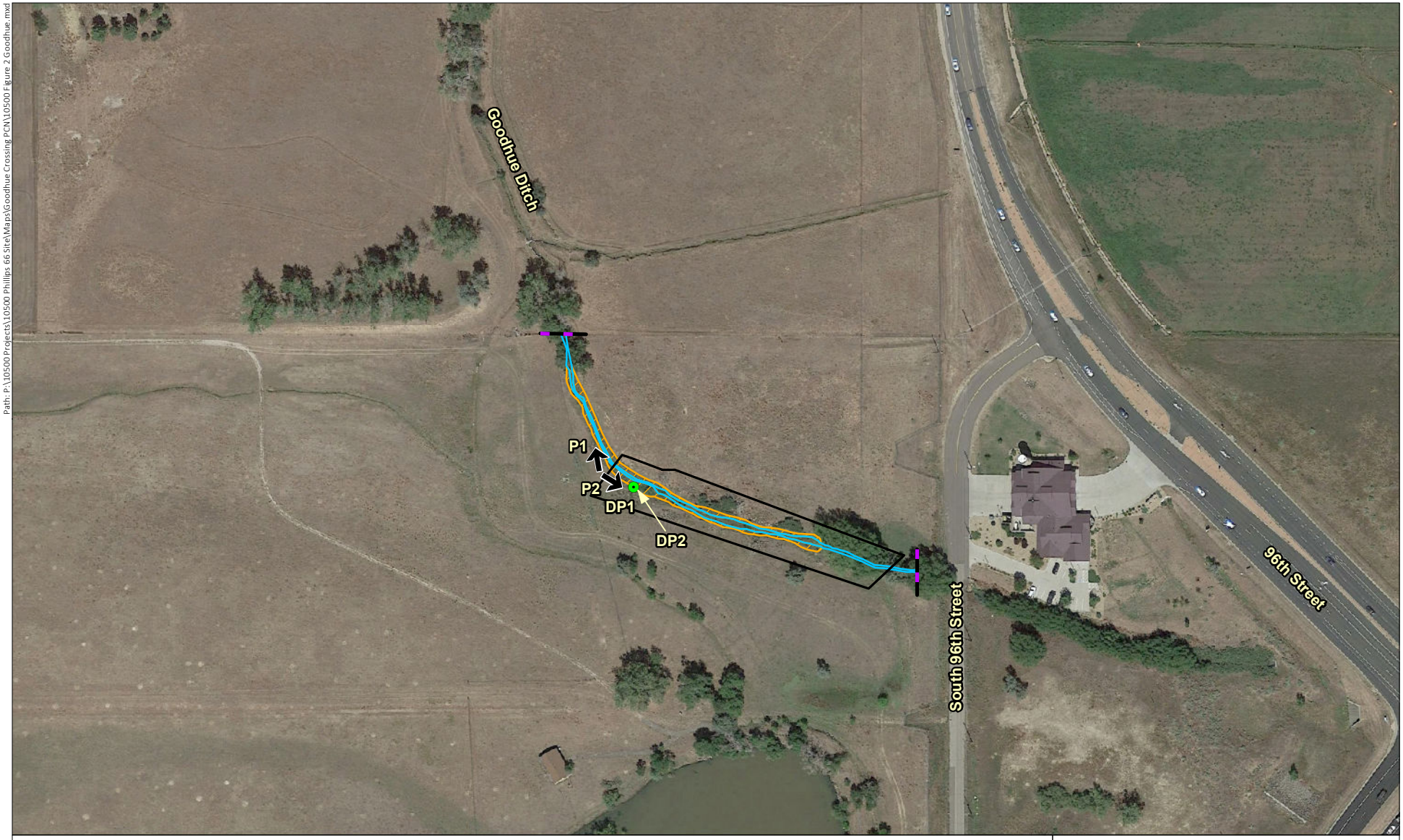
Path: P:\10500 Projects\10500 Phillips 66 Site\Maps\Goodhue Crossing PCN\10500 Figure 2 Goodhue.mxd



Goodhue Ditch Crossing PCN

- Data Point
- Photo Point
- Limit of Delineation

Wetlands and Waters (Total Acres, Project Area Acres)

- Ordinary High Water Mark (0.071, 0.052)
- Wetland (0.121, 0.080)

Project Area

0 100 200 Feet

N

Image Source: Google Earth©, September 2019

Figure 2
Existing Conditions

Prepared for: Brue Baukol
Capital Partners
File: 10500 Figure 2 Goodhue.mxd (GS)
February 24, 2020

ERO Resources Corp.

The Goodhue Ditch is approximately 2 to 6 feet wide within the project area (Photo 1; Figure 2). Wetlands occur along most of the length of the Goodhue Ditch (Figure 2). Vegetation along the banks of the Goodhue Ditch within the project area is dominated by sandbar willow (*Salix exigua*), peachleaf willow (*Salix amygdaloides*), reed canarygrass (*Phalaris arundinacea*), and marshpepper knotweed (*Polygonum hydropiper*) (Photos 1 and 2). Uplands adjacent to the Goodhue Ditch in the project area are dominated by Scotch thistle (*Onopordum acanthium*), smooth brome (*Bromus inermis*), and Canada thistle (*Cirsium arvense*) (Photos 1 and 2).

Soils Classification

The Natural Resources Conservation Service (NRCS) mapped two primary soil associations in the project area (U.S. Department of Agriculture (USDA)/NRCS 2020). Within the project area, the soil is predominately mapped as Nunn clay loam, 1 to 3 percent slopes and Valmont clay loam, 3 to 5 percent slopes. Nunn clay loam is typically found on terraces and consists of well-drained Pleistocene aged alluvium or eolian deposits. Valmont clay loam is typically found on terraces and fan remnants and consists of well-drained gravelly and cobbly loamy alluvium.

Wetlands and Other Waters

Methods

On August 23, 2019, Heidi Gerstung and Anna Wistrom with ERO assessed the project area for potential waters of the U.S., including abutting and adjacent wetlands (2019 site visit). Before the 2019 site visit, ERO reviewed U.S. Geological Survey (USGS) quadrangle topographic maps and aerial photography to identify mapped streams and areas of open water that could indicate wetlands or waters of the U.S.

ERO conducted the wetland delineation following the methods for routine on-site wetland determinations in areas of less than 5 acres as described in the 1987 Corps of Engineers Wetlands Delineation Manual (Environmental Laboratory 1987) and used methods in the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual*: Great Plains Region (Version 2.0) (U.S. Army Corps of Engineers (Corps) 2010) to record data on vegetation, soils, and hydrology on routine determination forms (Appendix B). The Corps defines wetlands as "areas that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas" (33 Code of Federal Regulations (CFR) 328.2(c)). Wetland boundaries were determined by a visible change in vegetation community, soils, topographic changes, and other visible distinctions between wetlands and uplands.

The wetland indicator status of plant species was identified using the National Wetland Plant List (Lichvar et al. 2016), taxonomy was determined using Flora of Colorado (Ackerfield 2015) and Colorado Flora: Eastern Slope (Weber and Wittmann 2012), and nomenclature was determined using *The PLANTS*

Database (USDA/NRCS 2019). Soil data were not always collected if hydrophytic vegetation and hydrology were present and did not appear altered (Environmental Laboratory 1987). In addition, soil data were not collected in conditions where there was a clear lack of hydrology and hydrophytic vegetation indicators. Where soil data were collected, a Munsell soil color chart was used to determine soil color.

Intermittent, ephemeral, and perennial drainages with characteristics of a defined streambed, streambank, ordinary high water mark (OHWM), and other erosional features also were identified. The OHWM identifies the lateral jurisdictional limits of nonwetland waters of the U.S. Federal jurisdiction over nonwetland waters of the U.S. extends to the OHWM, defined in 33 CFR 328.3 as "the line on the shore established by fluctuations of water and indicated by physical characteristics such as a clear, natural line impressed on the bank, shelving, changes in the character of the soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas." The Corps defines stream bed as "the substrate of the stream channel between the OHWMs. The substrate may be bedrock or inorganic particles that range in size from clay to boulders."

The boundaries of identified wetlands and other characteristics of a potential waters of the U.S. were mapped using a Trimble ProXR Global Positioning System (GPS) unit and TBC1 data logger. GPS data were differentially corrected using the CompassCom base station. All differential correction was completed using Trimble Pathfinder Office 5.90 software. GPS data were incorporated onto base mapping using ARC Geographic Information System (GIS) software. Additionally, where appropriate, wetlands were drawn on georectified aerials and then digitized. Delineated wetlands were also classified according to the U.S. Fish and Wildlife Service's (Service) Cowardin classification system (Cowardin et al. 1979) combined with a hydrogeomorphic (HGM) approach (Brinson 1993).

ERO also reviewed the proximity and potential surface water connection of wetlands to known jurisdictional waters of the U.S. using aerial photo interpretation, landowner information, and information from the wetland survey. Potential waters of the U.S., including adjacent wetlands, identified in the project area are shown on Figure 2. Data were collected from various locations in the project area to document the characteristics of uplands and wetlands and the transition areas between them. Each data point was given a label that corresponds to a location shown on Figure 2 and routine wetland determination forms (Appendix B). The following sections contain information on potential surface water connections of wetlands and other waters within the project area.

Streams and Open Water

Under existing regulations, waters tributary to navigable waters are considered waters of the U.S. and are subject to the Corps' jurisdiction (jurisdictional). The Goodhue Ditch is shown on the USGS Louisville topographic quadrangle and on the National Hydrography Dataset as a canal/ditch and intermittent

stream (Figure 1, Figure 2). The Goodhue Ditch is a tributary of Coal Creek, which is a tributary to the South Platte River. The Goodhue Ditch contains a defined bed and bank with fringe wetlands along portions of the banks. ERO mapped approximately 0.052 acre of open water along the Goodhue Ditch in the project area during the 2019 site visit. The Goodhue Ditch has been determined jurisdictional by the Corps (Corps File No. NWO-2019-00148-DEN, Corps 2019).

Wetlands

Jurisdictional wetlands meet the Corps' definition of wetlands and are adjacent, neighboring, or have a surface tributary connection to interstate or navigable waters of the U.S. During the 2019 site visit, ERO mapped approximately 0.08 acre of wetlands abutting the Goodhue Ditch within the project area (Table 1). ERO collected data from two data points (DP) near the Goodhue Ditch (DP1 and DP2).

Vegetation

The wetland fringe vegetation within the Goodhue Ditch is dominated by sandbar willow (facultative wetland (FACW)), peachleaf willow (FACW), marshpepper knotweed (obligate (OBL)), and reed canarygrass (FACW). Upland (UPL) vegetation is dominated by Scotch thistle, smooth brome, and Canada thistle. At DP2, the vegetation met the rapid test for hydrophytic vegetation. DP1 consisted primarily of smooth brome and did not meet the dominance test or prevalence index for hydrophytic vegetation. See Appendix B for additional information for each data point.

Soils

Soil data were collected from one location within the project area (DP2) (Figure 2). Soils at DP2 had a matrix color of 10YR 4/2 from 0 to 6 inches with 5 percent prominent redox features of 7.5YR 4/6 observed and a matrix color of 10YR 3/2 from 6 to 12 inches with 5 percent distinct redox features of 7.5YR 4/4 observed. The hydric soil indicator at DP2 was depleted matrix. Soils were not collected within the adjacent upland (DP1) due to the lack of hydrophytic vegetation and hydrologic indicators.

Hydrology

Hydrologic indicators observed at DP2 included the presence of surface water, saturation, geomorphic position, and the FAC-Neutral test. No hydrologic indicators were observed at DP1.

Table 1. Wetlands and open water within the project area.

Feature	Cowardin Type	HGM	Size (acres)
Open Water	Riverine, intermittent, streambed	Riverine	0.052
Wetland	Palustrine emergent, palustrine scrub-shrub	Riverine	0.08

Endangered Species Act Compliance

During the 2019 site visit, ERO assessed the project area for habitat for federally listed threatened and endangered species protected under the Endangered Species Act (ESA). The project area does not fall within Service habitat or survey guidelines developed by the Service for the majority of the species listed by the Service as potentially being present in the project area (Table 2).

Table 2. Federally threatened, endangered, and candidate species potentially found in the project area or potentially affected by projects in the project area.

Common Name	Scientific Name	Status*	Habitat	Habitat Present
Mammals				
Canada lynx	*Lynx Canadensis*	T	Climax boreal forest with a dense understory of thickets and windfalls	No
Preble's meadow jumping mouse (Preble's)	*Zapus hudsonius preblei*	T	Shrub riparian/wet meadows	Yes, but not likely to support Preble's
Birds				
Interior least tern**	*Sterna antillarum athalassos*	E	Sandy/pebble beaches on lakes, reservoirs, and rivers	No habitat; no depletions anticipated
Mexican spotted owl	*Strix occidentalis*	T	Closed canopy forests in steep canyons	No
Piping plover**	*Charadrius melodus*	T	Sandy lakeshore beaches and river sandbars	No habitat; no depletions anticipated
Whooping crane**	*Grus americana*	E	Mudflats around reservoirs and in agricultural areas	No habitat; no depletions anticipated
Fish				
Greenback cutthroat trout	*Oncorhynchus clarki stomias*	T	Clear, swift-flowing mountain streams with cover such as overhanging banks and vegetation and mountain lakes	No
Pallid sturgeon**	*Scaphirhynchus albus*	E	Large, turbid, free-flowing rivers with a strong current and gravel or sandy substrate	No habitat; no depletions anticipated

Common Name	Scientific Name	Status*	Habitat	Habitat Present
Plants				
Ute ladies'-tresses orchid (ULTO)	*Spiranthes diluvialis*	T	Moist to wet alluvial meadows, floodplains of perennial streams, and around springs and lakes below 7,800 feet in elevation	No, habitat on-site not conducive to establishment of this species
Western prairie fringed orchid**	*Platanthera praeclara*	T	Moist to wet prairies and meadows	No habitat; no depletions anticipated

*T = Federally Threatened Species; E = Federally Endangered Species.

**Water depletions in the South Platte River may affect the species and/or critical habitat in downstream reaches in other counties or states.

Source: Service 2020.

There is no likelihood for the proposed project to affect the Canada lynx, Mexican spotted owl, or greenback cutthroat trout because of the lack of habitat in the project area. The interior least tern, piping plover, whooping crane, pallid sturgeon, and western prairie fringed orchid are species that are affected by continued or ongoing water depletions to the Platte River system. Based on ERO's current knowledge of the project, the project activities would not result in any depletions to the South Platte River and, therefore, would not likely result in any changes to historic patterns of natural depletions to the South Platte River watershed. Because of the lack of depletions, the proposed project would not affect these species.

The project area falls within the general guidelines for a Preble's survey because the project area is within Boulder County below 7,600 feet in elevation. However, the project area is approximately 1 mile north of the Denver metro block clearance zone border marked by U.S. Highway 36, which is located south of the project area (Service 2016). While the project area does contain a small amount of woody wetland vegetation and wetlands along the Goodhue Ditch, the ditch upstream and downstream of the project area loses this shrub component. Additionally, numerous trapping surveys conducted in the vicinity of the project area, along Rock Creek and Coal Creek, have been negative for Preble's (Boulder County Parks and Open Space 1998 and 1999; Stoecker Ecological 1998). The closest known Preble's population is approximately 4.38 miles west of the project area (Beane 1999), with substantial development, human disturbance, and roads between this location and the project area. Because of these reasons, the project is unlikely to support a population of Preble's.

The project area is located in Boulder County, an area where ULTO habitat surveys are required if suitable habitat is present (Service 1992); however, the project area lacks suitable ULTO habitat. The project area around the Goodhue Ditch consists of a narrow riparian wetland adjacent to the ditch, which is heavily vegetated with sandbar willows and lacks the open wet meadow characteristics typical

of ULTO habitat. Additionally, the banks are fairly steep and there is an abrupt transition to grazed uplands dominated by smooth brome. The small areas of emergent wetlands abutting the Goodhue Ditch also lack any of the plant species commonly found with ULTO, and the soils are predominantly clay loam. For these reasons, ERO has determined that suitable ULTO habitat is not present in the project area, and the proposed project is not likely to affect this species.

National Historic Preservation Act Compliance

To assist with the Corps' consultation obligations under Section 106 of the National Historic Preservation Act (NHPA), ERO archaeologist Abigail Sanocki conducted a Class I file search of the project area using the Colorado Office of Archaeology and Historic Preservation online COMPASS database on January 20, 2020. COMPASS identified two overlapping segments of the Goodhue Ditch within the project area: 5BL2719.42 (determined officially not eligible in 1995) and 5BL2719.50 (evaluated as needs data in 2011). In an email to ERO on January 24, 2020, Nicholas Franke determined a formal evaluation of project effects on historic resources is necessary for the Goodhue Ditch (Franke, pers. comm. 2020), and defined the area of potential effects (APE) for a Class III survey as the extent of project construction limits overlapping jurisdictional waters.

ERO conducted the Class III pedestrian survey on February 2, 2020. The survey resulted in reevaluation and expansion of segment 5BL2719.50; no new resources were identified. Because the Goodhue Ditch (5BL2719) has not yet been evaluated in its entirety, the State Historic Preservation Officer considers the entire resource eligible for listing in the National Register of Historic Places for management purposes. However, ERO recommends segment 5BL2719.50 as nonsupporting of the eligibility of the entire resource because it is a part of a lateral system and has poor overall historic integrity. Therefore, ERO recommends a determination of "no adverse effect to historic properties" pursuant to 36 CFR 800.5 of the NHPA.

A survey report detailing the results of ERO's Class I and Class III surveys, methodology, and survey results is included for Section 106 NHPA consultation as Appendix C.

Activity to be Authorized

BBCP is proposing to construct a crossing over the Goodhue Ditch in the project area. The ditch crossing is associated with the Redtail Ridge proposed residential development. BBCP is proposing constructing a crossing for Campus Drive over the Goodhue Ditch to provide vehicular access to the development. The new structure installed would consist of approximately 400 linear feet of 54-inch reinforced concrete piping. See Appendix D for Project Plan Sheets for more detail.

The proposed project would permanently impact 0.049 acre of open water and 0.075 acre of adjacent wetlands (Figure 3; Table 3). Additional impacts from construction access would occur along the

Goodhue Ditch surrounding the project area, temporarily impacting approximately 0.003 acre of open water and 0.005 acre of adjacent wetlands, but these areas would be restored to preexisting conditions.

Table 3. Summary of impacts on wetlands and waters of the U.S.

Water/Wetland	Permanent Impacts (acres)	Temporary Impacts (acres)
Open Water	0.049	0.003
Wetland	0.075	0.005
Total Impacts	**0.124**	**0.008**

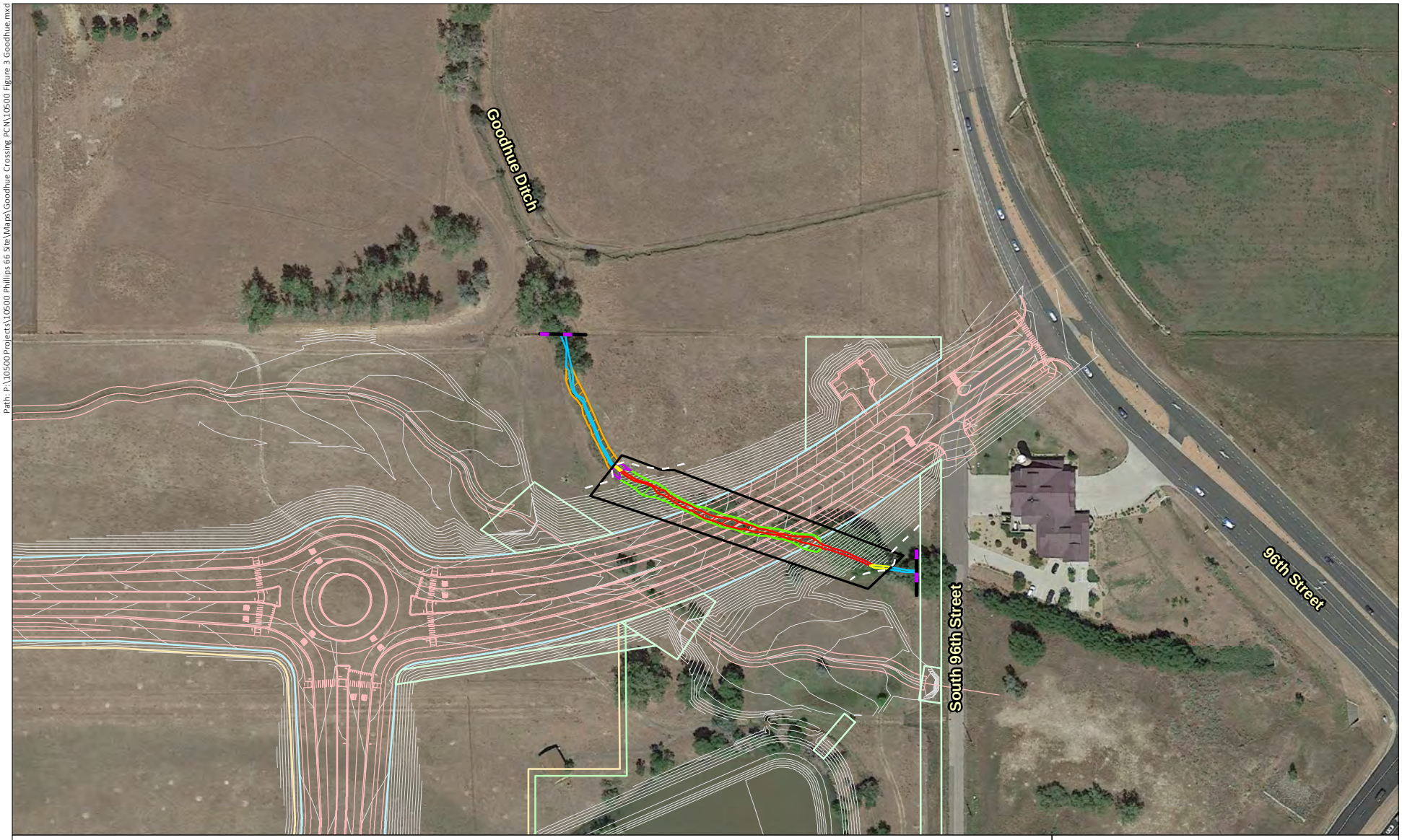
Avoidance and Minimization

The project has been designed to minimize impacts on waters of the U.S. and wetlands in the project area to the maximum extent possible, including minimizing the size of the culvert to reduce impacts on the Goodhue Ditch. The project has been designed to avoid and minimize impacts on areas outside of the project area limits. All temporary impacts associated with the project would be returned to pre-project conditions following completion of the proposed activities. In addition to the avoidance and minimization measures listed above, Best Management Practices (BMPs) would be implemented during construction to minimize indirect impacts on the adjacent wetlands abutting the Goodhue Ditch. These BMPs include installing temporary fencing to deter access to areas outside the project area limits, staging vehicles and equipment in upland areas, and installing sediment- and erosion-control devices, including erosion-control blankets, to minimize surface runoff in disturbed areas.

Mitigation

BBCP is not proposing specific compensatory wetland mitigation because less than 0.10 acre of wetlands would be impacted by the proposed project and the project would result in minimal adverse effects on the aquatic environment. All temporarily disturbed areas in the project area would be planted with native seed mixes appropriate for the site conditions and mulched directly after completion of construction.

Path: P:\10500 Projects\10500 Phillips 66 Site\Maps\Goodhue Crossing PCN\10500 Figure 3 Goodhue.mxd



Goodhue Ditch Crossing PCN

- Limit of Delineation
- Ordinary High Water Mark (0.071 ac)
- Wetland (0.121 ac)
- Project Area
- Permanent Ordinary High Water Mark Impact (0.049 ac)
- Permanent Wetland Impact (0.075 ac)
- Temporary Ordinary High Water Mark Impact (0.003 ac)
- Temporary Wetland Impact (0.005 ac)

0 100 200 Feet

N

Figure 3
Proposed Impacts

Image Source: Google Earth©, September 2019

Prepared for: Brue Baukol
Capital Partners
File: 10500 Figure 3 Goodhue.mxd (GS)
February 6, 2020

ERO Resources Corp.

Compliance with Nationwide and Regional Permit Conditions

ERO believes this work is authorized under NWP 14 for Linear Transportation, NWP 46 for Discharges in Ditches, or other appropriate NWPs as determined by the Corps. As currently designed, the proposed project complies with all applicable NWP general and Colorado regional conditions associated with current NWPs. All temporary and permanent impacts have been limited to the minimum amount necessary to construct the project.

Before commencing work in the project area, if construction would occur during the active nesting season, the project area would be surveyed for active nests in compliance with general condition 4 and the Migratory Bird Treaty Act. The project area was evaluated for threatened and endangered species habitat, and ERO recommends the project area is unlikely to support any federally threatened or endangered species and, therefore, would have no effect on threatened and endangered species in compliance with general condition 18 and the ESA. The project area was evaluated for historic resources, and ERO recommends the project does not have potential to affect historic properties in compliance with general condition 20 and the NHPA.

Project Contacts

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Appendix A Photo Log

Photo Log
Goodhue Ditch Crossing
Boulder County, Colorado
August 23, 2019

Photo 1 - Overview of Goodhue Ditch just outside of the northern project area boundary. View is to the north.

Photo 2 - Overview of wetlands abutting Goodhue Ditch. View is to the southeast.

Appendix B Routine Wetland Determination Datasheets

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: Phillips 66 Site | City/County: Louisville/ Boulder | Sampling Date: 8/23/2019

Applicant/Owner: Brue Baukol Capital Partners | State: CO | Sampling Point: DP1

Investigator(s): H. Gerstung, A. Wistrom | Section, Township, Range: 20, T1S, R69W

Landform (hillslope, terrace, etc.): terrace | Local relief (concave, convex, none): none | Slope (%): 1

Subregion (LRR): G | Lat: 39.949960°N | Long: 105.129775°W | Datum: NAD83

Soil Map Unit Name: Nunn clay loam, 1 to 3 percent slopes | NWI classification: R4SBC

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ☒ No ☐ (If no, explain in Remarks.)

Are Vegetation N, Soil N, or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes ☐ No ☒

Are Vegetation N, Soil N, or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ☐	No ☒	**Is the Sampled Area within a Wetland?** Yes ☐ No ☒
Hydric Soil Present?	Yes ☐	No ☒	
Wetland Hydrology Present?	Yes ☐	No ☒	

Remarks:

Terrace above drainage

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
	= Total Cover		
Sapling/Shrub Stratum (Plot size: 15')			
1. Salix exigua	10	Yes	FACW
2.			
3.			
4.			
5.			
	10 = Total Cover		
Herb Stratum (Plot size: 5')			
1. Onopordum acanthium	20	Yes	UPL
2. Bromus inermis	35	Yes	UPL
3. Cirsium arvense	20	Yes	FACU
4. Dipsacus fullonum	10	No	FACU
5.			
6.			
7.			
8.			
9.			
10.			
	85 = Total Cover		
Woody Vine Stratum (Plot size:)			
1.			
2.			
	= Total Cover		

% Bare Ground in Herb Stratum 15

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC−): 1 (A)

Total Number of Dominant Species Across All Strata: 4 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 25 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	
FACW species	10	x 2 =	20
FAC species		x 3 =	
FACU species	30	x 4 =	120
UPL species	55	x 5 =	275
Column Totals:	95 (A)		415 (B)

Prevalence Index = B/A = 4.37

Hydrophytic Vegetation Indicators:

☐ 1 - Rapid Test for Hydrophytic Vegetation

☐ 2 - Dominance Test is >50%

☐ 3 - Prevalence Index is ≤3.0[1]

☐ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

☐ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ☐ No ☒

Remarks:

SOIL

Sampling Point: DP1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5) (**LRR F**)
- ☐ 1 cm Muck (A9) (**LRR F, G, H**)
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1)
- ☐ 2.5 cm Mucky Peat or Peat (S2) (**LRR G, H**)
- ☐ 5 cm Mucky Peat or Peat (S3) (**LRR F**)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1)
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ High Plains Depressions (F16) (**MLRA 72 & 73 of LRR H**)

Indicators for Problematic Hydric Soils[3]:

- ☐ 1 cm Muck (A9) (**LRR I, J**)
- ☐ Coast Prairie Redox (A16) (**LRR F, G, H**)
- ☐ Dark Surface (S7) (**LRR G**)
- ☐ High Plains Depressions (F16) (**LRR H outside of MLRA 72 & 73**)
- ☐ Reduced Vertic (F18)
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (inches): _____

Hydric Soil Present? Yes ☐ No ☒

Remarks:

Soil not sampled due to upland vegetation and lack of hydrology indicators.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Salt Crust (B11)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Dry-Season Water Table (C2)
- ☐ Oxidized Rhizospheres on Living Roots (C3) (**where not tilled**)
- ☐ Presence of Reduced Iron (C4)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ☐ Surface Soil Cracks (B6)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Drainage Patterns (B10)
- ☐ Oxidized Rhizospheres on Living Roots (C3) (**where tilled**)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ FAC-Neutral Test (D5)
- ☐ Frost-Heave Hummocks (D7) (**LRR F**)

Field Observations:

Surface Water Present? Yes ☐ No ☒ Depth (inches): _____

Water Table Present? Yes ☐ No ☒ Depth (inches): _____

Saturation Present? (includes capillary fringe) Yes ☐ No ☒ Depth (inches): _____

Wetland Hydrology Present? Yes ☐ No ☒

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

no wetland hydrology indicators observed

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: Phillips 66 Site City/County: Louisville/Boulder Sampling Date: 8/23/2019

Applicant/Owner: Brue Baukol Capital Partners State: CO Sampling Point: DP2

Investigator(s): H.Gerstung, A,Wistrom Section, Township, Range: 20, T1S, R69W

Landform (hillslope, terrace, etc.): drainageway Local relief (concave, convex, none): concave Slope (%): <1

Subregion (LRR): G Lat: 39.949979°N Long: 105.129768°W Datum: NAD83

Soil Map Unit Name: Nunn clay loam, 1 to 3 percent slopes NWI classification: R4SBC

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ☒ No ☐ (If no, explain in Remarks.)

Are Vegetation N, Soil N, or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes ☒ No ☐

Are Vegetation N, Soil N, or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ☒ No ☐	**Is the Sampled Area within a Wetland?** Yes ☒ No ☐
Hydric Soil Present?	Yes ☒ No ☐	
Wetland Hydrology Present?	Yes ☒ No ☐	

Remarks:

In drainageway

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
	0	= Total Cover	
Sapling/Shrub Stratum (Plot size: 15')			
1. Populus angustifolia	20	Yes	FACW
2. Salix exigua	30	Yes	FACW
3.			
4.			
5.			
	50	= Total Cover	
Herb Stratum (Plot size: 5')			
1. Phalaris arundinacea	25	Yes	FACW
2. Polygonum hydropiper	10	Yes	OBL
3. Dipsacus fullonum	5	No	FACU
4. Echinochloa crus-galli	2	No	FAC
5.			
6.			
7.			
8.			
9.			
10.			
	42	= Total Cover	
Woody Vine Stratum (Plot size:)			
1.			
2.			
	0	= Total Cover	

% Bare Ground in Herb Stratum 58

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC−): 4 (A)

Total Number of Dominant Species Across All Strata: 4 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	
FACW species		x 2 =	
FAC species		x 3 =	
FACU species		x 4 =	
UPL species		x 5 =	
Column Totals:	(A)		(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

☒ 1 - Rapid Test for Hydrophytic Vegetation

☐ 2 - Dominance Test is >50%

☐ 3 - Prevalence Index is ≤3.0[1]

☐ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

☐ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ☒ No ☐

Remarks:

SOIL

Sampling Point: DP2

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-6	10YR 4/2	95	7.5YR 4/6	5	C	M	SCL	
6-12	10YR 3/2	95	7.5YR 4/4	5	C	M	SCL	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5) (**LRR F**)
- ☐ 1 cm Muck (A9) (**LRR F, G, H**)
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1)
- ☐ 2.5 cm Mucky Peat or Peat (S2) (**LRR G, H**)
- ☐ 5 cm Mucky Peat or Peat (S3) (**LRR F**)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1)
- ☐ Loamy Gleyed Matrix (F2)
- ☒ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ High Plains Depressions (F16) (**MLRA 72 & 73 of LRR H**)

Indicators for Problematic Hydric Soils[3]:

- ☐ 1 cm Muck (A9) (**LRR I, J**)
- ☐ Coast Prairie Redox (A16) (**LRR F, G, H**)
- ☐ Dark Surface (S7) (**LRR G**)
- ☐ High Plains Depressions (F16) (**LRR H outside of MLRA 72 & 73**)
- ☐ Reduced Vertic (F18)
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (inches): _____

Hydric Soil Present? Yes ☒ No ☐

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ☒ Surface Water (A1)
- ☐ High Water Table (A2)
- ☒ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Salt Crust (B11)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Dry-Season Water Table (C2)
- ☐ Oxidized Rhizospheres on Living Roots (C3) (**where not tilled**)
- ☐ Presence of Reduced Iron (C4)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ☐ Surface Soil Cracks (B6)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Drainage Patterns (B10)
- ☐ Oxidized Rhizospheres on Living Roots (C3) (**where tilled**)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☒ Geomorphic Position (D2)
- ☒ FAC-Neutral Test (D5)
- ☐ Frost-Heave Hummocks (D7) (**LRR F**)

Field Observations:

Surface Water Present? Yes ☒ No ☐ Depth (inches): Surface

Water Table Present? Yes ☐ No ☒ Depth (inches): _____

Saturation Present? (includes capillary fringe) Yes ☒ No ☐ Depth (inches): Surface

Wetland Hydrology Present? Yes ☒ No ☐

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Appendix C Cultural Resource Survey Report

ERO

Consultants in Natural Resources and the Environment

Cultural Resource Survey
Redtail Ridge Development-Goodhue Ditch Crossing
Boulder County, Colorado

Prepared for—

Brue Baukol Capital Partners
1555 Blake Street #210
Denver, Colorado 80202

Submitted to—

U.S. Army Corps of Engineers
Denver Regulatory Office
9307 South Wadsworth Boulevard
Littleton, Colorado 80128

Prepared by—

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Written by—

Matthew Howryla
Abigail Sanocki

Prepared under the supervision of—

Sean Larmore, Principal Investigator

State Permit No. 2019-75573
SHPO Report ID BL.AE.R23
ERO Project No. 10500

February 2020

For Official Use Only: Disclosure of site locations prohibited (43 CFR 7.18)

Abstract

Brue Baukol Capital Partners contracted ERO Resources Corporation (ERO) to conduct a cultural resource survey for construction of a new road crossing over the Goodhue Ditch in association with the proposed Redtail Ridge housing development. The proposed crossing would include blading and paving a new road and installing an approximately 400-foot-long reinforced concrete pipe. Because the project would impact waters of the U.S., the U.S. Army Corps of Engineers (Corps) will be issuing a Clean Water Act permit for the project. As part of the Corps' review of the permit application, the Corps will evaluate potential effects of the undertaking on historic properties pursuant to Appendix C of the Clean Water Act and Section 106 (54 United States Code (U.S.C.) § 306108) of the National Historic Preservation Act (54 U.S.C. § 300101 et seq.) (NHPA, 1966, as amended).

The Corps defined the area of potential effect (APE) for the cultural resource survey as all areas of impacts on waters of the U.S. with a 20-foot buffer (0.636 acre). Within or overlapping the APE, ERO reevaluated segment 5BL2719.50 of the Goodhue Ditch. ERO recommends 5BL2719.50 as nonsupporting the eligibility of the entire resource for listing in the National Register of Historic Places. Therefore, ERO recommends a determination of "no adverse effect to historic properties" pursuant to 36 Code of Federal Regulations 800.5 of the NHPA.

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Appendices

Appendix A Cultural Resource Location Map
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Cultural Resource Survey
Redtail Ridge Development-Goodhue Ditch Crossing
Boulder County, Colorado

February 2020

Project Description

Brue Baukol Capital Partners contracted ERO Resources Corporation (ERO) to conduct a cultural resource survey for construction of a new road crossing over the Goodhue Ditch in association with the proposed Redtail Ridge housing development. The proposed crossing would include blading and paving a new road and installing an approximately 400-foot-long reinforced concrete pipe. Because the project would impact waters of the U.S., the U.S. Army Corps of Engineers (Corps) will be issuing a Clean Water Act (CWA) permit for the project. As part of the Corps' review of the permit application, the Corps will evaluate potential effects of the undertaking on historic properties pursuant to Appendix C of the CWA and Section 106 (54 United States Code (U.S.C.) § 306108) of the National Historic Preservation Act (54 U.S.C. § 300101 et seq.) (NHPA, 1966, as amended).

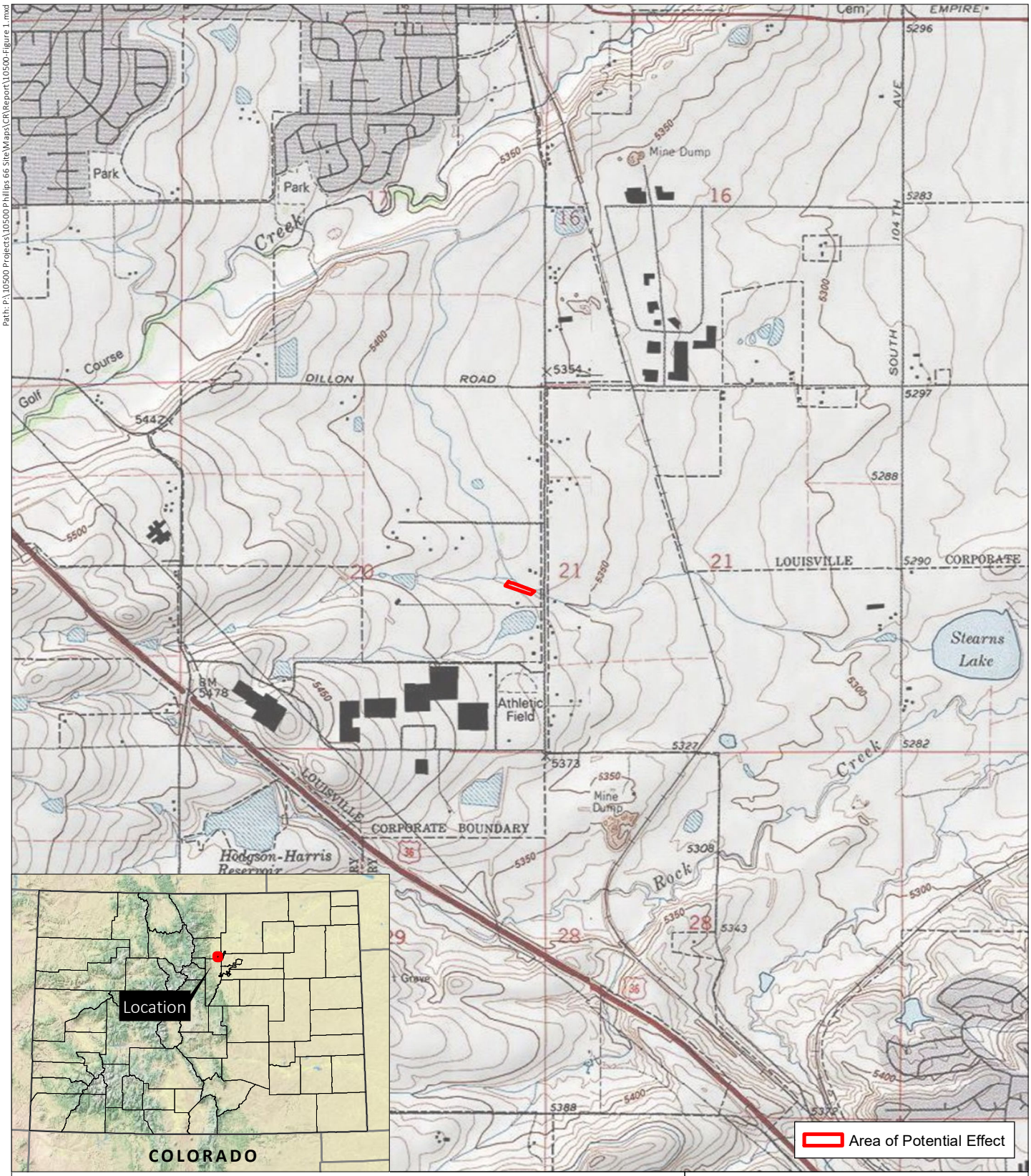
The Corps defined the area of potential effect (APE) for the cultural resource survey as all areas of Corps-permitted impacts on waters of the U.S. with a 20-foot buffer (0.636 acre). Land within the APE is owned by the Phillips 66 Company. The APE is located on the Louisville 7.5-minute U.S. Geological Survey (USGS) quadrangle (Figure 1). The legal location is the northeast quarter of the southeast quarter of Section 20, Township 1 South, Range 69 West of the 6th Principal Meridian in Boulder County, Colorado.

ERO archaeologist Abigail Sanocki conducted a Class III cultural resource survey of the APE on February 2, 2020.

Natural Environment

Contained within the Colorado Piedmont geological province, the APE is located in the open valley of Coal Creek; the creek is about 1.25 miles to the northwest. The area is characterized as a broad valley surrounded by rolling hills and mesas with shallow ephemeral drainages (Figure 2). The elevation of the APE ranges from 5,365 feet (ft) above sea level (asl) to 5,370 ft asl. Moderately dense grasses allowed for 60 to 90 percent ground visibility at the time of survey. The surface geology consists of Laramie and Fox Hills Sandstone formations comprised of sedimentary sandstone, shale, and claystone (Green 1992).

Path: P:\10500 Projects\10500 Phillips 66 Site\Maps\CR\Report\10500-Figure 1.mxd



Cultural Resource Survey
Redtail Ridge Development-Goodhue Ditch Crossing
Boulder County, Colorado

Section 20, Township 1S, Range 69W; 6th PM
USGS Louisville, CO Qudranlge (1:24,000, 1980)
Boulder County, Colorado

N

0 1,000 2,000 Feet

1:24,000

Figure 1
Project Location

Prepared for: Brue Baukol
Capital Partners
File: 10500-Figure 1.mxd (MH)
February 5, 2020

ERO Resources Corp.

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Based on the Web Soil Survey data compiled by the Natural Resources Conservation Service (NRCS), soils within the APE consist of Nunn Clay Loam 1 to 3 percent slope and Valmont Clay Loam, 1 to 3 percent slope. Nunn Clay Loams are typically found on terraces and are derived from Pleistocene age alluvium or eolian deposits. Valmont Clay Loams are typically found on terraces and alluvial fans and are derived from gravelly and cobbly alluvium (NRCS 2020).

Vegetation along the banks of the Goodhue Ditch is predominantly sandbar willow (*Salix exigua*), peachleaf willow (*Salix amygdaloides*), reed canarygrass (*Phalaris arundinacea*), and marshpepper knotweed (*Polygonum hydropiper*). Uplands adjacent to the Goodhue Ditch are dominated by smooth brome (*Bromus inermis*). Fauna includes coyotes, cottontails, jackrabbits, foxes, rodents, and various bird species.

Figure 2. APE overview, view to the northwest.

Cultural Overview

The overview provided here is regional and intended to provide a context for the historical development and construction of resources identified in the APE. Because no prehistoric resources were identified during ERO's survey, an intensive cultural overview of the prehistory of the region is unnecessary; refer to *Colorado Prehistory: A Context for the Platte River Basin* (Gilmore et al. 1999) for a complete overview.

The earliest settlements in the eastern plains of Colorado were established by Hispanic settlers. Until the end of the Mexican-American War and the transfer of control of large areas of the West to the

United States in 1848, most American contact with the area was in the form of exploratory and military parties. A second period of agricultural settlement was initiated by the discovery of gold in Colorado in 1858 (Church et al. 2007). Large numbers of individuals left the economically depressed Mississippi Valley to travel to Colorado in the hopes of wealth. While many failed and returned to the east, a number stayed to occupy mining communities or establish agricultural or commercial venues in the Colorado plains to supply miners and travelers. The United States government began to encourage western expansion and settlement following the Civil War by establishing a series of acts. The Homestead Act of 1862 encouraged the settlement of Colorado's plains for agricultural purposes by ensuring settlers could obtain cheap land.

Originally a prospector camp in 1858, the city of Boulder grew as a jumping-off point and supply center for gold seekers and early territorial settlers. In early 1859, A.A. Brookfield organized the Boulder City Town Company. As president, he platted the first subdivision along Pearl Street and sold lots to settlers for building cabins, stores, and cultivation. This subdivision quickly grew into a busy commercial district with mercantile, hardware, mining supply stores, banks, gambling establishments, and boarding houses (Baldwin 1978; Stone 1918). During the territorial days, these businesses were primarily directed at providing supplies and services to miners. As the mountain mining industry declined and after Colorado obtained statehood in 1876, the City's industries diversified when the University of Colorado was established and agricultural development on the high plains became important for subsistence and economic survival (Abbott et al. 2005; Baldwin 1978).

By the 1880s, waves of settlers were arriving in the plains and claiming the land Congress set aside for settlement. The settlers' migration and the establishment of agriculture further aided in the growth of Boulder and other Front Range towns, and prompted the construction of grain mills in the area (Baldwin 1978). The success of agriculture was further aided by the construction of railroad spurs across the Front Range by railroad companies organized by Colorado financiers and, later, state and federal government projects to improve highways across the plains (Fraser and Strand 1997). By 1889, permanent agricultural and ranching operations had been established throughout the plains, and the sustainability of these settlement efforts was increased by the establishment of irrigation systems and reservoirs (Church et al. 2007; Mehls 1982).

Due to Colorado's semiarid climate, agricultural development and permanent settlement would not have been possible without the construction of advanced water irrigation and conveyance systems. Irrigation ditches and canals across the state divert water from rivers and streams and carry it to agricultural areas and reservoirs. The era of historical agricultural irrigation in Colorado began in the south-central part of the state, in the San Luis Valley, with the construction of the San Luis People's Ditch in 1852 (Colorado Irrigation Centennial Committee 1952).

Typically, the first ditches constructed in an area, known as pioneer ditches, were used to irrigate low-lying areas in the floodplains and bottomlands by drawing water off of existing sources such as creeks, rivers, and streams. These early irrigation systems required little engineering or technology (King 1984). The best land in the immediate vicinity of rivers was claimed early on, so later settlers of lands further from the river sought a way to carry water through ditch systems for a greater distance (Colorado

Irrigation Centennial Committee 1952). In 1861, at the first session of the Colorado Territorial Legislature, an act was passed that allowed a landowner who was not adjacent to a stream to construct a ditch through land lying between his land and the stream to gain access to irrigation water (City of Boulder 2009). By the early 1860s, settlers were constructing much larger and longer ditch irrigation systems that required more sophisticated engineering and construction techniques. Some of these new systems expanded or replaced the early pioneer ditches, and some were entirely new enterprises.

Many of the early pioneer ditches were constructed by individuals, and some were constructed by several irrigators who banded together to form a mutual ditch company; larger ditches were almost always constructed by mutual ditch companies (Holleran 2005). Mutual ditch companies are legal entities in Colorado that allow ditches to be used by multiple individuals who are shareholders in the ditch company that operates the facility on their behalf. A share in a mutual ditch company represents an actual pro rata ownership interest in all of the water rights, ditches, facilities, and other assets of the company. The shareholders are, in essence, the company (Hobbs 1997).

In the late 19th and early 20th centuries, development of new irrigation ditches in Colorado began to be viewed as an investment opportunity, with speculators often enticing investors from the eastern United States with promises of quick wealth. Investors living in commercial centers on the East Coast and in Western Europe provided large sums of money for constructing irrigation systems to reach more remote areas of land in the hopes of creating a profit by selling water rights or, in many cases, just a contractual right to use water from water rights owned by another (Holleran 2005). Colorado's water laws are based on the appropriation doctrine, which protects the water rights of earlier users from diminishment by later users. Therefore, many of these later ditch investment companies were less successful than originally planned because of the limited quantity of water available to them (Holleran 2005). While many of the investment-style water companies tried to incorporate older systems or buy out senior water rights, it was soon realized that the maintenance costs of the irrigation ditches would prevent water companies from making a profit (Holleran 2005).

Many of the investment water companies' irrigation systems were not as profitable as anticipated and were later taken over by their users in the form of mutual ditch companies or irrigation districts. Irrigation districts were developed as a method to help diffuse the cost of developing a ditch system. The districts could be organized by a majority of the landowners within their boundaries, with acquisitions and construction paid through bonds paid off by assessments on all irrigated lands in the district. Irrigation districts were soon developed in some regions of Colorado as a means to acquire earlier failed irrigation companies and develop reservoirs and new canals to support existing systems (Holleran 2005).

As the demand on Colorado's water resources increased, it became necessary for the state to implement laws overseeing water rights and monitoring the amount of water diverted by each ditch system (Mehls and Mehls 2006). In 1889, state law mandated the installation of headgates to control and measure water flow. Most early attempts at water measurement tended to be unreliable as these methods were based on the calibration of laterals and headgates. Accurate flow measurements required the development of a measurement structure separate from the control gate. The need for

accurate measurements led to the development of several devices, including the Cipolletti weir, a measured opening across the flow of the ditch, and the Parshall flume, which is precalibrated to give a true flow measurement at a range of volumes (Holleran 2005).

The technology available for the construction of irrigation ditch systems has also improved, and many historical ditches have undergone modifications and improvements that help conserve water and monitor flow allotments. One significant change in ditch construction is the increased use of concrete, which began in the late 19th and early 20th centuries, when the cost decreased. Concrete can be seen in ditch features such as headgates and weirs and also as a channel liner in sections of a canal particularly susceptible to erosion or seepage. Another improvement was the development of patent iron or steel headgates in the 1890s. These iron and steel headgates replaced wooden gates, which had short life spans. Manufactured gates are usually set in concrete headwalls, although some earlier constructions were stone. Lastly, the most significant improvement to irrigation ditches was the use of electric-powered pumps to force water into field ditches or irrigation sprinklers (Holleran 2005), which began in the 1930s.

Methods

Historic Property Identification

This cultural resource survey provides compliance under Section 106 of the NHPA and its implementing regulations under 36 Code of Federal Regulations (CFR) Part 800 by undertaking a "reasonable and good faith effort" to identify historic properties (defined as listed in or eligible for listing in the National Register of Historic Places (NRHP)) within the defined APE. Identification and documentation standards conform to federal land managing agency requirements and secondly to guidelines provided by the State Historic Preservation Officer (SHPO). In doing so, the standards imposed by the *Secretary of the Interior for the Identification, Documentation, and Evaluation of Historic Properties* are also met. All personnel supervising survey and documentation are listed in applicable federal and state permits and meet or exceed the *Secretary of the Interior's Professional Qualification Standards* (36 CFR 61).

Historic properties may consist of buildings, structures, objects, or sites and can include districts, landscapes, and traditional cultural properties. The National Park Service has established an age criterion of 50 years for historic property evaluation and to be listed in the NRHP (but see criteria consideration (g) for an exception to the age guideline); in some instances, a federal agency will establish the age criterion at 45 years to account for the duration of the undertaking.

Cultural resources not identified in the Office of Archaeology and Historic Preservation (OAHP) file search and historical records were identified during pedestrian survey. This project used standard pedestrian survey transects spaced 15 to 20 meters (m) apart to identify unknown cultural resources within the APE. The APE is defined by the lead federal agency, generally in consultation with the SHPO, and means "the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character of use of historic properties, if any such properties exist" (36 CFR 800.16).

Cultural Resource Documentation

ERO documents cultural resources according to a standardized approach to ensure consistency and accuracy. Sites are digitally documented from multiple perspectives, and all significant tools, diagnostic artifacts, and features are photographed to scale. The site datum is also photographed if physically established and directed by the land managing agency. Individual site maps are produced using a mapping grade (submeter- and subcentimeter-capable) Trimble GeoXH Explorer global positioning system (GPS) unit. Elements of the site map include all cultural features, diagnostic and point provenience artifacts (designated as field specimens (FS)), artifact concentrations, major vegetation breaks and contour topography, modern features and disturbances, and the site datum (whether physically established or for location purposes).

All required forms are completed digitally in the field using a tablet. Archaeological resources and newly defined segments of linear resources such as ditches and railroads were documented using a Management Data Form (OAHP1400) and appropriate component form (prehistoric archaeology, historical archaeology, or linear); the boundaries of newly defined linear resource segments are limited to the extent of the resource within the APE. Newly identified historical buildings and structures were documented on an Architectural Inventory Form (OAHP1403). Previously recorded cultural resources identified during the OAHP file search were revisited and reevaluated on OAHP form 1405; if the resource has not been reevaluated within the last 10 years or substantial changes have occurred to the property since the previous evaluation, ERO rerecorded and reevaluated the resource by completing new state documentation forms. Location maps (Appendix A) and OAHP resource documentation forms (Appendix B) are included only for agency consultation and reside permanently with the OAHP.

Historic Period Sites

Historic period sites include such purposeful activities as homestead, ranching, or agricultural complexes; mining complexes; federal work programs; timber harvesting; and industry, among other site types. Age criteria is established for potential historic sites by referencing general land office (GLO) patents, county assessor records, state water division records, historical maps, and 15’ USGS maps. Historical dumps and artifact scatters without features are evaluated on a case-by-case basis. A single artifact class within a dump, such as sanitary cans, is recorded as an isolated occurrence; conversely, dumps that exhibit diverse artifact classes and date prior to the early part of the 20th century may be documented as archaeological sites, given their information potential.

Linear structures such as water conveyance systems, transmission lines, trails, and roads are documented as sites. An isolated fence line is generally not recorded as a resource unless it demarcates a boundary significant to the history of the area and can be physically linked with a purposeful activity; an isolated fence line may also be documented as a feature of a larger resource. Depending on their cultural context, single or small clusters of mining prospect pits with no associated artifacts are documented as isolated finds (IFs) due to general ubiquity and limited information potential.

Criteria for Evaluation

Documented cultural resources are evaluated for their eligibility to be listed in the NRHP. Significance criteria are codified under 36 CFR 60.4, summarized below:

The quality of significance in American history, architecture, archaeology, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and

a) that are associated with events that have made a significant contribution to the broad patterns of our history [Criterion A]; or
b) that are associated with the lives of persons significant in the past [Criterion B]; or
c) that embody the distinctive characteristics of a type, period, or method of construction, or that represents the work of a master, or that possess high artistic value, or that represent a significant or distinguishable entity whose components may lack individual distinction [Criterion C]; or
d) that have yielded, or are likely to yield, information important in prehistory or history [Criterion D].

Cultural resources that do not meet the 50-year age criterion but that are integral parts of a historic district or carry exceptional importance to the history of the region are considered for eligibility under criteria consideration (g).

Certain kinds of properties are not usually considered for listing in the NRHP: religious properties, moved properties, birthplaces and graves, cemeteries, reconstructed properties, commemorative properties, and properties achieving significance within the past fifty years" (U.S. Department of the Interior, National Park Service 1997). In order for a property to be eligible under a criteria consideration, the property must qualify for one of the four criteria and must possess integrity. Regional contexts and multiproperty nominations are used to evaluate significance under Criteria A, B, and C by defining a period of significance in which the cultural resource achieved significance given events important to the interpretation of history.

Regional contexts (e.g., Church et al. 2007; Gilmore et al. 1999) are used to evaluate significance under Criterion D by determining whether a potential property has the potential to answer defined research questions and/or date to a defined period of significance. Historical sites representative of the built environment (i.e., buildings, structures, and engineered features) typically qualify for listing in the NRHP under at least one of the first three criteria (A–C). Archaeological sites typically qualify exclusively under Criterion D, with notable exceptions. An otherwise heavily disturbed site may still retain information potential from intact features (potential chronometric or subsistence data) or discrete areas of the site that retain physical integrity. Archaeological sites with significant sediment deposition remain potentially eligible for listing in the NRHP even without evaluative testing.

Sites evaluated as "needs data" may be eligible under one or more criteria but require further work to determine NRHP eligibility. Cultural resources recommended "needs data" are predominantly archaeological sites (either prehistoric or historical) suspected of containing buried cultural deposits or historical sites where additional research is necessary to ascertain significance. Sites that are evaluated

as not eligible for listing in the NRHP do not meet any of the eligibility criteria and/or have lost physical integrity. Cultural resources are assessed for integrity only if the site meets one or more eligibility criteria. Eroded or otherwise heavily disturbed archaeological sites are typically not considered eligible since the ability to convey significance in the form of intact cultural deposits (i.e., information potential) has been lost through natural or modern disturbance.

For a property to be eligible under one or more criteria, the property must possess physical integrity and retain most if not all aspects of integrity: *location, design, setting, materials, workmanship, feeling, and association*. Most important of these for any building or structure are the aspects of location, design, and setting. Any property or linear resource that has been relocated/realigned no longer retains integrity of location, perhaps the most important aspect of integrity. The aspect of design is important for demonstrating a building or structure's association with significant historical trends, and is required for a property to qualify under Criterion A or C. Considering most historical properties are still in use, a resource can maintain integrity of design if materials have been maintained in-kind to the design of the original structure or building; for example, in-kind replacement of materials such as wood siding or railroad hardware with modern materials does not diminish integrity of design. However, modern maintenance and upgrades to earthen ditches such as the placement of modern diversion structures and concrete lining does diminish the ditch segment's ability to support eligibility under Criterion A or C. The aspects of feeling and association are intrinsically linked to the aspect of setting; suburban development and modern intrusions on the setting of a potential historic property diminish its ability to convey significance.

ERO uses the following generalized approach to assess integrity under Criterion D. Most archaeological sites are considered to be in their original *location* unless post-depositional processes, such as erosion, have transported artifacts away from their original context. Artifacts can move both vertically and horizontally in subsurface contexts. The site retains *location* if no significant post-depositional processes have altered the primary context of the artifacts. The aspect of *design* is present if the relationship between features or activity loci is apparent and the spatial organization of the site is discernible; *design* may also be present in highly formalized tools such as projectile points, ceramic vessels, architectural elements, or individual features. *Setting* refers to the surrounding physical environment of a site, which may be affected by modern development or changes to the natural environment (such as important biotic species) through climate change or modern development. *Setting* is considered intact if the surrounding environment is similar to the environment during the time of occupation. The aspect of *materials* is almost always retained due to the nature of the archaeological record and the material culture inherent to archaeological sites: If there were no physical artifacts or features (i.e., *materials*) present, there would not be a site. *Workmanship* is retained by the presence of artifacts, architecture, or features emblematic of a particular culture or people, such as a Puebloan kiva or a Clovis projectile point. The aspect of *feeling* is difficult to ascertain for archaeological sites and is often dependent on Native American perspective. Very few of the physical features present during occupation of a prehistoric site still exist in the present to convey a property's character. A site that retains *association* can be linked to a particular cultural-historical period through the presence of diagnostic artifacts or architectural elements or by chronometric means.

Each documented cultural resource described in the Survey Results section, below, is provided a recommendation of NRHP eligibility and evaluated for project effects. Based on this documentation, the lead agency will provide a determination of eligibility for each documented cultural resource based on ERO's recommendation and will provide a determination of project effect on historic properties. The lead agency will then provide the SHPO an opportunity to review and provide comment regarding NRHP eligibility and project effects per 36 CFR 800.4 through 800.5. If, during consultation between the lead agency and SHPO, a determination of "adverse effects to historic properties" occurs, further consultation is required to resolve adverse effects.

File and Literature Review

ERO conducted a file review of the APE using the OAHP's online COMPASS database on January 20, 2020. The database indicates that one previously conducted survey overlaps the entire APE: Lois Berger Group conducted the survey in 2010 on behalf of the Conoco Phillips Company and Boulder County (BL.PA.R29). COMPASS identified two overlapping segments of the Goodhue Ditch within the APE: 5BL2719.42 (determined officially not eligible in 1995) and 5BL2719.50 (evaluated as needs data in 2011). ERO reevaluated and expanded segment 5BL2719.50 during the current survey.

Additionally, ERO reviewed historical maps and aerial photographs. USGS topographic maps since 1899 depict the alignment of the Goodhue Ditch and demonstrate how the ditch builders advantageously appropriated a natural unnamed drainage into the ditch system within the APE (Figure 3) (USGS 1899, 1942, 1950, 1965). Additionally, the sinuous alignment of the natural drainage channel is visible in aerial photographs from 1963, 1964, and 1971. The 1965 USGS map and 1963-1971 aerial photographs depict a corral with small outbuildings located along the north side of the Goodhue Ditch and APE. The corral appears to have been abandoned by 1971 and all structures were removed between 1993 and 1999 (Nationwide Environmental Title Research (NETR) 2020). During the current reevaluation of 5BL2719.50, ERO documented an artifact concentration (AC1) and concrete riprap of various ages; some of these materials may be related to the corral structures.

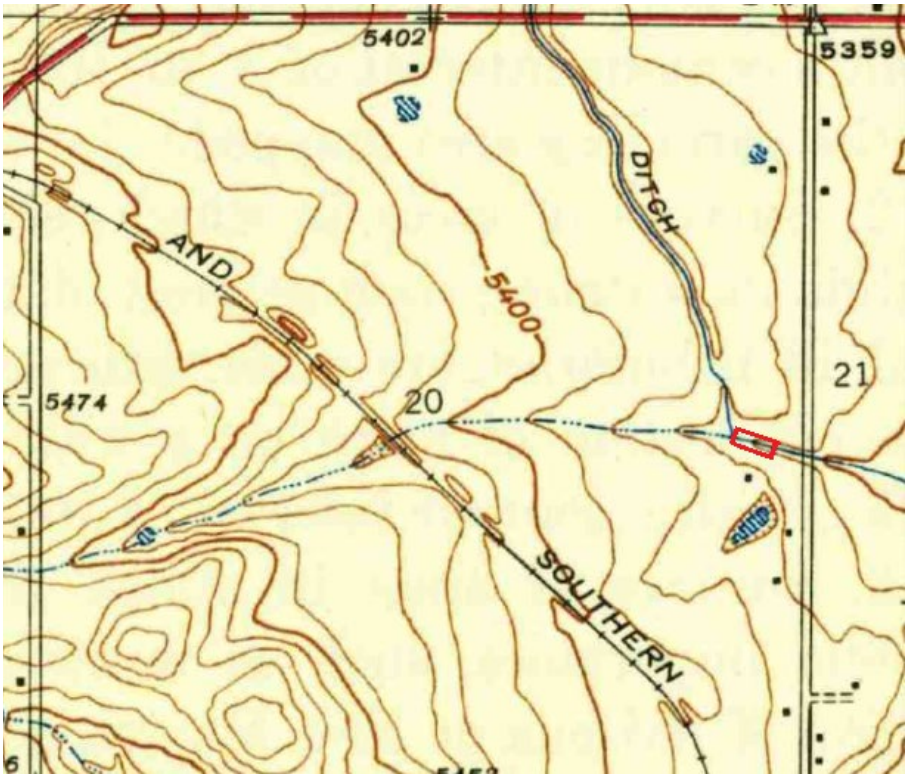

Figure 3. Alignment of Goodhue Ditch and a natural unnamed drainage; APE in red (USGS 1942).

Survey Results

ERO's pedestrian survey resulted in reevaluation and expansion of segment 5BL2719.50. OAHP documentation forms for the segment are included as Appendix B.

Resource Description

5BL2719.50

Goodhue Ditch lateral (segment)

Description: Segment 5BL2719.50 is a roughly 730-ft-long earthen ditch that generally trends northwest to southeast. It is located centrally within a southern lateral of the main Goodhue Ditch; the lateral begins in the Warembourg Open Space approximately 1 mile north of the subject segment and drains into Stearns Reservoir about 0.9 mile southeast of 5BL2709.50. The width of the recorded segment varies from 8 to 20 ft due to erosional slumping along the ditch banks. The depth varies from 6 to 12 ft due to erosion and incision of a central channel in the bottom of the ditch. The entire segment is lined by various types and ages of broken concrete and asphalt riprap, and is also littered with wood, metal, and other modern trash debris that has been washed or blown into the ditch, including PVC pipe, plywood, metal housing for a water pump, fragments of a porcelain toilet, golf and tennis balls, and various types of sheet metal. The ditch has no integrity of materials and design due to a lack of maintenance and the multiple episodes of dumping concrete and asphalt riprap onto its banks for ad hoc erosion control.

ERO documented AC1 on the northeast side of the segment (Figure 4). The concentration contains various types of broken concrete (a board-formed concrete beam with rebar, a prefabricated concrete beam with metal plates, broken concrete sidewalk slabs, and about 20 pieces of broken concrete ranging in size from 4 to 18 inches in diameter); asphalt fragments; broken sandstone flagstone pieces; about 5 common red brick fragments; about 5 wood fence posts; a milk glass fragment; a barrel hoop; aluminum straps; and 4 tennis balls (likely washed or blown into the area from nearby neighborhoods and parks). While some materials are likely associated with the corral that was historically located on the north side of the segment, the variety of concrete types and other materials indicates that AC1 is the result of later maintenance on the ditch and/or use of the area for dumping or storing construction materials.

Abner Goodhue and neighboring farmers began construction on the main Goodhue Ditch in 1873. The 20-mile-long main ditch drew water from South Boulder Creek and drained into Rock Creek. According to research conducted for the Boulder County Ditch Project, local irrigators constructed the south lateral on which segment 5BL2719.50 is located in 1875 or 1885 (Black 2007). Topographic maps and 1960s aerial photographs demonstrate that the builders advantageously incorporated an unnamed natural drainage into the south lateral system and within segment 5BL2719.50 (see Figure 3 above) (NETR 2020; USGS 1942). The Goodhue Ditch & Reservoir Company has continually maintained the ditch throughout the 1900s and for use today. Court records from the Colorado Decision Support System (CDSS) state that between 1970 and 1991 municipalities started allocating ditch water to provide water for the surrounding commercial and residential suburban developments (CDSS 2020).

Figure 4. Overview of AC1, concrete footer and beam visible in mid-ground, view to the northwest.

NRHP Eligibility: Because the Goodhue Ditch has not been evaluated in its entirety, the SHPO considers it NRHP-eligible for management purposes. The ditch is significant under Criterion A for its association

with settlement and development of dryland agriculture. The ditch is not known to be associated with any important people (Criterion B) or to convey any distinctive aspects of design or engineering (Criterion C). Additional research is unlikely to yield important information under Criterion D.

ERO recommends segment 5BL2719.50 as nonsupporting of the eligibility of the entire resource because it is part of a southern lateral and not the main ditch, a portion of the segment is a natural drainage, and the segment has poor overall integrity. The entire segment resembles a natural drainage channel and does not convey any integrity of design, materials, or workmanship due to slumping of the banks, the bottom being heavily incised, and the various types of riprap and modern debris within and along the segment. The segment has poor integrity of setting, feeling, and association due to modern highway expansion and construction of commercial, residential, and recreation developments in the surrounding area. The segment retains integrity of location.

Management Recommendations: No further work.

Summary and Management Recommendations

ERO reevaluated segment 5BL2719.50 of the Goodhue Ditch overlapping the APE and recommends it as nonsupporting of the eligibility of the entire resource for listing in the NRHP. ERO recommends no further work and a determination of “no adverse effect to historic properties” pursuant to 36 Code of Federal Regulations 800.5 of the NHPA.

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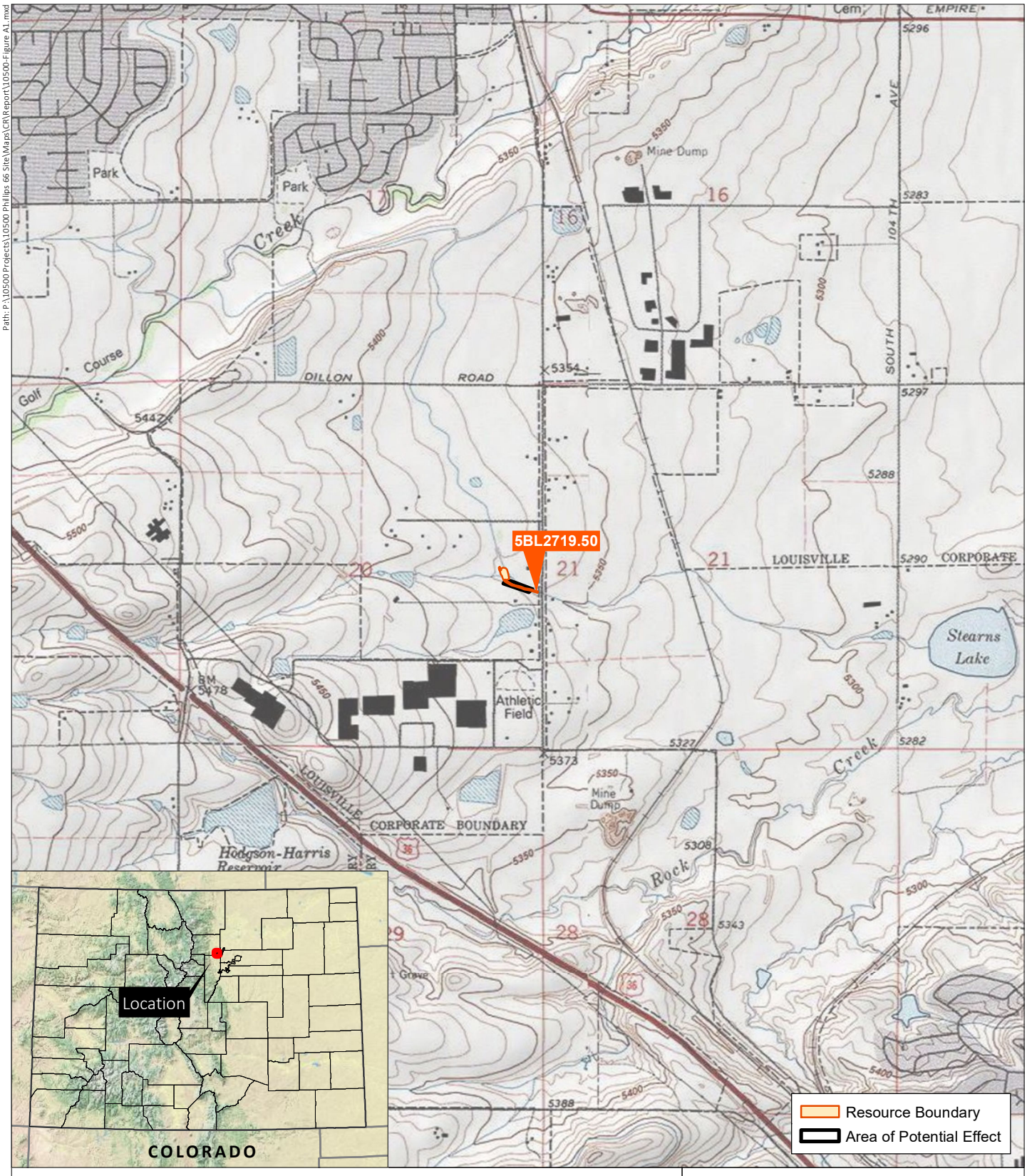
U.S. Geological Survey (USGS)
1899 *West Denver, Colorado* [topographic map]. 1:125,000. U.S. Department of the Interior, Washington DC.
1942 *Louisville, Colorado* [topographic map]. 1:31,680. U.S. Department of the Interior, Washington DC.
1950 *Louisville, Colorado* [topographic map]. 1:24,000. U.S. Department of the Interior, Washington DC.
1965 *Louisville, Colorado* [topographic map]. 1:31,680. U.S. Department of the Interior, Washington DC.

Appendix A Cultural Resource Location Map
For Official Use Only: Disclosure of Site Locations Prohibited (43 CFR 7.18)



Cultural Resource Survey
Redtail Ridge Development-Goodhue Ditch Crossing
Boulder County, Colorado

Section 20, Township 1S, Range 69W; 6th PM
USGS Louisville, CO Qudranlge (1:24,000, 1980)
Boulder County, Colorado

Figure A1
Resource Location

Prepared for: Brue Baukol
Capital Partners
File: 10500-Figure A1.mxd (MH)
February 5, 2020

ERO Resources Corp.

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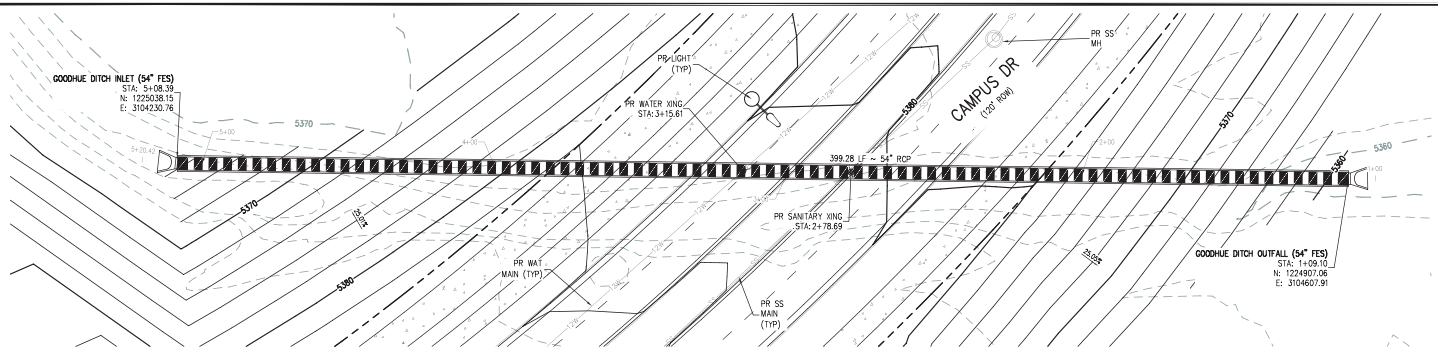
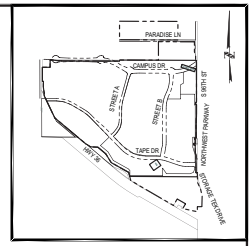
Appendix B OAHP Cultural Resource Documentation Forms
For Official Use Only: Disclosure of Site Locations Prohibited (43 CFR 7.18)

Appendix D Project Plan Sheets



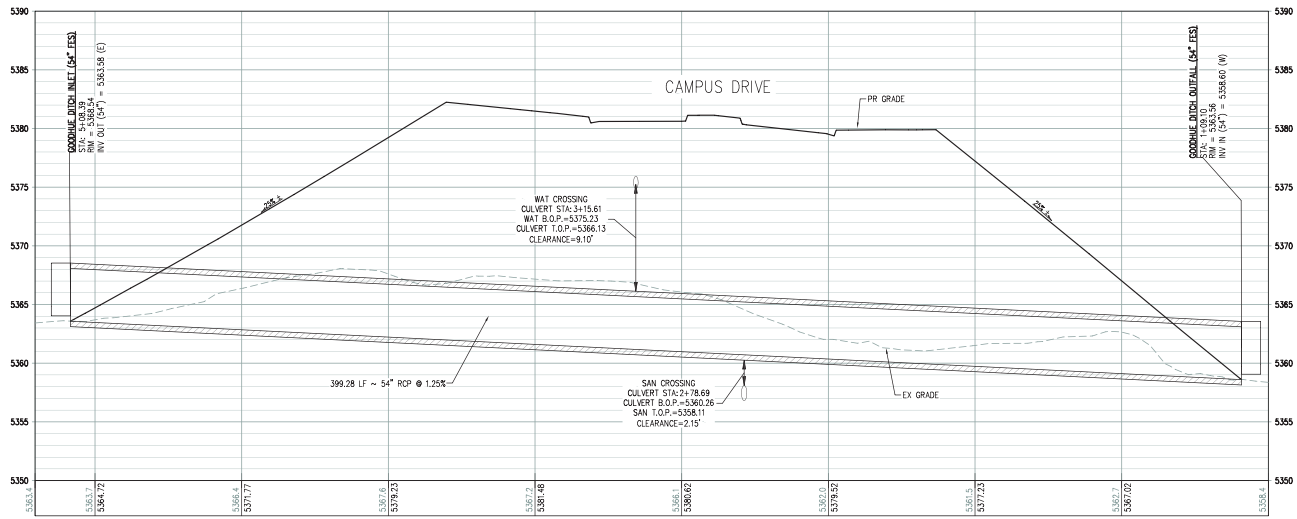
GOODHUE IRRIGATION DITCH CULVERT PLAN

SCALE: 1" = 20'



KEY MAP

SCALE: 1"=2000'



GOODHUE IRRIGATION DITCH CULVERT PROFILE

HORIZONTAL SCALE: 1" = 20'
VERTICAL SCALE: 1" = 5'

NOTES:

1. REFER TO CDOT DETAILS ON SHEETS 68-70 FOR CONSTRUCTION DETAILS.
2. CONCRETE MATERIAL PROPERTIES INDICATED IN STANDARD CDOT DETAILS ON SHEETS 68-70.
3. REFER TO REPORT BY CTL THOMPSON GEOTECHNICAL FOR BORING INFORMATION.
4. CONTRACTOR TO CONFIRM PROJECT RECEIPT OF 404 PERMIT AND CONDITIONS PRIOR TO CONSTRUCTION IN GOODHUE DITCH.

NO CHANGES ARE TO BE MADE TO THIS DRAWING WITHOUT WRITTEN PERMISSION OF HARRIS KOCHER SMITH

FILEPATH: P:\190108\ENGINEERING\DRAWINGS\CD SHEETS\GOODHUE DITCH IRRIGATION CULVERT PAP.DWG LAYOUT: LAYOUT1
8 XREFS: ccd - f1 - stamp - mv - xclose - e-topt - e-dtl - key map - psbase-f1 - p-legal-f1 - p-dtl
PLOTTED: THU 11/14/19 @ 03:39:39 PM BY TIM SAYLOR

Know what's below. Call before you dig.

CALL 3 BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE, OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES.

20 0 20 40
SCALE: 1" = 20'

DESIGNED BY: JMN
CHECKED BY: MAW
DRAWN BY: JMN

HARRIS KOCHER SMITH
1120 Lincoln Street, Suite 1000
Denver, Colorado 80203
P: 303.623.6300 F: 303.623.6311
HarrisKocherSmith.com

BRUE BAUKOL CAPITAL PARTNERS

NAWATNY RIDGE FILING #1
GOODHUE IRRIGATION DITCH - CULVERT PLAN & PROFILE

ISSUE DATE: 11-15-2019	PROJECT #: 190108
DATE	REVISION COMMENTS

PRELIMINARY NOT FOR CONSTRUCTION

SHEET NO.
104
104 OF 190

Mark West

From: Heidi Gerstung <hgerstung@eroresources.com>
Sent: Friday, March 27, 2020 8:57 AM
To: Jordan Swisher; Mark West
Cc: Moneka Worah; Abigail Sanocki
Subject: FW: Update on Goodhue Ditch Crossing, NWO-2020-00467-DEN

Follow Up Flag: Follow up
Flag Status: Flagged

Good morning Jordan and Mark,

While I was preparing this email, we just got one from Nick; but here you go anyway as it provides just a bit more information on it...

Great news! Please see below for the Corps update on this project.

This has happened to us before on other ditch projects when the consultation becomes too difficult. Normally agricultural activities in ditches are what is exempt - so if the company that owned the ditch wanted to pipe it or reconstruct it, they do not need a 404 permit. But technically if it is related to development or another entity that does not own the ditch, then it is not exempt.

Please let us know if you have any questions, thanks!

Heidi Gerstung
Ecologist

ERO Resources Corporation
Consultants in Natural Resources and the Environment
1842 Clarkson Street | Denver, CO 80218
303.830.1188 O | 720.468.2103 C | hgerstung@eroresources.com | https://urldefense.proofpoint.com/v2/url?u=http-3A__www.eroresources.com&d=DwIFAg&c=euGZstcaTDllvimEN8b7jXrwqOf-v5A_CdpgnVfiiMM&r=ADCGPxPp92MbL20W0qzp3g&m=nFNZQ4D8eZasRXG5-ZDhSCj-_7k70AQnEst-L_CLxOI&s=Z69s3B0Libl3Pd2l3VrL64aS9UkDdsoI2fQQVOV-NF4&e=

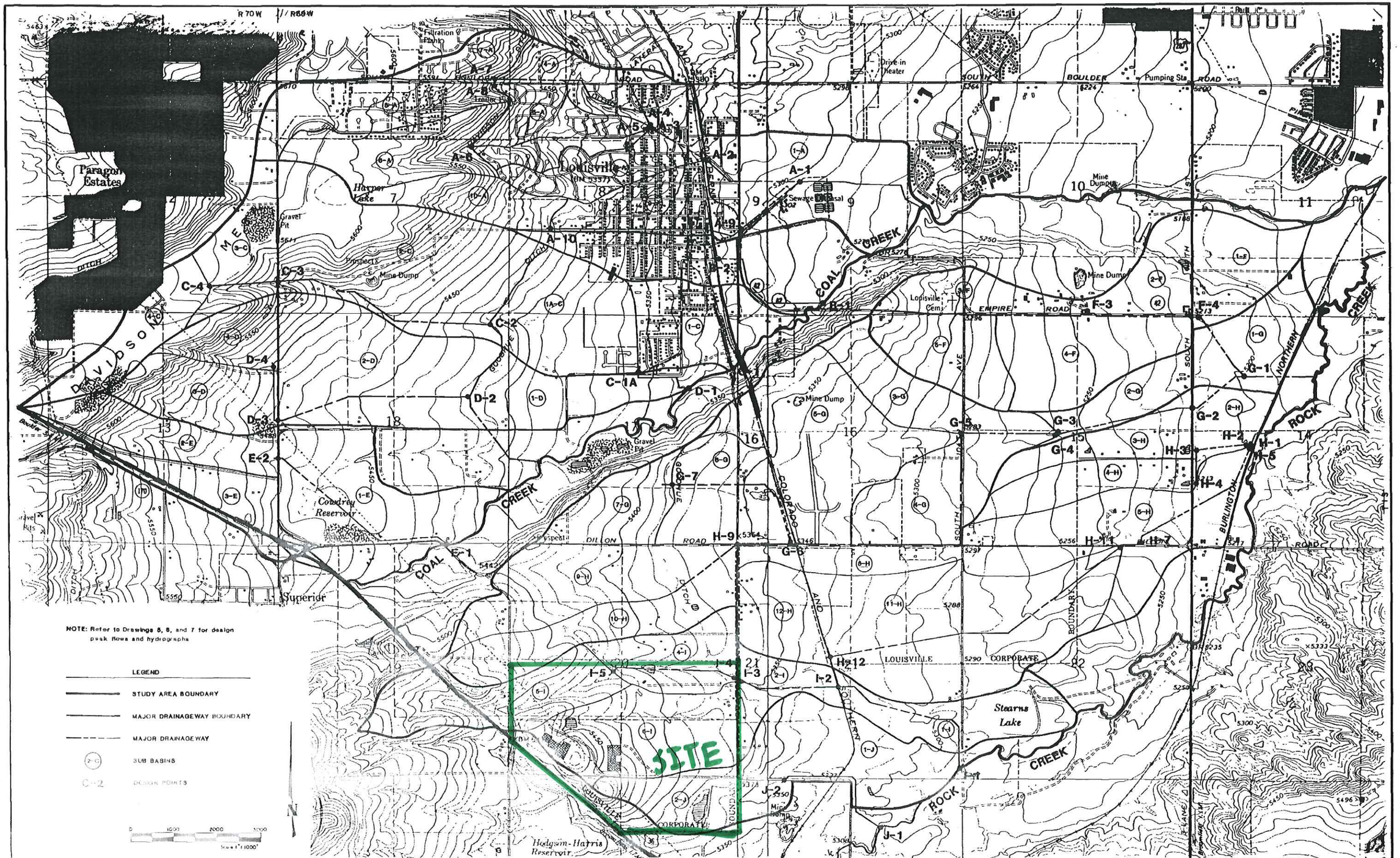
-----Original Message-----
From: Franke, Nicholas A CIV USARMY CENWO (USA) <https://urldefense.proofpoint.com/v2/url?u=http-3A__Nicholas.A.Franke-40usace.army.mil&d=DwIFAg&c=euGZstcaTDllvimEN8b7jXrwqOf-v5A_CdpgnVfiiMM&r=ADCGPxPp92MbL20W0qzp3g&m=nFNZQ4D8eZasRXG5-ZDhSCj-_7k70AQnEst-L_CLxOI&s=HUZjhj_bBWNwW_aUaqh2ppcS3gFbPyJjNLeZyjt7jB0&e=>
Sent: Thursday, March 26, 2020 2:11 PM
To: Heidi Gerstung <hgerstung@eroresources.com>
Subject: Update on Goodhue Ditch Crossing, NWO-2020-00467-DEN

Hi Heidi,

I just wanted to give you a heads-up that we heard back from SHPO; long story short the relationship isn't great, so in the interest of saving time and aggravation for everyone, we are going to go ahead and issue an exemption for this project. It will be considered construction of an irrigation ditch, which is exempt under Section 404(f), and won't require

a permit. You can reference Regulatory Guidance Letter 07-02, which goes into some more technical detail about what is and is not considered construction of an irrigation ditch.

Please let me know if you have any questions or concerns on this. And of course, stay healthy and safe!



BASE MAP
UNITED STATES GEOLOGICAL SURVEY MAP
LOUISVILLE QUAD - - LAFAYETTE QUAD
PHOTOREVISED 1979

WRC WATER RESOURCES CONSULTANTS, INC.
2765 South Colorado Boulevard
Suite 218
Denver, Colorado 80222

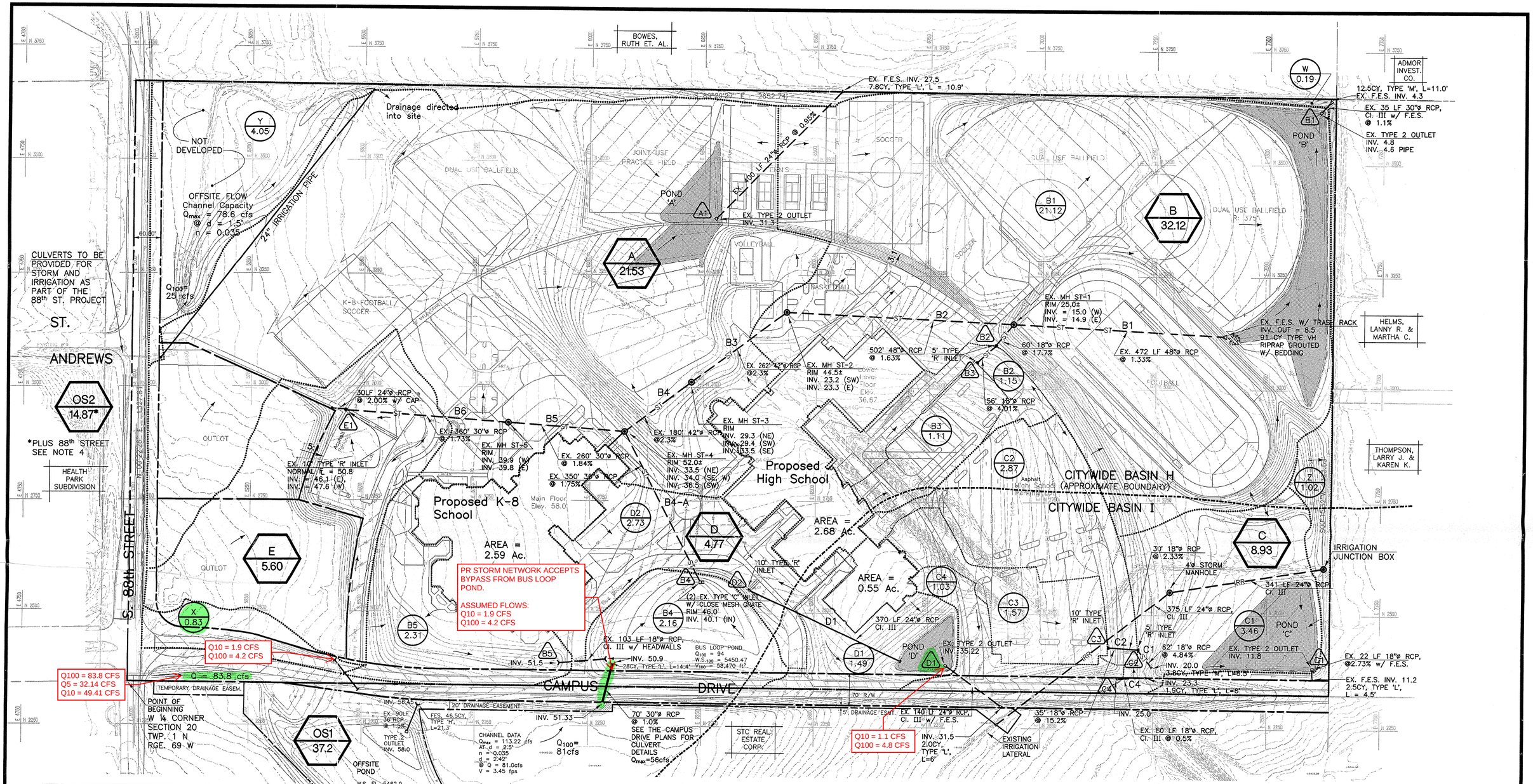
DESIGNED	A.J.L.	DATE	6-82
DRAWN	B.K.H.	DATE	6-82
CHECKED	W.P.R.	DATE	8-82
REVISED		DATE	

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
CITY OF LOUISVILLE BOULDER COUNTY

BASINWIDE MAJOR DRAINAGEWAY PLANNING
SELECTED ALTERNATIVE OUTFALL DESIGN

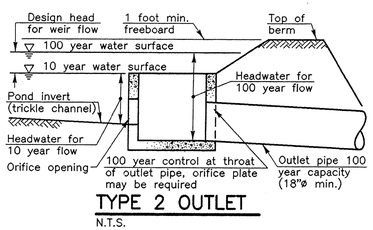
DRAINAGE BASINS

DRAWING 2



CITYWIDE vs. SITE BASIN COMPARISON			
MAJOR** BASIN	AREA	SITE TRIBUTARY BASINS	AREA
H	66.02	A,B,E,W,X,Y,Z* OS1*, OS2*	65.65
I	13.84	C,D,Z*	14.21

* PORTION OF BASIN TRIBUTARY
** APPROXIMATE



TYPE 2 OUTLET
N.T.S.

NOTES:

1. Drainage basins, characteristics, inlets, and concentration points are identified in the Master Drainage report.
2. Existing storm drains and inlets were constructed as part of the Phase I — Overlot Grading contract.
3. Citywide basins are approximate. The boundary shown is taken from the Basinwide Major Drainageway Planning, Drawing 2, prepared by WRC, Inc., Denver, CO.
4. 88th St. design is underway at the time of preparing this report. The 100-year flow at St. Andrews is taken from the preliminary 88th St. drainage analysis, as prepared by Charles Keim & Associates.
5. Offsite tributary drainage analysis is included in the appendix of the drainage report.

LEGEND:

- BASIN ACRES — MAJOR ONSITE BASIN
- BASIN ACRES — MINOR ONSITE BASIN
- A1 — DESIGN POINT
- MAJOR BASIN BOUNDARY
- MINOR BASIN BOUNDARY
- CITYWIDE BASIN BOUNDARY (APPROX.)
- EXISTING STORM DRAIN
- OVERLAND FLOW DIRECTION

DETENTION POND SUMMARY

POND	V_{10} (cfs)	V_{100} (ac. ft.)	Q_{R10} (cfs)	Q_{R100} (cfs)	WS_{10}	WS_{100}
DETAINED BASINS:						
A	0.232	0.426	5.2	21.5	5433.92	5434.34
B	1.039	1.867	7.1	28.2	5407.92	5408.62
C	0.367	0.651	2.1	8.9	5414.60	5415.42
D	1.039	0.250	1.1	4.8	5439.96	5440.45
TOTAL DETENTION RELEASE RATES:			15.5	63.4		
FREE RELEASE BASINS:						
W	—	—	0.3	0.8	—	—
X	—	—	1.9	4.2	—	—
Y	—	—	4.9	15.2	—	—
Z	—	—	2.0	4.5	—	—
TOTAL FREE RELEASE:			9.0	24.6	—	—

TOTAL SITE AREA = 79.86
DEVELOPED AREA = 75.81 (BASIN 'Y' NOT DEVELOPED)
RELEASE FROM DEVELOPED AREA = 72.90 cfs

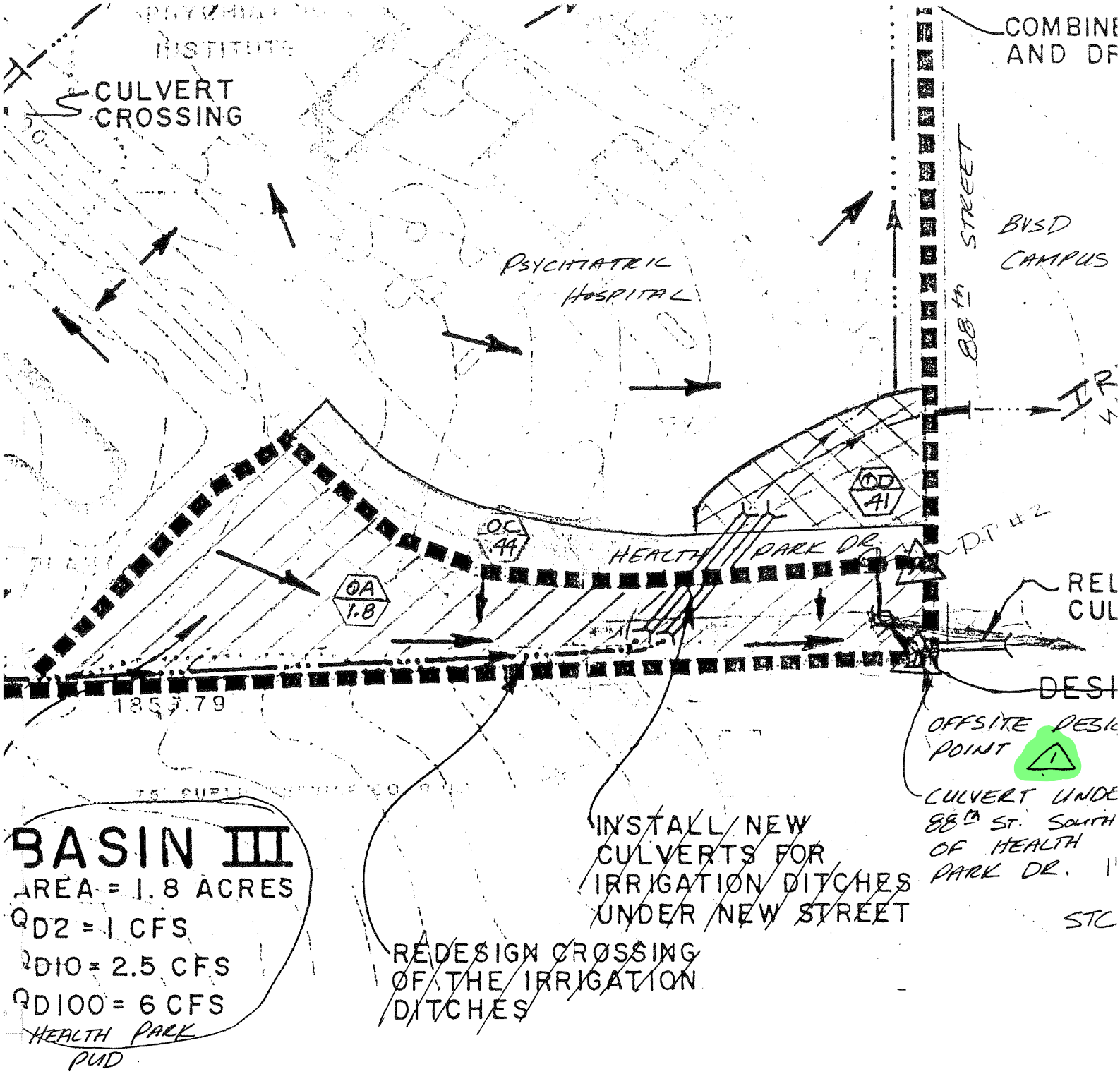
SCALE: 1" = 100'
100 50 0 100 200 400

BVSD LOUISVILLE K-12 CAMPUS
LOUISVILLE, COLORADO
MASTER DRAINAGE PLAN

Charles Keim & Associates
Consulting Engineers
1711 15th St., Suite 200
Boulder, Colorado 80302
(303) 447-0090

Revisions - Date	Date	Designed by	Job No.
	6/24/96	JLB	95-214
	Scale	Drawn by	Sheet of
	1" = 100'	CJC	
		Checked by CRK	Drawing No. D164

C:\Cabeen 6/24/96 2:18 pm C:\DRAWINGS\95-214\DRAINPLAN



OFFSITE BASIN 1-A
HEALTH PARK SUB.

88th & Health Park Drive

Future Developed Flows

5yr Flows			Time Ti (min)			Time Tt (min)					From Fig 13.10.01	
Basin	Area (acres)	C (5yr)	Length (ft)	Slope (%)	Ti (min)	Length (ft)	Slope (%)	Velocity (fps)	Tt (min)	Tc (min)	I (5yr)	Q (5yr)
0C	0.44	0.88	0	3.7	0.0	245	3.7	3.7	1.1	10.0	3.8	1.47
0D	0.41	0.1	80	2	12.8	0	2	2.2	0.0	12.8	3.48	0.14
D.P. #2	**0.85**											**1.61**
0A	1.8	0.4	200	3.4	11.9	800	3.4	1.2	11.1	23.0	2.6	1.87
0B	27.1	0.47	500	3.1	17.5	1850	3.1	2.6	11.9	29.3	2.25	28.66
D.P. #1	**29.75**											**32.14**

10yr Flows			Time Ti (min)			Time Tt (min)					From Fig 13.10.01	
Basin	Area (acres)	C (10yr)	Length (ft)	Slope (%)	Ti (min)	Length (ft)	Slope (%)	Velocity (fps)	Tt (min)	Tc (min)	I (10yr)	Q (10yr)
0C	0.44	0.90	0	3.7	0.0	245	3.7	3.7	1.1	10.0	4.65	1.84
0D	0.41	0.2	80	2	12.8	0	2	2.2	0.0	12.8	4.2	0.34
D.P. #2	**0.85**											**2.19**
0A	1.8	0.45	200	3.4	11.9	800	3.4	1.2	11.1	23.0	3.1	2.51
0B	27.1	0.55	500	3.1	17.5	1850	3.1	2.6	11.9	29.3	3	44.72
D.P. #1	**29.75**											**49.41**

100yr Flows			Time Ti (min)			Time Tt (min)					From Fig 13.10.01	
Basin	Area (acres)	C (100yr)	Length (ft)	Slope (%)	Ti (min)	Length (ft)	Slope (%)	Velocity (fps)	Tt (min)	Tc (min)	I (100yr)	Q (100yr)
0C	0.44	0.93	0	3.7	0.0	245	3.7	3.7	1.1	10.0	7.15	2.93
0D	0.41	0.4	80	2	12.8	0	2	2.2	0.0	12.8	6.5	1.07
D.P. #2	**0.85**											**3.99**
0A	1.8	0.65	200	3.4	11.9	800	3.4	1.2	11.1	23.0	5	5.85
0B	27.1	0.65	500	3.1	17.5	1850	3.1	2.6	11.9	29.3	4.2	73.98
D.P. #1	**29.75**											**83.82**

RUNOFF CALCULATIONS
BVSD - Louisville Campus

All calculations presented are based upon the criteria set forth in the City of Louisville Storm Drainage Design and Technical Criteria

Design Point	Surface Improvement	(ac) Area	2	5	10	100	(%) I	Comments
Sub-basin D								
D1	Lawn, Clay soil	1.24	0.10	0.20	0.30	0.60	0.00	Sheet flow to
	Drives and walks	0.25	0.85	0.87	0.90	0.92	96.00	detention pond
	Area/Avg.	1.49	0.23	0.31	0.40	0.65	16.11	
D2	Lawn, Clay soil	1.80	0.10	0.20	0.30	0.60	0.00	Type R Inlet
	Drives and walks	0.93	0.85	0.87	0.90	0.92	96.00	
	Area/Avg.	2.73	0.36	0.43	0.50	0.71	32.70	
Roofs	High School	0.55	0.80	0.85	0.90	0.90	96.00	Piped to pond
	Total Area	4.77		Avg. % Imperviousness			34.82	

Detention Pond D Sizing

V=kA

k10	k100	(ac-ft) V 10	(ac-ft) V 100
0.029	0.053	0.139	0.25

Pond outlet sizing

	(cfs) 10 yr	(cfs) 100 yr	
Release Rates	1.1	4.8	Type 2 Outlet

Historical Flow

Q2	Q10	Q100
1.1	6.0	19.6

Developed Flow

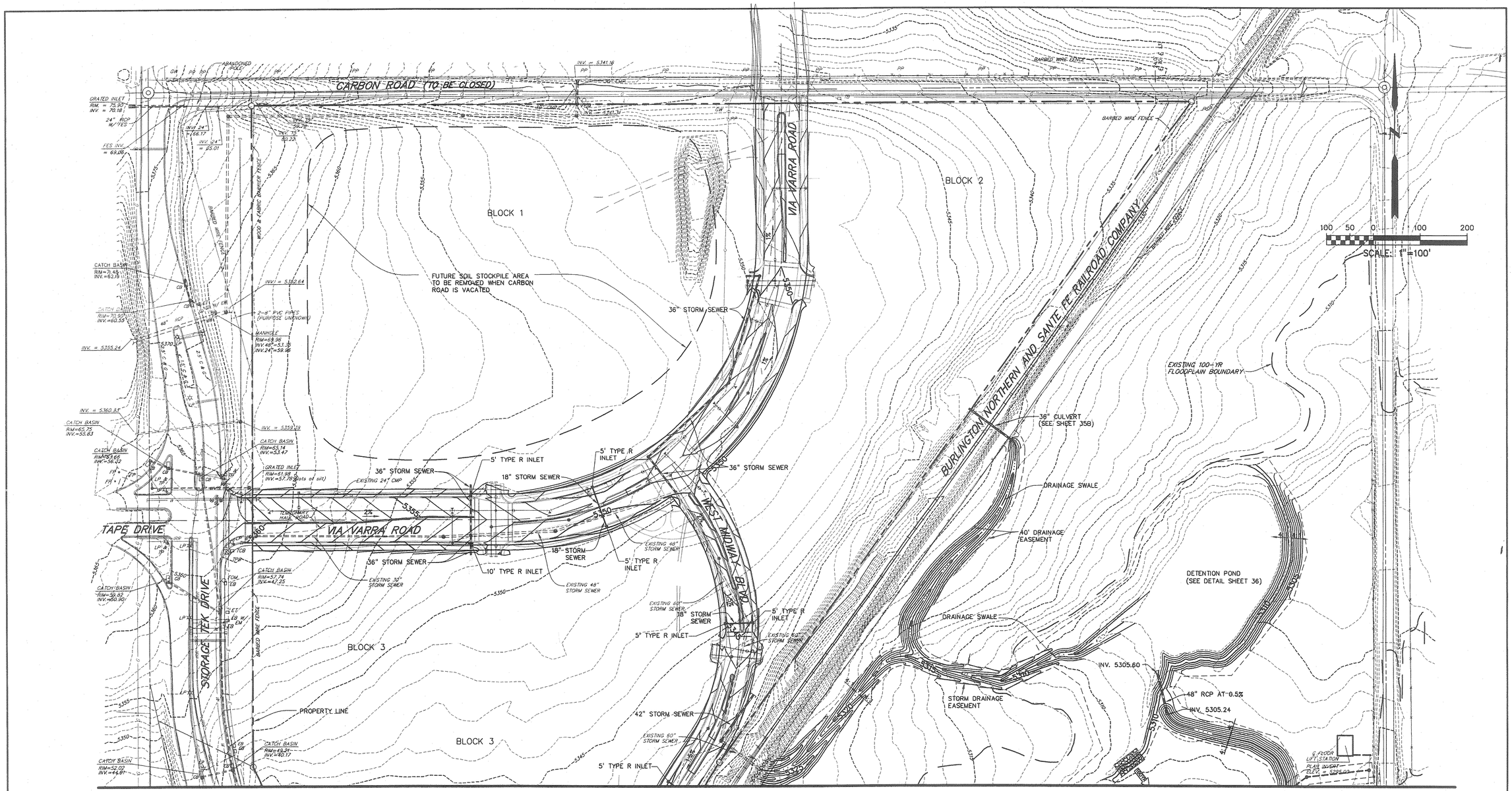
Q2	Q100
4.0	22.5

General Description

Central Plaza area between buildings, front of HS, and Pond D.

D1. Pond E and area outside HS building between Health Park Drive.
D2. Plaza and a portion of the bus loop.

Design Point D1. Standard type 2 outlet.
Design Point D2. Type R inlet in sump condition to intercept 100 yr. flow



MATCH LINE
SEE SHEET 4

LEGEND

- RAILROAD TRACKS
- EX. INTERMEDIATE CONTOUR
- EX. INDEX CONTOUR — 7960 —
- EX. SPOT ELEVATION × 54.67
- PROPOSED CONTOUR 5350
- OPEN CHANNEL
- FLOOD PLAIN BOUNDARY
- STORM DRAIN LINE
- PROPOSED MANHOLE

All work shall be constructed to City and County of Broomfield *STANDARDS AND SPECIFICATIONS*. This drawing has been reviewed and found to be in general compliance with these *STANDARDS AND SPECIFICATIONS* and other City and County requirements. *THE ENGINEERING DESIGN AND CONCEPT REMAINS THE RESPONSIBILITY OF THE PROFESSIONAL ENGINEER WHOSE STAMP AND SIGNATURE APPEAR HEREON.*

Accepted by: _____ City Engineer _____ Date

Job No. _____

4/30/03

COLORADO REGISTERED JOHN ARTHUR EWY 31639 PROFESSIONAL ENGINEER 4-17-03

NOT VALID WITHOUT ORIGINAL SIGNATURE AND DATE

PREPARED BY: Drexel Barrell & Co. Engineers Surveyors
4840 PEARL EAST CIRCLE, SUITE 114 BOULDER, COLORADO 80301 (303) 442-4338
6385 CORPORATE DRIVE COLORADO SPRINGS, COLORADO 80919 (719) 260-0887
5401 W. 10TH STREET, SUITE 100A GREELEY, COLORADO 80634 (970) 351-0645
CONTACT: JOHN EWY

PREPARED FOR: NJD LIMITED
3300 E FIRST AVE. SUITE 510
DENVER, COLORADO 80206
CONTACT: KIM SCOTT
(303) 399-6177

PROJECT INFO: VIA VARRA & WEST MIDWAY IMPROVEMENTS
96TH STREET AND CARBON ROAD
BROOMFIELD, COLORADO

DESIGNED BY:	REVISION DESCRIPTIONS	DATE
JE/AP	REVISED PER CITY COMMENTS	8 MARCH 2002
DRAWN BY: JJW	REVISED PER CITY COMMENTS	15 MAY 2002
	REVISED PER CITY COMMENTS	14 OCTOBER 2002
CHECKED BY:	REVISED PER CLIENT COMMENTS	04 DEC 2002

DRAWING INFO. GRADING PLAN (SHEET 1 OF 2)

DATE: 17 DEC 2001
SCALE: H: 1" = 100' V: N/A
JOB NO: EW 1135.3
DRAWING NO.: 5D 780
SHEET 3
SHEETS 39

RECEIVED
MAR 3 0 2002
ENGINEERING

Final
Drainage Report

For

PARKWAY CIRCLE
96TH STREET & CARBON ROAD
BROOMFIELD, COLORADO

March 8, 2002

Prepared For:
NJD Limited
3300 E. First Ave, Suite 510
Denver, Colorado 80206
Contact: Kim Scott

Prepared By:
Drexel, Barrell & Co.
4840 Pearl East Circle, Suite 114
Boulder, CO 80301
Contact: John Ewy, P.E.

oject Number EW1135.3

EXISTING CONDITIONS

Existing Offsite Facilities

A hydrological analysis of drainage areas tributary to this project was performed in the drainage study prepared for this project in October of 1999. A summary of the offsite drainage areas and runoff amounts are included in Appendix B of this report. Offsite runoff enters the site via existing 24" and 48" storm sewers running under Storage Tek Drive. Runoff from the 48" storm sewer is collected in a 48" HDPE storm system (Northern Storm System) that runs parallel to Storage Tek drive and turns east at Carbon Road. The system follows Carbon Road for approximately 800 feet before turning north and discharging runoff to the property north of the subject site.

Runoff from the 24" storm system is collected in the existing 30" to 60" HDPE on-site storm system (Southern Storm System). Offsite runoff will be combined with on-site runoff in the storm system and discharged to an improved swale east of the subject site. Runoff will continue to an existing irrigation pond located east of the subject property before being released into Rock Creek. The existing pond will be upgraded to provide Stormwater quality and quantity control of runoff for the Parkway Circle Development. It should be noted that stormwater management of off-site runoff is not included in the proposed detention pond.

Existing Onsite Facilities

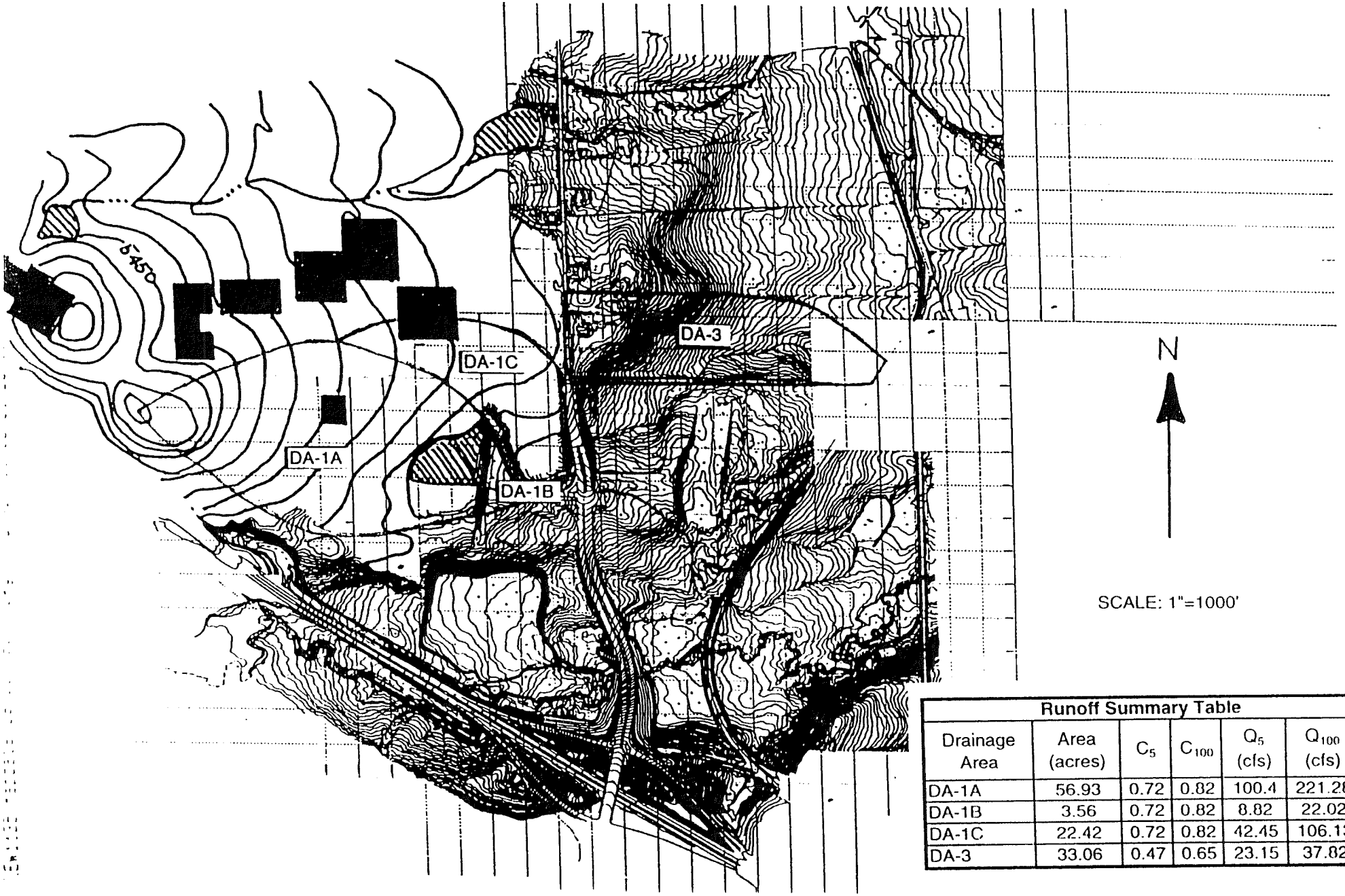
Since the preparation of the 1999 report, storm drainage facilities have been installed onsite. The facilities include a Northern Storm System to convey offsite runoff around the northern portion of the site and a Southern Storm System to convey onsite and offsite runoff to a detention pond located east of the project site. These facilities were sized in accordance with the preliminary hydrological analysis that was performed in the 1999 report. Storm system calculations are included in Appendix D.

Runoff from the developed site will be collected in the Southern Storm System and conveyed to the proposed detention pond located east of the project site. The proposed detention pond will detain both the 5-year and the 100-year runoff events in addition to water quality control. The pond will be located on land currently owned by Mr. Frank Varra through an agreement with the owner of the Parkway Circle Development. A signature block for Mr. Varra will be included on the plans. The signature block states that Mr. Varra approves of the proposed plans and that he fully understands the impact of the proposed improvements on his property.

Existing Flood Plain

The existing flood plain has been revised per a 2001 LOMR approval by FEMA (Appendix F). The new floodplain limits are similar to the floodplain limits shown in a 1999 CLOMR, which was submitted and subsequently approved by the City of Broomfield. The LOMR removes the buildable site from the floodplain but does not include the proposed embankment for Midway Boulevard. It is noted that the floodplain shown on the grading plans is the floodplain established in the 2001 LOMR.

OFFSITE DRAINAGE AREA MAP



SCALE: 1"=1000'

Runoff Summary Table					
Drainage Area	Area (acres)	C_5	C_{100}	Q_5 (cfs)	Q_{100} (cfs)
DA-1A	56.93	0.72	0.82	100.4	221.28
DA-1B	3.56	0.72	0.82	8.82	22.02
DA-1C	22.42	0.72	0.82	42.45	106.13
DA-3	33.06	0.47	0.65	23.15	37.82

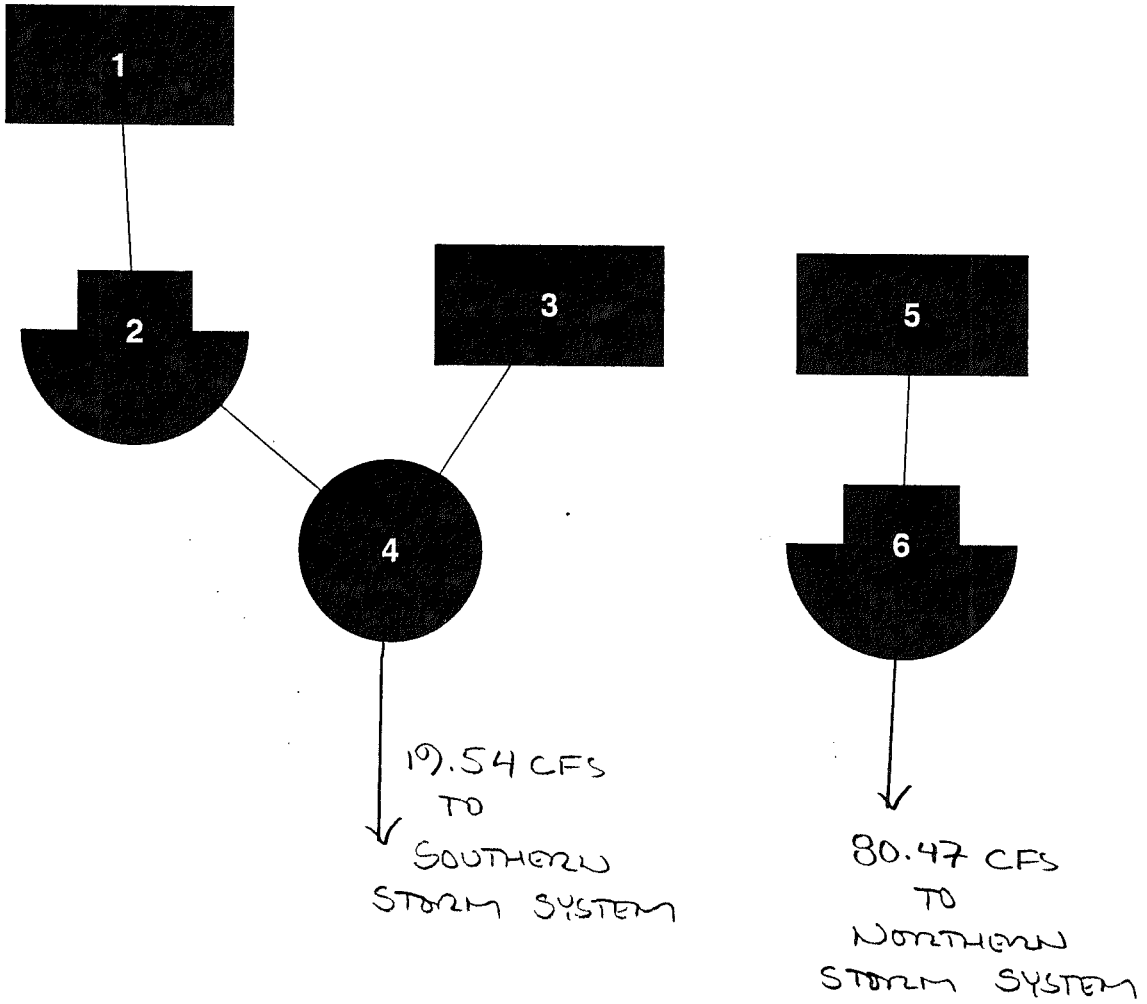
Runoff

Offsite Areas
Parkway Circle
Broomfield, Colorado

Basin	C_5	C_{100}	t_c (min)	I_5 (in/hr)	I_{100} (in/hr)	Area (acres)	Q_5 (cfs)	Q_{100} (cfs)
DA-1A	0.72	0.82	25.3	2.5	4.7	56.93	100.42	221.28
DA-1B	0.72	0.82	12.8	3.4	6.7	3.56	8.82	19.41
DA-1C	0.72	0.82	22.3	2.6	5.1	22.42	42.45	93.58
DA-3	0.47	0.65	55.4	1.5	1.8	33.06	23.15	37.82

NOTE:
RUNOFF AMOUNTS
DO NOT INCLUDE
ROUTING OFFSITE.

100-YEAR ROUTED OFFSITE FLOWS



Project: Historic 100-yr.GPW	IDF: 100year.IDF	6 hyd's	12-26-2001

Hydrograph Summary Report

100-YEAR ROUTED OFFSITE FLOWS

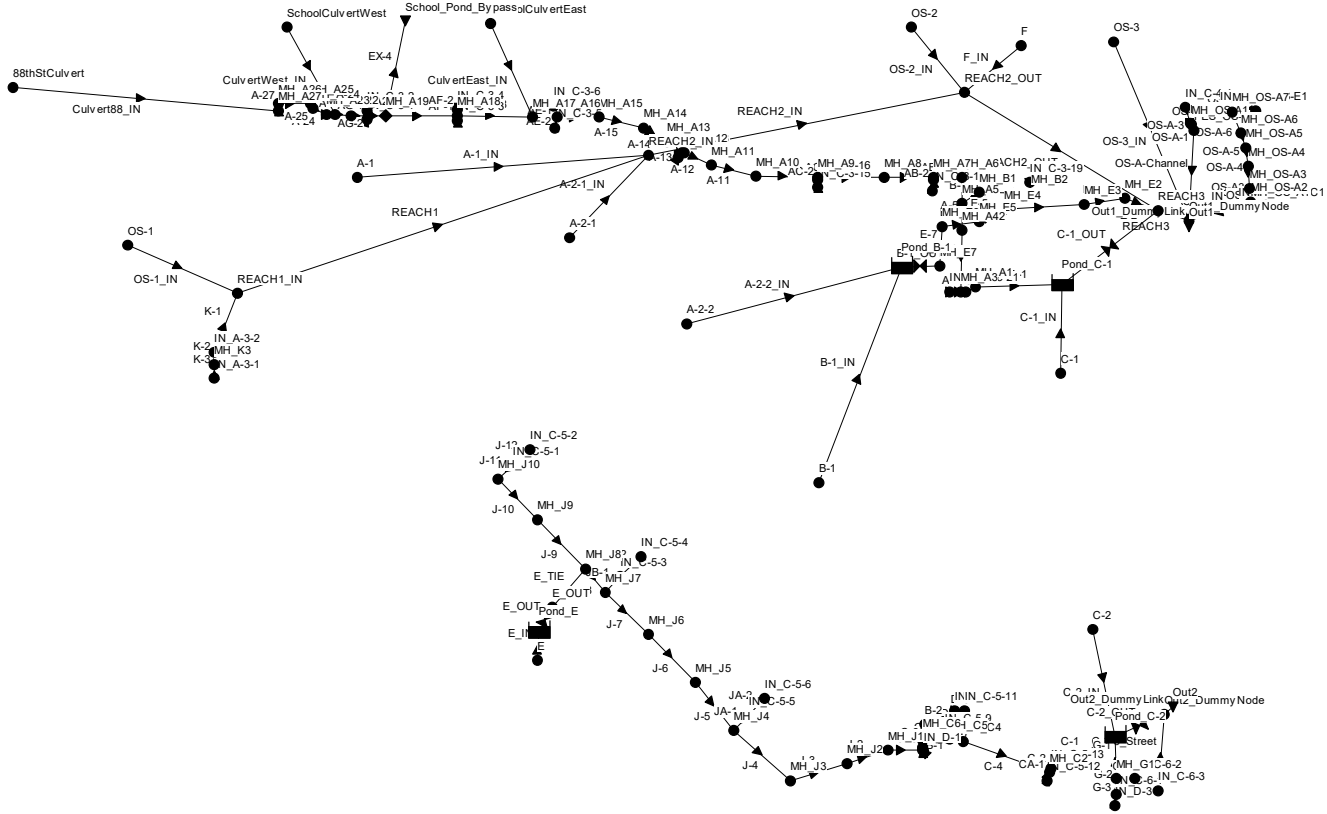
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (acft)	Return period (yrs)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (acft)	Hydrograph description
1	Rational	221.07	1	25	9.896	100	----	------	------	DA-1A
2	Reservoir	2.04	1	65	3.062	100	1	5376.31	9.809	
3	Rational	19.42	1	13	0.452	100	----	------	------	DA-1B
4	Combine	19.54	1	13	3.504	100	2 + 3	------	------	24 IN. WEST OF STO
5	Rational	93.61	1	22	3.688	100	----	------	------	DA-1C
6	Reservoir	80.47	1	27	3.675	100	5	5358.97	0.384	

Proj. file: Historic 100-yr.GPW | IDF file: 100year.IDF | Run date: 12-26-2001

APPENDIX C – Hydrologic and Hydraulic Computations

CUHP-SWMM
MHFD Detention Worksheet and Riprap Calculations
MHDF Inlet Calculations
ADS Barracuda Details
HY8 Culvert Analysis

Redtail Ridge



2-YR

Summary of Unit Hydrograph Parameters Used By Program and Calculated Results (Version 2.0.1)

		Unit Hydrograph Parameters and Results									Excess Precip.		Storm Hydrograph			
Catchment Name/ID	User Comment for Catchment	CT	Cp	W50 (min.)	W50 Before Peak	W75 (min.)	W75 Before Peak	Time to Peak (min.)	Peak (cfs)	Volume (c.f)	Excess (inches)	Excess (c.f.)	Time to Peak (min.)	Peak Flow (cfs)	Total Volume (c.f.)	Runoff per Unit Area (cfs/acre)
A-1		0.158	0.132	58.7	7.47	30.5	5.28	12.4	30	137,904	0.01	1,207	45.0	0	1,207	0.01
A-2-1		0.158	0.086	71.8	6.25	37.3	4.42	10.4	10	53,143	0.01	465	45.0	0	465	0.01
A-2-2		0.076	0.173	13.9	3.35	7.3	2.37	5.6	115	123,783	0.65	80,635	30.0	32	79,406	0.93
A-3		0.079	0.028	37.6	2.30	19.6	1.62	3.8	1	2,251	0.57	1,277	35.0	0	1,254	0.39
A-3-1		0.079	0.020	32.5	2.00	16.9	1.42	3.3	0	1,125	0.57	638	35.0	0	622	0.44
A-3-2		0.079	0.020	32.5	2.00	16.9	1.42	3.3	0	1,125	0.57	638	35.0	0	622	0.44
B-1		0.076	0.253	11.4	3.71	5.9	2.62	6.2	327	288,440	0.65	187,896	30.0	83	184,365	1.04
B-2		0.076	0.164	9.9	2.74	5.1	1.94	4.6	144	110,243	0.65	71,815	30.0	33	69,136	1.09
C-1		0.077	0.208	14.8	3.86	7.7	2.73	6.4	169	193,152	0.61	117,656	30.0	46	116,835	0.86
C-2		0.077	0.133	7.6	2.28	4.0	1.61	3.8	121	71,257	0.61	43,405	25.0	22	40,142	1.13
C-3		0.078	0.114	46.3	5.57	24.1	3.94	9.3	14	51,437	0.60	30,757	40.0	5	30,719	0.37
C-3-1		0.077	0.040	28.4	2.37	14.8	1.67	3.9	2	4,864	0.61	2,963	35.0	1	2,896	0.52
C-3-2		0.077	0.039	37.7	2.63	19.6	1.86	4.4	2	4,719	0.61	2,875	35.0	1	2,837	0.43
C-3-3		0.079	0.023	29.6	2.03	15.4	1.43	3.4	1	1,525	0.57	865	35.0	0	841	0.47
C-3-4		0.079	0.024	28.3	2.01	14.7	1.42	3.4	1	1,597	0.57	906	35.0	0	879	0.48
C-3-5		0.077	0.030	14.5	1.84	7.5	1.30	3.1	2	2,650	0.61	1,614	30.0	1	1,505	0.80
C-3-6		0.077	0.031	20.7	1.99	10.8	1.41	3.3	2	2,759	0.61	1,680	30.0	0	1,614	0.65
C-3-7		0.077	0.034	19.0	2.00	9.9	1.41	3.3	2	3,449	0.61	2,101	30.0	1	2,010	0.69
C-3-8		0.077	0.034	22.1	2.08	11.5	1.47	3.5	2	3,449	0.61	2,101	30.0	1	2,026	0.62
C-3-15		0.079	0.028	55.5	2.70	28.8	1.91	4.5	1	2,360	0.57	1,338	40.0	0	1,327	0.30
C-3-16		0.079	0.029	53.2	2.67	27.7	1.89	4.4	1	2,432	0.57	1,380	40.0	0	1,367	0.31
C-3-17		0.077	0.026	32.0	2.14	16.7	1.51	3.6	1	1,888	0.61	1,150	35.0	0	1,123	0.47
C-3-18		0.077	0.027	30.9	2.14	16.1	1.51	3.6	1	2,033	0.61	1,238	35.0	0	1,208	0.49
C-3-19		0.077	0.033	27.5	2.20	14.3	1.55	3.7	2	3,231	0.61	1,968	35.0	0	1,915	0.53
C-3-20		0.077	0.047	38.0	2.88	19.7	2.03	4.8	2	7,151	0.61	4,356	35.0	1	4,313	0.42
C-3-21		0.077	0.048	38.5	2.92	20.0	2.06	4.9	2	7,333	0.61	4,467	35.0	1	4,426	0.42
C-4		0.079	0.054	20.9	2.37	10.9	1.68	4.0	6	10,091	0.57	5,725	30.0	2	5,555	0.61
C-4-1		0.079	0.037	26.8	2.26	14.0	1.59	3.8	2	4,211	0.57	2,389	30.0	1	2,327	0.50
C-4-2		0.079	0.043	26.8	2.37	13.9	1.68	4.0	3	5,881	0.57	3,336	30.0	1	3,258	0.50
C-5		0.079	0.100	6.7	2.02	3.5	1.42	3.4	74	38,805	0.57	22,262	25.0	11	19,546	1.07
C-5-1		0.079	0.036	58.1	3.12	30.2	2.21	5.2	1	4,138	0.57	2,348	40.0	0	2,338	0.29
C-5-2		0.079	0.037	59.2	3.17	30.8	2.24	5.3	1	4,211	0.57	2,389	40.0	0	2,379	0.28
C-5-3		0.079	0.033	6.7	1.67	3.5	1.18	2.8	6	3,267	0.57	1,853	25.0	1	1,532	0.98
C-5-4		0.079	0.033	6.7	1.67	3.5	1.18	2.8	6	3,231	0.57	1,833	25.0	1	1,518	0.98
C-5-5		0.079	0.027	4.2	1.47	2.2	0.99	2.6	7	2,178	0.57	1,236	25.0	1	859	1.02
C-5-6		0.079	0.027	4.2	1.47	2.2	0.99	2.6	7	2,178	0.57	1,236	25.0	1	860	1.02
C-5-7		0.079	0.032	6.8	1.67	3.5	1.18	2.8	6	3,086	0.57	1,750	25.0	1	1,459	0.98
C-5-8		0.079	0.032	6.7	1.66	3.5	1.17	2.8	6	3,013	0.57	1,709	25.0	1	1,409	0.98
C-5-9		0.079	0.022	7.3	1.62	3.8	1.15	2.7	2	1,343	0.57	762	25.0	0	644	0.96
C-5-10		0.079	0.029	36.6	2.33	19.0	1.64	3.9	1	2,577	0.57	1,462	35.0	0	1,436	0.40
C-5-11		0.079	0.029	36.6	2.33	19.1	1.64	3.9	1	2,577	0.57	1,462	35.0	0	1,436	0.40
C-5-12		0.077	0.034	25.3	2.17	13.2	1.53	3.6	2	3,521	0.61	2,145	30.0	1	2,078	0.56
C-5-13		0.077	0.034	30.5	2.30	15.8	1.63	3.8	1	3,485	0.61	2,123	35.0	0	2,075	0.49
C-6		0.079	0.045	17.8	2.11	9.2	1.49	3.5	5	6,607	0.57	3,748	30.0	1	3,582	0.67
C-6-1		0.079	0.029	24.6	2.04	12.8	1.44	3.4	1	2,432	0.57	1,380	30.0	0	1,332	0.53
C-6-2		0.079	0.031	25.7	2.12	13.4	1.50	3.5	1	2,940	0.57	1,668	30.0	0	1,617	0.52

C-6-3		0.079	0.021	12.5	1.70	6.5	1.20	2.8	1	1,234	0.57	700	30.0	0	644	0.81
D-1		0.081	0.145	14.4	3.10	7.5	2.19	5.2	84	93,727	0.53	49,286	30.0	19	48,247	0.74
D-2		0.158	0.098	60.3	6.03	31.3	4.26	10.0	15	70,422	0.01	616	45.0	0	616	0.01
D-3		0.081	0.100	13.8	2.55	7.2	1.81	4.3	38	40,874	0.53	21,493	30.0	8	20,572	0.74
E		0.079	0.168	13.1	3.19	6.8	2.26	5.3	123	124,618	0.57	70,693	30.0	29	68,794	0.84
F		0.158	0.092	58.6	5.66	30.5	4.00	9.4	14	61,892	0.01	542	40.0	0	541	0.01
OS-1		0.139	0.162	43.4	6.91	22.6	4.88	11.5	84	281,071	0.04	11,546	40.0	3	11,545	0.04
OS-2		0.148	0.116	41.0	5.15	21.3	3.64	8.6	37	117,322	0.02	2,732	40.0	1	2,727	0.02
OS-3		0.151	0.094	39.1	4.32	20.3	3.05	7.2	23	70,821	0.02	1,317	40.0	0	1,314	0.02
EX-X		0.158	0.024	22.0	1.90	11.5	1.34	3.2	2	3,013	0.01	26	35.0	0	25	0.01
OS-4-1		0.076	0.043	36.1	2.68	18.8	1.89	4.5	2	5,481	0.65	3,583	35.0	1	3,536	0.47
OS-4-2		0.075	0.045	35.3	2.71	18.4	1.92	4.5	2	6,026	0.67	4,062	35.0	1	4,009	0.49
OS-7-1		0.073	0.027	42.0	2.38	21.8	1.68	4.0	1	1,924	0.79	1,513	40.0	0	1,490	0.50
OS-7-2		0.073	0.027	42.6	2.38	22.2	1.68	4.0	1	1,851	0.79	1,456	40.0	0	1,434	0.49
OS-7-3		0.073	0.028	45.2	2.46	23.5	1.74	4.1	1	1,997	0.79	1,570	40.0	0	1,550	0.47
OS-7-4		0.073	0.028	44.8	2.46	23.3	1.74	4.1	1	2,033	0.79	1,599	40.0	0	1,578	0.47

2-YR

Summary of CUHP Input Parameters (Version 2.0.1)

								Depression Storage		Horton's Infiltration Parameters			DCIA Level and Fractions			
Catchment Name/ID	SWMM Node/ID	Raingage Name/ID	Area (sq.mi.)	Dist. to Centroid (miles)	Length (miles)	Slope (ft./ft.)	Percent Imperv.	Pervious (inches)	Imperv. (inches)	Initial Rate (in./hr.)	Final Rate (in.hr.)	Decay Coeff. (1/sec.)	DCIA Level	Dir. Con'ct Imperv. Fraction	Receiv. Perv. Fraction	Percent Eff. Imperv.
A-1	A-1	2-YEAR CORRECTED	0.059	0.352	0.547	0.030	2.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.04	0.02	1.42
A-2-1	A-2-1	2-YEAR CORRECTED	0.023	0.302	0.409	0.032	2.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.04	0.02	1.42
A-2-2	A-2-2	2-YEAR CORRECTED	0.053	0.194	0.433	0.036	85.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.95	0.35	83.65
A-3	A-3	2-YEAR CORRECTED	0.001	0.075	0.103	0.012	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.24
A-3-1	IN_A-3-1	2-YEAR CORRECTED	0.000	0.037	0.074	0.010	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.24
A-3-2	IN_A-3-2	2-YEAR CORRECTED	0.000	0.037	0.074	0.010	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.24
B-1	B-1	2-YEAR CORRECTED	0.124	0.185	0.463	0.018	85.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.95	0.35	83.65
B-2	B-2	2-YEAR CORRECTED	0.047	0.117	0.325	0.039	85.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.95	0.35	83.65
C-1	C-1	2-YEAR CORRECTED	0.083	0.163	0.434	0.010	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	78.43
C-2	C-2	2-YEAR CORRECTED	0.031	0.078	0.201	0.050	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	78.43
C-3	C-3	2-YEAR CORRECTED	0.022	0.389	0.769	0.019	78.7	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	77.04
C-3-1	IN_C-3-1	2-YEAR CORRECTED	0.002	0.061	0.194	0.018	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	78.43
C-3-2	IN_C-3-2	2-YEAR CORRECTED	0.002	0.110	0.187	0.018	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	78.43
C-3-3	IN_C-3-3	2-YEAR CORRECTED	0.001	0.044	0.090	0.018	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.24
C-3-4	IN_C-3-4	2-YEAR CORRECTED	0.001	0.043	0.089	0.018	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.24
C-3-5	IN_C-3-5	2-YEAR CORRECTED	0.001	0.024	0.101	0.038	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	78.43
C-3-6	IN_C-3-6	2-YEAR CORRECTED	0.001	0.050	0.100	0.035	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	78.43
C-3-7	IN_C-3-7	2-YEAR CORRECTED	0.001	0.037	0.139	0.035	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	78.43
C-3-8	IN_C-3-8	2-YEAR CORRECTED	0.001	0.051	0.147	0.040	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	78.43
C-3-15	IN_C-3-15	2-YEAR CORRECTED	0.001	0.113	0.147	0.010	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.24
C-3-16	IN_C-3-16	2-YEAR CORRECTED	0.001	0.110	0.143	0.010	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.24
C-3-17	IN_C-3-17	2-YEAR CORRECTED	0.001	0.055	0.115	0.019	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	78.43
C-3-18	IN_C-3-18	2-YEAR CORRECTED	0.001	0.056	0.114	0.019	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	78.43
C-3-19	IN_C-3-19	2-YEAR CORRECTED	0.001	0.049	0.103	0.008	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	78.43
C-3-20	IN_C-3-20	2-YEAR CORRECTED	0.003	0.083	0.277	0.010	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	78.43
C-3-21	IN_C-3-21	2-YEAR CORRECTED	0.003	0.084	0.276	0.009	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	78.43
C-4	C-4	2-YEAR CORRECTED	0.004	0.063	0.218	0.026	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.24
C-4-1	IN_C-4-1	2-YEAR CORRECTED	0.002	0.060	0.170	0.026	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.24
C-4-2	IN_C-4-2	2-YEAR CORRECTED	0.003	0.063	0.218	0.026	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.24
C-5	C-5	2-YEAR CORRECTED	0.017	0.411	0.728	109.138	75.8	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	74.04
C-5-1	IN_C-5-1	2-YEAR CORRECTED	0.002	0.134	0.269	0.014	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.24
C-5-2	IN_C-5-2	2-YEAR CORRECTED	0.002	0.136	0.275	0.013	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.24
C-5-3	IN_C-5-3	2-YEAR CORRECTED	0.001	0.107	0.214	68.977	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.24
C-5-4	IN_C-5-4	2-YEAR CORRECTED	0.001	0.107	0.214	68.977	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.24
C-5-5	IN_C-5-5	2-YEAR CORRECTED	0.001	0.071	0.142	200.316	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.24
C-5-6	IN_C-5-6	2-YEAR CORRECTED	0.001	0.071	0.142	200.316	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.24
C-5-7	IN_C-5-7	2-YEAR CORRECTED	0.001	0.171	0.204	165.130	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.24
C-5-8	IN_C-5-8	2-YEAR CORRECTED	0.001	0.167	0.198	169.360	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.24
C-5-9	IN_C-5-9	2-YEAR CORRECTED	0.001	0.007	0.027	0.020	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.24
C-5-10	IN_C-5-10	2-YEAR CORRECTED	0.001	0.073	0.147	0.020	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.24
C-5-11	IN_C-5-11	2-YEAR CORRECTED	0.001	0.073	0.147	0.020	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.24
C-5-12	IN_C-5-12	2-YEAR CORRECTED	0.002	0.052	0.132	0.018	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	78.43
C-5-13	IN_C-5-13	2-YEAR CORRECTED	0.002	0.089	0.112	0.018	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	78.43
C-6	C-6	2-YEAR CORRECTED	0.003	0.040	0.131	0.017	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.24
C-6-1	IN_C-6-1	2-YEAR CORRECTED	0.001	0.045	0.092	0.017	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.24

C-6-2	IN_C-6-2	2-YEAR CORRECTED	0.001	0.053	0.098	0.016	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.24
C-6-3	IN_C-6-3	2-YEAR CORRECTED	0.001	0.016	0.038	0.024	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.24
D-1	IN_D-1	2-YEAR CORRECTED	0.040	0.178	0.256	0.025	70.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.92	0.30	68.09
D-2	D-2	2-YEAR CORRECTED	0.030	0.303	0.319	0.024	2.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.04	0.02	1.42
D-3	IN_D-3	2-YEAR CORRECTED	0.018	0.186	0.089	0.019	70.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.92	0.30	68.09
E	E	2-YEAR CORRECTED	0.054	0.127	0.360	0.018	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.24
F	F	2-YEAR CORRECTED	0.027	0.166	0.434	0.019	2.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.04	0.02	1.42
OS-1	OS-1	2-YEAR CORRECTED	0.121	0.297	0.687	0.030	8.7	0.35	0.10	3.00	0.50	0.0018	0.00	0.17	0.09	6.48
OS-2	OS-2	2-YEAR CORRECTED	0.051	0.182	0.372	0.022	5.7	0.40	0.10	3.00	0.50	0.0018	0.00	0.11	0.06	4.15
OS-3	OS-3	2-YEAR CORRECTED	0.030	0.166	0.225	0.021	4.6	0.40	0.10	3.00	0.50	0.0018	0.00	0.09	0.05	3.34
EX-X	X	2-YEAR CORRECTED	0.001	0.018	0.036	0.025	2.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.00	0.02	1.41
OS-4-1	Out1	2-YEAR CORRECTED	0.002	0.101	0.193	0.013	85.6	0.40	0.10	3.00	0.50	0.0018	0.00	0.95	0.35	84.23
OS-4-2	Out1	2-YEAR CORRECTED	0.003	0.102	0.187	0.011	87.9	0.40	0.10	3.00	0.50	0.0018	0.00	0.96	0.36	86.69
OS-7-1	IN_OS-E1	2-YEAR CORRECTED	0.001	0.057	0.118	0.004	100.0	0.40	0.10	3.00	0.50	0.0018	0.00	1.00	0.00	100.00
OS-7-2	IN_OS-D-1	2-YEAR CORRECTED	0.001	0.059	0.121	0.005	100.0	0.40	0.10	3.00	0.50	0.0018	0.00	1.00	0.00	100.00
OS-7-3	IN_OS-D-1	2-YEAR CORRECTED	0.001	0.064	0.130	0.005	100.0	0.40	0.10	3.00	0.50	0.0018	0.00	1.00	0.00	100.00
OS-7-4	IN_OS-E1	2-YEAR CORRECTED	0.001	0.064	0.130	0.005	100.0	0.40	0.10	3.00	0.50	0.0018	0.00	1.00	0.00	100.00

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.015)

Redtail Ridge
Proposed Storm Network
2-year Event

WARNING 08: elevation drop exceeds length for Conduit C-1_IN
WARNING 08: elevation drop exceeds length for Conduit E_IN
WARNING 04: minimum elevation drop used for Conduit Out1_DummyLink
WARNING 04: minimum elevation drop used for Conduit Out2_DummyLink

****
Element Count
****
Number of rain gages 0
Number of subcatchments ... 0
Number of nodes 130
Number of links 128
Number of pollutants 0
Number of land uses 0

****
Node Summary
****

Name	Type	Invert Elev.	Max. Depth	Ponded Area	External Inflow
88thStCulvert	JUNCTION	5469.71	0.00	0.0	Yes
A-1	JUNCTION	5399.18	0.00	0.0	
A-2-1	JUNCTION	5399.18	0.00	0.0	
A-2-2	JUNCTION	5383.23	0.00	0.0	
B-1	JUNCTION	5383.23	0.00	0.0	
B-2	JUNCTION	5370.12	16.66	0.0	
C-1	JUNCTION	5365.69	0.00	0.0	
C-2	JUNCTION	5357.25	0.00	0.0	
IN_D-3	JUNCTION	5358.99	8.17	0.0	
E	JUNCTION	5460.00	5.00	0.0	
E_OUT	JUNCTION	5456.72	7.00	0.0	
F	JUNCTION	5372.82	0.00	0.0	
FES_OS-A1	JUNCTION	5364.79	5.00	0.0	
IN_A-3-1	JUNCTION	5461.84	5.08	0.0	
IN_A-3-2	JUNCTION	5461.25	5.69	0.0	
IN_C-3-1	JUNCTION	5456.42	5.44	0.0	
IN_C-3-15	JUNCTION	5394.00	8.41	0.0	
IN_C-3-16	JUNCTION	5392.69	9.72	0.0	
IN_C-3-17	JUNCTION	5385.54	11.70	0.0	
IN_C-3-18	JUNCTION	5385.21	12.53	0.0	

IN_C-3-19	JUNCTION	5385.87	6.25	0.0
IN_C-3-2	JUNCTION	5456.27	5.79	0.0
IN_C-3-20	JUNCTION	5374.45	14.13	0.0
IN_C-3-21	JUNCTION	5370.68	17.90	0.0
IN_C-3-3	JUNCTION	5448.28	5.59	0.0
IN_C-3-4	JUNCTION	5448.38	5.66	0.0
IN_C-3-5	JUNCTION	5426.43	9.83	0.0
IN_C-3-6	JUNCTION	5426.24	10.69	0.0
IN_C-3-7	JUNCTION	5396.47	15.11	0.0
IN_C-3-8	JUNCTION	5395.61	15.97	0.0
IN_C-4-1	JUNCTION	5365.90	4.02	0.0
IN_C-4-2	JUNCTION	5365.40	4.68	0.0
IN_C-5-1	JUNCTION	5442.59	5.16	0.0
IN_C-5-10	JUNCTION	5377.70	5.85	0.0
IN_C-5-11	JUNCTION	5375.03	8.54	0.0
IN_C-5-12	JUNCTION	5367.94	5.68	0.0
IN_C-5-13	JUNCTION	5360.54	13.54	0.0
IN_C-5-2	JUNCTION	5443.19	4.56	0.0
IN_C-5-3	JUNCTION	5426.13	6.55	0.0
IN_C-5-4	JUNCTION	5427.19	5.49	0.0
IN_C-5-5	JUNCTION	5405.51	6.24	0.0
IN_C-5-6	JUNCTION	5406.51	5.22	0.0
IN_C-5-7	JUNCTION	5369.11	13.62	0.0
IN_C-5-8	JUNCTION	5368.46	14.41	0.0
IN_C-5-9	JUNCTION	5367.29	14.25	0.0
IN_C-6-1	JUNCTION	5358.82	7.54	0.0
IN_C-6-2	JUNCTION	5361.36	4.81	0.0
IN_C-6-3	JUNCTION	5355.27	0.00	0.0
IN_OS-B1	JUNCTION	5354.19	1.80	0.0
IN_OS-C1	JUNCTION	5354.55	1.80	0.0
IN_OS-D-1	JUNCTION	5363.04	1.80	0.0
IN_OS-E1	JUNCTION	5363.16	1.80	0.0
MH_A1	JUNCTION	5370.18	16.15	0.0
MH_A10	JUNCTION	5390.15	15.94	0.0
MH_A11	JUNCTION	5391.49	15.05	0.0
MH_A12	JUNCTION	5392.68	17.55	0.0
MH_A13	JUNCTION	5394.03	20.33	0.0
MH_A14	JUNCTION	5405.68	12.20	0.0
MH_A15	JUNCTION	5415.05	14.01	0.0
MH_A16	JUNCTION	5424.36	13.15	0.0
MH_A17	JUNCTION	5429.82	12.63	0.0
MH_A18	JUNCTION	5446.96	6.75	0.0
MH_A20	JUNCTION	5454.77	6.92	0.0
MH_A21	JUNCTION	5459.04	8.06	0.0
MH_A22	JUNCTION	5462.10	7.24	0.0
MH_A23	JUNCTION	5462.70	6.22	0.0
MH_A-24	JUNCTION	5465.71	8.40	0.0
MH_A25	JUNCTION	5466.19	8.48	0.0
MH_A26	JUNCTION	5469.13	9.97	0.0
MH_A27	JUNCTION	5469.73	9.55	0.0

MH_A3	JUNCTION	5370.91	17.45	0.0	
MH_A5	JUNCTION	5383.03	12.25	0.0	
MH_A6	JUNCTION	5383.96	12.46	0.0	
MH_A7	JUNCTION	5384.90	12.72	0.0	
MH_A8	JUNCTION	5386.41	13.21	0.0	
MH_A9	JUNCTION	5388.31	12.56	0.0	
MH_B1	JUNCTION	5383.85	11.42	0.0	
MH_B2	JUNCTION	5385.34	6.54	0.0	
MH_C2	JUNCTION	5360.73	13.24	0.0	
MH_C4	JUNCTION	5363.99	19.43	0.0	
MH_C5	JUNCTION	5366.43	15.68	0.0	
MH_C6	JUNCTION	5368.16	14.83	0.0	
MH_E2	JUNCTION	5372.94	10.70	0.0	
MH_E3	JUNCTION	5374.11	15.68	0.0	
MH_E4	JUNCTION	5376.05	18.61	0.0	
MH_E5	JUNCTION	5376.65	17.77	0.0	
MH_E6	JUNCTION	5378.08	15.66	0.0	
MH_E7	JUNCTION	5382.19	9.29	0.0	
MH_G1	JUNCTION	5358.56	8.75	0.0	
MH_J7	JUNCTION	5422.80	11.54	0.0	
MH_J8	JUNCTION	5430.52	9.95	0.0	
MH_J9	JUNCTION	5435.69	9.24	0.0	
MH_J10	JUNCTION	5442.15	8.21	0.0	
MH_C9	JUNCTION	5369.40	13.49	0.0	
MH_J1	JUNCTION	5371.94	12.23	0.0	
MH_J2	JUNCTION	5378.59	10.66	0.0	
MH_J3	JUNCTION	5387.89	10.46	0.0	
MH_J4	JUNCTION	5401.30	12.85	0.0	
MH_J5	JUNCTION	5409.95	13.66	0.0	
MH_J6	JUNCTION	5420.42	11.34	0.0	
MH_K3	JUNCTION	5461.60	5.03	0.0	
MH_OS_A1	JUNCTION	5353.79	6.54	0.0	
MH_OS-A1	JUNCTION	5365.21	5.24	0.0	
MH_OS-A2	JUNCTION	5355.35	9.74	0.0	
MH_OS-A3	JUNCTION	5356.55	11.08	0.0	
MH_OS-A4	JUNCTION	5358.00	10.74	0.0	
MH_OS-A5	JUNCTION	5360.03	9.50	0.0	
MH_OS-A6	JUNCTION	5361.88	6.00	0.0	
MH_OS-A7	JUNCTION	5362.65	4.71	0.0	
OS-1	JUNCTION	5451.06	0.00	0.0	
OS-2	JUNCTION	5372.82	0.00	0.0	
OS-3	JUNCTION	5351.00	0.00	0.0	
REACH1_IN	JUNCTION	5451.06	22.47	0.0	
REACH2_IN	JUNCTION	5399.18	22.47	0.0	
REACH2_OUT	JUNCTION	5372.82	6.01	0.0	
REACH3_IN	JUNCTION	5363.99	14.43	0.0	
SchoolCulvertEast	JUNCTION	5434.52	2.00	0.0	Yes
SchoolCulvertWest	JUNCTION	5464.00	1.50	0.0	Yes
Out1_DummyNode	JUNCTION	5351.00	14.43	0.0	
Out2_DummyNode	JUNCTION	5355.27	0.50	0.0	

MH_A42	JUNCTION	5382.42	11.44	0.0	
IN_D-1	JUNCTION	5370.45	6.13	0.0	
Out2	OUTFALL	5355.27	0.00	0.0	
Out1	OUTFALL	5351.00	0.00	0.0	
School_Pond_Bypass	OUTFALL	5450.90	2.50	0.0	
MH_A19	DIVIDER	5451.22	9.49	0.0	
Pond_B-1	STORAGE	5384.14	9.67	0.0	
Pond_C-1	STORAGE	5368.17	6.64	0.0	
Pond_C-2	STORAGE	5355.85	9.42	0.0	
Pond_E	STORAGE	5457.00	10.00	0.0	

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Link Summary
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Name	From Node	To Node	Type	Length	%Slope	Roughness
A-1	MH_A1	Pond_C-1	CONDUIT	294.6	0.6822	0.0130
A-1_IN	A-1	REACH2_IN	CONDUIT	1.0	-57.7350	0.0100
A-10	MH_A10	MH_A9	CONDUIT	297.2	0.5181	0.0130
A-11	MH_A11	MH_A10	CONDUIT	227.2	0.5018	0.0130
A-12	MH_A12	MH_A11	CONDUIT	197.5	0.5013	0.0130
A-13	MH_A13	MH_A12	CONDUIT	102.5	0.4977	0.0130
A-14	MH_A14	MH_A13	CONDUIT	213.3	5.3299	0.0130
A-15	MH_A15	MH_A14	CONDUIT	210.4	4.3633	0.0130
A-16	MH_A16	MH_A15	CONDUIT	218.0	4.2278	0.0130
A-17	MH_A17	MH_A16	CONDUIT	131.6	3.7711	0.0130
A-18	MH_A18	MH_A17	CONDUIT	396.9	4.2714	0.0130
A-19	MH_A19	MH_A18	CONDUIT	378.9	1.7318	0.0130
A-2	IN_C-3-21	MH_A1	CONDUIT	59.6	0.5037	0.0130
A-20	MH_A20	MH_A19	CONDUIT	90.1	0.9432	0.0130
A-21	MH_A21	MH_A20	CONDUIT	391.9	1.0385	0.0130

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  A-2-1_IN         A-2-1           REACH2_IN       CONDUIT           1.0
-57.7350    0.0100
  A-22             MH_A22          MH_A21          CONDUIT         142.6
2.0768    0.0130
  A-2-2_IN         A-2-2           Pond_B-1        CONDUIT           1.0
-219.4843    0.0100
  A-23             MH_A23          MH_A22          CONDUIT          96.9
0.5160    0.0130
  A-24             MH_A-24         MH_A23          CONDUIT         168.3
1.7297    0.0130
  A-25             MH_A25          MH_A-24         CONDUIT          20.0
1.4001    0.0130
  A-26             MH_A26          MH_A25          CONDUIT         196.3
1.3963    0.0130
  A-27             MH_A27          MH_A26          CONDUIT          39.5
1.0140    0.0130
  A-3              MH_A3           IN_C-3-21       CONDUIT           5.4
0.3690    0.0130
  A-6              MH_A6           MH_A5           CONDUIT         146.9
0.4968    0.0130
  A-7              MH_A7           MH_A6           CONDUIT         147.0
0.5034    0.0130
  A-8              MH_A8           MH_A7           CONDUIT         261.2
0.5015    0.0130
  A-9              MH_A9           MH_A8           CONDUIT         340.3
0.4995    0.0130
  AA-1             IN_C-3-20       MH_A3           CONDUIT          40.2
0.9958    0.0130
  AB-1             IN_C-3-18       MH_A7           CONDUIT          21.5
0.5116    0.0130
  AB-2             IN_C-3-17       IN_C-3-18       CONDUIT          45.8
0.5026    0.0130
  AC-1             IN_C-3-16       MH_A9           CONDUIT          25.8
1.7030    0.0130
  AC-2             IN_C-3-15       IN_C-3-16       CONDUIT          40.4
2.7520    0.0130
  AD-1             IN_C-3-8        MH_A12          CONDUIT          29.4
1.4613    0.0130
  AD-2             IN_C-3-7        IN_C-3-8        CONDUIT          40.3
1.5619    0.0130
  AE-1             IN_C-3-5        MH_A16          CONDUIT          62.1
0.5151    0.0130
  AE-2             IN_C-3-6        MH_A16          CONDUIT          28.9
0.4505    0.0130
  AF-1             IN_C-3-3        MH_A18          CONDUIT          12.7
0.7893    0.0130
  AF-2             IN_C-3-4        MH_A18          CONDUIT          34.7
0.6057    0.0130
  AG-1             IN_C-3-1        MH_A20          CONDUIT          12.7
0.5525    0.0130
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  AG-2             IN_C-3-2         MH_A20           CONDUIT           34.7
0.4903    0.0130
  B-1              MH_B1            MH_A5            CONDUIT          125.9
0.4925    0.0130
  B-1_IN           B-1              Pond_B-1         CONDUIT            1.0
-219.4843    0.0100
  B-2              MH_B2            MH_B1            CONDUIT          258.7
0.4987    0.0130
  B-3              IN_C-3-19        MH_B2            CONDUIT           66.0
0.4999    0.0130
  C-1              IN_C-5-13        Pond_C-2         CONDUIT          129.4
0.5021    0.0130
  C-1_IN           C-1              Pond_C-1         CONDUIT            1.0
-248.0000    0.0100
  C150             IN_OS-B1         Out1_DummyNode   CONDUIT           28.0
11.4675    0.0130
  C-2              MH_C2            IN_C-5-13        CONDUIT           15.4
0.5856    0.0130
  C-2_IN           C-2              Pond_C-2         CONDUIT           15.0
9.3743    0.0100
  C-4              MH_C4            MH_C2            CONDUIT          485.2
0.6307    0.0130
  C-5              MH_C5            MH_C4            CONDUIT           68.9
1.0739    0.0130
  C-6              MH_C6            MH_C5            CONDUIT          141.9
1.0784    0.0130
  C-6-3_Street     IN_C-6-3         Out2_DummyNode   CONDUIT           10.0
-5.0063    0.0100
  CA-1             IN_C-5-12        MH_C2            CONDUIT           56.6
7.1077    0.0130
  CB-1             IN_C-5-9         MH_C5            CONDUIT           28.8
2.2931    0.0130
  Culvert88_IN     88thStCulvert    MH_A27           CONDUIT            1.0
-60.8781    0.0100
  CulvertEast_IN   SchoolCulvertEast MH_A17          CONDUIT          104.3
4.0309    0.0130
  CulvertWest_IN   SchoolCulvertWest MH_A22          CONDUIT           88.0
0.5003    0.0130
  D-2              IN_C-5-11        MH_C4            CONDUIT          155.6
4.7237    0.0130
  D-3              IN_C-5-10        IN_C-5-11        CONDUIT           47.4
5.0073    0.0130
  CB-2             B-2              IN_C-5-9         CONDUIT           24.5
10.7971    0.0130
  E_IN             E                Pond_E           CONDUIT            1.0
250.0000    0.0100
  E-2              MH_E2            REACH3_IN        CONDUIT           34.7
0.4905    0.0130
  E-3              MH_E3            MH_E2            CONDUIT          194.7
0.4983    0.0130
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  E-4               MH_E4             MH_E3             CONDUIT          347.9
0.5002    0.0130
  E-5               MH_E5             MH_E4             CONDUIT           80.8
0.4949    0.0130
  E-6               MH_E6             MH_E5             CONDUIT          118.5
0.5064    0.0130
  E-7               MH_E7             MH_E6             CONDUIT          106.5
3.6749    0.0130
  EX-4              MH_A19            School_Pond_Bypass CONDUIT           35.5
0.9022    0.0130
  F_IN              F                 REACH2_OUT        CONDUIT            1.0
-57.7350    0.0100
  G-1               MH_G1             Pond_C-2          CONDUIT           56.5
0.1770    0.0130
  G-2               IN_C-6-1          MH_G1             CONDUIT           82.4
0.1941    0.0130
  G-3               IN_D-3            IN_C-6-1          CONDUIT           30.8
0.2272    0.0130
  GA-1              IN_C-6-2          MH_G1             CONDUIT           69.5
0.5181    0.0130
  C-7               IN_C-5-8          MH_C6             CONDUIT            9.1
1.1026    0.0130
  J-7               MH_J7             MH_J6             CONDUIT          109.0
2.0008    0.0130
  J-8               MH_J8             MH_J7             CONDUIT          376.8
1.9960    0.0130
  J-9               MH_J9             MH_J8             CONDUIT          333.9
1.2490    0.0130
  J-10              MH_J10            MH_J9             CONDUIT          417.7
1.4987    0.0130
  J-11              IN_C-5-1          MH_J10            CONDUIT           24.4
0.9849    0.0130
  J-12              IN_C-5-2          IN_C-5-1          CONDUIT           40.3
0.9919    0.0130
  C-8               IN_C-5-7          IN_C-5-8          CONDUIT           42.0
1.0728    0.0130
  C-9               MH_C9             IN_C-5-7          CONDUIT            8.7
1.0369    0.0130
  J-1               MH_J1             MH_C9             CONDUIT          117.0
1.9997    0.0130
  J-2               MH_J2             MH_J1             CONDUIT          258.1
2.4993    0.0130
  J-3               MH_J3             MH_J2             CONDUIT          364.0
2.5008    0.0130
  J-4               MH_J4             MH_J3             CONDUIT          440.5
3.0002    0.0130
  J-5               MH_J5             MH_J4             CONDUIT          272.0
2.9973    0.0130
  J-6               MH_J6             MH_J5             CONDUIT          371.1
1.9996    0.0130
```

JA-1	IN_C-5-5	MH_J4	CONDUIT	24.4	2.0111	0.0130
JA-2	IN_C-5-6	IN_C-5-5	CONDUIT	40.2	1.9895	0.0130
JB-1	IN_C-5-3	MH_J7	CONDUIT	24.4	1.9716	0.0130
JB-2	IN_C-5-4	IN_C-5-3	CONDUIT	40.4	2.0078	0.0130
E_TIE	E_OUT	MH_J8	CONDUIT	140.1	18.8890	0.0130
K-1	IN_A-3-2	REACH1_IN	CONDUIT	56.9	9.5656	0.0130
K-2	MH_K3	IN_A-3-2	CONDUIT	32.9	0.4566	0.0130
K-3	IN_A-3-1	MH_K3	CONDUIT	8.2	0.4896	0.0130
OS-1_IN	OS-1	REACH1_IN	CONDUIT	1.0	-57.7350	0.0100
OS-2_IN	OS-2	REACH2_OUT	CONDUIT	1.0	-57.7350	0.0100
OS-3_IN	OS-3	Out1_DummyNode	CONDUIT	1.0	-57.7350	0.0100
OS-A1	MH_OS-A2	MH_OS_A1	CONDUIT	311.9	0.5001	0.0130
OS-A-1	MH_OS-A1	FES_OS-A1	CONDUIT	36.5	1.1520	0.0130
OS-A2	MH_OS-A3	MH_OS-A2	CONDUIT	199.5	0.5012	0.0130
OS-A-2	IN_C-4-2	MH_OS-A1	CONDUIT	18.6	0.4844	0.0130
OS-A3	MH_OS-A4	MH_OS-A3	CONDUIT	250.9	0.4982	0.0130
OS-A-3	IN_C-4-1	IN_C-4-2	CONDUIT	79.6	0.5023	0.0130
OS-A-4	MH_OS-A5	MH_OS-A4	CONDUIT	365.0	0.5013	0.0130
OS-A-5	MH_OS-A6	MH_OS-A5	CONDUIT	330.8	0.4988	0.0130
OS-A-6	MH_OS-A7	MH_OS-A6	CONDUIT	114.7	0.4970	0.0130
OS-A-Channel	FES_OS-A1	Out1_DummyNode	CONDUIT	450.0	3.0659	0.0350
OS-B-1	MH_OS_A1	IN_OS-B1	CONDUIT	19.5	0.0513	0.0130
OS-C-1	IN_OS-C1	MH_OS_A1	CONDUIT	111.5	0.5022	0.0130
OS-D-1	IN_OS-D-1	MH_OS-A7	CONDUIT	18.0	0.5000	0.0130
OS-E-1	IN_OS-E1	MH_OS-A7	CONDUIT	62.0	0.5000	0.0130

REACH1	REACH1_IN	REACH2_IN	CONDUIT	2528.2	2.0525 0.0320
REACH2_IN	REACH2_IN	REACH2_OUT	CONDUIT	1436.4	1.8354 0.0350
REACH2_OUT	REACH2_OUT	REACH3_IN	CONDUIT	954.0	0.9256 0.0350
REACH3	REACH3_IN	Out1_DummyNode	CONDUIT	150.0	8.6927 0.0350
Out1_DummyLink	Out1_DummyNode	Out1	CONDUIT	10.0	0.0100 0.0100
Out2_DummyLink	Out2_DummyNode	Out2	CONDUIT	10.0	0.0100 0.0100
A-5	MH_A5	MH_A42	CONDUIT	81.8	0.5015 0.0130
A-5(1)	MH_A42	MH_A3	CONDUIT	387.1	2.9492 0.0130
C-10	IN_D-1	MH_C9	CONDUIT	42.6	1.9976 0.0130
C-1_OUT	Pond_C-1	REACH3_IN	OUTLET		
B-1_OUT	Pond_B-1	MH_E7	OUTLET		
C-2_OUT	Pond_C-2	Out2_DummyNode	OUTLET		
E_OUT	Pond_E	E_OUT	OUTLET		

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Cross Section Summary
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Conduit	Shape	Full Depth	Full Area	Hyd. Rad.	Max. Width	No. of Barrels	Full Flow
A-1	CIRCULAR	4.50	15.90	1.13	4.50	1	162.42
A-1_IN	DUMMY	0.00	0.00	0.00	0.00	1	0.00
A-10	CIRCULAR	4.00	12.57	1.00	4.00	1	103.40
A-11	CIRCULAR	4.00	12.57	1.00	4.00	1	101.76
A-12	CIRCULAR	4.00	12.57	1.00	4.00	1	101.71
A-13	HORIZ_ELLIPSE	2.42	7.41	0.74	3.75	1	48.90
A-14	CIRCULAR	3.00	7.07	0.75	3.00	1	153.98
A-15	CIRCULAR	3.00	7.07	0.75	3.00	1	139.32

A-16	CIRCULAR	3.00	7.07	0.75	3.00	1
137.14						
A-17	CIRCULAR	2.50	4.91	0.63	2.50	1
79.65						
A-18	CIRCULAR	2.50	4.91	0.63	2.50	1
84.77						
A-19	CIRCULAR	2.50	4.91	0.63	2.50	1
53.98						
A-2	CIRCULAR	4.50	15.90	1.13	4.50	1
139.57						
A-20	RECT_CLOSED	4.00	18.00	1.06	4.50	1
207.59						
A-21	CIRCULAR	4.00	12.57	1.00	4.00	1
146.38						
A-2-1_IN	DUMMY	0.00	0.00	0.00	0.00	1
0.00						
A-22	CIRCULAR	4.00	12.57	1.00	4.00	1
207.00						
A-2-2_IN	DUMMY	0.00	0.00	0.00	0.00	1
0.00						
A-23	HORIZ_ELLIPSE	3.17	12.90	0.97	5.00	1
103.72						
A-24	CIRCULAR	3.50	9.62	0.88	3.50	1
132.32						
A-25	CIRCULAR	3.50	9.62	0.88	3.50	1
119.05						
A-26	CIRCULAR	3.50	9.62	0.88	3.50	1
118.89						
A-27	CIRCULAR	3.50	9.62	0.88	3.50	1
101.31						
A-3	CIRCULAR	4.50	15.90	1.13	4.50	1
119.46						
A-6	CIRCULAR	4.00	12.57	1.00	4.00	1
101.25						
A-7	CIRCULAR	4.00	12.57	1.00	4.00	1
101.92						
A-8	CIRCULAR	4.00	12.57	1.00	4.00	1
101.72						
A-9	CIRCULAR	4.00	12.57	1.00	4.00	1
101.52						
AA-1	CIRCULAR	1.50	1.77	0.38	1.50	1
10.48						
AB-1	CIRCULAR	1.50	1.77	0.38	1.50	1
7.51						
AB-2	CIRCULAR	1.50	1.77	0.38	1.50	1
7.45						
AC-1	CIRCULAR	1.50	1.77	0.38	1.50	1
13.71						
AC-2	CIRCULAR	1.50	1.77	0.38	1.50	1
17.43						

AD-1	CIRCULAR	1.50	1.77	0.38	1.50	1	12.70
AD-2	CIRCULAR	1.50	1.77	0.38	1.50	1	13.13
AE-1	CIRCULAR	1.50	1.77	0.38	1.50	1	7.54
AE-2	CIRCULAR	1.50	1.77	0.38	1.50	1	7.05
AF-1	CIRCULAR	1.50	1.77	0.38	1.50	1	9.33
AF-2	CIRCULAR	1.50	1.77	0.38	1.50	1	8.18
AG-1	CIRCULAR	1.50	1.77	0.38	1.50	1	7.81
AG-2	CIRCULAR	1.50	1.77	0.38	1.50	1	7.36
B-1	CIRCULAR	1.50	1.77	0.38	1.50	1	7.37
B-1_IN	DUMMY	0.00	0.00	0.00	0.00	1	0.00
B-2	CIRCULAR	1.50	1.77	0.38	1.50	1	7.42
B-3	CIRCULAR	1.50	1.77	0.38	1.50	1	7.43
C-1	CIRCULAR	4.50	15.90	1.13	4.50	1	139.35
C-1_IN	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C150	CIRCULAR	1.50	1.77	0.38	1.50	1	35.57
C-2	CIRCULAR	4.50	15.90	1.13	4.50	1	150.48
C-2_IN	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C-4	CIRCULAR	4.50	15.90	1.13	4.50	1	156.17
C-5	CIRCULAR	3.50	9.62	0.88	3.50	1	104.26
C-6	CIRCULAR	3.00	7.07	0.75	3.00	1	69.26
C-6-3_Street	DUMMY	0.00	0.00	0.00	0.00	1	0.00
CA-1	CIRCULAR	1.50	1.77	0.38	1.50	1	28.00
CB-1	CIRCULAR	3.50	9.62	0.88	3.50	1	152.35
Culvert88_IN	DUMMY	0.00	0.00	0.00	0.00	1	0.00
CulvertEast_IN	CIRCULAR	2.00	3.14	0.50	2.00	1	45.42

CulvertWest_IN	CIRCULAR	1.50	1.77	0.38	1.50	1
7.43						
D-2	CIRCULAR	1.50	1.77	0.38	1.50	1
22.83						
D-3	CIRCULAR	1.50	1.77	0.38	1.50	1
23.51						
CB-2	CIRCULAR	3.50	9.62	0.88	3.50	1
330.59						
E_IN	DUMMY	0.00	0.00	0.00	0.00	1
0.00						
E-2	HORIZ_ELLIPSE	3.17	12.90	0.97	5.00	1
101.13						
E-3	CIRCULAR	4.00	12.57	1.00	4.00	1
101.40						
E-4	CIRCULAR	4.00	12.57	1.00	4.00	1
101.59						
E-5	CIRCULAR	4.00	12.57	1.00	4.00	1
101.05						
E-6	HORIZ_ELLIPSE	3.17	12.90	0.97	5.00	1
102.76						
E-7	CIRCULAR	4.00	12.57	1.00	4.00	1
275.36						
EX-4	CIRCULAR	2.50	4.91	0.63	2.50	1
38.96						
F_IN	DUMMY	0.00	0.00	0.00	0.00	1
0.00						
G-1	CIRCULAR	5.00	19.63	1.25	5.00	1
109.57						
G-2	CIRCULAR	4.50	15.90	1.13	4.50	1
86.64						
G-3	CIRCULAR	4.50	15.90	1.13	4.50	1
93.73						
GA-1	CIRCULAR	1.50	1.77	0.38	1.50	1
7.56						
C-7	CIRCULAR	3.00	7.07	0.75	3.00	1
70.04						
J-7	CIRCULAR	2.50	4.91	0.63	2.50	1
58.02						
J-8	CIRCULAR	2.50	4.91	0.63	2.50	1
57.95						
J-9	CIRCULAR	1.50	1.77	0.38	1.50	1
11.74						
J-10	CIRCULAR	1.50	1.77	0.38	1.50	1
12.86						
J-11	CIRCULAR	1.25	1.23	0.31	1.25	1
6.41						
J-12	CIRCULAR	1.25	1.23	0.31	1.25	1
6.43						
C-8	CIRCULAR	3.00	7.07	0.75	3.00	1
69.08						

C-9	CIRCULAR	3.00	7.07	0.75	3.00	1
67.92						
J-1	CIRCULAR	3.00	7.07	0.75	3.00	1
94.32						
J-2	CIRCULAR	3.00	7.07	0.75	3.00	1
105.45						
J-3	CIRCULAR	3.00	7.07	0.75	3.00	1
105.48						
J-4	CIRCULAR	3.00	7.07	0.75	3.00	1
115.53						
J-5	CIRCULAR	2.50	4.91	0.63	2.50	1
71.01						
J-6	CIRCULAR	2.50	4.91	0.63	2.50	1
58.00						
JA-1	CIRCULAR	1.25	1.23	0.31	1.25	1
9.16						
JA-2	CIRCULAR	1.25	1.23	0.31	1.25	1
9.11						
JB-1	CIRCULAR	1.50	1.77	0.38	1.50	1
14.75						
JB-2	CIRCULAR	1.25	1.23	0.31	1.25	1
9.15						
E_TIE	CIRCULAR	4.00	12.57	1.00	4.00	1
624.30						
K-1	CIRCULAR	1.50	1.77	0.38	1.50	1
32.49						
K-2	CIRCULAR	1.50	1.77	0.38	1.50	1
7.10						
K-3	CIRCULAR	1.50	1.77	0.38	1.50	1
7.35						
OS-1_IN	DUMMY	0.00	0.00	0.00	0.00	1
0.00						
OS-2_IN	DUMMY	0.00	0.00	0.00	0.00	1
0.00						
OS-3_IN	DUMMY	0.00	0.00	0.00	0.00	1
0.00						
OS-A1	CIRCULAR	1.50	1.77	0.38	1.50	1
7.43						
OS-A-1	CIRCULAR	1.50	1.77	0.38	1.50	1
11.27						
OS-A2	CIRCULAR	1.50	1.77	0.38	1.50	1
7.44						
OS-A-2	CIRCULAR	1.50	1.77	0.38	1.50	1
7.31						
OS-A3	CIRCULAR	1.50	1.77	0.38	1.50	1
7.41						
OS-A-3	CIRCULAR	1.50	1.77	0.38	1.50	1
7.44						
OS-A-4	CIRCULAR	1.50	1.77	0.38	1.50	1
7.44						

OS-A-5	CIRCULAR	1.50	1.77	0.38	1.50	1
7.42						
OS-A-6	CIRCULAR	1.50	1.77	0.38	1.50	1
7.41						
OS-A-Channel	TRAPEZOIDAL	5.00	125.00	2.70	45.00	1
1803.53						
OS-B-1	CIRCULAR	1.50	1.77	0.38	1.50	1
2.38						
OS-C-1	CIRCULAR	1.50	1.77	0.38	1.50	1
7.44						
OS-D-1	CIRCULAR	1.50	1.77	0.38	1.50	1
7.43						
OS-E-1	CIRCULAR	1.50	1.77	0.38	1.50	1
7.43						
REACH1	4650	22.47	6129.81	14.83	400.00	1
246170.39						
REACH2_IN	1700	6.01	1127.37	3.22	400.00	1
14146.37						
REACH2_OUT	1700	6.01	1127.37	3.22	400.00	1
10045.83						
REACH3	950	14.43	3735.58	12.03	400.00	1
245533.17						
Out1_DummyLink	DUMMY	0.00	0.00	0.00	0.00	1
0.00						
Out2_DummyLink	DUMMY	0.00	0.00	0.00	0.00	1
0.00						
A-5	CIRCULAR	4.00	12.57	1.00	4.00	1
101.72						
A-5(1)	CIRCULAR	4.00	12.57	1.00	4.00	1
246.68						
C-10	CIRCULAR	1.50	1.77	0.38	1.50	1
14.85						

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Transect Summary
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Transect 1700
Area:

0.0000	0.0001	0.0003	0.0005	0.0008
0.0011	0.0015	0.0020	0.0025	0.0032
0.0042	0.0074	0.0125	0.0198	0.0287
0.0384	0.0488	0.0599	0.0742	0.0900
0.1070	0.1250	0.1437	0.1631	0.1830
0.2036	0.2255	0.2484	0.2723	0.2971
0.3226	0.3491	0.3778	0.4075	0.4382
0.4705	0.5041	0.5385	0.5739	0.6100
0.6461	0.6824	0.7190	0.7562	0.7952

0.8351 0.8755 0.9163 0.9576 1.0000
Hrad:
0.0170 0.0341 0.0511 0.0681 0.0845
0.1009 0.1175 0.1322 0.1459 0.1621
0.1720 0.1410 0.1309 0.1400 0.1571
0.1820 0.2088 0.2321 0.2350 0.2575
0.2772 0.3067 0.3368 0.3671 0.3969
0.4256 0.4529 0.4794 0.4799 0.5083
0.5401 0.5698 0.5666 0.5922 0.6139
0.6409 0.6444 0.6718 0.6956 0.7333
0.7713 0.8081 0.8409 0.8736 0.8575
0.8845 0.9175 0.9515 0.9691 1.0000
Width:
0.0014 0.0028 0.0042 0.0056 0.0071
0.0087 0.0102 0.0120 0.0139 0.0167
0.0426 0.0957 0.1471 0.1928 0.2184
0.2356 0.2514 0.2885 0.3597 0.3836
0.4123 0.4303 0.4463 0.4604 0.4747
0.4962 0.5277 0.5476 0.5731 0.5907
0.6030 0.6497 0.6861 0.7081 0.7365
0.7756 0.7975 0.8178 0.8434 0.8466
0.8494 0.8533 0.8607 0.8986 0.9260
0.9423 0.9520 0.9607 0.9875 1.0000

Transect 950
Area:
0.0002 0.0007 0.0013 0.0025 0.0068
0.0143 0.0239 0.0348 0.0471 0.0604
0.0756 0.0924 0.1101 0.1287 0.1481
0.1684 0.1895 0.2114 0.2341 0.2571
0.2802 0.3034 0.3267 0.3500 0.3735
0.3971 0.4208 0.4446 0.4684 0.4924
0.5165 0.5407 0.5650 0.5894 0.6139
0.6386 0.6633 0.6881 0.7131 0.7381
0.7633 0.7885 0.8139 0.8394 0.8649
0.8906 0.9164 0.9426 0.9702 1.0000
Hrad:
0.0171 0.0303 0.0427 0.0476 0.0435
0.0514 0.0681 0.0855 0.1029 0.1198
0.1309 0.1484 0.1675 0.1864 0.2050
0.2234 0.2416 0.2595 0.2798 0.3049
0.3300 0.3549 0.3798 0.4046 0.4292
0.4537 0.4781 0.5024 0.5265 0.5506
0.5745 0.5983 0.6219 0.6454 0.6689
0.6922 0.7154 0.7385 0.7615 0.7844
0.8072 0.8298 0.8524 0.8749 0.8973
0.9196 0.9418 0.9635 0.9832 1.0000
Width:
0.0107 0.0165 0.0223 0.0848 0.1928
0.2893 0.3327 0.3751 0.4148 0.4545

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            0.5234     0.5600     0.5873     0.6145     0.6418
            0.6690     0.6962     0.7235     0.7421     0.7453
            0.7485     0.7517     0.7549     0.7581     0.7613
            0.7646     0.7680     0.7713     0.7746     0.7779
            0.7813     0.7847     0.7881     0.7916     0.7950
            0.7984     0.8019     0.8053     0.8087     0.8122
            0.8156     0.8191     0.8225     0.8259     0.8294
            0.8328     0.8362     0.8647     0.9289     1.0000

Transect 4650
Area:
            0.0032     0.0087     0.0155     0.0232     0.0318
            0.0410     0.0509     0.0614     0.0725     0.0841
            0.0962     0.1088     0.1218     0.1354     0.1495
            0.1641     0.1793     0.1955     0.2128     0.2311
            0.2501     0.2698     0.2903     0.3114     0.3332
            0.3557     0.3788     0.4026     0.4270     0.4519
            0.4772     0.5030     0.5290     0.5552     0.5816
            0.6082     0.6350     0.6619     0.6890     0.7163
            0.7438     0.7715     0.7993     0.8274     0.8557
            0.8842     0.9129     0.9417     0.9708     1.0000
Hrad:
            0.0211     0.0424     0.0637     0.0857     0.1079
            0.1292     0.1506     0.1711     0.1917     0.2127
            0.2349     0.2574     0.2792     0.3004     0.3213
            0.3417     0.3419     0.3496     0.3574     0.3705
            0.3862     0.4020     0.4180     0.4338     0.4506
            0.4673     0.4838     0.5008     0.5188     0.5392
            0.5592     0.5798     0.6051     0.6301     0.6548
            0.6793     0.7036     0.7278     0.7517     0.7753
            0.7986     0.8217     0.8443     0.8660     0.8886
            0.9112     0.9335     0.9558     0.9779     1.0000
Width:
            0.1571     0.2111     0.2498     0.2787     0.3028
            0.3261     0.3471     0.3683     0.3881     0.4061
            0.4204     0.4334     0.4539     0.4731     0.4901
            0.5069     0.5347     0.5705     0.6074     0.6364
            0.6610     0.6851     0.7090     0.7330     0.7551
            0.7773     0.7996     0.8211     0.8406     0.8559
            0.8714     0.8856     0.8914     0.8973     0.9034
            0.9094     0.9155     0.9215     0.9276     0.9339
            0.9403     0.9468     0.9538     0.9615     0.9680
            0.9744     0.9809     0.9873     0.9937     1.0000


**********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
**********************************************************
```

```
****************
Analysis Options
****************
Flow Units ............... CFS
Process Models:
  Rainfall/Runoff ........ NO
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ YES
  Water Quality .......... NO
Flow Routing Method ...... DYNWAVE
Surcharge Method ......... EXTRAN
Starting Date ............ 07/18/2022 00:00:00
Ending Date .............. 07/23/2022 00:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:05:00
Routing Time Step ........ 5.00 sec
Variable Time Step ....... YES
Maximum Trials ........... 8
Number of Threads ........ 1
Head Tolerance ........... 0.005000 ft


**************************        Volume        Volume
Flow Routing Continuity        acre-feet      10^6 gal
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......         0.000         0.000
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........        26.355         8.588
External Outflow .........        22.498         7.331
Flooding Loss ............         3.717         1.211
Evaporation Loss .........         0.000         0.000
Exfiltration Loss ........         0.000         0.000
Initial Stored Volume ....         0.000         0.000
Final Stored Volume ......         0.066         0.022
Continuity Error (%) .....         0.280


************************
Highest Continuity Errors
************************
Node REACH2_IN (37.14%)
Node MH_OS_A1 (1.17%)
```

```
**************************
Time-Step Critical Elements
**************************
Link C-9 (69.22%)
Link A-3 (8.57%)


*******************************
Highest Flow Instability Indexes
*******************************
All links are stable.


************************
Routing Time Step Summary
************************
Minimum Time Step           :     0.50 sec
Average Time Step           :     2.29 sec
Maximum Time Step           :     5.00 sec
Percent in Steady State     :    -0.00
Average Iterations per Step :     2.00
Percent Not Converging      :     0.01
Time Step Frequencies       :
    5.000 -  3.155 sec      :    21.77 %
    3.155 -  1.991 sec      :     5.28 %
    1.991 -  1.256 sec      :    63.66 %
    1.256 -  0.792 sec      :     2.02 %
    0.792 -  0.500 sec      :     7.26 %


******************
Analysis begun on:  Tue Jan 30 17:37:32 2024
Analysis ended on:  Tue Jan 30 17:37:49 2024
Total elapsed time: 00:00:17
```

5-YR

Summary of Unit Hydrograph Parameters Used By Program and Calculated Results (Version 2.0.1)

		Unit Hydrograph Parameters and Results									Excess Precip.		Storm Hydrograph			
Catchment Name/ID	User Comment for Catchment	CT	Cp	W50 (min.)	W50 Before Peak	W75 (min.)	W75 Before Peak	Time to Peak (min.)	Peak (cfs)	Volume (c.f)	Excess (inches)	Excess (c.f.)	Time to Peak (min.)	Peak Flow (cfs)	Total Volume (c.f.)	Runoff per Unit Area (cfs/acre)
A-1		0.157	0.132	58.7	7.45	30.5	5.26	12.4	30	137,904	0.07	9,810	45.0	2	9,810	0.05
A-2-1		0.157	0.086	71.8	6.24	37.3	4.41	10.4	10	53,143	0.07	3,780	45.0	1	3,781	0.04
A-2-2		0.076	0.173	13.9	3.35	7.2	2.37	5.6	115	123,783	0.93	114,626	30.0	44	112,860	1.30
A-3		0.079	0.028	37.5	2.30	19.5	1.62	3.8	1	2,251	0.82	1,843	35.0	0	1,810	0.56
A-3-1		0.079	0.020	32.4	2.00	16.8	1.42	3.3	0	1,125	0.82	921	35.0	0	898	0.62
A-3-2		0.079	0.020	32.4	2.00	16.8	1.42	3.3	0	1,125	0.82	921	35.0	0	898	0.62
B-1		0.076	0.253	11.4	3.71	5.9	2.62	6.2	328	288,440	0.93	267,103	30.0	115	262,118	1.44
B-2		0.076	0.164	9.8	2.74	5.1	1.94	4.6	145	110,243	0.93	102,088	25.0	46	98,257	1.51
C-1		0.077	0.209	14.7	3.86	7.7	2.73	6.4	169	193,152	0.87	168,482	30.0	65	167,252	1.21
C-2		0.077	0.133	7.6	2.28	4.0	1.61	3.8	121	71,257	0.87	62,156	25.0	32	57,468	1.61
C-3		0.078	0.115	46.2	5.56	24.0	3.93	9.3	14	51,437	0.86	44,135	40.0	7	44,079	0.52
C-3-1		0.077	0.040	28.3	2.37	14.7	1.67	3.9	2	4,864	0.87	4,243	30.0	1	4,146	0.73
C-3-2		0.077	0.039	37.6	2.63	19.5	1.86	4.4	2	4,719	0.87	4,116	35.0	1	4,062	0.60
C-3-3		0.079	0.023	29.5	2.03	15.3	1.43	3.4	1	1,525	0.82	1,248	35.0	0	1,214	0.67
C-3-4		0.079	0.024	28.2	2.01	14.7	1.42	3.4	1	1,597	0.82	1,308	30.0	0	1,269	0.69
C-3-5		0.077	0.030	14.5	1.84	7.5	1.30	3.1	2	2,650	0.87	2,311	30.0	1	2,155	1.12
C-3-6		0.077	0.031	20.7	1.99	10.7	1.41	3.3	2	2,759	0.87	2,406	30.0	1	2,310	0.92
C-3-7		0.077	0.034	19.0	2.00	9.9	1.41	3.3	2	3,449	0.87	3,008	30.0	1	2,877	0.97
C-3-8		0.077	0.034	22.1	2.08	11.5	1.47	3.5	2	3,449	0.87	3,008	30.0	1	2,901	0.88
C-3-15		0.079	0.028	55.3	2.70	28.8	1.91	4.5	1	2,360	0.82	1,932	40.0	0	1,916	0.42
C-3-16		0.079	0.029	53.1	2.67	27.6	1.89	4.4	1	2,432	0.82	1,991	40.0	0	1,973	0.43
C-3-17		0.077	0.026	32.0	2.14	16.6	1.51	3.6	1	1,888	0.87	1,647	35.0	0	1,607	0.67
C-3-18		0.077	0.027	30.8	2.14	16.0	1.51	3.6	1	2,033	0.87	1,773	35.0	0	1,729	0.69
C-3-19		0.077	0.033	27.5	2.20	14.3	1.55	3.7	2	3,231	0.87	2,818	30.0	1	2,743	0.75
C-3-20		0.077	0.047	37.9	2.88	19.7	2.03	4.8	2	7,151	0.87	6,238	35.0	1	6,176	0.60
C-3-21		0.077	0.048	38.5	2.91	20.0	2.06	4.9	2	7,333	0.87	6,396	35.0	1	6,338	0.59
C-4		0.079	0.054	20.9	2.37	10.9	1.68	4.0	6	10,091	0.82	8,263	30.0	2	8,018	0.87
C-4-1		0.079	0.037	26.8	2.25	13.9	1.59	3.8	2	4,211	0.82	3,448	30.0	1	3,359	0.72
C-4-2		0.079	0.043	26.7	2.37	13.9	1.68	4.0	3	5,881	0.82	4,815	30.0	1	4,702	0.72
C-5		0.079	0.100	6.7	2.01	3.5	1.42	3.4	75	38,805	0.83	32,093	25.0	16	28,147	1.54
C-5-1		0.079	0.036	57.9	3.12	30.1	2.20	5.2	1	4,138	0.82	3,388	40.0	0	3,374	0.41
C-5-2		0.079	0.037	59.1	3.16	30.7	2.24	5.3	1	4,211	0.82	3,448	45.0	0	3,434	0.40
C-5-3		0.079	0.033	6.7	1.67	3.5	1.18	2.8	6	3,267	0.82	2,675	25.0	1	2,208	1.41
C-5-4		0.079	0.033	6.7	1.67	3.5	1.18	2.8	6	3,231	0.82	2,645	25.0	1	2,188	1.41
C-5-5		0.079	0.027	4.2	1.47	2.2	0.98	2.6	7	2,178	0.82	1,783	25.0	1	1,239	1.46
C-5-6		0.079	0.027	4.2	1.47	2.2	0.98	2.6	7	2,178	0.82	1,783	25.0	1	1,239	1.46
C-5-7		0.079	0.032	6.8	1.67	3.5	1.18	2.8	6	3,086	0.82	2,526	25.0	1	2,103	1.41
C-5-8		0.079	0.032	6.7	1.66	3.5	1.17	2.8	6	3,013	0.82	2,467	25.0	1	2,031	1.41
C-5-9		0.079	0.022	7.3	1.62	3.8	1.15	2.7	2	1,343	0.82	1,100	25.0	1	929	1.39
C-5-10		0.079	0.029	36.5	2.32	19.0	1.64	3.9	1	2,577	0.82	2,110	35.0	0	2,072	0.58
C-5-11		0.079	0.029	36.5	2.32	19.0	1.64	3.9	1	2,577	0.82	2,110	35.0	0	2,072	0.58
C-5-12		0.077	0.034	25.2	2.17	13.1	1.53	3.6	2	3,521	0.87	3,071	30.0	1	2,976	0.79
C-5-13		0.077	0.034	30.4	2.30	15.8	1.62	3.8	1	3,485	0.87	3,040	35.0	1	2,972	0.69
C-6		0.079	0.045	17.7	2.11	9.2	1.49	3.5	5	6,607	0.82	5,410	30.0	2	5,169	0.96
C-6-1		0.079	0.029	24.5	2.04	12.8	1.44	3.4	1	2,432	0.82	1,991	30.0	1	1,923	0.76
C-6-2		0.079	0.031	25.7	2.12	13.3	1.49	3.5	1	2,940	0.82	2,408	30.0	1	2,333	0.74

C-6-3		0.079	0.021	12.5	1.70	6.5	1.20	2.8	1	1,234	0.82	1,011	30.0	0	930	1.14
D-1		0.081	0.145	14.3	3.10	7.4	2.19	5.2	85	93,727	0.77	71,758	30.0	28	70,235	1.07
D-2		0.157	0.098	60.3	6.02	31.3	4.25	10.0	15	70,422	0.07	5,010	40.0	1	5,010	0.05
D-3		0.081	0.100	13.7	2.55	7.1	1.80	4.3	39	40,874	0.77	31,293	30.0	12	29,944	1.06
E		0.079	0.168	13.1	3.19	6.8	2.25	5.3	123	124,618	0.82	102,039	30.0	41	99,290	1.19
F		0.157	0.092	58.6	5.64	30.5	3.99	9.4	14	61,892	0.07	4,403	40.0	1	4,400	0.05
OS-1		0.137	0.160	43.3	6.84	22.5	4.83	11.4	84	281,071	0.13	36,082	40.0	9	36,083	0.11
OS-2		0.146	0.115	41.0	5.11	21.3	3.61	8.5	37	117,322	0.06	6,474	40.0	1	6,461	0.05
OS-3		0.150	0.093	39.0	4.30	20.3	3.04	7.2	23	70,821	0.05	3,220	40.0	1	3,212	0.04
EX-X		0.157	0.024	22.0	1.90	11.5	1.34	3.2	2	3,013	0.07	214	35.0	0	206	0.12
OS-4-1		0.076	0.043	36.0	2.68	18.7	1.89	4.5	2	5,481	0.92	5,069	35.0	1	5,003	0.65
OS-4-2		0.075	0.045	35.3	2.71	18.4	1.92	4.5	2	6,026	0.95	5,733	35.0	1	5,658	0.68
OS-7-1		0.073	0.027	42.0	2.38	21.8	1.68	4.0	1	1,924	1.09	2,101	35.0	0	2,069	0.67
OS-7-2		0.073	0.027	42.6	2.38	22.2	1.68	4.0	1	1,851	1.09	2,022	35.0	0	1,991	0.66
OS-7-3		0.073	0.028	45.2	2.46	23.5	1.74	4.1	1	1,997	1.09	2,180	40.0	0	2,152	0.63
OS-7-4		0.073	0.028	44.8	2.46	23.3	1.74	4.1	1	2,033	1.09	2,220	40.0	0	2,190	0.63

5-YR

Summary of CUHP Input Parameters (Version 2.0.1)

								Depression Storage		Horton's Infiltration Parameters			DCIA Level and Fractions			
Catchment Name/ID	SWMM Node/ID	Raingage Name/ID	Area (sq.mi.)	Dist. to Centroid (miles)	Length (miles)	Slope (ft./ft.)	Percent Imperv.	Pervious (inches)	Imperv. (inches)	Initial Rate (in./hr.)	Final Rate (in.hr.)	Decay Coeff. (1/sec.)	DCIA Level	Dir. Con'ct Imperv. Fraction	Receiv. Perv. Fraction	Percent Eff. Imperv.
A-1	A-1	5-YEAR CORRECTED	0.059	0.352	0.547	0.030	2.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.04	0.02	1.55
A-2-1	A-2-1	5-YEAR CORRECTED	0.023	0.302	0.409	0.032	2.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.04	0.02	1.55
A-2-2	A-2-2	5-YEAR CORRECTED	0.053	0.194	0.433	0.036	85.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.95	0.35	83.96
A-3	A-3	5-YEAR CORRECTED	0.001	0.075	0.103	0.012	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.64
A-3-1	IN_A-3-1	5-YEAR CORRECTED	0.000	0.037	0.074	0.010	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.64
A-3-2	IN_A-3-2	5-YEAR CORRECTED	0.000	0.037	0.074	0.010	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.64
B-1	B-1	5-YEAR CORRECTED	0.124	0.185	0.463	0.018	85.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.95	0.35	83.96
B-2	B-2	5-YEAR CORRECTED	0.047	0.117	0.325	0.039	85.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.95	0.35	83.96
C-1	C-1	5-YEAR CORRECTED	0.083	0.163	0.434	0.010	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	78.79
C-2	C-2	5-YEAR CORRECTED	0.031	0.078	0.201	0.050	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	78.79
C-3	C-3	5-YEAR CORRECTED	0.022	0.389	0.769	0.019	78.7	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	77.42
C-3-1	IN_C-3-1	5-YEAR CORRECTED	0.002	0.061	0.194	0.018	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	78.79
C-3-2	IN_C-3-2	5-YEAR CORRECTED	0.002	0.110	0.187	0.018	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	78.79
C-3-3	IN_C-3-3	5-YEAR CORRECTED	0.001	0.044	0.090	0.018	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.64
C-3-4	IN_C-3-4	5-YEAR CORRECTED	0.001	0.043	0.089	0.018	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.64
C-3-5	IN_C-3-5	5-YEAR CORRECTED	0.001	0.024	0.101	0.038	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	78.79
C-3-6	IN_C-3-6	5-YEAR CORRECTED	0.001	0.050	0.100	0.035	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	78.79
C-3-7	IN_C-3-7	5-YEAR CORRECTED	0.001	0.037	0.139	0.035	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	78.79
C-3-8	IN_C-3-8	5-YEAR CORRECTED	0.001	0.051	0.147	0.040	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	78.79
C-3-15	IN_C-3-15	5-YEAR CORRECTED	0.001	0.113	0.147	0.010	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.64
C-3-16	IN_C-3-16	5-YEAR CORRECTED	0.001	0.110	0.143	0.010	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.64
C-3-17	IN_C-3-17	5-YEAR CORRECTED	0.001	0.055	0.115	0.019	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	78.79
C-3-18	IN_C-3-18	5-YEAR CORRECTED	0.001	0.056	0.114	0.019	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	78.79
C-3-19	IN_C-3-19	5-YEAR CORRECTED	0.001	0.049	0.103	0.008	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	78.79
C-3-20	IN_C-3-20	5-YEAR CORRECTED	0.003	0.083	0.277	0.010	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	78.79
C-3-21	IN_C-3-21	5-YEAR CORRECTED	0.003	0.084	0.276	0.009	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	78.79
C-4	C-4	5-YEAR CORRECTED	0.004	0.063	0.218	0.026	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.64
C-4-1	IN_C-4-1	5-YEAR CORRECTED	0.002	0.060	0.170	0.026	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.64
C-4-2	IN_C-4-2	5-YEAR CORRECTED	0.003	0.063	0.218	0.026	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.64
C-5	C-5	5-YEAR CORRECTED	0.017	0.411	0.728	109.138	75.8	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	74.43
C-5-1	IN_C-5-1	5-YEAR CORRECTED	0.002	0.134	0.269	0.014	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.64
C-5-2	IN_C-5-2	5-YEAR CORRECTED	0.002	0.136	0.275	0.013	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.64
C-5-3	IN_C-5-3	5-YEAR CORRECTED	0.001	0.107	0.214	68.977	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.64
C-5-4	IN_C-5-4	5-YEAR CORRECTED	0.001	0.107	0.214	68.977	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.64
C-5-5	IN_C-5-5	5-YEAR CORRECTED	0.001	0.071	0.142	200.316	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.64
C-5-6	IN_C-5-6	5-YEAR CORRECTED	0.001	0.071	0.142	200.316	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.64
C-5-7	IN_C-5-7	5-YEAR CORRECTED	0.001	0.171	0.204	165.130	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.64
C-5-8	IN_C-5-8	5-YEAR CORRECTED	0.001	0.167	0.198	169.360	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.64
C-5-9	IN_C-5-9	5-YEAR CORRECTED	0.001	0.007	0.027	0.020	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.64
C-5-10	IN_C-5-10	5-YEAR CORRECTED	0.001	0.073	0.147	0.020	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.64
C-5-11	IN_C-5-11	5-YEAR CORRECTED	0.001	0.073	0.147	0.020	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.64
C-5-12	IN_C-5-12	5-YEAR CORRECTED	0.002	0.052	0.132	0.018	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	78.79
C-5-13	IN_C-5-13	5-YEAR CORRECTED	0.002	0.089	0.112	0.018	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	78.79
C-6	C-6	5-YEAR CORRECTED	0.003	0.040	0.131	0.017	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.64
C-6-1	IN_C-6-1	5-YEAR CORRECTED	0.001	0.045	0.092	0.017	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.64

C-6-2	IN_C-6-2	5-YEAR CORRECTED	0.001	0.053	0.098	0.016	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.64
C-6-3	IN_C-6-3	5-YEAR CORRECTED	0.001	0.016	0.038	0.024	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.64
D-1	IN_D-1	5-YEAR CORRECTED	0.040	0.178	0.256	0.025	70.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.92	0.30	68.53
D-2	D-2	5-YEAR CORRECTED	0.030	0.303	0.319	0.024	2.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.04	0.02	1.55
D-3	IN_D-3	5-YEAR CORRECTED	0.018	0.186	0.089	0.019	70.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.92	0.30	68.53
E	E	5-YEAR CORRECTED	0.054	0.127	0.360	0.018	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.64
F	F	5-YEAR CORRECTED	0.027	0.166	0.434	0.019	2.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.04	0.02	1.55
OS-1	OS-1	5-YEAR CORRECTED	0.121	0.297	0.687	0.030	8.7	0.35	0.10	3.00	0.50	0.0018	0.00	0.17	0.09	6.98
OS-2	OS-2	5-YEAR CORRECTED	0.051	0.182	0.372	0.022	5.7	0.40	0.10	3.00	0.50	0.0018	0.00	0.11	0.06	4.50
OS-3	OS-3	5-YEAR CORRECTED	0.030	0.166	0.225	0.021	4.6	0.40	0.10	3.00	0.50	0.0018	0.00	0.09	0.05	3.63
EX-X	X	5-YEAR CORRECTED	0.001	0.018	0.036	0.025	2.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.00	0.02	1.54
OS-4-1	Out1	5-YEAR CORRECTED	0.002	0.101	0.193	0.013	85.6	0.40	0.10	3.00	0.50	0.0018	0.00	0.95	0.35	84.53
OS-4-2	Out1	5-YEAR CORRECTED	0.003	0.102	0.187	0.011	87.9	0.40	0.10	3.00	0.50	0.0018	0.00	0.96	0.36	86.96
OS-7-1	IN_OS-E1	5-YEAR CORRECTED	0.001	0.057	0.118	0.004	100.0	0.40	0.10	3.00	0.50	0.0018	0.00	1.00	0.00	100.00
OS-7-2	IN_OS-D-1	5-YEAR CORRECTED	0.001	0.059	0.121	0.005	100.0	0.40	0.10	3.00	0.50	0.0018	0.00	1.00	0.00	100.00
OS-7-3	IN_OS-D-1	5-YEAR CORRECTED	0.001	0.064	0.130	0.005	100.0	0.40	0.10	3.00	0.50	0.0018	0.00	1.00	0.00	100.00
OS-7-4	IN_OS-E1	5-YEAR CORRECTED	0.001	0.064	0.130	0.005	100.0	0.40	0.10	3.00	0.50	0.0018	0.00	1.00	0.00	100.00

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.015)

Redtail Ridge
Proposed Storm Network
5-year Event

WARNING 08: elevation drop exceeds length for Conduit C-1_IN
WARNING 08: elevation drop exceeds length for Conduit E_IN
WARNING 04: minimum elevation drop used for Conduit Out1_DummyLink
WARNING 04: minimum elevation drop used for Conduit Out2_DummyLink

****
Element Count
****
Number of rain gages 0
Number of subcatchments ... 0
Number of nodes 130
Number of links 128
Number of pollutants 0
Number of land uses 0

****
Node Summary
****

Name	Type	Invert Elev.	Max. Depth	Ponded Area	External Inflow
88thStCulvert	JUNCTION	5469.71	0.00	0.0	Yes
A-1	JUNCTION	5399.18	0.00	0.0	
A-2-1	JUNCTION	5399.18	0.00	0.0	
A-2-2	JUNCTION	5383.23	0.00	0.0	
B-1	JUNCTION	5383.23	0.00	0.0	
B-2	JUNCTION	5370.12	16.66	0.0	
C-1	JUNCTION	5365.69	0.00	0.0	
C-2	JUNCTION	5357.25	0.00	0.0	
IN_D-3	JUNCTION	5358.99	8.17	0.0	
E	JUNCTION	5460.00	5.00	0.0	
E_OUT	JUNCTION	5456.72	7.00	0.0	
F	JUNCTION	5372.82	0.00	0.0	
FES_OS-A1	JUNCTION	5364.79	5.00	0.0	
IN_A-3-1	JUNCTION	5461.84	5.08	0.0	
IN_A-3-2	JUNCTION	5461.25	5.69	0.0	
IN_C-3-1	JUNCTION	5456.42	5.44	0.0	
IN_C-3-15	JUNCTION	5394.00	8.41	0.0	
IN_C-3-16	JUNCTION	5392.69	9.72	0.0	
IN_C-3-17	JUNCTION	5385.54	11.70	0.0	
IN_C-3-18	JUNCTION	5385.21	12.53	0.0	
IN_C-3-19	JUNCTION	5385.87	6.25	0.0	

IN_C-3-2	JUNCTION	5456.27	5.79	0.0
IN_C-3-20	JUNCTION	5374.45	14.13	0.0
IN_C-3-21	JUNCTION	5370.68	17.90	0.0
IN_C-3-3	JUNCTION	5448.28	5.59	0.0
IN_C-3-4	JUNCTION	5448.38	5.66	0.0
IN_C-3-5	JUNCTION	5426.43	9.83	0.0
IN_C-3-6	JUNCTION	5426.24	10.69	0.0
IN_C-3-7	JUNCTION	5396.47	15.11	0.0
IN_C-3-8	JUNCTION	5395.61	15.97	0.0
IN_C-4-1	JUNCTION	5365.90	4.02	0.0
IN_C-4-2	JUNCTION	5365.40	4.68	0.0
IN_C-5-1	JUNCTION	5442.59	5.16	0.0
IN_C-5-10	JUNCTION	5377.70	5.85	0.0
IN_C-5-11	JUNCTION	5375.03	8.54	0.0
IN_C-5-12	JUNCTION	5367.94	5.68	0.0
IN_C-5-13	JUNCTION	5360.54	13.54	0.0
IN_C-5-2	JUNCTION	5443.19	4.56	0.0
IN_C-5-3	JUNCTION	5426.13	6.55	0.0
IN_C-5-4	JUNCTION	5427.19	5.49	0.0
IN_C-5-5	JUNCTION	5405.51	6.24	0.0
IN_C-5-6	JUNCTION	5406.51	5.22	0.0
IN_C-5-7	JUNCTION	5369.11	13.62	0.0
IN_C-5-8	JUNCTION	5368.46	14.41	0.0
IN_C-5-9	JUNCTION	5367.29	14.25	0.0
IN_C-6-1	JUNCTION	5358.82	7.54	0.0
IN_C-6-2	JUNCTION	5361.36	4.81	0.0
IN_C-6-3	JUNCTION	5355.27	0.00	0.0
IN_OS-B1	JUNCTION	5354.19	1.80	0.0
IN_OS-C1	JUNCTION	5354.55	1.80	0.0
IN_OS-D-1	JUNCTION	5363.04	1.80	0.0
IN_OS-E1	JUNCTION	5363.16	1.80	0.0
MH_A1	JUNCTION	5370.18	16.15	0.0
MH_A10	JUNCTION	5390.15	15.94	0.0
MH_A11	JUNCTION	5391.49	15.05	0.0
MH_A12	JUNCTION	5392.68	17.55	0.0
MH_A13	JUNCTION	5394.03	20.33	0.0
MH_A14	JUNCTION	5405.68	12.20	0.0
MH_A15	JUNCTION	5415.05	14.01	0.0
MH_A16	JUNCTION	5424.36	13.15	0.0
MH_A17	JUNCTION	5429.82	12.63	0.0
MH_A18	JUNCTION	5446.96	6.75	0.0
MH_A20	JUNCTION	5454.77	6.92	0.0
MH_A21	JUNCTION	5459.04	8.06	0.0
MH_A22	JUNCTION	5462.10	7.24	0.0
MH_A23	JUNCTION	5462.70	6.22	0.0
MH_A-24	JUNCTION	5465.71	8.40	0.0
MH_A25	JUNCTION	5466.19	8.48	0.0
MH_A26	JUNCTION	5469.13	9.97	0.0
MH_A27	JUNCTION	5469.73	9.55	0.0
MH_A3	JUNCTION	5370.91	17.45	0.0

MH_A5	JUNCTION	5383.03	12.25	0.0	
MH_A6	JUNCTION	5383.96	12.46	0.0	
MH_A7	JUNCTION	5384.90	12.72	0.0	
MH_A8	JUNCTION	5386.41	13.21	0.0	
MH_A9	JUNCTION	5388.31	12.56	0.0	
MH_B1	JUNCTION	5383.85	11.42	0.0	
MH_B2	JUNCTION	5385.34	6.54	0.0	
MH_C2	JUNCTION	5360.73	13.24	0.0	
MH_C4	JUNCTION	5363.99	19.43	0.0	
MH_C5	JUNCTION	5366.43	15.68	0.0	
MH_C6	JUNCTION	5368.16	14.83	0.0	
MH_E2	JUNCTION	5372.94	10.70	0.0	
MH_E3	JUNCTION	5374.11	15.68	0.0	
MH_E4	JUNCTION	5376.05	18.61	0.0	
MH_E5	JUNCTION	5376.65	17.77	0.0	
MH_E6	JUNCTION	5378.08	15.66	0.0	
MH_E7	JUNCTION	5382.19	9.29	0.0	
MH_G1	JUNCTION	5358.56	8.75	0.0	
MH_J7	JUNCTION	5422.80	11.54	0.0	
MH_J8	JUNCTION	5430.52	9.95	0.0	
MH_J9	JUNCTION	5435.69	9.24	0.0	
MH_J10	JUNCTION	5442.15	8.21	0.0	
MH_C9	JUNCTION	5369.40	13.49	0.0	
MH_J1	JUNCTION	5371.94	12.23	0.0	
MH_J2	JUNCTION	5378.59	10.66	0.0	
MH_J3	JUNCTION	5387.89	10.46	0.0	
MH_J4	JUNCTION	5401.30	12.85	0.0	
MH_J5	JUNCTION	5409.95	13.66	0.0	
MH_J6	JUNCTION	5420.42	11.34	0.0	
MH_K3	JUNCTION	5461.60	5.03	0.0	
MH_OS_A1	JUNCTION	5353.79	6.54	0.0	
MH_OS-A1	JUNCTION	5365.21	5.24	0.0	
MH_OS-A2	JUNCTION	5355.35	9.74	0.0	
MH_OS-A3	JUNCTION	5356.55	11.08	0.0	
MH_OS-A4	JUNCTION	5358.00	10.74	0.0	
MH_OS-A5	JUNCTION	5360.03	9.50	0.0	
MH_OS-A6	JUNCTION	5361.88	6.00	0.0	
MH_OS-A7	JUNCTION	5362.65	4.71	0.0	
OS-1	JUNCTION	5451.06	0.00	0.0	
OS-2	JUNCTION	5372.82	0.00	0.0	
OS-3	JUNCTION	5351.00	0.00	0.0	
REACH1_IN	JUNCTION	5451.06	22.47	0.0	
REACH2_IN	JUNCTION	5399.18	22.47	0.0	
REACH2_OUT	JUNCTION	5372.82	6.01	0.0	
REACH3_IN	JUNCTION	5363.99	14.43	0.0	
SchoolCulvertEast	JUNCTION	5434.52	2.00	0.0	Yes
SchoolCulvertWest	JUNCTION	5464.00	1.50	0.0	Yes
Out1_DummyNode	JUNCTION	5351.00	14.43	0.0	
Out2_DummyNode	JUNCTION	5355.27	0.50	0.0	
MH_A42	JUNCTION	5382.42	11.44	0.0	

IN_D-1	JUNCTION	5370.45	6.13	0.0
Out2	OUTFALL	5355.27	0.00	0.0
Out1	OUTFALL	5351.00	0.00	0.0
School_Pond_Bypass	OUTFALL	5450.90	2.50	0.0
MH_A19	DIVIDER	5451.22	9.49	0.0
Pond_B-1	STORAGE	5384.14	9.67	0.0
Pond_C-1	STORAGE	5368.17	6.64	0.0
Pond_C-2	STORAGE	5355.85	9.42	0.0
Pond_E	STORAGE	5457.00	10.00	0.0

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Link Summary
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Name	From Node	To Node	Type	Length	%Slope	Roughness
A-1	MH_A1	Pond_C-1	CONDUIT	294.6	0.6822	0.0130
A-1_IN	A-1	REACH2_IN	CONDUIT	1.0	-57.7350	0.0100
A-10	MH_A10	MH_A9	CONDUIT	297.2	0.5181	0.0130
A-11	MH_A11	MH_A10	CONDUIT	227.2	0.5018	0.0130
A-12	MH_A12	MH_A11	CONDUIT	197.5	0.5013	0.0130
A-13	MH_A13	MH_A12	CONDUIT	102.5	0.4977	0.0130
A-14	MH_A14	MH_A13	CONDUIT	213.3	5.3299	0.0130
A-15	MH_A15	MH_A14	CONDUIT	210.4	4.3633	0.0130
A-16	MH_A16	MH_A15	CONDUIT	218.0	4.2278	0.0130
A-17	MH_A17	MH_A16	CONDUIT	131.6	3.7711	0.0130
A-18	MH_A18	MH_A17	CONDUIT	396.9	4.2714	0.0130
A-19	MH_A19	MH_A18	CONDUIT	378.9	1.7318	0.0130
A-2	IN_C-3-21	MH_A1	CONDUIT	59.6	0.5037	0.0130
A-20	MH_A20	MH_A19	CONDUIT	90.1	0.9432	0.0130
A-21	MH_A21	MH_A20	CONDUIT	391.9	1.0385	0.0130
A-2-1_IN	A-2-1	REACH2_IN	CONDUIT	1.0		

-57.7350   0.0100
  A-22   MH_A22   MH_A21   CONDUIT   142.6
2.0768   0.0130
  A-2-2_IN   A-2-2   Pond_B-1   CONDUIT   1.0
-219.4843   0.0100
  A-23   MH_A23   MH_A22   CONDUIT   96.9
0.5160   0.0130
  A-24   MH_A-24   MH_A23   CONDUIT   168.3
1.7297   0.0130
  A-25   MH_A25   MH_A-24   CONDUIT   20.0
1.4001   0.0130
  A-26   MH_A26   MH_A25   CONDUIT   196.3
1.3963   0.0130
  A-27   MH_A27   MH_A26   CONDUIT   39.5
1.0140   0.0130
  A-3   MH_A3   IN_C-3-21   CONDUIT   5.4
0.3690   0.0130
  A-6   MH_A6   MH_A5   CONDUIT   146.9
0.4968   0.0130
  A-7   MH_A7   MH_A6   CONDUIT   147.0
0.5034   0.0130
  A-8   MH_A8   MH_A7   CONDUIT   261.2
0.5015   0.0130
  A-9   MH_A9   MH_A8   CONDUIT   340.3
0.4995   0.0130
  AA-1   IN_C-3-20   MH_A3   CONDUIT   40.2
0.9958   0.0130
  AB-1   IN_C-3-18   MH_A7   CONDUIT   21.5
0.5116   0.0130
  AB-2   IN_C-3-17   IN_C-3-18   CONDUIT   45.8
0.5026   0.0130
  AC-1   IN_C-3-16   MH_A9   CONDUIT   25.8
1.7030   0.0130
  AC-2   IN_C-3-15   IN_C-3-16   CONDUIT   40.4
2.7520   0.0130
  AD-1   IN_C-3-8   MH_A12   CONDUIT   29.4
1.4613   0.0130
  AD-2   IN_C-3-7   IN_C-3-8   CONDUIT   40.3
1.5619   0.0130
  AE-1   IN_C-3-5   MH_A16   CONDUIT   62.1
0.5151   0.0130
  AE-2   IN_C-3-6   MH_A16   CONDUIT   28.9
0.4505   0.0130
  AF-1   IN_C-3-3   MH_A18   CONDUIT   12.7
0.7893   0.0130
  AF-2   IN_C-3-4   MH_A18   CONDUIT   34.7
0.6057   0.0130
  AG-1   IN_C-3-1   MH_A20   CONDUIT   12.7
0.5525   0.0130
  AG-2   IN_C-3-2   MH_A20   CONDUIT   34.7

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0.4903    0.0130
  B-1             MH_B1           MH_A5           CONDUIT          125.9
0.4925    0.0130
  B-1_IN          B-1             Pond_B-1        CONDUIT            1.0
-219.4843    0.0100
  B-2             MH_B2           MH_B1           CONDUIT          258.7
0.4987    0.0130
  B-3             IN_C-3-19       MH_B2           CONDUIT           66.0
0.4999    0.0130
  C-1             IN_C-5-13       Pond_C-2        CONDUIT          129.4
0.5021    0.0130
  C-1_IN          C-1             Pond_C-1        CONDUIT            1.0
-248.0000    0.0100
  C150            IN_OS-B1        Out1_DummyNode  CONDUIT           28.0
11.4675    0.0130
  C-2             MH_C2           IN_C-5-13       CONDUIT           15.4
0.5856    0.0130
  C-2_IN          C-2             Pond_C-2        CONDUIT           15.0
9.3743    0.0100
  C-4             MH_C4           MH_C2           CONDUIT          485.2
0.6307    0.0130
  C-5             MH_C5           MH_C4           CONDUIT           68.9
1.0739    0.0130
  C-6             MH_C6           MH_C5           CONDUIT          141.9
1.0784    0.0130
  C-6-3_Street    IN_C-6-3        Out2_DummyNode  CONDUIT           10.0
-5.0063    0.0100
  CA-1            IN_C-5-12       MH_C2           CONDUIT           56.6
7.1077    0.0130
  CB-1            IN_C-5-9        MH_C5           CONDUIT           28.8
2.2931    0.0130
  Culvert88_IN    88thStCulvert   MH_A27          CONDUIT            1.0
-60.8781    0.0100
  CulvertEast_IN  SchoolCulvertEast MH_A17          CONDUIT          104.3
4.0309    0.0130
  CulvertWest_IN  SchoolCulvertWest MH_A22          CONDUIT           88.0
0.5003    0.0130
  D-2             IN_C-5-11       MH_C4           CONDUIT          155.6
4.7237    0.0130
  D-3             IN_C-5-10       IN_C-5-11       CONDUIT           47.4
5.0073    0.0130
  CB-2            B-2             IN_C-5-9        CONDUIT           24.5
10.7971    0.0130
  E_IN            E               Pond_E          CONDUIT            1.0
250.0000    0.0100
  E-2             MH_E2           REACH3_IN       CONDUIT           34.7
0.4905    0.0130
  E-3             MH_E3           MH_E2           CONDUIT          194.7
0.4983    0.0130
  E-4             MH_E4           MH_E3           CONDUIT          347.9
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0.5002    0.0130
  E-5             MH_E5           MH_E4           CONDUIT          80.8
0.4949    0.0130
  E-6             MH_E6           MH_E5           CONDUIT         118.5
0.5064    0.0130
  E-7             MH_E7           MH_E6           CONDUIT         106.5
3.6749    0.0130
  EX-4            MH_A19          School_Pond_Bypass CONDUIT        35.5
0.9022    0.0130
  F_IN            F               REACH2_OUT      CONDUIT          1.0
-57.7350    0.0100
  G-1             MH_G1           Pond_C-2        CONDUIT          56.5
0.1770    0.0130
  G-2             IN_C-6-1        MH_G1           CONDUIT          82.4
0.1941    0.0130
  G-3             IN_D-3          IN_C-6-1        CONDUIT          30.8
0.2272    0.0130
  GA-1            IN_C-6-2        MH_G1           CONDUIT          69.5
0.5181    0.0130
  C-7             IN_C-5-8        MH_C6           CONDUIT           9.1
1.1026    0.0130
  J-7             MH_J7           MH_J6           CONDUIT         109.0
2.0008    0.0130
  J-8             MH_J8           MH_J7           CONDUIT         376.8
1.9960    0.0130
  J-9             MH_J9           MH_J8           CONDUIT         333.9
1.2490    0.0130
  J-10            MH_J10          MH_J9           CONDUIT         417.7
1.4987    0.0130
  J-11            IN_C-5-1        MH_J10          CONDUIT          24.4
0.9849    0.0130
  J-12            IN_C-5-2        IN_C-5-1        CONDUIT          40.3
0.9919    0.0130
  C-8             IN_C-5-7        IN_C-5-8        CONDUIT          42.0
1.0728    0.0130
  C-9             MH_C9           IN_C-5-7        CONDUIT           8.7
1.0369    0.0130
  J-1             MH_J1           MH_C9           CONDUIT         117.0
1.9997    0.0130
  J-2             MH_J2           MH_J1           CONDUIT         258.1
2.4993    0.0130
  J-3             MH_J3           MH_J2           CONDUIT         364.0
2.5008    0.0130
  J-4             MH_J4           MH_J3           CONDUIT         440.5
3.0002    0.0130
  J-5             MH_J5           MH_J4           CONDUIT         272.0
2.9973    0.0130
  J-6             MH_J6           MH_J5           CONDUIT         371.1
1.9996    0.0130
  JA-1            IN_C-5-5        MH_J4           CONDUIT          24.4
```

2.0111 0.0130
JA-2 IN_C-5-6 IN_C-5-5 CONDUIT 40.2
1.9895 0.0130
JB-1 IN_C-5-3 MH_J7 CONDUIT 24.4
1.9716 0.0130
JB-2 IN_C-5-4 IN_C-5-3 CONDUIT 40.4
2.0078 0.0130
E_TIE E_OUT MH_J8 CONDUIT 140.1
18.8890 0.0130
K-1 IN_A-3-2 REACH1_IN CONDUIT 56.9
9.5656 0.0130
K-2 MH_K3 IN_A-3-2 CONDUIT 32.9
0.4566 0.0130
K-3 IN_A-3-1 MH_K3 CONDUIT 8.2
0.4896 0.0130
OS-1_IN OS-1 REACH1_IN CONDUIT 1.0
-57.7350 0.0100
OS-2_IN OS-2 REACH2_OUT CONDUIT 1.0
-57.7350 0.0100
OS-3_IN OS-3 Out1_DummyNode CONDUIT 1.0
-57.7350 0.0100
OS-A1 MH_OS-A2 MH_OS_A1 CONDUIT 311.9
0.5001 0.0130
OS-A-1 MH_OS-A1 FES_OS-A1 CONDUIT 36.5
1.1520 0.0130
OS-A2 MH_OS-A3 MH_OS-A2 CONDUIT 199.5
0.5012 0.0130
OS-A-2 IN_C-4-2 MH_OS-A1 CONDUIT 18.6
0.4844 0.0130
OS-A3 MH_OS-A4 MH_OS-A3 CONDUIT 250.9
0.4982 0.0130
OS-A-3 IN_C-4-1 IN_C-4-2 CONDUIT 79.6
0.5023 0.0130
OS-A-4 MH_OS-A5 MH_OS-A4 CONDUIT 365.0
0.5013 0.0130
OS-A-5 MH_OS-A6 MH_OS-A5 CONDUIT 330.8
0.4988 0.0130
OS-A-6 MH_OS-A7 MH_OS-A6 CONDUIT 114.7
0.4970 0.0130
OS-A-Channel FES_OS-A1 Out1_DummyNode CONDUIT 450.0
3.0659 0.0350
OS-B-1 MH_OS_A1 IN_OS-B1 CONDUIT 19.5
0.0513 0.0130
OS-C-1 IN_OS-C1 MH_OS_A1 CONDUIT 111.5
0.5022 0.0130
OS-D-1 IN_OS-D-1 MH_OS-A7 CONDUIT 18.0
0.5000 0.0130
OS-E-1 IN_OS-E1 MH_OS-A7 CONDUIT 62.0
0.5000 0.0130
REACH1 REACH1_IN REACH2_IN CONDUIT 2528.2

2.0525 0.0320
  REACH2_IN REACH2_IN REACH2_OUT CONDUIT 1436.4
1.8354 0.0350
  REACH2_OUT REACH2_OUT REACH3_IN CONDUIT 954.0
0.9256 0.0350
  REACH3 REACH3_IN Out1_DummyNode CONDUIT 150.0
8.6927 0.0350
  Out1_DummyLink Out1_DummyNode Out1 CONDUIT 10.0
0.0100 0.0100
  Out2_DummyLink Out2_DummyNode Out2 CONDUIT 10.0
0.0100 0.0100
  A-5 MH_A5 MH_A42 CONDUIT 81.8
0.5015 0.0130
  A-5(1) MH_A42 MH_A3 CONDUIT 387.1
2.9492 0.0130
  C-10 IN_D-1 MH_C9 CONDUIT 42.6
1.9976 0.0130
  C-1_OUT Pond_C-1 REACH3_IN OUTLET
  B-1_OUT Pond_B-1 MH_E7 OUTLET
  C-2_OUT Pond_C-2 Out2_DummyNode OUTLET
  E_OUT Pond_E E_OUT OUTLET

  ****
  Cross Section Summary
  ****

Conduit	Shape	Full Depth	Full Area	Hyd. Rad.	Max. Width	No. of Barrels	Full Flow
A-1	CIRCULAR	4.50	15.90	1.13	4.50	1	162.42
A-1_IN	DUMMY	0.00	0.00	0.00	0.00	1	0.00
A-10	CIRCULAR	4.00	12.57	1.00	4.00	1	103.40
A-11	CIRCULAR	4.00	12.57	1.00	4.00	1	101.76
A-12	CIRCULAR	4.00	12.57	1.00	4.00	1	101.71
A-13	HORIZ_ELLIPSE	2.42	7.41	0.74	3.75	1	48.90
A-14	CIRCULAR	3.00	7.07	0.75	3.00	1	153.98
A-15	CIRCULAR	3.00	7.07	0.75	3.00	1	139.32
A-16	CIRCULAR	3.00	7.07	0.75	3.00	1	

137.14
  A-17 CIRCULAR 2.50 4.91 0.63 2.50 1
79.65
  A-18 CIRCULAR 2.50 4.91 0.63 2.50 1
84.77
  A-19 CIRCULAR 2.50 4.91 0.63 2.50 1
53.98
  A-2 CIRCULAR 4.50 15.90 1.13 4.50 1
139.57
  A-20 RECT_CLOSED 4.00 18.00 1.06 4.50 1
207.59
  A-21 CIRCULAR 4.00 12.57 1.00 4.00 1
146.38
  A-2-1_IN DUMMY 0.00 0.00 0.00 0.00 1
0.00
  A-22 CIRCULAR 4.00 12.57 1.00 4.00 1
207.00
  A-2-2_IN DUMMY 0.00 0.00 0.00 0.00 1
0.00
  A-23 HORIZ_ELLIPSE 3.17 12.90 0.97 5.00 1
103.72
  A-24 CIRCULAR 3.50 9.62 0.88 3.50 1
132.32
  A-25 CIRCULAR 3.50 9.62 0.88 3.50 1
119.05
  A-26 CIRCULAR 3.50 9.62 0.88 3.50 1
118.89
  A-27 CIRCULAR 3.50 9.62 0.88 3.50 1
101.31
  A-3 CIRCULAR 4.50 15.90 1.13 4.50 1
119.46
  A-6 CIRCULAR 4.00 12.57 1.00 4.00 1
101.25
  A-7 CIRCULAR 4.00 12.57 1.00 4.00 1
101.92
  A-8 CIRCULAR 4.00 12.57 1.00 4.00 1
101.72
  A-9 CIRCULAR 4.00 12.57 1.00 4.00 1
101.52
  AA-1 CIRCULAR 1.50 1.77 0.38 1.50 1
10.48
  AB-1 CIRCULAR 1.50 1.77 0.38 1.50 1
7.51
  AB-2 CIRCULAR 1.50 1.77 0.38 1.50 1
7.45
  AC-1 CIRCULAR 1.50 1.77 0.38 1.50 1
13.71
  AC-2 CIRCULAR 1.50 1.77 0.38 1.50 1
17.43
  AD-1 CIRCULAR 1.50 1.77 0.38 1.50 1

12.70
  AD-2 CIRCULAR 1.50 1.77 0.38 1.50 1
13.13
  AE-1 CIRCULAR 1.50 1.77 0.38 1.50 1
7.54
  AE-2 CIRCULAR 1.50 1.77 0.38 1.50 1
7.05
  AF-1 CIRCULAR 1.50 1.77 0.38 1.50 1
9.33
  AF-2 CIRCULAR 1.50 1.77 0.38 1.50 1
8.18
  AG-1 CIRCULAR 1.50 1.77 0.38 1.50 1
7.81
  AG-2 CIRCULAR 1.50 1.77 0.38 1.50 1
7.36
  B-1 CIRCULAR 1.50 1.77 0.38 1.50 1
7.37
  B-1_IN DUMMY 0.00 0.00 0.00 0.00 1
0.00
  B-2 CIRCULAR 1.50 1.77 0.38 1.50 1
7.42
  B-3 CIRCULAR 1.50 1.77 0.38 1.50 1
7.43
  C-1 CIRCULAR 4.50 15.90 1.13 4.50 1
139.35
  C-1_IN DUMMY 0.00 0.00 0.00 0.00 1
0.00
  C150 CIRCULAR 1.50 1.77 0.38 1.50 1
35.57
  C-2 CIRCULAR 4.50 15.90 1.13 4.50 1
150.48
  C-2_IN DUMMY 0.00 0.00 0.00 0.00 1
0.00
  C-4 CIRCULAR 4.50 15.90 1.13 4.50 1
156.17
  C-5 CIRCULAR 3.50 9.62 0.88 3.50 1
104.26
  C-6 CIRCULAR 3.00 7.07 0.75 3.00 1
69.26
  C-6-3_Street DUMMY 0.00 0.00 0.00 0.00 1
0.00
  CA-1 CIRCULAR 1.50 1.77 0.38 1.50 1
28.00
  CB-1 CIRCULAR 3.50 9.62 0.88 3.50 1
152.35
  Culvert88_IN DUMMY 0.00 0.00 0.00 0.00 1
0.00
  CulvertEast_IN CIRCULAR 2.00 3.14 0.50 2.00 1
45.42
  CulvertWest_IN CIRCULAR 1.50 1.77 0.38 1.50 1

7.43
  D-2 CIRCULAR 1.50 1.77 0.38 1.50 1
22.83
  D-3 CIRCULAR 1.50 1.77 0.38 1.50 1
23.51
  CB-2 CIRCULAR 3.50 9.62 0.88 3.50 1
330.59
  E_IN DUMMY 0.00 0.00 0.00 0.00 1
0.00
  E-2 HORIZ_ELLIPSE 3.17 12.90 0.97 5.00 1
101.13
  E-3 CIRCULAR 4.00 12.57 1.00 4.00 1
101.40
  E-4 CIRCULAR 4.00 12.57 1.00 4.00 1
101.59
  E-5 CIRCULAR 4.00 12.57 1.00 4.00 1
101.05
  E-6 HORIZ_ELLIPSE 3.17 12.90 0.97 5.00 1
102.76
  E-7 CIRCULAR 4.00 12.57 1.00 4.00 1
275.36
  EX-4 CIRCULAR 2.50 4.91 0.63 2.50 1
38.96
  F_IN DUMMY 0.00 0.00 0.00 0.00 1
0.00
  G-1 CIRCULAR 5.00 19.63 1.25 5.00 1
109.57
  G-2 CIRCULAR 4.50 15.90 1.13 4.50 1
86.64
  G-3 CIRCULAR 4.50 15.90 1.13 4.50 1
93.73
  GA-1 CIRCULAR 1.50 1.77 0.38 1.50 1
7.56
  C-7 CIRCULAR 3.00 7.07 0.75 3.00 1
70.04
  J-7 CIRCULAR 2.50 4.91 0.63 2.50 1
58.02
  J-8 CIRCULAR 2.50 4.91 0.63 2.50 1
57.95
  J-9 CIRCULAR 1.50 1.77 0.38 1.50 1
11.74
  J-10 CIRCULAR 1.50 1.77 0.38 1.50 1
12.86
  J-11 CIRCULAR 1.25 1.23 0.31 1.25 1
6.41
  J-12 CIRCULAR 1.25 1.23 0.31 1.25 1
6.43
  C-8 CIRCULAR 3.00 7.07 0.75 3.00 1
69.08
  C-9 CIRCULAR 3.00 7.07 0.75 3.00 1

67.92
  J-1 CIRCULAR 3.00 7.07 0.75 3.00 1
94.32
  J-2 CIRCULAR 3.00 7.07 0.75 3.00 1
105.45
  J-3 CIRCULAR 3.00 7.07 0.75 3.00 1
105.48
  J-4 CIRCULAR 3.00 7.07 0.75 3.00 1
115.53
  J-5 CIRCULAR 2.50 4.91 0.63 2.50 1
71.01
  J-6 CIRCULAR 2.50 4.91 0.63 2.50 1
58.00
  JA-1 CIRCULAR 1.25 1.23 0.31 1.25 1
9.16
  JA-2 CIRCULAR 1.25 1.23 0.31 1.25 1
9.11
  JB-1 CIRCULAR 1.50 1.77 0.38 1.50 1
14.75
  JB-2 CIRCULAR 1.25 1.23 0.31 1.25 1
9.15
  E_TIE CIRCULAR 4.00 12.57 1.00 4.00 1
624.30
  K-1 CIRCULAR 1.50 1.77 0.38 1.50 1
32.49
  K-2 CIRCULAR 1.50 1.77 0.38 1.50 1
7.10
  K-3 CIRCULAR 1.50 1.77 0.38 1.50 1
7.35
  OS-1_IN DUMMY 0.00 0.00 0.00 0.00 1
0.00
  OS-2_IN DUMMY 0.00 0.00 0.00 0.00 1
0.00
  OS-3_IN DUMMY 0.00 0.00 0.00 0.00 1
0.00
  OS-A1 CIRCULAR 1.50 1.77 0.38 1.50 1
7.43
  OS-A-1 CIRCULAR 1.50 1.77 0.38 1.50 1
11.27
  OS-A2 CIRCULAR 1.50 1.77 0.38 1.50 1
7.44
  OS-A-2 CIRCULAR 1.50 1.77 0.38 1.50 1
7.31
  OS-A3 CIRCULAR 1.50 1.77 0.38 1.50 1
7.41
  OS-A-3 CIRCULAR 1.50 1.77 0.38 1.50 1
7.44
  OS-A-4 CIRCULAR 1.50 1.77 0.38 1.50 1
7.44
  OS-A-5 CIRCULAR 1.50 1.77 0.38 1.50 1

7.42
  OS-A-6   CIRCULAR   1.50   1.77   0.38   1.50   1
7.41
  OS-A-Channel   TRAPEZOIDAL   5.00   125.00   2.70   45.00   1
1803.53
  OS-B-1   CIRCULAR   1.50   1.77   0.38   1.50   1
2.38
  OS-C-1   CIRCULAR   1.50   1.77   0.38   1.50   1
7.44
  OS-D-1   CIRCULAR   1.50   1.77   0.38   1.50   1
7.43
  OS-E-1   CIRCULAR   1.50   1.77   0.38   1.50   1
7.43
  REACH1   4650   22.47 6129.81   14.83   400.00   1
246170.39
  REACH2_IN   1700   6.01 1127.37   3.22   400.00   1
14146.37
  REACH2_OUT   1700   6.01 1127.37   3.22   400.00   1
10045.83
  REACH3   950   14.43 3735.58   12.03   400.00   1
245533.17
  Out1_DummyLink   DUMMY   0.00   0.00   0.00   0.00   1
0.00
  Out2_DummyLink   DUMMY   0.00   0.00   0.00   0.00   1
0.00
  A-5   CIRCULAR   4.00   12.57   1.00   4.00   1
101.72
  A-5(1)   CIRCULAR   4.00   12.57   1.00   4.00   1
246.68
  C-10   CIRCULAR   1.50   1.77   0.38   1.50   1
14.85

  ****
  Transect Summary
  ****

  Transect 1700
  Area:
              0.0000   0.0001   0.0003   0.0005   0.0008
              0.0011   0.0015   0.0020   0.0025   0.0032
              0.0042   0.0074   0.0125   0.0198   0.0287
              0.0384   0.0488   0.0599   0.0742   0.0900
              0.1070   0.1250   0.1437   0.1631   0.1830
              0.2036   0.2255   0.2484   0.2723   0.2971
              0.3226   0.3491   0.3778   0.4075   0.4382
              0.4705   0.5041   0.5385   0.5739   0.6100
              0.6461   0.6824   0.7190   0.7562   0.7952
              0.8351   0.8755   0.9163   0.9576   1.0000

Hrad:

0.0170	0.0341	0.0511	0.0681	0.0845
0.1009	0.1175	0.1322	0.1459	0.1621
0.1720	0.1410	0.1309	0.1400	0.1571
0.1820	0.2088	0.2321	0.2350	0.2575
0.2772	0.3067	0.3368	0.3671	0.3969
0.4256	0.4529	0.4794	0.4799	0.5083
0.5401	0.5698	0.5666	0.5922	0.6139
0.6409	0.6444	0.6718	0.6956	0.7333
0.7713	0.8081	0.8409	0.8736	0.8575
0.8845	0.9175	0.9515	0.9691	1.0000

Width:

0.0014	0.0028	0.0042	0.0056	0.0071
0.0087	0.0102	0.0120	0.0139	0.0167
0.0426	0.0957	0.1471	0.1928	0.2184
0.2356	0.2514	0.2885	0.3597	0.3836
0.4123	0.4303	0.4463	0.4604	0.4747
0.4962	0.5277	0.5476	0.5731	0.5907
0.6030	0.6497	0.6861	0.7081	0.7365
0.7756	0.7975	0.8178	0.8434	0.8466
0.8494	0.8533	0.8607	0.8986	0.9260
0.9423	0.9520	0.9607	0.9875	1.0000

Transect 950

Area:

0.0002	0.0007	0.0013	0.0025	0.0068
0.0143	0.0239	0.0348	0.0471	0.0604
0.0756	0.0924	0.1101	0.1287	0.1481
0.1684	0.1895	0.2114	0.2341	0.2571
0.2802	0.3034	0.3267	0.3500	0.3735
0.3971	0.4208	0.4446	0.4684	0.4924
0.5165	0.5407	0.5650	0.5894	0.6139
0.6386	0.6633	0.6881	0.7131	0.7381
0.7633	0.7885	0.8139	0.8394	0.8649
0.8906	0.9164	0.9426	0.9702	1.0000

Hrad:

0.0171	0.0303	0.0427	0.0476	0.0435
0.0514	0.0681	0.0855	0.1029	0.1198
0.1309	0.1484	0.1675	0.1864	0.2050
0.2234	0.2416	0.2595	0.2798	0.3049
0.3300	0.3549	0.3798	0.4046	0.4292
0.4537	0.4781	0.5024	0.5265	0.5506
0.5745	0.5983	0.6219	0.6454	0.6689
0.6922	0.7154	0.7385	0.7615	0.7844
0.8072	0.8298	0.8524	0.8749	0.8973
0.9196	0.9418	0.9635	0.9832	1.0000

Width:

0.0107	0.0165	0.0223	0.0848	0.1928
0.2893	0.3327	0.3751	0.4148	0.4545
0.5234	0.5600	0.5873	0.6145	0.6418

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            0.6690     0.6962     0.7235     0.7421     0.7453
            0.7485     0.7517     0.7549     0.7581     0.7613
            0.7646     0.7680     0.7713     0.7746     0.7779
            0.7813     0.7847     0.7881     0.7916     0.7950
            0.7984     0.8019     0.8053     0.8087     0.8122
            0.8156     0.8191     0.8225     0.8259     0.8294
            0.8328     0.8362     0.8647     0.9289     1.0000

Transect 4650
Area:
            0.0032     0.0087     0.0155     0.0232     0.0318
            0.0410     0.0509     0.0614     0.0725     0.0841
            0.0962     0.1088     0.1218     0.1354     0.1495
            0.1641     0.1793     0.1955     0.2128     0.2311
            0.2501     0.2698     0.2903     0.3114     0.3332
            0.3557     0.3788     0.4026     0.4270     0.4519
            0.4772     0.5030     0.5290     0.5552     0.5816
            0.6082     0.6350     0.6619     0.6890     0.7163
            0.7438     0.7715     0.7993     0.8274     0.8557
            0.8842     0.9129     0.9417     0.9708     1.0000
Hrad:
            0.0211     0.0424     0.0637     0.0857     0.1079
            0.1292     0.1506     0.1711     0.1917     0.2127
            0.2349     0.2574     0.2792     0.3004     0.3213
            0.3417     0.3419     0.3496     0.3574     0.3705
            0.3862     0.4020     0.4180     0.4338     0.4506
            0.4673     0.4838     0.5008     0.5188     0.5392
            0.5592     0.5798     0.6051     0.6301     0.6548
            0.6793     0.7036     0.7278     0.7517     0.7753
            0.7986     0.8217     0.8443     0.8660     0.8886
            0.9112     0.9335     0.9558     0.9779     1.0000
Width:
            0.1571     0.2111     0.2498     0.2787     0.3028
            0.3261     0.3471     0.3683     0.3881     0.4061
            0.4204     0.4334     0.4539     0.4731     0.4901
            0.5069     0.5347     0.5705     0.6074     0.6364
            0.6610     0.6851     0.7090     0.7330     0.7551
            0.7773     0.7996     0.8211     0.8406     0.8559
            0.8714     0.8856     0.8914     0.8973     0.9034
            0.9094     0.9155     0.9215     0.9276     0.9339
            0.9403     0.9468     0.9538     0.9615     0.9680
            0.9744     0.9809     0.9873     0.9937     1.0000


**********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
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Analysis Options
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Flow Units ............... CFS
Process Models:
  Rainfall/Runoff ........ NO
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ YES
  Water Quality .......... NO
Flow Routing Method ...... DYNWAVE
Surcharge Method ......... EXTRAN
Starting Date ............ 07/18/2022 00:00:00
Ending Date .............. 07/23/2022 00:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:05:00
Routing Time Step ........ 5.00 sec
Variable Time Step ....... YES
Maximum Trials ........... 8
Number of Threads ........ 1
Head Tolerance ........... 0.005000 ft


**************************        Volume        Volume
Flow Routing Continuity        acre-feet      10^6 gal
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......         0.000         0.000
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........        34.341        11.191
External Outflow .........        28.826         9.394
Flooding Loss ............         5.366         1.748
Evaporation Loss .........         0.000         0.000
Exfiltration Loss ........         0.000         0.000
Initial Stored Volume ....         0.000         0.000
Final Stored Volume ......         0.074         0.024
Continuity Error (%) .....         0.220


************************
Highest Continuity Errors
************************
Node REACH2_IN (11.56%)


**************************
Time-Step Critical Elements
```

```
**************************
Link C-9 (78.64%)
Link A-3 (7.51%)


******************************
Highest Flow Instability Indexes
******************************
All links are stable.


************************
Routing Time Step Summary
************************
Minimum Time Step           :     0.50 sec
Average Time Step           :     1.99 sec
Maximum Time Step           :     5.00 sec
Percent in Steady State     :    -0.00
Average Iterations per Step :     2.00
Percent Not Converging      :     0.00
Time Step Frequencies       :
    5.000 -  3.155 sec      :    13.84 %
    3.155 -  1.991 sec      :     4.59 %
    1.991 -  1.256 sec      :    73.08 %
    1.256 -  0.792 sec      :     1.78 %
    0.792 -  0.500 sec      :     6.72 %


******************
Analysis begun on:  Tue Jan 30 17:43:44 2024
Analysis ended on:  Tue Jan 30 17:44:04 2024
Total elapsed time: 00:00:20
```

10-YR

Summary of Unit Hydrograph Parameters Used By Program and Calculated Results (Version 2.0.1)

		Unit Hydrograph Parameters and Results									Excess Precip.		Storm Hydrograph			
Catchment Name/ID	User Comment for Catchment	CT	Cp	W50 (min.)	W50 Before Peak	W75 (min.)	W75 Before Peak	Time to Peak (min.)	Peak (cfs)	Volume (c.f)	Excess (inches)	Excess (c.f.)	Time to Peak (min.)	Peak Flow (cfs)	Total Volume (c.f.)	Runoff per Unit Area (cfs/acre)
A-1		0.157	0.132	58.7	7.44	30.5	5.26	12.4	30	137,904	0.25	34,689	45.0	7	34,688	0.18
A-2-1		0.157	0.086	71.8	6.23	37.3	4.40	10.4	10	53,143	0.25	13,368	45.0	2	13,371	0.15
A-2-2		0.076	0.173	13.9	3.35	7.2	2.37	5.6	115	123,783	1.21	149,541	30.0	56	147,222	1.66
A-3		0.079	0.028	37.5	2.30	19.5	1.62	3.8	1	2,251	1.09	2,451	35.0	0	2,407	0.74
A-3-1		0.079	0.020	32.3	2.00	16.8	1.42	3.3	0	1,125	1.09	1,226	35.0	0	1,194	0.82
A-3-2		0.079	0.020	32.3	2.00	16.8	1.42	3.3	0	1,125	1.09	1,226	35.0	0	1,194	0.82
B-1		0.076	0.253	11.3	3.71	5.9	2.62	6.2	328	288,440	1.21	348,461	30.0	146	341,983	1.84
B-2		0.076	0.164	9.8	2.74	5.1	1.94	4.6	145	110,243	1.21	133,184	25.0	60	128,168	1.97
C-1		0.077	0.209	14.7	3.86	7.6	2.73	6.4	170	193,152	1.15	221,852	30.0	84	220,188	1.58
C-2		0.077	0.133	7.6	2.28	3.9	1.61	3.8	121	71,257	1.15	81,845	25.0	42	75,660	2.13
C-3		0.078	0.115	46.1	5.56	24.0	3.93	9.3	14	51,437	1.13	58,266	40.0	10	58,192	0.67
C-3-1		0.077	0.040	28.3	2.37	14.7	1.67	3.9	2	4,864	1.15	5,587	30.0	1	5,460	0.95
C-3-2		0.077	0.039	37.5	2.63	19.5	1.86	4.4	2	4,719	1.15	5,420	35.0	1	5,349	0.78
C-3-3		0.079	0.023	29.4	2.02	15.3	1.43	3.4	1	1,525	1.09	1,661	30.0	0	1,615	0.88
C-3-4		0.079	0.024	28.2	2.01	14.6	1.42	3.4	1	1,597	1.09	1,740	30.0	0	1,688	0.91
C-3-5		0.077	0.030	14.5	1.84	7.5	1.30	3.1	2	2,650	1.15	3,044	30.0	1	2,838	1.45
C-3-6		0.077	0.031	20.6	1.99	10.7	1.41	3.3	2	2,759	1.15	3,169	30.0	1	3,042	1.19
C-3-7		0.077	0.034	19.0	2.00	9.9	1.41	3.3	2	3,449	1.15	3,961	30.0	1	3,788	1.26
C-3-8		0.077	0.034	22.0	2.08	11.5	1.47	3.5	2	3,449	1.15	3,961	30.0	1	3,820	1.14
C-3-15		0.079	0.028	55.2	2.70	28.7	1.91	4.5	1	2,360	1.09	2,570	40.0	0	2,548	0.55
C-3-16		0.079	0.029	53.0	2.67	27.6	1.88	4.4	1	2,432	1.09	2,649	40.0	0	2,624	0.57
C-3-17		0.077	0.026	31.9	2.14	16.6	1.51	3.6	1	1,888	1.15	2,168	35.0	0	2,116	0.87
C-3-18		0.077	0.027	30.8	2.14	16.0	1.51	3.6	1	2,033	1.15	2,335	35.0	0	2,277	0.89
C-3-19		0.077	0.033	27.4	2.20	14.3	1.55	3.7	2	3,231	1.15	3,711	30.0	1	3,612	0.97
C-3-20		0.077	0.047	37.8	2.88	19.7	2.03	4.8	2	7,151	1.15	8,214	35.0	2	8,133	0.78
C-3-21		0.077	0.048	38.4	2.91	20.0	2.06	4.9	2	7,333	1.15	8,422	35.0	2	8,345	0.77
C-4		0.079	0.054	20.8	2.37	10.8	1.67	4.0	6	10,091	1.09	10,992	30.0	3	10,665	1.15
C-4-1		0.079	0.037	26.7	2.25	13.9	1.59	3.8	2	4,211	1.09	4,586	30.0	1	4,467	0.95
C-4-2		0.079	0.043	26.6	2.37	13.8	1.68	4.0	3	5,881	1.09	6,405	30.0	2	6,254	0.96
C-5		0.079	0.100	6.7	2.01	3.5	1.42	3.4	75	38,805	1.10	42,620	25.0	22	37,356	2.06
C-5-1		0.079	0.036	57.8	3.12	30.0	2.20	5.2	1	4,138	1.09	4,507	45.0	1	4,488	0.54
C-5-2		0.079	0.037	59.0	3.16	30.7	2.23	5.3	1	4,211	1.09	4,586	45.0	1	4,568	0.53
C-5-3		0.079	0.033	6.7	1.67	3.5	1.18	2.8	6	3,267	1.09	3,558	25.0	2	2,934	1.90
C-5-4		0.079	0.033	6.7	1.67	3.5	1.18	2.8	6	3,231	1.09	3,519	25.0	2	2,908	1.90
C-5-5		0.079	0.027	4.2	1.47	2.2	0.98	2.6	7	2,178	1.09	2,372	25.0	1	1,647	1.97
C-5-6		0.079	0.027	4.2	1.47	2.2	0.98	2.6	7	2,178	1.09	2,372	25.0	1	1,647	1.97
C-5-7		0.079	0.032	6.8	1.67	3.5	1.18	2.8	6	3,086	1.09	3,361	25.0	2	2,795	1.90
C-5-8		0.079	0.032	6.6	1.66	3.5	1.17	2.8	6	3,013	1.09	3,282	25.0	2	2,699	1.89
C-5-9		0.079	0.022	7.2	1.62	3.8	1.15	2.7	2	1,343	1.09	1,463	25.0	1	1,235	1.86
C-5-10		0.079	0.029	36.4	2.32	18.9	1.64	3.9	1	2,577	1.09	2,807	35.0	1	2,756	0.76
C-5-11		0.079	0.029	36.5	2.32	19.0	1.64	3.9	1	2,577	1.09	2,807	35.0	1	2,756	0.76
C-5-12		0.077	0.034	25.2	2.17	13.1	1.53	3.6	2	3,521	1.15	4,044	30.0	1	3,918	1.03
C-5-13		0.077	0.034	30.3	2.30	15.8	1.62	3.8	1	3,485	1.15	4,003	35.0	1	3,913	0.90
C-6		0.079	0.045	17.7	2.11	9.2	1.49	3.5	5	6,607	1.09	7,196	30.0	2	6,875	1.27
C-6-1		0.079	0.029	24.5	2.04	12.7	1.44	3.4	1	2,432	1.09	2,649	30.0	1	2,558	1.01
C-6-2		0.079	0.031	25.6	2.11	13.3	1.49	3.5	1	2,940	1.09	3,203	30.0	1	3,103	0.98

C-6-3		0.079	0.021	12.5	1.70	6.5	1.20	2.8	1	1,234	1.09	1,344	30.0	1	1,237	1.50
D-1		0.081	0.145	14.3	3.09	7.4	2.19	5.2	85	93,727	1.03	96,583	30.0	37	94,522	1.43
D-2		0.157	0.097	60.3	6.01	31.3	4.25	10.0	15	70,422	0.25	17,714	45.0	3	17,714	0.18
D-3		0.081	0.100	13.7	2.55	7.1	1.80	4.3	39	40,874	1.03	42,119	30.0	16	40,296	1.42
E		0.079	0.169	13.0	3.19	6.8	2.25	5.3	123	124,618	1.09	135,734	30.0	54	132,071	1.56
F		0.157	0.092	58.6	5.64	30.5	3.98	9.4	14	61,892	0.25	15,568	45.0	3	15,560	0.18
OS-1		0.136	0.159	43.3	6.79	22.5	4.80	11.3	84	281,071	0.32	90,162	40.0	22	90,172	0.28
OS-2		0.146	0.114	41.0	5.09	21.3	3.60	8.5	37	117,322	0.24	28,432	40.0	7	28,377	0.22
OS-3		0.149	0.093	39.0	4.28	20.3	3.03	7.1	23	70,821	0.23	16,338	40.0	4	16,298	0.22
EX-X		0.157	0.024	22.0	1.90	11.5	1.34	3.2	2	3,013	0.25	758	35.0	0	728	0.39
OS-4-1		0.076	0.043	36.0	2.68	18.7	1.89	4.5	2	5,481	1.21	6,619	35.0	1	6,532	0.83
OS-4-2		0.075	0.045	35.3	2.71	18.3	1.92	4.5	2	6,026	1.24	7,451	35.0	1	7,354	0.86
OS-7-1		0.073	0.027	42.0	2.38	21.8	1.68	4.0	1	1,924	1.39	2,672	35.0	0	2,631	0.83
OS-7-2		0.073	0.027	42.6	2.38	22.2	1.68	4.0	1	1,851	1.39	2,571	35.0	0	2,532	0.82
OS-7-3		0.073	0.028	45.2	2.46	23.5	1.74	4.1	1	1,997	1.39	2,773	35.0	0	2,736	0.78
OS-7-4		0.073	0.028	44.8	2.46	23.3	1.74	4.1	1	2,033	1.39	2,823	35.0	0	2,786	0.79

10-YR

Summary of CUHP Input Parameters (Version 2.0.1)

								Depression Storage		Horton's Infiltration Parameters			DCIA Level and Fractions			
Catchment Name/ID	SWMM Node/ID	Raingage Name/ID	Area (sq.mi.)	Dist. to Centroid (miles)	Length (miles)	Slope (ft./ft.)	Percent Imperv.	Pervious (inches)	Imperv. (inches)	Initial Rate (in./hr.)	Final Rate (in.hr.)	Decay Coeff. (1/sec.)	DCIA Level	Dir. Con'ct Imperv. Fraction	Receiv. Perv. Fraction	Percent Eff. Imperv.
A-1	A-1	10-YEAR CORRECTED	0.059	0.352	0.547	0.030	2.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.04	0.02	1.63
A-2-1	A-2-1	10-YEAR CORRECTED	0.023	0.302	0.409	0.032	2.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.04	0.02	1.63
A-2-2	A-2-2	10-YEAR CORRECTED	0.053	0.194	0.433	0.036	85.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.95	0.35	84.14
A-3	A-3	10-YEAR CORRECTED	0.001	0.075	0.103	0.012	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.88
A-3-1	IN_A-3-1	10-YEAR CORRECTED	0.000	0.037	0.074	0.010	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.88
A-3-2	IN_A-3-2	10-YEAR CORRECTED	0.000	0.037	0.074	0.010	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.88
B-1	B-1	10-YEAR CORRECTED	0.124	0.185	0.463	0.018	85.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.95	0.35	84.14
B-2	B-2	10-YEAR CORRECTED	0.047	0.117	0.325	0.039	85.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.95	0.35	84.14
C-1	C-1	10-YEAR CORRECTED	0.083	0.163	0.434	0.010	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	79.00
C-2	C-2	10-YEAR CORRECTED	0.031	0.078	0.201	0.050	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	79.00
C-3	C-3	10-YEAR CORRECTED	0.022	0.389	0.769	0.019	78.7	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	77.63
C-3-1	IN_C-3-1	10-YEAR CORRECTED	0.002	0.061	0.194	0.018	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	79.00
C-3-2	IN_C-3-2	10-YEAR CORRECTED	0.002	0.110	0.187	0.018	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	79.00
C-3-3	IN_C-3-3	10-YEAR CORRECTED	0.001	0.044	0.090	0.018	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.88
C-3-4	IN_C-3-4	10-YEAR CORRECTED	0.001	0.043	0.089	0.018	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.88
C-3-5	IN_C-3-5	10-YEAR CORRECTED	0.001	0.024	0.101	0.038	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	79.00
C-3-6	IN_C-3-6	10-YEAR CORRECTED	0.001	0.050	0.100	0.035	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	79.00
C-3-7	IN_C-3-7	10-YEAR CORRECTED	0.001	0.037	0.139	0.035	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	79.00
C-3-8	IN_C-3-8	10-YEAR CORRECTED	0.001	0.051	0.147	0.040	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	79.00
C-3-15	IN_C-3-15	10-YEAR CORRECTED	0.001	0.113	0.147	0.010	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.88
C-3-16	IN_C-3-16	10-YEAR CORRECTED	0.001	0.110	0.143	0.010	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.88
C-3-17	IN_C-3-17	10-YEAR CORRECTED	0.001	0.055	0.115	0.019	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	79.00
C-3-18	IN_C-3-18	10-YEAR CORRECTED	0.001	0.056	0.114	0.019	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	79.00
C-3-19	IN_C-3-19	10-YEAR CORRECTED	0.001	0.049	0.103	0.008	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	79.00
C-3-20	IN_C-3-20	10-YEAR CORRECTED	0.003	0.083	0.277	0.010	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	79.00
C-3-21	IN_C-3-21	10-YEAR CORRECTED	0.003	0.084	0.276	0.009	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	79.00
C-4	C-4	10-YEAR CORRECTED	0.004	0.063	0.218	0.026	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.88
C-4-1	IN_C-4-1	10-YEAR CORRECTED	0.002	0.060	0.170	0.026	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.88
C-4-2	IN_C-4-2	10-YEAR CORRECTED	0.003	0.063	0.218	0.026	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.88
C-5	C-5	10-YEAR CORRECTED	0.017	0.411	0.728	109.138	75.8	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	74.66
C-5-1	IN_C-5-1	10-YEAR CORRECTED	0.002	0.134	0.269	0.014	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.88
C-5-2	IN_C-5-2	10-YEAR CORRECTED	0.002	0.136	0.275	0.013	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.88
C-5-3	IN_C-5-3	10-YEAR CORRECTED	0.001	0.107	0.214	68.977	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.88
C-5-4	IN_C-5-4	10-YEAR CORRECTED	0.001	0.107	0.214	68.977	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.88
C-5-5	IN_C-5-5	10-YEAR CORRECTED	0.001	0.071	0.142	200.316	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.88
C-5-6	IN_C-5-6	10-YEAR CORRECTED	0.001	0.071	0.142	200.316	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.88
C-5-7	IN_C-5-7	10-YEAR CORRECTED	0.001	0.171	0.204	165.130	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.88
C-5-8	IN_C-5-8	10-YEAR CORRECTED	0.001	0.167	0.198	169.360	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.88
C-5-9	IN_C-5-9	10-YEAR CORRECTED	0.001	0.007	0.027	0.020	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.88
C-5-10	IN_C-5-10	10-YEAR CORRECTED	0.001	0.073	0.147	0.020	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.88
C-5-11	IN_C-5-11	10-YEAR CORRECTED	0.001	0.073	0.147	0.020	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.88
C-5-12	IN_C-5-12	10-YEAR CORRECTED	0.002	0.052	0.132	0.018	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	79.00
C-5-13	IN_C-5-13	10-YEAR CORRECTED	0.002	0.089	0.112	0.018	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	79.00
C-6	C-6	10-YEAR CORRECTED	0.003	0.040	0.131	0.017	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.88
C-6-1	IN_C-6-1	10-YEAR CORRECTED	0.001	0.045	0.092	0.017	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.88

C-6-2	IN_C-6-2	10-YEAR CORRECTED	0.001	0.053	0.098	0.016	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.88
C-6-3	IN_C-6-3	10-YEAR CORRECTED	0.001	0.016	0.038	0.024	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.88
D-1	IN_D-1	10-YEAR CORRECTED	0.040	0.178	0.256	0.025	70.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.92	0.30	68.78
D-2	D-2	10-YEAR CORRECTED	0.030	0.303	0.319	0.024	2.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.04	0.02	1.63
D-3	IN_D-3	10-YEAR CORRECTED	0.018	0.186	0.089	0.019	70.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.92	0.30	68.78
E	E	10-YEAR CORRECTED	0.054	0.127	0.360	0.018	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.88
F	F	10-YEAR CORRECTED	0.027	0.166	0.434	0.019	2.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.04	0.02	1.63
OS-1	OS-1	10-YEAR CORRECTED	0.121	0.297	0.687	0.030	8.7	0.35	0.10	3.00	0.50	0.0018	0.00	0.17	0.09	7.28
OS-2	OS-2	10-YEAR CORRECTED	0.051	0.182	0.372	0.022	5.7	0.40	0.10	3.00	0.50	0.0018	0.00	0.11	0.06	4.71
OS-3	OS-3	10-YEAR CORRECTED	0.030	0.166	0.225	0.021	4.6	0.40	0.10	3.00	0.50	0.0018	0.00	0.09	0.05	3.80
EX-X	X	10-YEAR CORRECTED	0.001	0.018	0.036	0.025	2.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.00	0.02	1.62
OS-4-1	Out1	10-YEAR CORRECTED	0.002	0.101	0.193	0.013	85.6	0.40	0.10	3.00	0.50	0.0018	0.00	0.95	0.35	84.71
OS-4-2	Out1	10-YEAR CORRECTED	0.003	0.102	0.187	0.011	87.9	0.40	0.10	3.00	0.50	0.0018	0.00	0.96	0.36	87.12
OS-7-1	IN_OS-E1	10-YEAR CORRECTED	0.001	0.057	0.118	0.004	100.0	0.40	0.10	3.00	0.50	0.0018	0.00	1.00	0.00	100.00
OS-7-2	IN_OS-D-1	10-YEAR CORRECTED	0.001	0.059	0.121	0.005	100.0	0.40	0.10	3.00	0.50	0.0018	0.00	1.00	0.00	100.00
OS-7-3	IN_OS-D-1	10-YEAR CORRECTED	0.001	0.064	0.130	0.005	100.0	0.40	0.10	3.00	0.50	0.0018	0.00	1.00	0.00	100.00
OS-7-4	IN_OS-E1	10-YEAR CORRECTED	0.001	0.064	0.130	0.005	100.0	0.40	0.10	3.00	0.50	0.0018	0.00	1.00	0.00	100.00

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.015)

Redtail Ridge
Proposed Storm Network
10-year Event

WARNING 08: elevation drop exceeds length for Conduit C-1_IN
WARNING 08: elevation drop exceeds length for Conduit E_IN
WARNING 04: minimum elevation drop used for Conduit Out1_DummyLink
WARNING 04: minimum elevation drop used for Conduit Out2_DummyLink

****
Element Count
****
Number of rain gages 0
Number of subcatchments ... 0
Number of nodes 130
Number of links 128
Number of pollutants 0
Number of land uses 0

****
Node Summary
****

Name	Type	Invert Elev.	Max. Depth	Ponded Area	External Inflow
88thStCulvert	JUNCTION	5469.71	0.00	0.0	Yes
A-1	JUNCTION	5399.18	0.00	0.0	
A-2-1	JUNCTION	5399.18	0.00	0.0	
A-2-2	JUNCTION	5383.23	0.00	0.0	
B-1	JUNCTION	5383.23	0.00	0.0	
B-2	JUNCTION	5370.12	16.66	0.0	
C-1	JUNCTION	5365.69	0.00	0.0	
C-2	JUNCTION	5357.25	0.00	0.0	
IN_D-3	JUNCTION	5358.99	8.17	0.0	
E	JUNCTION	5460.00	5.00	0.0	
E_OUT	JUNCTION	5456.72	7.00	0.0	
F	JUNCTION	5372.82	0.00	0.0	
FES_OS-A1	JUNCTION	5364.79	5.00	0.0	
IN_A-3-1	JUNCTION	5461.84	5.08	0.0	
IN_A-3-2	JUNCTION	5461.25	5.69	0.0	
IN_C-3-1	JUNCTION	5456.42	5.44	0.0	
IN_C-3-15	JUNCTION	5394.00	8.41	0.0	
IN_C-3-16	JUNCTION	5392.69	9.72	0.0	
IN_C-3-17	JUNCTION	5385.54	11.70	0.0	
IN_C-3-18	JUNCTION	5385.21	12.53	0.0	
IN_C-3-19	JUNCTION	5385.87	6.25	0.0	

IN_C-3-2	JUNCTION	5456.27	5.79	0.0
IN_C-3-20	JUNCTION	5374.45	14.13	0.0
IN_C-3-21	JUNCTION	5370.68	17.90	0.0
IN_C-3-3	JUNCTION	5448.28	5.59	0.0
IN_C-3-4	JUNCTION	5448.38	5.66	0.0
IN_C-3-5	JUNCTION	5426.43	9.83	0.0
IN_C-3-6	JUNCTION	5426.24	10.69	0.0
IN_C-3-7	JUNCTION	5396.47	15.11	0.0
IN_C-3-8	JUNCTION	5395.61	15.97	0.0
IN_C-4-1	JUNCTION	5365.90	4.02	0.0
IN_C-4-2	JUNCTION	5365.40	4.68	0.0
IN_C-5-1	JUNCTION	5442.59	5.16	0.0
IN_C-5-10	JUNCTION	5377.70	5.85	0.0
IN_C-5-11	JUNCTION	5375.03	8.54	0.0
IN_C-5-12	JUNCTION	5367.94	5.68	0.0
IN_C-5-13	JUNCTION	5360.54	13.54	0.0
IN_C-5-2	JUNCTION	5443.19	4.56	0.0
IN_C-5-3	JUNCTION	5426.13	6.55	0.0
IN_C-5-4	JUNCTION	5427.19	5.49	0.0
IN_C-5-5	JUNCTION	5405.51	6.24	0.0
IN_C-5-6	JUNCTION	5406.51	5.22	0.0
IN_C-5-7	JUNCTION	5369.11	13.62	0.0
IN_C-5-8	JUNCTION	5368.46	14.41	0.0
IN_C-5-9	JUNCTION	5367.29	14.25	0.0
IN_C-6-1	JUNCTION	5358.82	7.54	0.0
IN_C-6-2	JUNCTION	5361.36	4.81	0.0
IN_C-6-3	JUNCTION	5355.27	0.00	0.0
IN_OS-B1	JUNCTION	5354.19	1.80	0.0
IN_OS-C1	JUNCTION	5354.55	1.80	0.0
IN_OS-D-1	JUNCTION	5363.04	1.80	0.0
IN_OS-E1	JUNCTION	5363.16	1.80	0.0
MH_A1	JUNCTION	5370.18	16.15	0.0
MH_A10	JUNCTION	5390.15	15.94	0.0
MH_A11	JUNCTION	5391.49	15.05	0.0
MH_A12	JUNCTION	5392.68	17.55	0.0
MH_A13	JUNCTION	5394.03	20.33	0.0
MH_A14	JUNCTION	5405.68	12.20	0.0
MH_A15	JUNCTION	5415.05	14.01	0.0
MH_A16	JUNCTION	5424.36	13.15	0.0
MH_A17	JUNCTION	5429.82	12.63	0.0
MH_A18	JUNCTION	5446.96	6.75	0.0
MH_A20	JUNCTION	5454.77	6.92	0.0
MH_A21	JUNCTION	5459.04	8.06	0.0
MH_A22	JUNCTION	5462.10	7.24	0.0
MH_A23	JUNCTION	5462.70	6.22	0.0
MH_A-24	JUNCTION	5465.71	8.40	0.0
MH_A25	JUNCTION	5466.19	8.48	0.0
MH_A26	JUNCTION	5469.13	9.97	0.0
MH_A27	JUNCTION	5469.73	9.55	0.0
MH_A3	JUNCTION	5370.91	17.45	0.0

MH_A5	JUNCTION	5383.03	12.25	0.0	
MH_A6	JUNCTION	5383.96	12.46	0.0	
MH_A7	JUNCTION	5384.90	12.72	0.0	
MH_A8	JUNCTION	5386.41	13.21	0.0	
MH_A9	JUNCTION	5388.31	12.56	0.0	
MH_B1	JUNCTION	5383.85	11.42	0.0	
MH_B2	JUNCTION	5385.34	6.54	0.0	
MH_C2	JUNCTION	5360.73	13.24	0.0	
MH_C4	JUNCTION	5363.99	19.43	0.0	
MH_C5	JUNCTION	5366.43	15.68	0.0	
MH_C6	JUNCTION	5368.16	14.83	0.0	
MH_E2	JUNCTION	5372.94	10.70	0.0	
MH_E3	JUNCTION	5374.11	15.68	0.0	
MH_E4	JUNCTION	5376.05	18.61	0.0	
MH_E5	JUNCTION	5376.65	17.77	0.0	
MH_E6	JUNCTION	5378.08	15.66	0.0	
MH_E7	JUNCTION	5382.19	9.29	0.0	
MH_G1	JUNCTION	5358.56	8.75	0.0	
MH_J7	JUNCTION	5422.80	11.54	0.0	
MH_J8	JUNCTION	5430.52	9.95	0.0	
MH_J9	JUNCTION	5435.69	9.24	0.0	
MH_J10	JUNCTION	5442.15	8.21	0.0	
MH_C9	JUNCTION	5369.40	13.49	0.0	
MH_J1	JUNCTION	5371.94	12.23	0.0	
MH_J2	JUNCTION	5378.59	10.66	0.0	
MH_J3	JUNCTION	5387.89	10.46	0.0	
MH_J4	JUNCTION	5401.30	12.85	0.0	
MH_J5	JUNCTION	5409.95	13.66	0.0	
MH_J6	JUNCTION	5420.42	11.34	0.0	
MH_K3	JUNCTION	5461.60	5.03	0.0	
MH_OS_A1	JUNCTION	5353.79	6.54	0.0	
MH_OS-A1	JUNCTION	5365.21	5.24	0.0	
MH_OS-A2	JUNCTION	5355.35	9.74	0.0	
MH_OS-A3	JUNCTION	5356.55	11.08	0.0	
MH_OS-A4	JUNCTION	5358.00	10.74	0.0	
MH_OS-A5	JUNCTION	5360.03	9.50	0.0	
MH_OS-A6	JUNCTION	5361.88	6.00	0.0	
MH_OS-A7	JUNCTION	5362.65	4.71	0.0	
OS-1	JUNCTION	5451.06	0.00	0.0	
OS-2	JUNCTION	5372.82	0.00	0.0	
OS-3	JUNCTION	5351.00	0.00	0.0	
REACH1_IN	JUNCTION	5451.06	22.47	0.0	
REACH2_IN	JUNCTION	5399.18	22.47	0.0	
REACH2_OUT	JUNCTION	5372.82	6.01	0.0	
REACH3_IN	JUNCTION	5363.99	14.43	0.0	
SchoolCulvertEast	JUNCTION	5434.52	2.00	0.0	Yes
SchoolCulvertWest	JUNCTION	5464.00	1.50	0.0	Yes
Out1_DummyNode	JUNCTION	5351.00	14.43	0.0	
Out2_DummyNode	JUNCTION	5355.27	0.50	0.0	
MH_A42	JUNCTION	5382.42	11.44	0.0	

IN_D-1	JUNCTION	5370.45	6.13	0.0
Out2	OUTFALL	5355.27	0.00	0.0
Out1	OUTFALL	5351.00	0.00	0.0
School_Pond_Bypass	OUTFALL	5450.90	2.50	0.0
MH_A19	DIVIDER	5451.22	9.49	0.0
Pond_B-1	STORAGE	5384.14	9.67	0.0
Pond_C-1	STORAGE	5368.17	6.64	0.0
Pond_C-2	STORAGE	5355.85	9.42	0.0
Pond_E	STORAGE	5457.00	10.00	0.0

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Link Summary
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Name	From Node	To Node	Type	Length	%Slope	Roughness
A-1	MH_A1	Pond_C-1	CONDUIT	294.6	0.6822	0.0130
A-1_IN	A-1	REACH2_IN	CONDUIT	1.0	-57.7350	0.0100
A-10	MH_A10	MH_A9	CONDUIT	297.2	0.5181	0.0130
A-11	MH_A11	MH_A10	CONDUIT	227.2	0.5018	0.0130
A-12	MH_A12	MH_A11	CONDUIT	197.5	0.5013	0.0130
A-13	MH_A13	MH_A12	CONDUIT	102.5	0.4977	0.0130
A-14	MH_A14	MH_A13	CONDUIT	213.3	5.3299	0.0130
A-15	MH_A15	MH_A14	CONDUIT	210.4	4.3633	0.0130
A-16	MH_A16	MH_A15	CONDUIT	218.0	4.2278	0.0130
A-17	MH_A17	MH_A16	CONDUIT	131.6	3.7711	0.0130
A-18	MH_A18	MH_A17	CONDUIT	396.9	4.2714	0.0130
A-19	MH_A19	MH_A18	CONDUIT	378.9	1.7318	0.0130
A-2	IN_C-3-21	MH_A1	CONDUIT	59.6	0.5037	0.0130
A-20	MH_A20	MH_A19	CONDUIT	90.1	0.9432	0.0130
A-21	MH_A21	MH_A20	CONDUIT	391.9	1.0385	0.0130
A-2-1_IN	A-2-1	REACH2_IN	CONDUIT	1.0		

-57.7350   0.0100
  A-22   MH_A22   MH_A21   CONDUIT   142.6
2.0768   0.0130
  A-2-2_IN   A-2-2   Pond_B-1   CONDUIT   1.0
-219.4843   0.0100
  A-23   MH_A23   MH_A22   CONDUIT   96.9
0.5160   0.0130
  A-24   MH_A-24   MH_A23   CONDUIT   168.3
1.7297   0.0130
  A-25   MH_A25   MH_A-24   CONDUIT   20.0
1.4001   0.0130
  A-26   MH_A26   MH_A25   CONDUIT   196.3
1.3963   0.0130
  A-27   MH_A27   MH_A26   CONDUIT   39.5
1.0140   0.0130
  A-3   MH_A3   IN_C-3-21   CONDUIT   5.4
0.3690   0.0130
  A-6   MH_A6   MH_A5   CONDUIT   146.9
0.4968   0.0130
  A-7   MH_A7   MH_A6   CONDUIT   147.0
0.5034   0.0130
  A-8   MH_A8   MH_A7   CONDUIT   261.2
0.5015   0.0130
  A-9   MH_A9   MH_A8   CONDUIT   340.3
0.4995   0.0130
  AA-1   IN_C-3-20   MH_A3   CONDUIT   40.2
0.9958   0.0130
  AB-1   IN_C-3-18   MH_A7   CONDUIT   21.5
0.5116   0.0130
  AB-2   IN_C-3-17   IN_C-3-18   CONDUIT   45.8
0.5026   0.0130
  AC-1   IN_C-3-16   MH_A9   CONDUIT   25.8
1.7030   0.0130
  AC-2   IN_C-3-15   IN_C-3-16   CONDUIT   40.4
2.7520   0.0130
  AD-1   IN_C-3-8   MH_A12   CONDUIT   29.4
1.4613   0.0130
  AD-2   IN_C-3-7   IN_C-3-8   CONDUIT   40.3
1.5619   0.0130
  AE-1   IN_C-3-5   MH_A16   CONDUIT   62.1
0.5151   0.0130
  AE-2   IN_C-3-6   MH_A16   CONDUIT   28.9
0.4505   0.0130
  AF-1   IN_C-3-3   MH_A18   CONDUIT   12.7
0.7893   0.0130
  AF-2   IN_C-3-4   MH_A18   CONDUIT   34.7
0.6057   0.0130
  AG-1   IN_C-3-1   MH_A20   CONDUIT   12.7
0.5525   0.0130
  AG-2   IN_C-3-2   MH_A20   CONDUIT   34.7

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0.4903    0.0130
  B-1             MH_B1           MH_A5           CONDUIT          125.9
0.4925    0.0130
  B-1_IN          B-1             Pond_B-1        CONDUIT            1.0
-219.4843    0.0100
  B-2             MH_B2           MH_B1           CONDUIT          258.7
0.4987    0.0130
  B-3             IN_C-3-19       MH_B2           CONDUIT           66.0
0.4999    0.0130
  C-1             IN_C-5-13       Pond_C-2        CONDUIT          129.4
0.5021    0.0130
  C-1_IN          C-1             Pond_C-1        CONDUIT            1.0
-248.0000    0.0100
  C150            IN_OS-B1        Out1_DummyNode  CONDUIT           28.0
11.4675    0.0130
  C-2             MH_C2           IN_C-5-13       CONDUIT           15.4
0.5856    0.0130
  C-2_IN          C-2             Pond_C-2        CONDUIT           15.0
9.3743    0.0100
  C-4             MH_C4           MH_C2           CONDUIT          485.2
0.6307    0.0130
  C-5             MH_C5           MH_C4           CONDUIT           68.9
1.0739    0.0130
  C-6             MH_C6           MH_C5           CONDUIT          141.9
1.0784    0.0130
  C-6-3_Street    IN_C-6-3        Out2_DummyNode  CONDUIT           10.0
-5.0063    0.0100
  CA-1            IN_C-5-12       MH_C2           CONDUIT           56.6
7.1077    0.0130
  CB-1            IN_C-5-9        MH_C5           CONDUIT           28.8
2.2931    0.0130
  Culvert88_IN    88thStCulvert   MH_A27          CONDUIT            1.0
-60.8781    0.0100
  CulvertEast_IN  SchoolCulvertEast MH_A17          CONDUIT          104.3
4.0309    0.0130
  CulvertWest_IN  SchoolCulvertWest MH_A22          CONDUIT           88.0
0.5003    0.0130
  D-2             IN_C-5-11       MH_C4           CONDUIT          155.6
4.7237    0.0130
  D-3             IN_C-5-10       IN_C-5-11       CONDUIT           47.4
5.0073    0.0130
  CB-2            B-2             IN_C-5-9        CONDUIT           24.5
10.7971    0.0130
  E_IN            E               Pond_E          CONDUIT            1.0
250.0000    0.0100
  E-2             MH_E2           REACH3_IN       CONDUIT           34.7
0.4905    0.0130
  E-3             MH_E3           MH_E2           CONDUIT          194.7
0.4983    0.0130
  E-4             MH_E4           MH_E3           CONDUIT          347.9
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0.5002    0.0130
  E-5             MH_E5           MH_E4           CONDUIT          80.8
0.4949    0.0130
  E-6             MH_E6           MH_E5           CONDUIT         118.5
0.5064    0.0130
  E-7             MH_E7           MH_E6           CONDUIT         106.5
3.6749    0.0130
  EX-4            MH_A19          School_Pond_Bypass CONDUIT        35.5
0.9022    0.0130
  F_IN            F               REACH2_OUT      CONDUIT          1.0
-57.7350    0.0100
  G-1             MH_G1           Pond_C-2        CONDUIT          56.5
0.1770    0.0130
  G-2             IN_C-6-1        MH_G1           CONDUIT          82.4
0.1941    0.0130
  G-3             IN_D-3          IN_C-6-1        CONDUIT          30.8
0.2272    0.0130
  GA-1            IN_C-6-2        MH_G1           CONDUIT          69.5
0.5181    0.0130
  C-7             IN_C-5-8        MH_C6           CONDUIT           9.1
1.1026    0.0130
  J-7             MH_J7           MH_J6           CONDUIT         109.0
2.0008    0.0130
  J-8             MH_J8           MH_J7           CONDUIT         376.8
1.9960    0.0130
  J-9             MH_J9           MH_J8           CONDUIT         333.9
1.2490    0.0130
  J-10            MH_J10          MH_J9           CONDUIT         417.7
1.4987    0.0130
  J-11            IN_C-5-1        MH_J10          CONDUIT          24.4
0.9849    0.0130
  J-12            IN_C-5-2        IN_C-5-1        CONDUIT          40.3
0.9919    0.0130
  C-8             IN_C-5-7        IN_C-5-8        CONDUIT          42.0
1.0728    0.0130
  C-9             MH_C9           IN_C-5-7        CONDUIT           8.7
1.0369    0.0130
  J-1             MH_J1           MH_C9           CONDUIT         117.0
1.9997    0.0130
  J-2             MH_J2           MH_J1           CONDUIT         258.1
2.4993    0.0130
  J-3             MH_J3           MH_J2           CONDUIT         364.0
2.5008    0.0130
  J-4             MH_J4           MH_J3           CONDUIT         440.5
3.0002    0.0130
  J-5             MH_J5           MH_J4           CONDUIT         272.0
2.9973    0.0130
  J-6             MH_J6           MH_J5           CONDUIT         371.1
1.9996    0.0130
  JA-1            IN_C-5-5        MH_J4           CONDUIT          24.4
```

2.0111 0.0130
JA-2 IN_C-5-6 IN_C-5-5 CONDUIT 40.2
1.9895 0.0130
JB-1 IN_C-5-3 MH_J7 CONDUIT 24.4
1.9716 0.0130
JB-2 IN_C-5-4 IN_C-5-3 CONDUIT 40.4
2.0078 0.0130
E_TIE E_OUT MH_J8 CONDUIT 140.1
18.8890 0.0130
K-1 IN_A-3-2 REACH1_IN CONDUIT 56.9
9.5656 0.0130
K-2 MH_K3 IN_A-3-2 CONDUIT 32.9
0.4566 0.0130
K-3 IN_A-3-1 MH_K3 CONDUIT 8.2
0.4896 0.0130
OS-1_IN OS-1 REACH1_IN CONDUIT 1.0
-57.7350 0.0100
OS-2_IN OS-2 REACH2_OUT CONDUIT 1.0
-57.7350 0.0100
OS-3_IN OS-3 Out1_DummyNode CONDUIT 1.0
-57.7350 0.0100
OS-A1 MH_OS-A2 MH_OS_A1 CONDUIT 311.9
0.5001 0.0130
OS-A-1 MH_OS-A1 FES_OS-A1 CONDUIT 36.5
1.1520 0.0130
OS-A2 MH_OS-A3 MH_OS-A2 CONDUIT 199.5
0.5012 0.0130
OS-A-2 IN_C-4-2 MH_OS-A1 CONDUIT 18.6
0.4844 0.0130
OS-A3 MH_OS-A4 MH_OS-A3 CONDUIT 250.9
0.4982 0.0130
OS-A-3 IN_C-4-1 IN_C-4-2 CONDUIT 79.6
0.5023 0.0130
OS-A-4 MH_OS-A5 MH_OS-A4 CONDUIT 365.0
0.5013 0.0130
OS-A-5 MH_OS-A6 MH_OS-A5 CONDUIT 330.8
0.4988 0.0130
OS-A-6 MH_OS-A7 MH_OS-A6 CONDUIT 114.7
0.4970 0.0130
OS-A-Channel FES_OS-A1 Out1_DummyNode CONDUIT 450.0
3.0659 0.0350
OS-B-1 MH_OS_A1 IN_OS-B1 CONDUIT 19.5
0.0513 0.0130
OS-C-1 IN_OS-C1 MH_OS_A1 CONDUIT 111.5
0.5022 0.0130
OS-D-1 IN_OS-D-1 MH_OS-A7 CONDUIT 18.0
0.5000 0.0130
OS-E-1 IN_OS-E1 MH_OS-A7 CONDUIT 62.0
0.5000 0.0130
REACH1 REACH1_IN REACH2_IN CONDUIT 2528.2

2.0525 0.0320
  REACH2_IN REACH2_IN REACH2_OUT CONDUIT 1436.4
1.8354 0.0350
  REACH2_OUT REACH2_OUT REACH3_IN CONDUIT 954.0
0.9256 0.0350
  REACH3 REACH3_IN Out1_DummyNode CONDUIT 150.0
8.6927 0.0350
  Out1_DummyLink Out1_DummyNode Out1 CONDUIT 10.0
0.0100 0.0100
  Out2_DummyLink Out2_DummyNode Out2 CONDUIT 10.0
0.0100 0.0100
  A-5 MH_A5 MH_A42 CONDUIT 81.8
0.5015 0.0130
  A-5(1) MH_A42 MH_A3 CONDUIT 387.1
2.9492 0.0130
  C-10 IN_D-1 MH_C9 CONDUIT 42.6
1.9976 0.0130
  C-1_OUT Pond_C-1 REACH3_IN OUTLET
  B-1_OUT Pond_B-1 MH_E7 OUTLET
  C-2_OUT Pond_C-2 Out2_DummyNode OUTLET
  E_OUT Pond_E E_OUT OUTLET

  ****
  Cross Section Summary
  ****

Conduit	Shape	Full Depth	Full Area	Hyd. Rad.	Max. Width	No. of Barrels	Full Flow
A-1	CIRCULAR	4.50	15.90	1.13	4.50	1	162.42
A-1_IN	DUMMY	0.00	0.00	0.00	0.00	1	0.00
A-10	CIRCULAR	4.00	12.57	1.00	4.00	1	103.40
A-11	CIRCULAR	4.00	12.57	1.00	4.00	1	101.76
A-12	CIRCULAR	4.00	12.57	1.00	4.00	1	101.71
A-13	HORIZ_ELLIPSE	2.42	7.41	0.74	3.75	1	48.90
A-14	CIRCULAR	3.00	7.07	0.75	3.00	1	153.98
A-15	CIRCULAR	3.00	7.07	0.75	3.00	1	139.32
A-16	CIRCULAR	3.00	7.07	0.75	3.00	1	

137.14
  A-17 CIRCULAR 2.50 4.91 0.63 2.50 1
79.65
  A-18 CIRCULAR 2.50 4.91 0.63 2.50 1
84.77
  A-19 CIRCULAR 2.50 4.91 0.63 2.50 1
53.98
  A-2 CIRCULAR 4.50 15.90 1.13 4.50 1
139.57
  A-20 RECT_CLOSED 4.00 18.00 1.06 4.50 1
207.59
  A-21 CIRCULAR 4.00 12.57 1.00 4.00 1
146.38
  A-2-1_IN DUMMY 0.00 0.00 0.00 0.00 1
0.00
  A-22 CIRCULAR 4.00 12.57 1.00 4.00 1
207.00
  A-2-2_IN DUMMY 0.00 0.00 0.00 0.00 1
0.00
  A-23 HORIZ_ELLIPSE 3.17 12.90 0.97 5.00 1
103.72
  A-24 CIRCULAR 3.50 9.62 0.88 3.50 1
132.32
  A-25 CIRCULAR 3.50 9.62 0.88 3.50 1
119.05
  A-26 CIRCULAR 3.50 9.62 0.88 3.50 1
118.89
  A-27 CIRCULAR 3.50 9.62 0.88 3.50 1
101.31
  A-3 CIRCULAR 4.50 15.90 1.13 4.50 1
119.46
  A-6 CIRCULAR 4.00 12.57 1.00 4.00 1
101.25
  A-7 CIRCULAR 4.00 12.57 1.00 4.00 1
101.92
  A-8 CIRCULAR 4.00 12.57 1.00 4.00 1
101.72
  A-9 CIRCULAR 4.00 12.57 1.00 4.00 1
101.52
  AA-1 CIRCULAR 1.50 1.77 0.38 1.50 1
10.48
  AB-1 CIRCULAR 1.50 1.77 0.38 1.50 1
7.51
  AB-2 CIRCULAR 1.50 1.77 0.38 1.50 1
7.45
  AC-1 CIRCULAR 1.50 1.77 0.38 1.50 1
13.71
  AC-2 CIRCULAR 1.50 1.77 0.38 1.50 1
17.43
  AD-1 CIRCULAR 1.50 1.77 0.38 1.50 1

12.70
  AD-2 CIRCULAR 1.50 1.77 0.38 1.50 1
13.13
  AE-1 CIRCULAR 1.50 1.77 0.38 1.50 1
7.54
  AE-2 CIRCULAR 1.50 1.77 0.38 1.50 1
7.05
  AF-1 CIRCULAR 1.50 1.77 0.38 1.50 1
9.33
  AF-2 CIRCULAR 1.50 1.77 0.38 1.50 1
8.18
  AG-1 CIRCULAR 1.50 1.77 0.38 1.50 1
7.81
  AG-2 CIRCULAR 1.50 1.77 0.38 1.50 1
7.36
  B-1 CIRCULAR 1.50 1.77 0.38 1.50 1
7.37
  B-1_IN DUMMY 0.00 0.00 0.00 0.00 1
0.00
  B-2 CIRCULAR 1.50 1.77 0.38 1.50 1
7.42
  B-3 CIRCULAR 1.50 1.77 0.38 1.50 1
7.43
  C-1 CIRCULAR 4.50 15.90 1.13 4.50 1
139.35
  C-1_IN DUMMY 0.00 0.00 0.00 0.00 1
0.00
  C150 CIRCULAR 1.50 1.77 0.38 1.50 1
35.57
  C-2 CIRCULAR 4.50 15.90 1.13 4.50 1
150.48
  C-2_IN DUMMY 0.00 0.00 0.00 0.00 1
0.00
  C-4 CIRCULAR 4.50 15.90 1.13 4.50 1
156.17
  C-5 CIRCULAR 3.50 9.62 0.88 3.50 1
104.26
  C-6 CIRCULAR 3.00 7.07 0.75 3.00 1
69.26
  C-6-3_Street DUMMY 0.00 0.00 0.00 0.00 1
0.00
  CA-1 CIRCULAR 1.50 1.77 0.38 1.50 1
28.00
  CB-1 CIRCULAR 3.50 9.62 0.88 3.50 1
152.35
  Culvert88_IN DUMMY 0.00 0.00 0.00 0.00 1
0.00
  CulvertEast_IN CIRCULAR 2.00 3.14 0.50 2.00 1
45.42
  CulvertWest_IN CIRCULAR 1.50 1.77 0.38 1.50 1

7.43
  D-2 CIRCULAR 1.50 1.77 0.38 1.50 1
22.83
  D-3 CIRCULAR 1.50 1.77 0.38 1.50 1
23.51
  CB-2 CIRCULAR 3.50 9.62 0.88 3.50 1
330.59
  E_IN DUMMY 0.00 0.00 0.00 0.00 1
0.00
  E-2 HORIZ_ELLIPSE 3.17 12.90 0.97 5.00 1
101.13
  E-3 CIRCULAR 4.00 12.57 1.00 4.00 1
101.40
  E-4 CIRCULAR 4.00 12.57 1.00 4.00 1
101.59
  E-5 CIRCULAR 4.00 12.57 1.00 4.00 1
101.05
  E-6 HORIZ_ELLIPSE 3.17 12.90 0.97 5.00 1
102.76
  E-7 CIRCULAR 4.00 12.57 1.00 4.00 1
275.36
  EX-4 CIRCULAR 2.50 4.91 0.63 2.50 1
38.96
  F_IN DUMMY 0.00 0.00 0.00 0.00 1
0.00
  G-1 CIRCULAR 5.00 19.63 1.25 5.00 1
109.57
  G-2 CIRCULAR 4.50 15.90 1.13 4.50 1
86.64
  G-3 CIRCULAR 4.50 15.90 1.13 4.50 1
93.73
  GA-1 CIRCULAR 1.50 1.77 0.38 1.50 1
7.56
  C-7 CIRCULAR 3.00 7.07 0.75 3.00 1
70.04
  J-7 CIRCULAR 2.50 4.91 0.63 2.50 1
58.02
  J-8 CIRCULAR 2.50 4.91 0.63 2.50 1
57.95
  J-9 CIRCULAR 1.50 1.77 0.38 1.50 1
11.74
  J-10 CIRCULAR 1.50 1.77 0.38 1.50 1
12.86
  J-11 CIRCULAR 1.25 1.23 0.31 1.25 1
6.41
  J-12 CIRCULAR 1.25 1.23 0.31 1.25 1
6.43
  C-8 CIRCULAR 3.00 7.07 0.75 3.00 1
69.08
  C-9 CIRCULAR 3.00 7.07 0.75 3.00 1

67.92
  J-1 CIRCULAR 3.00 7.07 0.75 3.00 1
94.32
  J-2 CIRCULAR 3.00 7.07 0.75 3.00 1
105.45
  J-3 CIRCULAR 3.00 7.07 0.75 3.00 1
105.48
  J-4 CIRCULAR 3.00 7.07 0.75 3.00 1
115.53
  J-5 CIRCULAR 2.50 4.91 0.63 2.50 1
71.01
  J-6 CIRCULAR 2.50 4.91 0.63 2.50 1
58.00
  JA-1 CIRCULAR 1.25 1.23 0.31 1.25 1
9.16
  JA-2 CIRCULAR 1.25 1.23 0.31 1.25 1
9.11
  JB-1 CIRCULAR 1.50 1.77 0.38 1.50 1
14.75
  JB-2 CIRCULAR 1.25 1.23 0.31 1.25 1
9.15
  E_TIE CIRCULAR 4.00 12.57 1.00 4.00 1
624.30
  K-1 CIRCULAR 1.50 1.77 0.38 1.50 1
32.49
  K-2 CIRCULAR 1.50 1.77 0.38 1.50 1
7.10
  K-3 CIRCULAR 1.50 1.77 0.38 1.50 1
7.35
  OS-1_IN DUMMY 0.00 0.00 0.00 0.00 1
0.00
  OS-2_IN DUMMY 0.00 0.00 0.00 0.00 1
0.00
  OS-3_IN DUMMY 0.00 0.00 0.00 0.00 1
0.00
  OS-A1 CIRCULAR 1.50 1.77 0.38 1.50 1
7.43
  OS-A-1 CIRCULAR 1.50 1.77 0.38 1.50 1
11.27
  OS-A2 CIRCULAR 1.50 1.77 0.38 1.50 1
7.44
  OS-A-2 CIRCULAR 1.50 1.77 0.38 1.50 1
7.31
  OS-A3 CIRCULAR 1.50 1.77 0.38 1.50 1
7.41
  OS-A-3 CIRCULAR 1.50 1.77 0.38 1.50 1
7.44
  OS-A-4 CIRCULAR 1.50 1.77 0.38 1.50 1
7.44
  OS-A-5 CIRCULAR 1.50 1.77 0.38 1.50 1

7.42
  OS-A-6   CIRCULAR   1.50   1.77   0.38   1.50   1
7.41
  OS-A-Channel   TRAPEZOIDAL   5.00   125.00   2.70   45.00   1
1803.53
  OS-B-1   CIRCULAR   1.50   1.77   0.38   1.50   1
2.38
  OS-C-1   CIRCULAR   1.50   1.77   0.38   1.50   1
7.44
  OS-D-1   CIRCULAR   1.50   1.77   0.38   1.50   1
7.43
  OS-E-1   CIRCULAR   1.50   1.77   0.38   1.50   1
7.43
  REACH1   4650   22.47 6129.81   14.83   400.00   1
246170.39
  REACH2_IN   1700   6.01 1127.37   3.22   400.00   1
14146.37
  REACH2_OUT   1700   6.01 1127.37   3.22   400.00   1
10045.83
  REACH3   950   14.43 3735.58   12.03   400.00   1
245533.17
  Out1_DummyLink   DUMMY   0.00   0.00   0.00   0.00   1
0.00
  Out2_DummyLink   DUMMY   0.00   0.00   0.00   0.00   1
0.00
  A-5   CIRCULAR   4.00   12.57   1.00   4.00   1
101.72
  A-5(1)   CIRCULAR   4.00   12.57   1.00   4.00   1
246.68
  C-10   CIRCULAR   1.50   1.77   0.38   1.50   1
14.85

  ****
  Transect Summary
  ****

  Transect 1700
  Area:
              0.0000   0.0001   0.0003   0.0005   0.0008
              0.0011   0.0015   0.0020   0.0025   0.0032
              0.0042   0.0074   0.0125   0.0198   0.0287
              0.0384   0.0488   0.0599   0.0742   0.0900
              0.1070   0.1250   0.1437   0.1631   0.1830
              0.2036   0.2255   0.2484   0.2723   0.2971
              0.3226   0.3491   0.3778   0.4075   0.4382
              0.4705   0.5041   0.5385   0.5739   0.6100
              0.6461   0.6824   0.7190   0.7562   0.7952
              0.8351   0.8755   0.9163   0.9576   1.0000

Hrad:

0.0170	0.0341	0.0511	0.0681	0.0845
0.1009	0.1175	0.1322	0.1459	0.1621
0.1720	0.1410	0.1309	0.1400	0.1571
0.1820	0.2088	0.2321	0.2350	0.2575
0.2772	0.3067	0.3368	0.3671	0.3969
0.4256	0.4529	0.4794	0.4799	0.5083
0.5401	0.5698	0.5666	0.5922	0.6139
0.6409	0.6444	0.6718	0.6956	0.7333
0.7713	0.8081	0.8409	0.8736	0.8575
0.8845	0.9175	0.9515	0.9691	1.0000

Width:

0.0014	0.0028	0.0042	0.0056	0.0071
0.0087	0.0102	0.0120	0.0139	0.0167
0.0426	0.0957	0.1471	0.1928	0.2184
0.2356	0.2514	0.2885	0.3597	0.3836
0.4123	0.4303	0.4463	0.4604	0.4747
0.4962	0.5277	0.5476	0.5731	0.5907
0.6030	0.6497	0.6861	0.7081	0.7365
0.7756	0.7975	0.8178	0.8434	0.8466
0.8494	0.8533	0.8607	0.8986	0.9260
0.9423	0.9520	0.9607	0.9875	1.0000

Transect 950

Area:

0.0002	0.0007	0.0013	0.0025	0.0068
0.0143	0.0239	0.0348	0.0471	0.0604
0.0756	0.0924	0.1101	0.1287	0.1481
0.1684	0.1895	0.2114	0.2341	0.2571
0.2802	0.3034	0.3267	0.3500	0.3735
0.3971	0.4208	0.4446	0.4684	0.4924
0.5165	0.5407	0.5650	0.5894	0.6139
0.6386	0.6633	0.6881	0.7131	0.7381
0.7633	0.7885	0.8139	0.8394	0.8649
0.8906	0.9164	0.9426	0.9702	1.0000

Hrad:

0.0171	0.0303	0.0427	0.0476	0.0435
0.0514	0.0681	0.0855	0.1029	0.1198
0.1309	0.1484	0.1675	0.1864	0.2050
0.2234	0.2416	0.2595	0.2798	0.3049
0.3300	0.3549	0.3798	0.4046	0.4292
0.4537	0.4781	0.5024	0.5265	0.5506
0.5745	0.5983	0.6219	0.6454	0.6689
0.6922	0.7154	0.7385	0.7615	0.7844
0.8072	0.8298	0.8524	0.8749	0.8973
0.9196	0.9418	0.9635	0.9832	1.0000

Width:

0.0107	0.0165	0.0223	0.0848	0.1928
0.2893	0.3327	0.3751	0.4148	0.4545
0.5234	0.5600	0.5873	0.6145	0.6418

```
            0.6690     0.6962     0.7235     0.7421     0.7453
            0.7485     0.7517     0.7549     0.7581     0.7613
            0.7646     0.7680     0.7713     0.7746     0.7779
            0.7813     0.7847     0.7881     0.7916     0.7950
            0.7984     0.8019     0.8053     0.8087     0.8122
            0.8156     0.8191     0.8225     0.8259     0.8294
            0.8328     0.8362     0.8647     0.9289     1.0000

Transect 4650
Area:
            0.0032     0.0087     0.0155     0.0232     0.0318
            0.0410     0.0509     0.0614     0.0725     0.0841
            0.0962     0.1088     0.1218     0.1354     0.1495
            0.1641     0.1793     0.1955     0.2128     0.2311
            0.2501     0.2698     0.2903     0.3114     0.3332
            0.3557     0.3788     0.4026     0.4270     0.4519
            0.4772     0.5030     0.5290     0.5552     0.5816
            0.6082     0.6350     0.6619     0.6890     0.7163
            0.7438     0.7715     0.7993     0.8274     0.8557
            0.8842     0.9129     0.9417     0.9708     1.0000
Hrad:
            0.0211     0.0424     0.0637     0.0857     0.1079
            0.1292     0.1506     0.1711     0.1917     0.2127
            0.2349     0.2574     0.2792     0.3004     0.3213
            0.3417     0.3419     0.3496     0.3574     0.3705
            0.3862     0.4020     0.4180     0.4338     0.4506
            0.4673     0.4838     0.5008     0.5188     0.5392
            0.5592     0.5798     0.6051     0.6301     0.6548
            0.6793     0.7036     0.7278     0.7517     0.7753
            0.7986     0.8217     0.8443     0.8660     0.8886
            0.9112     0.9335     0.9558     0.9779     1.0000
Width:
            0.1571     0.2111     0.2498     0.2787     0.3028
            0.3261     0.3471     0.3683     0.3881     0.4061
            0.4204     0.4334     0.4539     0.4731     0.4901
            0.5069     0.5347     0.5705     0.6074     0.6364
            0.6610     0.6851     0.7090     0.7330     0.7551
            0.7773     0.7996     0.8211     0.8406     0.8559
            0.8714     0.8856     0.8914     0.8973     0.9034
            0.9094     0.9155     0.9215     0.9276     0.9339
            0.9403     0.9468     0.9538     0.9615     0.9680
            0.9744     0.9809     0.9873     0.9937     1.0000


**********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
**********************************************************
```

```
****************
Analysis Options
****************
Flow Units ............... CFS
Process Models:
  Rainfall/Runoff ........ NO
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ YES
  Water Quality .......... NO
Flow Routing Method ...... DYNWAVE
Surcharge Method ......... EXTRAN
Starting Date ............ 07/18/2022 00:00:00
Ending Date .............. 07/23/2022 00:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:05:00
Routing Time Step ........ 5.00 sec
Variable Time Step ....... YES
Maximum Trials ........... 8
Number of Threads ........ 1
Head Tolerance ........... 0.005000 ft


**************************        Volume        Volume
Flow Routing Continuity        acre-feet      10^6 gal
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......         0.000         0.000
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........        44.698        14.565
External Outflow .........        37.358        12.174
Flooding Loss ............         7.186         2.342
Evaporation Loss .........         0.000         0.000
Exfiltration Loss ........         0.000         0.000
Initial Stored Volume ....         0.000         0.000
Final Stored Volume ......         0.075         0.025
Continuity Error (%) .....         0.175


************************
Highest Continuity Errors
************************
Node REACH2_IN (5.23%)


**************************
Time-Step Critical Elements
```

```
**************************
Link C-9 (83.01%)
Link A-3 (6.25%)


******************************
Highest Flow Instability Indexes
******************************
All links are stable.


************************
Routing Time Step Summary
************************
Minimum Time Step           :     0.50 sec
Average Time Step           :     1.85 sec
Maximum Time Step           :     5.00 sec
Percent in Steady State     :    -0.00
Average Iterations per Step :     2.00
Percent Not Converging      :     0.00
Time Step Frequencies       :
    5.000 -  3.155 sec      :    10.37 %
    3.155 -  1.991 sec      :     4.26 %
    1.991 -  1.256 sec      :    76.33 %
    1.256 -  0.792 sec      :     2.48 %
    0.792 -  0.500 sec      :     6.56 %


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Analysis begun on:  Tue Jan 30 17:45:29 2024
Analysis ended on:  Tue Jan 30 17:45:50 2024
Total elapsed time: 00:00:21
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100-YR

Summary of Unit Hydrograph Parameters Used By Program and Calculated Results (Version 2.0.1)

		Unit Hydrograph Parameters and Results									Excess Precip.		Storm Hydrograph			
Catchment Name/ID	User Comment for Catchment	CT	Cp	W50 (min.)	W50 Before Peak	W75 (min.)	W75 Before Peak	Time to Peak (min.)	Peak (cfs)	Volume (c.f)	Excess (inches)	Excess (c.f.)	Time to Peak (min.)	Peak Flow (cfs)	Total Volume (c.f.)	Runoff per Unit Area (cfs/acre)
A-1		0.156	0.131	58.7	7.42	30.5	5.24	12.4	30	137,904	1.52	208,970	55.0	37	208,965	0.98
A-2-1		0.156	0.085	71.8	6.21	37.3	4.39	10.4	10	53,143	1.52	80,530	60.0	12	80,547	0.83
A-2-2		0.076	0.173	13.9	3.35	7.2	2.36	5.6	115	123,783	2.47	305,935	35.0	120	301,127	3.53
A-3		0.079	0.028	37.3	2.30	19.4	1.62	3.8	1	2,251	2.35	5,296	45.0	1	5,201	1.76
A-3-1		0.079	0.020	32.2	2.00	16.8	1.42	3.3	0	1,125	2.35	2,648	40.0	1	2,579	1.93
A-3-2		0.079	0.020	32.2	2.00	16.8	1.42	3.3	0	1,125	2.35	2,648	40.0	1	2,579	1.93
B-1		0.076	0.253	11.3	3.70	5.9	2.62	6.2	329	288,440	2.47	712,892	35.0	310	699,737	3.90
B-2		0.076	0.164	9.8	2.74	5.1	1.94	4.6	145	110,243	2.47	272,471	30.0	123	262,135	4.06
C-1		0.077	0.209	14.7	3.85	7.6	2.72	6.4	170	193,152	2.41	465,944	35.0	184	462,292	3.45
C-2		0.077	0.133	7.6	2.28	3.9	1.61	3.8	121	71,257	2.41	171,894	30.0	89	158,851	4.51
C-3		0.078	0.115	46.0	5.55	23.9	3.92	9.3	14	51,437	2.40	123,272	50.0	23	123,121	1.59
C-3-1		0.077	0.040	28.2	2.36	14.7	1.67	3.9	2	4,864	2.41	11,734	40.0	3	11,465	2.17
C-3-2		0.077	0.039	37.4	2.63	19.5	1.86	4.4	2	4,719	2.41	11,384	45.0	2	11,234	1.80
C-3-3		0.079	0.023	29.3	2.02	15.2	1.43	3.4	1	1,525	2.35	3,588	40.0	1	3,488	2.06
C-3-4		0.079	0.024	28.1	2.01	14.6	1.42	3.4	1	1,597	2.35	3,758	40.0	1	3,646	2.12
C-3-5		0.077	0.030	14.4	1.84	7.5	1.30	3.1	2	2,650	2.41	6,392	35.0	2	5,961	3.19
C-3-6		0.077	0.031	20.6	1.99	10.7	1.40	3.3	2	2,759	2.41	6,655	35.0	2	6,388	2.63
C-3-7		0.077	0.034	18.9	2.00	9.8	1.41	3.3	2	3,449	2.41	8,319	35.0	3	7,955	2.78
C-3-8		0.077	0.034	22.0	2.08	11.4	1.47	3.5	2	3,449	2.41	8,319	35.0	2	8,022	2.53
C-3-15		0.079	0.028	55.0	2.70	28.6	1.91	4.5	1	2,360	2.35	5,552	50.0	1	5,506	1.35
C-3-16		0.079	0.029	52.8	2.66	27.5	1.88	4.4	1	2,432	2.35	5,723	50.0	1	5,669	1.39
C-3-17		0.077	0.026	31.8	2.14	16.6	1.51	3.6	1	1,888	2.41	4,553	40.0	1	4,445	1.99
C-3-18		0.077	0.027	30.7	2.13	16.0	1.51	3.6	1	2,033	2.41	4,904	40.0	1	4,782	2.04
C-3-19		0.077	0.033	27.4	2.20	14.2	1.55	3.7	2	3,231	2.41	7,793	40.0	2	7,585	2.20
C-3-20		0.077	0.047	37.7	2.87	19.6	2.03	4.8	2	7,151	2.41	17,251	45.0	4	17,082	1.80
C-3-21		0.077	0.048	38.3	2.91	19.9	2.06	4.9	2	7,333	2.41	17,689	45.0	4	17,523	1.78
C-4		0.079	0.054	20.8	2.37	10.8	1.67	3.9	6	10,091	2.35	23,747	35.0	7	23,039	2.61
C-4-1		0.079	0.037	26.6	2.25	13.8	1.59	3.8	2	4,211	2.35	9,909	40.0	3	9,649	2.20
C-4-2		0.079	0.043	26.5	2.37	13.8	1.68	4.0	3	5,881	2.35	13,838	40.0	4	13,509	2.21
C-5		0.078	0.100	6.7	2.01	3.5	1.42	3.4	75	38,805	2.36	91,667	30.0	48	80,239	4.48
C-5-1		0.079	0.036	57.6	3.11	29.9	2.20	5.2	1	4,138	2.35	9,738	50.0	1	9,697	1.31
C-5-2		0.079	0.037	58.8	3.16	30.6	2.23	5.3	1	4,211	2.35	9,909	50.0	2	9,869	1.30
C-5-3		0.079	0.033	6.6	1.67	3.5	1.18	2.8	6	3,267	2.35	7,688	30.0	4	6,327	4.15
C-5-4		0.079	0.033	6.7	1.67	3.5	1.18	2.8	6	3,231	2.35	7,602	30.0	4	6,270	4.15
C-5-5		0.079	0.027	4.2	1.46	2.2	0.98	2.6	7	2,178	2.35	5,125	30.0	3	3,553	4.26
C-5-6		0.079	0.027	4.2	1.46	2.2	0.98	2.6	7	2,178	2.35	5,125	30.0	3	3,553	4.26
C-5-7		0.079	0.032	6.8	1.67	3.5	1.18	2.8	6	3,086	2.35	7,261	30.0	4	6,028	4.15
C-5-8		0.079	0.032	6.6	1.66	3.4	1.17	2.8	6	3,013	2.35	7,090	30.0	3	5,818	4.14
C-5-9		0.079	0.022	7.2	1.62	3.8	1.15	2.7	2	1,343	2.35	3,161	30.0	2	2,667	4.08
C-5-10		0.079	0.029	36.3	2.32	18.9	1.64	3.9	1	2,577	2.35	6,065	45.0	1	5,954	1.79
C-5-11		0.079	0.029	36.3	2.32	18.9	1.64	3.9	1	2,577	2.35	6,065	45.0	1	5,954	1.79
C-5-12		0.077	0.034	25.1	2.17	13.1	1.53	3.6	2	3,521	2.41	8,494	40.0	2	8,227	2.30
C-5-13		0.077	0.034	30.3	2.30	15.7	1.62	3.8	1	3,485	2.41	8,406	40.0	2	8,217	2.07
C-6		0.079	0.045	17.6	2.11	9.2	1.49	3.5	5	6,607	2.35	15,546	35.0	5	14,848	2.87
C-6-1		0.079	0.029	24.4	2.04	12.7	1.44	3.4	1	2,432	2.35	5,723	40.0	2	5,525	2.30
C-6-2		0.079	0.031	25.5	2.11	13.3	1.49	3.5	1	2,940	2.35	6,919	40.0	2	6,701	2.24

C-6-3		0.079	0.021	12.4	1.70	6.5	1.20	2.8	1	1,234	2.35	2,904	35.0	1	2,673	3.36
D-1		0.080	0.146	14.2	3.09	7.4	2.18	5.2	85	93,727	2.29	215,025	35.0	86	210,383	3.32
D-2		0.156	0.097	60.3	5.99	31.3	4.23	10.0	15	70,422	1.52	106,713	55.0	19	106,711	0.96
D-3		0.080	0.100	13.6	2.55	7.1	1.80	4.2	39	40,874	2.29	93,771	35.0	37	89,679	3.29
E		0.079	0.169	13.0	3.19	6.8	2.25	5.3	124	124,618	2.35	293,246	35.0	120	285,296	3.50
F		0.156	0.092	58.6	5.62	30.5	3.97	9.4	14	61,892	1.52	93,786	55.0	17	93,731	0.97
OS-1		0.134	0.157	43.2	6.71	22.4	4.74	11.2	84	281,071	1.59	445,892	50.0	100	445,986	1.29
OS-2		0.144	0.113	40.9	5.06	21.3	3.57	8.4	37	117,322	1.51	176,827	45.0	41	176,472	1.26
OS-3		0.148	0.092	39.0	4.26	20.3	3.01	7.1	23	70,821	1.50	105,895	45.0	25	105,642	1.30
EX-X		0.156	0.023	22.0	1.90	11.5	1.34	3.2	2	3,013	1.52	4,566	40.0	2	4,383	1.87
OS-4-1		0.076	0.043	35.9	2.68	18.7	1.89	4.5	2	5,481	2.47	13,544	40.0	3	13,365	1.87
OS-4-2		0.075	0.045	35.2	2.71	18.3	1.91	4.5	2	6,026	2.50	15,064	40.0	3	14,866	1.92
OS-7-1		0.073	0.027	42.0	2.38	21.8	1.68	4.0	1	1,924	2.65	5,099	45.0	1	5,021	1.76
OS-7-2		0.073	0.027	42.6	2.38	22.2	1.68	4.0	1	1,851	2.65	4,907	45.0	1	4,832	1.75
OS-7-3		0.073	0.028	45.2	2.46	23.5	1.74	4.1	1	1,997	2.65	5,292	45.0	1	5,222	1.68
OS-7-4		0.073	0.028	44.8	2.46	23.3	1.74	4.1	1	2,033	2.65	5,388	45.0	1	5,316	1.69

100-YR

Summary of CUHP Input Parameters (Version 2.0.1)

								Depression Storage		Horton's Infiltration Parameters			DCIA Level and Fractions			
Catchment Name/ID	SWMM Node/ID	Raingage Name/ID	Area (sq.mi.)	Dist. to Centroid (miles)	Length (miles)	Slope (ft./ft.)	Percent Imperv.	Pervious (inches)	Imperv. (inches)	Initial Rate (in./hr.)	Final Rate (in.hr.)	Decay Coeff. (1/sec.)	DCIA Level	Dir. Con'ct Imperv. Fraction	Receiv. Perv. Fraction	Percent Eff. Imperv.
A-1	A-1	100-YEAR CORRECTED	0.059	0.352	0.547	0.030	2.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.04	0.02	1.79
A-2-1	A-2-1	100-YEAR CORRECTED	0.023	0.302	0.409	0.032	2.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.04	0.02	1.79
A-2-2	A-2-2	100-YEAR CORRECTED	0.053	0.194	0.433	0.036	85.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.95	0.35	84.50
A-3	A-3	100-YEAR CORRECTED	0.001	0.075	0.103	0.012	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	74.34
A-3-1	IN_A-3-1	100-YEAR CORRECTED	0.000	0.037	0.074	0.010	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	74.34
A-3-2	IN_A-3-2	100-YEAR CORRECTED	0.000	0.037	0.074	0.010	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	74.34
B-1	B-1	100-YEAR CORRECTED	0.124	0.185	0.463	0.018	85.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.95	0.35	84.50
B-2	B-2	100-YEAR CORRECTED	0.047	0.117	0.325	0.039	85.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.95	0.35	84.50
C-1	C-1	100-YEAR CORRECTED	0.083	0.163	0.434	0.010	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	79.42
C-2	C-2	100-YEAR CORRECTED	0.031	0.078	0.201	0.050	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	79.42
C-3	C-3	100-YEAR CORRECTED	0.022	0.389	0.769	0.019	78.7	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	78.07
C-3-1	IN_C-3-1	100-YEAR CORRECTED	0.002	0.061	0.194	0.018	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	79.42
C-3-2	IN_C-3-2	100-YEAR CORRECTED	0.002	0.110	0.187	0.018	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	79.42
C-3-3	IN_C-3-3	100-YEAR CORRECTED	0.001	0.044	0.090	0.018	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	74.34
C-3-4	IN_C-3-4	100-YEAR CORRECTED	0.001	0.043	0.089	0.018	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	74.34
C-3-5	IN_C-3-5	100-YEAR CORRECTED	0.001	0.024	0.101	0.038	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	79.42
C-3-6	IN_C-3-6	100-YEAR CORRECTED	0.001	0.050	0.100	0.035	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	79.42
C-3-7	IN_C-3-7	100-YEAR CORRECTED	0.001	0.037	0.139	0.035	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	79.42
C-3-8	IN_C-3-8	100-YEAR CORRECTED	0.001	0.051	0.147	0.040	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	79.42
C-3-15	IN_C-3-15	100-YEAR CORRECTED	0.001	0.113	0.147	0.010	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	74.34
C-3-16	IN_C-3-16	100-YEAR CORRECTED	0.001	0.110	0.143	0.010	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	74.34
C-3-17	IN_C-3-17	100-YEAR CORRECTED	0.001	0.055	0.115	0.019	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	79.42
C-3-18	IN_C-3-18	100-YEAR CORRECTED	0.001	0.056	0.114	0.019	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	79.42
C-3-19	IN_C-3-19	100-YEAR CORRECTED	0.001	0.049	0.103	0.008	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	79.42
C-3-20	IN_C-3-20	100-YEAR CORRECTED	0.003	0.083	0.277	0.010	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	79.42
C-3-21	IN_C-3-21	100-YEAR CORRECTED	0.003	0.084	0.276	0.009	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	79.42
C-4	C-4	100-YEAR CORRECTED	0.004	0.063	0.218	0.026	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	74.34
C-4-1	IN_C-4-1	100-YEAR CORRECTED	0.002	0.060	0.170	0.026	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	74.34
C-4-2	IN_C-4-2	100-YEAR CORRECTED	0.003	0.063	0.218	0.026	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	74.34
C-5	C-5	100-YEAR CORRECTED	0.017	0.411	0.728	109.138	75.8	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	75.12
C-5-1	IN_C-5-1	100-YEAR CORRECTED	0.002	0.134	0.269	0.014	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	74.34
C-5-2	IN_C-5-2	100-YEAR CORRECTED	0.002	0.136	0.275	0.013	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	74.34
C-5-3	IN_C-5-3	100-YEAR CORRECTED	0.001	0.107	0.214	68.977	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	74.34
C-5-4	IN_C-5-4	100-YEAR CORRECTED	0.001	0.107	0.214	68.977	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	74.34
C-5-5	IN_C-5-5	100-YEAR CORRECTED	0.001	0.071	0.142	200.316	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	74.34
C-5-6	IN_C-5-6	100-YEAR CORRECTED	0.001	0.071	0.142	200.316	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	74.34
C-5-7	IN_C-5-7	100-YEAR CORRECTED	0.001	0.171	0.204	165.130	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	74.34
C-5-8	IN_C-5-8	100-YEAR CORRECTED	0.001	0.167	0.198	169.360	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	74.34
C-5-9	IN_C-5-9	100-YEAR CORRECTED	0.001	0.007	0.027	0.020	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	74.34
C-5-10	IN_C-5-10	100-YEAR CORRECTED	0.001	0.073	0.147	0.020	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	74.34
C-5-11	IN_C-5-11	100-YEAR CORRECTED	0.001	0.073	0.147	0.020	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	74.34
C-5-12	IN_C-5-12	100-YEAR CORRECTED	0.002	0.052	0.132	0.018	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	79.42
C-5-13	IN_C-5-13	100-YEAR CORRECTED	0.002	0.089	0.112	0.018	80.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.94	0.33	79.42
C-6	C-6	100-YEAR CORRECTED	0.003	0.040	0.131	0.017	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	74.34
C-6-1	IN_C-6-1	100-YEAR CORRECTED	0.001	0.045	0.092	0.017	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	74.34

C-6-2	IN_C-6-2	100-YEAR CORRECTED	0.001	0.053	0.098	0.016	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	74.34
C-6-3	IN_C-6-3	100-YEAR CORRECTED	0.001	0.016	0.038	0.024	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	74.34
D-1	IN_D-1	100-YEAR CORRECTED	0.040	0.178	0.256	0.025	70.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.92	0.30	69.29
D-2	D-2	100-YEAR CORRECTED	0.030	0.303	0.319	0.024	2.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.04	0.02	1.79
D-3	IN_D-3	100-YEAR CORRECTED	0.018	0.186	0.089	0.019	70.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.92	0.30	69.29
E	E	100-YEAR CORRECTED	0.054	0.127	0.360	0.018	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	74.34
F	F	100-YEAR CORRECTED	0.027	0.166	0.434	0.019	2.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.04	0.02	1.79
OS-1	OS-1	100-YEAR CORRECTED	0.121	0.297	0.687	0.030	8.7	0.35	0.10	3.00	0.50	0.0018	0.00	0.17	0.09	7.89
OS-2	OS-2	100-YEAR CORRECTED	0.051	0.182	0.372	0.022	5.7	0.40	0.10	3.00	0.50	0.0018	0.00	0.11	0.06	5.13
OS-3	OS-3	100-YEAR CORRECTED	0.030	0.166	0.225	0.021	4.6	0.40	0.10	3.00	0.50	0.0018	0.00	0.09	0.05	4.15
EX-X	X	100-YEAR CORRECTED	0.001	0.018	0.036	0.025	2.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.00	0.02	1.79
OS-4-1	Out1	100-YEAR CORRECTED	0.002	0.101	0.193	0.013	85.6	0.40	0.10	3.00	0.50	0.0018	0.00	0.95	0.35	85.07
OS-4-2	Out1	100-YEAR CORRECTED	0.003	0.102	0.187	0.011	87.9	0.40	0.10	3.00	0.50	0.0018	0.00	0.96	0.36	87.45
OS-7-1	IN_OS-E1	100-YEAR CORRECTED	0.001	0.057	0.118	0.004	100.0	0.40	0.10	3.00	0.50	0.0018	0.00	1.00	0.00	100.00
OS-7-2	IN_OS-D-1	100-YEAR CORRECTED	0.001	0.059	0.121	0.005	100.0	0.40	0.10	3.00	0.50	0.0018	0.00	1.00	0.00	100.00
OS-7-3	IN_OS-D-1	100-YEAR CORRECTED	0.001	0.064	0.130	0.005	100.0	0.40	0.10	3.00	0.50	0.0018	0.00	1.00	0.00	100.00
OS-7-4	IN_OS-E1	100-YEAR CORRECTED	0.001	0.064	0.130	0.005	100.0	0.40	0.10	3.00	0.50	0.0018	0.00	1.00	0.00	100.00

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.015)

Redtail Ridge
Proposed Storm Network
100-year Event

WARNING 08: elevation drop exceeds length for Conduit C-1_IN
WARNING 08: elevation drop exceeds length for Conduit E_IN
WARNING 04: minimum elevation drop used for Conduit Out1_DummyLink
WARNING 04: minimum elevation drop used for Conduit Out2_DummyLink

****
Element Count
****
Number of rain gages 0
Number of subcatchments ... 0
Number of nodes 130
Number of links 128
Number of pollutants 0
Number of land uses 0

****
Node Summary
****

Name	Type	Invert Elev.	Max. Depth	Ponded Area	External Inflow
88thStCulvert	JUNCTION	5469.71	0.00	0.0	Yes
A-1	JUNCTION	5399.18	0.00	0.0	
A-2-1	JUNCTION	5399.18	0.00	0.0	
A-2-2	JUNCTION	5383.23	0.00	0.0	
B-1	JUNCTION	5383.23	0.00	0.0	
B-2	JUNCTION	5370.12	16.66	0.0	
C-1	JUNCTION	5365.69	0.00	0.0	
C-2	JUNCTION	5357.25	0.00	0.0	
IN_D-3	JUNCTION	5358.99	8.17	0.0	
E	JUNCTION	5460.00	5.00	0.0	
E_OUT	JUNCTION	5456.72	7.00	0.0	
F	JUNCTION	5372.82	0.00	0.0	
FES_OS-A1	JUNCTION	5364.79	5.00	0.0	
IN_A-3-1	JUNCTION	5461.84	5.08	0.0	
IN_A-3-2	JUNCTION	5461.25	5.69	0.0	
IN_C-3-1	JUNCTION	5456.42	5.44	0.0	
IN_C-3-15	JUNCTION	5394.00	8.41	0.0	
IN_C-3-16	JUNCTION	5392.69	9.72	0.0	
IN_C-3-17	JUNCTION	5385.54	11.70	0.0	
IN_C-3-18	JUNCTION	5385.21	12.53	0.0	

IN_C-3-19	JUNCTION	5385.87	6.25	0.0
IN_C-3-2	JUNCTION	5456.27	5.79	0.0
IN_C-3-20	JUNCTION	5374.45	14.13	0.0
IN_C-3-21	JUNCTION	5370.68	17.90	0.0
IN_C-3-3	JUNCTION	5448.28	5.59	0.0
IN_C-3-4	JUNCTION	5448.38	5.66	0.0
IN_C-3-5	JUNCTION	5426.43	9.83	0.0
IN_C-3-6	JUNCTION	5426.24	10.69	0.0
IN_C-3-7	JUNCTION	5396.47	15.11	0.0
IN_C-3-8	JUNCTION	5395.61	15.97	0.0
IN_C-4-1	JUNCTION	5365.90	4.02	0.0
IN_C-4-2	JUNCTION	5365.40	4.68	0.0
IN_C-5-1	JUNCTION	5442.59	5.16	0.0
IN_C-5-10	JUNCTION	5377.70	5.85	0.0
IN_C-5-11	JUNCTION	5375.03	8.54	0.0
IN_C-5-12	JUNCTION	5367.94	5.68	0.0
IN_C-5-13	JUNCTION	5360.54	13.54	0.0
IN_C-5-2	JUNCTION	5443.19	4.56	0.0
IN_C-5-3	JUNCTION	5426.13	6.55	0.0
IN_C-5-4	JUNCTION	5427.19	5.49	0.0
IN_C-5-5	JUNCTION	5405.51	6.24	0.0
IN_C-5-6	JUNCTION	5406.51	5.22	0.0
IN_C-5-7	JUNCTION	5369.11	13.62	0.0
IN_C-5-8	JUNCTION	5368.46	14.41	0.0
IN_C-5-9	JUNCTION	5367.29	14.25	0.0
IN_C-6-1	JUNCTION	5358.82	7.54	0.0
IN_C-6-2	JUNCTION	5361.36	4.81	0.0
IN_C-6-3	JUNCTION	5355.27	0.00	0.0
IN_OS-B1	JUNCTION	5354.19	1.80	0.0
IN_OS-C1	JUNCTION	5354.55	1.80	0.0
IN_OS-D-1	JUNCTION	5363.04	1.80	0.0
IN_OS-E1	JUNCTION	5363.16	1.80	0.0
MH_A1	JUNCTION	5370.18	16.15	0.0
MH_A10	JUNCTION	5390.15	15.94	0.0
MH_A11	JUNCTION	5391.49	15.05	0.0
MH_A12	JUNCTION	5392.68	17.55	0.0
MH_A13	JUNCTION	5394.03	20.33	0.0
MH_A14	JUNCTION	5405.68	12.20	0.0
MH_A15	JUNCTION	5415.05	14.01	0.0
MH_A16	JUNCTION	5424.36	13.15	0.0
MH_A17	JUNCTION	5429.82	12.63	0.0
MH_A18	JUNCTION	5446.96	6.75	0.0
MH_A20	JUNCTION	5454.77	6.92	0.0
MH_A21	JUNCTION	5459.04	8.06	0.0
MH_A22	JUNCTION	5462.10	7.24	0.0
MH_A23	JUNCTION	5462.70	6.22	0.0
MH_A-24	JUNCTION	5465.71	8.40	0.0
MH_A25	JUNCTION	5466.19	8.48	0.0
MH_A26	JUNCTION	5469.13	9.97	0.0
MH_A27	JUNCTION	5469.73	9.55	0.0

MH_A3	JUNCTION	5370.91	17.45	0.0	
MH_A5	JUNCTION	5383.03	12.25	0.0	
MH_A6	JUNCTION	5383.96	12.46	0.0	
MH_A7	JUNCTION	5384.90	12.72	0.0	
MH_A8	JUNCTION	5386.41	13.21	0.0	
MH_A9	JUNCTION	5388.31	12.56	0.0	
MH_B1	JUNCTION	5383.85	11.42	0.0	
MH_B2	JUNCTION	5385.34	6.54	0.0	
MH_C2	JUNCTION	5360.73	13.24	0.0	
MH_C4	JUNCTION	5363.99	19.43	0.0	
MH_C5	JUNCTION	5366.43	15.68	0.0	
MH_C6	JUNCTION	5368.16	14.83	0.0	
MH_E2	JUNCTION	5372.94	10.70	0.0	
MH_E3	JUNCTION	5374.11	15.68	0.0	
MH_E4	JUNCTION	5376.05	18.61	0.0	
MH_E5	JUNCTION	5376.65	17.77	0.0	
MH_E6	JUNCTION	5378.08	15.66	0.0	
MH_E7	JUNCTION	5382.19	9.29	0.0	
MH_G1	JUNCTION	5358.56	8.75	0.0	
MH_J7	JUNCTION	5422.80	11.54	0.0	
MH_J8	JUNCTION	5430.52	9.95	0.0	
MH_J9	JUNCTION	5435.69	9.24	0.0	
MH_J10	JUNCTION	5442.15	8.21	0.0	
MH_C9	JUNCTION	5369.40	13.49	0.0	
MH_J1	JUNCTION	5371.94	12.23	0.0	
MH_J2	JUNCTION	5378.59	10.66	0.0	
MH_J3	JUNCTION	5387.89	10.46	0.0	
MH_J4	JUNCTION	5401.30	12.85	0.0	
MH_J5	JUNCTION	5409.95	13.66	0.0	
MH_J6	JUNCTION	5420.42	11.34	0.0	
MH_K3	JUNCTION	5461.60	5.03	0.0	
MH_OS_A1	JUNCTION	5353.79	6.54	0.0	
MH_OS-A1	JUNCTION	5365.21	5.24	0.0	
MH_OS-A2	JUNCTION	5355.35	9.74	0.0	
MH_OS-A3	JUNCTION	5356.55	11.08	0.0	
MH_OS-A4	JUNCTION	5358.00	10.74	0.0	
MH_OS-A5	JUNCTION	5360.03	9.50	0.0	
MH_OS-A6	JUNCTION	5361.88	6.00	0.0	
MH_OS-A7	JUNCTION	5362.65	4.71	0.0	
OS-1	JUNCTION	5451.06	0.00	0.0	
OS-2	JUNCTION	5372.82	0.00	0.0	
OS-3	JUNCTION	5351.00	0.00	0.0	
REACH1_IN	JUNCTION	5451.06	22.47	0.0	
REACH2_IN	JUNCTION	5399.18	22.47	0.0	
REACH2_OUT	JUNCTION	5372.82	6.01	0.0	
REACH3_IN	JUNCTION	5363.99	14.43	0.0	
SchoolCulvertEast	JUNCTION	5434.52	2.00	0.0	Yes
SchoolCulvertWest	JUNCTION	5464.00	1.50	0.0	Yes
Out1_DummyNode	JUNCTION	5351.00	14.43	0.0	
Out2_DummyNode	JUNCTION	5355.27	0.50	0.0	

MH_A42	JUNCTION	5382.42	11.44	0.0	
IN_D-1	JUNCTION	5370.45	6.13	0.0	
Out2	OUTFALL	5355.27	0.00	0.0	
Out1	OUTFALL	5351.00	0.00	0.0	
School_Pond_Bypass	OUTFALL	5450.90	2.50	0.0	
MH_A19	DIVIDER	5451.22	9.49	0.0	
Pond_B-1	STORAGE	5384.14	9.67	0.0	
Pond_C-1	STORAGE	5368.17	6.64	0.0	
Pond_C-2	STORAGE	5355.85	9.42	0.0	
Pond_E	STORAGE	5457.00	10.00	0.0	

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Link Summary
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Name	From Node	To Node	Type	Length	%Slope	Roughness
A-1	MH_A1	Pond_C-1	CONDUIT	294.6	0.6822	0.0130
A-1_IN	A-1	REACH2_IN	CONDUIT	1.0	-57.7350	0.0100
A-10	MH_A10	MH_A9	CONDUIT	297.2	0.5181	0.0130
A-11	MH_A11	MH_A10	CONDUIT	227.2	0.5018	0.0130
A-12	MH_A12	MH_A11	CONDUIT	197.5	0.5013	0.0130
A-13	MH_A13	MH_A12	CONDUIT	102.5	0.4977	0.0130
A-14	MH_A14	MH_A13	CONDUIT	213.3	5.3299	0.0130
A-15	MH_A15	MH_A14	CONDUIT	210.4	4.3633	0.0130
A-16	MH_A16	MH_A15	CONDUIT	218.0	4.2278	0.0130
A-17	MH_A17	MH_A16	CONDUIT	131.6	3.7711	0.0130
A-18	MH_A18	MH_A17	CONDUIT	396.9	4.2714	0.0130
A-19	MH_A19	MH_A18	CONDUIT	378.9	1.7318	0.0130
A-2	IN_C-3-21	MH_A1	CONDUIT	59.6	0.5037	0.0130
A-20	MH_A20	MH_A19	CONDUIT	90.1	0.9432	0.0130
A-21	MH_A21	MH_A20	CONDUIT	391.9	1.0385	0.0130

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  A-2-1_IN         A-2-1           REACH2_IN       CONDUIT           1.0
-57.7350    0.0100
  A-22             MH_A22          MH_A21          CONDUIT         142.6
2.0768    0.0130
  A-2-2_IN         A-2-2           Pond_B-1        CONDUIT           1.0
-219.4843    0.0100
  A-23             MH_A23          MH_A22          CONDUIT          96.9
0.5160    0.0130
  A-24             MH_A-24         MH_A23          CONDUIT         168.3
1.7297    0.0130
  A-25             MH_A25          MH_A-24         CONDUIT          20.0
1.4001    0.0130
  A-26             MH_A26          MH_A25          CONDUIT         196.3
1.3963    0.0130
  A-27             MH_A27          MH_A26          CONDUIT          39.5
1.0140    0.0130
  A-3              MH_A3           IN_C-3-21       CONDUIT           5.4
0.3690    0.0130
  A-6              MH_A6           MH_A5           CONDUIT         146.9
0.4968    0.0130
  A-7              MH_A7           MH_A6           CONDUIT         147.0
0.5034    0.0130
  A-8              MH_A8           MH_A7           CONDUIT         261.2
0.5015    0.0130
  A-9              MH_A9           MH_A8           CONDUIT         340.3
0.4995    0.0130
  AA-1             IN_C-3-20       MH_A3           CONDUIT          40.2
0.9958    0.0130
  AB-1             IN_C-3-18       MH_A7           CONDUIT          21.5
0.5116    0.0130
  AB-2             IN_C-3-17       IN_C-3-18       CONDUIT          45.8
0.5026    0.0130
  AC-1             IN_C-3-16       MH_A9           CONDUIT          25.8
1.7030    0.0130
  AC-2             IN_C-3-15       IN_C-3-16       CONDUIT          40.4
2.7520    0.0130
  AD-1             IN_C-3-8        MH_A12          CONDUIT          29.4
1.4613    0.0130
  AD-2             IN_C-3-7        IN_C-3-8        CONDUIT          40.3
1.5619    0.0130
  AE-1             IN_C-3-5        MH_A16          CONDUIT          62.1
0.5151    0.0130
  AE-2             IN_C-3-6        MH_A16          CONDUIT          28.9
0.4505    0.0130
  AF-1             IN_C-3-3        MH_A18          CONDUIT          12.7
0.7893    0.0130
  AF-2             IN_C-3-4        MH_A18          CONDUIT          34.7
0.6057    0.0130
  AG-1             IN_C-3-1        MH_A20          CONDUIT          12.7
0.5525    0.0130
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  AG-2             IN_C-3-2         MH_A20           CONDUIT           34.7
0.4903    0.0130
  B-1              MH_B1            MH_A5            CONDUIT          125.9
0.4925    0.0130
  B-1_IN           B-1              Pond_B-1         CONDUIT            1.0
-219.4843    0.0100
  B-2              MH_B2            MH_B1            CONDUIT          258.7
0.4987    0.0130
  B-3              IN_C-3-19        MH_B2            CONDUIT           66.0
0.4999    0.0130
  C-1              IN_C-5-13        Pond_C-2         CONDUIT          129.4
0.5021    0.0130
  C-1_IN           C-1              Pond_C-1         CONDUIT            1.0
-248.0000    0.0100
  C150             IN_OS-B1         Out1_DummyNode   CONDUIT           28.0
11.4675    0.0130
  C-2              MH_C2            IN_C-5-13        CONDUIT           15.4
0.5856    0.0130
  C-2_IN           C-2              Pond_C-2         CONDUIT           15.0
9.3743    0.0100
  C-4              MH_C4            MH_C2            CONDUIT          485.2
0.6307    0.0130
  C-5              MH_C5            MH_C4            CONDUIT           68.9
1.0739    0.0130
  C-6              MH_C6            MH_C5            CONDUIT          141.9
1.0784    0.0130
  C-6-3_Street     IN_C-6-3         Out2_DummyNode   CONDUIT           10.0
-5.0063    0.0100
  CA-1             IN_C-5-12        MH_C2            CONDUIT           56.6
7.1077    0.0130
  CB-1             IN_C-5-9         MH_C5            CONDUIT           28.8
2.2931    0.0130
  Culvert88_IN     88thStCulvert    MH_A27           CONDUIT            1.0
-60.8781    0.0100
  CulvertEast_IN   SchoolCulvertEast MH_A17          CONDUIT          104.3
4.0309    0.0130
  CulvertWest_IN   SchoolCulvertWest MH_A22          CONDUIT           88.0
0.5003    0.0130
  D-2              IN_C-5-11        MH_C4            CONDUIT          155.6
4.7237    0.0130
  D-3              IN_C-5-10        IN_C-5-11        CONDUIT           47.4
5.0073    0.0130
  CB-2             B-2              IN_C-5-9         CONDUIT           24.5
10.7971    0.0130
  E_IN             E                Pond_E           CONDUIT            1.0
250.0000    0.0100
  E-2              MH_E2            REACH3_IN        CONDUIT           34.7
0.4905    0.0130
  E-3              MH_E3            MH_E2            CONDUIT          194.7
0.4983    0.0130
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  E-4               MH_E4             MH_E3             CONDUIT          347.9
0.5002    0.0130
  E-5               MH_E5             MH_E4             CONDUIT           80.8
0.4949    0.0130
  E-6               MH_E6             MH_E5             CONDUIT          118.5
0.5064    0.0130
  E-7               MH_E7             MH_E6             CONDUIT          106.5
3.6749    0.0130
  EX-4              MH_A19            School_Pond_Bypass CONDUIT           35.5
0.9022    0.0130
  F_IN              F                 REACH2_OUT        CONDUIT            1.0
-57.7350    0.0100
  G-1               MH_G1             Pond_C-2          CONDUIT           56.5
0.1770    0.0130
  G-2               IN_C-6-1          MH_G1             CONDUIT           82.4
0.1941    0.0130
  G-3               IN_D-3            IN_C-6-1          CONDUIT           30.8
0.2272    0.0130
  GA-1              IN_C-6-2          MH_G1             CONDUIT           69.5
0.5181    0.0130
  C-7               IN_C-5-8          MH_C6             CONDUIT            9.1
1.1026    0.0130
  J-7               MH_J7             MH_J6             CONDUIT          109.0
2.0008    0.0130
  J-8               MH_J8             MH_J7             CONDUIT          376.8
1.9960    0.0130
  J-9               MH_J9             MH_J8             CONDUIT          333.9
1.2490    0.0130
  J-10              MH_J10            MH_J9             CONDUIT          417.7
1.4987    0.0130
  J-11              IN_C-5-1          MH_J10            CONDUIT           24.4
0.9849    0.0130
  J-12              IN_C-5-2          IN_C-5-1          CONDUIT           40.3
0.9919    0.0130
  C-8               IN_C-5-7          IN_C-5-8          CONDUIT           42.0
1.0728    0.0130
  C-9               MH_C9             IN_C-5-7          CONDUIT            8.7
1.0369    0.0130
  J-1               MH_J1             MH_C9             CONDUIT          117.0
1.9997    0.0130
  J-2               MH_J2             MH_J1             CONDUIT          258.1
2.4993    0.0130
  J-3               MH_J3             MH_J2             CONDUIT          364.0
2.5008    0.0130
  J-4               MH_J4             MH_J3             CONDUIT          440.5
3.0002    0.0130
  J-5               MH_J5             MH_J4             CONDUIT          272.0
2.9973    0.0130
  J-6               MH_J6             MH_J5             CONDUIT          371.1
1.9996    0.0130
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JA-1	IN_C-5-5	MH_J4	CONDUIT	24.4	2.0111	0.0130
JA-2	IN_C-5-6	IN_C-5-5	CONDUIT	40.2	1.9895	0.0130
JB-1	IN_C-5-3	MH_J7	CONDUIT	24.4	1.9716	0.0130
JB-2	IN_C-5-4	IN_C-5-3	CONDUIT	40.4	2.0078	0.0130
E_TIE	E_OUT	MH_J8	CONDUIT	140.1	18.8890	0.0130
K-1	IN_A-3-2	REACH1_IN	CONDUIT	56.9	9.5656	0.0130
K-2	MH_K3	IN_A-3-2	CONDUIT	32.9	0.4566	0.0130
K-3	IN_A-3-1	MH_K3	CONDUIT	8.2	0.4896	0.0130
OS-1_IN	OS-1	REACH1_IN	CONDUIT	1.0	-57.7350	0.0100
OS-2_IN	OS-2	REACH2_OUT	CONDUIT	1.0	-57.7350	0.0100
OS-3_IN	OS-3	Out1_DummyNode	CONDUIT	1.0	-57.7350	0.0100
OS-A1	MH_OS-A2	MH_OS_A1	CONDUIT	311.9	0.5001	0.0130
OS-A-1	MH_OS-A1	FES_OS-A1	CONDUIT	36.5	1.1520	0.0130
OS-A2	MH_OS-A3	MH_OS-A2	CONDUIT	199.5	0.5012	0.0130
OS-A-2	IN_C-4-2	MH_OS-A1	CONDUIT	18.6	0.4844	0.0130
OS-A3	MH_OS-A4	MH_OS-A3	CONDUIT	250.9	0.4982	0.0130
OS-A-3	IN_C-4-1	IN_C-4-2	CONDUIT	79.6	0.5023	0.0130
OS-A-4	MH_OS-A5	MH_OS-A4	CONDUIT	365.0	0.5013	0.0130
OS-A-5	MH_OS-A6	MH_OS-A5	CONDUIT	330.8	0.4988	0.0130
OS-A-6	MH_OS-A7	MH_OS-A6	CONDUIT	114.7	0.4970	0.0130
OS-A-Channel	FES_OS-A1	Out1_DummyNode	CONDUIT	450.0	3.0659	0.0350
OS-B-1	MH_OS_A1	IN_OS-B1	CONDUIT	19.5	0.0513	0.0130
OS-C-1	IN_OS-C1	MH_OS_A1	CONDUIT	111.5	0.5022	0.0130
OS-D-1	IN_OS-D-1	MH_OS-A7	CONDUIT	18.0	0.5000	0.0130
OS-E-1	IN_OS-E1	MH_OS-A7	CONDUIT	62.0	0.5000	0.0130

REACH1	REACH1_IN	REACH2_IN	CONDUIT	2528.2	2.0525 0.0320
REACH2_IN	REACH2_IN	REACH2_OUT	CONDUIT	1436.4	1.8354 0.0350
REACH2_OUT	REACH2_OUT	REACH3_IN	CONDUIT	954.0	0.9256 0.0350
REACH3	REACH3_IN	Out1_DummyNode	CONDUIT	150.0	8.6927 0.0350
Out1_DummyLink	Out1_DummyNode	Out1	CONDUIT	10.0	0.0100 0.0100
Out2_DummyLink	Out2_DummyNode	Out2	CONDUIT	10.0	0.0100 0.0100
A-5	MH_A5	MH_A42	CONDUIT	81.8	0.5015 0.0130
A-5(1)	MH_A42	MH_A3	CONDUIT	387.1	2.9492 0.0130
C-10	IN_D-1	MH_C9	CONDUIT	42.6	1.9976 0.0130
C-1_OUT	Pond_C-1	REACH3_IN	OUTLET		
B-1_OUT	Pond_B-1	MH_E7	OUTLET		
C-2_OUT	Pond_C-2	Out2_DummyNode	OUTLET		
E_OUT	Pond_E	E_OUT	OUTLET		

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Cross Section Summary
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Conduit	Shape	Full Depth	Full Area	Hyd. Rad.	Max. Width	No. of Barrels	Full Flow
A-1	CIRCULAR	4.50	15.90	1.13	4.50	1	162.42
A-1_IN	DUMMY	0.00	0.00	0.00	0.00	1	0.00
A-10	CIRCULAR	4.00	12.57	1.00	4.00	1	103.40
A-11	CIRCULAR	4.00	12.57	1.00	4.00	1	101.76
A-12	CIRCULAR	4.00	12.57	1.00	4.00	1	101.71
A-13	HORIZ_ELLIPSE	2.42	7.41	0.74	3.75	1	48.90
A-14	CIRCULAR	3.00	7.07	0.75	3.00	1	153.98
A-15	CIRCULAR	3.00	7.07	0.75	3.00	1	139.32

A-16	CIRCULAR	3.00	7.07	0.75	3.00	1
137.14						
A-17	CIRCULAR	2.50	4.91	0.63	2.50	1
79.65						
A-18	CIRCULAR	2.50	4.91	0.63	2.50	1
84.77						
A-19	CIRCULAR	2.50	4.91	0.63	2.50	1
53.98						
A-2	CIRCULAR	4.50	15.90	1.13	4.50	1
139.57						
A-20	RECT_CLOSED	4.00	18.00	1.06	4.50	1
207.59						
A-21	CIRCULAR	4.00	12.57	1.00	4.00	1
146.38						
A-2-1_IN	DUMMY	0.00	0.00	0.00	0.00	1
0.00						
A-22	CIRCULAR	4.00	12.57	1.00	4.00	1
207.00						
A-2-2_IN	DUMMY	0.00	0.00	0.00	0.00	1
0.00						
A-23	HORIZ_ELLIPSE	3.17	12.90	0.97	5.00	1
103.72						
A-24	CIRCULAR	3.50	9.62	0.88	3.50	1
132.32						
A-25	CIRCULAR	3.50	9.62	0.88	3.50	1
119.05						
A-26	CIRCULAR	3.50	9.62	0.88	3.50	1
118.89						
A-27	CIRCULAR	3.50	9.62	0.88	3.50	1
101.31						
A-3	CIRCULAR	4.50	15.90	1.13	4.50	1
119.46						
A-6	CIRCULAR	4.00	12.57	1.00	4.00	1
101.25						
A-7	CIRCULAR	4.00	12.57	1.00	4.00	1
101.92						
A-8	CIRCULAR	4.00	12.57	1.00	4.00	1
101.72						
A-9	CIRCULAR	4.00	12.57	1.00	4.00	1
101.52						
AA-1	CIRCULAR	1.50	1.77	0.38	1.50	1
10.48						
AB-1	CIRCULAR	1.50	1.77	0.38	1.50	1
7.51						
AB-2	CIRCULAR	1.50	1.77	0.38	1.50	1
7.45						
AC-1	CIRCULAR	1.50	1.77	0.38	1.50	1
13.71						
AC-2	CIRCULAR	1.50	1.77	0.38	1.50	1
17.43						

AD-1	CIRCULAR	1.50	1.77	0.38	1.50	1	12.70
AD-2	CIRCULAR	1.50	1.77	0.38	1.50	1	13.13
AE-1	CIRCULAR	1.50	1.77	0.38	1.50	1	7.54
AE-2	CIRCULAR	1.50	1.77	0.38	1.50	1	7.05
AF-1	CIRCULAR	1.50	1.77	0.38	1.50	1	9.33
AF-2	CIRCULAR	1.50	1.77	0.38	1.50	1	8.18
AG-1	CIRCULAR	1.50	1.77	0.38	1.50	1	7.81
AG-2	CIRCULAR	1.50	1.77	0.38	1.50	1	7.36
B-1	CIRCULAR	1.50	1.77	0.38	1.50	1	7.37
B-1_IN	DUMMY	0.00	0.00	0.00	0.00	1	0.00
B-2	CIRCULAR	1.50	1.77	0.38	1.50	1	7.42
B-3	CIRCULAR	1.50	1.77	0.38	1.50	1	7.43
C-1	CIRCULAR	4.50	15.90	1.13	4.50	1	139.35
C-1_IN	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C150	CIRCULAR	1.50	1.77	0.38	1.50	1	35.57
C-2	CIRCULAR	4.50	15.90	1.13	4.50	1	150.48
C-2_IN	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C-4	CIRCULAR	4.50	15.90	1.13	4.50	1	156.17
C-5	CIRCULAR	3.50	9.62	0.88	3.50	1	104.26
C-6	CIRCULAR	3.00	7.07	0.75	3.00	1	69.26
C-6-3_Street	DUMMY	0.00	0.00	0.00	0.00	1	0.00
CA-1	CIRCULAR	1.50	1.77	0.38	1.50	1	28.00
CB-1	CIRCULAR	3.50	9.62	0.88	3.50	1	152.35
Culvert88_IN	DUMMY	0.00	0.00	0.00	0.00	1	0.00
CulvertEast_IN	CIRCULAR	2.00	3.14	0.50	2.00	1	45.42

CulvertWest_IN	CIRCULAR	1.50	1.77	0.38	1.50	1
7.43						
D-2	CIRCULAR	1.50	1.77	0.38	1.50	1
22.83						
D-3	CIRCULAR	1.50	1.77	0.38	1.50	1
23.51						
CB-2	CIRCULAR	3.50	9.62	0.88	3.50	1
330.59						
E_IN	DUMMY	0.00	0.00	0.00	0.00	1
0.00						
E-2	HORIZ_ELLIPSE	3.17	12.90	0.97	5.00	1
101.13						
E-3	CIRCULAR	4.00	12.57	1.00	4.00	1
101.40						
E-4	CIRCULAR	4.00	12.57	1.00	4.00	1
101.59						
E-5	CIRCULAR	4.00	12.57	1.00	4.00	1
101.05						
E-6	HORIZ_ELLIPSE	3.17	12.90	0.97	5.00	1
102.76						
E-7	CIRCULAR	4.00	12.57	1.00	4.00	1
275.36						
EX-4	CIRCULAR	2.50	4.91	0.63	2.50	1
38.96						
F_IN	DUMMY	0.00	0.00	0.00	0.00	1
0.00						
G-1	CIRCULAR	5.00	19.63	1.25	5.00	1
109.57						
G-2	CIRCULAR	4.50	15.90	1.13	4.50	1
86.64						
G-3	CIRCULAR	4.50	15.90	1.13	4.50	1
93.73						
GA-1	CIRCULAR	1.50	1.77	0.38	1.50	1
7.56						
C-7	CIRCULAR	3.00	7.07	0.75	3.00	1
70.04						
J-7	CIRCULAR	2.50	4.91	0.63	2.50	1
58.02						
J-8	CIRCULAR	2.50	4.91	0.63	2.50	1
57.95						
J-9	CIRCULAR	1.50	1.77	0.38	1.50	1
11.74						
J-10	CIRCULAR	1.50	1.77	0.38	1.50	1
12.86						
J-11	CIRCULAR	1.25	1.23	0.31	1.25	1
6.41						
J-12	CIRCULAR	1.25	1.23	0.31	1.25	1
6.43						
C-8	CIRCULAR	3.00	7.07	0.75	3.00	1
69.08						

C-9	CIRCULAR	3.00	7.07	0.75	3.00	1
67.92						
J-1	CIRCULAR	3.00	7.07	0.75	3.00	1
94.32						
J-2	CIRCULAR	3.00	7.07	0.75	3.00	1
105.45						
J-3	CIRCULAR	3.00	7.07	0.75	3.00	1
105.48						
J-4	CIRCULAR	3.00	7.07	0.75	3.00	1
115.53						
J-5	CIRCULAR	2.50	4.91	0.63	2.50	1
71.01						
J-6	CIRCULAR	2.50	4.91	0.63	2.50	1
58.00						
JA-1	CIRCULAR	1.25	1.23	0.31	1.25	1
9.16						
JA-2	CIRCULAR	1.25	1.23	0.31	1.25	1
9.11						
JB-1	CIRCULAR	1.50	1.77	0.38	1.50	1
14.75						
JB-2	CIRCULAR	1.25	1.23	0.31	1.25	1
9.15						
E_TIE	CIRCULAR	4.00	12.57	1.00	4.00	1
624.30						
K-1	CIRCULAR	1.50	1.77	0.38	1.50	1
32.49						
K-2	CIRCULAR	1.50	1.77	0.38	1.50	1
7.10						
K-3	CIRCULAR	1.50	1.77	0.38	1.50	1
7.35						
OS-1_IN	DUMMY	0.00	0.00	0.00	0.00	1
0.00						
OS-2_IN	DUMMY	0.00	0.00	0.00	0.00	1
0.00						
OS-3_IN	DUMMY	0.00	0.00	0.00	0.00	1
0.00						
OS-A1	CIRCULAR	1.50	1.77	0.38	1.50	1
7.43						
OS-A-1	CIRCULAR	1.50	1.77	0.38	1.50	1
11.27						
OS-A2	CIRCULAR	1.50	1.77	0.38	1.50	1
7.44						
OS-A-2	CIRCULAR	1.50	1.77	0.38	1.50	1
7.31						
OS-A3	CIRCULAR	1.50	1.77	0.38	1.50	1
7.41						
OS-A-3	CIRCULAR	1.50	1.77	0.38	1.50	1
7.44						
OS-A-4	CIRCULAR	1.50	1.77	0.38	1.50	1
7.44						

OS-A-5	CIRCULAR	1.50	1.77	0.38	1.50	1
7.42						
OS-A-6	CIRCULAR	1.50	1.77	0.38	1.50	1
7.41						
OS-A-Channel	TRAPEZOIDAL	5.00	125.00	2.70	45.00	1
1803.53						
OS-B-1	CIRCULAR	1.50	1.77	0.38	1.50	1
2.38						
OS-C-1	CIRCULAR	1.50	1.77	0.38	1.50	1
7.44						
OS-D-1	CIRCULAR	1.50	1.77	0.38	1.50	1
7.43						
OS-E-1	CIRCULAR	1.50	1.77	0.38	1.50	1
7.43						
REACH1	4650	22.47	6129.81	14.83	400.00	1
246170.39						
REACH2_IN	1700	6.01	1127.37	3.22	400.00	1
14146.37						
REACH2_OUT	1700	6.01	1127.37	3.22	400.00	1
10045.83						
REACH3	950	14.43	3735.58	12.03	400.00	1
245533.17						
Out1_DummyLink	DUMMY	0.00	0.00	0.00	0.00	1
0.00						
Out2_DummyLink	DUMMY	0.00	0.00	0.00	0.00	1
0.00						
A-5	CIRCULAR	4.00	12.57	1.00	4.00	1
101.72						
A-5(1)	CIRCULAR	4.00	12.57	1.00	4.00	1
246.68						
C-10	CIRCULAR	1.50	1.77	0.38	1.50	1
14.85						

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Transect Summary
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Transect 1700
Area:

0.0000	0.0001	0.0003	0.0005	0.0008
0.0011	0.0015	0.0020	0.0025	0.0032
0.0042	0.0074	0.0125	0.0198	0.0287
0.0384	0.0488	0.0599	0.0742	0.0900
0.1070	0.1250	0.1437	0.1631	0.1830
0.2036	0.2255	0.2484	0.2723	0.2971
0.3226	0.3491	0.3778	0.4075	0.4382
0.4705	0.5041	0.5385	0.5739	0.6100
0.6461	0.6824	0.7190	0.7562	0.7952

0.8351 0.8755 0.9163 0.9576 1.0000
Hrad:
0.0170 0.0341 0.0511 0.0681 0.0845
0.1009 0.1175 0.1322 0.1459 0.1621
0.1720 0.1410 0.1309 0.1400 0.1571
0.1820 0.2088 0.2321 0.2350 0.2575
0.2772 0.3067 0.3368 0.3671 0.3969
0.4256 0.4529 0.4794 0.4799 0.5083
0.5401 0.5698 0.5666 0.5922 0.6139
0.6409 0.6444 0.6718 0.6956 0.7333
0.7713 0.8081 0.8409 0.8736 0.8575
0.8845 0.9175 0.9515 0.9691 1.0000
Width:
0.0014 0.0028 0.0042 0.0056 0.0071
0.0087 0.0102 0.0120 0.0139 0.0167
0.0426 0.0957 0.1471 0.1928 0.2184
0.2356 0.2514 0.2885 0.3597 0.3836
0.4123 0.4303 0.4463 0.4604 0.4747
0.4962 0.5277 0.5476 0.5731 0.5907
0.6030 0.6497 0.6861 0.7081 0.7365
0.7756 0.7975 0.8178 0.8434 0.8466
0.8494 0.8533 0.8607 0.8986 0.9260
0.9423 0.9520 0.9607 0.9875 1.0000

Transect 950
Area:
0.0002 0.0007 0.0013 0.0025 0.0068
0.0143 0.0239 0.0348 0.0471 0.0604
0.0756 0.0924 0.1101 0.1287 0.1481
0.1684 0.1895 0.2114 0.2341 0.2571
0.2802 0.3034 0.3267 0.3500 0.3735
0.3971 0.4208 0.4446 0.4684 0.4924
0.5165 0.5407 0.5650 0.5894 0.6139
0.6386 0.6633 0.6881 0.7131 0.7381
0.7633 0.7885 0.8139 0.8394 0.8649
0.8906 0.9164 0.9426 0.9702 1.0000
Hrad:
0.0171 0.0303 0.0427 0.0476 0.0435
0.0514 0.0681 0.0855 0.1029 0.1198
0.1309 0.1484 0.1675 0.1864 0.2050
0.2234 0.2416 0.2595 0.2798 0.3049
0.3300 0.3549 0.3798 0.4046 0.4292
0.4537 0.4781 0.5024 0.5265 0.5506
0.5745 0.5983 0.6219 0.6454 0.6689
0.6922 0.7154 0.7385 0.7615 0.7844
0.8072 0.8298 0.8524 0.8749 0.8973
0.9196 0.9418 0.9635 0.9832 1.0000
Width:
0.0107 0.0165 0.0223 0.0848 0.1928
0.2893 0.3327 0.3751 0.4148 0.4545

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            0.5234     0.5600     0.5873     0.6145     0.6418
            0.6690     0.6962     0.7235     0.7421     0.7453
            0.7485     0.7517     0.7549     0.7581     0.7613
            0.7646     0.7680     0.7713     0.7746     0.7779
            0.7813     0.7847     0.7881     0.7916     0.7950
            0.7984     0.8019     0.8053     0.8087     0.8122
            0.8156     0.8191     0.8225     0.8259     0.8294
            0.8328     0.8362     0.8647     0.9289     1.0000

Transect 4650
Area:
            0.0032     0.0087     0.0155     0.0232     0.0318
            0.0410     0.0509     0.0614     0.0725     0.0841
            0.0962     0.1088     0.1218     0.1354     0.1495
            0.1641     0.1793     0.1955     0.2128     0.2311
            0.2501     0.2698     0.2903     0.3114     0.3332
            0.3557     0.3788     0.4026     0.4270     0.4519
            0.4772     0.5030     0.5290     0.5552     0.5816
            0.6082     0.6350     0.6619     0.6890     0.7163
            0.7438     0.7715     0.7993     0.8274     0.8557
            0.8842     0.9129     0.9417     0.9708     1.0000
Hrad:
            0.0211     0.0424     0.0637     0.0857     0.1079
            0.1292     0.1506     0.1711     0.1917     0.2127
            0.2349     0.2574     0.2792     0.3004     0.3213
            0.3417     0.3419     0.3496     0.3574     0.3705
            0.3862     0.4020     0.4180     0.4338     0.4506
            0.4673     0.4838     0.5008     0.5188     0.5392
            0.5592     0.5798     0.6051     0.6301     0.6548
            0.6793     0.7036     0.7278     0.7517     0.7753
            0.7986     0.8217     0.8443     0.8660     0.8886
            0.9112     0.9335     0.9558     0.9779     1.0000
Width:
            0.1571     0.2111     0.2498     0.2787     0.3028
            0.3261     0.3471     0.3683     0.3881     0.4061
            0.4204     0.4334     0.4539     0.4731     0.4901
            0.5069     0.5347     0.5705     0.6074     0.6364
            0.6610     0.6851     0.7090     0.7330     0.7551
            0.7773     0.7996     0.8211     0.8406     0.8559
            0.8714     0.8856     0.8914     0.8973     0.9034
            0.9094     0.9155     0.9215     0.9276     0.9339
            0.9403     0.9468     0.9538     0.9615     0.9680
            0.9744     0.9809     0.9873     0.9937     1.0000


**********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
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Analysis Options
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Flow Units ............... CFS
Process Models:
  Rainfall/Runoff ........ NO
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ YES
  Water Quality .......... NO
Flow Routing Method ...... DYNWAVE
Surcharge Method ......... EXTRAN
Starting Date ............ 07/18/2022 00:00:00
Ending Date .............. 07/23/2022 00:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:05:00
Routing Time Step ........ 5.00 sec
Variable Time Step ....... YES
Maximum Trials ........... 8
Number of Threads ........ 1
Head Tolerance ........... 0.005000 ft


**************************        Volume        Volume
Flow Routing Continuity        acre-feet      10^6 gal
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......         0.000         0.000
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........        98.803        32.196
External Outflow .........        81.919        26.695
Flooding Loss ............        16.716         5.447
Evaporation Loss .........         0.000         0.000
Exfiltration Loss ........         0.000         0.000
Initial Stored Volume ....         0.000         0.000
Final Stored Volume ......         0.076         0.025
Continuity Error (%) .....         0.092


*************************
Highest Continuity Errors
*************************
Node REACH2_IN (2.64%)
Node REACH1_IN (-1.61%)
```

```
**************************
Time-Step Critical Elements
**************************
Link C-9 (85.00%)
Link A-3 (3.82%)
Link C-7 (1.22%)


******************************
Highest Flow Instability Indexes
******************************
All links are stable.


************************
Routing Time Step Summary
************************
Minimum Time Step           :     0.50 sec
Average Time Step           :     1.83 sec
Maximum Time Step           :     5.00 sec
Percent in Steady State     :    -0.00
Average Iterations per Step :     2.01
Percent Not Converging      :     0.10
Time Step Frequencies       :
    5.000 -  3.155 sec      :    10.06 %
    3.155 -  1.991 sec      :     4.21 %
    1.991 -  1.256 sec      :    75.51 %
    1.256 -  0.792 sec      :     2.81 %
    0.792 -  0.500 sec      :     7.41 %

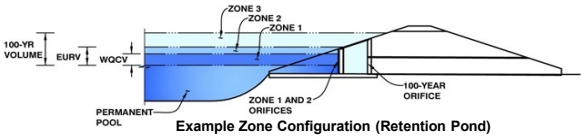

******************
Analysis begun on:  Tue Jan 30 15:58:29 2024
Analysis ended on:  Tue Jan 30 15:58:51 2024
Total elapsed time: 00:00:22
```

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.05 (January 2022)

Project: Redtail Ridge - On-Site Improvements

Basin ID: Pond B



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	EDB	
Watershed Area =	113.55	acres
Watershed Length =	2,707	ft
Watershed Length to Centroid =	1,276	ft
Watershed Slope =	0.033	ft/ft
Watershed Imperviousness =	85.00%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	100.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	Louisville - City Hall	

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

		Optional User Overrides	
Water Quality Capture Volume (WQCV) =	3.426	acre-feet	acre-feet
Excess Urban Runoff Volume (EURV) =	9.527	acre-feet	acre-feet
2-yr Runoff Volume (P1 = 0.8 in.) =	6.123	acre-feet	inches
5-yr Runoff Volume (P1 = 1.09 in.) =	8.791	acre-feet	inches
10-yr Runoff Volume (P1 = 1.35 in.) =	11.341	acre-feet	inches
25-yr Runoff Volume (P1 = 1.78 in.) =	15.778	acre-feet	inches
50-yr Runoff Volume (P1 = 2.14 in.) =	19.443	acre-feet	inches
100-yr Runoff Volume (P1 = 2.54 in.) =	23.614	acre-feet	inches
500-yr Runoff Volume (P1 = 3.63 in.) =	34.775	acre-feet	inches
Approximate 2-yr Detention Volume =	5.839	acre-feet	
Approximate 5-yr Detention Volume =	8.471	acre-feet	
Approximate 10-yr Detention Volume =	10.391	acre-feet	
Approximate 25-yr Detention Volume =	12.689	acre-feet	
Approximate 50-yr Detention Volume =	13.863	acre-feet	
Approximate 100-yr Detention Volume =	15.378	acre-feet	

Define Zones and Basin Geometry

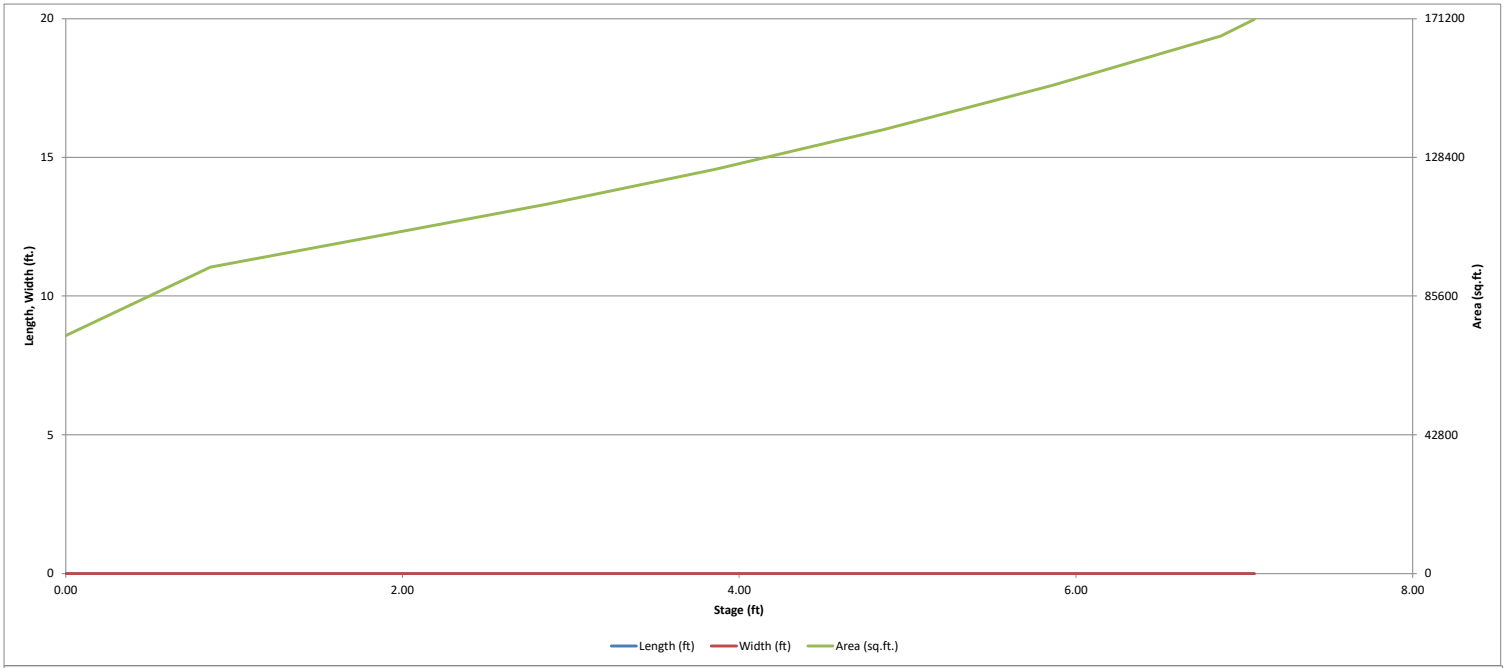
Zone 1 Volume (WQCV) =	3.426	acre-feet
Zone 2 Volume (EURV - Zone 1) =	6.101	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	5.851	acre-feet
Total Detention Basin Volume =	15.378	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

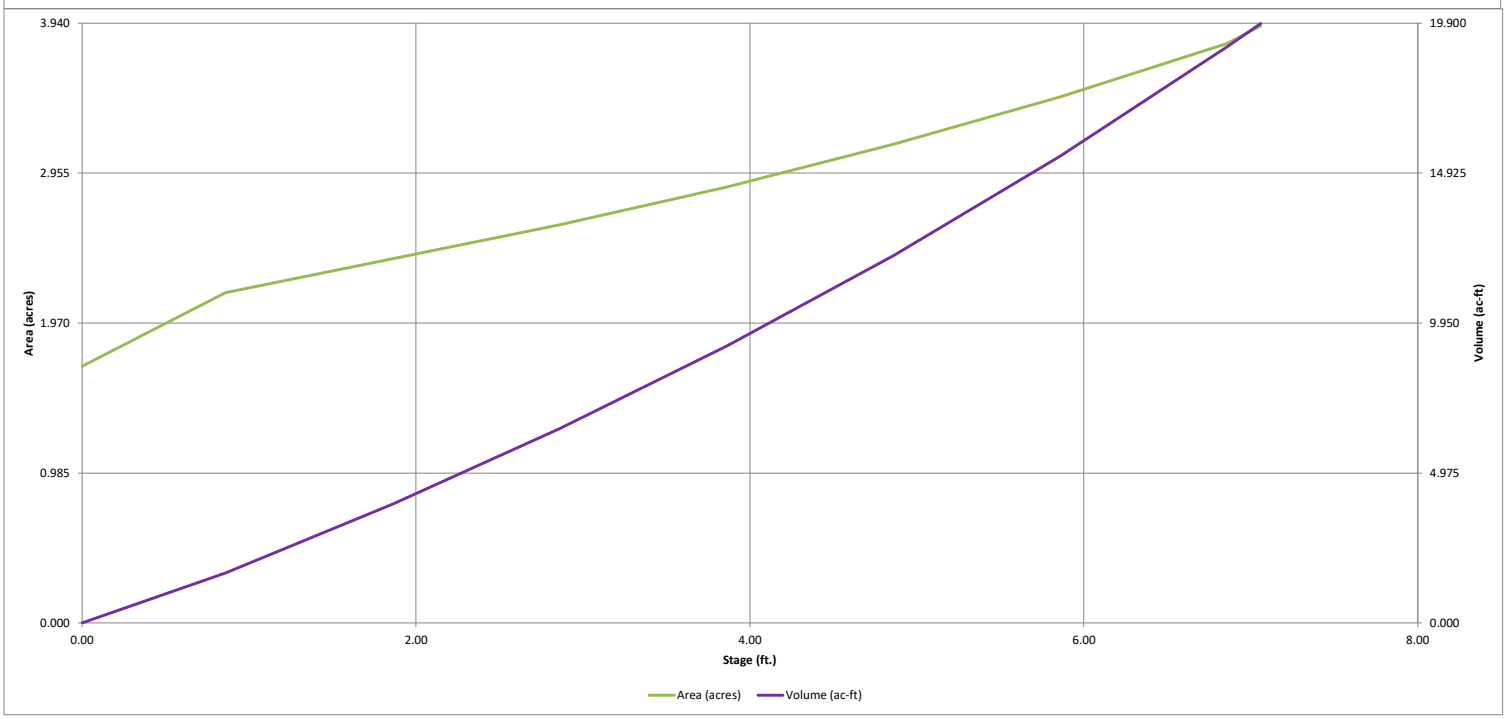
Depth Increment = 1.00 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	73,447	1.686		
5385	--	0.86	--	--	--	94,497	2.169	72,216	1.658
5386	--	1.86	--	--	--	104,199	2.392	171,564	3.939
5387	--	2.86	--	--	--	113,946	2.616	280,637	6.443
5388	--	3.86	--	--	--	124,733	2.863	399,976	9.182
5389	--	4.86	--	--	--	137,013	3.145	530,849	12.187
5390	--	5.86	--	--	--	150,574	3.457	674,642	15.488
5391	--	6.86	--	--	--	165,819	3.807	832,839	19.119
5391.2	--	7.06	--	--	--	170,953	3.925	866,516	19.892

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.05 (January 2022)



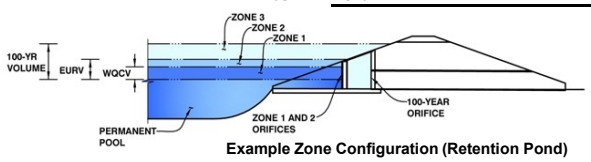


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.05 (January 2022)

Project: Redtail Ridge - On-Site Improvements

Basin ID: Pond B



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.65	3.426	Orifice Plate
Zone 2 (EURV)	3.98	6.101	Orifice Plate
Zone 3 (100-year)	5.83	5.851	Weir&Pipe (Restrict)
Total (all zones)		15.378	

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =		ft (distance below the filtration media surface)	Underdrain Orifice Area =		ft^2
Underdrain Orifice Diameter =		inches	Underdrain Orifice Centroid =		feet

Calculated Parameters for Underdrain

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	N/A	ft^2
Depth at top of Zone using Orifice Plate =	3.95	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	N/A	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	N/A	sq. inches	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.50	1.00	1.50				
Orifice Area (sq. inches)	29.00	30.40	30.40	30.40				

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected			Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	N/A	N/A	ft^2
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	N/A	N/A	feet
Vertical Orifice Diameter =	N/A	N/A	inches				

Calculated Parameters for Vertical Orifice

User Input: Overflow Weir (Dropbox with Flat or Sloped Grate and Outlet Pipe OR Rectangular/Trapezoidal Weir and No Outlet Pipe)

	Zone 3 Weir	Not Selected			Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	4.25	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	4.25	N/A	feet
Overflow Weir Front Edge Length =	11.00	N/A	feet	Overflow Weir Slope Length =	11.00	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	14.47	N/A	
Horiz. Length of Weir Sides =	11.00	N/A	feet	Overflow Grate Open Area w/o Debris =	95.71	N/A	ft^2
Overflow Grate Type =	Close Mesh Grate	N/A		Overflow Grate Open Area w/ Debris =	47.86	N/A	ft^2
Debris Clogging % =	50%	N/A	%				

Calculated Parameters for Overflow Weir

User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)

	Zone 3 Restrictor	Not Selected			Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	2.36	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	6.62	N/A	ft^2
Outlet Pipe Diameter =	48.00	N/A	inches	Outlet Orifice Centroid =	1.20	N/A	feet
Restrictor Plate Height Above Pipe Invert =	25.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	1.61	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	7.14	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	1.07	feet
Spillway Crest Length =	150.00	feet	Stage at Top of Freeboard =	9.21	feet
Spillway End Slopes =	2.00	H:V	Basin Area at Top of Freeboard =	3.92	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	19.89	acre-ft

Calculated Parameters for Spillway

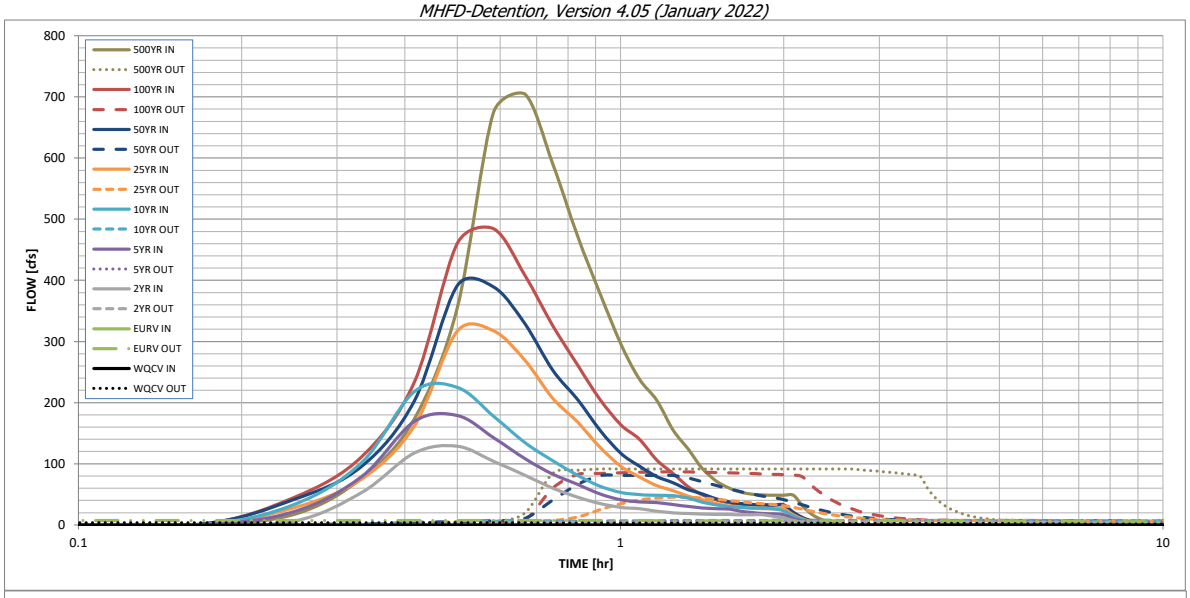
Routed Hydrograph Results

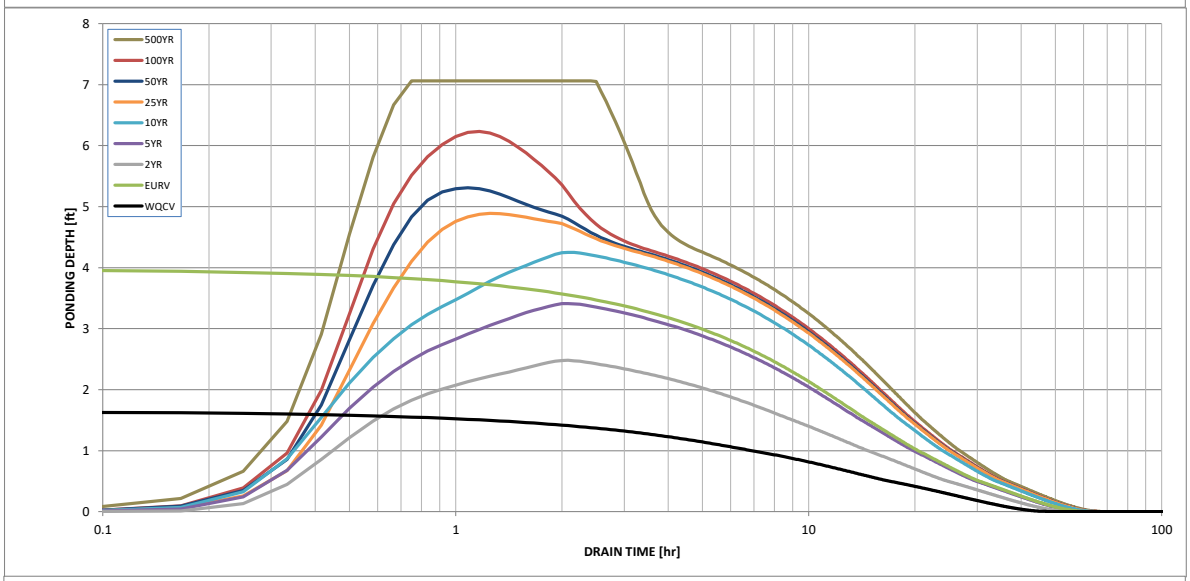
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

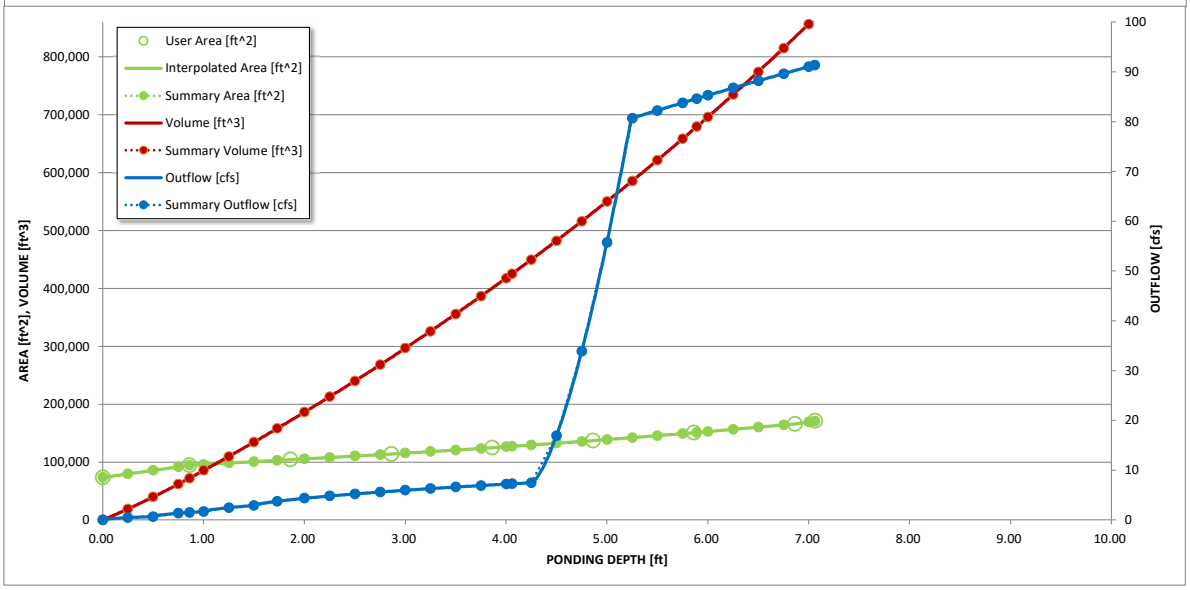
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	0.80	1.09	1.35	1.78	2.14	2.54	3.63
CUHP Runoff Volume (acre-ft) =	3.426	9.527	6.123	8.791	11.341	15.778	19.443	23.614	34.775
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	6.123	8.791	11.341	15.778	19.443	23.614	34.775
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	1.33	12.8	38.0	101.3	144.2	196.4	325.2
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.11	0.33	0.89	1.27	1.73	2.86
Peak Inflow Q (cfs) =	N/A	N/A	128.7	178.8	224.9	317.4	391.3	484.4	704.3
Peak Outflow Q (cfs) =	3.516	7.176	5.198	6.509	7.485	45.167	81.044	86.635	91.360
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.5	0.2	0.4	0.6	0.4	0.3
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1	N/A
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	0.4	0.8	0.8	0.8
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	45	42	45	46	44	42	39	35
Time to Drain 99% of Inflow Volume (hours) =	**42**	52	48	52	55	54	52	51	49
Maximum Ponding Depth (ft) =	1.65	3.98	2.48	3.41	4.25	4.89	5.31	6.23	7.06
Area at Maximum Ponding Depth (acres) =	2.35	2.90	2.53	2.75	2.97	3.15	3.28	3.59	3.92
Maximum Volume Stored (acre-ft) =	3.441	9.528	5.439	7.919	10.291	12.250	13.601	16.791	19.892

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.05 (January 2022)







S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename: _____

Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	1.04	0.61	17.25
	0:15:00	0.00	0.00	5.93	21.64	33.34	28.34	41.54	44.99	76.52
	0:20:00	0.00	0.00	53.14	79.48	102.21	75.30	96.01	111.99	173.54
	0:25:00	0.00	0.00	117.67	169.17	218.28	162.28	202.70	233.55	355.42
	0:30:00	0.00	0.00	128.68	178.85	224.87	316.81	391.26	460.21	674.68
	0:35:00	0.00	0.00	104.06	142.46	177.71	317.36	389.32	484.44	704.28
	0:40:00	0.00	0.00	80.96	108.05	134.52	268.71	328.42	407.49	590.57
	0:45:00	0.00	0.00	60.20	83.11	105.07	207.33	252.96	326.15	472.32
	0:50:00	0.00	0.00	45.60	66.09	81.22	168.13	204.99	261.27	378.47
	0:55:00	0.00	0.00	34.93	50.71	63.42	126.82	154.77	205.23	297.36
	1:00:00	0.00	0.00	28.74	41.34	53.16	96.33	117.67	164.17	238.23
	1:05:00	0.00	0.00	26.28	37.59	49.55	78.54	96.15	140.09	203.86
	1:10:00	0.00	0.00	22.40	36.28	48.39	64.31	79.05	106.01	155.15
	1:15:00	0.00	0.00	19.88	33.38	47.94	55.98	69.02	83.97	123.64
	1:20:00	0.00	0.00	18.50	29.99	43.73	46.84	57.62	62.31	91.90
	1:25:00	0.00	0.00	17.71	27.81	37.23	41.19	50.52	48.98	72.28
	1:30:00	0.00	0.00	17.20	26.59	32.82	34.97	42.86	40.93	60.42
	1:35:00	0.00	0.00	16.90	25.85	30.21	30.86	37.82	36.23	53.52
	1:40:00	0.00	0.00	16.79	22.47	28.65	28.51	34.93	33.95	50.14
	1:45:00	0.00	0.00	16.79	20.08	27.68	27.28	33.42	33.05	48.79
	1:50:00	0.00	0.00	16.79	18.71	27.20	26.63	32.62	32.75	48.34
	1:55:00	0.00	0.00	13.74	17.96	25.96	26.33	32.26	32.75	48.34
	2:00:00	0.00	0.00	11.47	16.66	23.07	26.23	32.14	32.75	48.34
	2:05:00	0.00	0.00	7.05	10.37	14.36	16.68	20.43	20.81	30.71
	2:10:00	0.00	0.00	3.99	5.88	8.18	9.58	11.72	11.94	17.60
	2:15:00	0.00	0.00	2.11	3.23	4.45	5.27	6.44	6.56	9.66
	2:20:00	0.00	0.00	1.02	1.71	2.29	2.82	3.46	3.52	5.18
	2:25:00	0.00	0.00	0.41	0.75	0.96	1.26	1.54	1.57	2.30
	2:30:00	0.00	0.00	0.11	0.18	0.23	0.32	0.39	0.39	0.57
	2:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.05 (January 2022)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.
The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]
MICROPOOL/PERM. WSEL	0.00	73,447	1.686	0	0.000	0.00
	0.25	79,566	1.827	19,127	0.439	0.48
	0.50	85,686	1.967	39,783	0.913	0.69
	0.75	91,805	2.108	61,969	1.423	1.35
	0.86	94,497	2.169	72,216	1.658	1.51
	1.00	95,856	2.201	85,541	1.964	1.69
	1.25	98,281	2.256	109,808	2.521	2.47
	1.50	100,706	2.312	134,681	3.092	2.92
WQCV	1.73	102,938	2.363	158,100	3.629	3.76
	2.00	105,564	2.423	186,248	4.276	4.35
	2.25	108,000	2.479	212,943	4.889	4.82
	2.50	110,437	2.535	240,248	5.515	5.23
	2.75	112,874	2.591	268,162	6.156	5.61
	3.00	115,456	2.651	296,695	6.811	5.97
	3.25	118,153	2.712	325,896	7.482	6.30
	3.50	120,850	2.774	355,771	8.167	6.62
	3.75	123,546	2.836	386,321	8.869	6.92
	4.00	126,452	2.903	417,559	9.586	7.21
EURV	4.06	127,189	2.920	425,168	9.761	7.28
	4.25	129,522	2.973	449,556	10.320	7.49
	4.50	132,592	3.044	482,320	11.073	16.89
	4.75	135,662	3.114	515,852	11.842	33.85
	5.00	138,912	3.189	550,164	12.630	55.74
	5.25	142,302	3.267	585,315	13.437	80.68
	5.50	145,692	3.345	621,315	14.263	82.24
	5.75	149,082	3.422	658,161	15.109	83.77
V100	5.89	151,031	3.467	679,167	15.592	84.61
	6.00	152,708	3.506	695,872	15.975	85.27
	6.25	156,520	3.593	734,526	16.862	86.74
	6.50	160,331	3.681	774,132	17.772	88.20
	6.75	164,142	3.768	814,691	18.703	89.62
	7.00	169,413	3.889	856,305	19.658	91.03
EMERGENCY SPILLWAY	7.06	170,953	3.925	866,516	19.892	91.36

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

Design Procedure Form: Extended Detention Basin (EDB)

UD-BMP (Version 3.07, March 2018)

Designer: EDL
Company: HKS
Date: January 31, 2024
Project: Redtail Ridge - Pond B Forebay 1 (West)
Location: Louisville, CO

1. Basin Storage Volume

A) Effective Imperviousness of Tributary Area, I_a — I_a = 85.0 %

B) Tributary Area's Imperviousness Ratio ($i = I_a / 100$) — i = 0.850

C) Contributing Watershed Area — Area = 61.650 ac

D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm — d_6 = ____ in

E) Design Concept (Select EURV when also designing for flood control)

Choose One
- (●) Water Quality Capture Volume (WQCV)
- ( ) Excess Urban Runoff Volume (EURV)

F) Design Volume (WQCV) Based on 40-hour Drain Time
($V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * Area$)
V_{DESIGN} = 1.860 ac-ft

G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume
($V_{WQCV\ OTHER} = (d_6 * (V_{DESIGN}/0.43))$)
$V_{DESIGN\ OTHER}$ = ____ ac-ft

H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired)
$V_{DESIGN\ USER}$ = ____ ac-ft

I) NRCS Hydrologic Soil Groups of Tributary Watershed
i) Percentage of Watershed consisting of Type A Soils — HSG_A = ____ %
ii) Percentage of Watershed consisting of Type B Soils — HSG_B = ____ %
iii) Percentage of Watershed consisting of Type C/D Soils — $HSG_{C/D}$ = ____ %

J) Excess Urban Runoff Volume (EURV) Design Volume
For HSG A: $EURV_A = 1.68 * i^{1.28}$
For HSG B: $EURV_B = 1.36 * i^{1.08}$
For HSG C/D: $EURV_{C/D} = 1.20 * i^{1.08}$
$EURV_{DESIGN}$ = ____ ac-ft

K) User Input of Excess Urban Runoff Volume (EURV) Design Volume (Only if a different EURV Design Volume is desired)
$EURV_{DESIGN\ USER}$ = ____ ac-ft

2. Basin Shape: Length to Width Ratio (A basin length to width ratio of at least 2:1 will improve TSS reduction.)
L : W = ____ : 1

3. Basin Side Slopes

A) Basin Maximum Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred)
Z = ____ ft / ft

4. Inlet

A) Describe means of providing energy dissipation at concentrated inflow locations:

5. Forebay

A) Minimum Forebay Volume (V_{FMIN} = 3% of the WQCV)
V_{FMIN} = 0.056 ac-ft

B) Actual Forebay Volume
V_F = 0.057 ac-ft

C) Forebay Depth (D_F = 30 inch maximum)
D_F = 24.0 in

D) Forebay Discharge

i) Undetained 100-year Peak Discharge
Q_{100} = 233.64 cfs

ii) Forebay Discharge Design Flow ($Q_F = 0.02 * Q_{100}$)
Q_F = 4.67 cfs

E) Forebay Discharge Design

Choose One
- ( ) Berm With Pipe
- (●) Wall with Rect. Notch
- ( ) Wall with V-Notch Weir

F) Discharge Pipe Size (minimum 8-inches)
Calculated D_P = ____ in

G) Rectangular Notch Width
Calculated W_N = 10.8 in

Design Procedure Form: Extended Detention Basin (EDB)

Designer: EDL
Company: HKS
Date: January 31, 2024
Project: Redtail Ridge - Pond B Forebay 1 (West)
Location: Louisville, CO

6. Trickle Channel

A) Type of Trickle Channel — Choose One: (●) Concrete ( ) Soft Bottom

F) Slope of Trickle Channel — S = 0.0050 ft / ft

7. Micropool and Outlet Structure

A) Depth of Micropool (2.5-feet minimum) — D_M = 2.5 ft

B) Surface Area of Micropool (10 ft^2 minimum) — A_M = 185 sq ft

C) Outlet Type — Choose One: (●) Orifice Plate ( ) Other (Describe):

D) Smallest Dimension of Orifice Opening Based on Hydrograph Routing (Use UD-Detention) — $D_{orifice}$ = inches

E) Total Outlet Area — A_{ot} = 16.00 square inches

8. Initial Surcharge Volume

A) Depth of Initial Surcharge Volume (Minimum recommended depth is 4 inches) — D_{IS} = 4 in

B) Minimum Initial Surcharge Volume (Minimum volume of 0.3% of the WQCV) — V_{IS} = 243 cu ft

C) Initial Surcharge Provided Above Micropool — V_s = 61.7 cu ft

9. Trash Rack

A) Water Quality Screen Open Area: $A_t = A_{ot} * 38.5*(e^{-0.095D})$ — A_t = square inches

B) Type of Screen (If specifying an alternative to the materials recommended in the USDCM, indicate "other" and enter the ratio of the total open are to the total screen are for the material specified.)

Other (Y/N): N

C) Ratio of Total Open Area to Total Area (only for type 'Other') — User Ratio =

D) Total Water Quality Screen Area (based on screen type) — A_{total} = sq. in.

E) Depth of Design Volume (EURV or WQCV) (Based on design concept chosen under 1E) — H= feet

F) Height of Water Quality Screen (H_{TR}) — H_{TR}= inches

G) Width of Water Quality Screen Opening ($W_{opening}$) (Minimum of 12 inches is recommended) — $W_{opening}$ = inches

Design Procedure Form: Extended Detention Basin (EDB)

Designer: EDL
Company: HKS
Date: January 31, 2024
Project: Redtail Ridge - Pond B Forebay 1 (West)
Location: Louisville, CO

10. Overflow Embankment

A) Describe embankment protection for 100-year and greater overtopping:

B) Slope of Overflow Embankment
(Horizontal distance per unit vertical, 4:1 or flatter preferred)

Ze = ft / ft

11. Vegetation

Choose One
- ○ Irrigated
- ○ Not Irrigated

12. Access

A) Describe Sediment Removal Procedures

Notes:

Design Procedure Form: Extended Detention Basin (EDB)

UD-BMP (Version 3.07, March 2018)

Designer: EDL
Company: HKS
Date: January 31, 2024
Project: Redtail Ridge - Pond B Forebay 2 (South)
Location: Louisville, CO

1. Basin Storage Volume

A) Effective Imperviousness of Tributary Area, I_a — I_a = 85.0 %

B) Tributary Area's Imperviousness Ratio ($i = I_a / 100$) — i = 0.850

C) Contributing Watershed Area — Area = 33.940 ac

D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm — d_6 = ____ in

E) Design Concept (Select EURV when also designing for flood control)

Choose One
- (●) Water Quality Capture Volume (WQCV)
- ( ) Excess Urban Runoff Volume (EURV)

F) Design Volume (WQCV) Based on 40-hour Drain Time
($V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * Area$)
V_{DESIGN} = 1.024 ac-ft

G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume
($V_{WQCV\ OTHER} = (d_6 * (V_{DESIGN}/0.43))$)
$V_{DESIGN\ OTHER}$ = ____ ac-ft

H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired)
$V_{DESIGN\ USER}$ = ____ ac-ft

I) NRCS Hydrologic Soil Groups of Tributary Watershed
- i) Percentage of Watershed consisting of Type A Soils — HSG_A = ____ %
- ii) Percentage of Watershed consisting of Type B Soils — HSG_B = ____ %
- iii) Percentage of Watershed consisting of Type C/D Soils — $HSG_{C/D}$ = ____ %

J) Excess Urban Runoff Volume (EURV) Design Volume
For HSG A: $EURV_A = 1.68 * i^{1.28}$
For HSG B: $EURV_B = 1.36 * i^{1.08}$
For HSG C/D: $EURV_{C/D} = 1.20 * i^{1.08}$
$EURV_{DESIGN}$ = ____ ac-f t

K) User Input of Excess Urban Runoff Volume (EURV) Design Volume (Only if a different EURV Design Volume is desired)
$EURV_{DESIGN\ USER}$ = ____ ac-f t

2. Basin Shape: Length to Width Ratio

(A basin length to width ratio of at least 2:1 will improve TSS reduction.)

L : W = ____ : 1

3. Basin Side Slopes

A) Basin Maximum Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred)

Z = ____ ft / ft

4. Inlet

A) Describe means of providing energy dissipation at concentrated inflow locations:

5. Forebay

A) Minimum Forebay Volume (V_{FMIN} = 3% of the WQCV)
V_{FMIN} = 0.031 ac-ft

B) Actual Forebay Volume
V_F = 0.032 ac-ft

C) Forebay Depth (D_F = 30 inch maximum)
D_F = 24.0 in

D) Forebay Discharge

i) Undetained 100-year Peak Discharge
Q_{100} = 128.63 cfs

ii) Forebay Discharge Design Flow ($Q_F = 0.02 * Q_{100}$)
Q_F = 2.57 cfs

E) Forebay Discharge Design

Choose One
- ( ) Berm With Pipe
- (●) Wall with Rect. Notch
- ( ) Wall with V-Notch Weir

F) Discharge Pipe Size (minimum 8-inches)
Calculated D_P = ____ in

G) Rectangular Notch Width
Calculated W_N = 8.1 in

Design Procedure Form: Extended Detention Basin (EDB)

Designer: EDL
Company: HKS
Date: January 31, 2024
Project: Redtail Ridge - Pond B Forebay 2 (South)
Location: Louisville, CO

6. Trickle Channel

A) Type of Trickle Channel — Choose One: (●) Concrete ( ) Soft Bottom

F) Slope of Trickle Channel — S = 0.0050 ft / ft

7. Micropool and Outlet Structure

A) Depth of Micropool (2.5-feet minimum) — D_M = 2.5 ft

B) Surface Area of Micropool (10 ft^2 minimum) — A_M = 185 sq ft

C) Outlet Type — Choose One: (●) Orifice Plate ( ) Other (Describe):

D) Smallest Dimension of Orifice Opening Based on Hydrograph Routing (Use UD-Detention) — $D_{orifice}$ = inches

E) Total Outlet Area — A_{ot} = 16.00 square inches

8. Initial Surcharge Volume

A) Depth of Initial Surcharge Volume (Minimum recommended depth is 4 inches) — D_{IS} = 4 in

B) Minimum Initial Surcharge Volume (Minimum volume of 0.3% of the WQCV) — V_{IS} = 134 cu ft

C) Initial Surcharge Provided Above Micropool — V_s = 61.7 cu ft

9. Trash Rack

A) Water Quality Screen Open Area: $A_t = A_{ot} * 38.5*(e^{-0.095D})$ — A_t = square inches

B) Type of Screen (If specifying an alternative to the materials recommended in the USDCM, indicate "other" and enter the ratio of the total open are to the total screen are for the material specified.)

Other (Y/N): N

C) Ratio of Total Open Area to Total Area (only for type 'Other') — User Ratio =

D) Total Water Quality Screen Area (based on screen type) — A_{total} = sq. in.

E) Depth of Design Volume (EURV or WQCV) (Based on design concept chosen under 1E) — H= feet

F) Height of Water Quality Screen (H_{TR}) — H_{TR}= inches

G) Width of Water Quality Screen Opening ($W_{opening}$) (Minimum of 12 inches is recommended) — $W_{opening}$ = inches

Design Procedure Form: Extended Detention Basin (EDB)

Designer: EDL
Company: HKS
Date: January 31, 2024
Project: Redtail Ridge - Pond B Forebay 2 (South)
Location: Louisville, CO

10. Overflow Embankment

A) Describe embankment protection for 100-year and greater overtopping:

B) Slope of Overflow Embankment
(Horizontal distance per unit vertical, 4:1 or flatter preferred)

Ze = ft / ft

11. Vegetation

Choose One
- ○ Irrigated
- ○ Not Irrigated

12. Access

A) Describe Sediment Removal Procedures

Notes:

Design Procedure Form: Extended Detention Basin (EDB)

UD-BMP (Version 3.07, March 2018)

Designer: EDL
Company: HKS
Date: January 31, 2024
Project: Redtail Ridge - Pond B Forebay 3 (East)
Location: Louisville, CO

1. Basin Storage Volume

A) Effective Imperviousness of Tributary Area, I_a — I_a = 85.0 %

B) Tributary Area's Imperviousness Ratio ($i = I_a / 100$) — i = 0.850

C) Contributing Watershed Area — Area = 9.600 ac

D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm — d_6 = ____ in

E) Design Concept (Select EURV when also designing for flood control)

Choose One
- (•) Water Quality Capture Volume (WQCV)
- ( ) Excess Urban Runoff Volume (EURV)

F) Design Volume (WQCV) Based on 40-hour Drain Time
($V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * Area$)
V_{DESIGN} = 0.290 ac-ft

G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume
($V_{WQCV\ OTHER} = (d_6 * (V_{DESIGN}/0.43))$)
$V_{DESIGN\ OTHER}$ = ____ ac-ft

H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired)
$V_{DESIGN\ USER}$ = ____ ac-ft

I) NRCS Hydrologic Soil Groups of Tributary Watershed
i) Percentage of Watershed consisting of Type A Soils — HSG_A = ____ %
ii) Percentage of Watershed consisting of Type B Soils — HSG_B = ____ %
iii) Percentage of Watershed consisting of Type C/D Soils — $HSG_{C/D}$ = ____ %

J) Excess Urban Runoff Volume (EURV) Design Volume
For HSG A: $EURV_A = 1.68 * i^{1.28}$
For HSG B: $EURV_B = 1.36 * i^{1.08}$
For HSG C/D: $EURV_{C/D} = 1.20 * i^{1.08}$
$EURV_{DESIGN}$ = ____ ac-ft

K) User Input of Excess Urban Runoff Volume (EURV) Design Volume (Only if a different EURV Design Volume is desired)
$EURV_{DESIGN\ USER}$ = ____ ac-ft

2. Basin Shape: Length to Width Ratio (A basin length to width ratio of at least 2:1 will improve TSS reduction.)
L : W = ____ : 1

3. Basin Side Slopes

A) Basin Maximum Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred)
Z = ____ ft / ft

4. Inlet

A) Describe means of providing energy dissipation at concentrated inflow locations:

5. Forebay

A) Minimum Forebay Volume (V_{FMIN} = 3% of the WQCV)
V_{FMIN} = 0.009 ac-ft

B) Actual Forebay Volume
V_F = 0.010 ac-ft

C) Forebay Depth (D_F = 18 inch maximum)
D_F = 18.0 in

D) Forebay Discharge

i) Undetained 100-year Peak Discharge
Q_{100} = 36.38 cfs

ii) Forebay Discharge Design Flow ($Q_F = 0.02 * Q_{100}$)
Q_F = 0.73 cfs

E) Forebay Discharge Design

Choose One
- ( ) Berm With Pipe
- (•) Wall with Rect. Notch
- ( ) Wall with V-Notch Weir

Flow too small for berm w/ pipe

F) Discharge Pipe Size (minimum 8-inches)
Calculated D_P = ____ in

G) Rectangular Notch Width
Calculated W_N = 5.0 in

Design Procedure Form: Extended Detention Basin (EDB)

Designer: EDL
Company: HKS
Date: January 31, 2024
Project: Redtail Ridge - Pond B Forebay 3 (East)
Location: Louisville, CO

6. Trickle Channel	
A) Type of Trickle Channel	Choose One: (●) Concrete ( ) Soft Bottom
F) Slope of Trickle Channel	S = 0.0050 ft / ft
7. Micropool and Outlet Structure	
A) Depth of Micropool (2.5-feet minimum)	D_M = 2.5 ft
B) Surface Area of Micropool (10 ft^2 minimum)	A_M = 185 sq ft
C) Outlet Type	Choose One: (●) Orifice Plate ( ) Other (Describe):
D) Smallest Dimension of Orifice Opening Based on Hydrograph Routing (Use UD-Detention)	$D_{orifice}$ = inches
E) Total Outlet Area	A_{ot} = 16.00 square inches
8. Initial Surcharge Volume	
A) Depth of Initial Surcharge Volume (Minimum recommended depth is 4 inches)	D_{IS} = 4 in
B) Minimum Initial Surcharge Volume (Minimum volume of 0.3% of the WQCV)	V_{IS} = 38 cu ft
C) Initial Surcharge Provided Above Micropool	V_s = 61.7 cu ft
9. Trash Rack	
A) Water Quality Screen Open Area: $A_t = A_{ot} * 38.5*(e^{-0.095D})$	A_t = square inches
B) Type of Screen (If specifying an alternative to the materials recommended in the USDCM, indicate "other" and enter the ratio of the total open are to the total screen are for the material specified.)	
Other (Y/N): N	
C) Ratio of Total Open Area to Total Area (only for type 'Other')	User Ratio =
D) Total Water Quality Screen Area (based on screen type)	A_{total} = sq. in.
E) Depth of Design Volume (EURV or WQCV) (Based on design concept chosen under 1E)	H= feet
F) Height of Water Quality Screen (H_{TR})	H_{TR}= inches
G) Width of Water Quality Screen Opening ($W_{opening}$) (Minimum of 12 inches is recommended)	$W_{opening}$ = inches

Design Procedure Form: Extended Detention Basin (EDB)

Designer: EDL
Company: HKS
Date: January 31, 2024
Project: Redtail Ridge - Pond B Forebay 3 (East)
Location: Louisville, CO

10. Overflow Embankment A) Describe embankment protection for 100-year and greater overtopping:	
B) Slope of Overflow Embankment (Horizontal distance per unit vertical, 4:1 or flatter preferred)	Ze = ft / ft
11. Vegetation	Choose One ○ Irrigated ○ Not Irrigated
12. Access A) Describe Sediment Removal Procedures	

Notes:

Riprap Sizing for Mild Slopes

Project:	Redtail Ridge - 190109
Channel ID:	Pond B
Date:	1/29/2024

Source: https://udfcd.org/wp-content/uploads/uploads/vol1%20criteria%20manual/08_Open%20Channels.pdf

8.1.1 Mild Slope Conditions

When subcritical flow conditions occur and/or slopes are mild (less than 2 percent), UDFCD recommends the following equation (Hughes, et al, 1983):

$$d_{50} \geq \left[\frac{VS^{0.17}}{4.5(G_s - 1)^{0.66}} \right]^2 \qquad \text{Equation 8-11}$$

V= mean channel velocity (ft/sec)
S= longitudinal channel slope (%)
d_{50}= mean rock size (ft)
G_s= specific gravity
S.F= Safety Factor (dimensionless)

S=	2 %		
V=	1.74 ft/s	*hydraflow express	
G_s=	2.5		
S.F =	1.5		
	d_{50}= 0.11 ft	1.99 inches	Use Type VL RipRap

RIPRAP DESIGNATION	% SMALLER THAN GIVEN SIZE BY WEIGHT	INTERMEDIATE ROCK DIMENSION (INCHES)	D_{50}* (INCHES)
TYPE VL	70 – 100 50 – 70 35 – 50 2 – 10	12 9 6 2	6
TYPE L	70 – 100 50 – 70 35 – 50 2 – 10	15 12 9 3	9
TYPE M	70 – 100 50 – 70 35 – 50 2 – 10	21 18 12 4	12
TYPE H	70 – 100 50 – 70 35 – 50 2 – 10	30 24 18 6	18
*D_{50} = MEAN ROCK SIZE			

Figure 8-34. Riprap and soil riprap placement and gradation (part 1 of 3)

Note: Void Filled Riprap shall be Type VL Riprap of D_{50}=6 inches or larger

Weir Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Monday, Feb 19 2024

Pond B Emergency Spillway - 100 YR

Trapezoidal Weir

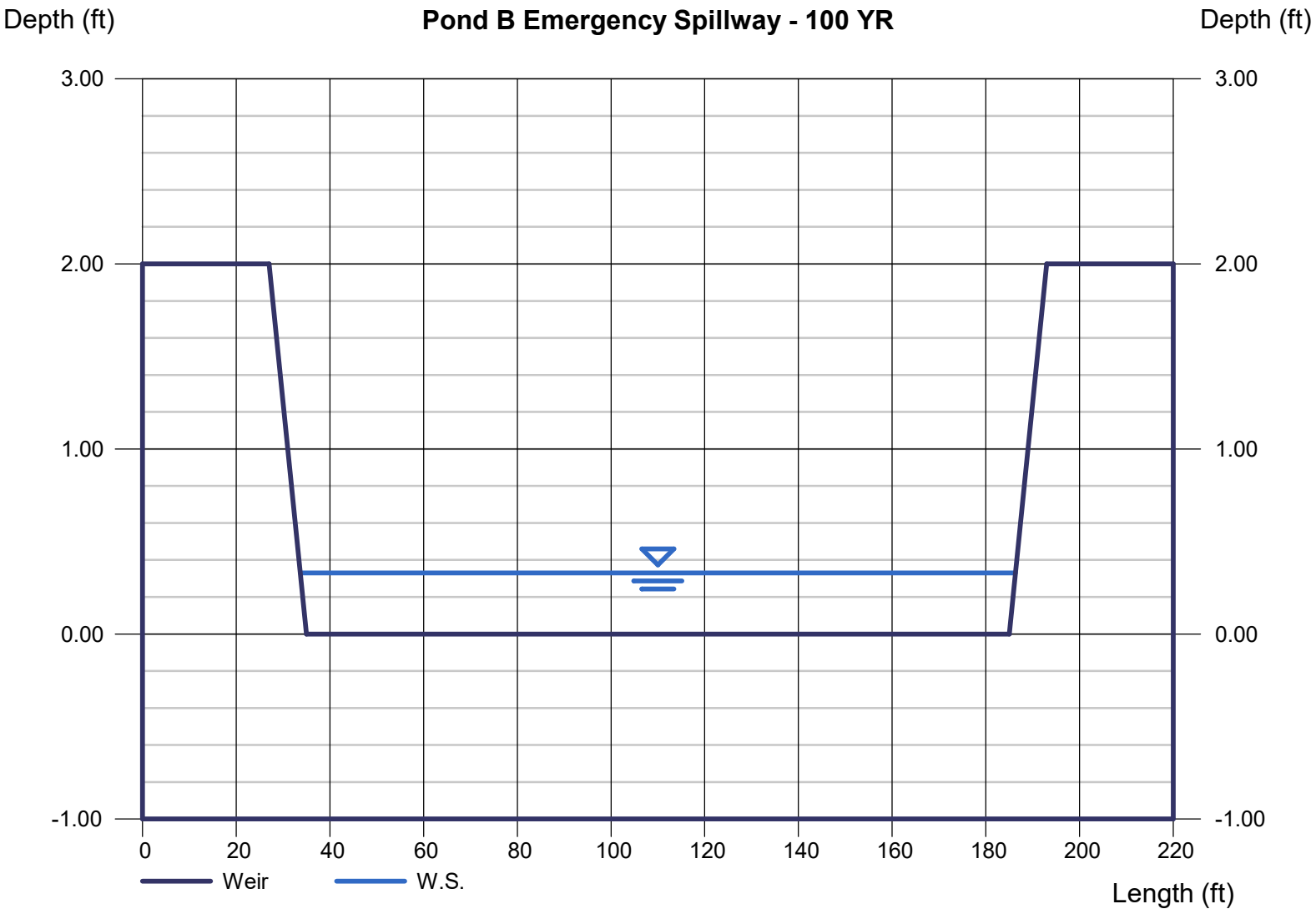
Crest	= Sharp
Bottom Length (ft)	= 150.00
Total Depth (ft)	= 2.00
Side Slope (z:1)	= 4.00

Calculations

Weir Coeff. Cw	= 3.10
Compute by:	Known Q
Known Q (cfs)	= 86.64

Highlighted

Depth (ft)	= 0.33
Q (cfs)	= 86.64
Area (sqft)	= 49.94
Velocity (ft/s)	= 1.74
Top Width (ft)	= 152.64

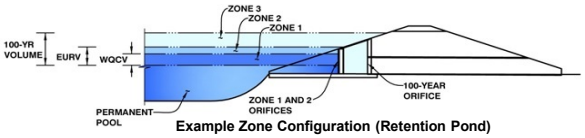


DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.05 (January 2022)

Project: Redtail Ridge - On-Site Improvements

Basin ID: Pond C-1



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	EDB	
Watershed Area =	67.38	acres
Watershed Length =	4,800	ft
Watershed Length to Centroid =	2,400	ft
Watershed Slope =	0.020	ft/ft
Watershed Imperviousness =	79.84%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	100.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	Louisville - City Hall	

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

		Optional User Overrides	
Water Quality Capture Volume (WQCV) =	1.838	acre-feet	acre-feet
Excess Urban Runoff Volume (EURV) =	5.284	acre-feet	acre-feet
2-yr Runoff Volume (P1 = 0.8 in.) =	3.411	acre-feet	inches
5-yr Runoff Volume (P1 = 1.09 in.) =	4.936	acre-feet	inches
10-yr Runoff Volume (P1 = 1.35 in.) =	6.427	acre-feet	inches
25-yr Runoff Volume (P1 = 1.78 in.) =	9.078	acre-feet	inches
50-yr Runoff Volume (P1 = 2.14 in.) =	11.255	acre-feet	inches
100-yr Runoff Volume (P1 = 2.54 in.) =	13.754	acre-feet	inches
500-yr Runoff Volume (P1 = 3.63 in.) =	20.400	acre-feet	inches
Approximate 2-yr Detention Volume =	3.227	acre-feet	
Approximate 5-yr Detention Volume =	4.734	acre-feet	
Approximate 10-yr Detention Volume =	5.790	acre-feet	
Approximate 25-yr Detention Volume =	7.079	acre-feet	
Approximate 50-yr Detention Volume =	7.746	acre-feet	
Approximate 100-yr Detention Volume =	8.679	acre-feet	

Define Zones and Basin Geometry

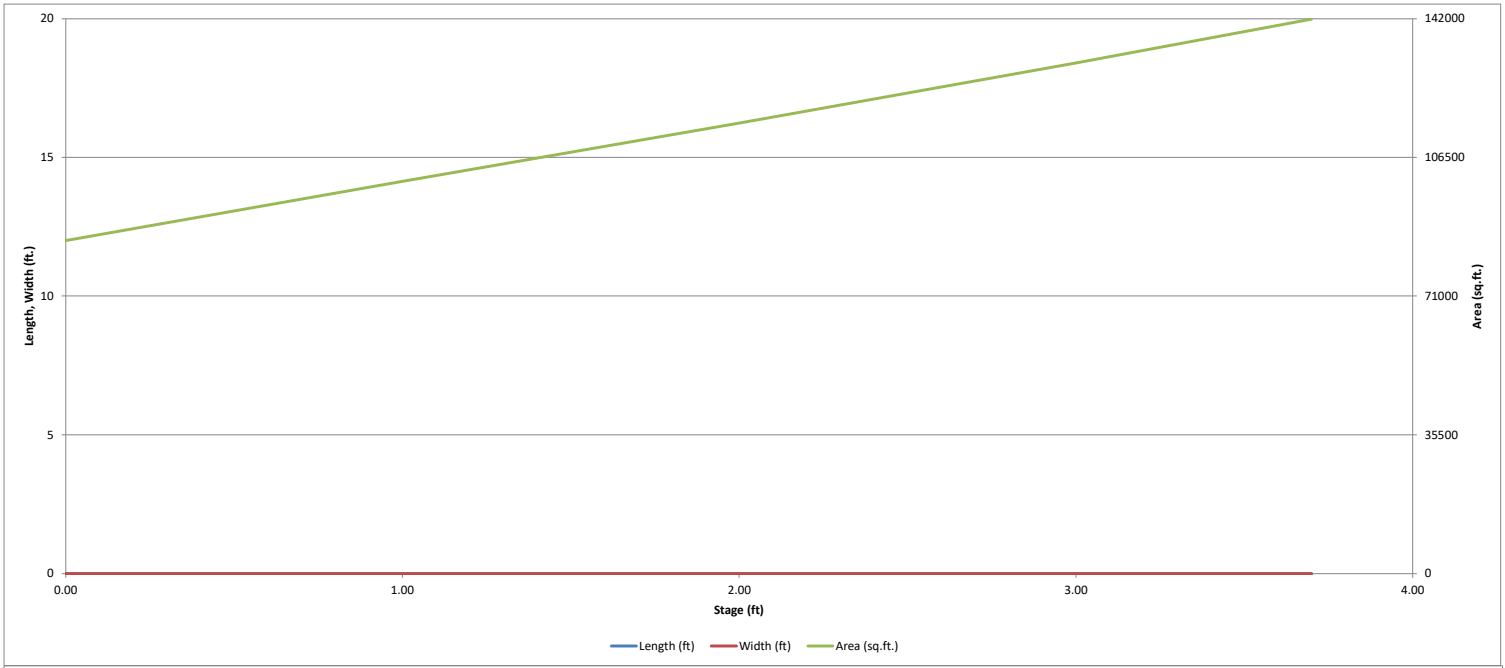
Zone 1 Volume (WQCV) =	1.838	acre-feet
Zone 2 Volume (EURV - Zone 1) =	3.446	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	3.396	acre-feet
Total Detention Basin Volume =	8.679	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

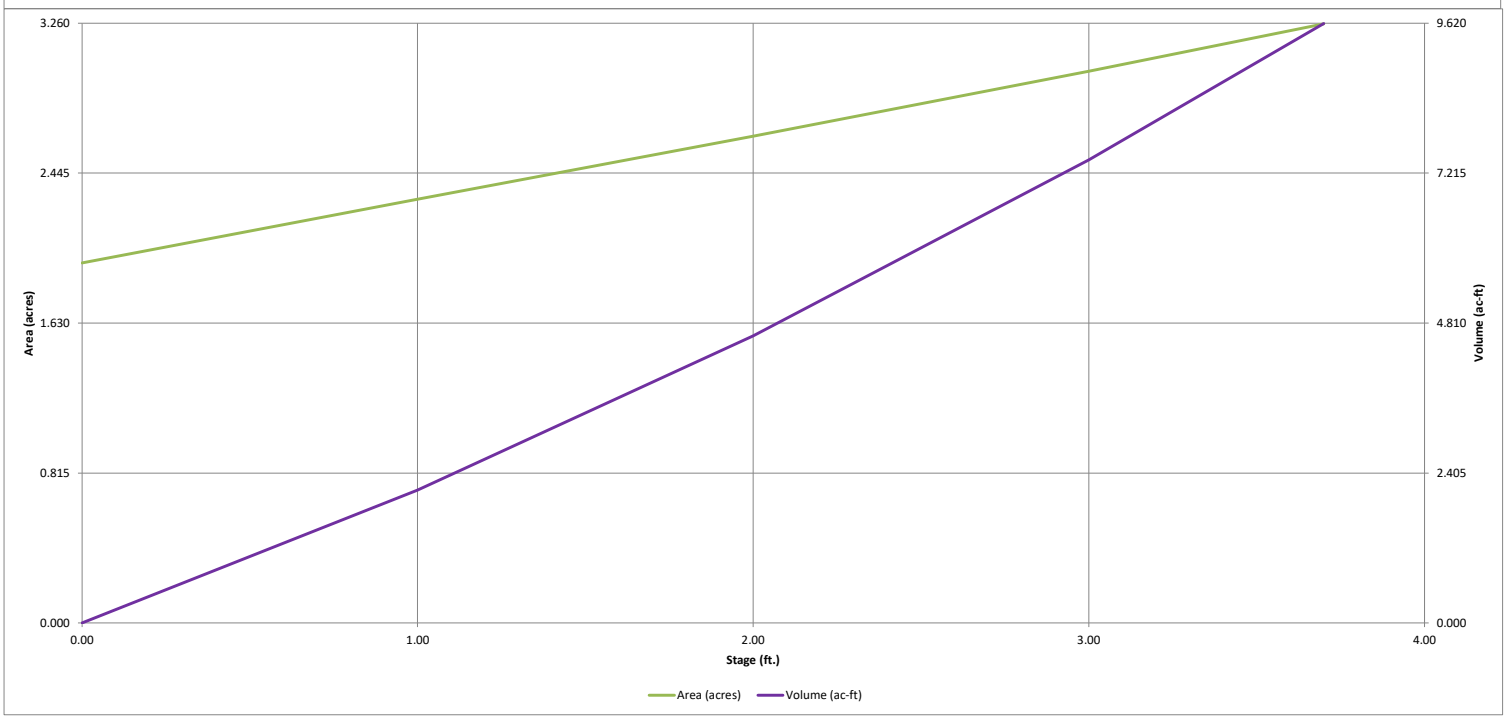
Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	85,260	1.957		
5369	--	1.00	--	--	--	100,344	2.304	92,802	2.130
5370	--	2.00	--	--	--	115,227	2.645	200,588	4.605
5371	--	3.00	--	--	--	130,663	3.000	323,533	7.427
5371.7 (SPILL)	--	3.70	--	--	--	141,868	3.257	418,919	9.617

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.05 (January 2022)



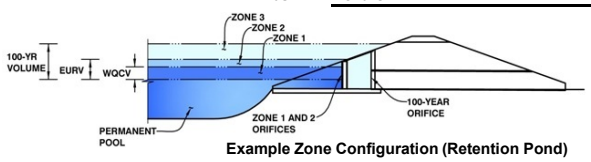


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.05 (January 2022)

Project: Redtail Ridge - On-Site Improvements

Basin ID: Pond C-1



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	0.88	1.838	Orifice Plate
Zone 2 (EURV)	2.26	3.446	Orifice Plate
Zone 3 (100-year)	3.41	3.396	Weir&Pipe (Restrict)
Total (all zones)		8.679	

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)	Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

Calculated Parameters for Underdrain

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	N/A	ft^2
Depth at top of Zone using Orifice Plate =	2.37	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	N/A	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	N/A	sq. inches	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.50	1.00	1.50				
Orifice Area (sq. inches)	25.98	25.98	25.98	10.00				

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected			Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	N/A	N/A	ft^2
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	N/A	N/A	feet
Vertical Orifice Diameter =	N/A	N/A	inches				

Calculated Parameters for Vertical Orifice

User Input: Overflow Weir (Dropbox with Flat or Sloped Grate and Outlet Pipe OR Rectangular/Trapezoidal Weir and No Outlet Pipe)

	Zone 3 Weir	Not Selected			Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	2.37	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	2.37	N/A	feet
Overflow Weir Front Edge Length =	8.00	N/A	feet	Overflow Weir Slope Length =	8.00	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	8.06	N/A	
Horiz. Length of Weir Sides =	8.00	N/A	feet	Overflow Grate Open Area w/o Debris =	50.62	N/A	ft^2
Overflow Grate Type =	Close Mesh Grate	N/A		Overflow Grate Open Area w/ Debris =	25.31	N/A	ft^2
Debris Clogging % =	50%	N/A	%				

Calculated Parameters for Overflow Weir

User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)

	Zone 3 Restrictor	Not Selected			Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.00	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	6.28	N/A	ft^2
Outlet Pipe Diameter =	48.00	N/A	inches	Outlet Orifice Centroid =	1.15	N/A	feet
Restrictor Plate Height Above Pipe Invert =	24.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	1.57	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	3.70	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.47	feet
Spillway Crest Length =	165.94	feet	Stage at Top of Freeboard =	5.17	feet
Spillway End Slopes =	0.05	H:V	Basin Area at Top of Freeboard =	3.26	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	9.62	acre-ft

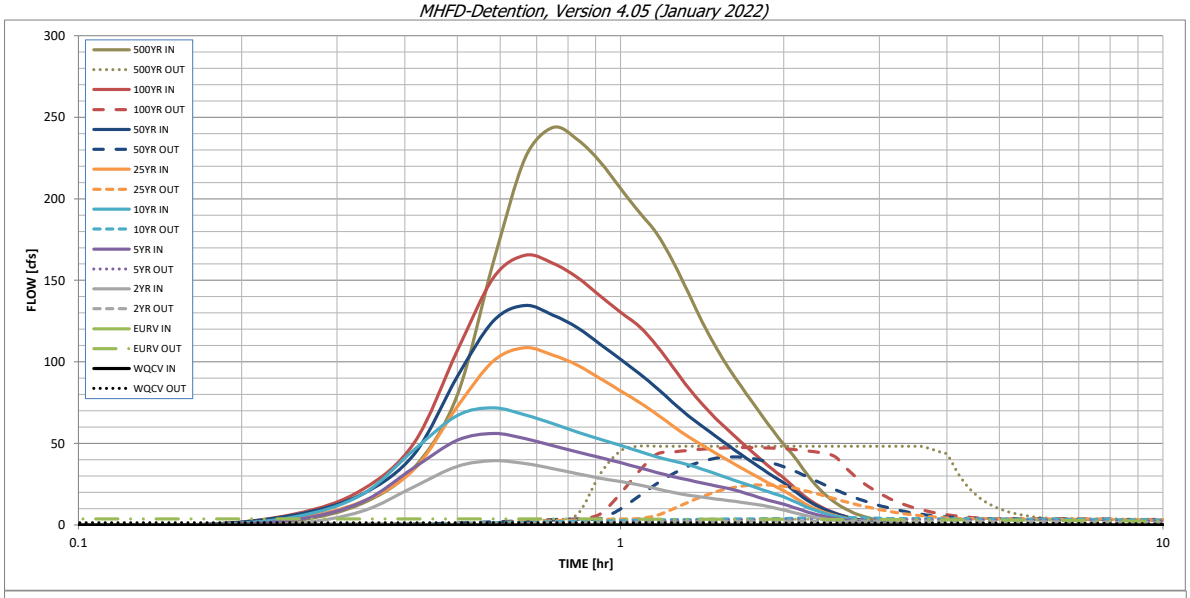
Calculated Parameters for Spillway

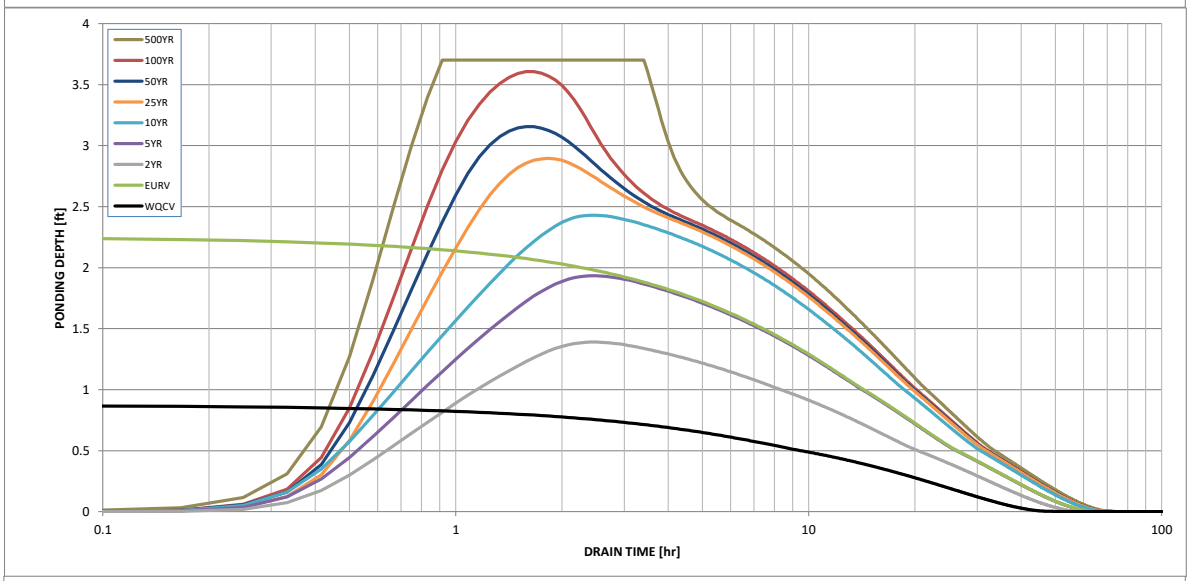
Routed Hydrograph Results *The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).*

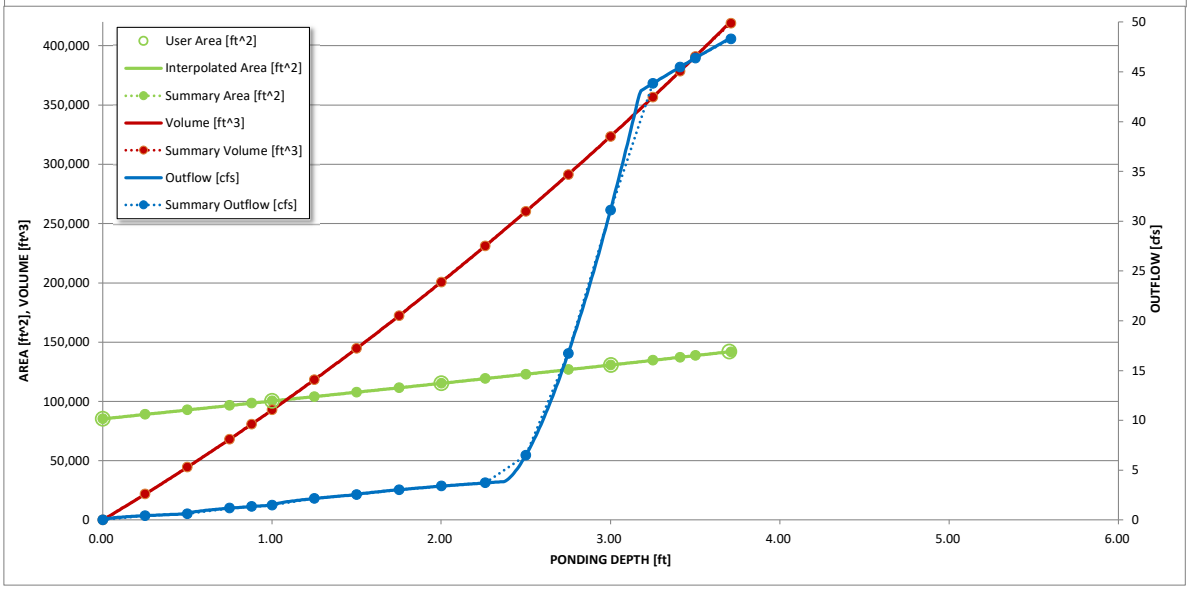
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	0.80	1.09	1.35	1.78	2.14	2.54	3.63
CUHP Runoff Volume (acre-ft) =	1.838	5.284	3.411	4.936	6.427	9.078	11.255	13.754	20.400
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	3.411	4.936	6.427	9.078	11.255	13.754	20.400
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.35	3.2	10.1	29.1	41.5	58.6	97.9
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.05	0.15	0.43	0.62	0.87	1.45
Peak Inflow Q (cfs) =	N/A	N/A	39.3	56.0	71.8	108.7	134.6	165.3	243.7
Peak Outflow Q (cfs) =	1.338	3.710	2.384	3.305	4.688	24.561	41.627	47.395	48.300
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	1.0	0.5	0.8	1.0	0.8	0.5
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	N/A
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.0	0.4	0.7	0.8	0.9
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	40	51	48	51	53	51	49	47	43
Time to Drain 99% of Inflow Volume (hours) =	**44**	57	53	57	61	60	59	57	56
Maximum Ponding Depth (ft) =	0.88	2.26	1.39	1.93	2.43	2.89	3.15	3.61	3.70
Area at Maximum Ponding Depth (acres) =	2.26	2.74	2.43	2.62	2.79	2.96	3.05	3.22	3.26
Maximum Volume Stored (acre-ft) =	1.857	5.305	3.030	4.421	5.747	7.099	7.881	9.293	9.617

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.05 (January 2022)







S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename: _____

Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.09	2.49
	0:15:00	0.00	0.00	0.85	3.12	4.80	4.09	6.12	6.57	13.11
	0:20:00	0.00	0.00	8.34	14.02	18.64	14.23	18.85	21.48	35.37
	0:25:00	0.00	0.00	23.56	35.30	46.23	34.20	43.57	50.50	79.57
	0:30:00	0.00	0.00	35.89	51.92	67.15	72.51	90.94	106.82	161.51
	0:35:00	0.00	0.00	39.30	56.02	71.83	100.57	125.18	151.61	224.99
	0:40:00	0.00	0.00	37.70	52.89	67.43	108.68	134.58	165.32	243.70
	0:45:00	0.00	0.00	34.51	48.56	62.14	104.22	128.79	160.58	236.24
	0:50:00	0.00	0.00	31.28	44.66	56.89	97.96	120.93	151.61	222.77
	0:55:00	0.00	0.00	28.70	41.30	52.56	89.85	110.88	140.45	206.32
	1:00:00	0.00	0.00	26.56	38.13	48.73	82.27	101.53	130.50	191.67
	1:05:00	0.00	0.00	24.47	35.00	45.04	75.21	92.84	121.72	178.75
	1:10:00	0.00	0.00	22.08	32.18	41.67	67.93	83.91	109.90	161.50
	1:15:00	0.00	0.00	19.88	29.66	39.12	60.63	74.97	96.68	142.34
	1:20:00	0.00	0.00	18.27	27.53	36.91	54.07	66.90	84.13	124.10
	1:25:00	0.00	0.00	17.04	25.63	34.19	48.81	60.36	73.86	109.00
	1:30:00	0.00	0.00	15.94	23.90	31.28	43.88	54.23	65.16	96.16
	1:35:00	0.00	0.00	14.92	22.30	28.58	39.31	48.55	57.77	85.22
	1:40:00	0.00	0.00	13.90	20.34	26.08	35.06	43.27	51.02	75.22
	1:45:00	0.00	0.00	12.88	18.16	23.71	31.16	38.42	44.75	65.94
	1:50:00	0.00	0.00	11.87	16.05	21.44	27.44	33.80	38.84	57.26
	1:55:00	0.00	0.00	10.48	14.19	19.25	24.02	29.59	33.48	49.39
	2:00:00	0.00	0.00	9.08	12.65	17.16	21.01	25.88	28.81	42.58
	2:05:00	0.00	0.00	7.62	10.83	14.65	17.34	21.37	23.45	34.77
	2:10:00	0.00	0.00	6.24	8.88	12.03	13.84	17.07	18.52	27.51
	2:15:00	0.00	0.00	5.05	7.17	9.76	10.94	13.50	14.48	21.54
	2:20:00	0.00	0.00	4.12	5.81	7.93	8.74	10.79	11.38	16.94
	2:25:00	0.00	0.00	3.33	4.69	6.41	6.95	8.58	8.89	13.25
	2:30:00	0.00	0.00	2.68	3.78	5.15	5.55	6.84	6.95	10.35
	2:35:00	0.00	0.00	2.13	3.01	4.07	4.36	5.38	5.36	7.99
	2:40:00	0.00	0.00	1.69	2.36	3.18	3.40	4.18	4.13	6.16
	2:45:00	0.00	0.00	1.35	1.83	2.47	2.64	3.25	3.22	4.79
	2:50:00	0.00	0.00	1.06	1.43	1.93	2.06	2.53	2.53	3.77
	2:55:00	0.00	0.00	0.83	1.11	1.51	1.62	1.99	2.01	3.00
	3:00:00	0.00	0.00	0.62	0.83	1.15	1.24	1.53	1.55	2.31
	3:05:00	0.00	0.00	0.44	0.60	0.84	0.92	1.13	1.15	1.72
	3:10:00	0.00	0.00	0.30	0.41	0.58	0.65	0.80	0.81	1.21
	3:15:00	0.00	0.00	0.18	0.27	0.37	0.43	0.52	0.53	0.79
	3:20:00	0.00	0.00	0.10	0.16	0.21	0.25	0.31	0.31	0.46
	3:25:00	0.00	0.00	0.04	0.07	0.09	0.12	0.15	0.15	0.22
	3:30:00	0.00	0.00	0.01	0.02	0.03	0.04	0.04	0.04	0.06
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.05 (January 2022)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]
MICROPOOL/PERM. WSEL	0.00	85,260	1.957	0	0.000	0.00
	0.25	89,031	2.044	21,786	0.500	0.43
	0.50	92,802	2.130	44,515	1.022	0.61
	0.75	96,573	2.217	68,187	1.565	1.19
WQCV	0.88	98,534	2.262	80,869	1.857	1.35
	1.00	100,344	2.304	92,802	2.130	1.48
	1.25	104,065	2.389	118,353	2.717	2.16
	1.50	107,786	2.474	144,834	3.325	2.55
	1.75	111,507	2.560	172,246	3.954	3.04
	2.00	115,227	2.645	200,588	4.605	3.40
EURV	2.26	119,241	2.737	231,069	5.305	3.73
	2.50	122,945	2.822	260,131	5.972	6.49
	2.75	126,804	2.911	291,349	6.688	16.72
	3.00	130,663	3.000	323,533	7.427	31.10
	3.25	134,665	3.091	356,699	8.189	43.83
V100	3.41	137,226	3.150	378,450	8.688	45.47
	3.50	138,667	3.183	390,865	8.973	46.37
EMERGENCY SPILLWAY	3.71	141,868	3.257	418,919	9.617	48.30

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

Design Procedure Form: Extended Detention Basin (EDB)

UD-BMP (Version 3.07, March 2018)

Designer: SDM
Company: HKS
Date: January 31, 2024
Project: Redtail Ridge - Pond C-1 West Forebay
Location: Louisville, CO

1. Basin Storage Volume

A) Effective Imperviousness of Tributary Area, I_a — I_a = 79.2 %

B) Tributary Area's Imperviousness Ratio ($i = I_a / 100$) — i = 0.792

C) Contributing Watershed Area — Area = 14.190 ac

D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm — d_6 = in

E) Design Concept (Select EURV when also designing for flood control)

Choose One
- ○ Water Quality Capture Volume (WQCV)
- ◉ Excess Urban Runoff Volume (EURV)

F) Design Volume (WQCV) Based on 40-hour Drain Time
($V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * Area$)
V_{DESIGN} = 0.383 ac-ft

G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume
($V_{WQCV\ OTHER} = (d_6 * (V_{DESIGN}/0.43))$)
$V_{DESIGN\ OTHER}$ = ac-ft

H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired)
$V_{DESIGN\ USER}$ = ac-ft

I) NRCS Hydrologic Soil Groups of Tributary Watershed
- i) Percentage of Watershed consisting of Type A Soils — HSG_A = 0 %
- ii) Percentage of Watershed consisting of Type B Soils — HSG_B = 0 %
- iii) Percentage of Watershed consisting of Type C/D Soils — $HSG_{C/D}$ = 100 %

J) Excess Urban Runoff Volume (EURV) Design Volume
For HSG A: $EURV_A = 1.68 * i^{1.28}$
For HSG B: $EURV_B = 1.36 * i^{1.08}$
For HSG C/D: $EURV_{C/D} = 1.20 * i^{1.08}$
$EURV_{DESIGN}$ = 1.104 ac-f t

K) User Input of Excess Urban Runoff Volume (EURV) Design Volume (Only if a different EURV Design Volume is desired)
$EURV_{DESIGN\ USER}$ = ac-f t

2. Basin Shape: Length to Width Ratio

(A basin length to width ratio of at least 2:1 will improve TSS reduction.)

L : W = : 1

3. Basin Side Slopes

A) Basin Maximum Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred)

Z = ft / ft

4. Inlet

A) Describe means of providing energy dissipation at concentrated inflow locations:

5. Forebay

A) Minimum Forebay Volume (V_{FMIN} = 3% of the WQCV)
V_{FMIN} = 0.011 ac-ft

B) Actual Forebay Volume
V_F = 0.011 ac-ft

C) Forebay Depth (D_F = 18 inch maximum)
D_F = 18.0 in

D) Forebay Discharge

i) Undetained 100-year Peak Discharge
Q_{100} = 126.48 cfs

ii) Forebay Discharge Design Flow ($Q_F = 0.02 * Q_{100}$)
Q_F = 2.53 cfs

E) Forebay Discharge Design

Choose One
- ○ Berm With Pipe
- ◉ Wall with Rect. Notch
- ○ Wall with V-Notch Weir

Flow too small for berm w/ pipe

F) Discharge Pipe Size (minimum 8-inches)
Calculated D_P = in

G) Rectangular Notch Width
Calculated W_N = 8.6 in

Design Procedure Form: Extended Detention Basin (EDB)

Designer:	SDM
Company:	HKS
Date:	January 31, 2024
Project:	Redtail Ridge - Pond C-1 West Forebay
Location:	Louisville, CO

6. Trickle Channel	
A) Type of Trickle Channel	Choose One: (•) Concrete ( ) Soft Bottom
F) Slope of Trickle Channel	S = 0.0040 ft / ft
7. Micropool and Outlet Structure	
A) Depth of Micropool (2.5-feet minimum)	D_M = 2.5 ft
B) Surface Area of Micropool (10 ft^2 minimum)	A_M = 160 sq ft
C) Outlet Type	Choose One: (•) Orifice Plate ( ) Other (Describe):
D) Smallest Dimension of Orifice Opening Based on Hydrograph Routing (Use UD-Detention)	$D_{orifice}$ = 1.12 inches
E) Total Outlet Area	A_{ot} = 20.91 square inches
8. Initial Surcharge Volume	
A) Depth of Initial Surcharge Volume (Minimum recommended depth is 4 inches)	D_{IS} = 4 in
B) Minimum Initial Surcharge Volume (Minimum volume of 0.3% of the WQCV)	V_{IS} = 50 cu ft
C) Initial Surcharge Provided Above Micropool	V_s = 53.3 cu ft
9. Trash Rack	
A) Water Quality Screen Open Area: $A_t = A_{ot} * 38.5*(e^{-0.095D})$	A_t = 724 square inches
B) Type of Screen (If specifying an alternative to the materials recommended in the USDCM, indicate "other" and enter the ratio of the total open are to the total screen are for the material specified.)	*S.S. Well Screen with 60% Open Area*
Other (Y/N): N	
C) Ratio of Total Open Area to Total Area (only for type 'Other')	User Ratio =
D) Total Water Quality Screen Area (based on screen type)	A_{total} = 1206 sq. in.
E) Depth of Design Volume (EURV or WQCV) (Based on design concept chosen under 1E)	H= 3.95 feet
F) Height of Water Quality Screen (H_{TR})	H_{TR}= 75.4 inches
G) Width of Water Quality Screen Opening ($W_{opening}$) (Minimum of 12 inches is recommended)	$W_{opening}$ = 16.0 inches

Design Procedure Form: Extended Detention Basin (EDB)

Designer: SDM
Company: HKS
Date: January 31, 2024
Project: Redtail Ridge - Pond C-1 West Forebay
Location: Louisville, CO

10. Overflow Embankment A) Describe embankment protection for 100-year and greater overtopping:	
B) Slope of Overflow Embankment (Horizontal distance per unit vertical, 4:1 or flatter preferred)	Ze = ft / ft
11. Vegetation	Choose One ○ Irrigated ○ Not Irrigated
12. Access A) Describe Sediment Removal Procedures	

Notes:

Riprap Sizing for Mild Slopes

Project:	Redtail Ridge - 190109
Channel ID:	Pond C-1
Date:	1/29/2024

Source: https://udfcd.org/wp-content/uploads/uploads/vol1%20criteria%20manual/08_Open%20Channels.pdf

8.1.1 Mild Slope Conditions

When subcritical flow conditions occur and/or slopes are mild (less than 2 percent), UDFCD recommends the following equation (Hughes, et al, 1983):

$$d_{50} \geq \left[\frac{VS^{0.17}}{4.5(G_s - 1)^{0.66}} \right]^2 \qquad \text{Equation 8-11}$$

V= mean channel velocity (ft/sec)
S= longitudinal channel slope (%)
d_{50}= mean rock size (ft)
G_s= specific gravity
S.F= Safety Factor (dimensionless)

S=	2 %		
V=	1.35 ft/s	*Hydraflow express	
G_s=	2.5		
S.F =	1.5		
	d_{50}= 0.07 ft	1.20 inches	Use Type VL RipRap

RIPRAP DESIGNATION	% SMALLER THAN GIVEN SIZE BY WEIGHT	INTERMEDIATE ROCK DIMENSION (INCHES)	D_{50}* (INCHES)
TYPE VL	70 – 100 50 – 70 35 – 50 2 – 10	12 9 6 2	6
TYPE L	70 – 100 50 – 70 35 – 50 2 – 10	15 12 9 3	9
TYPE M	70 – 100 50 – 70 35 – 50 2 – 10	21 18 12 4	12
TYPE H	70 – 100 50 – 70 35 – 50 2 – 10	30 24 18 6	18
*D_{50} = MEAN ROCK SIZE			

Figure 8-34. Riprap and soil riprap placement and gradation (part 1 of 3)

Note: Void Filled Riprap shall be Type VL Riprap of D_{50}=6 inches or larger

Weir Report

Pond C-1 Emergency Spillway

Trapezoidal Weir

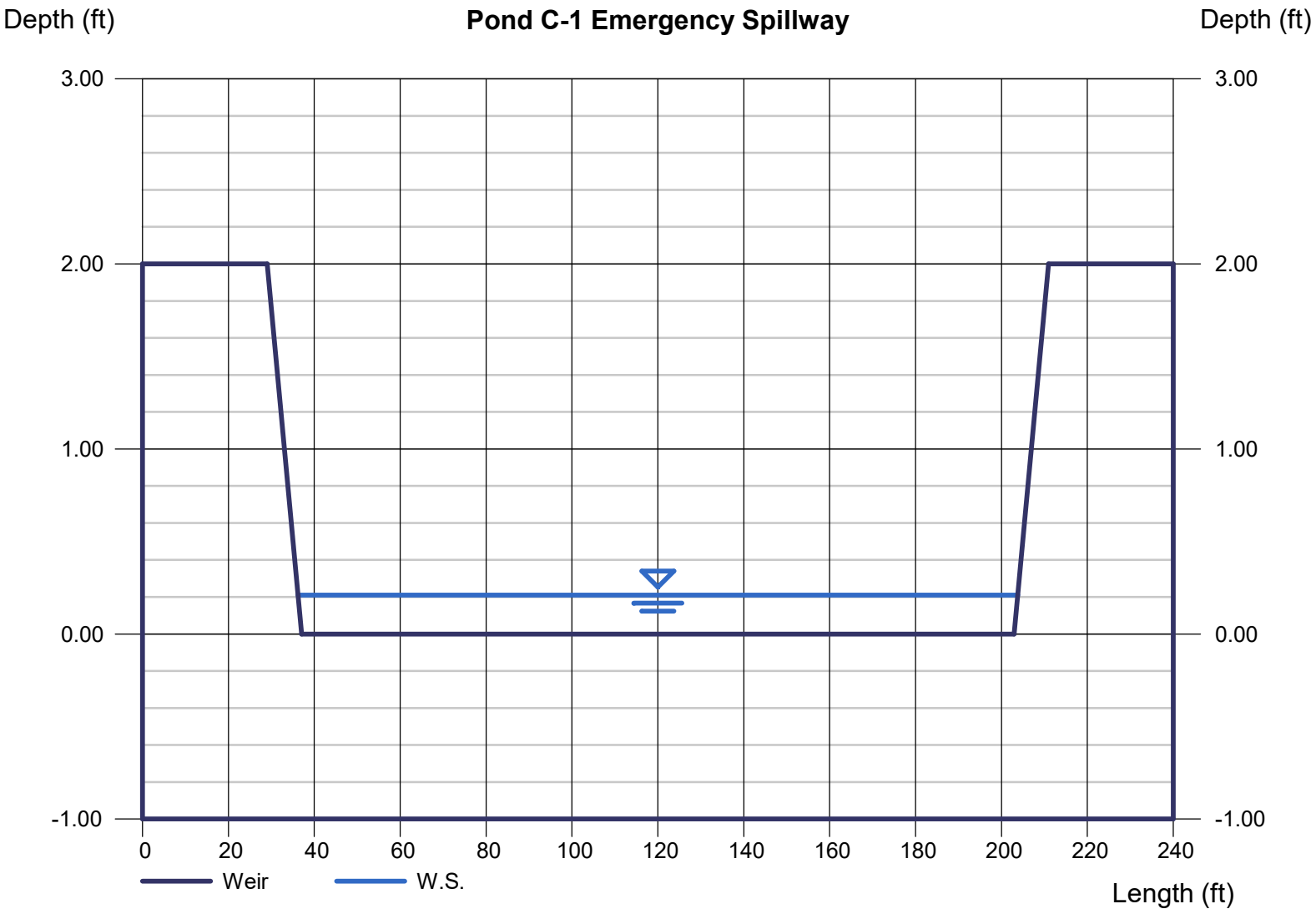
Crest	= Sharp
Bottom Length (ft)	= 165.94
Total Depth (ft)	= 2.00
Side Slope (z:1)	= 4.00

Calculations

Weir Coeff. Cw	= 3.10
Compute by:	Known Q
Known Q (cfs)	= 47.40

Highlighted

Depth (ft)	= 0.21
Q (cfs)	= 47.40
Area (sqft)	= 35.02
Velocity (ft/s)	= 1.35
Top Width (ft)	= 167.62



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Monday, Feb 19 2024

Pond C-1 Outfall Channel

User-defined

Invert Elev (ft)	= 5364.92
Slope (%)	= 0.74
N-Value	= 0.035

Calculations

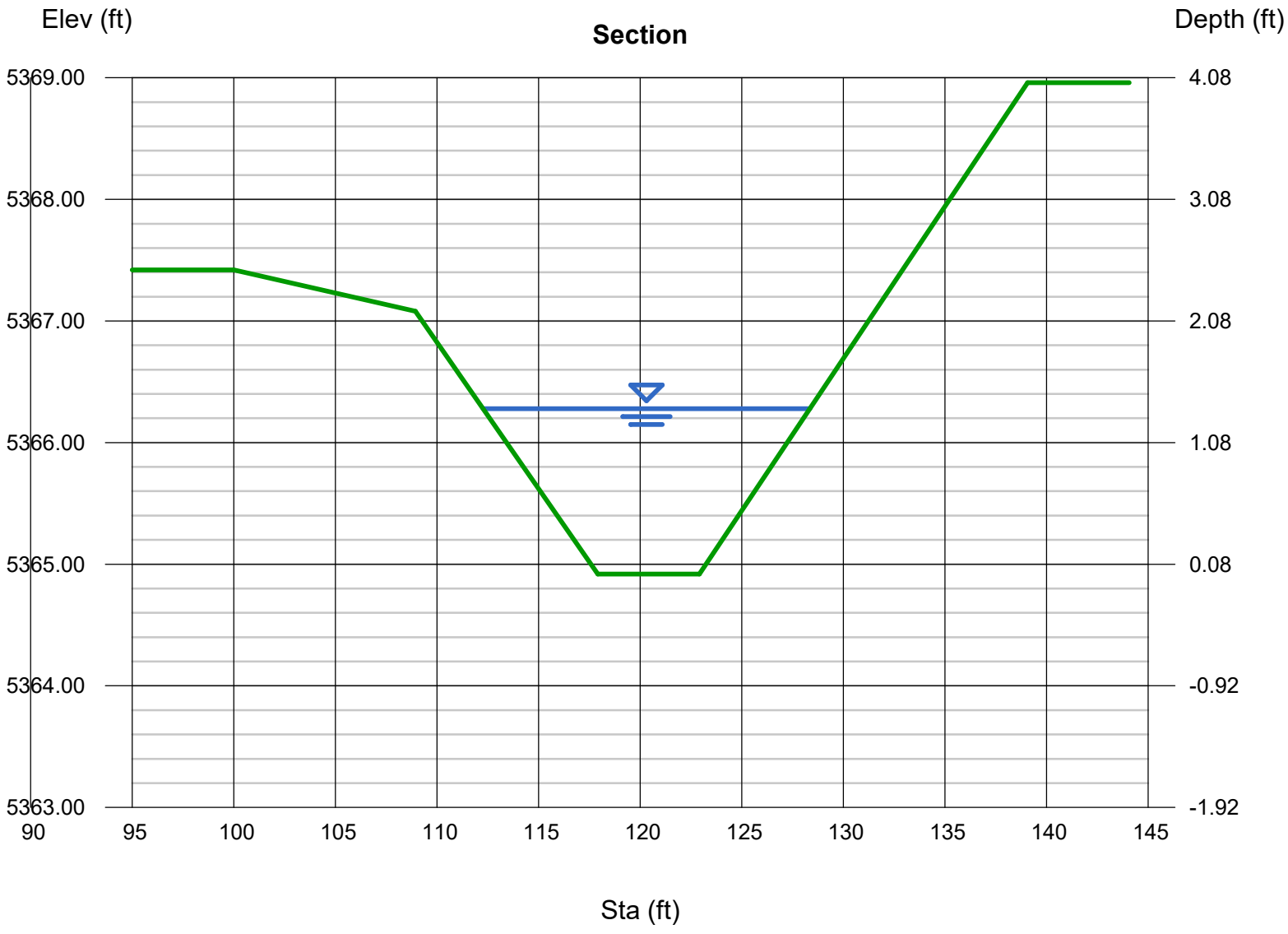
Compute by:	Known Q
Known Q (cfs)	= 47.40

Highlighted

Depth (ft)	= 1.36
Q (cfs)	= 47.40
Area (sqft)	= 14.34
Velocity (ft/s)	= 3.31
Wetted Perim (ft)	= 16.42
Crit Depth, Yc (ft)	= 1.06
Top Width (ft)	= 16.09
EGL (ft)	= 1.53

(Sta, El, n)-(Sta, El, n)...

(100.00, 5367.42)-(108.94, 5367.08, 0.035)-(117.92, 5364.92, 0.035)-(122.92, 5364.92, 0.035)-(139.07, 5368.96, 0.035)



Pond C-1: Outfall Channel Riprap Sizing

Pond C-1 Outfall Riprap Apron Sizing for Circular Conduit

Variables				Calculations			
Q =	47.4	ft^3/s	*MHFD peak outflow	**L_p**	36.6	ft	Length of riprap apron protection
***V =**	3.31	ft/s	*Hydraflow express	**A_t**	14.32024	ft^2	
D =	4	ft		**Expansion Factor**	5.6		Determined from Fig 9-35
Y_t =	1.36	ft	*Hydraflow express	**Θ**	0.08905		Expansion angle of culvert flow
				Q/D^5/2	1.48125		Froude parameter
				T	10.5	ft	Width of Riprap apron protection
				Y_t/D	0.34		

***Acceptable major event velocity 5 ft/s for A and B soils, 7 ft/s for C and D soils**

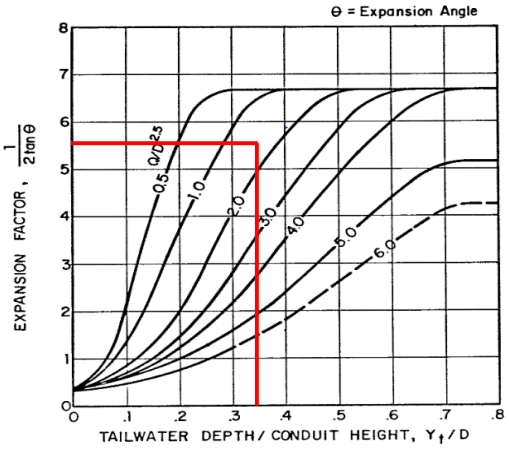


Figure 9-35. Expansion factor for circular conduits

$$L_p = \left(\frac{1}{2\tan\theta}\right)\left(\frac{A_t}{Y_t} - W\right)$$ Equation 9-11

Where:

L_p = length of protection (ft)

W = width of the conduit (ft, use diameter for circular conduits)

Y_t = tailwater depth (ft)

θ = the expansion angle of the culvert flow

and:

$$A_t = \frac{Q}{V}$$ Equation 9-12

Where:

Q = design discharge (cfs)

V = the allowable non-eroding velocity in the downstream channel (ft/sec)

A_t = required area of flow at allowable velocity (ft²)

$$\theta = \tan^{-1}\left(\frac{1}{2(\text{ExpansionFactor})}\right)$$ Equation 9-13

Where:

Expansion Factor = determined using Figure 9-35 or 9-36

T is then calculated using the following equation:

$$T = 2(L_p \tan\theta) + W$$ Equation 9-14

In certain circumstances, Equation 9-11 may yield unreasonable results. Therefore, in no case should L_p be less than $3H$ or $3D$, nor does L_p need to be greater than $10H$ or $10D$ whenever the Froude parameter, $Q/WH^{1.5}$ or $Q/D^{2.5}$, is less than 8.0 or 6.0, respectively. Whenever the Froude parameter is greater than these maximums, increase the maximum L_p required by ¼ D_c or ¼ H for circular or rectangular (box) culverts, respectively, for each whole number by which the Froude parameter is greater than 8.0 or 6.0, respectively.

Once L_p has been determined, the width of the riprap protection at the furthest downstream point should be verified. This dimension is labeled "T" on Figure 9-34. The first step is to solve for θ using the results from Figure 9-35 or 9-36:

Is L_p less than 3D:	NO	
Is L_p greater than 10D and the Froude number less than 6:	NO	
Is the Froude number greater than 6:	NO	
If YES, then by how many whole numbers:		
New L_p	36.5657	ft

Pond C-1: Outfall Channel Riprap Type

Pond C-1 Outfall Riprap Type Selection for Circular Conduits

Variables			Calculations		
D =	4 ft		**D_a**	2 ft	
Q =	47.4 ft^3/s		**Q/(D^1.5)**	5.9	
Y_t =	1.36 ft		**Riprap Size =**	L	Using Figure 9-38
Y_t/D =	0.34				
Y_n =		ft (normal depth of supercritical flow)			

References: UDFCD Criteria Manual Volume 2 (March 2017)

3.2.3 Rock Sizing for Riprap Apron and Low Tailwater Basin

Scour resulting from highly turbulent, rapidly decelerating flow is a common problem at conduit outlets. The following section summarizes the method for sizing riprap protection for both riprap aprons (Section 3.2.1) and low tailwater basins (Section 3.2.2).

Use Figure 9-38 to determine the required rock size for circular conduits and Figure 9-39 for rectangular conduits. Figure 9-38 is valid for $Q/D_c^{2.5}$ of 6.0 or less and Figure 9-39 is valid for $Q/WH^{1.5}$ of 8.0 or less. The parameters in these two figures are:

1. $Q/D^{1.5}$ or $Q/WH^{0.5}$ in which Q is the design discharge in cfs, D_c is the diameter of a circular conduit in feet, and W and H are the width and height of a rectangular conduit in feet.
2. Y_t/D_c or Y_t/H in which Y_t is the tailwater depth in feet, D_c is the diameter of a circular conduit in feet, and H is the height of a rectangular conduit in feet. In cases where Y_t is unknown or a hydraulic jump is suspected downstream of the outlet, use $Y_t/D_t = Y_t/H = 0.40$ when using Figures 9-38 and 9-39.
3. The riprap size requirements in Figures 9-38 and 9-39 are based on the non-dimensional parametric Equations 9-16 and 9-17 (Steven, Simons, and Watts 1971 and Smith 1975).

Circular culvert:

$$d_{50} = \frac{0.023Q}{Y_t^{1.2} D_c^{0.3}} \qquad \text{Equation 9-16}$$

Can use figure 9-38:	YES	
Is a hydraulic jump expected downstream:	NO	(Type "YES" or "NO")
Is the flow in the culvert supercritical:	NO	(Type "YES" or "NO")
New Y_t/D =	0.34	

These rock size requirements assume that the flow in the culvert is subcritical. It is possible to use Equations 9-16 and 9-17 when the flow in the culvert is supercritical (and less than full) if the value of D_c or H is modified for use in Figures 9-38 and 9-39. Note that rock sizes referenced in these figures are defined in the *Open Channels* chapter. Whenever the flow is supercritical in the culvert, substitute D_a for D_c and H_a for H, in which D_a is defined as:

$$D_a = \frac{(D_c + Y_n)}{2} \qquad \text{Equation 9-18}$$

Where the maximum value of D_a shall not exceed D_c, and

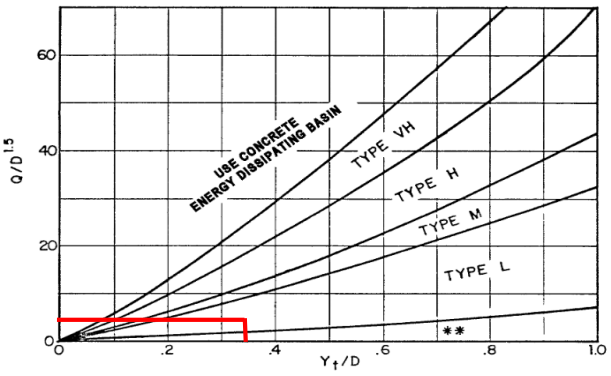
D_a = parameter to use in place of D in Figure 9-38 when flow is supercritical (ft)

D_c = diameter of circular culvert (ft)

H_a = parameter to use in place of H in Figure 9-39 when flow is supercritical (ft)

H = height of rectangular culvert (ft)

Y_n = normal depth of supercritical flow in the culvert (ft)



Use D_a instead of D whenever flow is supercritical in the barrel.
** Use Type L for a distance of 3D downstream.

Figure 9-38. Riprap erosion protection at circular conduit outlet (valid for Q/D2.5 ≤ 6.0)

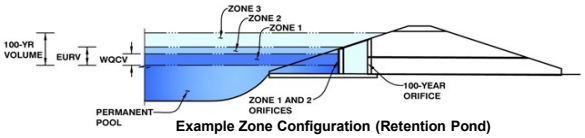
Is L_p equal to 3D: NO **If YES, Riprap type will be L**

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.05 (January 2022)

Project: Redtail Ridge - On-Site Improvements

Basin ID: Pond C-2



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	EDB	
Watershed Area =	87.99	acres
Watershed Length =	4,607	ft
Watershed Length to Centroid =	1,027	ft
Watershed Slope =	0.026	ft/ft
Watershed Imperviousness =	78.21%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	100.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

			Optional User Overrides
Water Quality Capture Volume (WQCV) =	2.328	acre-feet	acre-feet
Excess Urban Runoff Volume (EURV) =	6.748	acre-feet	acre-feet
2-yr Runoff Volume (P1 = 0.8 in.) =	4.331	acre-feet	0.80 inches
5-yr Runoff Volume (P1 = 1.08 in.) =	6.230	acre-feet	1.08 inches
10-yr Runoff Volume (P1 = 1.34 in.) =	8.155	acre-feet	1.34 inches
25-yr Runoff Volume (P1 = 1.76 in.) =	11.535	acre-feet	1.76 inches
50-yr Runoff Volume (P1 = 2.11 in.) =	14.285	acre-feet	2.11 inches
100-yr Runoff Volume (P1 = 2.49 in.) =	17.387	acre-feet	2.49 inches
500-yr Runoff Volume (P1 = 3.52 in.) =	25.553	acre-feet	3.52 inches
Approximate 2-yr Detention Volume =	4.107	acre-feet	
Approximate 5-yr Detention Volume =	6.006	acre-feet	
Approximate 10-yr Detention Volume =	7.352	acre-feet	
Approximate 25-yr Detention Volume =	8.958	acre-feet	
Approximate 50-yr Detention Volume =	9.780	acre-feet	
Approximate 100-yr Detention Volume =	10.931	acre-feet	

Define Zones and Basin Geometry

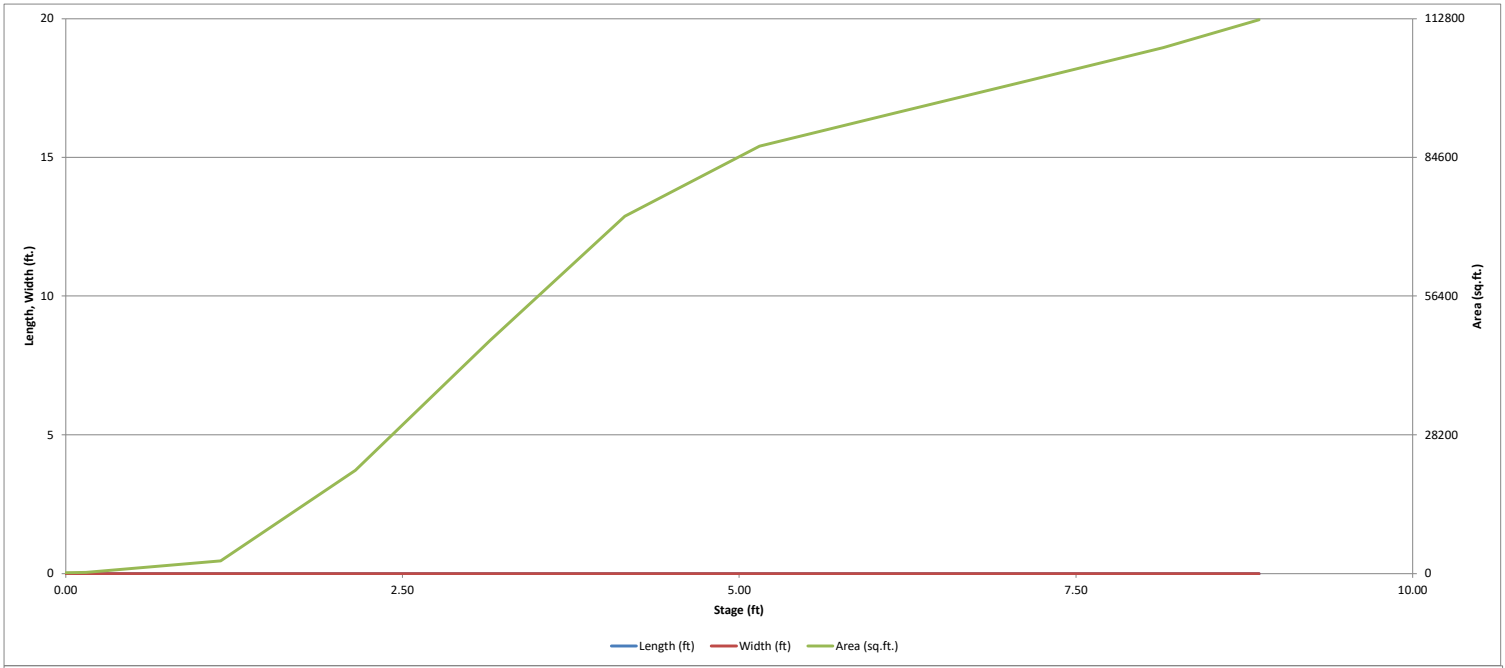
Zone 1 Volume (WQCV) =	2.328	acre-feet
Zone 2 Volume (EURV - Zone 1) =	4.420	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	4.184	acre-feet
Total Detention Basin Volume =	10.931	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	user	acre-feet

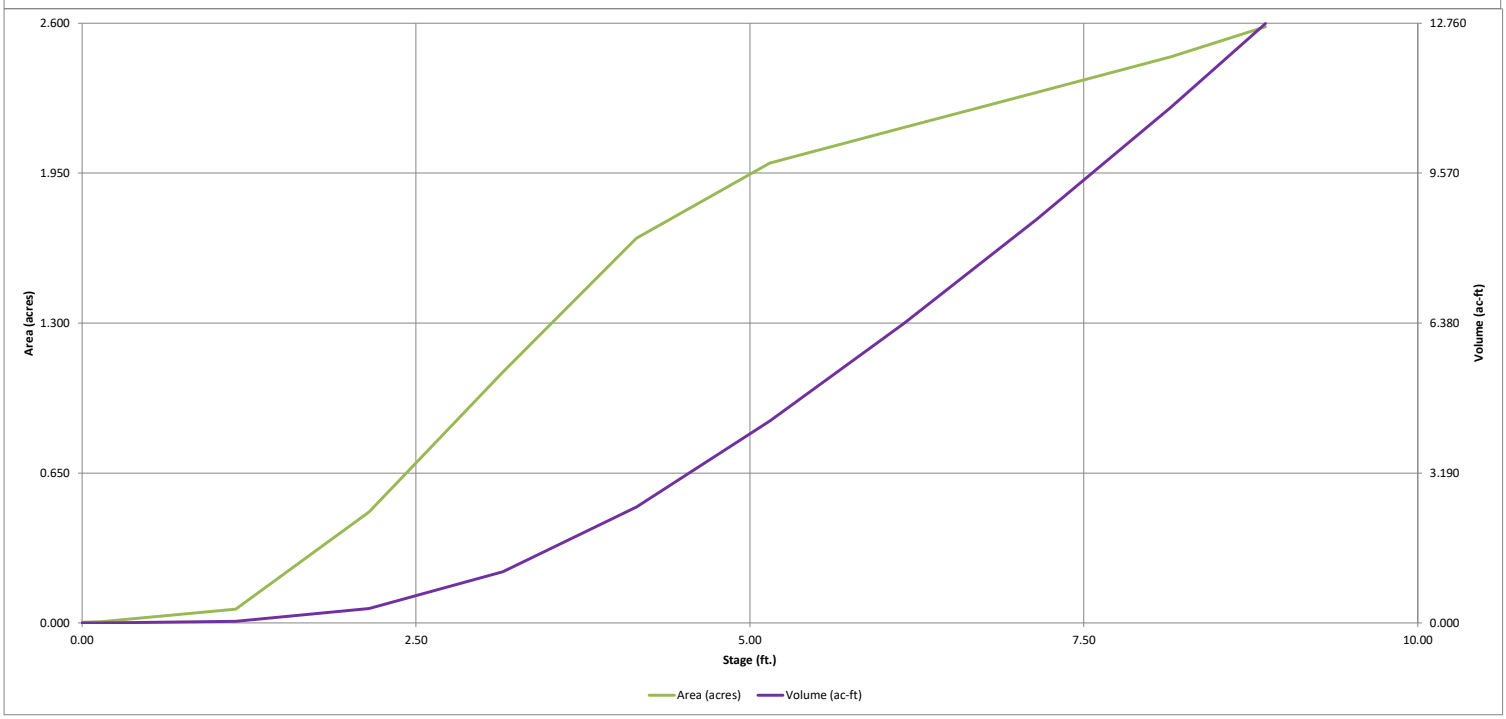
Depth Increment = 1.00 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	160	0.004		
5356	--	0.15	--	--	--	240	0.006	30	0.001
5357	--	1.15	--	--	--	2,596	0.060	1,448	0.033
5358	--	2.15	--	--	--	20,986	0.482	13,239	0.304
5359	--	3.15	--	--	--	47,383	1.088	47,424	1.089
5360	--	4.15	--	--	--	72,618	1.667	107,424	2.466
5361	--	5.15	--	--	--	86,851	1.994	187,159	4.297
5362	--	6.15	--	--	--	93,532	2.147	277,351	6.367
5363	--	7.15	--	--	--	100,215	2.301	374,224	8.591
5364	--	8.15	--	--	--	106,921	2.455	477,792	10.969
5364.71	--	8.86	--	--	--	112,588	2.585	555,718	12.758

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.05 (January 2022)



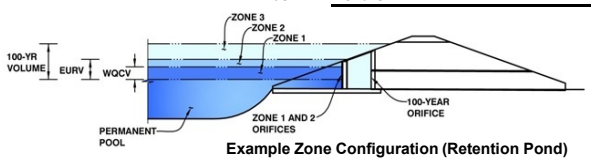


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.05 (January 2022)

Project: **Redtail Ridge - On-Site Improvements**

Basin ID: **Pond C-2**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	4.07	2.328	Orifice Plate
Zone 2 (EURV)	6.33	4.420	Orifice Plate
Zone 3 (100-year)	8.14	4.184	Weir&Pipe (Restrict)
Total (all zones)		10.931	

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)	Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

Calculated Parameters for Underdrain

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	5.910E-02	ft^2
Depth at top of Zone using Orifice Plate =	6.32	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	25.08	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	8.51	sq. inches (use rectangular openings)	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	2.10	4.20					
Orifice Area (sq. inches)	8.51	8.51	8.51					

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected			Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	N/A	N/A	ft^2
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	N/A	N/A	feet
Vertical Orifice Diameter =	N/A	N/A	inches				

Calculated Parameters for Vertical Orifice

User Input: Overflow Weir (Dropbox with Flat or Sloped Grate and Outlet Pipe OR Rectangular/Trapezoidal Weir and No Outlet Pipe)

	Zone 3 Weir	Not Selected			Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	6.32	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	6.32	N/A	feet
Overflow Weir Front Edge Length =	8.00	N/A	feet	Overflow Weir Slope Length =	8.00	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	8.91	N/A	
Horiz. Length of Weir Sides =	8.00	N/A	feet	Overflow Grate Open Area w/o Debris =	50.62	N/A	ft^2
Overflow Grate Type =	Close Mesh Grate	N/A		Overflow Grate Open Area w/ Debris =	25.31	N/A	ft^2
Debris Clogging % =	50%	N/A	%				

Calculated Parameters for Overflow Weir

User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)

	Zone 3 Restrictor	Not Selected			Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.04	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	5.68	N/A	ft^2
Outlet Pipe Diameter =	42.00	N/A	inches	Outlet Orifice Centroid =	1.14	N/A	feet
Restrictor Plate Height Above Pipe Invert =	24.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	1.71	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	8.86	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.52	feet
Spillway Crest Length =	265.00	feet	Stage at Top of Freeboard =	10.38	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	2.58	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	12.76	acre-ft

Calculated Parameters for Spillway

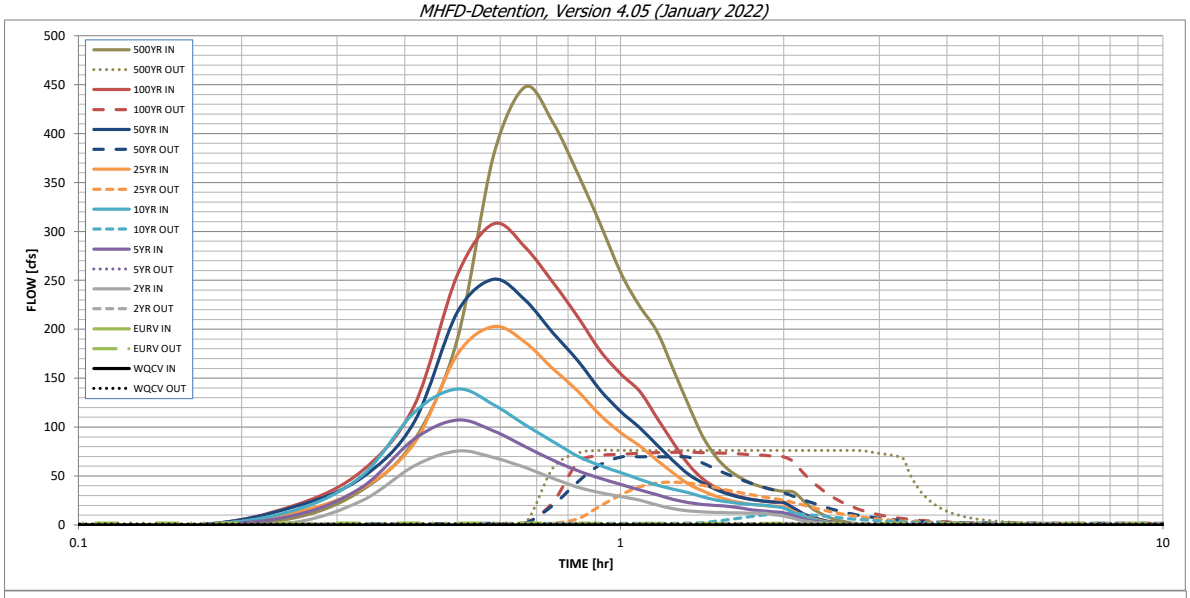
Routed Hydrograph Results

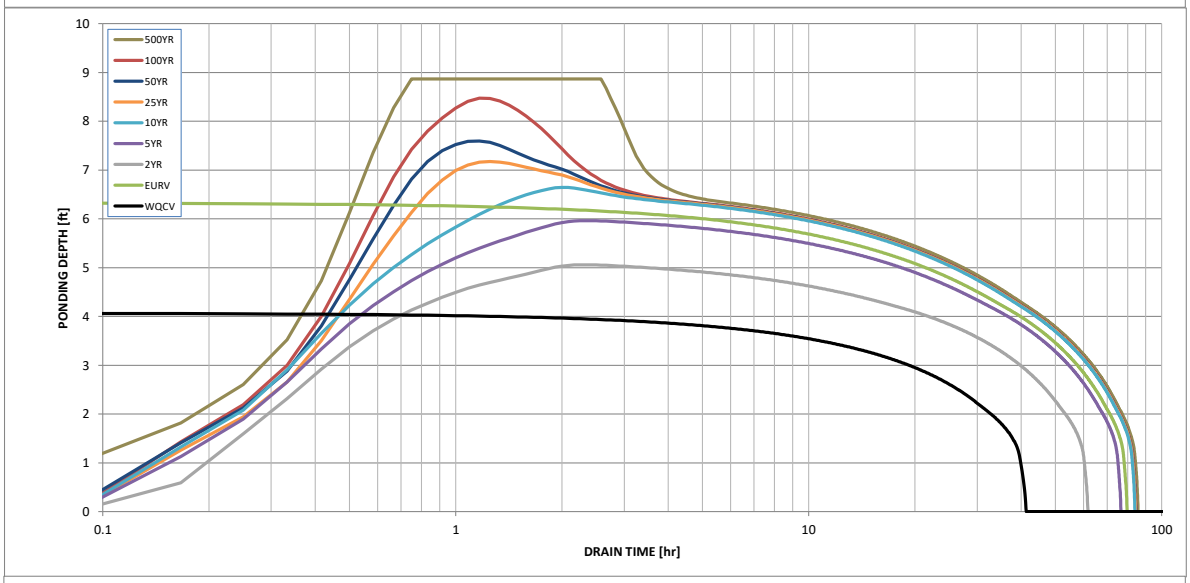
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

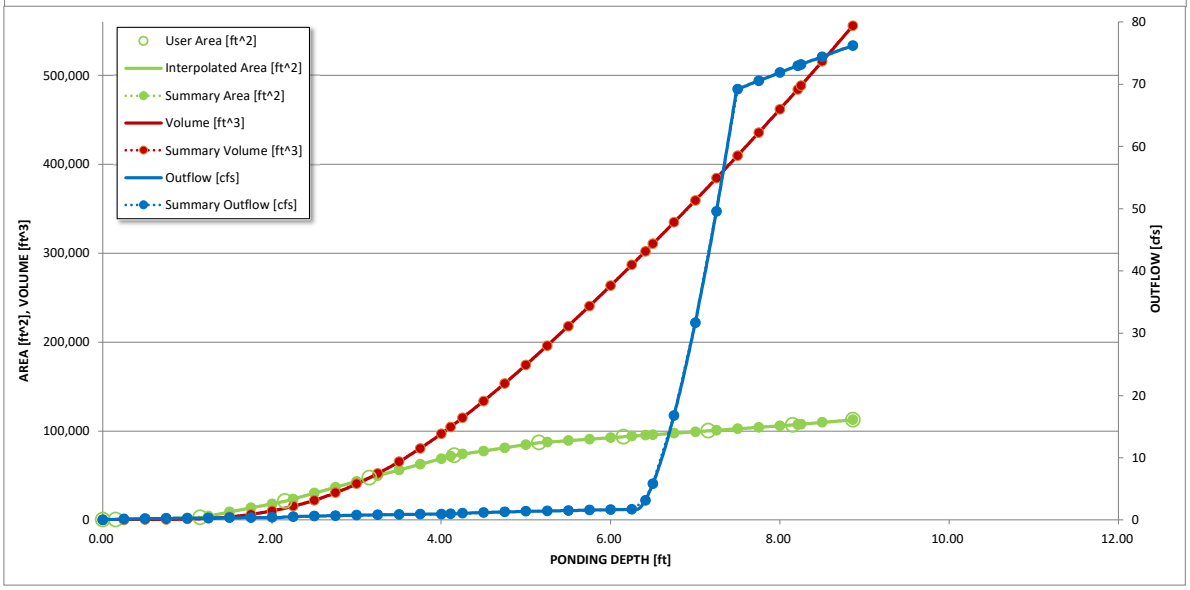
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	0.80	1.08	1.34	1.76	2.11	2.49	3.52
CUHP Runoff Volume (acre-ft) =	2.328	6.748	4.331	6.230	8.155	11.535	14.285	17.387	25.553
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	4.331	6.230	8.155	11.535	14.285	17.387	25.553
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.79	6.8	22.1	60.6	85.7	117.4	192.5
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.08	0.25	0.69	0.97	1.33	2.19
Peak Inflow Q (cfs) =	N/A	N/A	75.5	107.1	138.8	202.8	251.0	307.9	447.8
Peak Outflow Q (cfs) =	0.972	1.734	1.393	1.632	11.528	43.722	69.725	74.273	76.218
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.2	0.5	0.7	0.8	0.6	0.4
Structure Controlling Flow =	Plate	Overflow Weir 1	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1	N/A
Max Velocity through Grate 1 (fps) =	N/A	0.00	N/A	N/A	0.2	0.8	1.3	1.4	1.5
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	72	57	70	75	73	71	70	66
Time to Drain 99% of Inflow Volume (hours) =	**40**	77	60	74	81	80	79	78	77
Maximum Ponding Depth (ft) =	4.07	6.33	5.06	5.96	6.64	7.17	7.59	8.47	8.86
Area at Maximum Ponding Depth (acres) =	1.62	2.17	1.96	2.12	2.22	2.30	2.37	2.51	2.58
Maximum Volume Stored (acre-ft) =	2.335	6.756	4.099	5.962	7.438	8.637	9.618	11.738	12.758

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.05 (January 2022)







S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename: _____

Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.00	7.07
	0:15:00	0.00	0.00	2.63	9.55	14.87	12.52	18.47	19.75	35.44
	0:20:00	0.00	0.00	24.75	38.45	50.23	37.42	48.41	55.13	86.84
	0:25:00	0.00	0.00	60.38	87.75	115.11	83.77	105.41	122.16	189.73
	0:30:00	0.00	0.00	75.54	107.14	138.77	174.29	217.54	255.42	377.53
	0:35:00	0.00	0.00	68.85	95.99	122.90	202.78	250.99	307.85	447.77
	0:40:00	0.00	0.00	58.64	80.11	102.30	186.64	229.73	283.97	411.85
	0:45:00	0.00	0.00	47.59	66.21	85.37	159.88	196.62	248.23	359.52
	0:50:00	0.00	0.00	38.59	55.43	70.34	136.90	168.18	213.00	308.17
	0:55:00	0.00	0.00	33.03	47.59	60.60	112.34	138.04	178.21	258.16
	1:00:00	0.00	0.00	29.01	41.37	53.42	94.38	116.10	154.51	223.84
	1:05:00	0.00	0.00	25.29	35.80	46.73	80.88	99.53	136.83	198.28
	1:10:00	0.00	0.00	20.49	30.87	40.80	66.36	81.84	109.74	159.39
	1:15:00	0.00	0.00	16.53	26.17	36.51	53.20	65.80	84.20	122.92
	1:20:00	0.00	0.00	14.44	22.91	32.91	41.88	51.81	62.01	90.98
	1:25:00	0.00	0.00	13.38	20.98	28.74	34.87	43.09	47.24	69.48
	1:30:00	0.00	0.00	12.75	19.76	25.48	29.26	36.15	38.16	56.23
	1:35:00	0.00	0.00	12.43	18.95	23.31	25.30	31.23	32.52	47.95
	1:40:00	0.00	0.00	12.18	17.12	21.81	22.64	27.93	28.60	42.19
	1:45:00	0.00	0.00	12.00	15.42	20.78	21.00	25.89	26.04	38.43
	1:50:00	0.00	0.00	11.87	14.26	20.07	19.81	24.41	24.24	35.79
	1:55:00	0.00	0.00	10.44	13.42	19.04	19.07	23.48	23.20	34.25
	2:00:00	0.00	0.00	9.00	12.48	17.23	18.63	22.92	22.83	33.68
	2:05:00	0.00	0.00	6.66	9.35	12.71	14.10	17.34	17.35	25.57
	2:10:00	0.00	0.00	4.52	6.32	8.61	9.53	11.71	11.79	17.38
	2:15:00	0.00	0.00	3.06	4.27	5.88	6.51	8.00	8.10	11.94
	2:20:00	0.00	0.00	2.05	2.81	3.93	4.38	5.38	5.44	8.01
	2:25:00	0.00	0.00	1.30	1.79	2.55	2.84	3.49	3.53	5.20
	2:30:00	0.00	0.00	0.80	1.17	1.63	1.87	2.30	2.33	3.42
	2:35:00	0.00	0.00	0.42	0.68	0.92	1.10	1.35	1.37	2.01
	2:40:00	0.00	0.00	0.18	0.33	0.42	0.54	0.66	0.66	0.97
	2:45:00	0.00	0.00	0.06	0.10	0.12	0.17	0.20	0.21	0.30
	2:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.05 (January 2022)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.
The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]
MICROPOOL	0.00	160	0.004	0	0.000	0.00
	0.25	476	0.011	66	0.002	0.14
	0.50	1,065	0.024	258	0.006	0.20
	0.75	1,654	0.038	598	0.014	0.25
	1.00	2,243	0.051	1,085	0.025	0.28
	1.25	4,435	0.102	1,799	0.041	0.32
	1.50	9,033	0.207	3,483	0.080	0.35
	1.75	13,630	0.313	6,316	0.145	0.38
	2.00	18,228	0.418	10,298	0.236	0.40
	2.25	23,626	0.542	15,470	0.355	0.54
	2.50	30,225	0.694	22,201	0.510	0.63
	2.75	36,825	0.845	30,582	0.702	0.70
	3.00	43,424	0.997	40,613	0.932	0.76
	3.25	49,907	1.146	52,288	1.200	0.82
	3.50	56,216	1.291	65,554	1.505	0.87
	3.75	62,524	1.435	80,396	1.846	0.92
	4.00	68,833	1.580	96,816	2.223	0.96
WQCV	4.11	71,609	1.644	104,540	2.400	0.98
	4.25	74,041	1.700	114,757	2.634	1.07
	4.50	77,600	1.781	133,712	3.070	1.20
	4.75	81,158	1.863	153,557	3.525	1.29
	5.00	84,716	1.945	174,291	4.001	1.38
	5.25	87,519	2.009	195,877	4.497	1.45
	5.50	89,189	2.048	217,966	5.004	1.52
	5.75	90,860	2.086	240,472	5.520	1.58
	6.00	92,530	2.124	263,396	6.047	1.64
	6.25	94,200	2.163	286,737	6.583	1.70
EURV	6.41	95,270	2.187	301,895	6.931	3.17
	6.50	95,871	2.201	310,496	7.128	5.81
	6.75	97,542	2.239	334,673	7.683	16.80
	7.00	99,213	2.278	359,267	8.248	31.67
	7.25	100,886	2.316	384,279	8.822	49.59
	7.50	102,562	2.355	409,710	9.406	69.22
	7.75	104,239	2.393	435,561	9.999	70.56
	8.00	105,915	2.431	461,830	10.602	71.87
V100	8.21	107,399	2.466	484,222	11.116	72.96
	8.25	107,719	2.473	488,524	11.215	73.16
	8.50	109,714	2.519	515,703	11.839	74.43
EMERGENCY SPILLWAY	8.86	112,588	2.585	555,718	12.758	76.22

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

Design Procedure Form: Extended Detention Basin (EDB)

UD-BMP (Version 3.07, March 2018)

Designer: SDM
Company: HKS
Date: January 31, 2024
Project: Redtail Ridge - Pond C-2 East Forebay
Location: Louisville, CO

1. Basin Storage Volume

A) Effective Imperviousness of Tributary Area, I_a — I_a = 79.0 %

B) Tributary Area's Imperviousness Ratio ($i = I_a / 100$) — i = 0.790

C) Contributing Watershed Area — Area = 55.610 ac

D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm — d_6 = in

E) Design Concept (Select EURV when also designing for flood control)

Choose One
- (●) Water Quality Capture Volume (WQCV)
- ( ) Excess Urban Runoff Volume (EURV)

F) Design Volume (WQCV) Based on 40-hour Drain Time
($V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * Area$) — V_{DESIGN} = 1.493 ac-ft

G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume
($V_{WQCV\ OTHER} = (d_6 * (V_{DESIGN}/0.43))$) — $V_{DESIGN\ OTHER}$ = ac-ft

H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired) — $V_{DESIGN\ USER}$ = ac-ft

I) NRCS Hydrologic Soil Groups of Tributary Watershed
- i) Percentage of Watershed consisting of Type A Soils — HSG_A = %
- ii) Percentage of Watershed consisting of Type B Soils — HSG_B = %
- iii) Percentage of Watershed consisting of Type C/D Soils — $HSG_{C/D}$ = %

J) Excess Urban Runoff Volume (EURV) Design Volume
For HSG A: $EURV_A = 1.68 * i^{1.28}$
For HSG B: $EURV_B = 1.36 * i^{1.08}$
For HSG C/D: $EURV_{C/D} = 1.20 * i^{1.08}$
— $EURV_{DESIGN}$ = ac-f t

K) User Input of Excess Urban Runoff Volume (EURV) Design Volume (Only if a different EURV Design Volume is desired) — $EURV_{DESIGN\ USER}$ = ac-f t

2. Basin Shape: Length to Width Ratio

(A basin length to width ratio of at least 2:1 will improve TSS reduction.) — L : W = : 1

3. Basin Side Slopes

A) Basin Maximum Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred) — Z = ft / ft

4. Inlet

A) Describe means of providing energy dissipation at concentrated inflow locations:

5. Forebay

A) Minimum Forebay Volume (V_{FMIN} = 3% of the WQCV) — V_{FMIN} = 0.045 ac-ft

B) Actual Forebay Volume — V_F = 0.022 ac-ft **VF < MINIMUM VF**

C) Forebay Depth (D_F = 30 inch maximum) — D_F = 18.0 in

D) Forebay Discharge

i) Undetained 100-year Peak Discharge — Q_{100} = 39.30 cfs

ii) Forebay Discharge Design Flow ($Q_F = 0.02 * Q_{100}$) — Q_F = 0.79 cfs

E) Forebay Discharge Design

Choose One
- ( ) Berm With Pipe
- (●) Wall with Rect. Notch
- ( ) Wall with V-Notch Weir

F) Discharge Pipe Size (minimum 8-inches) — Calculated D_P = in

G) Rectangular Notch Width — Calculated W_N = 5.14 in

Design Procedure Form: Extended Detention Basin (EDB)

Designer: SDM
Company: HKS
Date: January 31, 2024
Project: Redtail Ridge - Pond C-2 East Forebay
Location: Louisville, CO

6. Trickle Channel

A) Type of Trickle Channel — Choose One: (•) Concrete ( ) Soft Bottom

F) Slope of Trickle Channel — S = ____ ft / ft

7. Micropool and Outlet Structure

A) Depth of Micropool (2.5-feet minimum) — D_M = ____ ft

B) Surface Area of Micropool (10 ft^2 minimum) — A_M = ____ sq ft

C) Outlet Type — Choose One: (•) Orifice Plate ( ) Other (Describe):

D) Smallest Dimension of Orifice Opening Based on Hydrograph Routing (Use UD-Detention) — $D_{orifice}$ = ____ inches

E) Total Outlet Area — A_{ot} = ____ square inches

8. **Initial Surcharge Volume**

A) Depth of Initial Surcharge Volume (Minimum recommended depth is 4 inches) — D_{IS} = ____ in

B) Minimum Initial Surcharge Volume (Minimum volume of 0.3% of the WQCV) — V_{IS} = 195 cu ft

C) Initial Surcharge Provided Above Micropool — V_s = ____ cu ft

9. Trash Rack

A) Water Quality Screen Open Area: $A_t = A_{ot} * 38.5*(e^{-0.095D})$ — A_t = ____ square inches

B) Type of Screen (If specifying an alternative to the materials recommended in the USDCM, indicate "other" and enter the ratio of the total open are to the total screen are for the material specified.)

Other (Y/N): N

C) Ratio of Total Open Area to Total Area (only for type 'Other') — User Ratio = ____

D) Total Water Quality Screen Area (based on screen type) — A_{total} = ____ sq. in.

E) Depth of Design Volume (EURV or WQCV) (Based on design concept chosen under 1E) — H= ____ feet

F) Height of Water Quality Screen (H_{TR}) — H_{TR}= ____ inches

G) Width of Water Quality Screen Opening ($W_{opening}$) (Minimum of 12 inches is recommended) — $W_{opening}$ = ____ inches

Design Procedure Form: Extended Detention Basin (EDB)

Designer: SDM
Company: HKS
Date: January 31, 2024
Project: Redtail Ridge - Pond C-2 East Forebay
Location: Louisville, CO

10. Overflow Embankment

A) Describe embankment protection for 100-year and greater overtopping:

B) Slope of Overflow Embankment
(Horizontal distance per unit vertical, 4:1 or flatter preferred)

Ze = ft / ft

11. Vegetation

Choose One
- Irrigated
- Not Irrigated

12. Access

A) Describe Sediment Removal Procedures

Notes:

Design Procedure Form: Extended Detention Basin (EDB)

UD-BMP (Version 3.07, March 2018)

Designer: SDM
Company: HKS
Date: January 31, 2024
Project: Redtail Ridge - Pond C-2 North Forebay
Location: Louisville, CO

1. Basin Storage Volume

A) Effective Imperviousness of Tributary Area, I_a — I_a = 80.0 %

B) Tributary Area's Imperviousness Ratio ($i = I_a / 100$) — i = 0.800

C) Contributing Watershed Area — Area = 19.630 ac

D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm — d_6 = ____ in

E) Design Concept (Select EURV when also designing for flood control)

Choose One
- (•) Water Quality Capture Volume (WQCV)
- ( ) Excess Urban Runoff Volume (EURV)

F) Design Volume (WQCV) Based on 40-hour Drain Time
($V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * Area$)
V_{DESIGN} = 0.537 ac-ft

G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume
($V_{WQCV\ OTHER} = (d_6 * (V_{DESIGN}/0.43))$)
$V_{DESIGN\ OTHER}$ = ____ ac-ft

H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired)
$V_{DESIGN\ USER}$ = ____ ac-ft

I) NRCS Hydrologic Soil Groups of Tributary Watershed
- i) Percentage of Watershed consisting of Type A Soils — HSG_A = ____ %
- ii) Percentage of Watershed consisting of Type B Soils — HSG_B = ____ %
- iii) Percentage of Watershed consisting of Type C/D Soils — $HSG_{C/D}$ = ____ %

J) Excess Urban Runoff Volume (EURV) Design Volume
For HSG A: $EURV_A = 1.68 * i^{1.28}$
For HSG B: $EURV_B = 1.36 * i^{1.08}$
For HSG C/D: $EURV_{C/D} = 1.20 * i^{1.08}$
$EURV_{DESIGN}$ = ____ ac-f t

K) User Input of Excess Urban Runoff Volume (EURV) Design Volume (Only if a different EURV Design Volume is desired)
$EURV_{DESIGN\ USER}$ = ____ ac-f t

2. Basin Shape: Length to Width Ratio

(A basin length to width ratio of at least 2:1 will improve TSS reduction.)

L : W = ____ : 1

3. Basin Side Slopes

A) Basin Maximum Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred)

Z = ____ ft / ft

4. Inlet

A) Describe means of providing energy dissipation at concentrated inflow locations:

5. Forebay

A) Minimum Forebay Volume (V_{FMIN} = 3% of the WQCV)
V_{FMIN} = 0.016 ac-ft

B) Actual Forebay Volume
V_F = 0.016 ac-ft

C) Forebay Depth (D_F = 18 inch maximum)
D_F = 18.0 in

D) Forebay Discharge

i) Undetained 100-year Peak Discharge
Q_{100} = 88.58 cfs

ii) Forebay Discharge Design Flow ($Q_F = 0.02 * Q_{100}$)
Q_F = 1.77 cfs

E) Forebay Discharge Design

Choose One
- ( ) Berm With Pipe
- (•) Wall with Rect. Notch
- ( ) Wall with V-Notch Weir

Flow too small for berm w/ pipe

F) Discharge Pipe Size (minimum 8-inches)
Calculated D_P = ____ in

G) Rectangular Notch Width
Calculated W_N = 7.08 in

Design Procedure Form: Extended Detention Basin (EDB)

Designer: SDM
Company: HKS
Date: January 31, 2024
Project: Redtail Ridge - Pond C-2 North Forebay
Location: Louisville, CO

6. Trickle Channel	
A) Type of Trickle Channel	Choose One: (●) Concrete ( ) Soft Bottom
F) Slope of Trickle Channel	S = ft / ft
7. Micropool and Outlet Structure	
A) Depth of Micropool (2.5-feet minimum)	D_M = ft
B) Surface Area of Micropool (10 ft^2 minimum)	A_M = sq ft
C) Outlet Type	Choose One: (●) Orifice Plate ( ) Other (Describe):
D) Smallest Dimension of Orifice Opening Based on Hydrograph Routing (Use UD-Detention)	$D_{orifice}$ = inches
E) Total Outlet Area	A_{ot} = square inches
8. Initial Surcharge Volume	
A) Depth of Initial Surcharge Volume (Minimum recommended depth is 4 inches)	D_{IS} = in
B) Minimum Initial Surcharge Volume (Minimum volume of 0.3% of the WQCV)	V_{IS} = 70 cu ft
C) Initial Surcharge Provided Above Micropool	V_s = cu ft
9. Trash Rack	
A) Water Quality Screen Open Area: $A_t = A_{ot} * 38.5*(e^{-0.095D})$	A_t = square inches
B) Type of Screen (If specifying an alternative to the materials recommended in the USDCM, indicate "other" and enter the ratio of the total open are to the total screen are for the material specified.)	
Other (Y/N): N	
C) Ratio of Total Open Area to Total Area (only for type 'Other')	User Ratio =
D) Total Water Quality Screen Area (based on screen type)	A_{total} = sq. in.
E) Depth of Design Volume (EURV or WQCV) (Based on design concept chosen under 1E)	H= feet
F) Height of Water Quality Screen (H_{TR})	H_{TR}= inches
G) Width of Water Quality Screen Opening ($W_{opening}$) (Minimum of 12 inches is recommended)	$W_{opening}$ = inches

Design Procedure Form: Extended Detention Basin (EDB)

Designer: SDM
Company: HKS
Date: January 31, 2024
Project: Redtail Ridge - Pond C-2 North Forebay
Location: Louisville, CO

10. Overflow Embankment A) Describe embankment protection for 100-year and greater overtopping:	
B) Slope of Overflow Embankment (Horizontal distance per unit vertical, 4:1 or flatter preferred)	Ze = ft / ft
11. Vegetation	Choose One ○ Irrigated ○ Not Irrigated
12. Access A) Describe Sediment Removal Procedures	

Notes:

Design Procedure Form: Extended Detention Basin (EDB)

UD-BMP (Version 3.07, March 2018)

Designer: SDM
Company: HKS
Date: January 31, 2024
Project: Redtail Ridge - Pond C-2 West Forebay
Location: Louisville, CO

1. Basin Storage Volume

A) Effective Imperviousness of Tributary Area, I_a — I_a = 70.6 %

B) Tributary Area's Imperviousness Ratio ($i = I_a / 100$) — i = 0.706

C) Contributing Watershed Area — Area = 12.740 ac

D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm — d_6 = in

E) Design Concept (Select EURV when also designing for flood control)

Choose One
- (•) Water Quality Capture Volume (WQCV)
- ( ) Excess Urban Runoff Volume (EURV)

F) Design Volume (WQCV) Based on 40-hour Drain Time
($V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * Area$)
V_{DESIGN} = 0.295 ac-ft

G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume
($V_{WQCV\ OTHER} = (d_6 * (V_{DESIGN}/0.43))$)
$V_{DESIGN\ OTHER}$ = ac-ft

H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired)
$V_{DESIGN\ USER}$ = ac-ft

I) NRCS Hydrologic Soil Groups of Tributary Watershed
- i) Percentage of Watershed consisting of Type A Soils — HSG_A = %
- ii) Percentage of Watershed consisting of Type B Soils — HSG_B = %
- iii) Percentage of Watershed consisting of Type C/D Soils — $HSG_{C/D}$ = %

J) Excess Urban Runoff Volume (EURV) Design Volume
For HSG A: $EURV_A = 1.68 * i^{1.28}$
For HSG B: $EURV_B = 1.36 * i^{1.08}$
For HSG C/D: $EURV_{C/D} = 1.20 * i^{1.08}$
$EURV_{DESIGN}$ = ac-f t

K) User Input of Excess Urban Runoff Volume (EURV) Design Volume (Only if a different EURV Design Volume is desired)
$EURV_{DESIGN\ USER}$ = ac-f t

2. Basin Shape: Length to Width Ratio (A basin length to width ratio of at least 2:1 will improve TSS reduction.)
L : W = : 1

3. Basin Side Slopes

A) Basin Maximum Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred)
Z = ft / ft

4. Inlet

A) Describe means of providing energy dissipation at concentrated inflow locations:

5. Forebay

A) Minimum Forebay Volume (V_{FMIN} = 3% of the WQCV)
V_{FMIN} = 0.009 ac-ft

B) Actual Forebay Volume
V_F = 0.034 ac-ft

C) Forebay Depth (D_F = 18 inch maximum)
D_F = 24.0 in DF > DF MAXIMUM

D) Forebay Discharge

i) Undetained 100-year Peak Discharge
Q_{100} = 149.20 cfs

ii) Forebay Discharge Design Flow ($Q_F = 0.02 * Q_{100}$)
Q_F = 2.98 cfs

E) Forebay Discharge Design

Choose One
- ( ) Berm With Pipe
- (•) Wall with Rect. Notch
- ( ) Wall with V-Notch Weir

Flow too small for berm w/ pipe

F) Discharge Pipe Size (minimum 8-inches)
Calculated D_P = in

G) Rectangular Notch Width
Calculated W_N = 8.60 in

Design Procedure Form: Extended Detention Basin (EDB)

Designer:	SDM
Company:	HKS
Date:	January 31, 2024
Project:	Redtail Ridge - Pond C-2 West Forebay
Location:	Louisville, CO

6. Trickle Channel

A) Type of Trickle Channel — Choose One: (•) Concrete ( ) Soft Bottom

F) Slope of Trickle Channel — S = [ ] ft / ft

7. Micropool and Outlet Structure

A) Depth of Micropool (2.5-feet minimum) — D_M = [ ] ft

B) Surface Area of Micropool (10 ft^2 minimum) — A_M = [ ] sq ft

C) Outlet Type — Choose One: (•) Orifice Plate ( ) Other (Describe):

D) Smallest Dimension of Orifice Opening Based on Hydrograph Routing (Use UD-Detention) — $D_{orifice}$ = [ ] inches

E) Total Outlet Area — A_{ot} = [ ] square inches

8. **Initial Surcharge Volume**

A) Depth of Initial Surcharge Volume (Minimum recommended depth is 4 inches) — D_{IS} = [ ] in

B) Minimum Initial Surcharge Volume (Minimum volume of 0.3% of the WQCV) — V_{IS} = [39] cu ft

C) Initial Surcharge Provided Above Micropool — V_s = [ ] cu ft

9. Trash Rack

A) Water Quality Screen Open Area: $A_t = A_{ot} * 38.5*(e^{-0.095D})$ — A_t = [ ] square inches

B) Type of Screen (If specifying an alternative to the materials recommended in the USDCM, indicate "other" and enter the ratio of the total open are to the total screen are for the material specified.)

Other (Y/N): [N]

C) Ratio of Total Open Area to Total Area (only for type 'Other') — User Ratio = [ ]

D) Total Water Quality Screen Area (based on screen type) — A_{total} = [ ] sq. in.

E) Depth of Design Volume (EURV or WQCV) (Based on design concept chosen under 1E) — H= [ ] feet

F) Height of Water Quality Screen (H_{TR}) — H_{TR}= [ ] inches

G) Width of Water Quality Screen Opening ($W_{opening}$) (Minimum of 12 inches is recommended) — $W_{opening}$ = [ ] inches

Design Procedure Form: Extended Detention Basin (EDB)

Designer: SDM
Company: HKS
Date: January 31, 2024
Project: Redtail Ridge - Pond C-2 West Forebay
Location: Louisville, CO

10. Overflow Embankment

A) Describe embankment protection for 100-year and greater overtopping:

B) Slope of Overflow Embankment
(Horizontal distance per unit vertical, 4:1 or flatter preferred)

Ze = ft / ft

11. Vegetation

Choose One
- Irrigated
- Not Irrigated

12. Access

A) Describe Sediment Removal Procedures

Notes:

Riprap Sizing for Mild Slopes

Project:	Redtail Ridge - 190109
Channel ID:	Pond C-2
Date:	1/29/2024

Source: https://udfcd.org/wp-content/uploads/uploads/vol1%20criteria%20manual/08_Open%20Channels.pdf

8.1.1 Mild Slope Conditions

When subcritical flow conditions occur and/or slopes are mild (less than 2 percent), UDFCD recommends the following equation (Hughes, et al, 1983):

$$d_{50} \geq \left[\frac{VS^{0.17}}{4.5(G_s - 1)^{0.66}} \right]^2 \qquad \text{Equation 8-11}$$

V= mean channel velocity (ft/sec)
S= longitudinal channel slope (%)
d_{50}= mean rock size (ft)
G_s= specific gravity
S.F= Safety Factor (dimensionless)

S=	2 %		
V=	1.33 ft/s	*Hydraflow express	
G_s=	2.5		
S.F =	1.5		
	d_{50}= 0.06 ft	1.17 inches	Use Type VL RipRap

RIPRAP DESIGNATION	% SMALLER THAN GIVEN SIZE BY WEIGHT	INTERMEDIATE ROCK DIMENSION (INCHES)	D_{50}* (INCHES)
TYPE VL	70 – 100 50 – 70 35 – 50 2 – 10	12 9 6 2	6
TYPE L	70 – 100 50 – 70 35 – 50 2 – 10	15 12 9 3	9
TYPE M	70 – 100 50 – 70 35 – 50 2 – 10	21 18 12 4	12
TYPE H	70 – 100 50 – 70 35 – 50 2 – 10	30 24 18 6	18
*D_{50} = MEAN ROCK SIZE			

Figure 8-34. Riprap and soil riprap placement and gradation (part 1 of 3)

Note: Void Filled Riprap shall be Type VL Riprap of D_{50}=6 inches or larger

Weir Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Monday, Feb 19 2024

Pond C-2 Emergency Spillway

Trapezoidal Weir

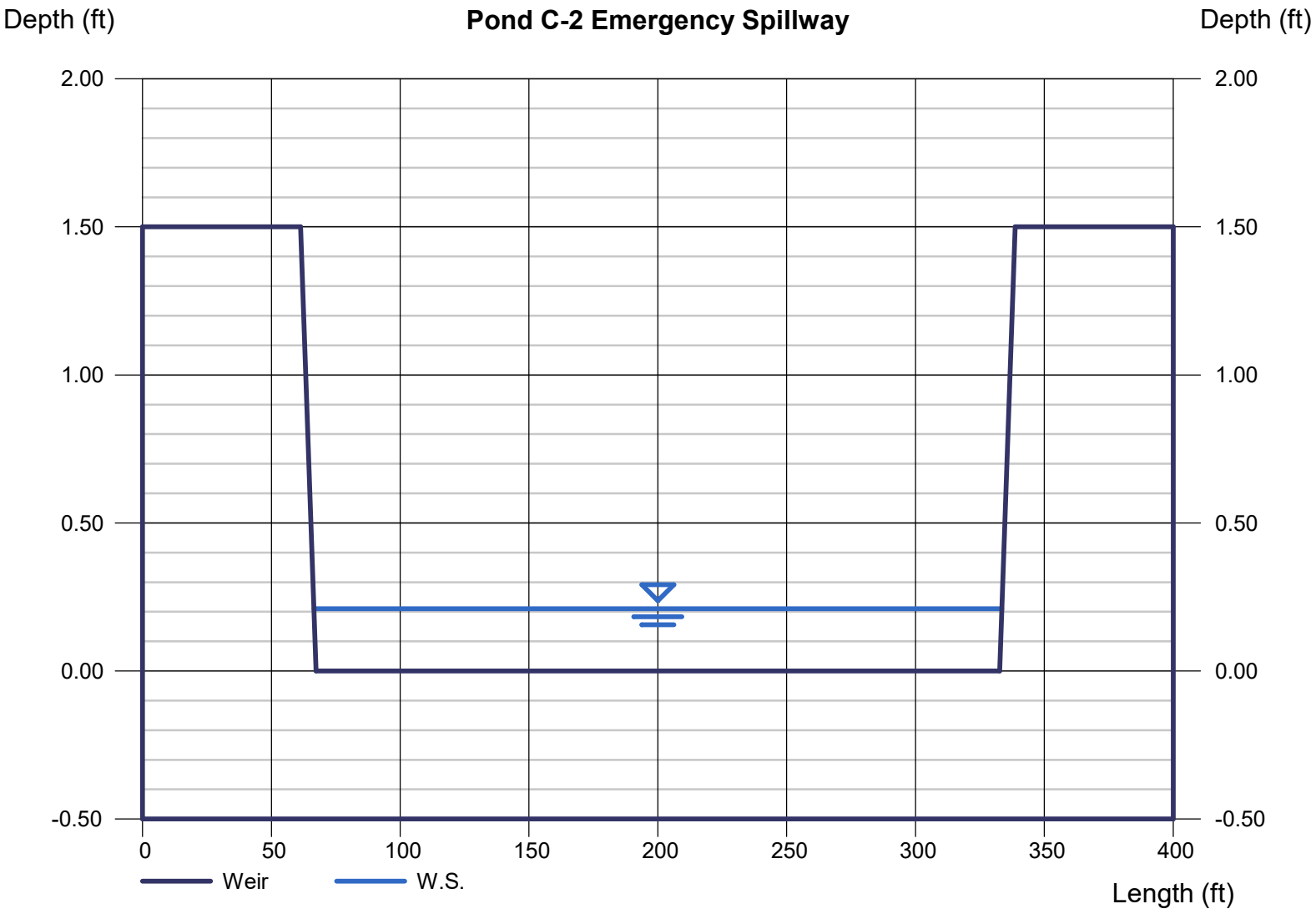
Crest	= Sharp
Bottom Length (ft)	= 265.26
Total Depth (ft)	= 1.50
Side Slope (z:1)	= 4.00

Calculations

Weir Coeff. Cw	= 3.10
Compute by:	Known Q
Known Q (cfs)	= 74.27

Highlighted

Depth (ft)	= 0.21
Q (cfs)	= 74.27
Area (sqft)	= 55.88
Velocity (ft/s)	= 1.33
Top Width (ft)	= 266.94



Storm Line F Riprap Apron Sizing for Circular Conduit

Variables			Calculations			
Q =	12.5	ft^3/s	**L_p**	0.7	ft	Length of riprap apron protection
***V =**	7	ft/s	**A_t**	1.785714	ft^2	
D =	2	ft	**Expansion Factor**	5.8		Determined from Fig 9-35
Y_t =	0.84	ft	**Θ**	0.085994		Expansion angle of culvert flow
			Q/D^5/2	2.209709		Froude parameter
***5 ft/s for A and B soils, 7 ft/s for C and D soils**			**T**	3.0	ft	Width of Riprap apron protection
			Y_t/D	0.42		

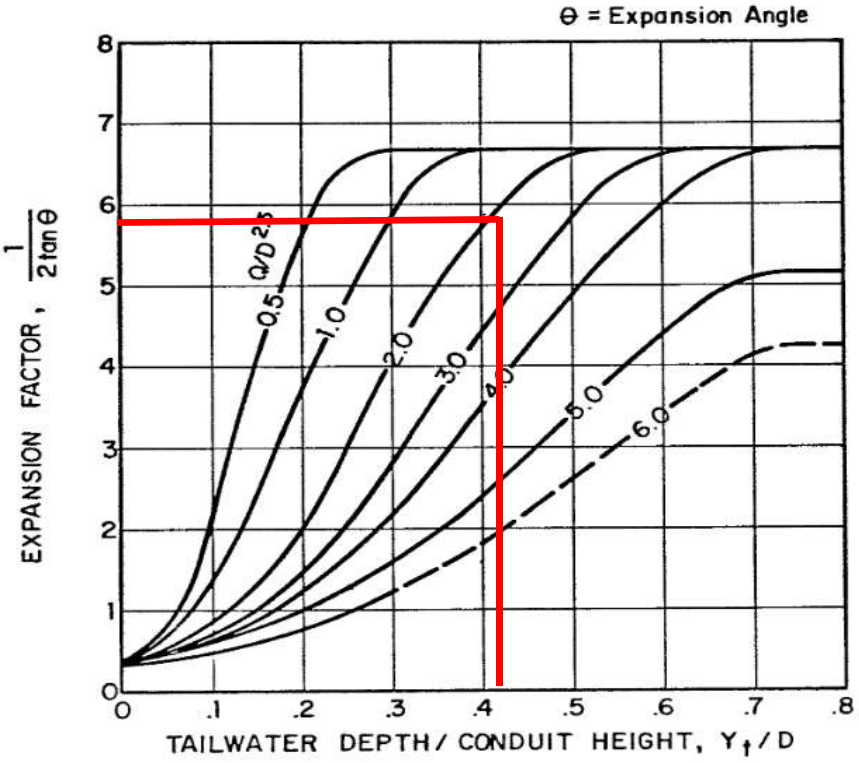


Figure 9-35. Expansion factor for circular conduits

$$L_p = \left(\frac{1}{2\tan\theta}\right)\left(\frac{A_t}{Y_t} - W\right)$$ Equation 9-11

Where:

L_p = length of protection (ft)

W = width of the conduit (ft, use diameter for circular conduits)

Y_t = tailwater depth (ft)

θ = the expansion angle of the culvert flow

and:

$$A_t = \frac{Q}{V} \qquad \text{Equation 9-12}$$

Where:

Q = design discharge (cfs)

V = the allowable non-eroding velocity in the downstream channel (ft/sec)

A_t = required area of flow at allowable velocity (ft²)

$$\theta = \tan^{-1}\left(\frac{1}{2(\text{ExpansionFactor})}\right) \qquad \text{Equation 9-13}$$

Where:

Expansion Factor = determined using Figure 9-35 or 9-36

T is then calculated using the following equation:

$$T = 2(L_r \tan\theta) + W \qquad \text{Equation 9-14}$$

In certain circumstances, Equation 9-11 may yield unreasonable results. Therefore, in no case should L_p be less than $3H$ or $3D$, nor does L_p need to be greater than $10H$ or $10D$ whenever the Froude parameter, $Q/WH^{1.5}$ or $Q/D^{2.5}$, is less than 8.0 or 6.0, respectively. Whenever the Froude parameter is greater than these maximums, increase the maximum L_p required by ¼ D_c or ¼ H for circular or rectangular (box) culverts, respectively, for each whole number by which the Froude parameter is greater than 8.0 or 6.0, respectively.

Once L_p has been determined, the width of the riprap protection at the furthest downstream point should be verified. This dimension is labeled "T" on Figure 9-34. The first step is to solve for ϑ using the results from Figure 9-35 or 9-36:

Is L_p less than 3D:	YES
Is L_p greater than 10D and the Froude number less than 6:	NO
Is the Froude number greater than 6:	NO
If YES, then by how many whole numbers:	NO

New L_p	6 ft

Storm Line F Riprap Type Selection for Circular Conduits

Variables			Calculations		
D =	2	ft	**D_a**	1.52	ft
Q =	12.5	ft^3/s	**Q/(D^1.5)**	4.4	
Y_t =	0.84	ft	**Riprap Size =**	L	Using Figure 9-38
Y_t/D =	0.42				
Y_n =	1.04	ft	(normal depth of supercritical flow)		

3.2.3 Rock Sizing for Riprap Apron and Low Tailwater Basin

Scour resulting from highly turbulent, rapidly decelerating flow is a common problem at conduit outlets. The following section summarizes the method for sizing riprap protection for both riprap aprons (Section 3.2.1) and low tailwater basins (Section 3.2.2).

Use Figure 9-38 to determine the required rock size for circular conduits and Figure 9-39 for rectangular conduits. Figure 9-38 is valid for $Q/D_c^{2.5}$ of 6.0 or less and Figure 9-39 is valid for $Q/WH^{1.5}$ of 8.0 or less. The parameters in these two figures are:

1. $Q/D^{1.5}$ or $Q/WH^{0.5}$ in which Q is the design discharge in cfs, D_c is the diameter of a circular conduit in feet, and W and H are the width and height of a rectangular conduit in feet.

2. Y_t/D_c or Y_t/H in which Y_t is the tailwater depth in feet, D_c is the diameter of a circular conduit in feet, and H is the height of a rectangular conduit in feet. In cases where Y_t is unknown or a hydraulic jump is suspected downstream of the outlet, use $Y_t/D_t = Y_t/H = 0.40$ when using Figures 9-38 and 9-39.

3. The riprap size requirements in Figures 9-38 and 9-39 are based on the non-dimensional parametric Equations 9-16 and 9-17 (Steven, Simons, and Watts 1971 and Smith 1975).

Circular culvert:

$$d_{50} = \frac{0.023Q}{Y_t^{1.2} D_c^{0.3}}$$ Equation 9-16

Can use figure 9-38:	YES	
Is a hydraulic jump expected downstream:	NO	(Type "YES" or "NO")

Is the flow in the culvert supercritical: YES (Type "YES" or "NO")

New Y_t/D = 0.552632

These rock size requirements assume that the flow in the culvert is subcritical. It is possible to use Equations 9-16 and 9-17 when the flow in the culvert is supercritical (and less than full) if the value of D_c or H is modified for use in Figures 9-38 and 9-39. Note that rock sizes referenced in these figures are defined in the *Open Channels* chapter. Whenever the flow is supercritical in the culvert, substitute D_a for D_c and H_a for H, in which D_a is defined as:

$$D_a = \frac{(D_c + Y_n)}{2} \qquad \text{Equation 9-18}$$

Where the maximum value of D_a shall not exceed D_c, and

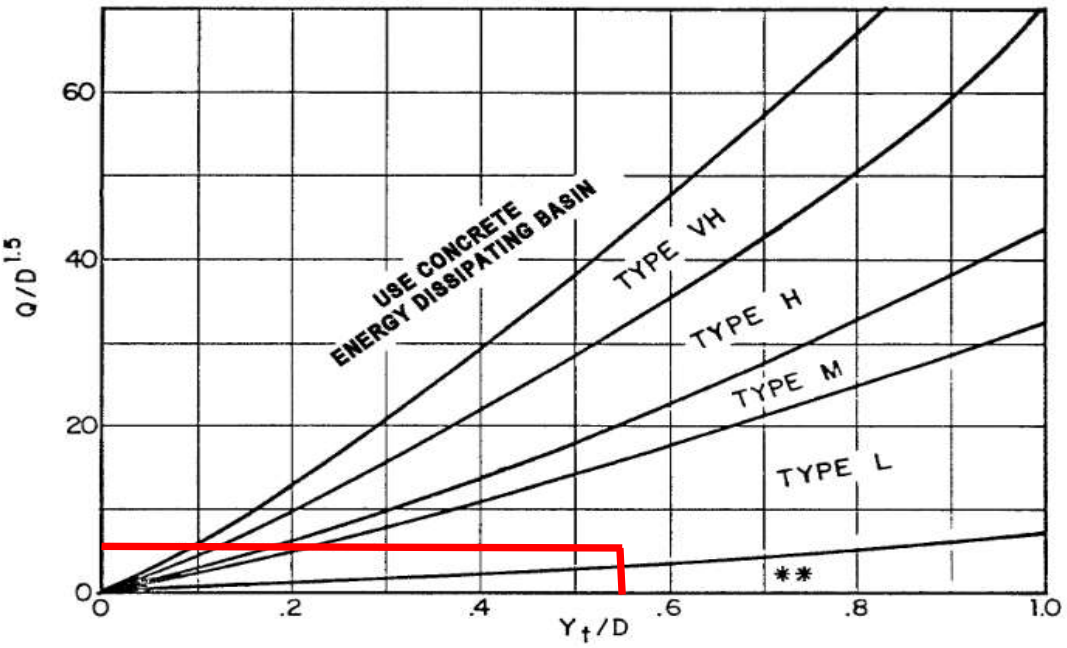
D_a = parameter to use in place of D in Figure 9-38 when flow is supercritical (ft)

D_c = diameter of circular culvert (ft)

H_a = parameter to use in place of H in Figure 9-39 when flow is supercritical (ft)

H = height of rectangular culvert (ft)

Y_n = normal depth of supercritical flow in the culvert (ft)



Use D_a instead of D whenever flow is supercritical in the barrel.
** Use Type L for a distance of 3D downstream.

Figure 9-38. Riprap erosion protection at circular conduit outlet (valid for Q/D2.5 ≤ 6.0)

Goodhue Ditch Riprap Sizing

Riprap Apron Sizing for Circular Conduit

Variables			Calculations			
Q =	50	ft^3/s	**L_p**	6.2	ft	Length of riprap apron protection
***V =**	7	ft/s	**A_t**	7.142857	ft^2	
D =	4.5	ft	**Expansion Factor**	5.1		Determined from Fig 9-35
Y_t =	1.25	ft	**Θ**	0.097727		Expansion angle of culvert flow
			Q/D^5/2	1.163962		Froude parameter
***5 ft/s for A and B soils, 7 ft/s for C and D soils**			**T**	7.1	ft	Width of Riprap apron protection
			Y_t/D	0.277778		

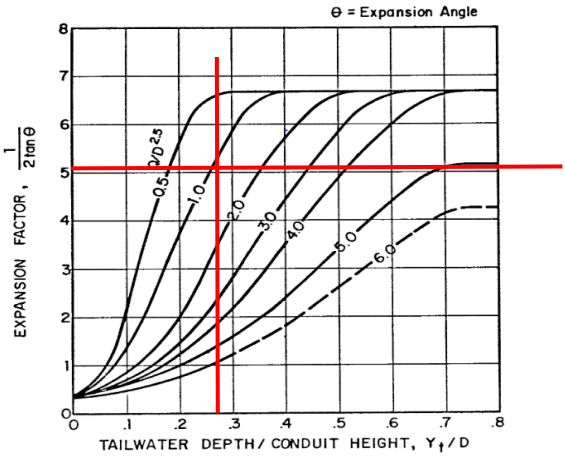


Figure 9-35. Expansion factor for circular conduits

$$L_p = \left(\frac{1}{2\tan\theta}\right)\left(\frac{A_t}{Y_t} - W\right)$$ Equation 9-11

Where:

L_p = length of protection (ft)

W = width of the conduit (ft, use diameter for circular conduits)

Y_t = tailwater depth (ft)

θ = the expansion angle of the culvert flow

and:

$$A_t = \frac{Q}{V}$$ Equation 9-12

Where:

Q = design discharge (cfs)

V = the allowable non-eroding velocity in the downstream channel (ft/sec)

A_t = required area of flow at allowable velocity (ft²)

$$\theta = \tan^{-1}\left(\frac{1}{2(\text{ExpansionFactor})}\right)$$ Equation 9-13

Where:

Expansion Factor = determined using Figure 9-35 or 9-36

T is then calculated using the following equation:

$$T = 2(L_p \tan\theta) + W$$ Equation 9-14

In certain circumstances, Equation 9-11 may yield unreasonable results. Therefore, in no case should L_p be less than $3H$ or $3D$, nor does L_p need to be greater than $10H$ or $10D$ whenever the Froude parameter, $Q/WH^{1.5}$ or $Q/D^{2.5}$, is less than 8.0 or 6.0, respectively. Whenever the Froude parameter is greater than these maximums, increase the maximum L_p required by ¼ D_c or ¼ H for circular or rectangular (box) culverts, respectively, for each whole number by which the Froude parameter is greater than 8.0 or 6.0, respectively.

Once L_p has been determined, the width of the riprap protection at the furthest downstream point should be verified. This dimension is labeled "T" on Figure 9-34. The first step is to solve for θ using the results from Figure 9-35 or 9-36:

Is L_p less than 3D:	YES
Is L_p greater than 10D and the Froude number less than 6:	NO
Is the Froude number greater than 6:	NO
If YES, then by how many whole numbers:	0

New L_p	13.5 ft

Goodhue Ditch Riprap Type

Riprap Type Selection for Circular Conduits

Variables			Calculations		
D =	4.5 ft		**D_a**	2.98 ft	
Q =	50 ft^3/s		**Q/(D^1.5)**	5.2	
Y_t =	1.25 ft		**Riprap Size =**	L	Using Figure 9-38
Y_t/D =	0.277778				
Y_n =	1.46 ft	(normal depth of supercritical flow)			

3.2.3 Rock Sizing for Riprap Apron and Low Tailwater Basin

Scour resulting from highly turbulent, rapidly decelerating flow is a common problem at conduit outlets. The following section summarizes the method for sizing riprap protection for both riprap aprons (Section 3.2.1) and low tailwater basins (Section 3.2.2).

Use Figure 9-38 to determine the required rock size for circular conduits and Figure 9-39 for rectangular conduits. Figure 9-38 is valid for $Q/D_c^{2.5}$ of 6.0 or less and Figure 9-39 is valid for $Q/WH^{1.5}$ of 8.0 or less. The parameters in these two figures are:

References: UDFCD Criteria Manual Volume 2 (March 2017)

1. $Q/D^{1.5}$ or $Q/WH^{0.5}$ in which Q is the design discharge in cfs, D_c is the diameter of a circular conduit in feet, and W and H are the width and height of a rectangular conduit in feet.
2. Y_t/D_c or Y_t/H in which Y_t is the tailwater depth in feet, D_c is the diameter of a circular conduit in feet, and H is the height of a rectangular conduit in feet. In cases where Y_t is unknown or a hydraulic jump is suspected downstream of the outlet, use $Y_t/D_t = Y_t/H = 0.40$ when using Figures 9-38 and 9-39.
3. The riprap size requirements in Figures 9-38 and 9-39 are based on the non-dimensional parametric Equations 9-16 and 9-17 (Steven, Simons, and Watts 1971 and Smith 1975).

Circular culvert:

$$d_{50} = \frac{0.023Q}{Y_t^{1.2} D_c^{0.3}} \qquad \text{Equation 9-16}$$

Can use figure 9-38:	YES	
Is a hydraulic jump expected downstream:	NO	(Type "YES" or "NO")
Is the flow in the culvert supercritical:	YES	(Type "YES" or "NO")
New Y_t/D =	0.419463	

These rock size requirements assume that the flow in the culvert is subcritical. It is possible to use Equations 9-16 and 9-17 when the flow in the culvert is supercritical (and less than full) if the value of D_c or H is modified for use in Figures 9-38 and 9-39. Note that rock sizes referenced in these figures are defined in the *Open Channels* chapter. Whenever the flow is supercritical in the culvert, substitute D_a for D_c and H_a for H, in which D_a is defined as:

$$D_a = \frac{(D_c + Y_n)}{2} \qquad \text{Equation 9-18}$$

Where the maximum value of D_a shall not exceed D_c, and

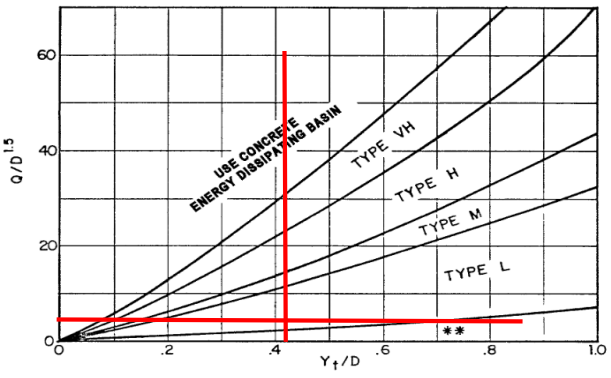
D_a = parameter to use in place of D in Figure 9-38 when flow is supercritical (ft)

D_c = diameter of circular culvert (ft)

H_a = parameter to use in place of H in Figure 9-39 when flow is supercritical (ft)

H = height of rectangular culvert (ft)

Y_n = normal depth of supercritical flow in the culvert (ft)



Use D_a instead of D whenever flow is supercritical in the barrel.
** Use Type L for a distance of 3D downstream.

Figure 9-38. Riprap erosion protection at circular conduit outlet (valid for Q/D2.5 ≤ 6.0)

Is L_p equal to 3D: YES **If YES, Riprap type will be L**

Q = 256 CFS

Rockcreek Tributary UDFCD Channel Riprap Sizing

Mild Slope Channel Bottom Riprap (for < 2% Longitudinal Slopes & Subcritical Flo

Variables		Calculations	
V =	7 ft/s	D_{50} =	0.289237 ft
S =	0.012 ft/ft	D_{50} =	3.470848 in
G_s =	2.6	Chosen Riprap Size	Type VL

$$d_{50} \geq \left[\frac{VS^{0.17}}{4.5(G_s - 1)^{0.66}}\right]^2$$ Equation

Where:

V = mean channel velocity (ft/sec)

S = longitudinal channel slope (ft/ft)

d_{50} = mean rock size (ft)

Gs = specific gravity of stone (minimum = 2.50, typically 2.5 to 2.7), Note: In this equation considers the buoyancy of the water, in that the specific gravity of water is subtracted from t specific gravity of the rock.

Note that Equation 8-11 is applicable for sizing riprap for channel lining with a longitudinal slope more than 2%. This equation is not intended for use in sizing riprap for steep slopes (typically in of 2 percent), rundowns, or protection downstream of culverts. Information on rundowns is provi Section 7.0 of the *Hydraulic Structures* chapter of the USDCM, and protection downstream of cu discussed in the *Culverts and Bridges* chapter. For channel slopes greater than 2% use one of the methods presented in 8.1.2.

Rock size does not need to be increased for steeper channel side slopes, provided the side slopes steeper than 2.5H:1V (UDFCD 1982). Channel side slopes steeper than 2.5H:1V are not recomm because of stability, safety, and maintenance considerations. See Figure 8-34 for riprap placemer specifications. At the upstream and downstream termination of a riprap lining, the thickness shou increased 50% for at least 3 feet to prevent undercutting.

Table 1: Riprap Gradation

Riprap Designation	% Smaller Than Given Size By Weight	Intermediate Rock Dimension (inches)	d_{50}* (inches)
Type VL	70 - 100 50 - 70 35 - 50 2 - 10	12 9 6 2	6**
Type L	70 - 100 50 - 70 35 - 50 2 - 10	15 12 9 3	9**
Type M	70 - 100 50 - 70 35 - 50 2 - 10	21 18 12 4	12**
Type H	70 - 100 50 - 70 35 - 50 2 - 10	30 24 18 6	18
Type VH	70 - 100 50 - 70 35 - 50 2 - 10	41 33 24 9	24

*d_{50} = Mean Particle Size

**Mix VL, L and M riprap with 35% topsoil (by volume) and bury it with 4 to 6 inches of topsoil, all vibration compacted, and revegetate.

10-yr Culvert Riprap Sizing West Campus

Riprap Apron Sizing - 10YR Campus West Culvert (STA 30+00)

Variables		Calculations		
Q =	262 ft^3/s			
V =	7 ft/s	**L_p**	34.5 ft	Length of riprap apron protection
H =	5 ft	**A_t**	37.42857 ft^2	
W =	7 ft	**Expansion Factor**	6.5	Determined from Fig 9-36
Y_t =	3.04 ft	**ϴ**	0.076772	Expansion angle of culvert flow
		Q/WH^3/2	1.265317	
		T	7.1 ft	Width of Riprap apron protection
		Yt/H	0.608	

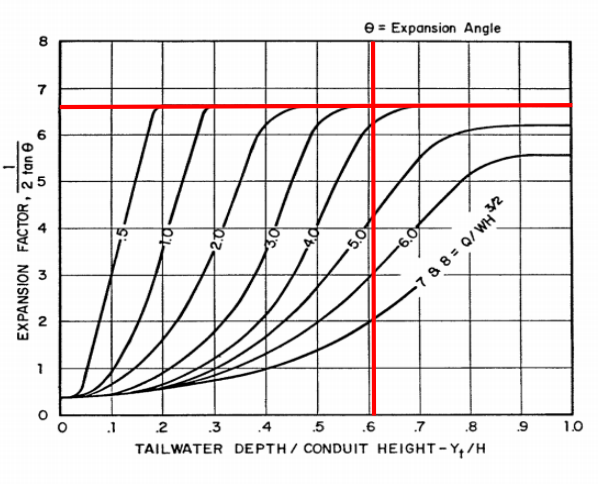


Figure 9-36. Expansion factor for rectangular conduits

$$L_p = \left(\frac{1}{2\tan\theta}\right)\left(\frac{A_t}{Y_t} - W\right) \qquad \text{Equation 9-11}$$

Where:

L_p = length of protection (ft)

W = width of the conduit (ft, use diameter for circular conduits)

Y_t = tailwater depth (ft)

θ = the expansion angle of the culvert flow

and:

$$A_t = \frac{Q}{V} \qquad \text{Equation 9-12}$$

Where:

Q = design discharge (cfs)

V = the allowable non-eroding velocity in the downstream channel (ft/sec)

A_t = required area of flow at allowable velocity (ft²)

$$\theta = \tan^{-1}\left(\frac{1}{2(\text{ExpansionFactor})}\right) \qquad \text{Equation 9-13}$$

Where:

Expansion Factor = determined using Figure 9-35 or 9-36

T is then calculated using the following equation:

$$T = 2(L_p \tan\theta) + W \qquad \text{Equation 9-14}$$

In certain circumstances, Equation 9-11 may yield unreasonable results. Therefore, in no case should L_p be less than $3H$ or $3D$, nor does L_p need to be greater than $10H$ or $10D$ whenever the Froude parameter, $Q/WH^{1.5}$ or $Q/D^{2.5}$, is less than 8.0 or 6.0, respectively. Whenever the Froude parameter is greater than these maximums, increase the maximum L_p required by ¼ D_c or ¼ H for circular or rectangular (box) culverts, respectively, for each whole number by which the Froude parameter is greater than 8.0 or 6.0, respectively.

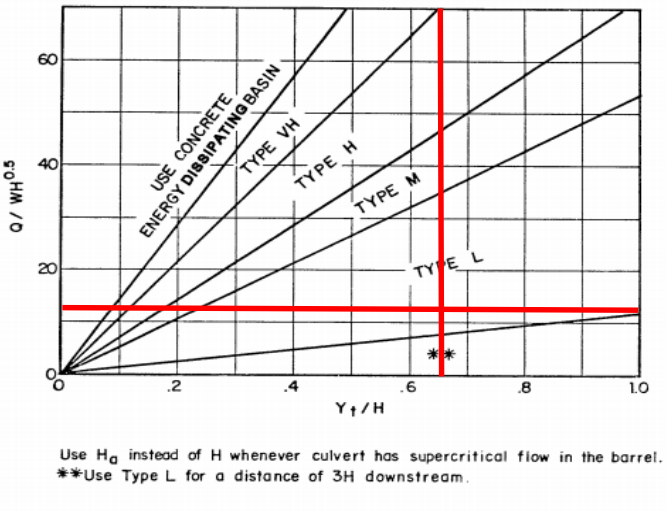
Once L_p has been determined, the width of the riprap protection at the furthest downstream point should be verified. This dimension is labeled "T" on Figure 9-34. The first step is to solve for θ using the results from Figure 9-35 or 9-36:

10-yr Culvert Riprap Type West Campus

Riprap Type Selection - 10YR Campus West Culvert (STA 30+00)

Cannot use 9-17 due to super critical flow - see HY-8 Calculations

H =	8 ft	**H_a**	4.67 ft
Q =	262 ft^3/s	**Y_n**	1.34 ft
Y_t	3.04 ft	**Q/(W*H_a^.5)**	12.1
W	10 ft	**Y_t/H_a**	0.65
		Riprap Size =	L Using Figure 9-39



References: UDFCD Criteria Manual Volume 2 (March 2017)

Figure 9-39. Riprap erosion protection at rectangular conduit outlet (valid for Q/WH1.5 ≤ 8.0)

Rectangular culvert:

$$d_{50} = \frac{0.014 H^{0.5} Q}{Y_t W}$$ Equation 9-17

These rock size requirements assume that the flow in the culvert is subcritical. It is possible to use Equations 9-16 and 9-17 when the flow in the culvert is supercritical (and less than full) if the value of D_c or H is modified for use in Figures 9-38 and 9-39. Note that rock sizes referenced in these figures are defined in the *Open Channels* chapter. Whenever the flow is supercritical in the culvert, substitute D_a for D_c and H_a for H, in which D_a is defined as:

$$D_a = \frac{(D_c + Y_n)}{2}$$ Equation 9-18

$$H_a = \frac{(H + Y_n)}{2}$$ Equation 9-19

Where the maximum value of H_a shall not exceed H, and:

D_a = parameter to use in place of D in Figure 9-38 when flow is supercritical (ft)

D_c = diameter of circular culvert (ft)

H_a = parameter to use in place of H in Figure 9-39 when flow is supercritical (ft)

H = height of rectangular culvert (ft)

Y_n = normal depth of supercritical flow in the culvert (ft)

PED Culvert Riprap Sizing West Campus

Riprap Apron Sizing - PED Campus West Culvert (STA 30+00)

Variables			Calculations		
Q =	262	ft^3/s			
V =	5	ft/s	**L_p**	47.0 ft	Length of riprap apron protection
H =	8	ft	**A_t**	52.4 ft^2	
W =	10	ft	**Expansion Factor**	6.5	Determined from Fig 9-36
Y_t =	3.04	ft	**Θ**	0.076772	Expansion angle of culvert flow
			Q/WH^3/2	0.366156	
			T	10.1 ft	Width of Riprap apron protection
			Yt/h	0.38	

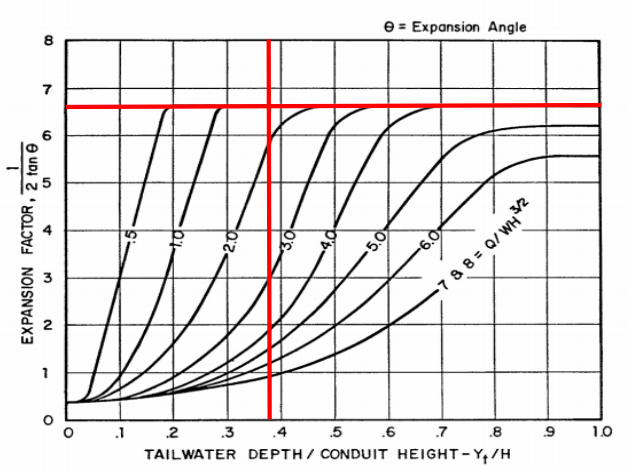


Figure 9-36. Expansion factor for rectangular conduits

$$L_p = \left(\frac{1}{2\tan\theta}\right)\left(\frac{A_t}{Y_t} - W\right)$$ Equation 9-11

Where:

L_p = length of protection (ft)

W = width of the conduit (ft, use diameter for circular conduits)

Y_t = tailwater depth (ft)

θ = the expansion angle of the culvert flow

and:

$$A_t = \frac{Q}{V}$$ Equation 9-12

Where:

Q = design discharge (cfs)

V = the allowable non-eroding velocity in the downstream channel (ft/sec)

A_t = required area of flow at allowable velocity (ft²)

$$\theta = \tan^{-1}\left(\frac{1}{2(\text{ExpansionFactor})}\right)$$ Equation 9-13

Where:

Expansion Factor = determined using Figure 9-35 or 9-36

T is then calculated using the following equation:

$$T = 2(L_p \tan\theta) + W$$ Equation 9-14

In certain circumstances, Equation 9-11 may yield unreasonable results. Therefore, in no case should L_p be less than $3H$ or $3D$, nor does L_p need to be greater than $10H$ or $10D$ whenever the Froude parameter, $Q/WH^{1.5}$ or $Q/D^{2.5}$, is less than 8.0 or 6.0, respectively. Whenever the Froude parameter is greater than these maximums, increase the maximum L_p required by ¼ D_c or ¼ H for circular or rectangular (box) culverts, respectively, for each whole number by which the Froude parameter is greater than 8.0 or 6.0, respectively.

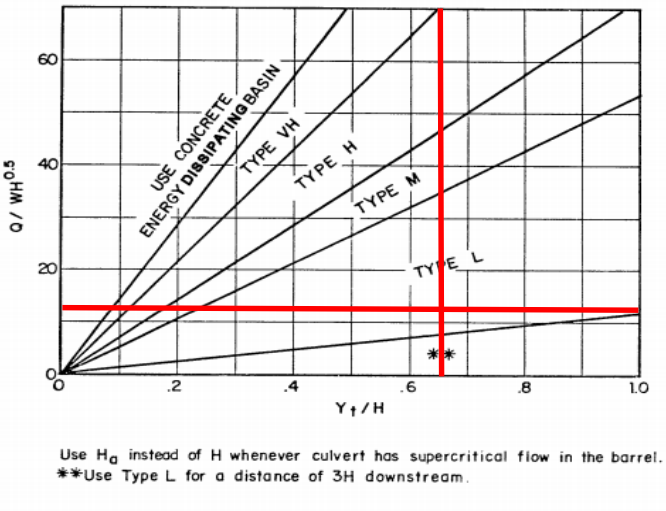
Once L_p has been determined, the width of the riprap protection at the furthest downstream point should be verified. This dimension is labeled "T" on Figure 9-34. The first step is to solve for θ using the results from Figure 9-35 or 9-36:

PED Culvert Riprap Type West Campus

Riprap Type Selection - PED Campus West Culvert (STA 30+00)

Cannot use 9-17 due to super critical flow - see HY-8 Calculations

H =	8 ft	**H_a**	4.415 ft
Q =	262 ft^3/s	**Y_n**	0.83 ft
Y_t	3.04 ft	**Q/(W*H_a^.5)**	12.5
W	10 ft	**Y_t/H_a**	0.69
		Riprap Size =	L Using Figure 9-39



References: UDFCD Criteria Manual Volume 2 (March 2017)

Figure 9-39. Riprap erosion protection at rectangular conduit outlet (valid for Q/WH1.5 ≤ 8.0)

Rectangular culvert:

$$d_{50} = \frac{0.014 H^{0.5} Q}{Y_t W}$$ Equation 9-17

These rock size requirements assume that the flow in the culvert is subcritical. It is possible to use Equations 9-16 and 9-17 when the flow in the culvert is supercritical (and less than full) if the value of D_c or H is modified for use in Figures 9-38 and 9-39. Note that rock sizes referenced in these figures are defined in the *Open Channels* chapter. Whenever the flow is supercritical in the culvert, substitute D_a for D_c and H_a for H, in which D_a is defined as:

$$D_a = \frac{(D_c + Y_n)}{2}$$ Equation 9-18

$$H_a = \frac{(H + Y_n)}{2}$$ Equation 9-19

Where the maximum value of H_a shall not exceed H, and:

D_a = parameter to use in place of D in Figure 9-38 when flow is supercritical (ft)

D_c = diameter of circular culvert (ft)

H_a = parameter to use in place of H in Figure 9-39 when flow is supercritical (ft)

H = height of rectangular culvert (ft)

Y_n = normal depth of supercritical flow in the culvert (ft)

10-yr Culvert Riprap Sizing East Campus

Riprap Apron Sizing - 10-YR Campus East Culvert (STA 7+00)

Variables		Calculations		
Q =	262 ft^3/s			
V =	5 ft/s	**L_p**	53.1 ft	Length of riprap apron protection
H =	5 ft	**A_t**	52.4 ft^2	
W =	8 ft	**Expansion Factor**	6.5	Determined from Fig 9-36
Y_t =	3.24 ft	**ϴ**	0.076772	Expansion angle of culvert flow
		Q/WH^3/2	1.035646	
		T	8.1 ft	Width of Riprap apron protection
		Yt/h	0.648	

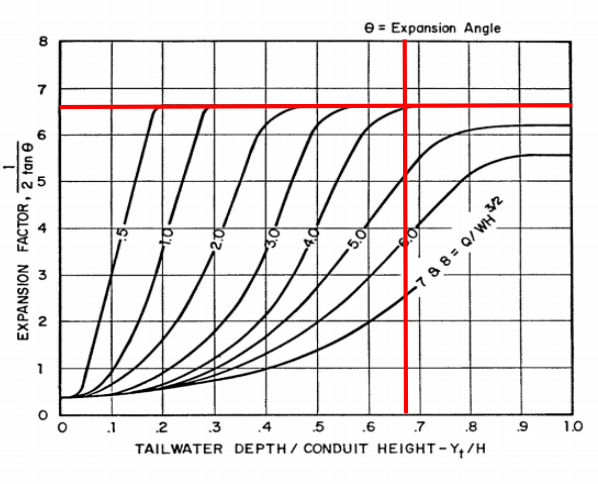


Figure 9-36. Expansion factor for rectangular conduits

$$L_p = \left(\frac{1}{2\tan\theta}\right)\left(\frac{A_t}{Y_t} - W\right)$$ Equation 9-11

Where:

L_p = length of protection (ft)

W = width of the conduit (ft, use diameter for circular conduits)

Y_t = tailwater depth (ft)

θ = the expansion angle of the culvert flow

and:

$$A_t = \frac{Q}{V}$$ Equation 9-12

Where:

Q = design discharge (cfs)

V = the allowable non-eroding velocity in the downstream channel (ft/sec)

A_t = required area of flow at allowable velocity (ft²)

$$\theta = \tan^{-1}\left(\frac{1}{2(\text{ExpansionFactor})}\right)$$ Equation 9-13

Where:

Expansion Factor = determined using Figure 9-35 or 9-36

T is then calculated using the following equation:

$$T = 2(L_p \tan\theta) + W$$ Equation 9-14

In certain circumstances, Equation 9-11 may yield unreasonable results. Therefore, in no case should L_p be less than $3H$ or $3D$, nor does L_p need to be greater than $10H$ or $10D$ whenever the Froude parameter, $Q/WH^{1.5}$ or $Q/D^{2.5}$, is less than 8.0 or 6.0, respectively. Whenever the Froude parameter is greater than these maximums, increase the maximum L_p required by ¼ D_c or ¼ H for circular or rectangular (box) culverts, respectively, for each whole number by which the Froude parameter is greater than 8.0 or 6.0, respectively.

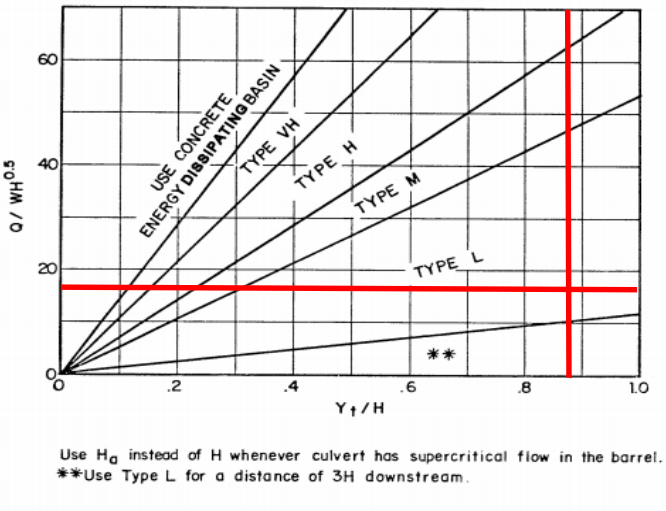
Once L_p has been determined, the width of the riprap protection at the furthest downstream point should be verified. This dimension is labeled "T" on Figure 9-34. The first step is to solve for θ using the results from Figure 9-35 or 9-36:

10-yr Culvert Riprap Type East Campus

Riprap Type Selection - 10YR Campus East Culvert (STA 7+00)

Cannot use 9-17 due to super critical flow - see HY-8 Calculations

H =	5 ft	**H_a**	3.71 ft
Q =	262 ft^3/s	**Y_n**	2.42 ft
Y_t	3.24 ft	**Q/(W*H_a^.5)**	17.0
W	8 ft	**Y_t/H_a**	0.87
		Riprap Size =	L Using Figure 9-39



References: UDFCD Criteria Manual Volume 2 (March 2017)

Figure 9-39. Riprap erosion protection at rectangular conduit outlet (valid for Q/WH1.5 ≤ 8.0)

Rectangular culvert:

$$d_{50} = \frac{0.014 H^{0.5} Q}{Y_t W}$$ Equation 9-17

These rock size requirements assume that the flow in the culvert is subcritical. It is possible to use Equations 9-16 and 9-17 when the flow in the culvert is supercritical (and less than full) if the value of D_c or H is modified for use in Figures 9-38 and 9-39. Note that rock sizes referenced in these figures are defined in the *Open Channels* chapter. Whenever the flow is supercritical in the culvert, substitute D_a for D_c and H_a for H, in which D_a is defined as:

$$D_a = \frac{(D_c + Y_n)}{2}$$ Equation 9-18

$$H_a = \frac{(H + Y_n)}{2}$$ Equation 9-19

Where the maximum value of H_a shall not exceed H, and:

D_a = parameter to use in place of D in Figure 9-38 when flow is supercritical (ft)

D_c = diameter of circular culvert (ft)

H_a = parameter to use in place of H in Figure 9-39 when flow is supercritical (ft)

H = height of rectangular culvert (ft)

Y_n = normal depth of supercritical flow in the culvert (ft)

PED Culvert Riprap Sizing East Campus

Riprap Apron Sizing - PED Campus East Culvert (STA 7+00)

Variables			Calculations		
Q =	262	ft^3/s			
V =	5	ft/s	**L_p**	40.1 ft	Length of riprap apron protection
H =	8	ft	**A_t**	52.4 ft^2	
W =	10	ft	**Expansion Factor**	6.5	Determined from Fig 9-36
Y_t =	3.24	ft	**ϴ**	0.076772	Expansion angle of culvert flow
			Q/WH^3/2	0.366156	
			T	10.1 ft	Width of Riprap apron protection
			Yt/h	0.405	

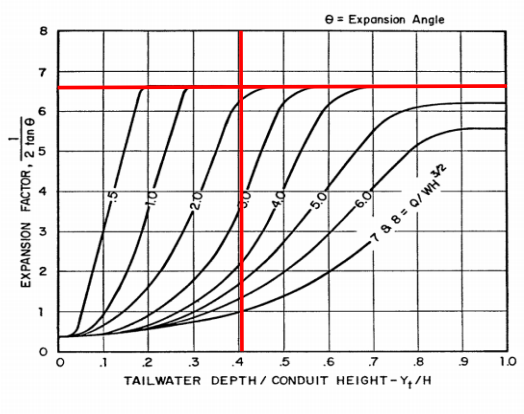


Figure 9-36. Expansion factor for rectangular conduits

$$L_p = \left(\frac{1}{2\tan\theta}\right)\left(\frac{A_t}{Y_t} - W\right)$$ Equation 9-11

Where:

L_p = length of protection (ft)

W = width of the conduit (ft, use diameter for circular conduits)

Y_t = tailwater depth (ft)

θ = the expansion angle of the culvert flow

and:

$$A_t = \frac{Q}{V}$$ Equation 9-12

Where:

Q = design discharge (cfs)

V = the allowable non-eroding velocity in the downstream channel (ft/sec)

A_t = required area of flow at allowable velocity (ft²)

$$\theta = \tan^{-1}\left(\frac{1}{2(\text{ExpansionFactor})}\right)$$ Equation 9-13

Where:

Expansion Factor = determined using Figure 9-35 or 9-36

T is then calculated using the following equation:

$$T = 2(L_p \tan\theta) + W$$ Equation 9-14

In certain circumstances, Equation 9-11 may yield unreasonable results. Therefore, in no case should L_p be less than $3H$ or $3D$, nor does L_p need to be greater than $10H$ or $10D$ whenever the Froude parameter, $Q/WH^{1.5}$ or $Q/D^{2.5}$, is less than 8.0 or 6.0, respectively. Whenever the Froude parameter is greater than these maximums, increase the maximum L_p required by ¼ D_c or ¼ H for circular or rectangular (box) culverts, respectively, for each whole number by which the Froude parameter is greater than 8.0 or 6.0, respectively.

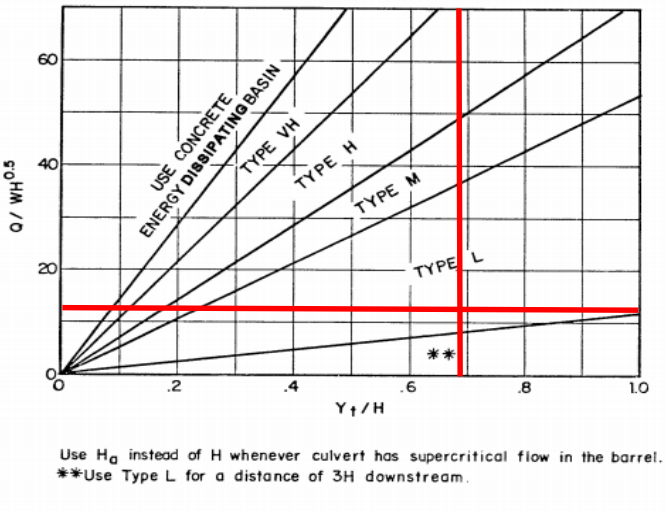
Once L_p has been determined, the width of the riprap protection at the furthest downstream point should be verified. This dimension is labeled "T" on Figure 9-34. The first step is to solve for θ using the results from Figure 9-35 or 9-36:

PED Culvert Riprap Type East Campus

Riprap Type Selection - PED Campus East Culvert (STA 7+00)

Cannot use 9-17 due to super critical flow - see HY-8 Calculations

H =	8 ft	**H_a**	4.715 ft
Q =	262 ft^3/s	**Y_n**	1.43 ft
Y_t	3.24 ft	**Q/(W*H_a^.5)**	12.1
W	10 ft	**Y_t/H_a**	0.69
		Riprap Size =	L Using Figure 9-39



References: UDFCD Criteria Manual Volume 2 (March 2017)

Figure 9-39. Riprap erosion protection at rectangular conduit outlet (valid for Q/WH1.5 ≤ 8.0)

Rectangular culvert:

$$d_{50} = \frac{0.014 H^{0.5} Q}{Y_t W}$$ Equation 9-17

These rock size requirements assume that the flow in the culvert is subcritical. It is possible to use Equations 9-16 and 9-17 when the flow in the culvert is supercritical (and less than full) if the value of D_c or H is modified for use in Figures 9-38 and 9-39. Note that rock sizes referenced in these figures are defined in the *Open Channels* chapter. Whenever the flow is supercritical in the culvert, substitute D_a for D_c and H_a for H, in which D_a is defined as:

$$D_a = \frac{(D_c + Y_n)}{2}$$ Equation 9-18

$$H_a = \frac{(H + Y_n)}{2}$$ Equation 9-19

Where the maximum value of H_a shall not exceed H, and:

D_a = parameter to use in place of D in Figure 9-38 when flow is supercritical (ft)

D_c = diameter of circular culvert (ft)

H_a = parameter to use in place of H in Figure 9-39 when flow is supercritical (ft)

H = height of rectangular culvert (ft)

Y_n = normal depth of supercritical flow in the culvert (ft)

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INLET MANAGEMENT

Worksheet Protected

INLET NAME	Basin C-3-1 (Str. AG1)	Basin C-3-2 (Str. AG2)	Basin C-3-3 (Str. AF1)	Basin C-3-4 (Str. AF2)	Basin C-3-5 (Str. AE1)
Site Type (Urban or Rural)		URBAN	URBAN	URBAN	URBAN
Inlet Application (Street or Area)	STREET	STREET	STREET	STREET	STREET
Hydraulic Condition	On Grade	On Grade	On Grade	On Grade	On Grade
Inlet Type	CDOT Type R Curb Opening	CDOT Type R Curb Opening	CDOT Type R Curb Opening	CDOT Type R Curb Opening	CDOT Type R Curb Opening

USER-DEFINED INPUT

User-Defined Design Flows

Minor Q_{Known} (cfs)	1.0	0.8	0.3	0.3	0.8
Major Q_{Known} (cfs)	2.9	2.3	0.9	0.9	2.3

Bypass (Carry-Over) Flow from Upstream Inlets must be organized from upstream (left) to downstream (right) in order for bypass flows to be linked.

Receive Bypass Flow from:	No Bypass Flow Received	No Bypass Flow Received	Basin C-3-1 (Str. AG1)	Basin C-3-2 (Str. AG2)	Basin C-3-3 (Str. AF1)
Minor Bypass Flow Received, Q_b (cfs)	0.0	0.0	0.0	0.0	0.0
Major Bypass Flow Received, Q_b (cfs)	0.0	0.0	0.7	0.4	0.1

Watershed Characteristics

Subcatchment Area (acres)					
Percent Impervious					
NRCS Soil Type					

Watershed Profile

Overland Slope (ft/ft)					
Overland Length (ft)					
Channel Slope (ft/ft)					
Channel Length (ft)					

Minor Storm Rainfall Input

Design Storm Return Period, T_r (years)					
One-Hour Precipitation, P_1 (inches)					

Major Storm Rainfall Input

Design Storm Return Period, T_r (years)					
One-Hour Precipitation, P_1 (inches)					

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INLET MANAGEMENT

Worksheet Protected

INLET NAME	Basin C-3-6 (Str. AE2)	Basin C-3-7 (Str. AD2)	Basin C-3-8 (Str. AD1)	Basin C-3-15 (Str. AC2)	Basin C-3-16 (Str. AC1)
Site Type (Urban or Rural)	URBAN	URBAN	URBAN	URBAN	URBAN
Inlet Application (Street or Area)	STREET	STREET	STREET	STREET	STREET
Hydraulic Condition	On Grade	On Grade	On Grade	On Grade	On Grade
Inlet Type	CDOT Type R Curb Opening	CDOT Type R Curb Opening	CDOT Type R Curb Opening	CDOT Type R Curb Opening	CDOT Type R Curb Opening

USER-DEFINED INPUT

User-Defined Design Flows

Minor Q_{Known} (cfs)	0.7	0.9	0.8	0.3	0.3
Major Q_{Known} (cfs)	2.0	2.6	2.4	0.9	0.9

Bypass (Carry-Over) Flow from Upstream

Receive Bypass Flow from:	Basin C-3-4 (Str. AF2)	Basin C-3-5 (Str. AE1)	Basin C-3-6 (Str. AE2)	Basin C-3-7 (Str. AD2)	Basin C-3-8 (Str. AD1)
Minor Bypass Flow Received, Q_b (cfs)	0.0	0.0	0.0	0.0	0.0
Major Bypass Flow Received, Q_b (cfs)	0.0	0.4	0.2	0.8	0.6

Watershed Characteristics

Subcatchment Area (acres)					
Percent Impervious					
NRCS Soil Type					

Watershed Profile

Overland Slope (ft/ft)					
Overland Length (ft)					
Channel Slope (ft/ft)					
Channel Length (ft)					

Minor Storm Rainfall Input

Design Storm Return Period, T_r (years)					
One-Hour Precipitation, P_1 (inches)					

Major Storm Rainfall Input

Design Storm Return Period, T_r (years)					
One-Hour Precipitation, P_1 (inches)					

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INLET MANAGEMENT

Worksheet Protected

INLET NAME	Basin C-3-17 (Str. AB2)	Basin C-3-18 (Str. AB1)	Basin C-3-19 (Str. B3)	Basin C-3-20 (Str. AA1)	Basin C-3-21 (Str. A2)
Site Type (Urban or Rural)	URBAN	URBAN	URBAN	URBAN	URBAN
Inlet Application (Street or Area)	STREET	STREET	STREET	STREET	STREET
Hydraulic Condition	On Grade	On Grade	On Grade	In Sump	In Sump
Inlet Type	CDOT Type R Curb Opening	CDOT Type R Curb Opening	CDOT Type R Curb Opening	CDOT Type R Curb Opening	CDOT Type R Curb Opening

USER-DEFINED INPUT

User-Defined Design Flows

Minor Q_{Known} (cfs)	0.4	0.4	0.7	1.2	1.2
Major Q_{Known} (cfs)	1.0	1.1	2.0	3.5	3.6

Bypass (Carry-Over) Flow from Upstream

Receive Bypass Flow from:	Basin C-3-15 (Str. AC2)	Basin C-3-16 (Str. AC1)	Basin C-3-18 (Str. AB1)	Basin C-3-17 (Str. AB2)	No Bypass Flow Received
Minor Bypass Flow Received, Q_b (cfs)	0.0	0.0	0.0	0.0	0.0
Major Bypass Flow Received, Q_b (cfs)	0.1	0.1	0.0	0.0	0.0

Watershed Characteristics

Subcatchment Area (acres)					
Percent Impervious					
NRCS Soil Type					

Watershed Profile

Overland Slope (ft/ft)					
Overland Length (ft)					
Channel Slope (ft/ft)					
Channel Length (ft)					

Minor Storm Rainfall Input

Design Storm Return Period, T_r (years)					
One-Hour Precipitation, P_1 (inches)					

Major Storm Rainfall Input

Design Storm Return Period, T_r (years)					
One-Hour Precipitation, P_1 (inches)					

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INLET MANAGEMENT

Worksheet Protected

INLET NAME	Basin C-4-1 (Str. OS-A3)	Basin C-4-2 (Str. OS-A2)	Basin C-5-10 (Str. D3)	Basin C-5-9 (Str. CB1)	Basin C-5-11 (Str. D2)
Site Type (Urban or Rural)	URBAN	URBAN	URBAN	URBAN	URBAN
Inlet Application (Street or Area)	STREET	STREET	STREET	STREET	STREET
Hydraulic Condition	On Grade	On Grade	On Grade	In Sump	On Grade
Inlet Type	CDOT Type R Curb Opening	CDOT Type R Curb Opening	CDOT Type R Curb Opening	CDOT Type R Curb Opening	CDOT Type R Curb Opening

USER-DEFINED INPUT

User-Defined Design Flows

Minor Q_{Known} (cfs)	0.8	1.2	0.4	0.5	0.4
Major Q_{Known} (cfs)	2.6	3.6	1.3	1.5	1.3

Bypass (Carry-Over) Flow from Upstream

Receive Bypass Flow from:	Basin C-3-19 (Str. B3)	No Bypass Flow Received	No Bypass Flow Received	Basin C-5-10 (Str. D3)	No Bypass Flow Received
Minor Bypass Flow Received, Q_b (cfs)	0.0	0.0	0.0	0.0	0.0
Major Bypass Flow Received, Q_b (cfs)	0.2	0.0	0.0	0.0	0.0

Watershed Characteristics

Subcatchment Area (acres)					
Percent Impervious					
NRCS Soil Type					

Watershed Profile

Overland Slope (ft/ft)					
Overland Length (ft)					
Channel Slope (ft/ft)					
Channel Length (ft)					

Minor Storm Rainfall Input

Design Storm Return Period, T_r (years)					
One-Hour Precipitation, P_1 (inches)					

Major Storm Rainfall Input

Design Storm Return Period, T_r (years)					
One-Hour Precipitation, P_1 (inches)					

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INLET MANAGEMENT

Worksheet Protected

INLET NAME	Basin C-5-12 (Str. CA1)	Basin C-5-13 (Str. C1)	Basin C-6-1 (Str. G2)	Basin C-6-2 (Str. RS1)	Basin C-6-3 (Str. GA1)
Site Type (Urban or Rural)	URBAN	URBAN	URBAN	URBAN	URBAN
Inlet Application (Street or Area)	STREET	STREET	STREET	STREET	STREET
Hydraulic Condition	On Grade	On Grade	On Grade	On Grade	In Sump
Inlet Type	CDOT Type R Curb Opening	CDOT Type R Curb Opening	CDOT Type R Curb Opening	CDOT Type R Curb Opening	CDOT Type R Curb Opening

USER-DEFINED INPUT

User-Defined Design Flows

Minor Q_{Known} (cfs)	0.8	0.7	0.5	0.6	0.4
Major Q_{Known} (cfs)	2.2	2.0	1.5	1.8	1.1

Bypass (Carry-Over) Flow from Upstream

Receive Bypass Flow from:	No Bypass Flow Received	Basin C-5-11 (Str. D2)	Basin C-5-12 (Str. CA1)	Basin C-5-13 (Str. C1)	Basin C-6-1 (Str. G2)
Minor Bypass Flow Received, Q_b (cfs)	0.0	0.0	0.0	0.0	0.0
Major Bypass Flow Received, Q_b (cfs)	0.0	0.0	0.0	0.0	0.0

Watershed Characteristics

Subcatchment Area (acres)					
Percent Impervious					
NRCS Soil Type					

Watershed Profile

Overland Slope (ft/ft)					
Overland Length (ft)					
Channel Slope (ft/ft)					
Channel Length (ft)					

Minor Storm Rainfall Input

Design Storm Return Period, T_r (years)					
One-Hour Precipitation, P_1 (inches)					

Major Storm Rainfall Input

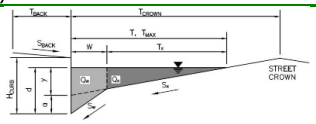
Design Storm Return Period, T_r (years)					
One-Hour Precipitation, P_1 (inches)					

MHFD-Inlet, Version 5.02 (August 2022)

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: Redtail Ridge - Phase 1
Inlet ID: Basin C-3-1 (Str. AG1)



Gutter Geometry:			
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	16.5	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	18.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.025	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.011	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	13.0	13.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	18.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	Q_{allow} =	**7.8**	**7.8**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 0.98 cfs on sheet 'Inlet Management'
Major storm max. allowable capacity GOOD - greater than the design peak flow of 2.90 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

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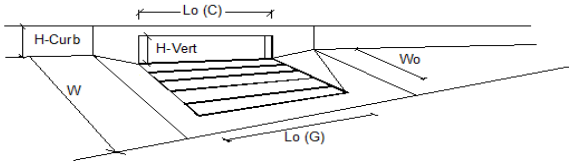


Design Information (Input)		MINOR	MAJOR	
Type of Inlet (CDOT Type R Curb Opening)	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)	W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f (G) =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f (C) =	0.10	0.10	

Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Design Discharge for Half of Street (from *Inlet Management*)	Q_o =	1.0	2.9	cfs
Water Spread Width	T =	4.8	8.5	ft
Water Depth at Flowline (outside of local depression)	d =	2.8	3.9	inches
Water Depth at Street Crown (or at T_{MAX})	d_{CROWN} =	0.0	0.0	inches
Ratio of Gutter Flow to Design Flow	E_o =	0.883	0.630	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	0.1	1.1	cfs
Discharge within the Gutter Section W	Q_w =	0.9	1.8	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.0	0.0	cfs
Flow Area within the Gutter Section W	A_W =	0.30	0.48	sq ft
Velocity within the Gutter Section W	V_W =	2.9	3.8	fps
Water Depth for Design Condition	d_{LOCAL} =	5.8	6.9	inches

Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	N/A	N/A	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	N/A	N/A	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Interception Capacity	Q_i =	N/A	N/A	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoeff =	N/A	N/A	
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =	N/A	N/A	
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =	N/A	N/A	ft
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Actual Interception Capacity	**Q_a =**	**N/A**	**N/A**	**cfs**
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	**Q_b =**	**N/A**	**N/A**	**cfs**

Curb Opening or Slotted Inlet Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e	S_e =	0.187	0.140	ft/ft
Required Length L_T to Have 100% Interception	L_T =	4.19	8.31	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	4.19	5.00	ft
Interception Capacity	Q_i =	1.0	2.3	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoeff =	1.00	1.00	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.10	0.10	
Effective (Unclogged) Length	L_e =	4.19	4.50	ft
Actual Interception Capacity	**Q_a =**	**1.0**	**2.2**	**cfs**
Carry-Over Flow = $Q_{o\text{-}GRATE}$-Q_a	**Q_b =**	**0.0**	**0.7**	**cfs**

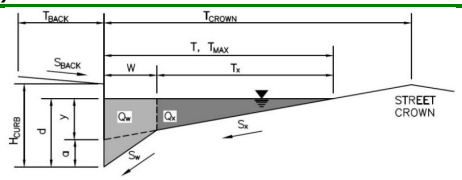
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**1.0**	**2.2**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.7**	**cfs**
Capture Percentage = Q_a/Q_o	**C% =**	**100**	**75**	**%**

Note: Storm sewer should be sized for the sum of the unclogged interception capacities (Qminor = 1 cfs and Qmajor = 2.3 cfs)

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: **Redtail Ridge - Phase 1**
Inlet ID: **Basin C-3-2 (Str. AG2)**



Gutter Geometry:			
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	16.5	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	18.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.025	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.011	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

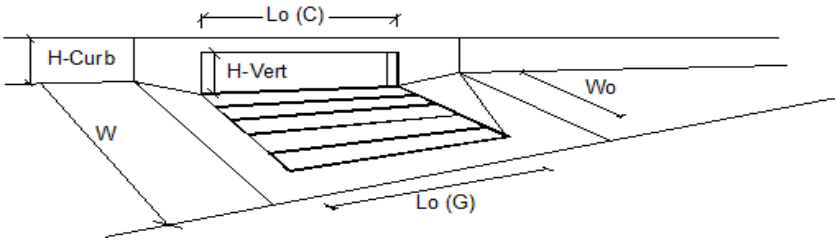
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	13.0	13.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	18.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**7.8**	**7.8**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 0.78 cfs on sheet 'Inlet Management'
Major storm max. allowable capacity GOOD - greater than the design peak flow of 2.34 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.02 (August 2022)



Design Information (Input)	CDOT Type R Curb Opening		MINOR	MAJOR	
Type of Inlet		Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')		a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)		No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)		L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		C_f (G) =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		C_f (C) =	0.10	0.10	

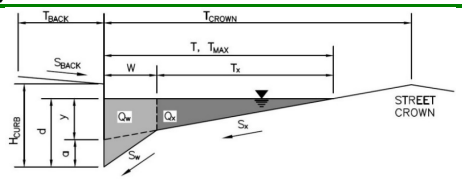
Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**0.8**	**1.9**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.4**	**cfs**
Capture Percentage = Q_a/Q_o	**C% =**	**100**	**83**	**%**

Note: Storm sewer should be sized for the sum of the unclogged interception capacities (Qminor = 0.8 cfs and Qmajor = 2.1 cfs)

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: **Redtail Ridge - Phase 1**
Inlet ID: **Basin C-3-3 (Str. AF1)**



Gutter Geometry:			
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	16.5	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	18.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.025	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.011	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

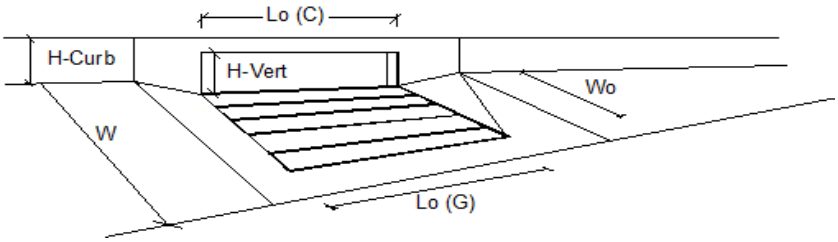
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	13.0	13.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	18.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**7.8**	**7.8**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 0.28 cfs on sheet 'Inlet Management'
Major storm max. allowable capacity GOOD - greater than the design peak flow of 1.58 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.02 (August 2022)



Design Information (Input)	CDOT Type R Curb Opening		MINOR	MAJOR	
Type of Inlet		Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')		a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)		No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)		L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		C_f (G) =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		C_f (C) =	0.10	0.10	

Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**0.3**	**1.5**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.1**	**cfs**
Capture Percentage = Q_a/Q_o	**C% =**	**100**	**94**	**%**

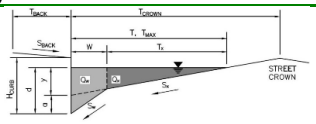
Note: Storm sewer should be sized for the sum of the unclogged interception capacities (Qminor = 0.3 cfs and Qmajor = 1.6 cfs)

MHFD-Inlet, Version 5.02 (August 2022)

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: Redtail Ridge - Phase 1
Inlet ID: Basin C-3-4 (Str. AF2)



Gutter Geometry:			
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	16.5	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.020	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	18.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.025	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.032	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

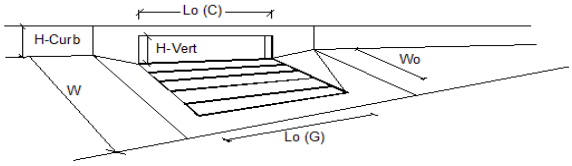
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	13.0	13.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	18.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**13.6**	**13.6**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 0.30 cfs on sheet 'Inlet Management'
Major storm max. allowable capacity GOOD - greater than the design peak flow of 1.34 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.02 (August 2022)



Design Information (Input)		MINOR	MAJOR	
Type of Inlet (CDOT Type R Curb Opening)	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)	W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f (G) =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f (C) =	0.10	0.10	

Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Design Discharge for Half of Street (from *Inlet Management*)	Q_o =	0.3	1.3	cfs
Water Spread Width	T =	1.5	4.1	ft
Water Depth at Flowline (outside of local depression)	d =	1.9	2.6	inches
Water Depth at Street Crown (or at T_{MAX})	d_{CROWN} =	0.0	0.0	inches
Ratio of Gutter Flow to Design Flow	E_o =	1.000	0.932	
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	0.0	0.1	cfs
Discharge within the Gutter Section W	Q_w =	0.3	1.2	cfs
Discharge Behind the Curb Face	Q_{BACK} =	0.0	0.0	cfs
Flow Area within the Gutter Section W	A_W =	0.00	0.27	sq ft
Velocity within the Gutter Section W	V_W =	0.0	4.6	fps
Water Depth for Design Condition	d_{LOCAL} =	4.9	5.6	inches

Grate Analysis (Calculated)		MINOR	MAJOR	
Total Length of Inlet Grate Opening	L =	N/A	N/A	ft
Ratio of Grate Flow to Design Flow	$E_{o\text{-}GRATE}$ =	N/A	N/A	
Under No-Clogging Condition		MINOR	MAJOR	
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Interception Capacity	Q_i =	N/A	N/A	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient for Multiple-unit Grate Inlet	GrateCoeff =	N/A	N/A	
Clogging Factor for Multiple-unit Grate Inlet	GrateClog =	N/A	N/A	
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =	N/A	N/A	ft
Minimum Velocity Where Grate Splash-Over Begins	V_o =	N/A	N/A	fps
Interception Rate of Frontal Flow	R_f =	N/A	N/A	
Interception Rate of Side Flow	R_x =	N/A	N/A	
Actual Interception Capacity	**Q_a =**	**N/A**	**N/A**	**cfs**
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening or next d/s inlet)	**Q_b =**	**N/A**	**N/A**	**cfs**

Curb Opening or Slotted Inlet Analysis (Calculated)		MINOR	MAJOR	
Equivalent Slope S_e	S_e =	0.208	0.196	ft/ft
Required Length L_T to Have 100% Interception	L_T =	2.32	5.12	ft
Under No-Clogging Condition		MINOR	MAJOR	
Effective Length of Curb Opening or Slotted Inlet (minimum of L, L_T)	L =	2.32	5.00	ft
Interception Capacity	Q_i =	0.3	1.3	cfs
Under Clogging Condition		MINOR	MAJOR	
Clogging Coefficient	CurbCoeff =	1.00	1.00	
Clogging Factor for Multiple-unit Curb Opening or Slotted Inlet	CurbClog =	0.10	0.10	
Effective (Unclogged) Length	L_e =	2.32	4.50	ft
Actual Interception Capacity	**Q_a =**	**0.3**	**1.3**	**cfs**
Carry-Over Flow = $Q_{o\text{-}GRATE}$-Q_a	**Q_b =**	**0.0**	**0.0**	**cfs**

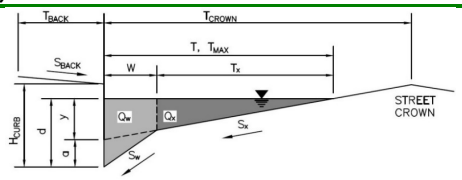
Summary		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**0.3**	**1.3**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.0**	**cfs**
Capture Percentage = Q_a/Q_o	**C% =**	**100**	**98**	**%**

Note: Storm sewer should be sized for the sum of the unclogged interception capacities (Qminor = 0.3 cfs and Qmajor = 1.3 cfs)

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: **Redtail Ridge - Phase 1**
Inlet ID: **Basin C-3-5 (Str. AE1)**



Gutter Geometry:			
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	16.5	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.045	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	36.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.037	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.033	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

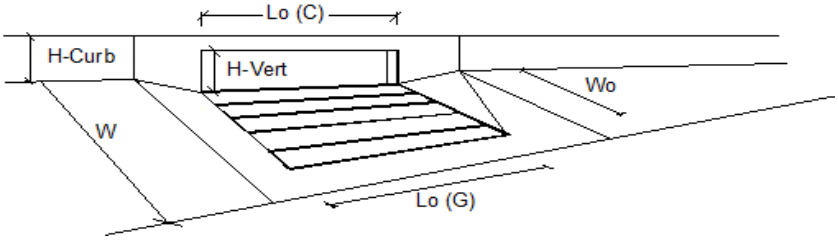
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	31.0	31.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	18.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**11.9**	**296.1**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 0.82 cfs on sheet 'Inlet Management'
Major storm max. allowable capacity GOOD - greater than the design peak flow of 2.42 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.02 (August 2022)



Design Information (Input)	CDOT Type R Curb Opening		MINOR	MAJOR	
Type of Inlet		Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')		a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)		No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)		L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		C_f (G) =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		C_f (C) =	0.10	0.10	

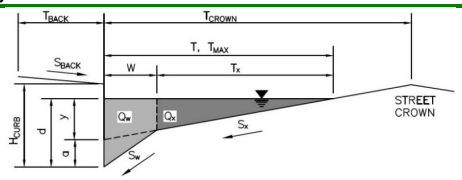
Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**0.8**	**2.0**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.4**	**cfs**
Capture Percentage = Q_a/Q_o	**C% =**	**100**	**83**	**%**

Note: Storm sewer should be sized for the sum of the unclogged interception capacities (Qminor = 0.8 cfs and Qmajor = 2.1 cfs)

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: **Redtail Ridge - Phase 1**
Inlet ID: **Basin C-3-6 (Str. AE2)**



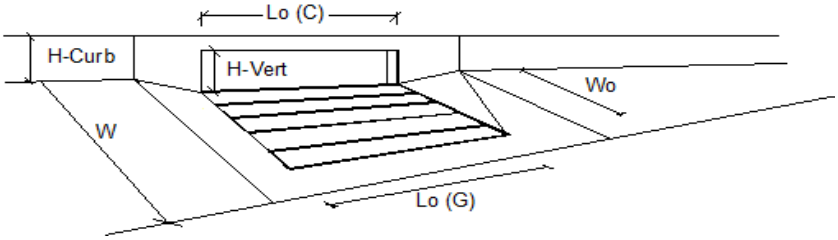
Gutter Geometry:				
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	16.5		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.045		ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00		inches
Distance from Curb Face to Street Crown	T_{CROWN} =	36.0		ft
Gutter Width	W =	2.00		ft
Street Transverse Slope	S_X =	0.037		ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083		ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.033		ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016		
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	31.0	31.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	18.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**11.9**	**296.6**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 0.70 cfs on sheet 'Inlet Management'
Major storm max. allowable capacity GOOD - greater than the design peak flow of 2.03 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.02 (August 2022)



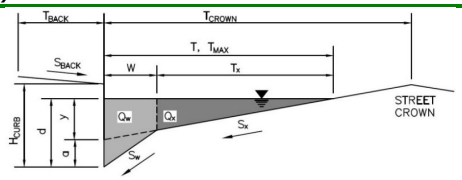
Design Information (Input)	CDOT Type R Curb Opening		MINOR	MAJOR	
Type of Inlet		Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')		a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)		No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)		L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		C_f (G) =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		C_f (C) =	0.10	0.10	
Street Hydraulics: OK - Q < Allowable Street Capacity'			MINOR	MAJOR	
Total Inlet Interception Capacity		**Q =**	**0.7**	**1.8**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)		**Q_b =**	**0.0**	**0.2**	**cfs**
Capture Percentage = Q_a/Q_o		**C% =**	**100**	**88**	**%**

Note: Storm sewer should be sized for the sum of the unclogged interception capacities (Qminor = 0.7 cfs and Qmajor = 1.9 cfs)

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: **Redtail Ridge - Phase 1**
Inlet ID: **Basin C-3-7 (Str. AD2)**



Gutter Geometry:			
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	16.5	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.018	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	18.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.025	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.036	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

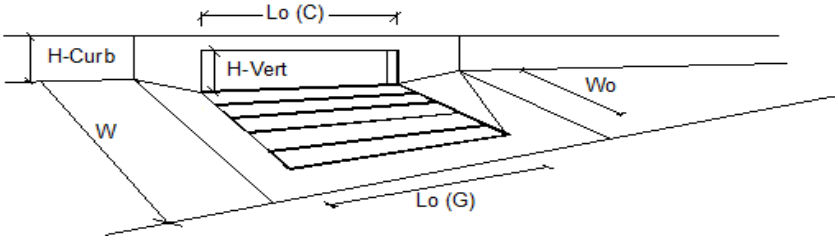
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	13.0	13.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	18.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**14.5**	**15.0**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 0.92 cfs on sheet 'Inlet Management'
Major storm max. allowable capacity GOOD - greater than the design peak flow of 3.05 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.02 (August 2022)



Design Information (Input)	CDOT Type R Curb Opening		MINOR	MAJOR	
Type of Inlet		Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')		a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)		No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)		L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		C_f (G) =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		C_f (C) =	0.10	0.10	

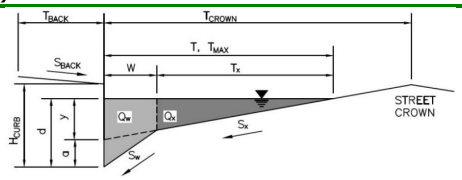
Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**0.9**	**2.3**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.8**	**cfs**
Capture Percentage = Q_a/Q_o	**C% =**	**100**	**74**	**%**

Note: Storm sewer should be sized for the sum of the unclogged interception capacities (Qminor = 0.9 cfs and Qmajor = 2.4 cfs)

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: **Redtail Ridge - Phase 1**
Inlet ID: **Basin C-3-8 (Str. AD1)**



Gutter Geometry:			
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	16.5	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.018	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	18.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.031	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

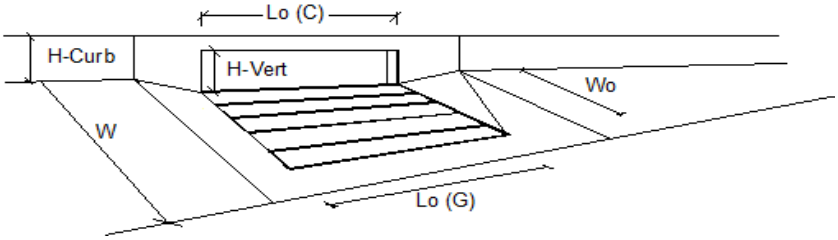
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	13.0	13.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	18.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**10.0**	**10.0**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 0.83 cfs on sheet 'Inlet Management'
Major storm max. allowable capacity GOOD - greater than the design peak flow of 2.64 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.02 (August 2022)



Design Information (Input)	CDOT Type R Curb Opening		MINOR	MAJOR	
Type of Inlet		Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')		a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)		No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)		L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		C_f (G) =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		C_f (C) =	0.10	0.10	

Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**0.8**	**2.1**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.6**	**cfs**
Capture Percentage = Q_a/Q_o	**C% =**	**100**	**78**	**%**

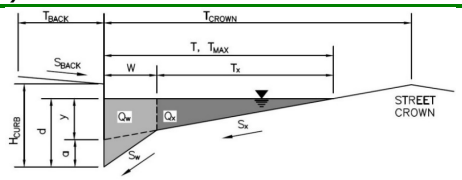
Note: Storm sewer should be sized for the sum of the unclogged interception capacities (Qminor = 0.8 cfs and Qmajor = 2.2 cfs)

MHFD-Inlet, Version 5.02 (August 2022)

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: **Redtail Ridge - Phase 1**
Inlet ID: **Basin C-3-15 (Str. AC2)**



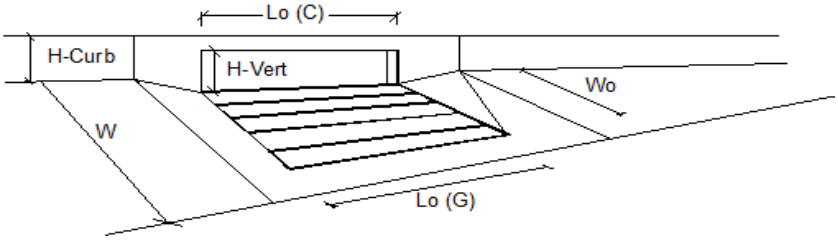
Gutter Geometry:				
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	16.5		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.017		ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00		inches
Distance from Curb Face to Street Crown	T_{CROWN} =	18.0		ft
Gutter Width	W =	2.00		ft
Street Transverse Slope	S_X =	0.020		ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083		ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.008		ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016		
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	13.0	13.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	18.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**4.9**	**4.9**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 0.27 cfs on sheet 'Inlet Management'
Major storm max. allowable capacity GOOD - greater than the design peak flow of 1.66 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.02 (August 2022)



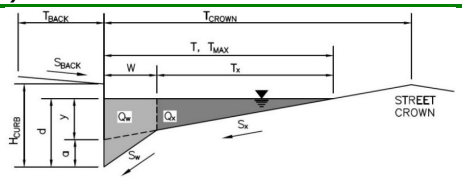
Design Information (Input)	CDOT Type R Curb Opening		MINOR	MAJOR	
Type of Inlet		Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')		a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)		No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)		L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		C_f (G) =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		C_f (C) =	0.10	0.10	
Street Hydraulics: OK - Q < Allowable Street Capacity'			MINOR	MAJOR	
Total Inlet Interception Capacity		**Q =**	**0.3**	**1.5**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)		**Q_b =**	**0.0**	**0.1**	**cfs**
Capture Percentage = Q_a/Q_o		**C% =**	**100**	**92**	**%**

Note: Storm sewer should be sized for the sum of the unclogged interception capacities (Qminor = 0.3 cfs and Qmajor = 1.6 cfs)

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: **Redtail Ridge - Phase 1**
Inlet ID: **Basin C-3-16 (Str. AC1)**



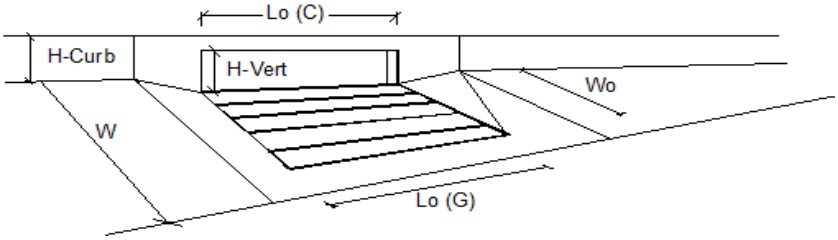
Gutter Geometry:				
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	16.5		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.017		ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00		inches
Distance from Curb Face to Street Crown	T_{CROWN} =	18.0		ft
Gutter Width	W =	2.00		ft
Street Transverse Slope	S_X =	0.020		ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083		ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.008		ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016		
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	13.0	13.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	18.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Spread Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**4.9**	**4.9**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 0.29 cfs on sheet 'Inlet Management'
Major storm max. allowable capacity GOOD - greater than the design peak flow of 1.51 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.02 (August 2022)



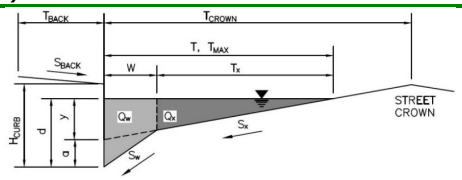
Design Information (Input)	CDOT Type R Curb Opening		MINOR	MAJOR	
Type of Inlet		Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')		a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)		No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)		L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		C_f (G) =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		C_f (C) =	0.10	0.10	
Street Hydraulics: OK - Q < Allowable Street Capacity'			MINOR	MAJOR	
Total Inlet Interception Capacity		**Q =**	**0.3**	**1.4**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)		**Q_b =**	**0.0**	**0.1**	**cfs**
Capture Percentage = Q_a/Q_o		**C% =**	**100**	**95**	**%**

Note: Storm sewer should be sized for the sum of the unclogged interception capacities (Qminor = 0.3 cfs and Qmajor = 1.5 cfs)

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: **Redtail Ridge - Phase 1**
Inlet ID: **Basin C-3-17 (Str. AB2)**



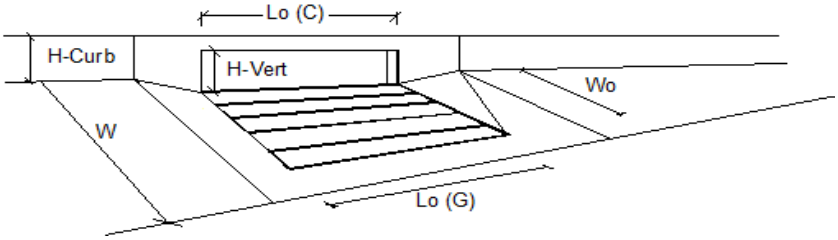
Gutter Geometry:				
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	16.5		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.045		ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00		inches
Distance from Curb Face to Street Crown	T_{CROWN} =	18.0		ft
Gutter Width	W =	2.00		ft
Street Transverse Slope	S_X =	0.058		ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083		ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.010		ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016		
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	13.0	13.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	18.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**7.6**	**31.1**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 0.35 cfs on sheet 'Inlet Management'
Major storm max. allowable capacity GOOD - greater than the design peak flow of 1.16 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.02 (August 2022)



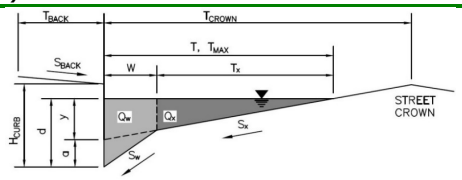
Design Information (Input)	CDOT Type R Curb Opening		MINOR	MAJOR	
Type of Inlet		Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')		a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)		No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)		L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		C_f (G) =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		C_f (C) =	0.10	0.10	
Street Hydraulics: OK - Q < Allowable Street Capacity'			MINOR	MAJOR	
Total Inlet Interception Capacity		**Q =**	**0.4**	**1.2**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)		**Q_b =**	**0.0**	**0.0**	**cfs**
Capture Percentage = Q_a/Q_o		**C% =**	**100**	**100**	**%**

Note: Storm sewer should be sized for the sum of the unclogged interception capacities (Qminor = 0.4 cfs and Qmajor = 1.2 cfs)

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: **Redtail Ridge - Phase 1**
Inlet ID: **Basin C-3-18 (Str. AB1)**



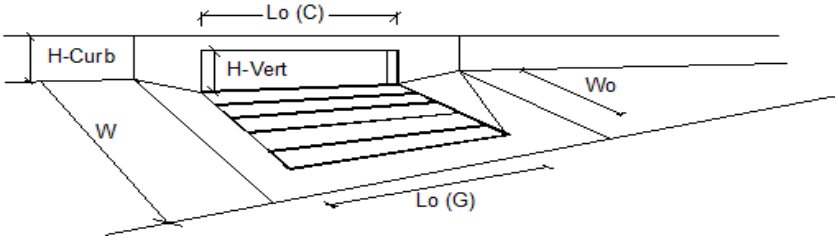
Gutter Geometry:				
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	16.5		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.045		ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00		inches
Distance from Curb Face to Street Crown	T_{CROWN} =	18.0		ft
Gutter Width	W =	2.00		ft
Street Transverse Slope	S_X =	0.045		ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083		ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.010		ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016		
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	13.0	13.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	18.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**8.6**	**19.9**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 0.38 cfs on sheet 'Inlet Management'
Major storm max. allowable capacity GOOD - greater than the design peak flow of 1.22 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.02 (August 2022)



Design Information (Input)	CDOT Type R Curb Opening		MINOR	MAJOR	
Type of Inlet		Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')		a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)		No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)		L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		C_f (G) =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		C_f (C) =	0.10	0.10	
Street Hydraulics: OK - Q < Allowable Street Capacity'			MINOR	MAJOR	
Total Inlet Interception Capacity		**Q =**	**0.4**	**1.2**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)		**Q_b =**	**0.0**	**0.0**	**cfs**
Capture Percentage = Q_a/Q_o		**C% =**	**100**	**100**	**%**

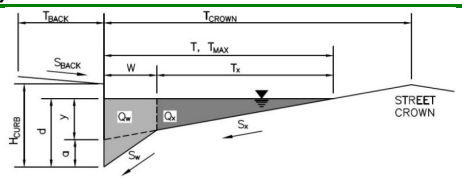
Note: Storm sewer should be sized for the sum of the unclogged interception capacities (Qminor = 0.4 cfs and Qmajor = 1.2 cfs)

MHFD-Inlet, Version 5.02 (August 2022)

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: **Redtail Ridge - Phase 1**
Inlet ID: **Basin C-3-19 (Str. B3)**

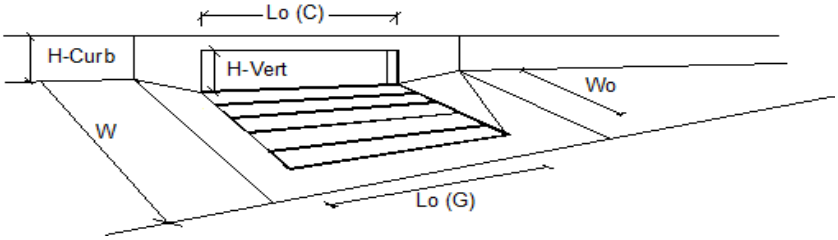


Gutter Geometry:				
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	16.5		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.018		ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00		inches
Distance from Curb Face to Street Crown	T_{CROWN} =	36.0		ft
Gutter Width	W =	2.00		ft
Street Transverse Slope	S_X =	0.037		ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083		ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.023		ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016		
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	31.0	31.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	18.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**13.1**	**292.7**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 0.66 cfs on sheet 'Inlet Management'
Major storm max. allowable capacity GOOD - greater than the design peak flow of 1.96 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.02 (August 2022)



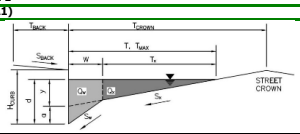
Design Information (Input)	CDOT Type R Curb Opening		MINOR	MAJOR	
Type of Inlet		Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')		a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)		No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)		L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		C_f (G) =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		C_f (C) =	0.10	0.10	
Street Hydraulics: OK - Q < Allowable Street Capacity'			MINOR	MAJOR	
Total Inlet Interception Capacity		**Q =**	**0.7**	**1.8**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)		**Q_b =**	**0.0**	**0.2**	**cfs**
Capture Percentage = Q_a/Q_o		**C% =**	**100**	**90**	**%**

Note: Storm sewer should be sized for the sum of the unclogged interception capacities (Qminor = 0.7 cfs and Qmajor = 1.8 cfs)

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

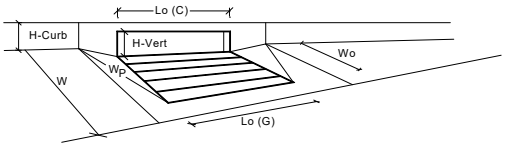
Project: Redtail Ridge - Phase 1
Inlet ID: Basin C-3-20 (Str. AA1)



Gutter Geometry:				
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	16.5		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.018		ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00		inches
Distance from Curb Face to Street Crown	T_{CROWN} =	23.0		ft
Gutter Width	W =	2.00		ft
Street Transverse Slope	S_x =	0.020		ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083		ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000		ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016		
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	18.0	18.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	18.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is not applicable to Sump Condition				
MAJOR STORM Allowable Capacity is not applicable to Sump Condition	**Q_{allow} =**	**SUMP**	**SUMP**	**cfs**

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.02 (August 2022)



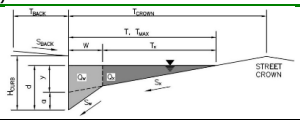
Design Information (Input)		MINOR	MAJOR	
Type of Inlet (CDOT Type R Curb Opening)	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	5.8	5.8	inches
Grate Information		MINOR	MAJOR	☐ Override Depths
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Open Area Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	5.00	5.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	
Grate Flow Analysis (Calculated)		MINOR	MAJOR	
Clogging Coefficient for Multiple Units	Coef =	N/A	N/A	
Clogging Factor for Multiple Units	Clog =	N/A	N/A	
Grate Capacity as a Weir (based on MHFD - CSU 2010 Study)		MINOR	MAJOR	
Interception without Clogging	Q_{wi} =	N/A	N/A	cfs
Interception with Clogging	Q_{wa} =	N/A	N/A	cfs
Grate Capacity as an Orifice (based on MHFD - CSU 2010 Study)		MINOR	MAJOR	
Interception without Clogging	Q_{oi} =	N/A	N/A	cfs
Interception with Clogging	Q_{oa} =	N/A	N/A	cfs
Grate Capacity as Mixed Flow		MINOR	MAJOR	
Interception without Clogging	Q_{mi} =	N/A	N/A	cfs
Interception with Clogging	Q_{ma} =	N/A	N/A	cfs
Resulting Grate Capacity (assumes clogged condition)	**Q_{Grate} =**	**N/A**	**N/A**	**cfs**
Curb Opening Flow Analysis (Calculated)		MINOR	MAJOR	
Clogging Coefficient for Multiple Units	Coef =	1.00	1.00	
Clogging Factor for Multiple Units	Clog =	0.10	0.10	
Curb Capacity as a Weir (based on MHFD - CSU 2010 Study)		MINOR	MAJOR	
Interception without Clogging	Q_{wi} =	5.6	5.6	cfs
Interception with Clogging	Q_{wa} =	5.0	5.0	cfs
Curb Capacity as an Orifice (based on MHFD - CSU 2010 Study)		MINOR	MAJOR	
Interception without Clogging	Q_{oi} =	9.6	9.6	cfs
Interception with Clogging	Q_{oa} =	8.7	8.7	cfs
Curb Opening Capacity as Mixed Flow		MINOR	MAJOR	
Interception without Clogging	Q_{mi} =	6.8	6.8	cfs
Interception with Clogging	Q_{ma} =	6.1	6.1	cfs
Resulting Curb Opening Capacity (assumes clogged condition)	**Q_{Curb} =**	**5.0**	**5.0**	**cfs**
Resultant Street Conditions		MINOR	MAJOR	
Total Inlet Length	L =	5.00	5.00	feet
Resultant Street Flow Spread (based on street geometry from above)	T =	18.0	18.0	ft
Resultant Flow Depth at Street Crown	d_{CROWN} =	0.0	0.0	inches
Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.32	0.32	ft
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	N/A	N/A	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	1.00	1.00	
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	N/A	N/A	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**5.0**	**5.0**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms (>Q Peak)	$Q_{PEAK\ REQUIRED}$ =	1.2	3.5	cfs

MHFD-Inlet, Version 5.02 (August 2022)

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

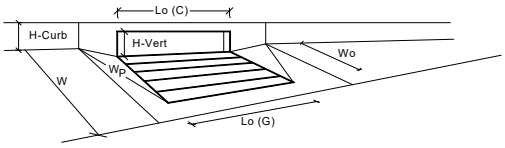
Project: Redtail Ridge - Phase 1
Inlet ID: Basin C-3-21 (Str. A2)



Gutter Geometry:				
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	16.5		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.018		ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00		inches
Distance from Curb Face to Street Crown	T_{CROWN} =	23.0		ft
Gutter Width	W =	2.00		ft
Street Transverse Slope	S_x =	0.020		ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083		ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000		ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016		
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	18.0	18.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	18.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is not applicable to Sump Condition MAJOR STORM Allowable Capacity is not applicable to Sump Condition	**Q_{allow} =**	**SUMP**	**SUMP**	**cfs**

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.02 (August 2022)

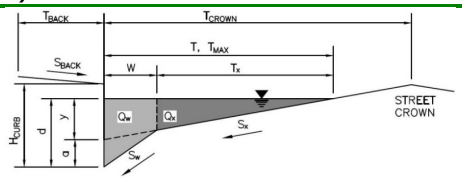


Design Information (Input)		MINOR	MAJOR	
Type of Inlet (CDOT Type R Curb Opening)	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	5.8	5.8	inches
Grate Information		MINOR	MAJOR	☐ Override Depths
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Open Area Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	10.00	10.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	
Grate Flow Analysis (Calculated)		MINOR	MAJOR	
Clogging Coefficient for Multiple Units	Coef =	N/A	N/A	
Clogging Factor for Multiple Units	Clog =	N/A	N/A	
Grate Capacity as a Weir (based on MHFD - CSU 2010 Study)		MINOR	MAJOR	
Interception without Clogging	Q_{wi} =	N/A	N/A	cfs
Interception with Clogging	Q_{wa} =	N/A	N/A	cfs
Grate Capacity as an Orifice (based on MHFD - CSU 2010 Study)		MINOR	MAJOR	
Interception without Clogging	Q_{oi} =	N/A	N/A	cfs
Interception with Clogging	Q_{oa} =	N/A	N/A	cfs
Grate Capacity as Mixed Flow		MINOR	MAJOR	
Interception without Clogging	Q_{mi} =	N/A	N/A	cfs
Interception with Clogging	Q_{ma} =	N/A	N/A	cfs
Resulting Grate Capacity (assumes clogged condition)	**Q_{Grate} =**	**N/A**	**N/A**	**cfs**
Curb Opening Flow Analysis (Calculated)		MINOR	MAJOR	
Clogging Coefficient for Multiple Units	Coef =	1.25	1.25	
Clogging Factor for Multiple Units	Clog =	0.06	0.06	
Curb Capacity as a Weir (based on MHFD - CSU 2010 Study)		MINOR	MAJOR	
Interception without Clogging	Q_{wi} =	8.2	8.2	cfs
Interception with Clogging	Q_{wa} =	7.7	7.7	cfs
Curb Capacity as an Orifice (based on MHFD - CSU 2010 Study)		MINOR	MAJOR	
Interception without Clogging	Q_{oi} =	19.2	19.2	cfs
Interception with Clogging	Q_{oa} =	18.0	18.0	cfs
Curb Opening Capacity as Mixed Flow		MINOR	MAJOR	
Interception without Clogging	Q_{mi} =	11.7	11.7	cfs
Interception with Clogging	Q_{ma} =	10.9	10.9	cfs
Resulting Curb Opening Capacity (assumes clogged condition)	**Q_{Curb} =**	**7.7**	**7.7**	**cfs**
Resultant Street Conditions		MINOR	MAJOR	
Total Inlet Length	L =	10.00	10.00	feet
Resultant Street Flow Spread (based on street geometry from above)	T =	18.0	18.0	ft
Resultant Flow Depth at Street Crown	d_{CROWN} =	0.0	0.0	inches
Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.32	0.32	ft
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	N/A	N/A	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	0.92	0.92	
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	N/A	N/A	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**7.7**	**7.7**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms (>Q Peak)	$Q_{PEAK\ REQUIRED}$ =	1.2	3.6	cfs

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: **Redtail Ridge - Phase 1**
Inlet ID: **Basin C-4-1 (Str. OS-A3)**



Gutter Geometry:			
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	16.5	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.018	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	32.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.027	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

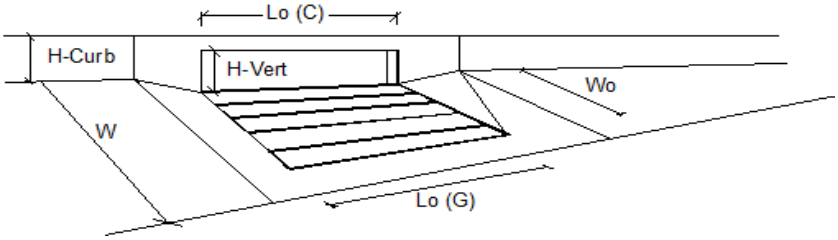
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	27.0	27.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	18.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**18.3**	**60.3**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 0.83 cfs on sheet 'Inlet Management'
Major storm max. allowable capacity GOOD - greater than the design peak flow of 2.76 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.02 (August 2022)



Design Information (Input)	CDOT Type R Curb Opening		MINOR	MAJOR	
Type of Inlet		Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')		a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)		No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)		L_o =	10.00	10.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		C_f (G) =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		C_f (C) =	0.10	0.10	

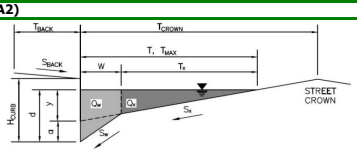
Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**0.8**	**2.8**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.0**	**cfs**
Capture Percentage = Q_a/Q_o	**C% =**	**100**	**100**	**%**

Note: Storm sewer should be sized for the sum of the unclogged interception capacities (Qminor = 0.8 cfs and Qmajor = 2.8 cfs)

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: **Redtail Ridge - Phase 1**
Inlet ID: **Basin C-4-2 (Str. OS-A2)**



Gutter Geometry:			
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	16.5	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.018	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	32.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.015	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.003	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	27.0	27.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	18.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

Maximum Capacity for 1/2 Street based On Allowable Spread		Minor Storm	Major Storm	
Water Depth without Gutter Depression (T * S_x * 12)	y =	4.86	4.86	inches
Vertical Depth between Gutter Lip and Gutter Flowline (W * S_w * 12)	d_C =	2.0	2.0	inches
Gutter Depression (d_C - (W * S_x * 12))	a =	1.63	1.63	inches
Water Depth at Gutter Flowline (y + a)	d =	6.49	6.49	inches
Allowable Spread for Discharge outside the Gutter Section (T - W)	T_X =	25.0	25.0	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.230	0.230	
Discharge outside the Gutter Section, carried in Section T_X	Q_X =	8.9	8.9	cfs
Discharge within the Gutter Section (Q_T - Q_X - Q_{BACK})	Q_W =	2.7	2.7	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	0.0	cfs
Maximum Flow Based On Allowable Spread	**Q_T =**	**11.5**	**11.5**	**cfs**
Flow Velocity within the Gutter Section	V =	2.9	2.9	fps
V*d Product: Flow Velocity times Gutter Flowline Depth	V*d =	1.6	1.6	

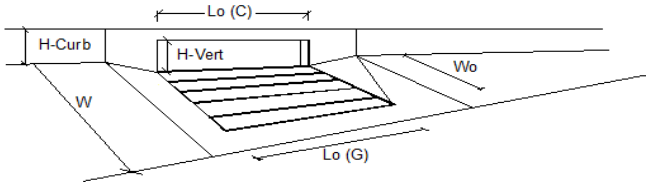
Maximum Capacity for 1/2 Street based on Allowable Depth		Minor Storm	Major Storm	
Theoretical Water Spread	T_{TH} =	24.3	90.9	ft
Theoretical Spread for Discharge outside the Gutter Section (T - W)	$T_{X\,TH}$ =	22.3	88.9	ft
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. 7-7)	E_O =	0.259	0.062	
Theoretical Discharge outside the Gutter Section, carried in Section $T_{X\,TH}$	$Q_{X\,TH}$ =	6.5	261.5	cfs
Actual Discharge outside the Gutter Section, (limited by distance T_{CROWN})	Q_X =	6.5	174.2	cfs
Discharge within the Gutter Section (Q_d - Q_X)	Q_W =	2.3	17.4	cfs
Discharge Behind the Curb (e.g., sidewalk, driveways, & lawns)	Q_{BACK} =	0.0	49.6	cfs
Total Discharge for Major & Minor Storm (Pre-Safety Factor)	Q =	8.8	241.2	cfs
Average Flow Velocity Within the Gutter Section	V =	2.7	6.1	fps
V*d Product: Flow Velocity Times Gutter Flowline Depth	V*d =	1.4	9.2	
Slope-Based Safety Factor for Minor/Major Storm depth reduction, d ≥ 6"	R =	1.00	1.00	
Max Flow based on Allowable Depth (Safety Factor Applied)	**Q_d =**	**8.8**	**241.2**	**cfs**
Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)	d =	6.00	18.00	inches
Resultant Flow Depth at Street Crown (Safety Factor Applied)	d_{CROWN} =	0.00	10.61	inches

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**8.8**	**11.5**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 1.17 cfs on sheet 'Inlet Management'
Major storm max. allowable capacity GOOD - greater than the design peak flow of 3.59 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.02 (August 2022)



Design Information (Input)		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	15.00	15.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)	W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f (G) =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f (C) =	0.10	0.10	

Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**1.2**	**3.6**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.0**	**cfs**
Capture Percentage = Q_a/Q_o	**C% =**	**100**	**100**	**%**

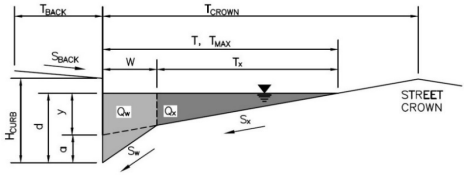
Note: Storm sewer should be sized for the sum of the unclogged interception capacities (Qminor = 1.2 cfs and Qmajor = 3.6 cfs)

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: **Redtail Ridge - Phase 1**

Inlet ID: **Basin C-5-10 (Str. D3)**



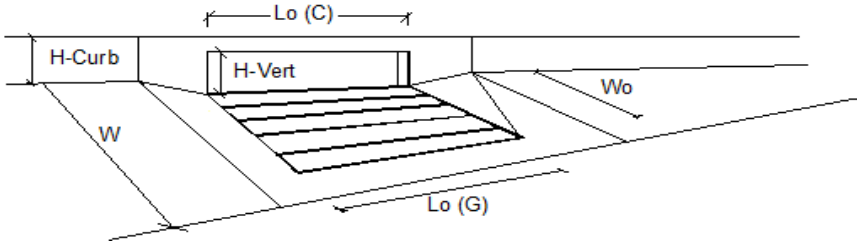
Gutter Geometry:				
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	16.5		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.018		ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00		inches
Distance from Curb Face to Street Crown	T_{CROWN} =	23.0		ft
Gutter Width	W =	2.00		ft
Street Transverse Slope	S_X =	0.048		ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083		ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.006		ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016		
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	18.0	18.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	18.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**6.3**	**49.4**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 0.41 cfs on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design peak flow of 1.27 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.02 (August 2022)

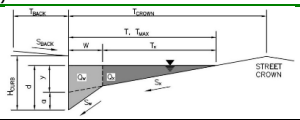


Design Information (Input)		MINOR	MAJOR	
Type of Inlet (CDOT Type R Curb Opening)	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	10.00	10.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)	W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f (G) =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f (C) =	0.10	0.10	
Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**0.4**	**1.3**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.0**	**cfs**
Capture Percentage = Q_a/Q_o	**C% =**	**100**	**100**	**%**

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: Redtail Ridge - Phase 1
Inlet ID: Basin C-5-9 (Str. CB1)

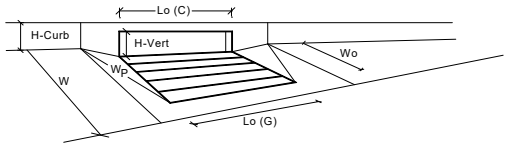


Gutter Geometry:			
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	16.5	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.019	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	18.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_x =	0.031	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	13.0	13.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	18.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	
MINOR STORM Allowable Capacity is not applicable to Sump Condition				
MAJOR STORM Allowable Capacity is not applicable to Sump Condition		Minor Storm	Major Storm	
	Q_{allow} =	**SUMP**	**SUMP**	**cfs**

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.02 (August 2022)

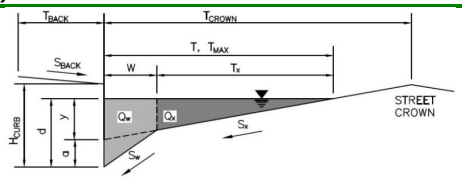


Design Information (Input)		MINOR	MAJOR	
Type of Inlet (CDOT Type R Curb Opening)	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	6.0	6.0	inches
Grate Information		MINOR	MAJOR	☐ Override Depths
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Open Area Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	5.00	5.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	
Grate Flow Analysis (Calculated)		MINOR	MAJOR	
Clogging Coefficient for Multiple Units	Coef =	N/A	N/A	
Clogging Factor for Multiple Units	Clog =	N/A	N/A	
Grate Capacity as a Weir (based on MHFD - CSU 2010 Study)		MINOR	MAJOR	
Interception without Clogging	Q_{wi} =	N/A	N/A	cfs
Interception with Clogging	Q_{wa} =	N/A	N/A	cfs
Grate Capacity as an Orifice (based on MHFD - CSU 2010 Study)		MINOR	MAJOR	
Interception without Clogging	Q_{oi} =	N/A	N/A	cfs
Interception with Clogging	Q_{oa} =	N/A	N/A	cfs
Grate Capacity as Mixed Flow		MINOR	MAJOR	
Interception without Clogging	Q_{mi} =	N/A	N/A	cfs
Interception with Clogging	Q_{ma} =	N/A	N/A	cfs
Resulting Grate Capacity (assumes clogged condition)	**Q_{Grate} =**	**N/A**	**N/A**	**cfs**
Curb Opening Flow Analysis (Calculated)		MINOR	MAJOR	
Clogging Coefficient for Multiple Units	Coef =	1.00	1.00	
Clogging Factor for Multiple Units	Clog =	0.10	0.10	
Curb Capacity as a Weir (based on MHFD - CSU 2010 Study)		MINOR	MAJOR	
Interception without Clogging	Q_{wi} =	6.0	6.0	cfs
Interception with Clogging	Q_{wa} =	5.4	5.4	cfs
Curb Capacity as an Orifice (based on MHFD - CSU 2010 Study)		MINOR	MAJOR	
Interception without Clogging	Q_{oi} =	9.8	9.8	cfs
Interception with Clogging	Q_{oa} =	8.8	8.8	cfs
Curb Opening Capacity as Mixed Flow		MINOR	MAJOR	
Interception without Clogging	Q_{mi} =	7.1	7.1	cfs
Interception with Clogging	Q_{ma} =	6.4	6.4	cfs
Resulting Curb Opening Capacity (assumes clogged condition)	**Q_{Curb} =**	**5.4**	**5.4**	**cfs**
Resultant Street Conditions		MINOR	MAJOR	
Total Inlet Length	L =	5.00	5.00	feet
Resultant Street Flow Spread (based on street geometry from above)	T =	13.0	13.0	ft
Resultant Flow Depth at Street Crown	d_{CROWN} =	0.0	0.0	inches
Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.33	0.34	ft
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	N/A	N/A	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	1.00	1.00	
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	N/A	N/A	
		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**5.4**	**5.4**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms (>Q Peak)	$Q_{PEAK\ REQUIRED}$ =	0.5	1.5	cfs

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: **Redtail Ridge - Phase 1**
Inlet ID: **Basin C-5-11 (Str. D2)**



Gutter Geometry:			
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	16.5	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.018	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	23.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.048	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.006	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

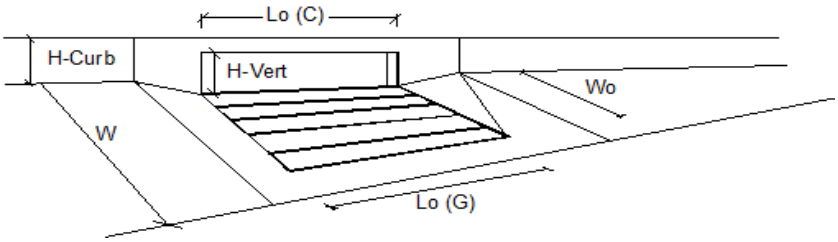
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	18.0	18.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	18.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**6.3**	**49.4**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 0.41 cfs on sheet 'Inlet Management'
Major storm max. allowable capacity GOOD - greater than the design peak flow of 1.27 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.02 (August 2022)



Design Information (Input)	CDOT Type R Curb Opening		MINOR	MAJOR	
Type of Inlet		Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')		a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)		No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)		L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		C_f (G) =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		C_f (C) =	0.10	0.10	

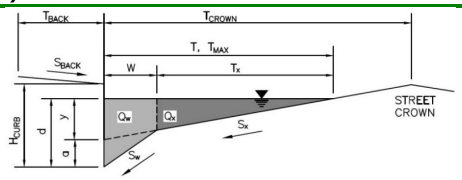
Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**0.4**	**1.3**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.0**	**cfs**
Capture Percentage = Q_a/Q_o	**C% =**	**100**	**100**	**%**

Note: Storm sewer should be sized for the sum of the unclogged interception capacities (Qminor = 0.4 cfs and Qmajor = 1.3 cfs)

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: **Redtail Ridge - Phase 1**
Inlet ID: **Basin C-5-12 (Str. CA1)**

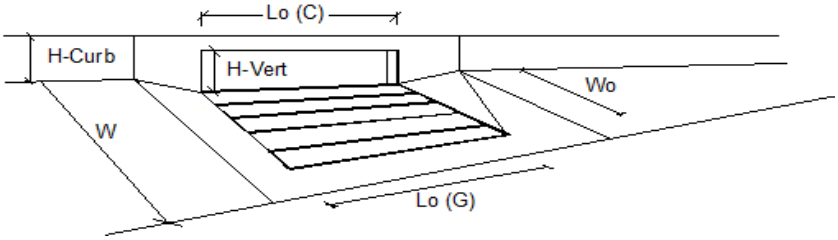


Gutter Geometry:				
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	16.5		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.018		ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00		inches
Distance from Curb Face to Street Crown	T_{CROWN} =	36.0		ft
Gutter Width	W =	2.00		ft
Street Transverse Slope	S_X =	0.034		ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083		ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.018		ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016		
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	31.0	31.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	18.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**13.0**	**216.8**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 0.77 cfs on sheet 'Inlet Management'
Major storm max. allowable capacity GOOD - greater than the design peak flow of 2.23 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.02 (August 2022)



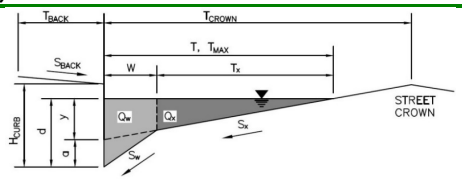
Design Information (Input)	CDOT Type R Curb Opening		MINOR	MAJOR	
Type of Inlet		Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')		a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)		No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)		L_o =	10.00	10.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		C_f (G) =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		C_f (C) =	0.10	0.10	
Street Hydraulics: OK - Q < Allowable Street Capacity'			MINOR	MAJOR	
Total Inlet Interception Capacity		**Q =**	**0.8**	**2.2**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)		**Q_b =**	**0.0**	**0.0**	**cfs**
Capture Percentage = Q_a/Q_o		**C% =**	**100**	**100**	**%**

Note: Storm sewer should be sized for the sum of the unclogged interception capacities (Qminor = 0.8 cfs and Qmajor = 2.2 cfs)

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: **Redtail Ridge - Phase 1**
Inlet ID: **Basin C-5-13 (Str. C1)**

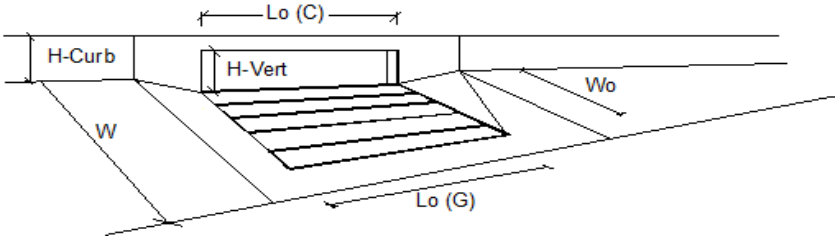


Gutter Geometry:				
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	16.5		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.018		ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00		inches
Distance from Curb Face to Street Crown	T_{CROWN} =	36.0		ft
Gutter Width	W =	2.00		ft
Street Transverse Slope	S_X =	0.034		ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083		ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.017		ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016		
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	31.0	31.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	18.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**13.0**	**216.3**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 0.67 cfs on sheet 'Inlet Management'
Major storm max. allowable capacity GOOD - greater than the design peak flow of 1.98 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.02 (August 2022)



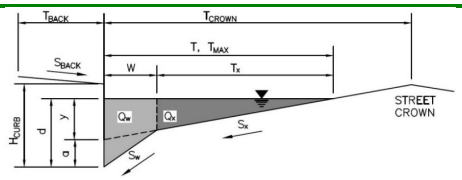
Design Information (Input)	CDOT Type R Curb Opening		MINOR	MAJOR	
Type of Inlet		Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')		a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)		No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)		L_o =	10.00	10.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		C_f (G) =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		C_f (C) =	0.10	0.10	
Street Hydraulics: OK - Q < Allowable Street Capacity'			MINOR	MAJOR	
Total Inlet Interception Capacity		**Q =**	**0.7**	**2.0**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)		**Q_b =**	**0.0**	**0.0**	**cfs**
Capture Percentage = Q_a/Q_o		**C% =**	**100**	**100**	**%**

Note: Storm sewer should be sized for the sum of the unclogged interception capacities (Qminor = 0.7 cfs and Qmajor = 2 cfs)

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: **Redtail Ridge - Phase 1**
Inlet ID: **Basin C-6-1 (Str. G2)**



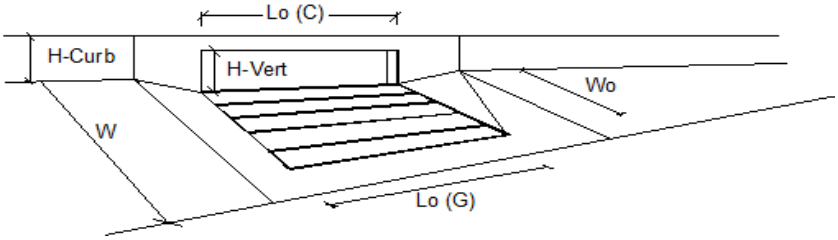
Gutter Geometry:				
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	16.5		ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.018		ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020		
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00		inches
Distance from Curb Face to Street Crown	T_{CROWN} =	36.0		ft
Gutter Width	W =	2.00		ft
Street Transverse Slope	S_X =	0.052		ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083		ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.013		ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016		
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	31.0	31.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	18.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	**Q_{allow} =**	**9.2**	**313.2**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 0.51 cfs on sheet 'Inlet Management'
Major storm max. allowable capacity GOOD - greater than the design peak flow of 1.54 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.02 (August 2022)



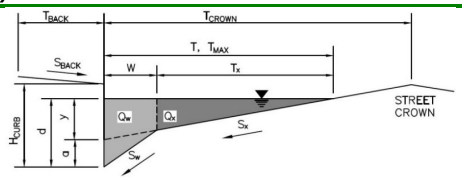
Design Information (Input)	CDOT Type R Curb Opening		MINOR	MAJOR	
Type of Inlet		Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')		a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)		No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)		L_o =	10.00	10.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)		W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)		C_f (G) =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)		C_f (C) =	0.10	0.10	
Street Hydraulics: OK - Q < Allowable Street Capacity'			MINOR	MAJOR	
Total Inlet Interception Capacity		**Q =**	**0.5**	**1.5**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)		**Q_b =**	**0.0**	**0.0**	**cfs**
Capture Percentage = Q_a/Q_o		**C% =**	**100**	**100**	**%**

Note: Storm sewer should be sized for the sum of the unclogged interception capacities (Qminor = 0.5 cfs and Qmajor = 1.5 cfs)

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: **Redtail Ridge - Phase 1**
Inlet ID: **Basin C-6-2 (Str. RS1)**



Gutter Geometry:			
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	16.5	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.018	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	36.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.015	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

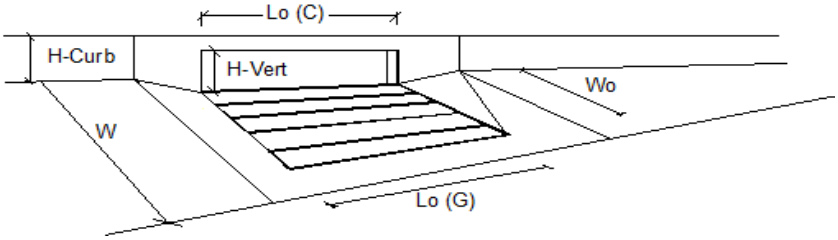
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	31.0	31.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	18.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	**Q_{allow} =**	**16.9**	**66.3**	**cfs**

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 0.60 cfs on sheet 'Inlet Management'
Major storm max. allowable capacity GOOD - greater than the design peak flow of 1.82 cfs on sheet 'Inlet Management'

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.02 (August 2022)



Design Information (Input)	CDOT Type R Curb Opening	MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a')	a_{LOCAL} =	3.0	3.0	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	1	1	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	10.00	10.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)	W_o =	N/A	N/A	ft
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	C_f (G) =	N/A	N/A	
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	C_f (C) =	0.10	0.10	

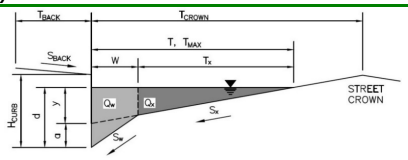
Street Hydraulics: OK - Q < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**0.6**	**1.8**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.0**	**cfs**
Capture Percentage = Q_a/Q_o	**C% =**	**100**	**100**	**%**

Note: Storm sewer should be sized for the sum of the unclogged interception capacities (Qminor = 0.6 cfs and Qmajor = 1.8 cfs)

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: Redtail Ridge - Phase 1
Inlet ID: Basin C-6-3 (Str. GA1)



Gutter Geometry:

Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	16.5	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =	0.018	ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	36.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

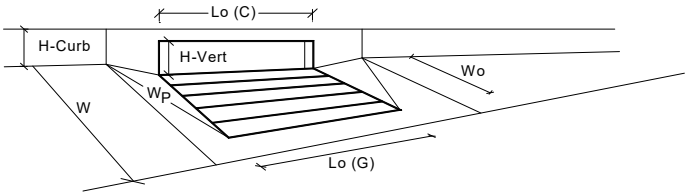
		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	31.0	31.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	18.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

MINOR STORM Allowable Capacity is not applicable to Sump Condition
MAJOR STORM Allowable Capacity is not applicable to Sump Condition

	Minor Storm	Major Storm	
Q_{allow} =	**SUMP**	**SUMP**	**cfs**

INLET IN A SUMP OR SAG LOCATION

MHFD-Inlet, Version 5.02 (August 2022)



Design Information (Input) — Type of Inlet: CDOT Type R Curb Opening

		MINOR	MAJOR	
Type of Inlet	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	1	1	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	6.0	9.0	inches

Grate Information — ☐ Override Depths

		MINOR	MAJOR	
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Open Area Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	

Curb Opening Information

		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	5.00	5.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	

Low Head Performance Reduction (Calculated)

		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.33	0.58	ft
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	N/A	N/A	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	1.00	1.00	
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	N/A	N/A	

		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**5.4**	**10.6**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms (>Q Peak)	$Q_{PEAK\ REQUIRED}$ =	0.4	1.1	cfs

BAYSAVER TECHNOLOGIES®

1030 Deer Hollow Drive 1-800-BAYSAVER
Mount Airy, MD 21771 1-800-229-7283

APPROVED BY:

SIGNED _____

DATE _____

COMPANY: _____

PHONE & EMAIL _____

ADS™

ADVANCED DRAINAGE SYSTEMS, INC.

Redtail Ridge

louisville, CO

CONTRACTOR PROVIDED DELIVERY SCHEDULE & SITE INFORMATION:

SCHEDULING INFORMATION									
SYSTEM DESIGNATION / SIZE									
SYSTEM DELIVERY DATE									

*ACTUAL DATE REQUIRED, ASAP IS NOT ACCEPTABLE AND A MINIMUM OF 4 WEEKS MUST BE PROVIDED UNLESS OTHERWISE DISCUSSED WITH A SALES REPRESENTATIVE.

DELIVERY INFORMATION			
JOB SITE STREET ADDRESS		CITY	
CONTACT		CONTACT PHONE	
ALTERNATE CONTACT		ALTERNATE PHONE	

DIRECTIONS TO JOB SITE FROM NEAREST INTERSTATE:
(PLEASE NO MAPS)

PRODUCT SPECIFICATIONS

- THE STORMWATER TREATMENT UNIT SHALL BE AN INLINE UNIT CAPABLE OF CONVEYING 100% OF THE DESIGN PEAK FLOW. IF PEAK FLOW RATES EXCEED MAXIMUM HYDRAULIC RATE, THE UNIT SHALL BE INSTALLED OFFLINE.
- THE BARRACUDA UNIT SHALL BE DESIGNED TO REMOVE AT LEAST 80% OF THE SUSPENDED SOLIDS ON AN ANNUAL AGGREGATE REMOVAL BASIS. SAID REMOVAL SHALL BE BASED ON FULL-SCALE THIRD PARTY TESTING USING OK-110 MEDIA GRADATION OR EQUIVALENT AND 300 mg/L INFLUENT CONCENTRATION. SAID FULL SCALE TESTING SHALL HAVE INCLUDED SEDIMENT CAPTURE BASED ON ACTUAL TOTAL MASS COLLECTED BY THE STORMWATER TREATMENT UNIT.

-OR -

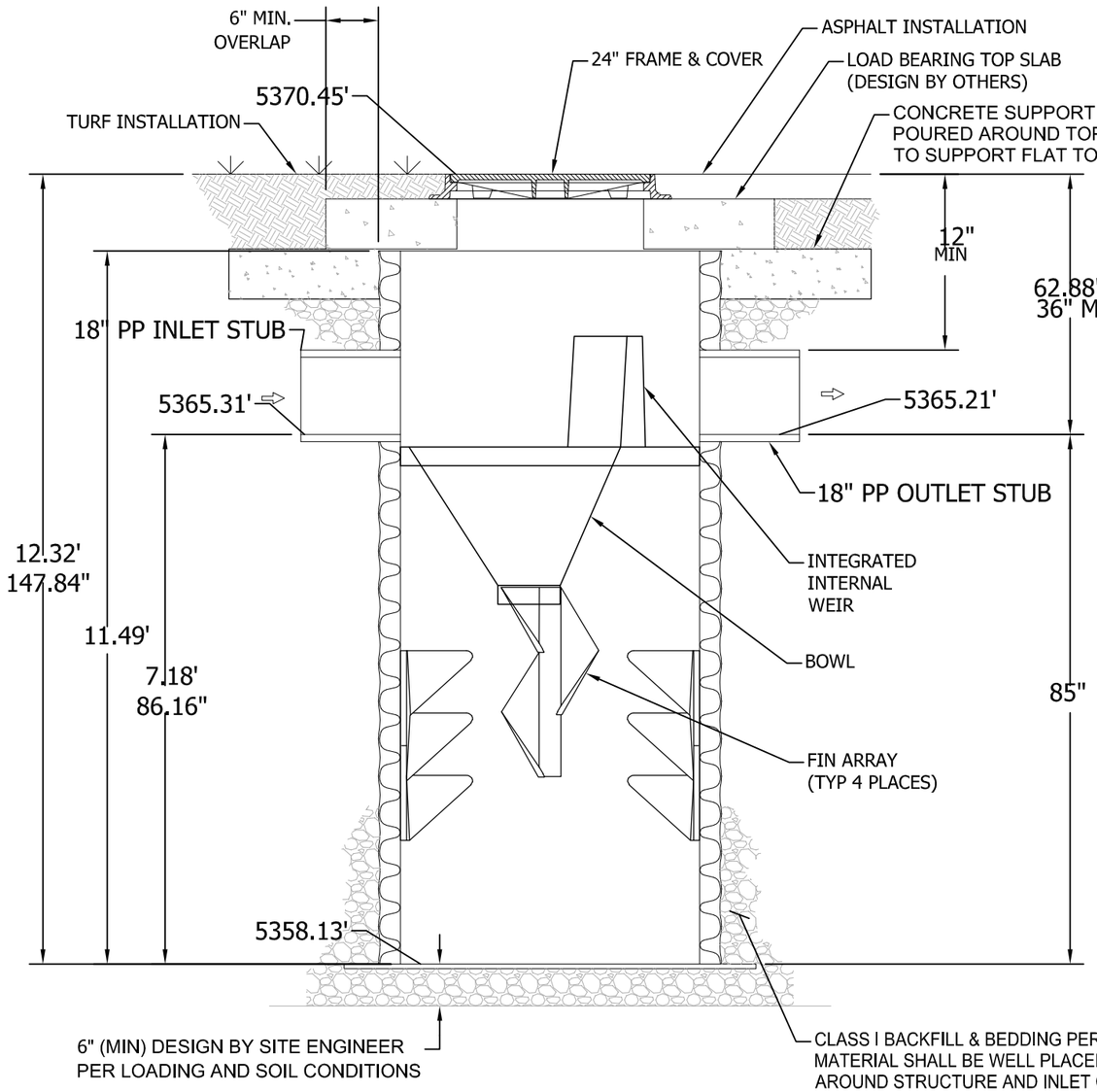
THE BARRACUDA UNIT SHALL BE DESIGNED TO REMOVE AT LEAST 50% OF TSS USING A MEDIA MIX WITH d/50=75 MICRON AND 200 MG/L INFLUENT CONCENTRATION.

-OR -

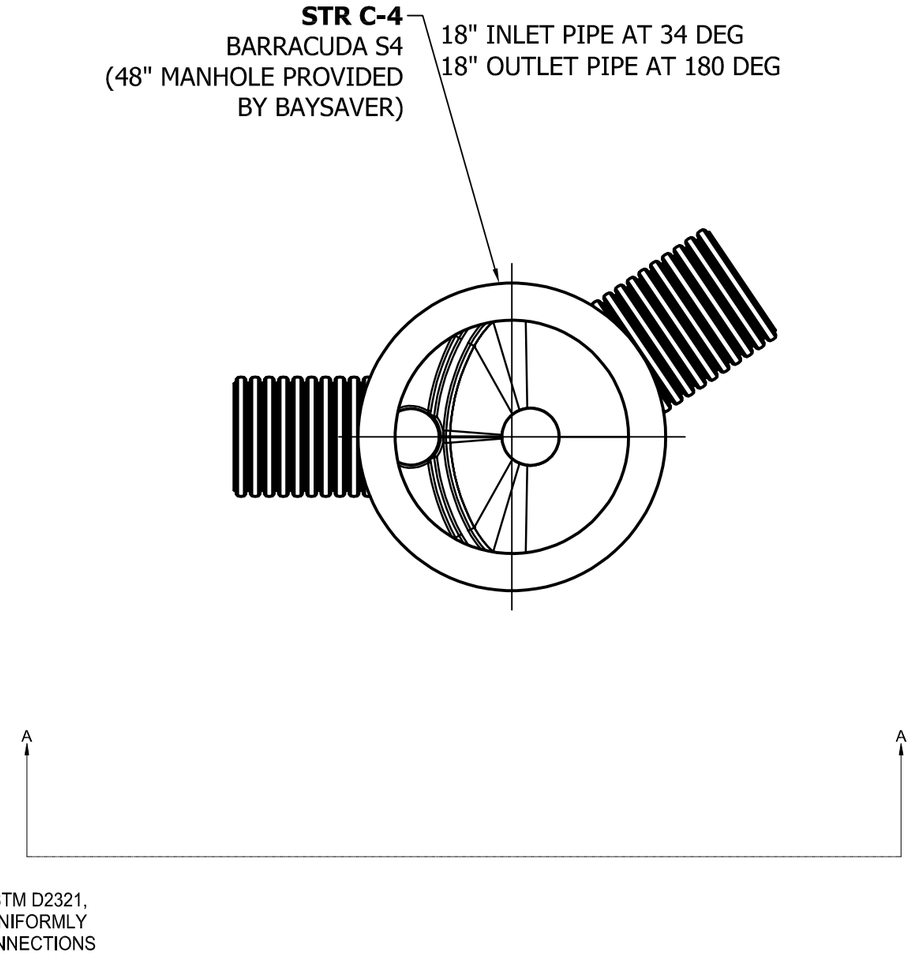
THE BARRACUDA UNIT SHALL BE DESIGNED TO REMOVE AT LEAST 50% OF TSS PER CURRENT NJDEP/NJCAT HDS PROTOCOL.

BARRACUDA S4	
UNIT ID	STR C-4
PEAK FLOW RATE CFS	N/A
TREATMENT FLOW RATE CFS	0

*TREATMENT FLOW RATE PER OK-110



SECTION VIEW A-A
SCALE: N.T.S.



SITE SPECIFIC PLAN VIEW
SCALE 1:27

REDTAIL RIDGE
REV 01/11/2024
LOT 15 & 16 PH 2
DATE:
DRAWN:
CHECKED:
PROJECT #:

1030 Deer Hollow Drive
Mount Airy, MD 21771
1-800-BAYSAVER
1-800-229-7283
Barracuda

4640 TRUEMAN BLVD
HILLIARD, OH 43026
ADVANCED DRAINAGE SYSTEMS, INC.

SCALE: AS NOTED

THIS DRAWING HAS BEEN PREPARED BASED ON INFORMATION PROVIDED TO ADS UNDER THE DIRECTION OF THE SITE DESIGN ENGINEER OR OTHER PROJECT REPRESENTATIVE. THE SITE DESIGN ENGINEER SHALL REVIEW THIS DRAWING PRIOR TO CONSTRUCTION. IT IS THE ULTIMATE RESPONSIBILITY OF THE SITE DESIGN ENGINEER TO ENSURE THAT THE PRODUCT(S) DEPICTED AND ALL ASSOCIATED DETAILS MEET ALL APPLICABLE LAWS, REGULATIONS, AND PROJECT REQUIREMENTS.

SHEET:
1 OF 1

Project Name:Redtail Ridge - Rev 01/11/2024 02:19:50 PM
Date: 1/11/24
Location:louisville, CO

Site Designation: Redtail Ridge - Rev 01/11/2024 02:19:50 PM

Peak Treatment Rate: (Manual Entry)	0	cfs
Barracuda Size:	**S4**	
Peak treatment rate:	1.52	cfs
Unit Bypass Flow:	0	cfs

ADS® Barracuda™ Max

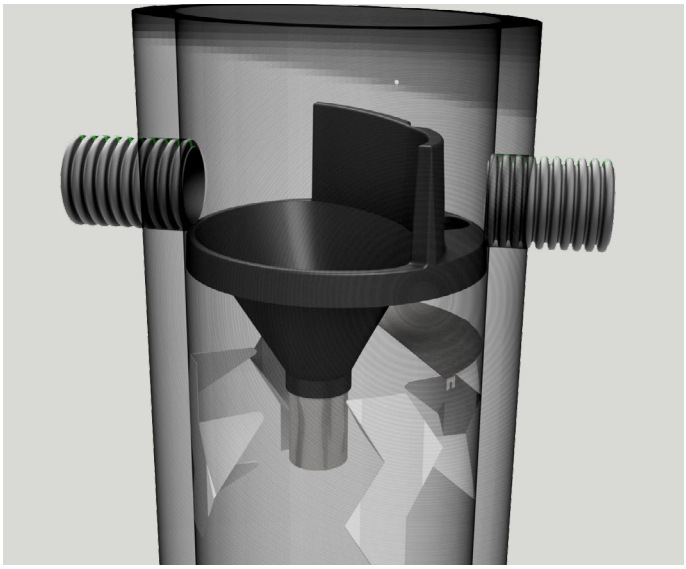
The Barracuda Max is market-changing stormwater quality technology. This high-performance vortex hydrodynamic separator is designed to remove total suspended solids in order to protect our precious receiving waters. The Barracuda Max is also an outstanding value that offers multiple pipe configurations, and quick installation. The “Max” version of the Barracuda is built on the base platform of the original ADS Barracuda with improved removal efficiencies and installation components.

Features

- Single manhole design
- No elevation loss between the inlet and outlet
- Variable inlet/outlet angle configurations (not just 180 degree orientation)
- Internal bypass for inline installation (where applicable)
- Revolutionary, patent-pending “teeth” mitigate turbulence in the sump area to prevent re-suspension of captured contaminants and an added deflector plate and bowl extension enhance the unit’s removal capabilities

Benefits

- Internal components are in stock for quick delivery
- The S3, S4, S6, and S8 can be installed in a standard 36” (900 mm), 48” (1200 m), 72” (1800 m), and 96” (2400 m) precast manhole, respectively
- The S3 & S4 can be provided factory installed within a 36” (900 mm) and 48” (1200 mm) ADS HP manhole and delivered to the jobsite
- The Barracuda Max “teeth” and deflector plate apparatus are fabricated and designed for quick and easy field assembly
- Designed for easy maintenance using a vacuum truck or similar equipment.
- Inspection and maintenance are performed from the surface with no confined space entry



ADS™

Barrucuda Specification

Materials and Design

- Concrete Structures: Designed for H-20 traffic loading and applicable soil loads or as otherwise determined by a Licensed Professional Engineer. The materials and structural design of the devices shall be per ASTM C857 and ASTM C858.
- 36” (900 mm) and 48” (1200 mm) HP Manhole Structures: Made from an impact modified copolymer polypropylene meeting the material requirements of ASTM F2764. The eccentric cone reducer shall be manufactured from polyethylene material meeting ASTM D3350 cell class 213320C. Gaskets shall be made of material meeting the requirements of ASTM F477.
- Separator internals shall be substantially constructed of stainless steel, polyethylene or other thermoplastic material approved by the manufacturer.

Performance

- The stormwater treatment unit shall be an inline unit capable of conveying 100% of the design peak flow. If peak flow rates exceed maximum hydraulic rate, the unit shall be installed offline.
- The Barracuda Max unit shall be designed to remove at least 80% of the suspended solids on an annual aggregate removal basis. Said removal shall be based on full-scale third party testing using OK-110 media gradation or equivalent and 300 mg/L influent concentration. Said full scale testing shall have included sediment capture based on actual total mass collected by the stormwater treatment unit.

  - OR -

  The Barracuda Max unit shall be designed to remove at least 50% of TSS using a media mix with d_{50}=75 micron and 200 mg/L influent concentration.

  - OR -

  The Barracuda Max unit shall be designed to remove at least 50% of TSS per current NJDEP/NJCAT HDS protocol.
- The stormwater treatment unit internals shall consist of (1) separator cone assembly, and (1) sump assembly, which includes the “teeth”.

Barracuda Max Model	Manhole Diameter	NJDEP (50% removal)	OK-110 (80% removal)
S3	36” (900 mm)	0.85 CFS (24.1 L/s)	0.86 CFS (24.1 L/s)
S4	48” (1200 mm)	1.52 CFS (43.0 L/s)	1.52 CFS (43.0 L/s)
S6	72” (1800 mm)	3.40 CFS (96.3 L/s)	3.42 CFS (96.8 L/s)
S8	96” (2400 mm)	6.08 CFS (172.2 L/s)	6.08 CFS (172.2 L/s)

* Peak bypass flows are dependent on final design

Installation

Installation of the stormwater treatment unit(s) shall be performed per manufacturer’s installation instructions. Such instructions can be obtained by calling Advanced Drainage Systems at 800-821-6710 or by logging on to www.adspipe.com.

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adspipe.com
800-821-6710

Barracuda® Max & Barracuda Maintenance Guide

One of Barracuda's advantages is the ease of maintenance. Like any system that collects pollutants, the Barracuda must be maintained for continued effectiveness. Maintenance is a simple procedure performed using a vacuum truck or similar equipment. The systems were designed to minimize the volume of water removed during routine maintenance, reducing disposal costs.

Contractors can access the pollutants stored in the manhole through the manhole cover. This allows them to gain vacuum hose access to the bottom of the manhole to remove sediment and trash. There is no confined space entry necessary for inspection or maintenance.

The entire maintenance procedure typically takes 2 to 4 hours, depending on the system's size, the captured material, and the vacuum truck's capacity.

Local regulations may apply to the maintenance procedure. Safe and legal disposal of pollutants is the responsibility of the maintenance contractor. Maintenance should be performed only by a qualified contractor.

Inspection and Cleaning Cycle

Periodic inspection is needed to determine the need for and frequency of maintenance. You should begin inspecting as soon as construction is complete and then on an annual basis. Typically, the system needs to be cleaned every 1-3 years.

Excessive oils, fuels or sediments may reduce the maintenance cycle. Periodic inspection is important.

Determining When to Clean

To determine the sediment depth, the maintenance contractor should lower a stadia rod into the manhole until it contacts the top of the captured sediment and mark that spot on the rod. Then push the probe through to the bottom of the sump and mark that spot to determine sediment depth.

Maintenance should occur when the sediment has reached the levels indicated in the Storage Capacity Chart.

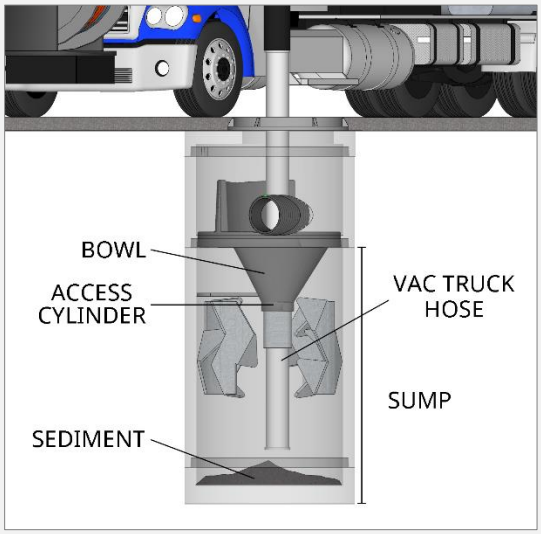
Barracuda Storage Capacities

Model	Manhole Diameter in. (mm)	Total System Volume Gallons (Liters)	Treatment Chamber Capacity Gallons (Liters)	Standard Sediment Capacity (20" depth) Yards^3 (meters^3)	NJDEP Sediment Capacity (50% of standard depth) Yards^3 (meters^3)
S3	36 (900)	264 (999)	212 (803)	0.44 (0.34)	0.22 (0.17)
S4	48 (1200)	665 (2517)	564 (2135)	0.78 (0.60)	0.39 (0.30)
S6	72 (1800)	1497 (5667)	1269 (4804)	1.75 (1.34)	0.88 (0.67)
S8	96 (2400)	4196 (15884)	3835 (14517)	3.10 (2.37)	1.55 (1.19)

Maintenance Instructions

1. Remove the manhole cover to provide access to the pollutant storage. Pollutants are stored in the sump, below the bowl assembly visible from the surface. Access this area through the 8" (200 mm), 10" (250 mm), 15" (375 mm) or 20" (500 mm) diameter access cylinder.
2. Use a vacuum truck or other similar equipment to remove all water, debris, oils and sediment. See figure 1.
3. Use a high pressure hose to clean the manhole of all the remaining sediment and debris. Then, use the vacuum truck to remove the water.
4. Fill the cleaned manhole with water until the level reaches the invert of the outlet pipe.
5. Replace the manhole cover.
6. Dispose of the polluted water, oils, sediment and trash at an approved facility.
   a. Local regulations prohibit the discharge of solid material into the sanitary system. Check with the local sewer authority for authority to discharge the liquid.
   b. Some localities treat the pollutants as leachate. Check with local regulators about disposal requirements.
   c. Additional local regulations may apply to the maintenance procedure.

Figure 1



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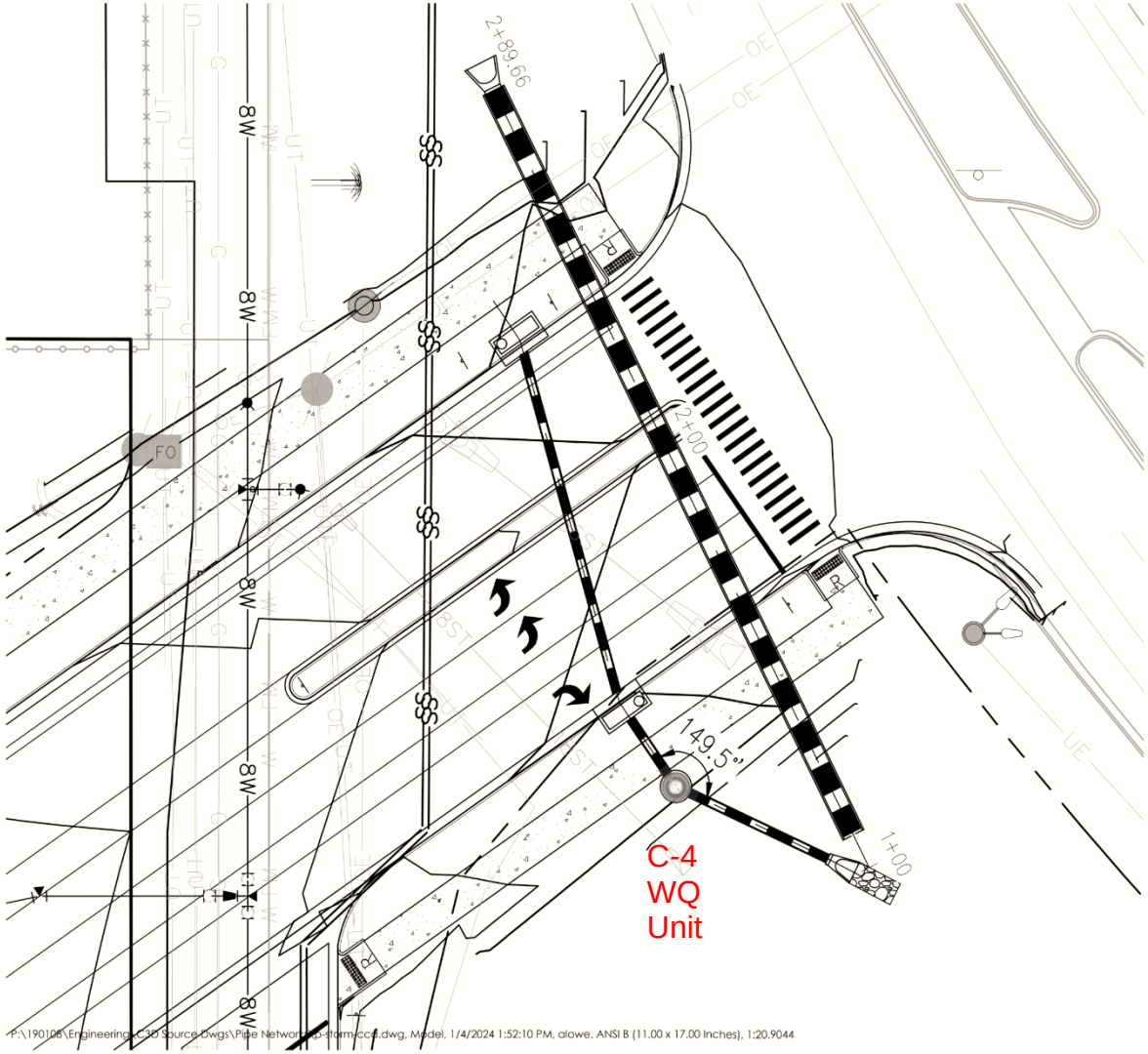
2+89.66
8W
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2+00
149.5°
1+00
C-4
WQ
Unit
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HY-8 Culvert Analysis Report

Crossing Notes: Station 30+00 10-Year Culvert

* Full Flow Headwater elevation is below inlet invert.

****

Straight 8'x5' Concrete Box Culvert

Inlet Elevation (invert): 5399.18 ft, Outlet Elevation (invert): 5398.72 ft

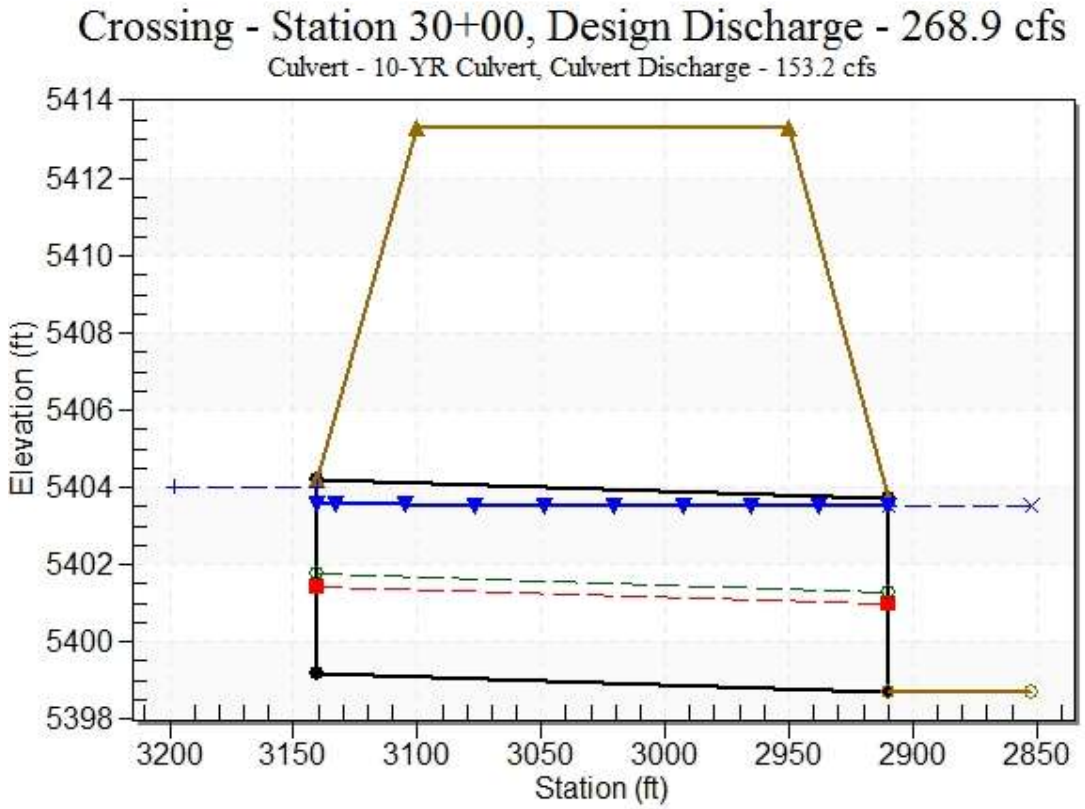
Culvert Length: 230.41 ft, Culvert Slope: 0.0020

****

Culvert Summary Table: 10-YR Culvert

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
38.19	37.11	5401.06	1.499	1.882	3-M1t	0.980	0.874	2.150	2.150	2.158	2.102
61.47	49.53	5401.55	1.817	2.374	3-M1t	1.185	1.060	2.626	2.626	2.357	2.370
84.75	61.13	5401.95	2.090	2.769	3-M1t	1.363	1.219	3.000	3.000	2.547	2.568
108.03	72.75	5402.29	2.347	3.111	3-M1t	1.532	1.369	3.314	3.314	2.744	2.730
131.31	84.50	5402.60	2.591	3.417	3-M1t	1.695	1.513	3.588	3.588	2.943	2.867
154.60	96.24	5402.87	2.817	3.695	3-M1t	1.853	1.650	3.834	3.834	3.138	2.986
177.88	107.81	5403.13	3.031	3.952	3-M1t	2.004	1.780	4.058	4.058	3.321	3.093
201.16	119.45	5403.37	3.239	4.192	3-M1t	2.152	1.906	4.264	4.264	3.502	3.190
224.44	131.05	5403.60	3.440	4.419	3-M1t	2.297	2.027	4.455	4.455	3.677	3.278
268.90	153.16	5404.00	3.807	4.822	3-M1t	2.564	2.249	4.790	4.790	3.997	3.430
271.00	154.16	5404.02	3.823	4.840	3-M1t	2.576	2.259	4.804	4.804	4.011	3.437

Water Surface Profile Plot for Culvert: 10-YR Culvert



Crossing Notes: Station 30+00 Pedestrian Culvert

* Full Flow Headwater elevation is below inlet invert.

****

Straight 10'x8' Concrete Box Culvert

Inlet Elevation (invert): 5400.93 ft, Outlet Elevation (invert): 5400.47 ft

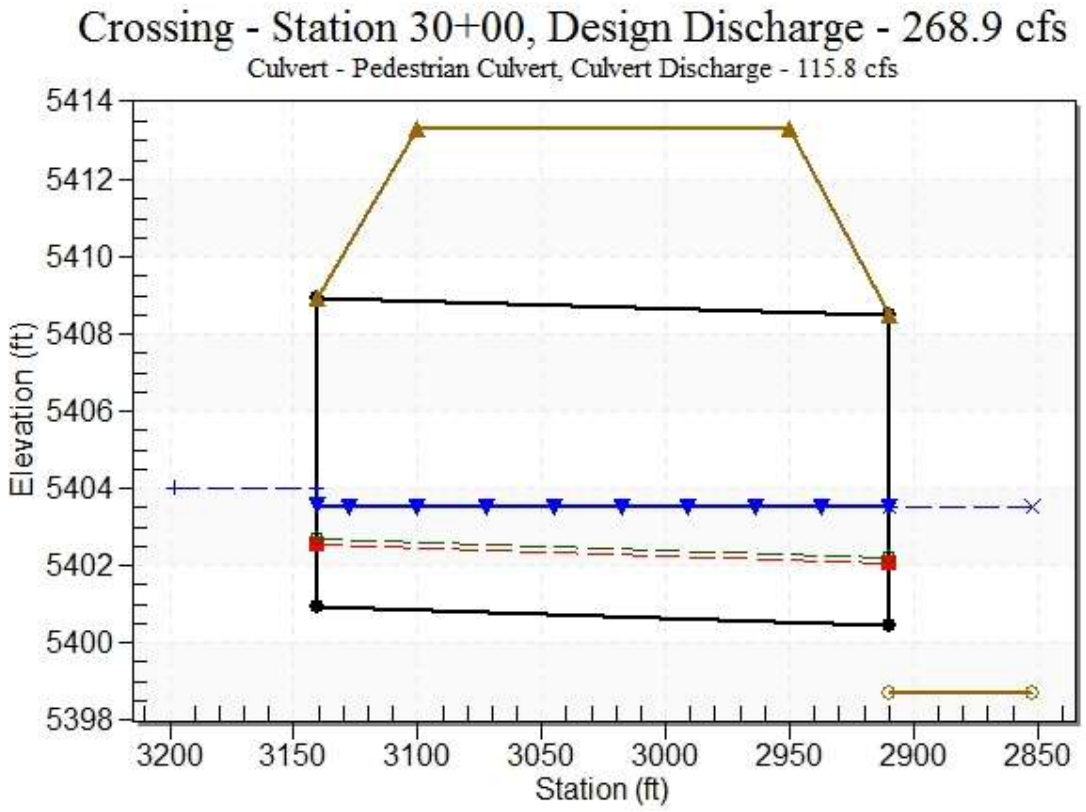
Culvert Length: 230.41 ft, Culvert Slope: 0.0020

****

Culvert Summary Table: Pedestrian Culvert

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
38.19	1.23	5401.06	0.133	0.0*	1-S2n	0.065	0.078	0.065	2.150	1.877	2.102
61.47	12.03	5401.55	0.609	0.624	3-M1t	0.412	0.356	0.876	2.626	1.373	2.370
84.75	23.79	5401.95	0.960	1.019	3-M1t	0.630	0.560	1.250	3.000	1.904	2.568
108.03	35.33	5402.29	1.250	1.360	3-M1t	0.810	0.729	1.564	3.314	2.259	2.730
131.31	47.03	5402.60	1.512	1.668	3-M1t	0.971	0.882	1.838	3.588	2.558	2.867
154.60	58.52	5402.87	1.750	1.945	3-M1t	1.118	1.021	2.084	3.834	2.808	2.986
177.88	70.15	5403.13	1.974	2.203	3-M1t	1.259	1.152	2.308	4.058	3.040	3.093
201.16	81.77	5403.37	2.187	2.443	3-M1t	1.392	1.276	2.514	4.264	3.253	3.190
224.44	93.42	5403.60	2.390	2.670	3-M1t	1.519	1.394	2.705	4.455	3.453	3.278
268.90	115.81	5404.00	2.758	3.073	3-M1t	1.753	1.609	3.040	4.790	3.810	3.430
271.00	116.84	5404.02	2.774	3.091	3-M1t	1.764	1.618	3.054	4.804	3.825	3.437

Water Surface Profile Plot for Culvert: Pedestrian Culvert



Crossing Notes: Station 7+00 10-Year Culvert

* Full Flow Headwater elevation is below inlet invert.

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Straight 8'x5' Concrete Box Culvert

Inlet Elevation (invert): 5372.82 ft, Outlet Elevation (invert): 5370.42 ft

Culvert Length: 240.13 ft, Culvert Slope: 0.0100

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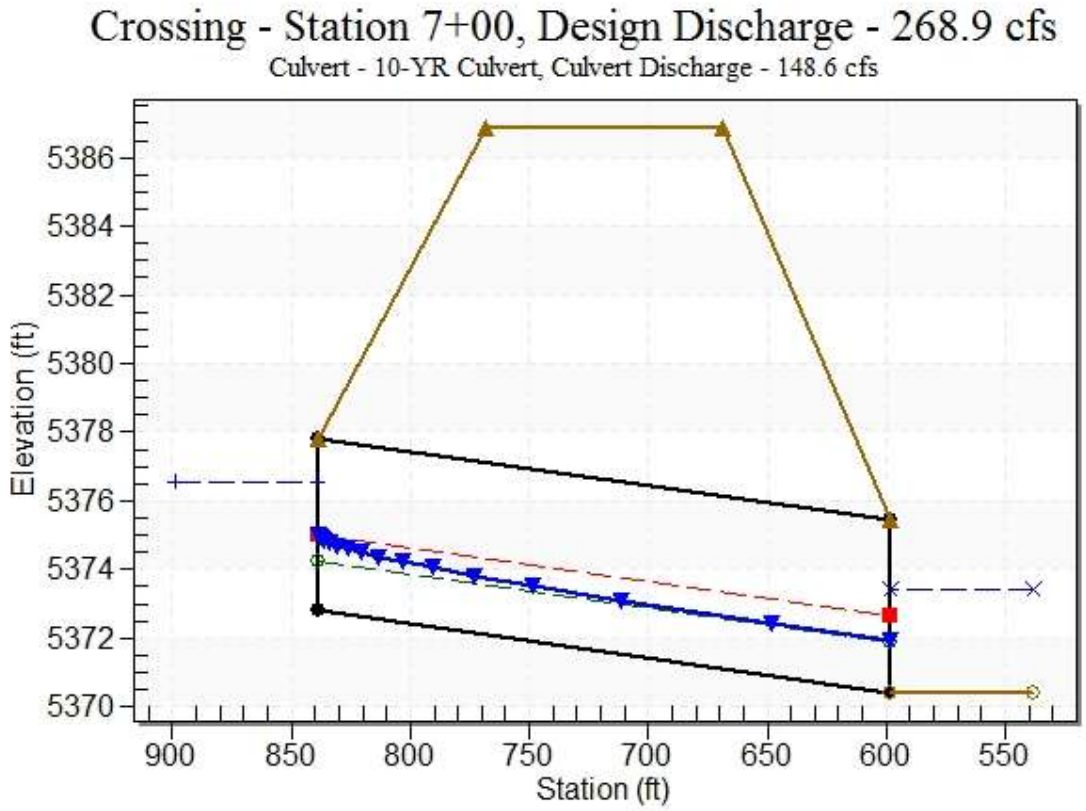
Culvert Summary Table: 10-YR Culvert

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
38.19	38.16	5374.33	1.514	0.0*	1-JS1t	0.594	0.891	1.369	1.369	3.484	4.307
61.47	56.78	5374.79	1.973	0.0*	1-S2n	0.767	1.161	0.767	1.659	9.250	4.853
84.75	69.19	5375.07	2.251	0.0*	1-S2n	0.871	1.324	0.871	1.886	9.933	5.259
108.03	80.30	5375.31	2.486	0.0*	1-S2n	0.959	1.463	0.966	2.077	10.386	5.589
131.31	90.98	5375.52	2.697	0.009	1-S2n	1.041	1.590	1.061	2.244	10.714	5.868
154.60	101.27	5375.71	2.891	0.198	1-S2n	1.116	1.707	1.146	2.393	11.044	6.113
177.88	111.27	5375.89	3.074	0.376	1-S2n	1.188	1.818	1.217	2.528	11.426	6.331
201.16	121.05	5376.07	3.247	0.547	1-S2n	1.256	1.923	1.287	2.653	11.756	6.528
224.44	130.67	5376.23	3.413	0.712	1-S2n	1.322	2.024	1.362	2.769	11.993	6.710
268.90	148.64	5376.53	3.713	1.015	1-S2n	1.441	2.205	1.490	2.972	12.472	7.021
271.00	149.47	5376.55	3.727	1.029	1-S2n	1.446	2.213	1.495	2.981	12.493	7.034

Water Surface Profile Plot for Culvert: 10-YR Culvert



Crossing Notes: Station 7+00 Pedestrian Culvert

* Full Flow Headwater elevation is below inlet invert.

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Straight 10'x8' Concrete Box Culvert

Inlet Elevation (invert): 5374.57 ft, Outlet Elevation (invert): 5372.17 ft

Culvert Length: 240.13 ft, Culvert Slope: 0.0100

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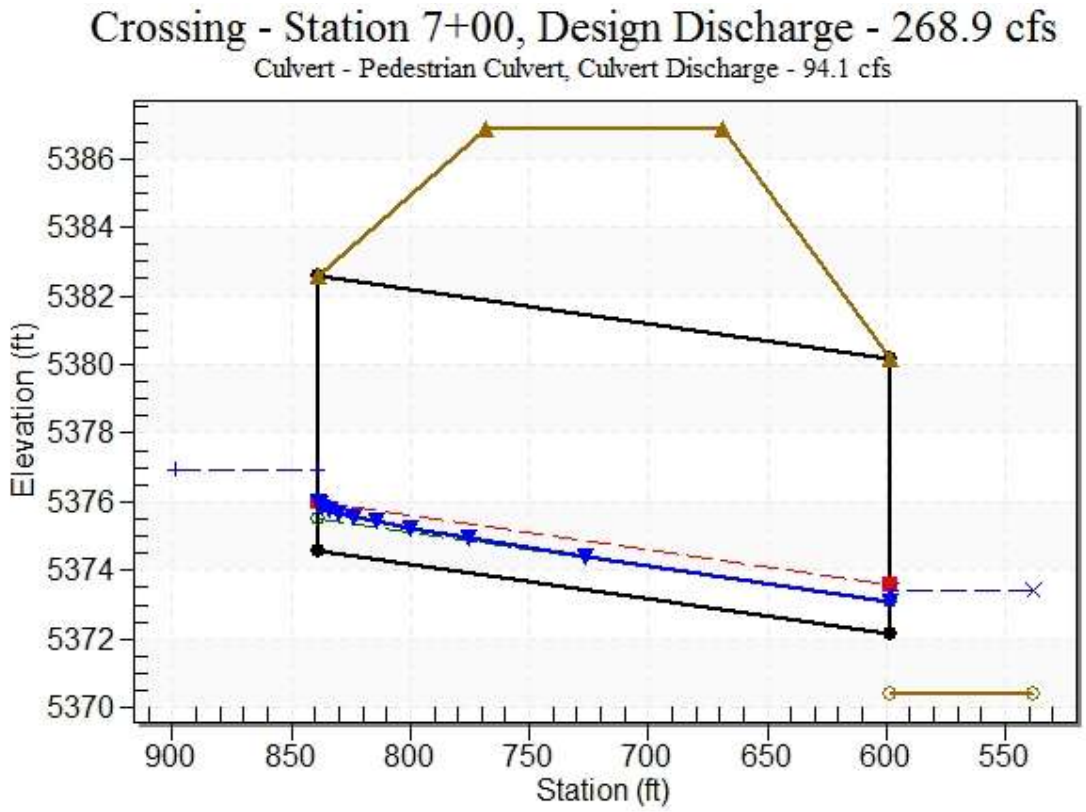
Culvert Summary Table: Pedestrian Culvert

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
38.19	0.00	5374.33	0.000	0.000	0-NF	0.000	0.000	0.000	1.369	0.000	4.307
61.47	3.30	5374.82	0.255	0.0*	1-S2n	0.079	0.150	0.079	1.659	4.201	4.853
84.75	11.52	5375.16	0.587	0.0*	1-S2n	0.238	0.345	0.238	1.886	4.838	5.259
108.03	20.87	5375.44	0.873	0.0*	1-S2n	0.344	0.513	0.344	2.077	6.060	5.589
131.31	30.71	5375.70	1.129	0.0*	1-S2n	0.444	0.664	0.444	2.244	6.913	5.868
154.60	40.91	5375.94	1.367	0.0*	1-S2n	0.530	0.804	0.530	2.393	7.722	6.113
177.88	51.40	5376.16	1.591	0.0*	1-S2n	0.617	0.936	0.617	2.528	8.326	6.331
201.16	62.06	5376.37	1.804	0.0*	1-S2n	0.691	1.061	0.691	2.653	8.975	6.528
224.44	72.91	5376.58	2.009	0.0*	1-S2n	0.767	1.182	0.767	2.769	9.507	6.710
268.90	94.06	5376.95	2.381	0.0*	1-S2n	0.902	1.401	0.920	2.972	10.222	7.021
271.00	95.11	5376.97	2.399	0.0*	1-S2n	0.909	1.411	0.923	2.981	10.309	7.034

Water Surface Profile Plot for Culvert: Pedestrian Culvert



Crossing Notes: 96th Street

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Straight Dual Barrel 8'x5' Concrete Box Culvert

Inlet Elevation (invert): 5363.99 ft, Outlet Elevation (invert): 5363.59 ft

Culvert Length: 80.00 ft, Culvert Slope: 0.0050

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Culvert Summary Table: 96th Street Culvert

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	5363.99	0.000	0.000	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
44.00	44.00	5365.31	1.054	1.321	1-S1t	0.523	0.617	1.615	1.615	1.702	3.650
88.00	88.00	5365.94	1.674	1.945	1-S1t	0.813	0.979	2.129	2.129	2.583	4.342
132.00	132.00	5366.42	2.193	2.435	1-S1t	1.058	1.283	2.498	2.498	3.302	4.806
176.00	176.00	5366.85	2.652	2.860	1-S1t	1.280	1.555	2.797	2.797	3.933	5.164
220.00	220.00	5367.24	3.063	3.249	1-S1t	1.485	1.804	3.051	3.051	4.506	5.460
264.00	264.00	5367.60	3.448	3.613	1-S1t	1.681	2.037	3.276	3.276	5.037	5.715
308.00	308.00	5367.95	3.813	3.959	1-S1t	1.867	2.258	3.478	3.478	5.535	5.940
352.00	352.00	5368.28	4.163	4.293	1-S1t	2.048	2.468	3.662	3.662	6.007	6.141
439.53	439.53	5368.92	4.838	4.931	1-S1t	2.392	2.862	3.991	3.991	6.883	6.492
440.00	440.00	5368.92	4.842	4.935	1-S1t	2.394	2.864	3.993	3.993	6.888	6.494

Water Surface Profile Plot for Culvert: 96th Street Culvert

Crossing Notes: Goodhue Ditch

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Straight Culvert

Inlet Elevation (invert): 5365.64 ft, Outlet Elevation (invert): 5356.40 ft

Culvert Length: 700.79 ft, Culvert Slope: 0.0129

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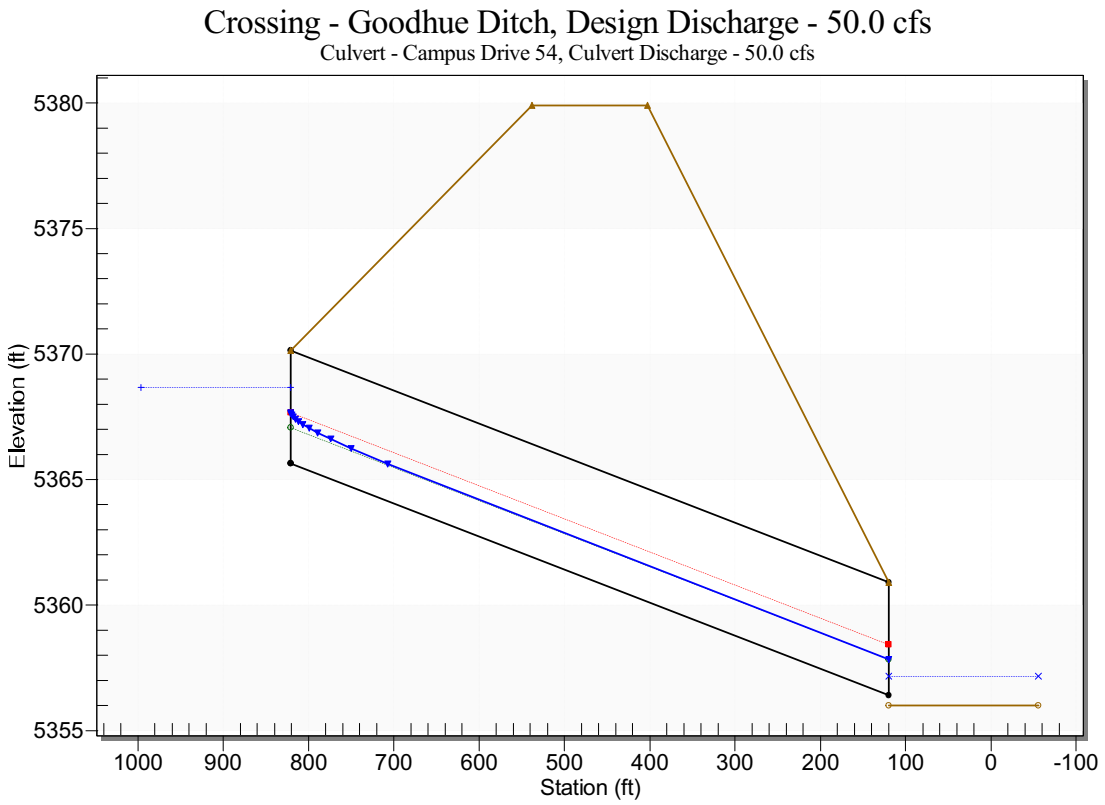
Culvert Summary Table: Goodhue Ditch Culvert

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	5365.64	0.00	0.0	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
5.00	5.00	5366.53	0.89	0.0*	1-S2n	0.46	0.63	0.46	0.36	5.81	2.57
10.00	10.00	5366.92	1.28	0.0*	1-S2n	0.64	0.89	0.64	0.52	7.17	3.16
15.00	15.00	5367.22	1.58	0.0*	1-S2n	0.78	1.10	0.78	0.64	8.07	3.55
20.00	20.00	5367.48	1.84	0.0*	1-S2n	0.90	1.27	0.90	0.74	8.78	3.85
25.00	25.00	5367.71	2.07	0.0*	1-S2n	1.01	1.43	1.01	0.83	9.37	4.09
30.00	30.00	5367.92	2.28	0.0*	1-S2n	1.11	1.57	1.11	0.91	9.88	4.30
35.00	35.00	5368.13	2.49	0.0*	1-S2n	1.20	1.70	1.20	0.98	10.33	4.48
40.00	40.00	5368.33	2.69	0.0*	1-S2n	1.28	1.82	1.28	1.05	10.73	4.64
45.00	45.00	5368.51	2.87	0.0*	1-S2n	1.36	1.94	1.36	1.11	11.09	4.79
50.00	50.00	5368.68	3.04	0.0*	1-S2n	1.44	2.05	1.44	1.17	11.43	4.93

Water Surface Profile Plot for Culvert: Goodhue Ditch Culvert



HY-8 Culvert Analysis Report
Existing Dual 10'x6' Box Culvert at E470

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 0 cfs

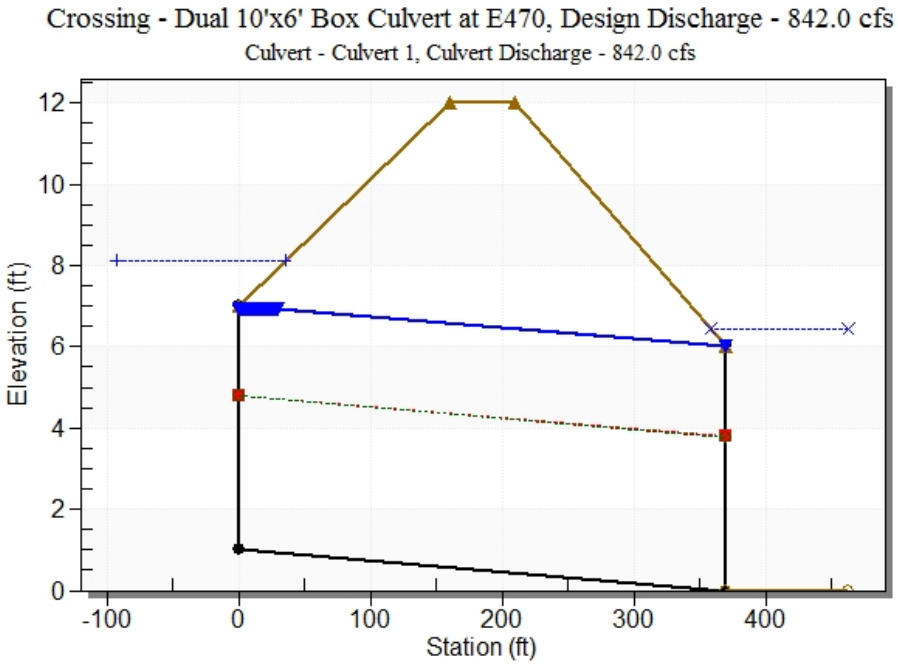
Design Flow: 842 cfs

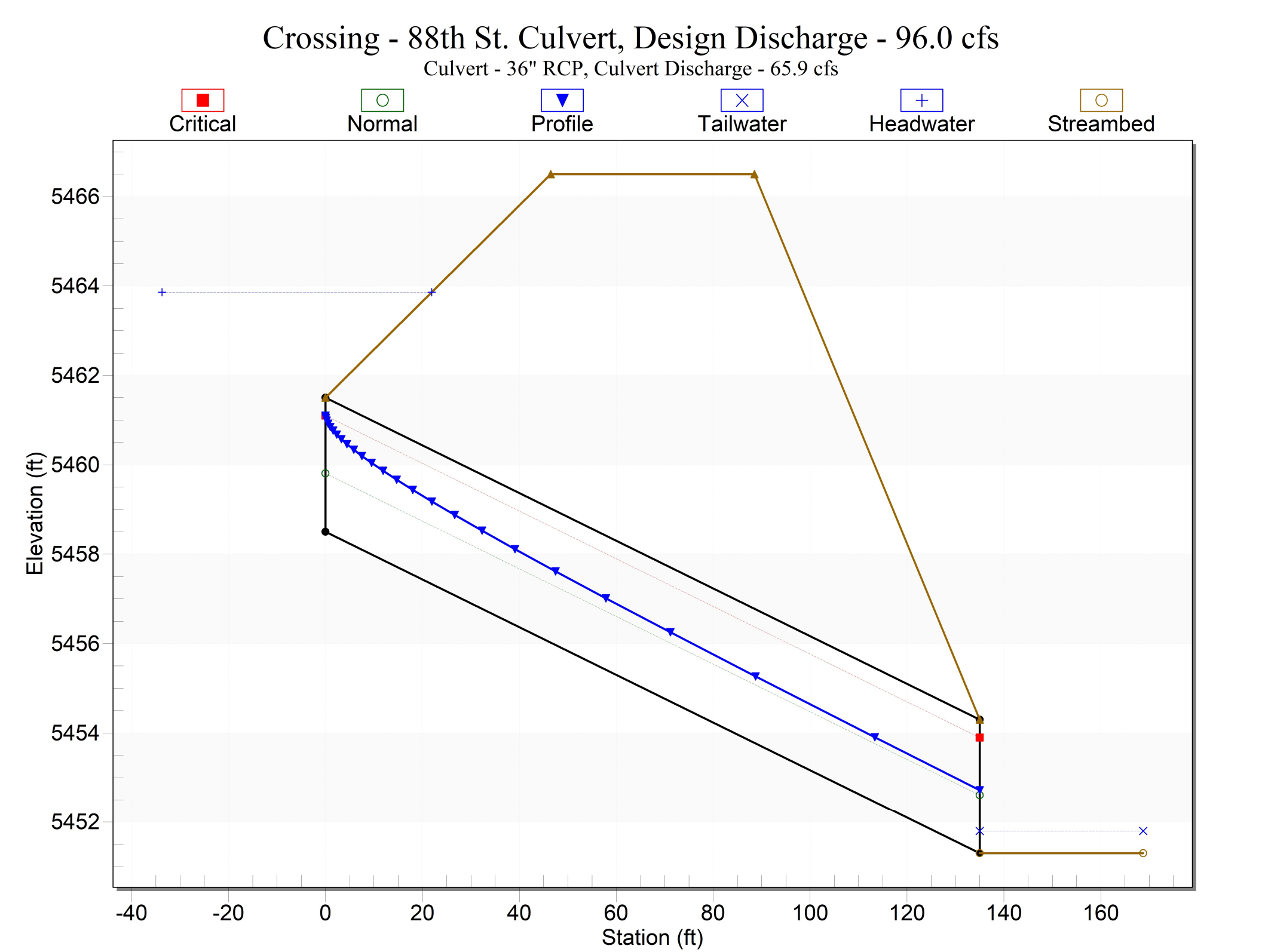
Maximum Flow: 842 cfs

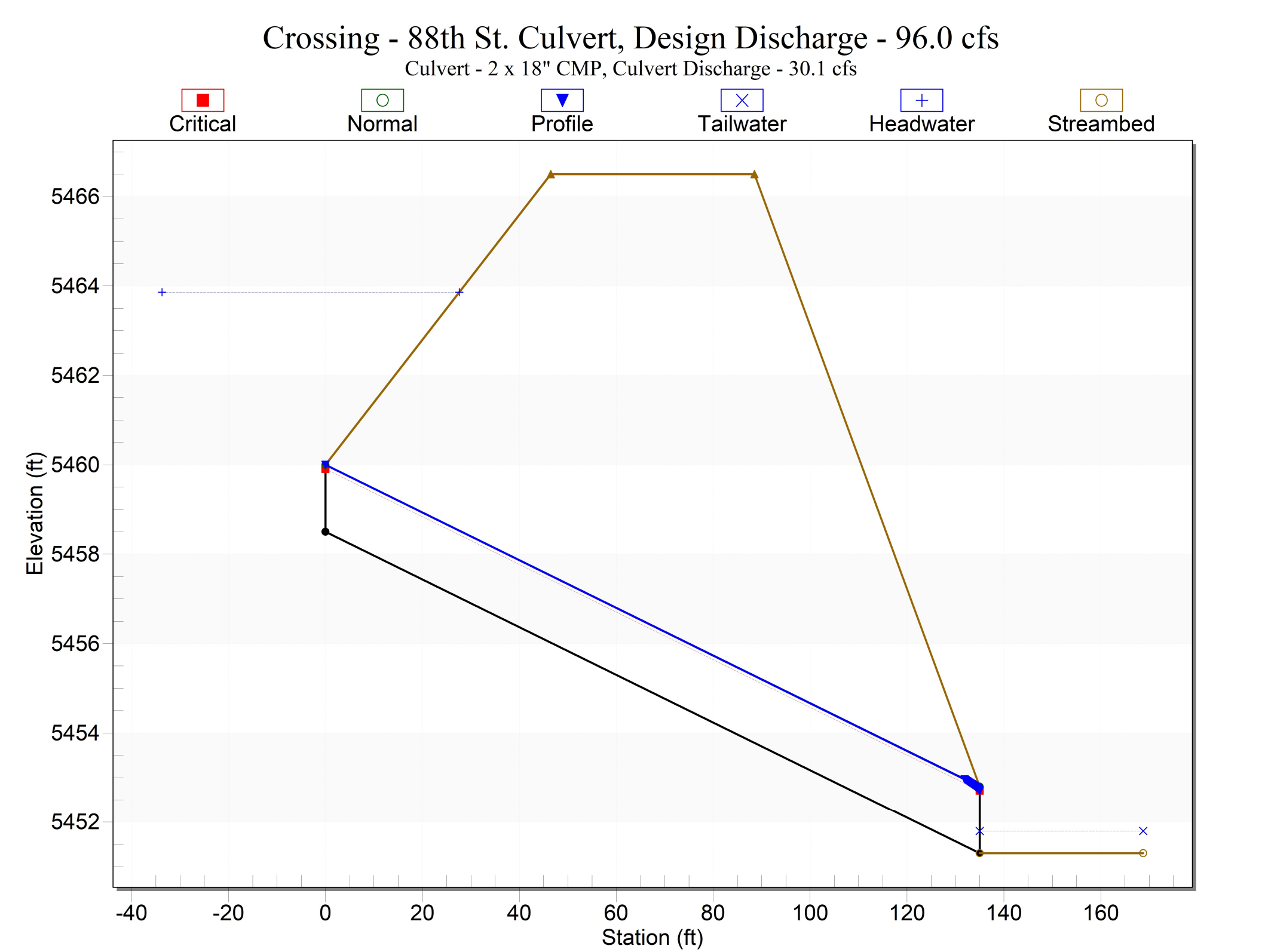
Summary of Culvert Flows at Crossing: Dual 10'x6' Box Culvert at E470

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	1.00	0.000	0.000	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
84.20	84.20	2.40	1.404	0.415	1-S2n	0.800	0.820	0.800	1.398	5.260	3.010
168.40	168.40	3.23	2.228	1.243	1-JS1t	1.252	1.301	2.176	2.176	3.869	3.869
252.60	252.60	3.95	2.920	2.947	1-S1t	1.637	1.705	2.835	2.835	4.455	4.455
336.80	336.80	4.55	3.518	3.549	1-S1t	1.987	2.065	3.431	3.431	4.909	4.909
421.00	421.00	5.15	4.065	4.148	1-S1t	2.314	2.396	3.986	3.986	5.281	5.281
505.20	505.20	5.73	4.577	4.729	1-S1t	2.626	2.706	4.513	4.513	5.597	5.597
589.40	589.40	6.29	5.066	5.290	1-S1t	2.926	2.999	5.019	5.019	5.872	5.872
673.60	673.60	6.83	5.541	5.834	1-S1t	3.217	3.278	5.508	5.508	6.115	6.115
757.80	757.80	7.36	6.011	6.362	1-S1t	3.500	3.546	5.983	5.983	6.333	6.333
842.00	842.00	8.10	6.485	7.102	1-S1f	3.778	3.804	6.000	6.447	7.017	6.531

Water Surface Profile Plot for Culvert




Crossing - 88th St. Culvert, Design Discharge - 96.0 cfs
Culvert - 36" RCP, Culvert Discharge - 65.9 cfs
Critical
Normal
Profile
Tailwater
Headwater
Streambed
Elevation (ft)
5466
5464
5462
5460
5458
5456
5454
5452
-40
-20
0
20
40
60
80
100
120
140
160
Station (ft)


Crossing - 88th St. Culvert, Design Discharge - 96.0 cfs
Culvert - 2 x 18" CMP, Culvert Discharge - 30.1 cfs
Critical
Normal
Profile
Tailwater
Headwater
Streambed
Elevation (ft)
5466
5464
5462
5460
5458
5456
5454
5452
-40
-20
0
20
40
60
80
100
120
140
160
Station (ft)

HY-8 Analysis Results

Crossing Summary Table

Culvert Crossing: 88th St. Culvert

Headwater Elevation (ft)	Total Discharge (cfs)	36" RCP Discharge (cfs)	2 x 18" CMP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
5459.28	8.36	3.64	4.72	0.00	5
5459.68	17.13	8.08	9.03	0.00	3
5460.02	25.90	12.84	13.05	0.00	4
5460.38	34.66	17.78	16.88	0.00	3
5460.73	43.43	23.41	20.02	0.00	3
5461.09	52.20	29.50	22.71	0.00	3
5461.46	60.97	35.82	25.15	0.00	4
5461.87	69.74	42.22	27.53	0.00	4
5462.43	78.50	50.12	28.39	0.00	4
5463.10	87.27	58.15	29.14	0.00	3
5463.86	96.04	65.91	30.14	0.00	3
5466.50	120.91	87.41	33.50	0.00	Overtopping

HY-8 Analysis Results

Water Surface Profiles

Culvert Crossing: 88th St. Culvert

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth(ft)	Outlet Control Depth(ft)	Flow Type	Length Full (ft)	Length Free (ft)
8.36	4.72	5459.28	0.78	0.0*	1-S2n	0.00	135.00
17.13	9.03	5459.68	1.18	0.0*	1-S2n	0.00	135.00
25.90	13.05	5460.02	1.52	0.0*	5-S2n	0.00	135.00
34.66	16.88	5460.38	1.88	0.0*	5-S2n	0.00	135.00
43.43	20.02	5460.73	2.23	0.0*	5-S2n	0.00	135.00
52.20	22.71	5461.09	2.59	0.51	5-S2n	0.00	135.00
60.97	25.15	5461.46	2.96	1.96	5-S2n	0.00	135.00
69.74	27.53	5461.87	3.37	0.0*	5-S2n	0.00	135.00
78.50	28.39	5462.43	3.52	3.93	7-M2c	108.49	26.51
87.27	29.14	5463.10	3.66	4.60	7-M2c	128.15	6.85
96.04	30.14	5463.86	3.85	5.36	7-M2c	131.88	3.12

HY-8 Analysis Results

Culvert Summary Table - 36" RCP

Culvert Crossing: 88th St. Culvert

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth(ft)	Outlet Control Depth(ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
8.36	3.64	5459.28	0.78	0.0*	1-S2n	0.31	0.59	0.31	0.12	9.61	2.08
17.13	8.08	5459.68	1.18	0.0*	1-S2n	0.45	0.90	0.45	0.18	12.23	2.72
25.90	12.84	5460.02	1.52	0.0*	1-S2n	0.56	1.14	0.56	0.23	14.02	3.16
34.66	17.78	5460.38	1.88	0.0*	1-S2n	0.66	1.35	0.69	0.28	14.62	3.50
43.43	23.41	5460.73	2.23	0.0*	1-S2n	0.76	1.56	0.79	0.32	15.83	3.79
52.20	29.50	5461.09	2.59	0.0*	1-S2n	0.85	1.76	0.89	0.35	16.76	4.04
60.97	35.82	5461.46	2.96	0.0*	1-S2n	0.94	1.95	0.99	0.38	17.61	4.25
69.74	42.22	5461.87	3.37	0.0*	5-S2n	1.03	2.12	1.09	0.42	18.24	4.45
78.50	50.12	5462.43	3.93	0.0*	5-S2n	1.13	2.30	1.20	0.44	18.96	4.63
87.27	58.15	5463.10	4.60	0.0*	5-S2n	1.22	2.47	1.31	0.47	19.53	4.80
96.04	65.91	5463.86	5.36	0.0*	5-S2n	1.31	2.60	1.42	0.50	20.00	4.95

HY-8 Analysis Results

Culvert Summary Table - 2 x 18" CMP

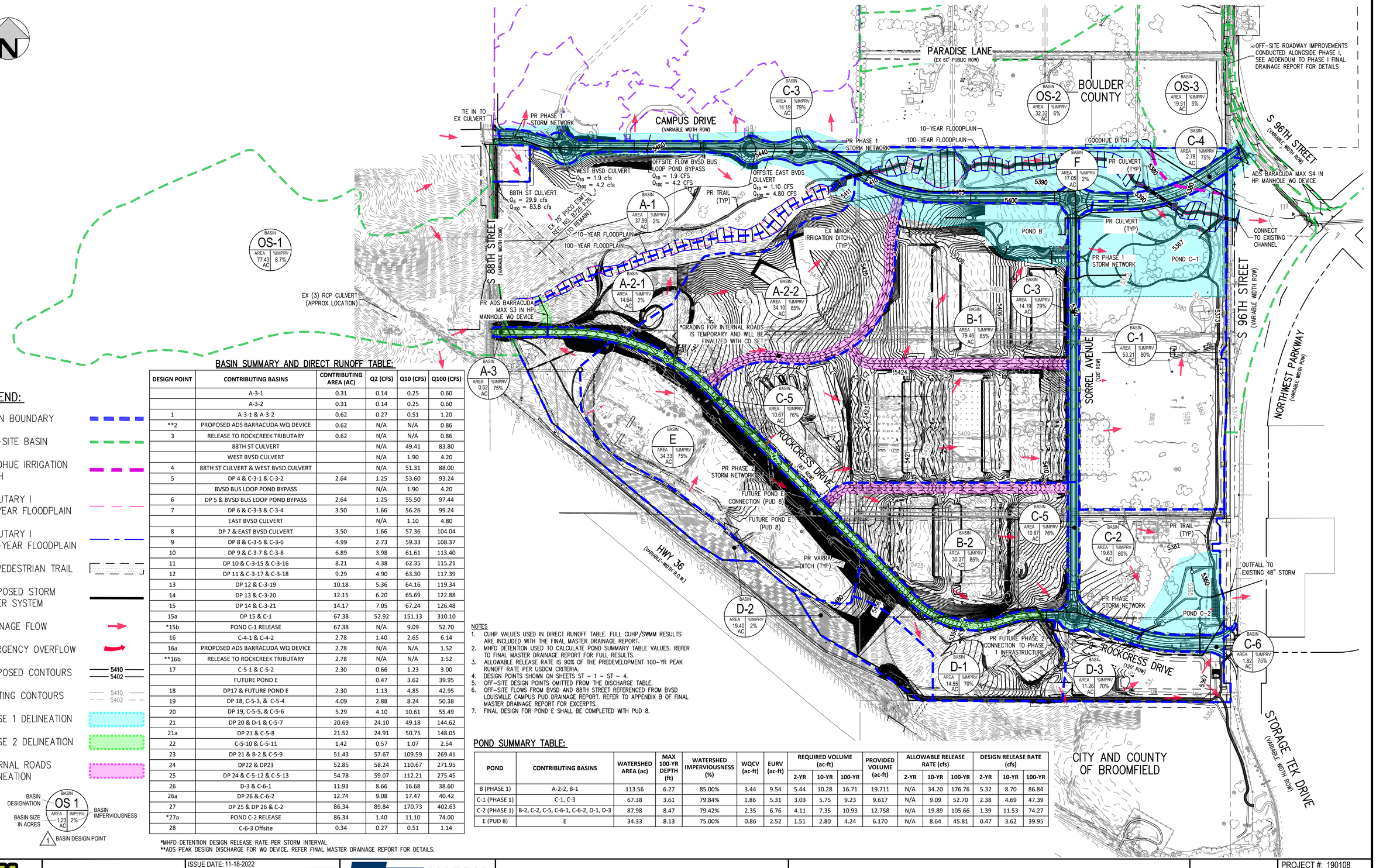
Culvert Crossing: 88th St. Culvert

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth(ft)	Outlet Control Depth(ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
8.36	4.72	5459.28	0.78	0.0*	1-S2n	0.43	0.58	0.43	0.12	5.64	2.08
17.13	9.03	5459.68	1.18	0.0*	1-S2n	0.61	0.82	0.61	0.18	6.75	2.72
25.90	13.05	5460.02	1.52	0.0*	5-S2n	0.75	0.99	0.75	0.23	7.44	3.16
34.66	16.88	5460.38	1.88	0.0*	5-S2n	0.87	1.13	0.87	0.28	7.91	3.50
43.43	20.02	5460.73	2.23	0.0*	5-S2n	0.98	1.22	0.98	0.32	8.20	3.79
52.20	22.71	5461.09	2.59	0.51	5-S2n	1.07	1.29	1.07	0.35	8.38	4.04
60.97	25.15	5461.46	2.96	1.96	5-S2n	1.17	1.34	1.17	0.38	8.48	4.25
69.74	27.53	5461.87	3.37	0.0*	5-S2n	1.30	1.37	1.30	0.42	8.45	4.45
78.50	28.39	5462.43	3.52	3.93	7-M2c	1.50	1.39	1.39	0.44	8.32	4.63
87.27	29.14	5463.10	3.66	4.60	7-M2c	1.50	1.40	1.40	0.47	8.50	4.80
96.04	30.14	5463.86	3.85	5.36	7-M2c	1.50	1.41	1.41	0.50	8.75	4.95

APPENDIX D – Existing and Master Drainage

Master Drainage Plan
Existing Drainage Plan

NO CHANGES ARE TO BE MADE TO THIS DRAWING WITHOUT WRITTEN PERMISSION OF HARRIS KOCHER SMITH.



LEGEND:

- BASIN BOUNDARY
- OFF-SITE BASIN
- GOODHUE IRRIGATION DITCH
- TRIBUTARY I 10-YEAR FLOODPLAIN
- TRIBUTARY I 100-YEAR FLOODPLAIN
- PR PEDESTRIAN TRAIL
- PROPOSED STORM SEWER SYSTEM
- DRAINAGE FLOW
- EMERGENCY OVERFLOW
- PROPOSED CONTOURS 5410 / 5402
- EXISTING CONTOURS 5410 / 5402
- PHASE 1 DELINEATION
- PHASE 2 DELINEATION
- INTERNAL ROADS DELINEATION

BASIN DESIGNATION — BASIN SIZE IN ACRES — BASIN IMPERVIOUSNESS — BASIN DESIGN POINT

BASIN SUMMARY AND DIRECT RUNOFF TABLE:

DESIGN POINT	CONTRIBUTING BASINS	CONTRIBUTING AREA (AC)	Q2 (CFS)	Q10 (CFS)	Q100 (CFS)
	A-3-1	0.31	0.14	0.25	0.60
	A-3-2	0.31	0.14	0.25	0.60
1	A-3-1 & A-3-2	0.62	0.27	0.51	1.20
**2	PROPOSED ADS BARRACUDA WQ DEVICE	0.62	N/A	N/A	0.86
3	RELEASE TO ROCKCREEK TRIBUTARY	0.62	N/A	N/A	0.86
	88TH ST CULVERT		N/A	49.41	83.80
	WEST BVSD CULVERT		N/A	1.90	4.20
4	88TH ST CULVERT & WEST BVSD CULVERT		N/A	51.31	88.00
5	DP 4 & C-3-1 & C-3-2	2.64	1.25	53.60	93.24
	BVSD BUS LOOP POND BYPASS		N/A	1.90	4.20
6	DP 5 & BVSD BUS LOOP POND BYPASS	2.64	1.25	55.50	97.44
7	DP 6 & C-3-3 & C-3-4	3.50	1.66	56.26	99.24
	EAST BVSD CULVERT		N/A	1.10	4.80
8	DP 7 & EAST BVSD CULVERT	3.50	1.66	57.36	104.04
9	DP 8 & C-3-5 & C-3-6	4.99	2.73	59.33	108.37
10	DP 9 & C-3-7 & C-3-8	6.89	3.98	61.61	113.40
11	DP 10 & C-3-15 & C-3-16	8.21	4.38	62.35	115.21
12	DP 11 & C-3-17 & C-3-18	9.29	4.90	63.30	117.39
13	DP 12 & C-3-19	10.18	5.36	64.16	119.34
14	DP 13 & C-3-20	12.15	6.20	65.69	122.88
15	DP 14 & C-3-21	14.17	7.05	67.24	126.48
15a	DP 15 & C-1	67.38	52.92	151.13	310.10
*15b	POND C-1 RELEASE	67.38	N/A	9.09	52.70
16	C-4-1 & C-4-2	2.78	1.40	2.65	6.14
16a	PROPOSED ADS BARRACUDA WQ DEVICE	2.78	N/A	N/A	1.52
**16b	RELEASE TO ROCKCREEK TRIBUTARY	2.78	N/A	N/A	1.52
17	C-5-1 & C-5-2	2.30	0.66	1.23	3.00
	FUTURE POND E		0.47	3.62	39.95
18	DP17 & FUTURE POND E	2.30	1.13	4.85	42.95
19	DP 18, C-5-3, & C-5-4	4.09	2.88	8.24	50.38
20	DP 19, C-5-5, & C-5-6	5.29	4.10	10.61	55.49
21	DP 20 & D-1 & C-5-7	20.69	24.10	49.18	144.62
21a	DP 21 & C-5-8	21.52	24.91	50.75	148.05
22	C-5-10 & C-5-11	1.42	0.57	1.07	2.54
23	DP 21 & B-2 & C-5-9	51.43	57.67	109.59	269.41
24	DP22 & DP23	52.85	58.24	110.67	271.95
25	DP 24 & C-5-12 & C-5-13	54.78	59.07	112.21	275.45
26	D-3 & C-6-1	11.93	8.66	16.68	38.60
26a	DP 26 & C-6-2	12.74	9.08	17.47	40.42
27	DP 25 & DP 26 & C-2	86.34	89.84	170.73	402.63
*27a	POND C-2 RELEASE	86.34	1.40	11.10	74.00
28	C-6-3 Offsite	0.34	0.27	0.51	1.14

*MHFD DETENTION DESIGN RELEASE RATE PER STORM INTERVAL
**ADS PEAK DESIGN DISCHARGE FOR WQ DEVICE. REFER FINAL MASTER DRAINAGE REPORT FOR DETAILS.

NOTES
1. CUHP VALUES USED IN DIRECT RUNOFF TABLE. FULL CUHP/SWMM RESULTS ARE INCLUDED WITH THE FINAL MASTER DRAINAGE REPORT.
2. MHFD DETENTION USED TO CALCULATE POND SUMMARY TABLE VALUES. REFER TO FINAL MASTER DRAINAGE REPORT FOR FULL RESULTS.
3. ALLOWABLE RELEASE RATE IS 90% OF THE PREDEVELOPMENT 100-YR PEAK RUNOFF RATE PER USDCM CRITERIA.
4. DESIGN POINTS SHOWN ON SHEETS ST – 1 – ST – 4.
5. OFF-SITE DESIGN POINTS OMITTED FROM THE DISCHARGE TABLE.
6. OFF-SITE FLOWS FROM BVSD AND 88TH STREET REFERENCED FROM BVSD LOUISVILLE CAMPUS PUD DRAINAGE REPORT. REFER TO APPENDIX B OF FINAL MASTER DRAINAGE REPORT FOR EXCERPTS.
7. FINAL DESIGN FOR POND E SHALL BE COMPLETED WITH PUD 8.

POND SUMMARY TABLE:

POND	CONTRIBUTING BASINS	WATERSHED AREA (ac)	MAX 100-YR DEPTH (ft)	WATERSHED IMPERVIOUSNESS (%)	WQCV (ac-ft)	EURV (ac-ft)	REQUIRED VOLUME (ac-ft)			PROVIDED VOLUME (ac-ft)	ALLOWABLE RELEASE RATE (cfs)			DESIGN RELEASE RATE (cfs)		
							2-YR	10-YR	100-YR		2-YR	10-YR	100-YR	2-YR	10-YR	100-YR
B (PHASE 1)	A-2-2, B-1	113.56	6.27	85.00%	3.44	9.54	5.44	10.28	16.71	19.711	N/A	34.20	176.76	5.32	8.70	86.84
C-1 (PHASE 1)	C-1, C-3	67.38	3.61	79.84%	1.86	5.31	3.03	5.75	9.23	9.617	N/A	9.09	52.70	2.38	4.69	47.39
C-2 (PHASE 1)	B-2, C-2, C-5, C-6-1, C-6-2, D-1, D-3	87.98	8.47	79.42%	2.35	6.76	4.11	7.35	10.93	12.758	N/A	19.89	105.66	1.39	11.53	74.27
E (PUD 8)	E	34.33	8.13	75.00%	0.86	2.52	1.51	2.80	4.24	6.170	N/A	8.64	45.81	0.47	3.62	39.95

811 Know what's below. Call before you dig.

300 0 300 600
SCALE: 1" = 300'

DESIGNED BY: SDM
CHECKED BY: MAW
DRAWN BY: SDM

ISSUE DATE: 11-18-2022

DATE	REVISION COMMENTS

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HarrisKocherSmith.com

STERLING BAY

REDTAIL RIDGE PHASE 2
OVERALL DRAINAGE PLAN

PRELIMINARY NOT FOR CONSTRUCTION

PROJECT #: 190108
SHEET NUMBER
CD - 4
4 OF 47

FILEPATH: P:\2019\190108\ENGINEERING\DRAINAGE\2024 MASTER DRAINAGE PLAN\- F2 DWG LAYOUT- OVERALL DRAINAGE PLAN
11 XREFs: e-base, e-legal, e-utl, key map, p-base-f1, p-base-f2, p-dmg, p-legal-f1, p-legal-f2, stamp - storm, storm - f1 - stamp
PLOTTED: WED 01/31/24 1:30:09P BY: GRANT SAVILLE

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TIE IN TO EX CULVERT

TIE EX BVSD STORM TO PR STORM NETWORK

88TH ST CULVERT
Q_5 = 29.9 cfs
Q_{100} = 83.8 cfs

WEST BVSD CULVERT
Q_{10} = 1.9 cfs
Q_{100} = 4.2 cfs

CAMPUS DRIVE
(VARIABLE WIDTH ROW)

TIE EX STORM TO PR STORM NETWORK

TIE EX STORM TO PR STORM NETWORK

PR PHASE 1 STORM NETWORK (TYP)

OFFSITE FLOW BVSD BUS LOOP POND BYPASS
Q_{10} = 1.9 CFS
Q_{100} = 4.2 CFS

OFFSITE EAST BVDS CULVERT
Q_{10} = 1.10 CFS
Q_{100} = 4.80 CFS

PR CULVERT (TYP)

PR TRAIL (TYP)

TRACT A
REDTAIL RIDGE SUBDIVISION
FILING NO. 1

TRACT B
REDTAIL RIDGE SUBDIVISION
FILING NO. 1

LOT 1 BLOCK 1
REDTAIL RIDGE SUBDIVISION
FILING NO. 1

LOT 1 BLOCK 3
REDTAIL RIDGE SUBDIVISION
FILING NO. 1

TRACT L
REDTAIL RIDGE SUBDIVISION
FILING NO. 1

S 88TH STREET
(VARIABLE WIDTH ROW)

PROPERTY BOUNDARY (TYP)

EX 7' PSCO ESMT REC. NO. B725 P76 (TO REMAIN)

10-YEAR FLOODPLAIN

100-YEAR FLOODPLAIN

ROCK CREEK TRIBUTARY 1

MINOR IRRIGATION DITCH (TYP)

FES TO BE CLEANED OR REPLACED

WQ DEVICE OUTFALLS TO TRIBUTARY I

PR ADS BARRACUDA MAX S3 IN HP MANHOLE WQ DEVICE

PR PHASE 2 STORM NETWORK

PR VARRA DITCH (TYP)

ROCKCRESS DRIVE
(85' ROW)

*GRADING FOR INTERNAL ROADS IS TEMPORARY AND WILL BE FINALIZED WITH CD SET

BASIN C-3-2 | AREA 1.30 AC | %IMPRV 80%

BASIN C-3-4 | AREA 0.44 AC | %IMPRV 75%

BASIN C-3-6 | AREA 0.76 AC | %IMPRV 80%

BASIN C-3-8 | AREA 0.95 AC | %IMPRV 80%

BASIN C-3-1 | AREA 1.34 AC | %IMPRV 80%

BASIN C-3-3 | AREA 0.42 AC | %IMPRV 75%

BASIN C-3-5 | AREA 0.73 AC | %IMPRV 80%

BASIN C-3-7 | AREA 0.95 AC | %IMPRV 80%

BASIN A-1 | AREA 37.99 AC | %IMPRV 2%

BASIN A-2-1 | AREA 14.64 AC | %IMPRV 2%

BASIN A-2-2 | AREA 34.10 AC | %IMPRV 85%

BASIN A-3-2 | AREA 0.31 AC | %IMPRV 75%

BASIN A-3-1 | AREA 0.31 AC | %IMPRV 75%

BASIN C-5-2 | AREA 1.16 AC | %IMPRV 75%

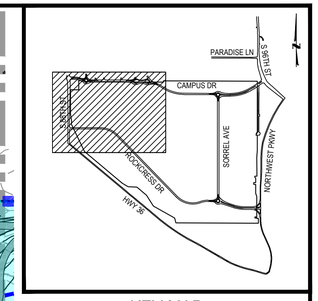
BASIN C-5-1 | AREA 1.14 AC | %IMPRV 75%

BASIN E | AREA 34.33 AC | %IMPRV 75%

BASIN B-1 | AREA 79.46 AC | %IMPRV 85%

MATCHLINE - SEE SHEET ST - 4

MATCHLINE - SEE SHEET ST - 2



KEY MAP
1"=2000'

N

BASIN DESIGNATION: OS 1
BASIN SIZE IN ACRES: AREA 1.23 AC
BASIN IMPERVIOUSNESS: IMPERV 2%
BASIN DESIGN POINT: 1

LEGEND:

- BASIN BOUNDARY
- OFF-SITE BASIN
- GOODHUE IRRIGATION DITCH
- TRIBUTARY I 10-YEAR FLOODPLAIN
- TRIBUTARY I 100-YEAR FLOODPLAIN
- PR PEDESTRIAN TRAIL
- PROPOSED STORM SEWER SYSTEM
- DRAINAGE FLOW
- EMERGENCY OVERFLOW
- PROPOSED CONTOURS 5410 5402
- EXISTING CONTOURS 5410 5402
- PHASE 1 DELINEATION
- PHASE 2 DELINEATION
- INTERNAL ROADS DELINEATION

Know what's below. Call before you dig.

100 0 100 200
SCALE: 1" = 100'

DESIGNED BY: SDM
CHECKED BY: MAW
DRAWN BY: SDM

ISSUE DATE: 11-18-2022

DATE	REVISION COMMENTS

HARRIS KOCHER SMITH
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STERLING BAY

REDTAIL RIDGE PHASE 2
DRAINAGE PLAN NW

PRELIMINARY NOT FOR CONSTRUCTION

PROJECT #: 190108
SHEET NUMBER
ST - 1
10 OF 47

FILEPATH: P:\2019\190108\ENGINEERING\DRAINAGE\2024 MASTER DRAINAGE PLAN - F2.DWG LAYOUT: DRAINAGE PLAN NW
11 XREFs: e-base, e-legal, p-util, key map, p-base-f1, p-base-f2, p-dmg, p-legal-f1, p-legal-f2, stamp - storm_storm - f1 - stamp
PLOTTED: WED 01/31/24 1:30:28P BY: GRANT SAVILLE

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MATCHLINE - SEE SHEET ST - 1

LOT 1 BLOCK 3
REDTAIL RIDGE SUBDIVISION
FILING NO. 1

EX 75' ESMT REC NO B725-P76 (TO REMAIN)

LOT 1 BLOCK 1
REDTAIL RIDGE SUBDIVISION
FILING NO. 1

ROCKCRESS DRIVE (61' ROW)

PR PHASE 2 STORM NETWORK (TYP)

PR PHASE 2 STORM NETWORK

*GRADING FOR INTERNAL ROADS IS TEMPORARY AND WILL BE FINALIZED WITH CD SET

FUTURE POND E CONNECTION (PUD 8)

PR VARRA DITCH (TYP)

FUTURE POND E (PUD 8)

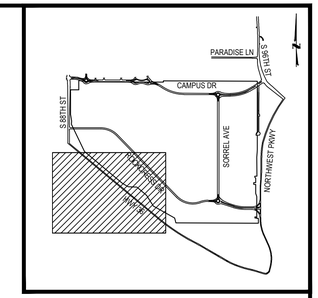
PROPERTY BOUNDARY (TYP)

HWY 36 (VARIABLE-WIDTH R.O.W.)

FILING 2

BASIN	AREA	%IMPRV
C-5-1	1.14 AC	75%
C-5-2	1.16 AC	75%
C-5-3	0.90 AC	75%
C-5-4	0.89 AC	75%
C-5-5	0.60 AC	75%
C-5-6	0.60 AC	75%
E	34.33 AC	75%
B-1	79.46 AC	85%
B-2	30.37 AC	85%
D-1	14.55 AC	70%
D-2	19.40 AC	2%

MATCHLINE - SEE SHEET ST - 3



KEY MAP
1"=2000'

N

BASIN DESIGNATION: OS 1 | AREA: 1.23 AC | IMPERV: 2% (BASIN IMPERVIOUSNESS)
1 BASIN DESIGN POINT

LEGEND:

- BASIN BOUNDARY
- OFF-SITE BASIN
- GOODHUE IRRIGATION DITCH
- TRIBUTARY I 10-YEAR FLOODPLAIN
- TRIBUTARY I 100-YEAR FLOODPLAIN
- PR PEDESTRIAN TRAIL
- PROPOSED STORM SEWER SYSTEM
- DRAINAGE FLOW
- EMERGENCY OVERFLOW
- PROPOSED CONTOURS 5410 / 5402
- EXISTING CONTOURS 5410 / 5402
- PHASE 1 DELINEATION
- PHASE 2 DELINEATION
- INTERNAL ROADS DELINEATION

Know what's below. Call before you dig.

100 0 100 200
SCALE: 1" = 100'

DESIGNED BY: SDM
CHECKED BY: MAW
DRAWN BY: SDM

ISSUE DATE: 11-18-2022

DATE	REVISION COMMENTS

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Denver, Colorado 80203
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STERLING BAY

REDTAIL RIDGE PHASE 2
DRAINAGE PLAN SW

PRELIMINARY NOT FOR CONSTRUCTION

PROJECT #: 190108
SHEET NUMBER
ST - 2
11 OF 47

FILEPATH: P:\2019\190108\ENGINEERING\DRAINAGE\2024 MASTER DRAINAGE PLAN_F2.DWG LAYOUT: DRAINAGE PLAN SW
11 XREFs: e-base, e-legal, e-util, key map, p-base-f1, p-base-f2, p-dmg, p-legal-f1, p-legal-f2, p-samp - storm, storm - f1 - stamp
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MATCHLINE - SEE SHEET ST - 4

MATCHLINE - SEE SHEET ST - 2

*GRADING FOR INTERNAL ROADS IS TEMPORARY AND WILL BE FINALIZED WITH CD SET

ROCKCRESS DRIVE (130' ROW)

NORTHWEST PARKWAY (VARIABLE WIDTH ROW)

FUTURE PUD 1 CONNECTION

PR PHASE STORM NETWORK

PR PHASE 2 STORM NETWORK (TYP)

PR FUTURE PHASE 2 CONNECTION TO PHASE 1 INFRASTRUCTURE

EX XCEL SUBSTATION (TO REMAIN)

PR VARRA DITCH (TYP)

PR MAINTENANCE PATH (TYP)

PR TRAIL (TYP)

PROPERTY BOUNDARY (TYP)

POND C-2

PR NORTH FOREBAY, REFER TO PHASE 1 CDS FOR DETAILS

PR TRICKLE CHANNEL (TYP)

APPROXIMATE 100-YR WSEL = 5364.06

APPROXIMATE EURV WSEL = 5362.26

APPROXIMATE WQ WSEL = 5359.96

PR OUTLET STRUCTURE, REFER TO PHASE 1 CDS FOR DETAILS

PR EAST FOREBAY, REFER TO PHASE 1 CDS FOR DETAILS

PR WEST FOREBAY, REFER TO PHASE 1 CDS FOR DETAILS

RESET EX STM INLETS

RESET EX STM INLET

STUB OUT FOR FUTURE USE

OUTFALL TO EXISTING 48" STORM

PR 20' UTIL. ESMT

BASIN	AREA (AC)	%IMPRV
B-1	79.46	85%
B-2	30.37	85%
C-1	53.21	80%
C-2	19.63	80%
C-5-5	0.60	75%
C-5-6	0.60	75%
C-5-7	0.85	75%
C-5-8	0.83	75%
C-5-9	0.37	75%
C-5-10	0.71	75%
C-5-11	0.71	75%
C-5-12	0.97	80%
C-5-13	0.96	80%
C-6-1	0.67	75%
C-6-2	0.81	75%
C-6-3	0.34	75%
D-1	14.55	70%
D-2	19.40	2%
D-3	11.26	70%

KEY MAP
1"=2000'

PARADISE LN
CAMPUS DR
S 88TH ST
S 90TH ST
ROCKCRESS DR
HWY 36
ROSE AVE
NORTHWEST PKWY

BASIN DESIGNATION: OS 1 | AREA: 1.23 AC | IMPERV: 2% | BASIN IMPERVIOUSNESS
BASIN SIZE IN ACRES
1 BASIN DESIGN POINT

LEGEND:

- BASIN BOUNDARY
- OFF-SITE BASIN
- GOODHUE IRRIGATION DITCH
- TRIBUTARY I 10-YEAR FLOODPLAIN
- TRIBUTARY I 100-YEAR FLOODPLAIN
- PR PEDESTRIAN TRAIL
- PROPOSED STORM SEWER SYSTEM
- DRAINAGE FLOW
- EMERGENCY OVERFLOW
- PROPOSED CONTOURS 5410 / 5402
- EXISTING CONTOURS 5410 / 5402
- PHASE 1 DELINEATION
- PHASE 2 DELINEATION
- INTERNAL ROADS DELINEATION

Know what's below. Call before you dig.

100 0 100 200
SCALE: 1" = 100'

DESIGNED BY: SDM
CHECKED BY: MAW
DRAWN BY: SDM

ISSUE DATE: 11-18-2022

DATE	REVISION COMMENTS

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STERLING BAY

REDTAIL RIDGE PHASE 2
DRAINAGE PLAN SE

PRELIMINARY NOT FOR CONSTRUCTION

PROJECT #: 190108
SHEET NUMBER
ST - 3
12 OF 47

FILEPATH: P:\2019\190108\ENGINEERING\DRAINAGE\2024 MASTER DRAINAGE PLAN\ - P2 DWG - LAYOUT - DRAINAGE PLAN SE
11 XREFs: e-base, e-legal, e-util, key map, p-base-f1, p-base-f2, p-dmg, p-legal-f1, p-legal-f2, stamp - storm, storm - 11 - stamp
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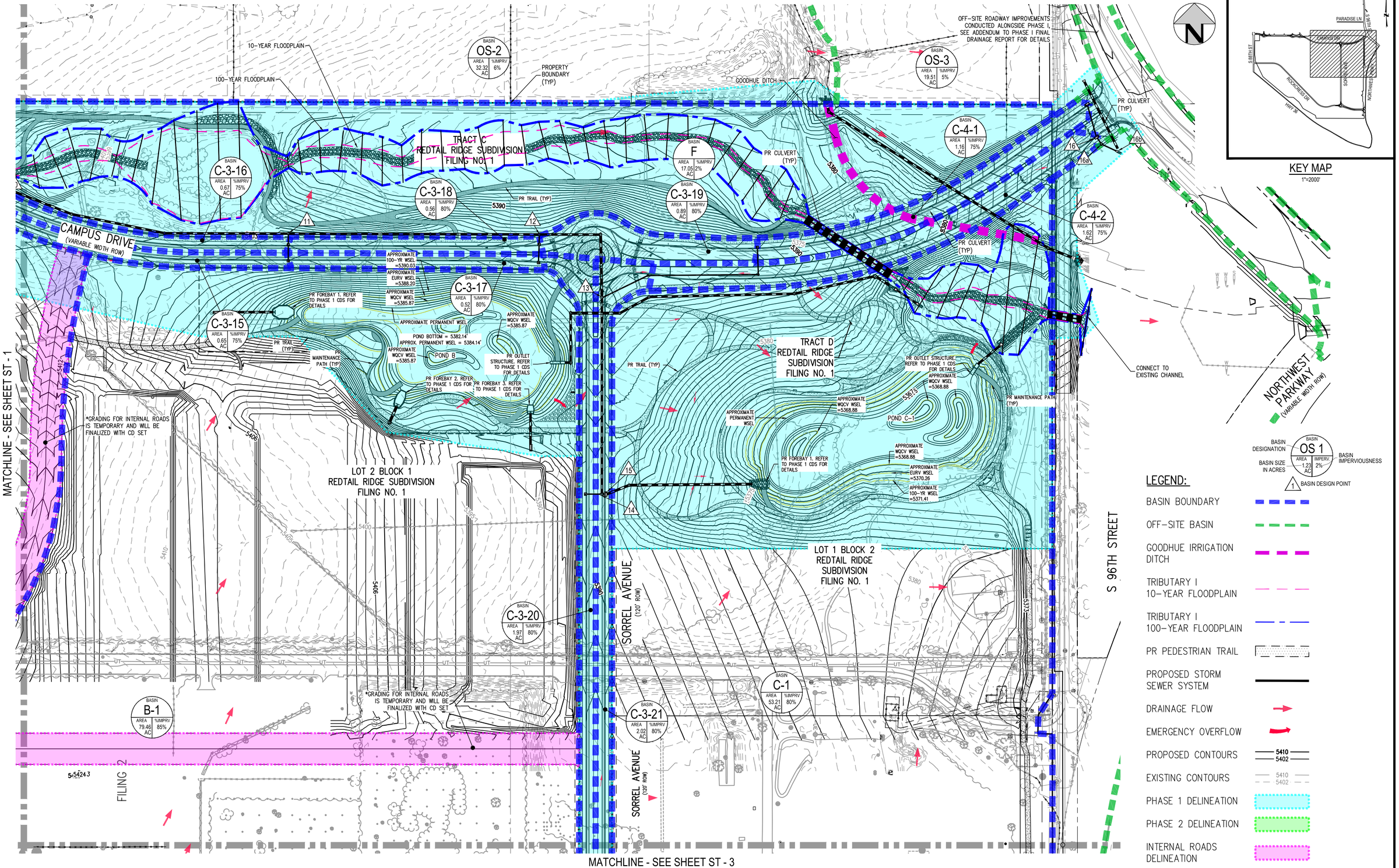

KEY MAP
1"=2000'

BASIN DESIGNATION — BASIN OS 1 — BASIN IMPERVIOUSNESS
BASIN SIZE IN ACRES — AREA 1.23 AC — IMPERV 2%
1 BASIN DESIGN POINT

LEGEND:

- BASIN BOUNDARY
- OFF-SITE BASIN
- GOODHUE IRRIGATION DITCH
- TRIBUTARY I 10-YEAR FLOODPLAIN
- TRIBUTARY I 100-YEAR FLOODPLAIN
- PR PEDESTRIAN TRAIL
- PROPOSED STORM SEWER SYSTEM
- DRAINAGE FLOW
- EMERGENCY OVERFLOW
- PROPOSED CONTOURS 5410 / 5402
- EXISTING CONTOURS 5410 / 5402
- PHASE 1 DELINEATION
- PHASE 2 DELINEATION
- INTERNAL ROADS DELINEATION

811 Know what's below. Call before you dig.

100 0 100 200
SCALE: 1" = 100'

DESIGNED BY: SDM
CHECKED BY: MAW
DRAWN BY: SDM

ISSUE DATE: 11-18-2022

DATE	REVISION COMMENTS

HARRIS KOCHER SMITH
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Denver, Colorado 80203
P: 303.623.6300 F: 303.623.6311
HarrisKocherSmith.com

STERLING BAY

REDTAIL RIDGE PHASE 2
DRAINAGE PLAN NE

PRELIMINARY NOT FOR CONSTRUCTION

PROJECT #: 190108
SHEET NUMBER
ST - 4
13 OF 47

FILEPATH: P:\2019\190108\ENGINEERING\DRAINAGE\2024 MASTER DRAINAGE PLAN - F2.DWG, LAYOUT: DRAINAGE PLAN NE
11 XREFs: e-base, e-legal, e-util, key map, p-base-f1, p-base-f2, p-cmp, p-legal-f1, p-legal-f2, stamp - storm, storm - f1 - stamp
PLOTTED: WED 01/31/24 1:31:28P BY: GRANT SAVILLE

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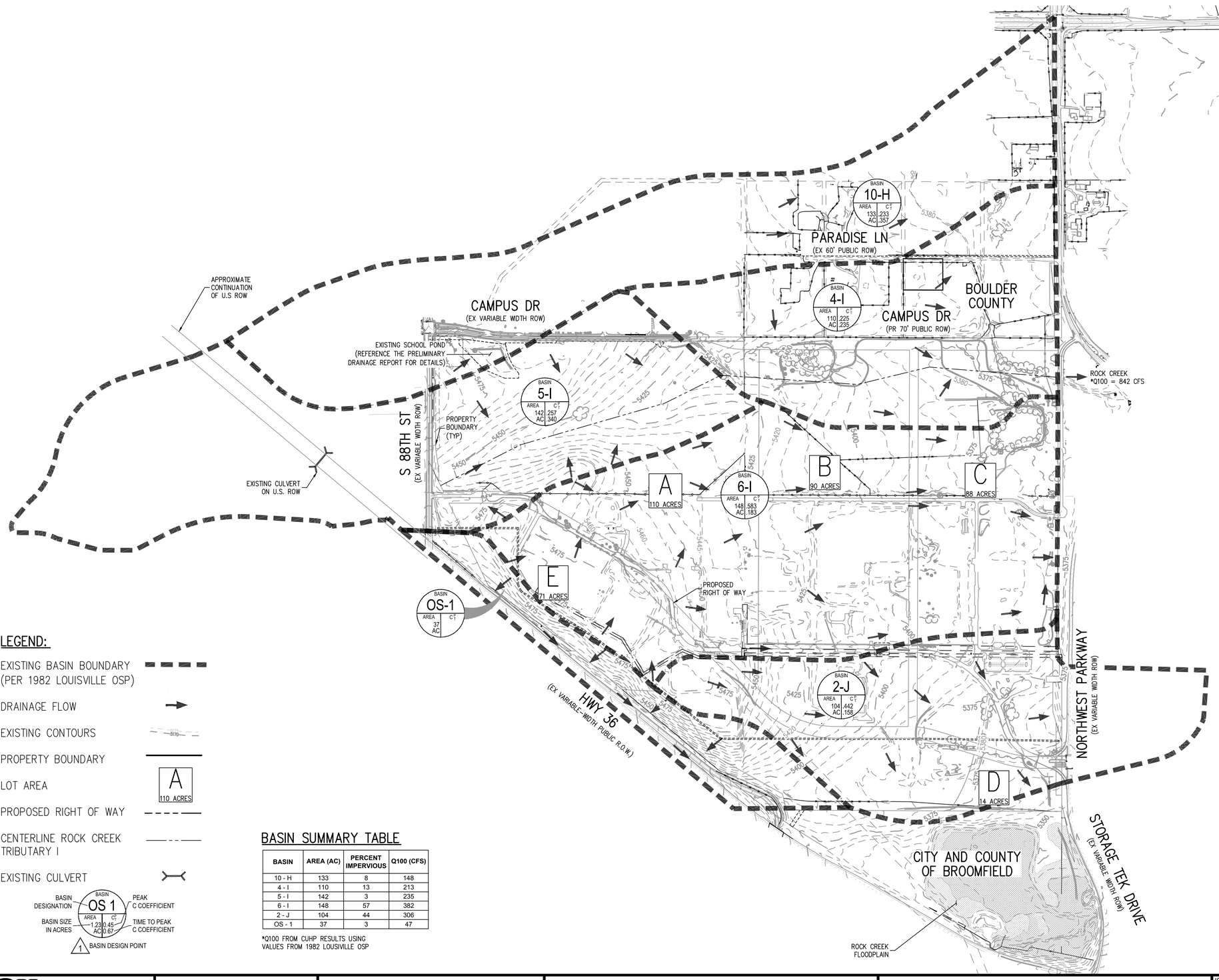


LEGEND:

- EXISTING BASIN BOUNDARY (PER 1982 LOUISVILLE OSP)
- DRAINAGE FLOW
- EXISTING CONTOURS
- PROPERTY BOUNDARY
- LOT AREA (A, 110 ACRES)
- PROPOSED RIGHT OF WAY
- CENTERLINE ROCK CREEK TRIBUTARY I
- EXISTING CULVERT

BASIN DESIGNATION (OS 1) — PEAK C COEFFICIENT
BASIN SIZE IN ACRES (AREA 1.23 AC) — TIME TO PEAK (C 0.45 / C 0.67)
1 BASIN DESIGN POINT

BASIN SUMMARY TABLE

BASIN	AREA (AC)	PERCENT IMPERVIOUS	Q100 (CFS)
10 - H	133	8	148
4 - I	110	13	213
5 - I	142	3	235
6 - I	148	57	382
2 - J	104	44	306
OS - 1	37	3	47

*Q100 FROM CUHP RESULTS USING VALUES FROM 1982 LOUISVILLE OSP

811 Know what's below. Call before you dig.
CALL 3 BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE, OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES.

400 0 400 800
SCALE: 1" = 400'

DESIGNED BY: TMW
CHECKED BY: MAW
DRAWN BY: TMW

HARRIS KOCHER SMITH
1120 Lincoln Street, Suite 1000
Denver, Colorado 80203
P: 303.623.6300 F: 303.623.6311
HarrisKocherSmith.com

BRUE·BAUKOL CAPITAL PARTNERS

NATWATNY RIDGE
EXISTING DRAINAGE PLAN

ISSUE DATE: 10-02-2019	PROJECT #: 190108
DATE	REVISION COMMENTS

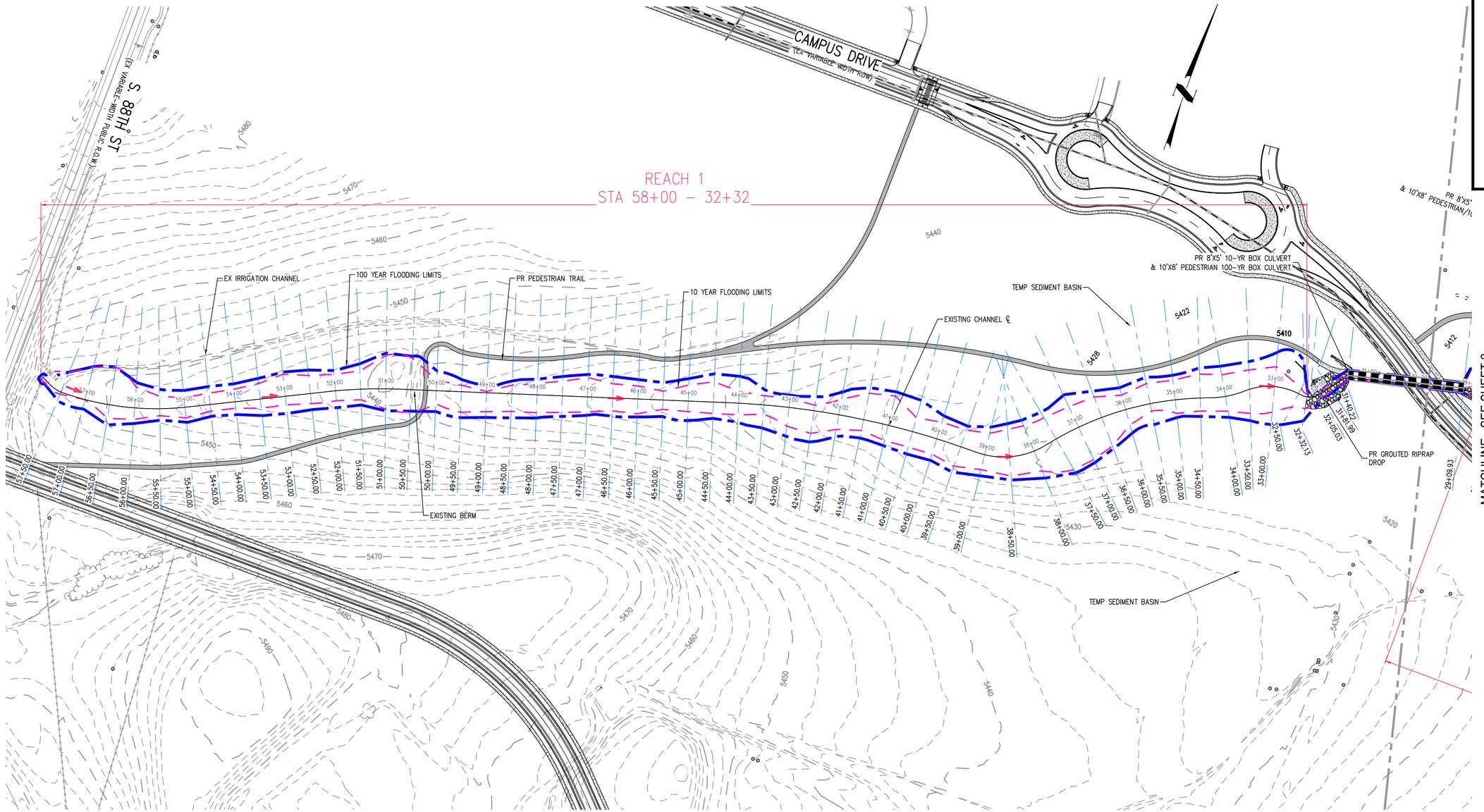
SHEET NO. 1
1 OF 14

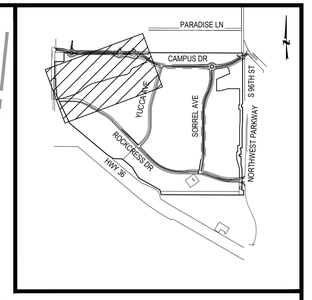
FILEPATH: P:\190108\ENGINEERING\GDP\GDP - EXISTING DRAINAGE PLAN.DWG LAYOUT: HKS TITLE SHEET
6 XREFs: client logo, e-base, e-legal, topos, p-base[full], p-legal[full]
PLOTTED: WED 04/08/20 4:06:50P BY: MICHAEL WALTON

APPENDIX E – HEC-RAS Model

Floodplain Workmap
Existing HEC-RAS Results
Proposed HEC-RAS Results

NO CHANGES ARE TO BE MADE TO THIS DRAWING WITHOUT WRITTEN PERMISSION OF HARRIS KOCHER SMITH.





KEY MAP
SCALE: 1"=2000'

LEGEND:

- PROPOSED 100-YR FLOODPLAIN
- PROPOSED 10-YR FLOODPLAIN
- CHANNEL CENTERLINE
- CHANNEL CROSS SECTION (STA)
- DRAINAGE FLOW
- PROPOSED CONTOURS
- EXISTING CONTOURS

811 Know what's below. Call before you dig.

CALL 3 BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE, OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES.

100 0 100 200
SCALE: 1" = 100'

DESIGNED BY: KAS
CHECKED BY: MAW
DRAWN BY: KAS

HARRIS KOCHER SMITH
1120 Lincoln Street, Suite 1000
Denver, Colorado 80203
P: 303.623.6300 F: 303.623.6311
HarrisKocherSmith.com

BRUE BAUKOL CAPITOL PARTNERS

REDTAIL RIDGE FILING NO. 1
FLOODPLAIN WORKMAP

ISSUE DATE: 11-15-2019 | PROJECT #: 190108

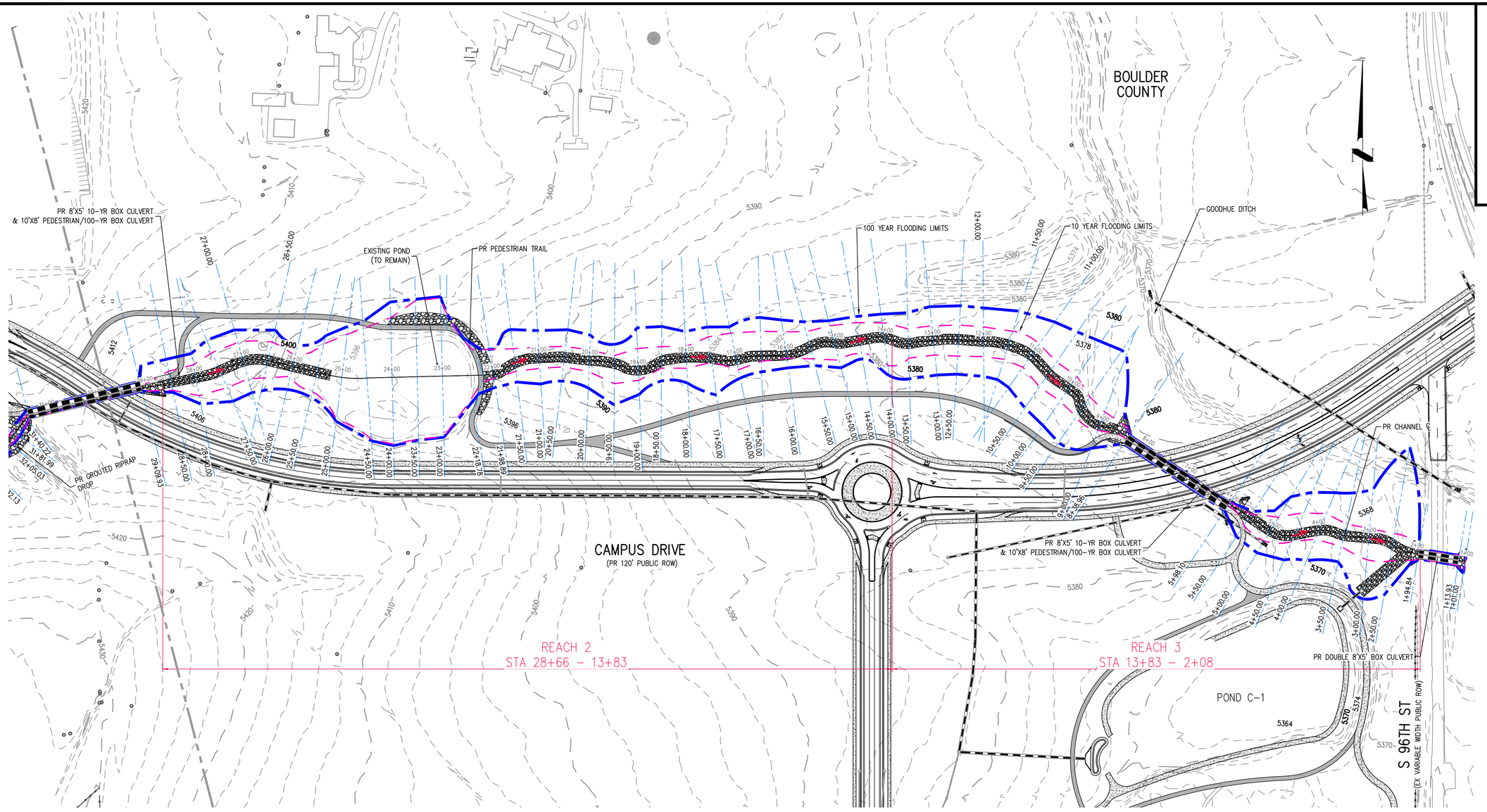
DATE	REVISION COMMENTS
04-06-2020	PER CITY COMMENTS
04-22-2020	PER MHFD COMMENTS
01-21-2021	SITE REVISIONS

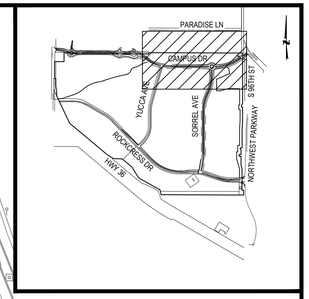
PRELIMINARY NOT FOR CONSTRUCTION

SHEET NO.
1
1 OF 2

FILEPATH: P:\190108\ENGINEERING\DRAINAGE\FLOODPLAIN WORKMAP.DWG LAYOUT: LAYOUT1
5 XREFs: e-base, key map, p-base-f1, p-base-f2(j), p-dtrg
PLOTTED: THU 01/21/21 2:30:45P BY: KENT STEINHAUS

NO CHANGES ARE TO BE MADE TO THIS DRAWING WITHOUT WRITTEN PERMISSION OF HARRIS KOCHER SMITH.





KEY MAP
SCALE: 1"=2000'

LEGEND:

- PROPOSED 100-YR FLOODPLAIN
- PROPOSED 10-YR FLOODPLAIN
- CHANNEL CENTERLINE
- CHANNEL CROSS SECTION (STA)
- DRAINAGE FLOW
- PROPOSED CONTOURS
- EXISTING CONTOURS

811 Know what's below. Call before you dig.
CALL 3 BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE, OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES.

100 0 100 200
SCALE: 1" = 100'

DESIGNED BY: KAS
CHECKED BY: MAW
DRAWN BY: KAS

HARRIS KOCHER SMITH
1120 Lincoln Street, Suite 1000
Denver, Colorado 80203
P: 303.623.6300 F: 303.623.6311
HarrisKocherSmith.com

BRUE BAUKOL CAPITOL PARTNERS

REDTAIL RIDGE FILING NO. 1
FLOODPLAIN WORKMAP

ISSUE DATE: 11-15-2019	PROJECT #: 190108
DATE	REVISION COMMENTS
04-06-2020	PER CITY COMMENTS
04-22-2020	PER MHFD COMMENTS
01-21-2021	SITE REVISIONS

PRELIMINARY NOT FOR CONSTRUCTION

SHEET NO. 2
2 OF 2

FILEPATH: P:\190108\ENGINEERING\DRAINAGE\FLOODPLAIN WORKMAP.DWG LAYOUT: LAYOUT2
5 XREFs: e-base, key map, p-base-1, p-base-2[0], p-dr1g
PLOTTED: THU 01/21/21 2:00:35P BY: KENT STEINHAUS

HEC-RAS Plan: EX-low-n River: PR Channel w EX Reach: PR Channel w EX Profile: 2 YR

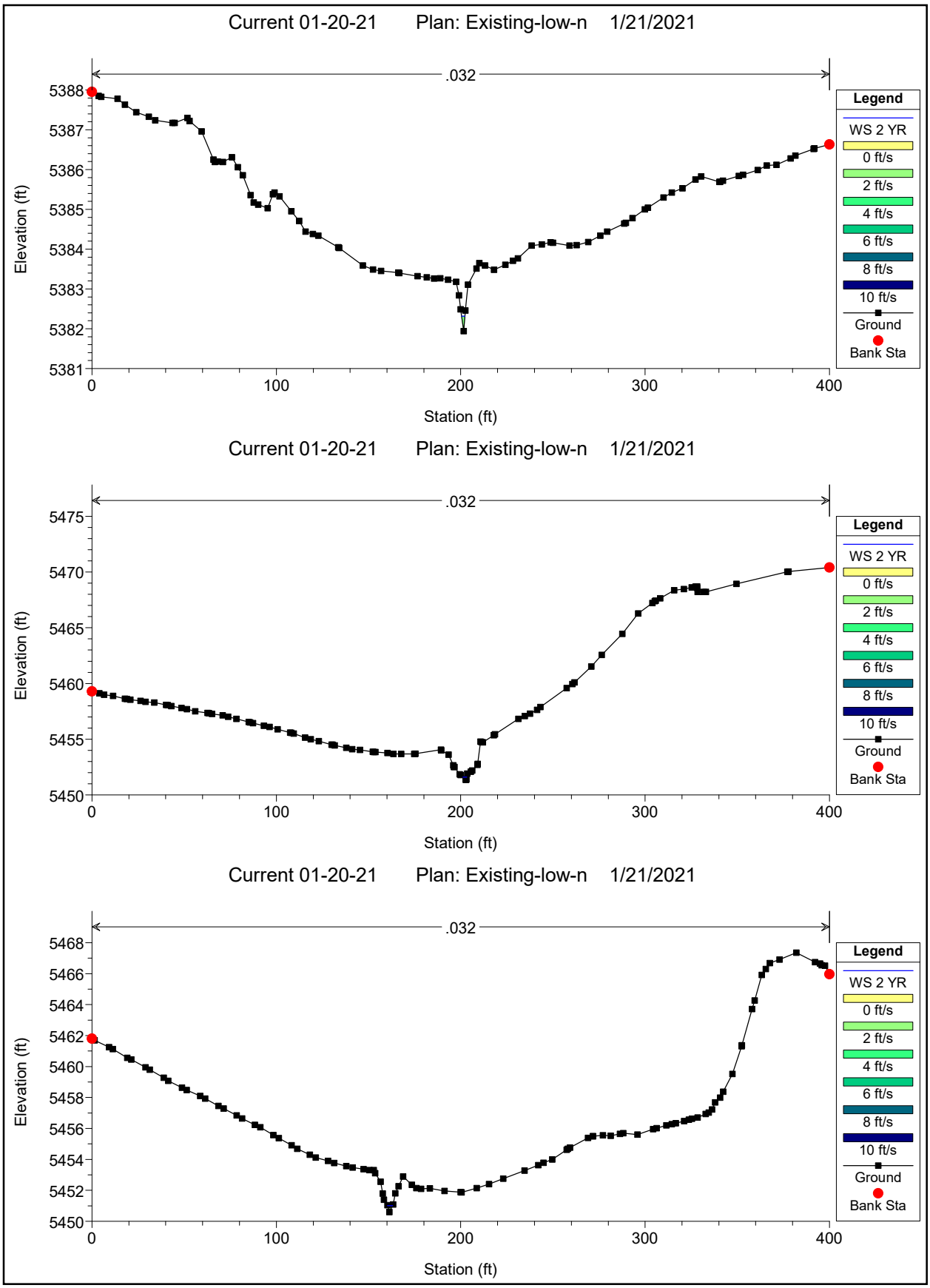
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
PR Channel w EX	5800	2 YR	0.52	5451.37	5451.60	5451.60	5451.67	0.032569	2.04	0.26	2.03	1.01	0.24
PR Channel w EX	5750	2 YR	0.52	5450.60	5451.01		5451.03	0.003348	0.91	0.57	2.76	0.35	0.04
PR Channel w EX	5700	2 YR	0.52	5450.44	5450.72	5450.67	5450.75	0.010675	1.29	0.40	2.71	0.59	0.09
PR Channel w EX	5650	2 YR	0.52	5449.59	5449.67	5449.67	5449.68	0.059947	0.94	0.55	23.04	1.07	0.09
PR Channel w EX	5600	2 YR	0.52	5448.20	5448.26	5448.26	5448.26	0.008355	0.45	1.17	34.28	0.43	0.02
PR Channel w EX	5550	2 YR	0.52	5446.73	5446.84	5446.84	5446.86	0.026149	1.13	0.46	7.91	0.82	0.10
PR Channel w EX	5500	2 YR	0.52	5445.70	5445.82	5445.78	5445.82	0.005298	0.57	0.92	13.35	0.38	0.02
PR Channel w EX	5450	2 YR	0.52	5445.18	5445.24	5445.24	5445.26	0.038968	1.09	0.48	11.74	0.95	0.10
PR Channel w EX	5400	2 YR	0.52	5444.02	5444.14	5444.12	5444.15	0.012529	0.83	0.63	9.93	0.58	0.05
PR Channel w EX	5350	2 YR	0.52	5443.50	5443.55	5443.53	5443.56	0.010873	0.52	1.00	28.36	0.49	0.02
PR Channel w EX	5300	2 YR	0.52	5443.06	5443.12	5443.11	5443.13	0.006775	0.43	1.22	32.71	0.39	0.02
PR Channel w EX	5250	2 YR	0.52	5442.30	5442.36	5442.36	5442.37	0.059968	0.93	0.56	24.17	1.07	0.09
PR Channel w EX	5200	2 YR	0.52	5441.16	5441.19	5441.19	5441.22	0.124750	1.32	0.39	17.26	1.54	0.18
PR Channel w EX	5150	2 YR	0.52	5440.47	5440.84		5440.84	0.000004	0.04	14.20	58.62	0.01	0.00
PR Channel w EX	5100	2 YR	0.52	5438.22	5440.84		5440.84	0.000000	0.00	151.41	97.17	0.00	0.00
PR Channel w EX	5050	2 YR	0.52	5440.75	5440.82	5440.82	5440.84	0.028382	0.92	0.57	14.08	0.81	0.07
PR Channel w EX	5000	2 YR	0.52	5438.11	5438.27	5438.26	5438.30	0.032005	1.53	0.34	4.26	0.96	0.16
PR Channel w EX	4950	2 YR	0.52	5437.46	5437.58	5437.55	5437.59	0.007884	0.67	0.77	11.77	0.46	0.03
PR Channel w EX	4900	2 YR	0.52	5436.63	5436.70	5436.70	5436.73	0.063975	1.25	0.42	11.98	1.18	0.14
PR Channel w EX	4850	2 YR	0.52	5435.74	5435.85	5435.81	5435.85	0.004148	0.47	1.11	18.04	0.33	0.02
PR Channel w EX	4800	2 YR	0.52	5435.30	5435.38	5435.38	5435.40	0.032500	0.99	0.53	13.06	0.86	0.08
PR Channel w EX	4750	2 YR	0.52	5434.70	5434.78	5434.76	5434.78	0.005828	0.36	1.45	44.92	0.35	0.01
PR Channel w EX	4700	2 YR	0.52	5434.00	5434.09	5434.09	5434.11	0.055068	0.98	0.53	19.58	1.05	0.09
PR Channel w EX	4650	2 YR	0.52	5433.19	5433.24	5433.23	5433.25	0.020470	0.65	0.81	26.60	0.65	0.04
PR Channel w EX	4600	2 YR	0.52	5432.42	5432.49		5432.49	0.011303	0.52	1.00	29.06	0.50	0.02
PR Channel w EX	4550	2 YR	0.52	5431.42	5431.50	5431.50	5431.52	0.040694	1.19	0.44	9.58	0.99	0.12
PR Channel w EX	4500	2 YR	0.52	5430.16	5430.65		5430.65	0.000020	0.10	5.31	16.49	0.03	0.00
PR Channel w EX	4450	2 YR	0.52	5430.58	5430.63	5430.63	5430.64	0.044418	0.86	0.61	23.29	0.94	0.07
PR Channel w EX	4400	2 YR	0.52	5428.93	5429.02		5429.03	0.010423	0.70	0.75	13.22	0.52	0.04
PR Channel w EX	4350	2 YR	0.52	5427.79	5427.87	5427.86	5427.89	0.053029	1.25	0.42	10.50	1.10	0.13
PR Channel w EX	4300	2 YR	0.52	5426.79	5426.90		5426.90	0.010321	0.66	0.78	14.86	0.51	0.03
PR Channel w EX	4250	2 YR	0.52	5426.01	5426.07	5426.07	5426.09	0.030405	0.83	0.63	19.09	0.81	0.06
PR Channel w EX	4200	2 YR	0.52	5425.01	5425.11		5425.12	0.010796	0.66	0.79	15.83	0.52	0.03
PR Channel w EX	4150	2 YR	0.52	5424.35	5424.44	5424.42	5424.44	0.017783	0.67	0.78	21.89	0.63	0.04
PR Channel w EX	4100	2 YR	0.52	5423.68	5423.75		5423.75	0.011209	0.57	0.91	23.18	0.51	0.03
PR Channel w EX	4050	2 YR	0.52	5422.77	5422.84	5422.84	5422.85	0.034147	0.86	0.60	18.78	0.85	0.07
PR Channel w EX	4000	2 YR	0.52	5422.17	5422.25		5422.26	0.005995	0.44	1.17	26.91	0.38	0.02
PR Channel w EX	3950	2 YR	0.52	5421.53	5421.60	5421.60	5421.62	0.043328	1.00	0.52	15.61	0.97	0.09
PR Channel w EX	3900	2 YR	0.52	5420.98	5421.03	5421.03	5421.04	0.026495	0.76	0.68	21.41	0.75	0.05
PR Channel w EX	3850	2 YR	0.52	5420.39	5420.54	5420.49	5420.54	0.005229	0.50	1.04	18.21	0.37	0.02
PR Channel w EX	3800	2 YR	0.52	5419.85	5419.95	5419.95	5419.97	0.040081	1.10	0.47	11.62	0.96	0.10
PR Channel w EX	3750	2 YR	0.52	5418.83	5418.95	5418.92	5418.96	0.012145	0.78	0.66	11.07	0.56	0.05
PR Channel w EX	3700	2 YR	0.52	5417.94	5418.05	5418.04	5418.07	0.027984	1.14	0.46	8.07	0.85	0.10
PR Channel w EX	3650	2 YR	0.52	5416.94	5417.02		5417.03	0.016076	0.69	0.75	18.57	0.61	0.04
PR Channel w EX	3600	2 YR	0.52	5415.54	5415.61	5415.61	5415.64	0.060437	1.26	0.41	11.17	1.16	0.14
PR Channel w EX	3550	2 YR	0.52	5414.52	5414.58		5414.58	0.007885	0.45	1.17	32.75	0.42	0.02
PR Channel w EX	3500	2 YR	0.52	5413.69	5413.75	5413.75	5413.76	0.052504	0.89	0.58	23.98	1.01	0.08
PR Channel w EX	3450	2 YR	0.52	5412.61	5412.70	5412.67	5412.70	0.004997	0.45	1.15	22.32	0.35	0.02
PR Channel w EX	3400	2 YR	0.84	5411.86	5411.91	5411.91	5411.92	0.056470	1.07	0.78	25.73	1.09	0.11
PR Channel w EX	3350	2 YR	0.84	5411.23	5411.34	5411.30	5411.34	0.004398	0.41	2.04	41.58	0.33	0.01
PR Channel w EX	3300	2 YR	0.84	5410.86	5410.92	5410.92	5410.93	0.020386	0.80	1.05	24.88	0.69	0.05
PR Channel w EX	3250	2 YR	0.84	5408.73	5410.02	5410.02	5410.08	0.031382	2.05	0.41	35.11	1.02	0.24
PR Channel w EX	3225		Culvert										
PR Channel w EX	3150	2 YR	0.84	5408.50	5408.66	5408.66	5408.70	0.037853	1.71	0.49	5.98	1.05	0.19
PR Channel w EX	3100	2 YR	0.84	5407.06	5407.22		5407.22	0.000880	0.34	2.48	20.36	0.17	0.01
PR Channel w EX	3050	2 YR	0.84	5407.04	5407.14		5407.15	0.004073	0.48	1.74	26.49	0.33	0.02
PR Channel w EX	3000	2 YR	0.84	5406.60	5406.66	5406.66	5406.68	0.040104	0.98	0.86	25.29	0.93	0.09
PR Channel w EX	2950	2 YR	0.84	5404.92	5405.09	5405.08	5405.12	0.024281	1.41	0.60	6.90	0.85	0.13
PR Channel w EX	2900	2 YR	0.84	5403.66	5403.90	5403.88	5403.94	0.023293	1.65	0.51	4.50	0.87	0.16
PR Channel w EX	2850	2 YR	0.84	5402.27	5402.52	5402.52	5402.59	0.031734	2.00	0.42	3.47	1.02	0.24
PR Channel w EX	2800	2 YR	0.84	5400.99	5401.26	5401.24	5401.31	0.020942	1.83	0.46	3.16	0.85	0.19
PR Channel w EX	2750	2 YR	0.84	5399.72	5399.85	5399.85	5399.88	0.040239	1.30	0.65	12.40	1.00	0.13
PR Channel w EX	2700	2 YR	0.84	5399.21	5399.34		5399.34	0.000207	0.14	6.03	63.14	0.08	0.00
PR Channel w EX	2650	2 YR	0.84	5399.21	5399.30	5399.29	5399.31	0.017785	0.76	1.11	26.11	0.65	0.05
PR Channel w EX	2600	2 YR	0.84	5398.06	5398.15	5398.14	5398.17	0.029658	1.13	0.74	13.85	0.87	0.10
PR Channel w EX	2550	2 YR	0.84	5396.34	5396.44	5396.44	5396.46	0.039839	1.20	0.70	15.00	0.98	0.12
PR Channel w EX	2500	2 YR	0.84	5394.48	5394.65	5394.59	5394.65	0.003959	0.46	1.83	29.27	0.32	0.02
PR Channel w EX	2450	2 YR	0.84	5394.37	5394.42	5394.42	5394.42	0.005570	0.46	1.84	38.38	0.37	0.02
PR Channel w EX	2400	2 YR	0.84	5394.18	5394.31		5394.31	0.000185	0.15	5.52	46.63	0.08	0.00
PR Channel w EX	2350	2 YR	0.84	5394.18	5394.30		5394.30	0.000537	0.17	4.89	76.53	0.12	0.00
PR Channel w EX	2300	2 YR	0.84	5394.18	5394.22	5394.21	5394.22	0.012734	0.49	1.72	60.84	0.51	0.02
PR Channel w EX	2250	2 YR	0.84	5393.01	5393.38	5393.35	5393.44	0.019577	1.98	0.42	2.41	0.83	0.21
PR Channel w EX	2200	2 YR	0.84	5391.94	5392.07	5392.07	5392.10	0.038325	1.26	0.67	12.95	0.98	0.12
PR Channel w EX	2150	2 YR	0.84	5389.65	5389.98		5390.00	0.008120	1.24	0.68	4.10	0.54	0.08
PR Channel w EX	2100	2 YR	0.84	5388.87	5389.99		5389.99	0.000005	0.07	11.80	21.33	0.02	0.00
PR Channel w EX	2050	2 YR	0.84	5389.86	5389.97	5389.97	5389.99	0.021605	0.99	0.85	15.51	0.74	0.07
PR Channel w EX	2000	2 YR	0.84	5386.96	5387.26	5387.26	5387.33	0.029511	2.20	0.38	2.58	1.01	0.27
PR Channel w EX	1950	2 YR	0.84	5385.84	5386.21	5386.16	5386.26	0.013447	1.69	0.50	2.71	0.70	0.15
PR Channel w EX	1900	2 YR	0.84	5385.10	5385.37	5385.35	5385.42	0.021444	1.84	0.46	3.21	0.86	0.19
PR Channel w EX	1850	2 YR	0.84	5384.15	5384.63	5384.56	5384.68	0.010748	1.70	0.49	2.05	0.61	0.14
PR Channel w EX	1800	2 YR	0.84	5383.39	5383.77	5383.76	5383.85	0.027717	2.40	0.35	1.87	0.98	0.30
PR Channel w EX	1750	2 YR	0.84	5382.66	5383.10		5383.14	0.008333	1.48	0.57	2.56	0.56	0.11
PR Channel w EX	1700	2 YR	0.84	5381.94	5382.32	5382.32	5382.42	0.029933	2.50	0.34	1.78	1.01	0.32
PR Channel w EX	1650	2 YR	0.84	5381.09	5381.53		5381.55	0.007041	1.37	0.61	2.83	0.52	0.09
PR Channel w EX	1600	2 YR	0.84	5380.66	5381.08	5381.01	5381.13	0.010835	1.65	0.51	2.40	0.63	0.13
PR Channel w EX	1550	2 YR	0.84	5379.85	5380.19	5380.19	5380.28	0.028929	2.33	0.36	2.11	1.00	0.29
PR Channel w EX	1500	2 YR	0.84	5379.19	5379.62		5379.64	0.004996	1.16	0.73	3.33	0.44	0.07
PR Channel w EX	1450	2 YR	0.84	5378.72	5379.08	5379.08	5379.16	0.024539	2.23	0.38	2.09	0.93	0.26
PR Channel w EX	1400	2 YR	1.93	5377.94	5378.60		5378.65	0.006645	1.73	1.12	3.34	0.53	0.13
PR Channel w EX	1350	2 YR	1.93	5377.74	5378.35	5378.25	5378.36	0.004718	0.91	2.12	13.69	0.41	0.04

HEC-RAS Plan: EX-low-n River: PR Channel w EX Reach: PR Channel w EX Profile: 2 YR (Continued)

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	Shear Chan
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
PR Channel w EX	1300	2 YR	1.93	5377.72	5377.84	5377.84	5377.87	0.032287	1.40	1.38	23.00	0.94	0.14
PR Channel w EX	1250	2 YR	1.93	5375.82	5376.46	5376.36	5376.53	0.010657	2.10	0.92	2.85	0.65	0.19
PR Channel w EX	1200	2 YR	1.93	5375.37	5375.99	5375.88	5376.05	0.008718	1.90	1.02	10.76	0.60	0.16
PR Channel w EX	1150	2 YR	1.93	5373.83	5375.53	5375.44	5375.59	0.009824	1.84	1.05	41.49	0.63	0.16
PR Channel w EX	1100	2 YR	1.93	5374.53	5374.70	5374.70	5374.74	0.036070	1.46	1.32	19.66	0.99	0.15
PR Channel w EX	1050	2 YR	1.93	5372.62	5372.84		5372.85	0.005208	0.79	2.44	21.30	0.41	0.04
PR Channel w EX	1000	2 YR	1.93	5372.05	5372.28	5372.28	5372.33	0.030241	1.86	1.04	9.41	0.98	0.21
PR Channel w EX	950	2 YR	1.93	5363.66	5370.75		5370.75	0.000000	0.02	98.60	100.50	0.00	0.00
PR Channel w EX	900	2 YR	1.93	5370.50	5370.70	5370.70	5370.75	0.034567	1.82	1.06	11.01	1.03	0.21
PR Channel w EX	850	2 YR	1.93	5363.67	5364.32		5364.34	0.003257	1.22	1.58	4.90	0.38	0.06
PR Channel w EX	800	2 YR	1.93	5363.51	5364.05		5364.09	0.007697	1.66	1.16	4.30	0.57	0.13
PR Channel w EX	750	2 YR	1.93	5363.16	5363.90		5363.92	0.001790	1.00	1.92	5.01	0.29	0.04
PR Channel w EX	700	2 YR	1.93	5363.03	5363.86		5363.86	0.000733	0.72	2.69	5.98	0.19	0.02
PR Channel w EX	650	2 YR	1.93	5363.27	5363.78		5363.80	0.002570	0.98	1.97	7.26	0.33	0.04
PR Channel w EX	600	2 YR	1.93	5363.06	5363.76		5363.77	0.000256	0.41	4.72	11.47	0.11	0.01
PR Channel w EX	550	2 YR	1.93	5361.10	5363.76		5363.76	0.000002	0.08	24.62	17.17	0.01	0.00
PR Channel w EX	500	2 YR	1.93	5361.07	5363.76		5363.76	0.000001	0.06	29.87	15.49	0.01	0.00
PR Channel w EX	450	2 YR	1.93	5363.05	5363.76		5363.76	0.000703	0.63	3.05	7.66	0.18	0.02
PR Channel w EX	400	2 YR	1.93	5360.98	5363.76		5363.76	0.000001	0.07	29.23	19.09	0.01	0.00
PR Channel w EX	350	2 YR	1.93	5360.77	5363.76		5363.76	0.000000	0.04	54.32	31.80	0.00	0.00
PR Channel w EX	300	2 YR	1.93	5359.06	5363.76		5363.76	0.000000	0.02	92.55	84.64	0.00	0.00
PR Channel w EX	250	2 YR	1.93	5363.39	5363.74		5363.76	0.007490	1.24	1.56	9.14	0.53	0.08
PR Channel w EX	200	2 YR	1.93	5362.85	5363.02	5363.02	5363.06	0.035289	1.51	1.28	17.85	0.99	0.16
PR Channel w EX	150	2 YR	1.93	5355.69	5356.30	5356.20	5356.36	0.009995	2.00	0.96	3.16	0.64	0.18

HEC-RAS Plan: EX-low-n River: PR Channel w EX Reach: PR Channel w EX Profile: 2 YR

Reach	River Sta	Profile	E.G. US.	W.S. US.	E.G. IC	E.G. OC	Min El Weir Flow	Q Culv Group	Q Weir	Delta WS	Culv Vel US	Culv Vel DS
			(ft)	(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(ft)	(ft/s)	(ft/s)
PR Channel w EX	3225 EX 7'x7'	2 YR	5408.93	5410.02	5408.93	5408.96	5425.01	0.84		1.36	1.30	1.57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Station (ft)
Legend
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0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 01-20-21 Plan: Existing-low-n 1/21/2021
.032
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Station (ft)
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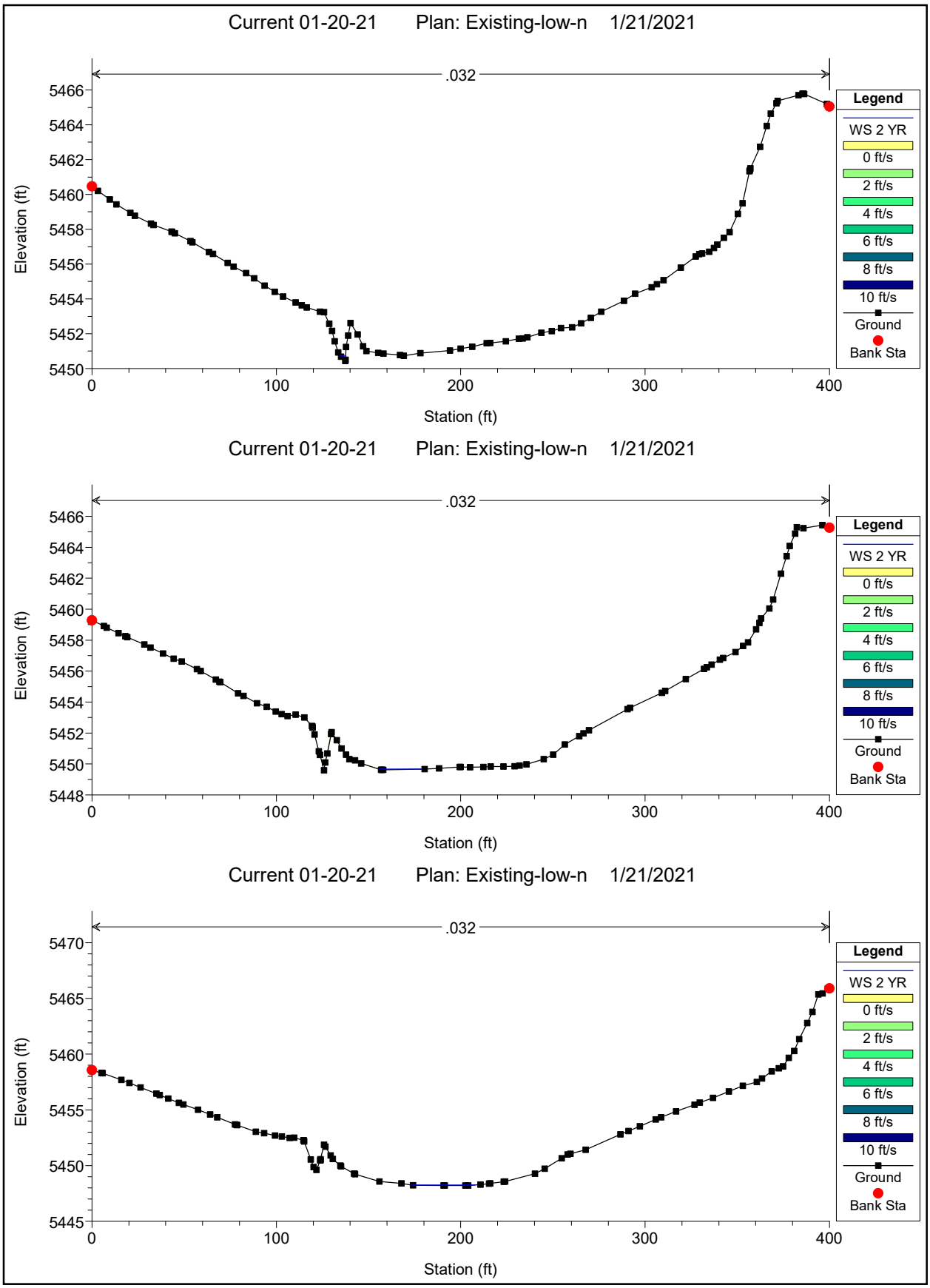
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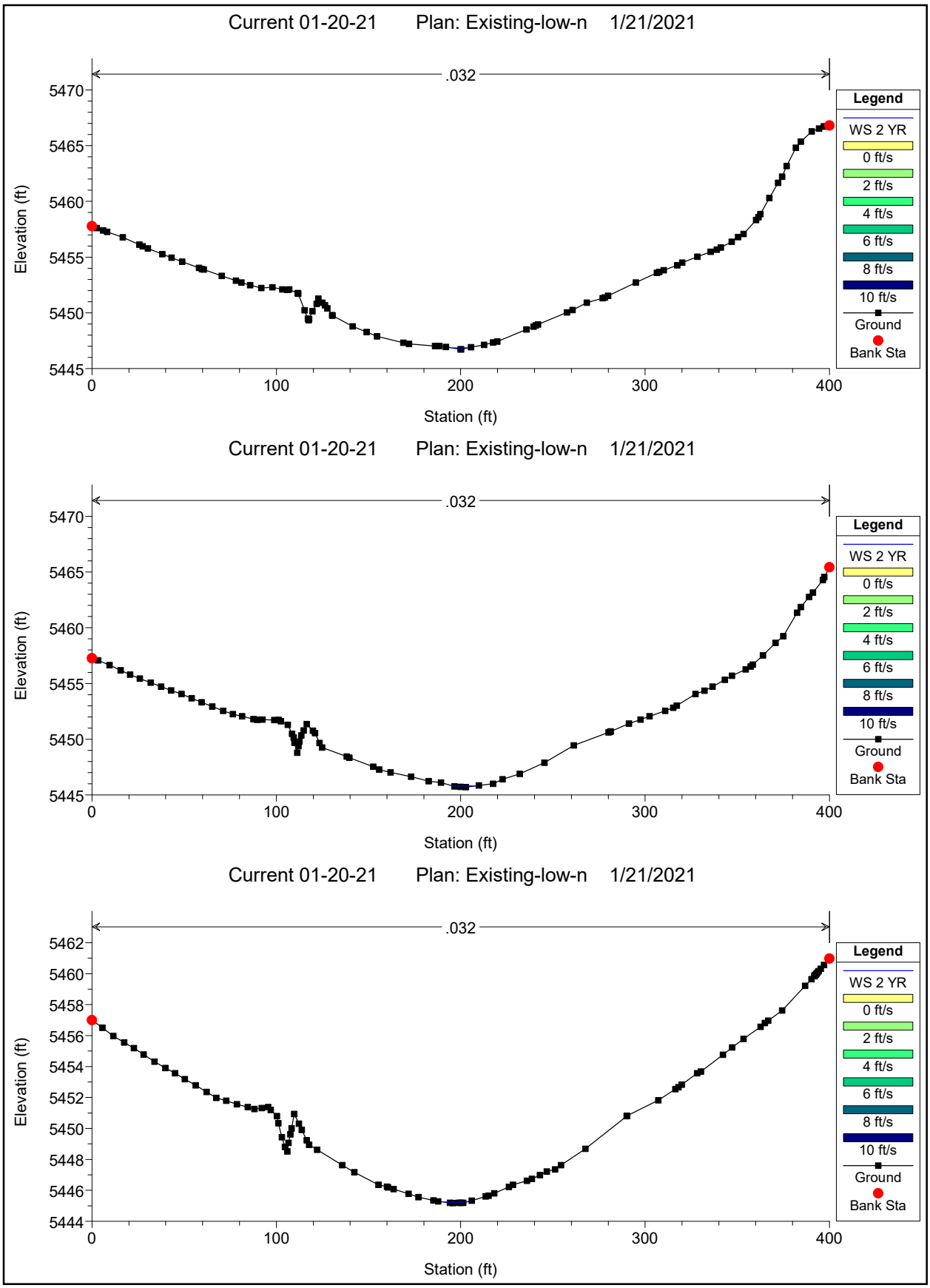
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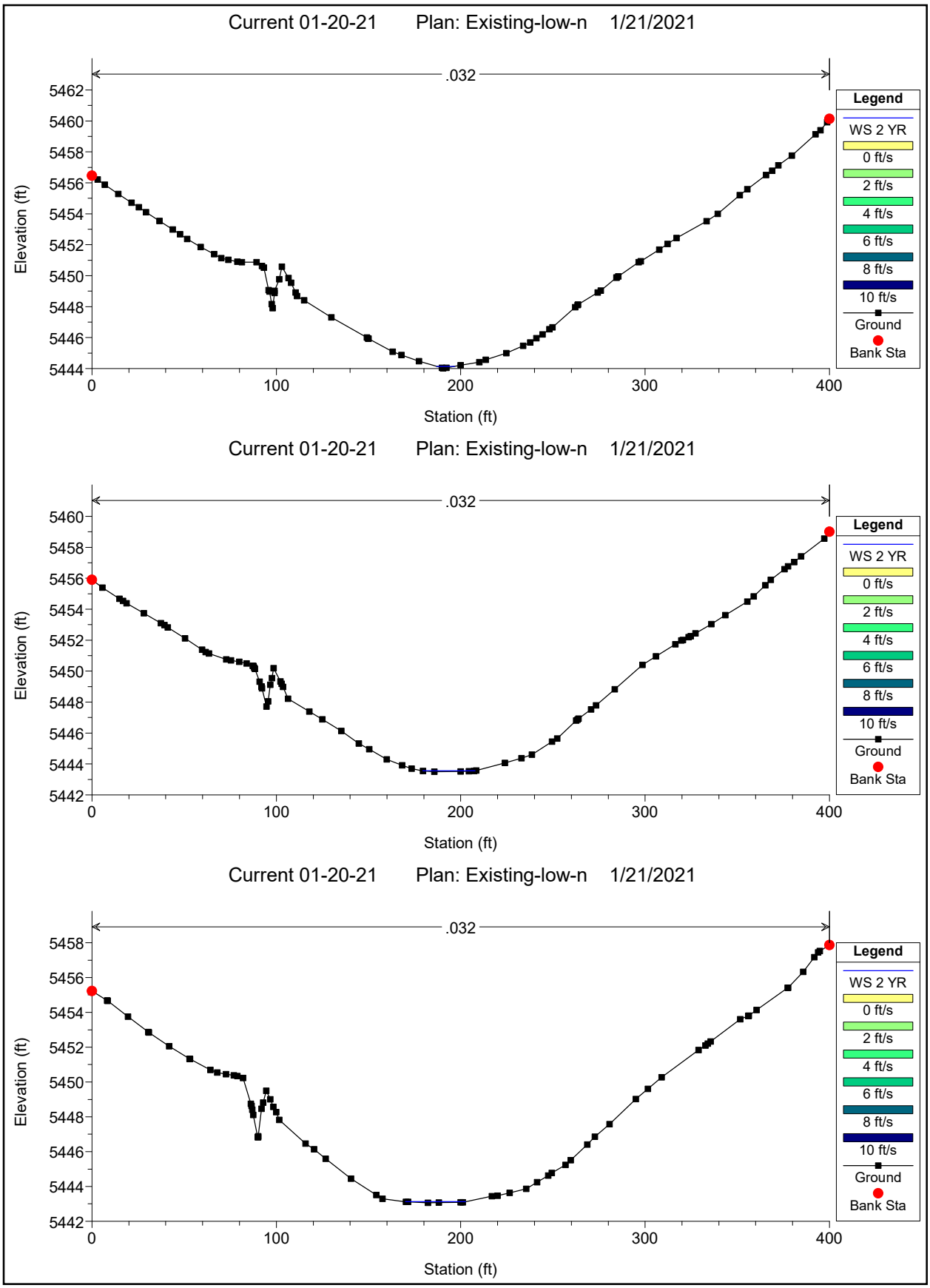
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Bank Sta
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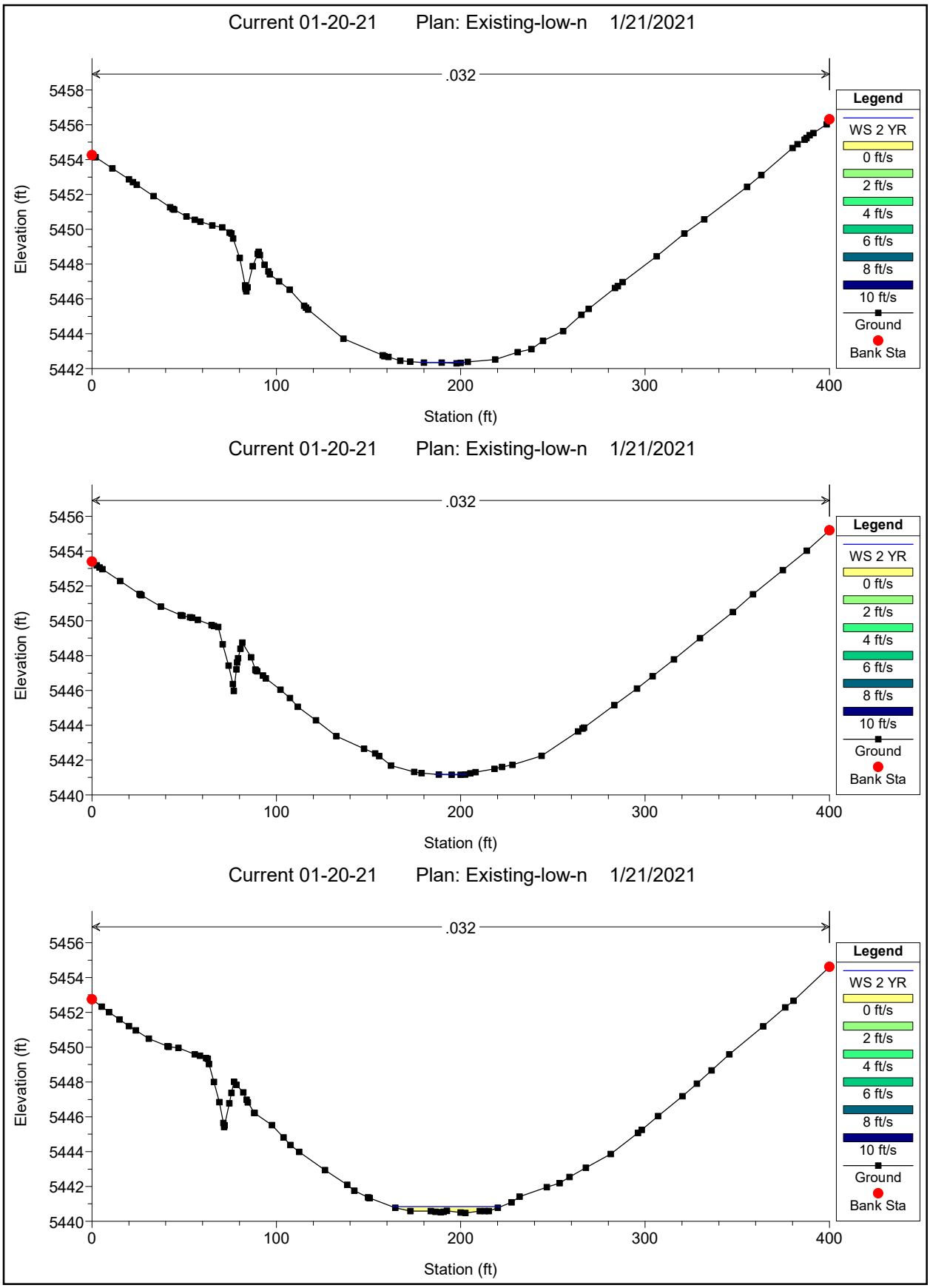
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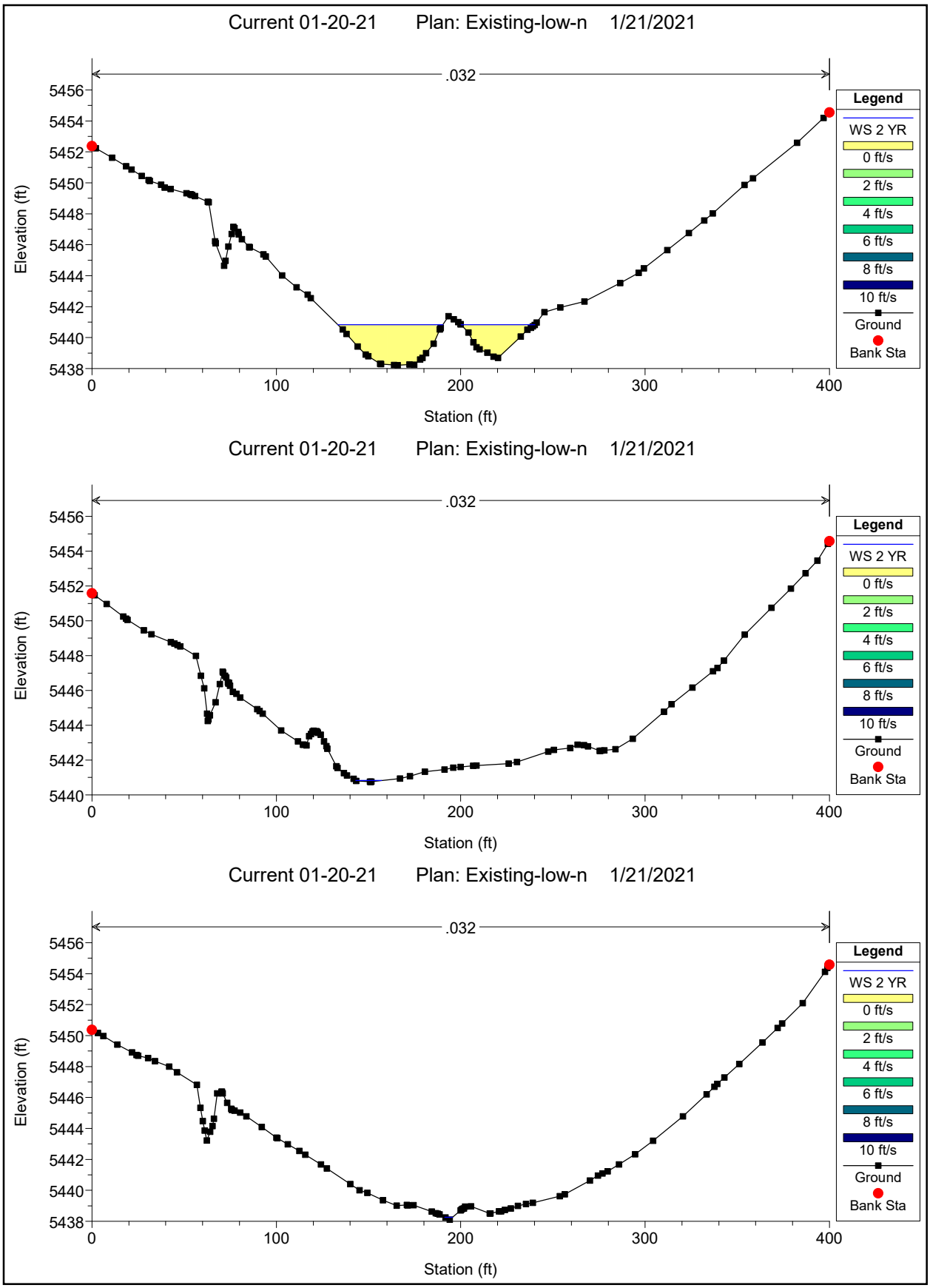
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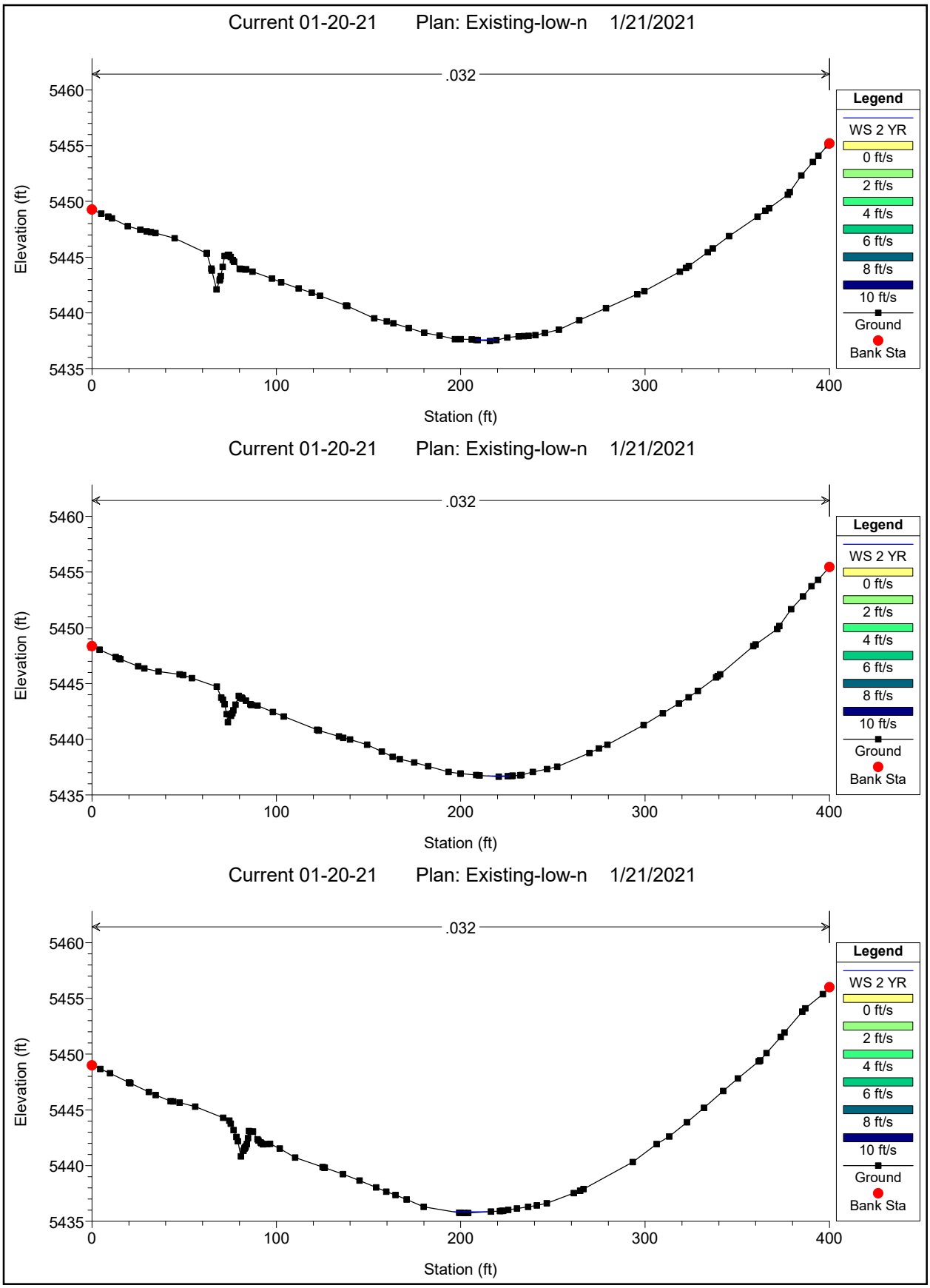
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Station (ft)
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Legend
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Current 01-20-21 Plan: Existing-low-n 1/21/2021
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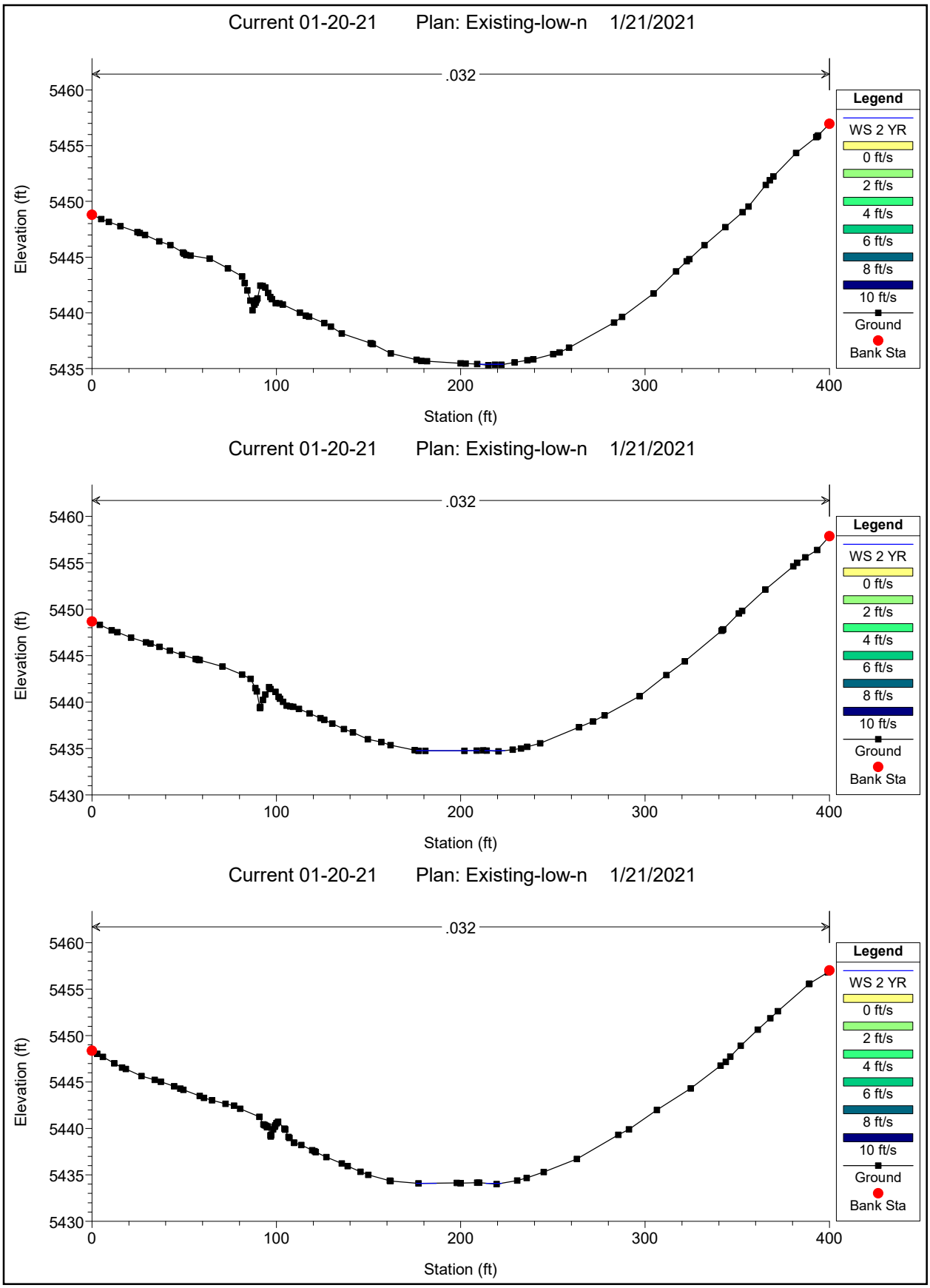
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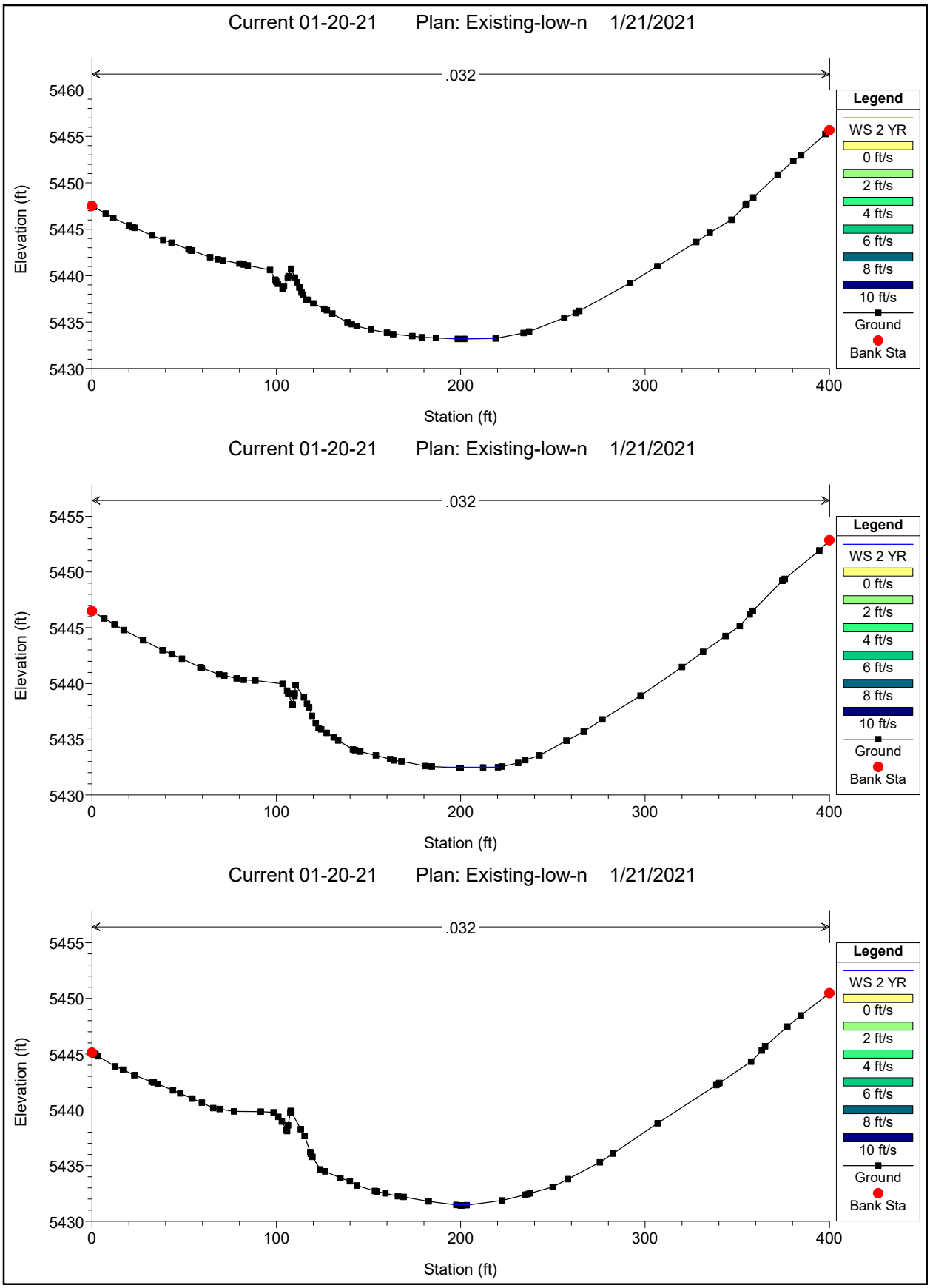
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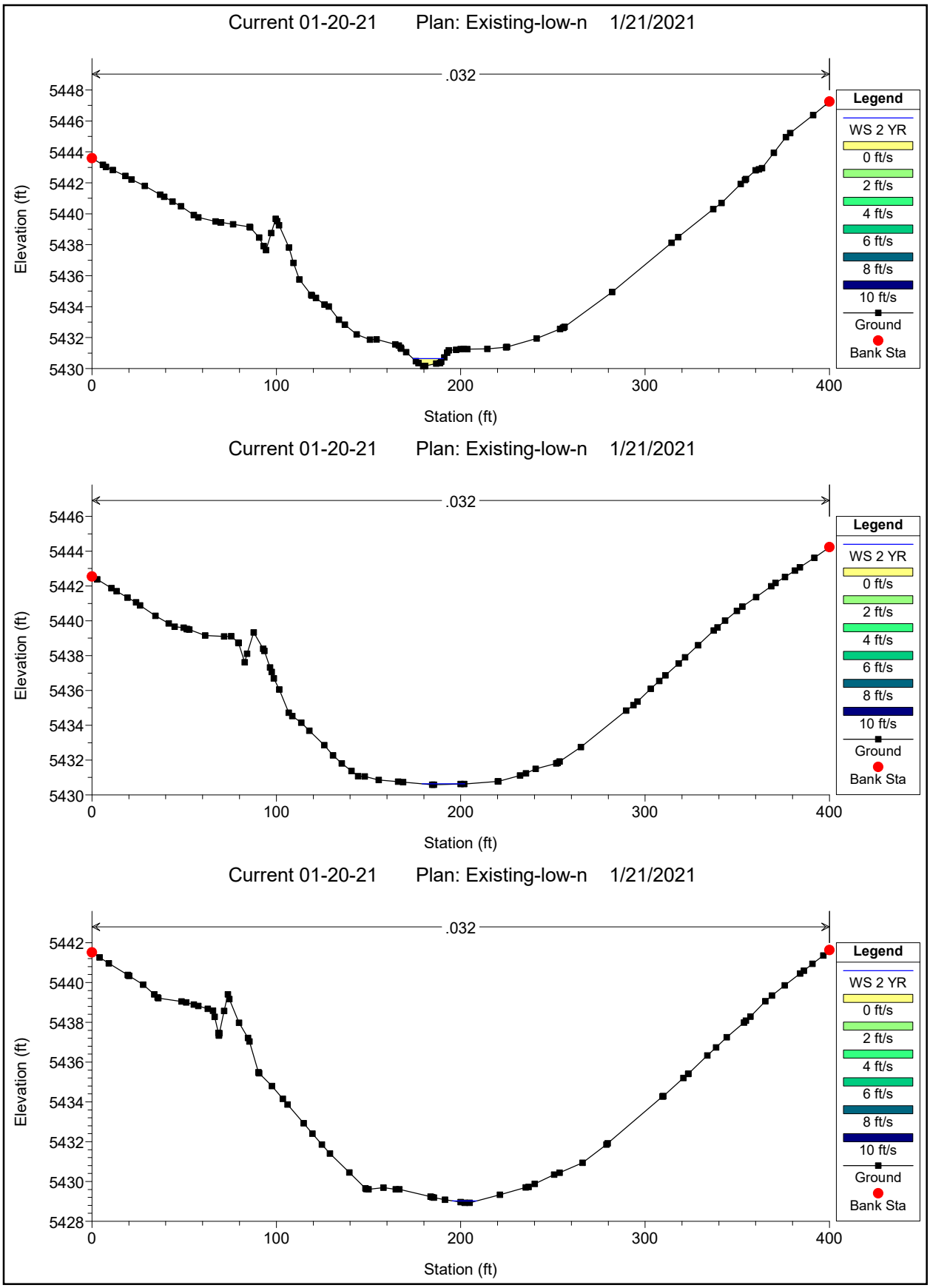
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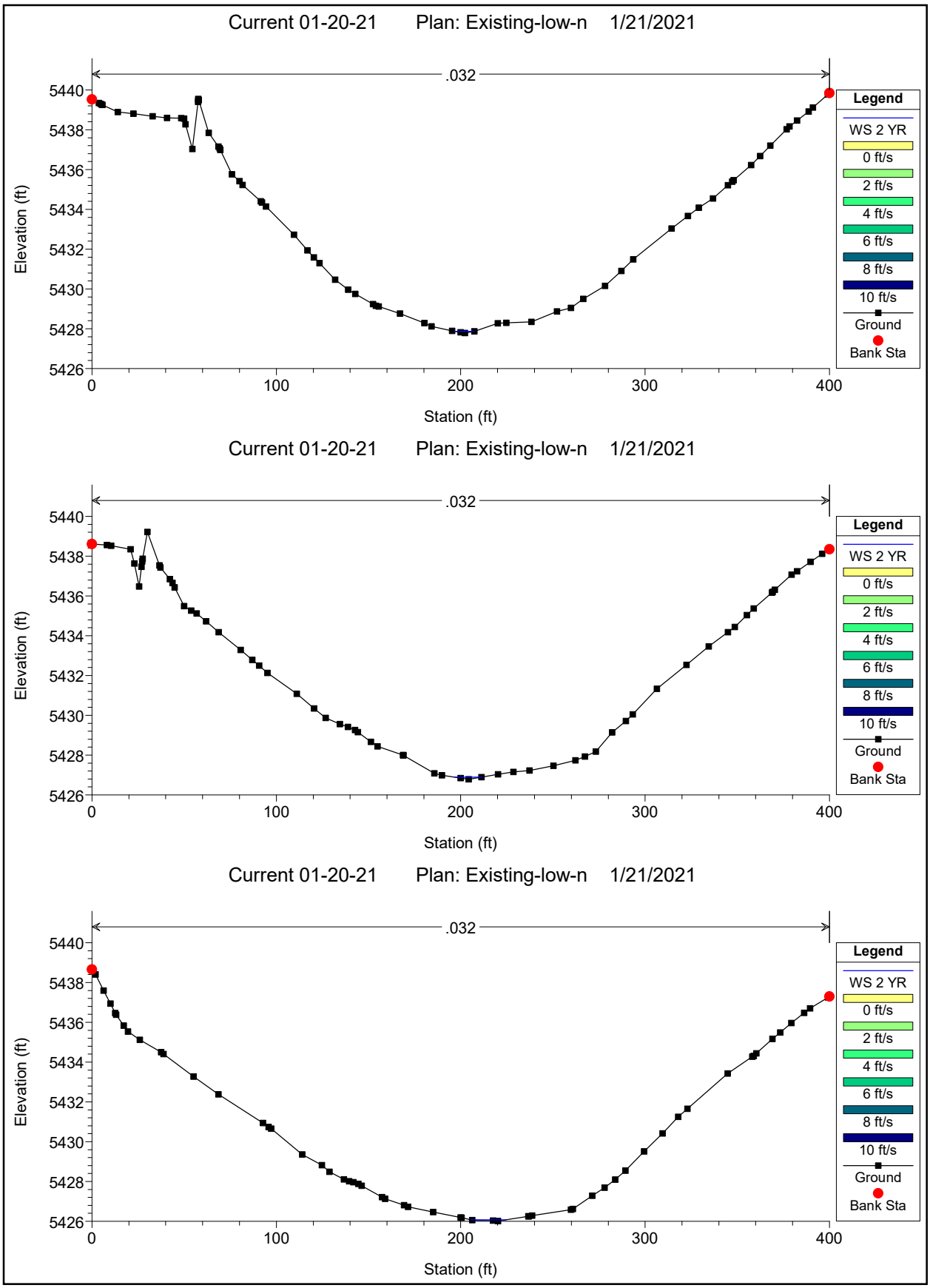
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Station (ft)
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Ground
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Current 01-20-21 Plan: Existing-low-n 1/21/2021
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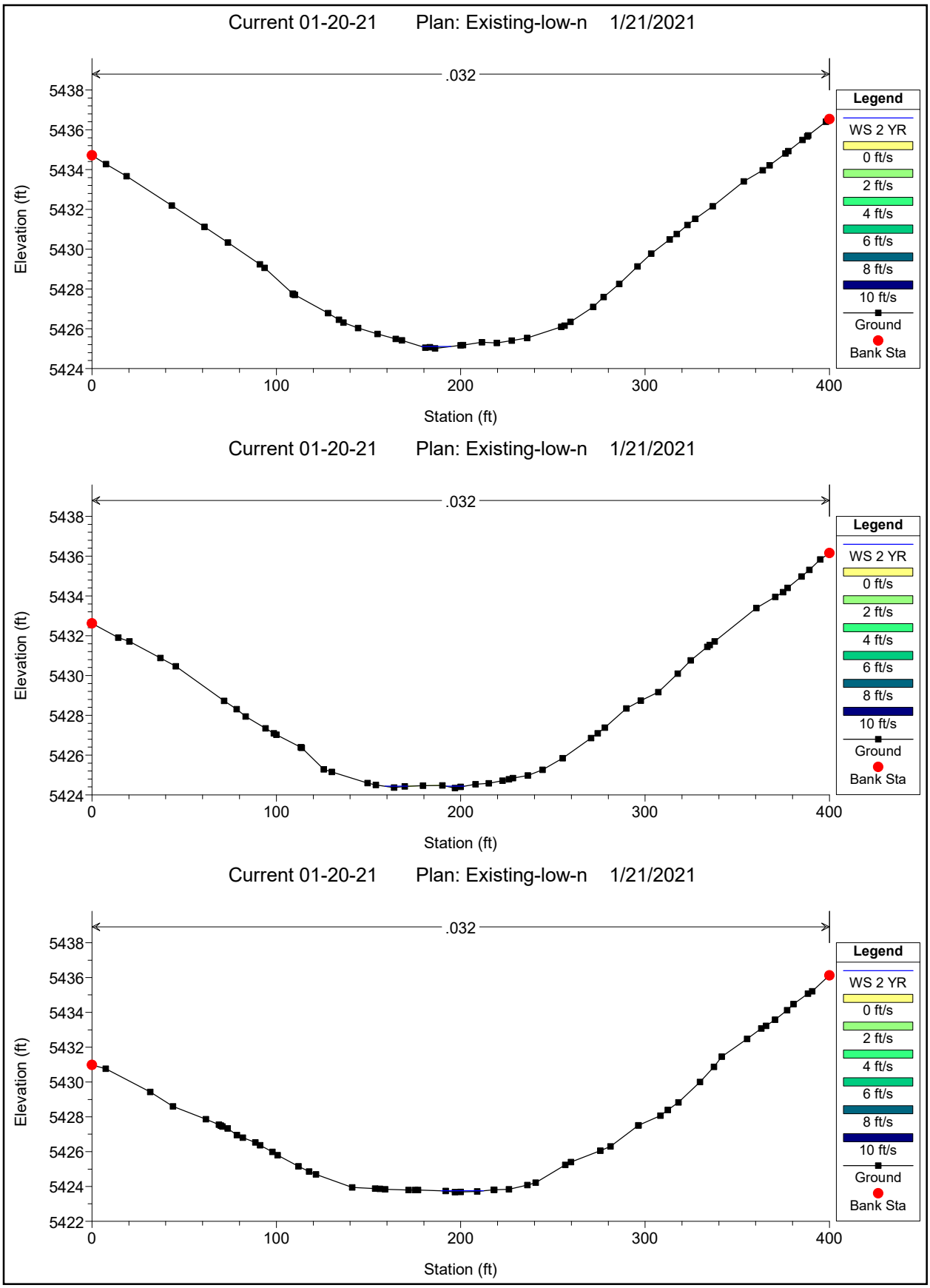
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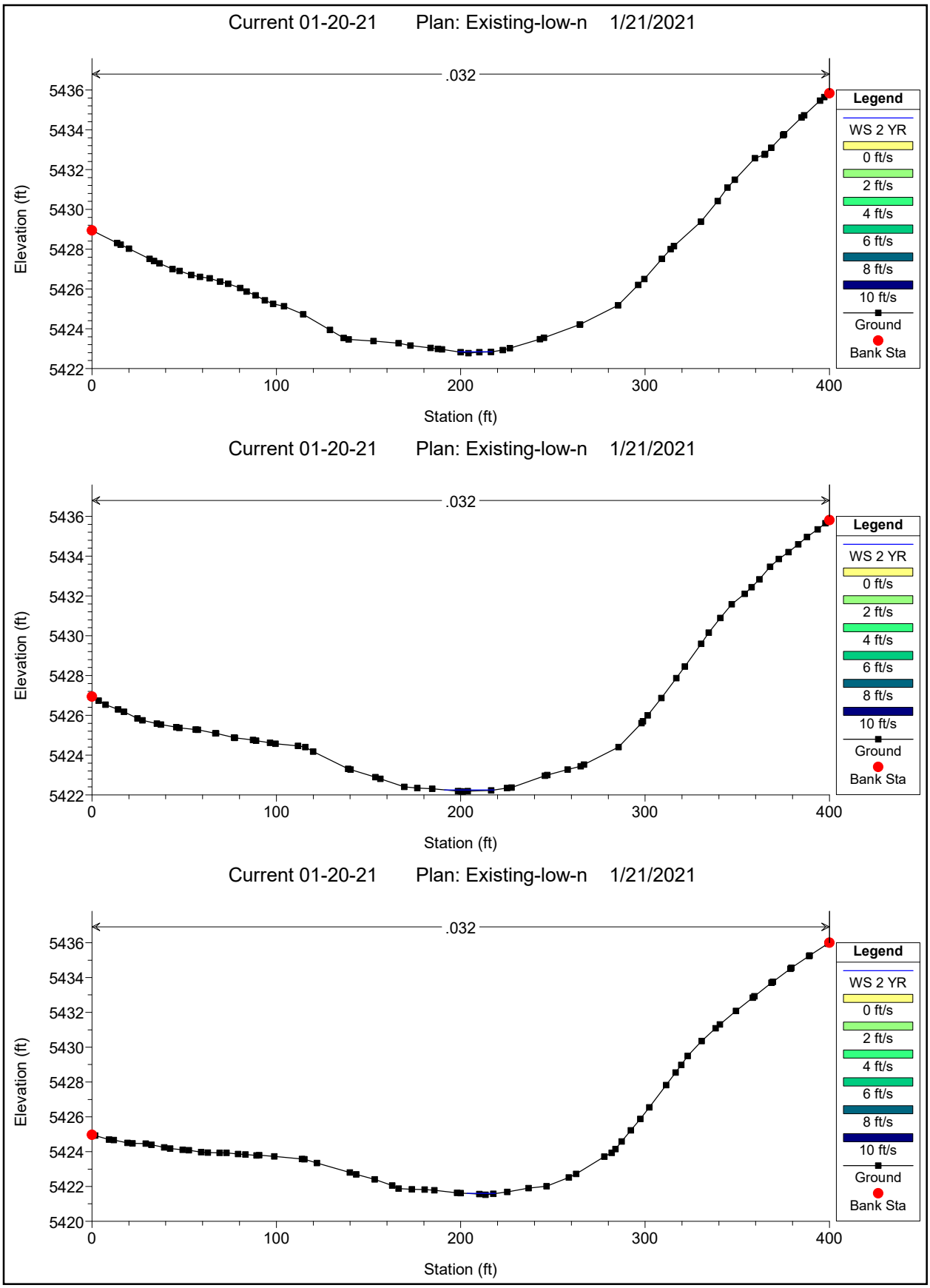
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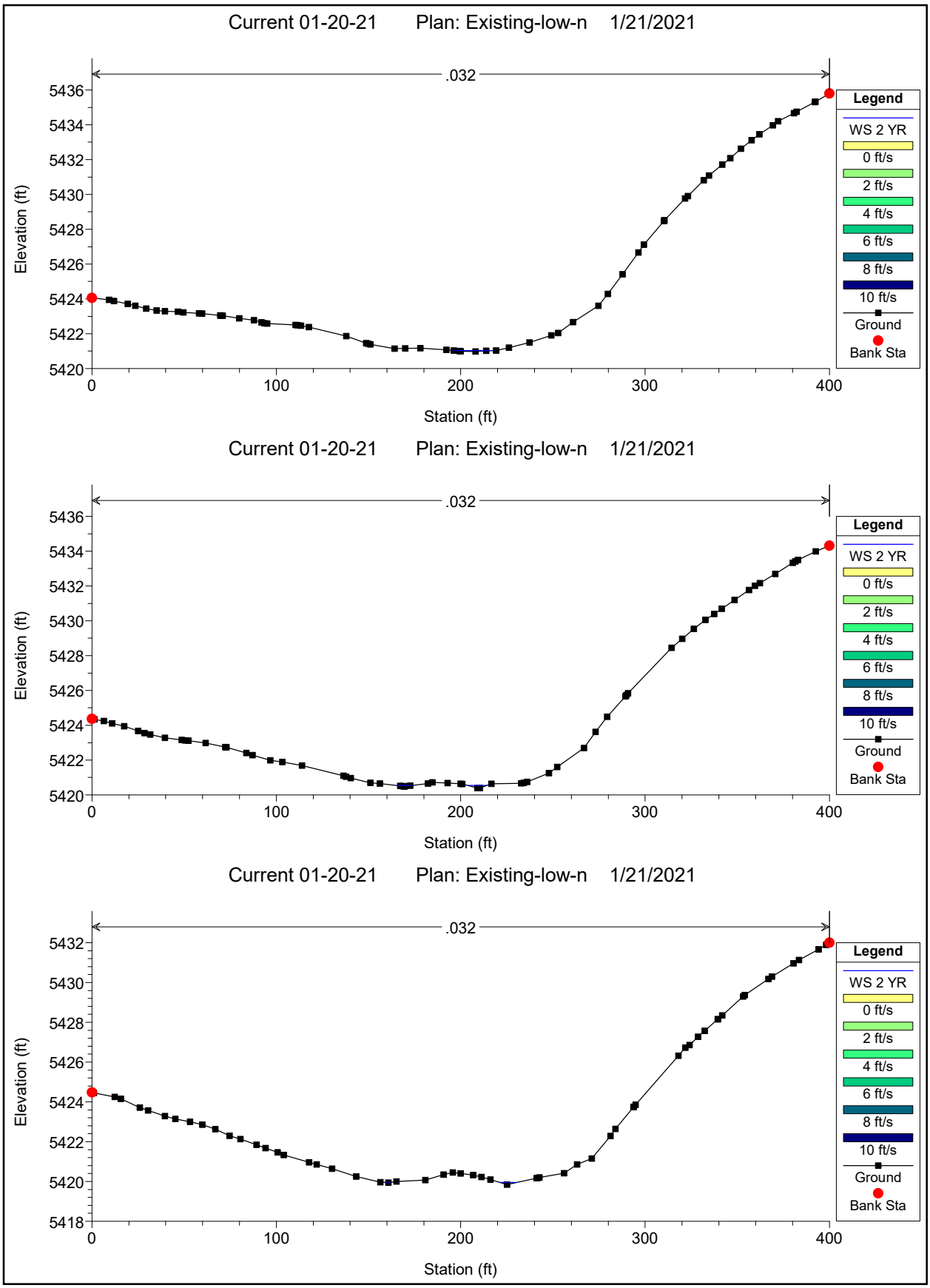
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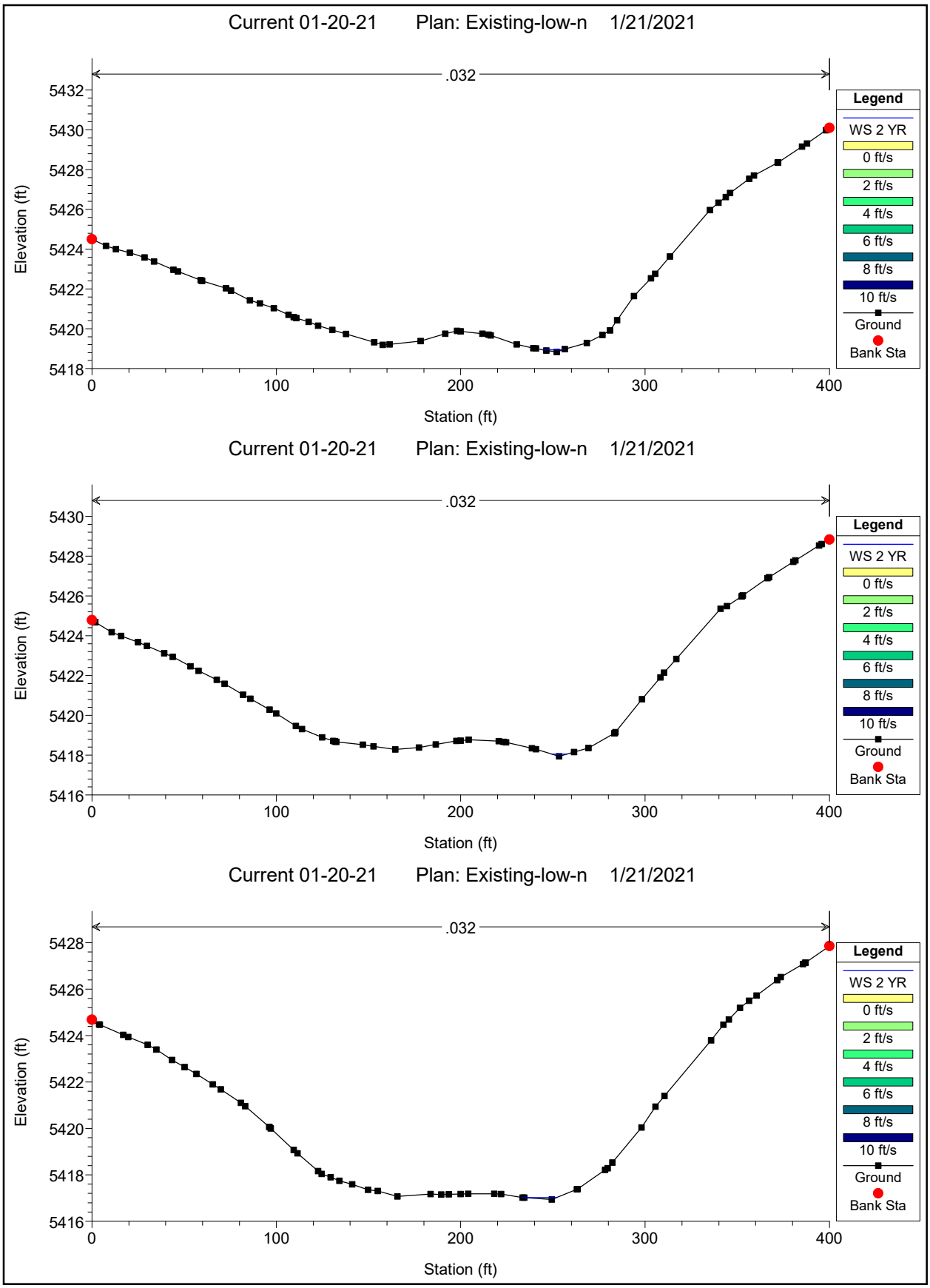
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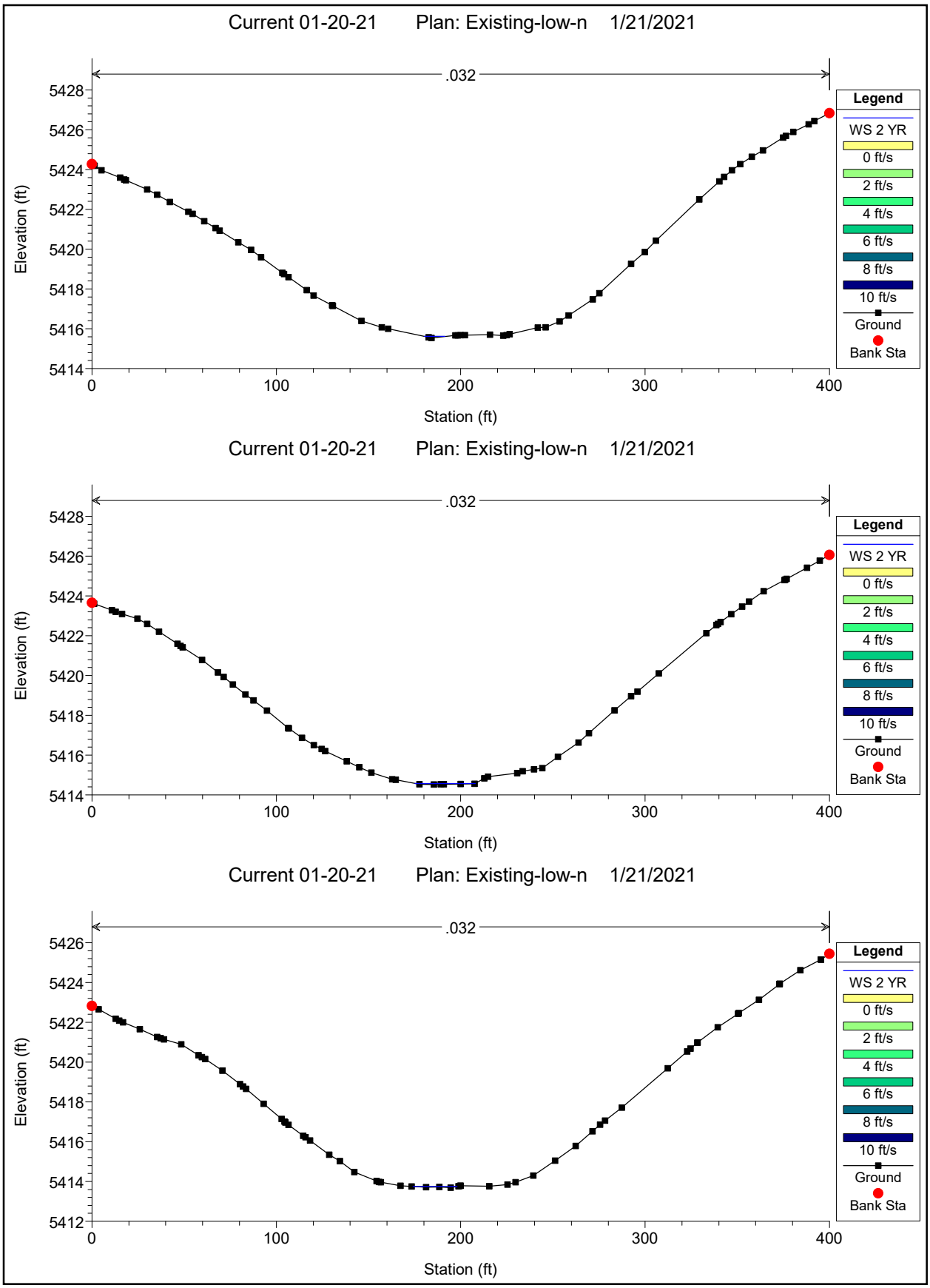
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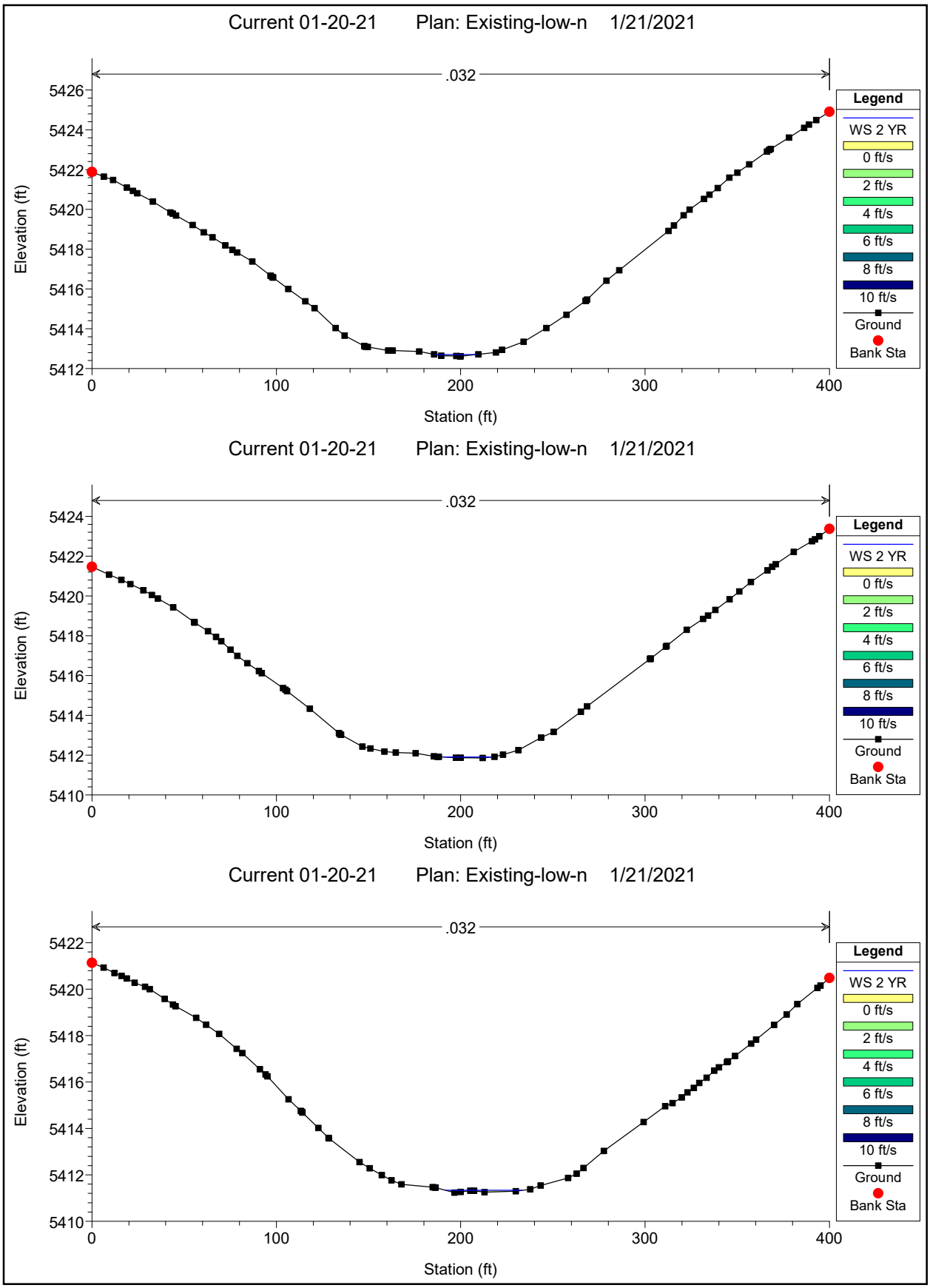
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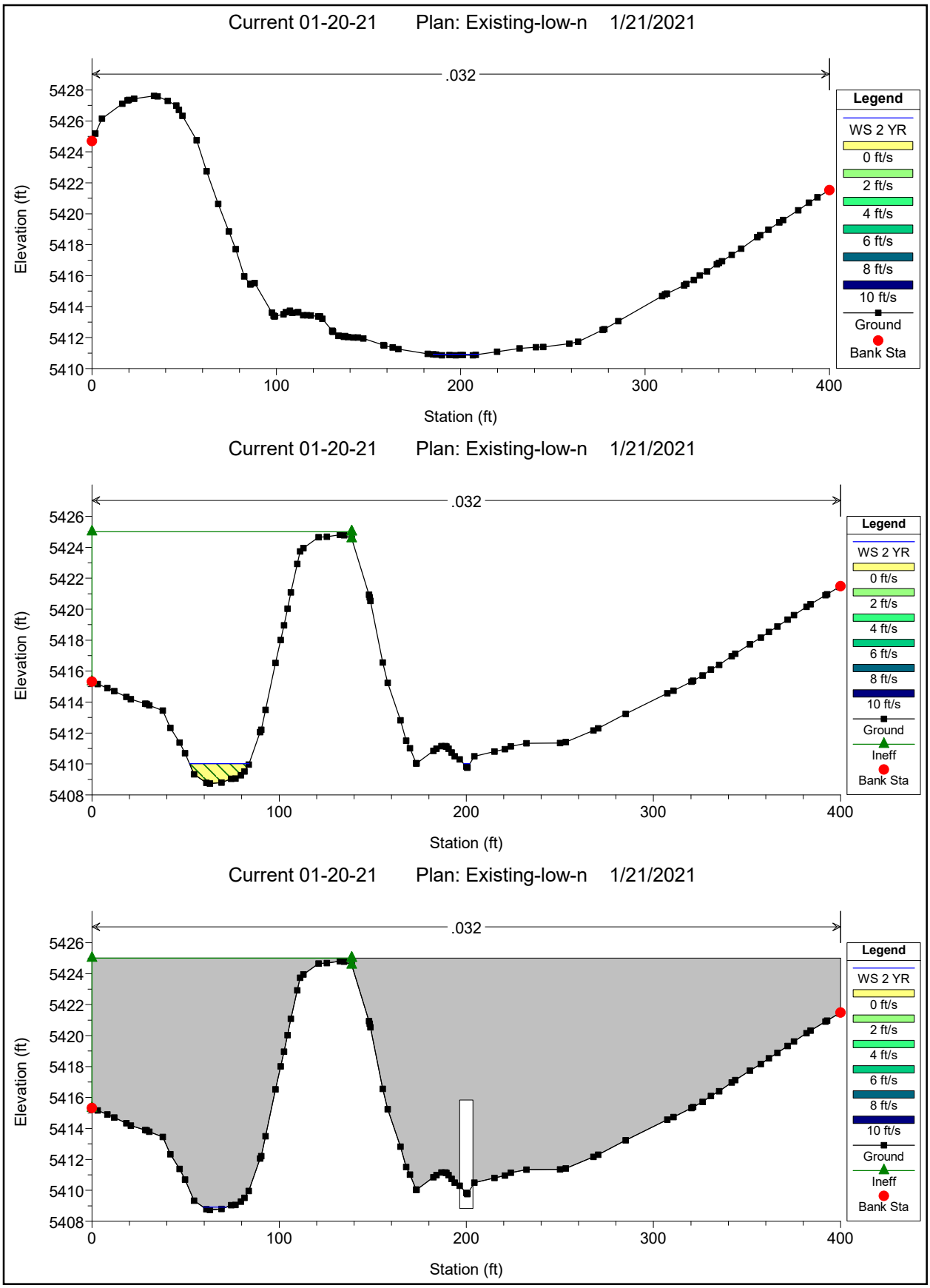
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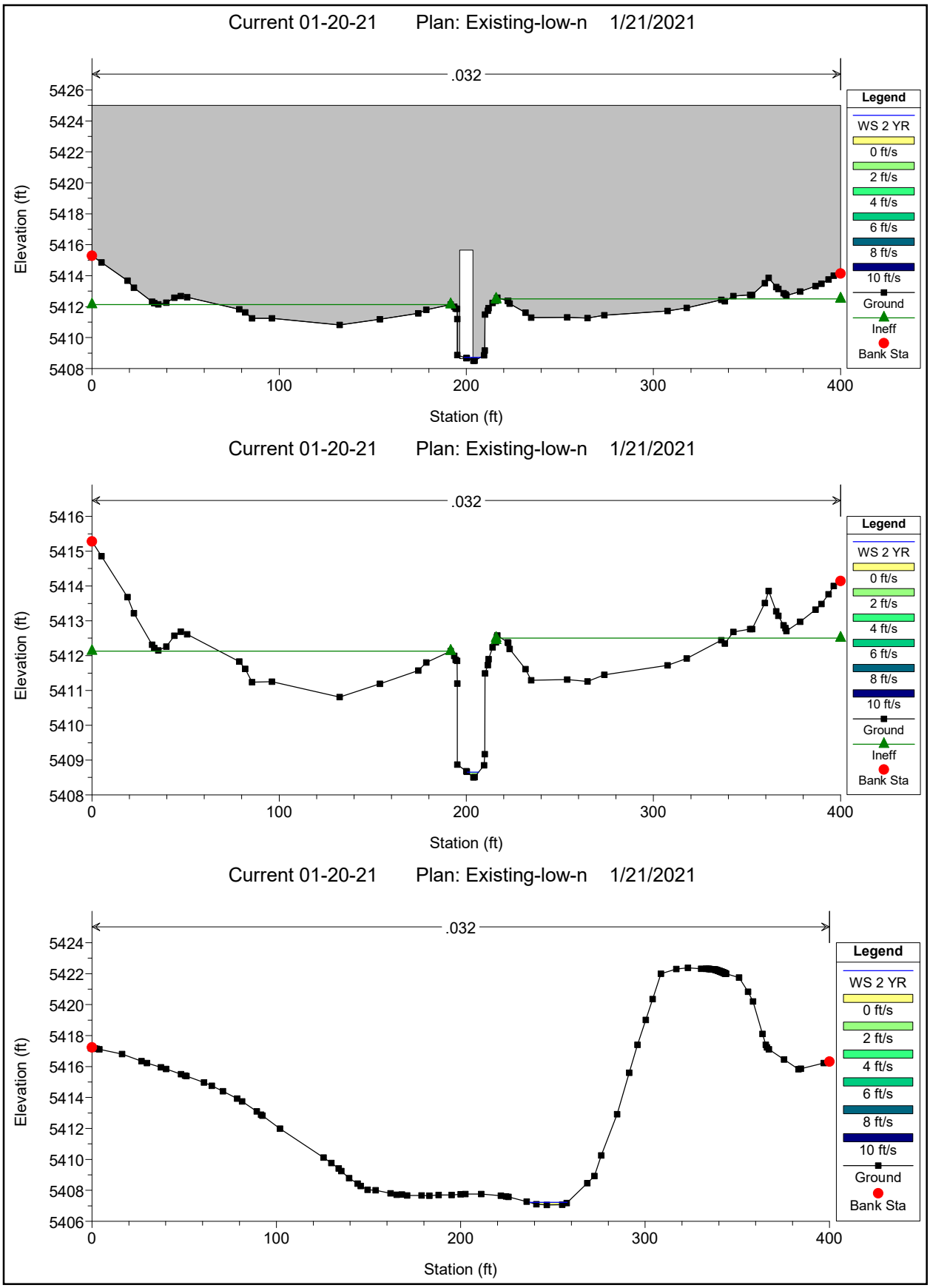
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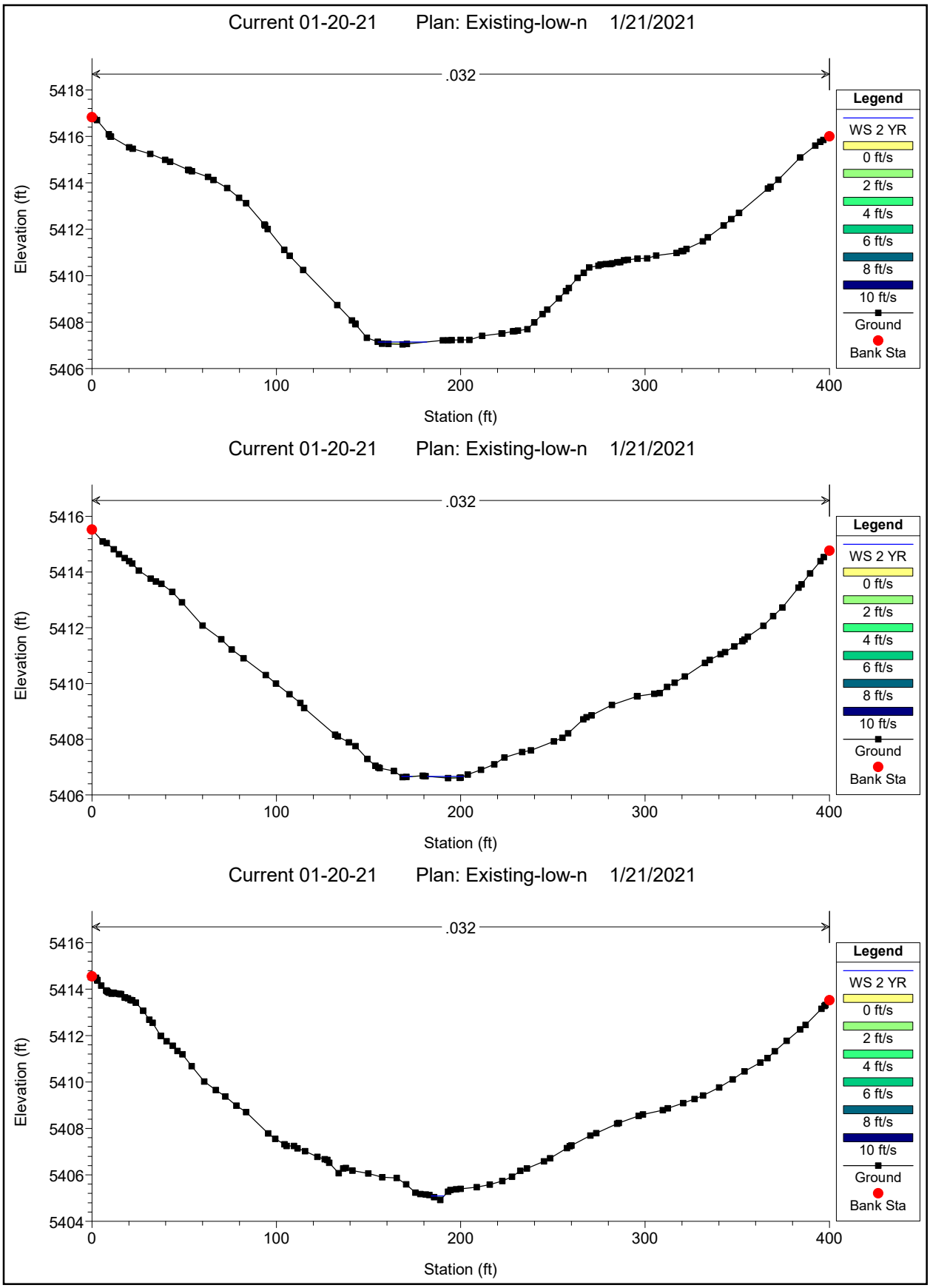
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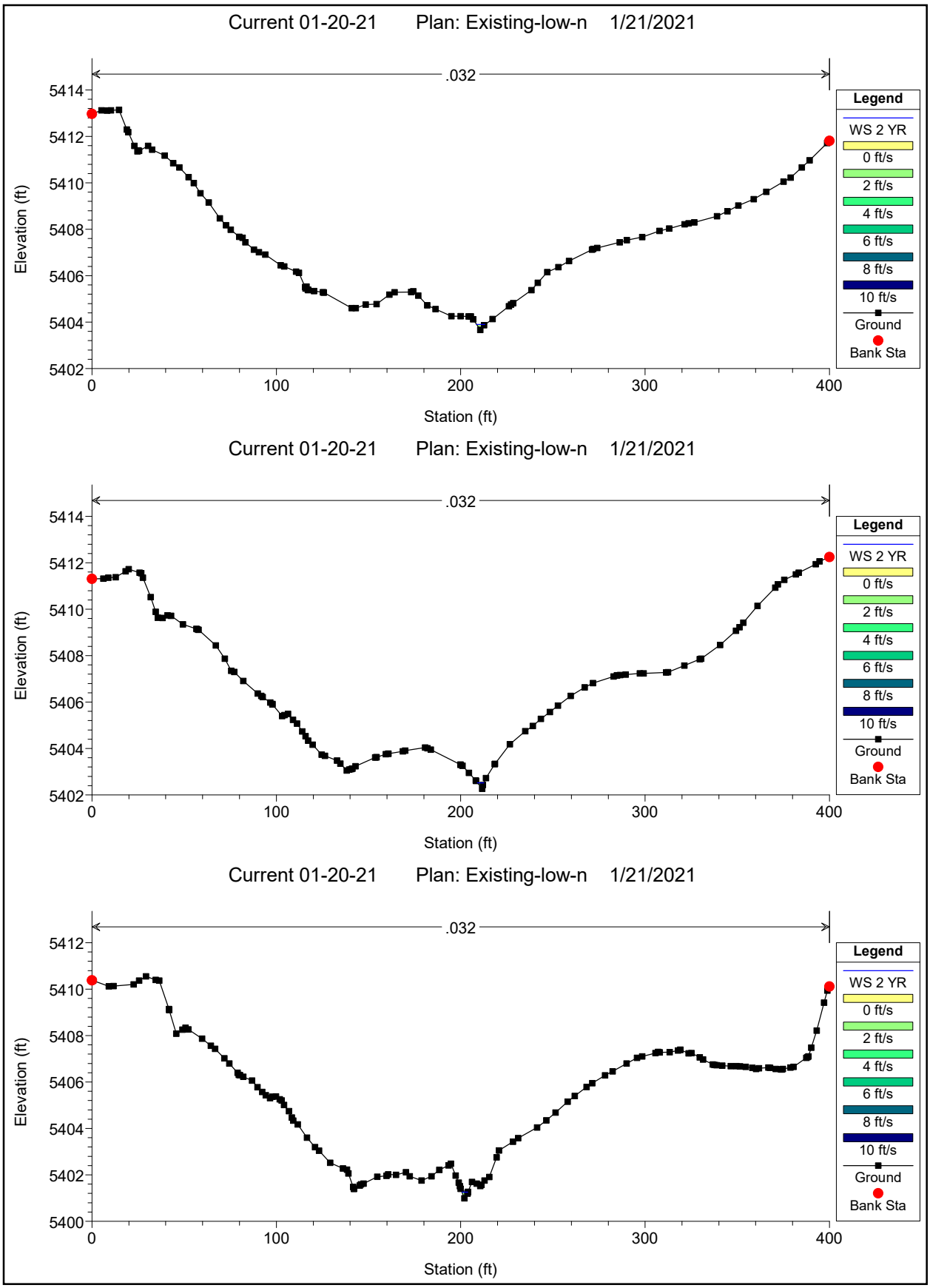
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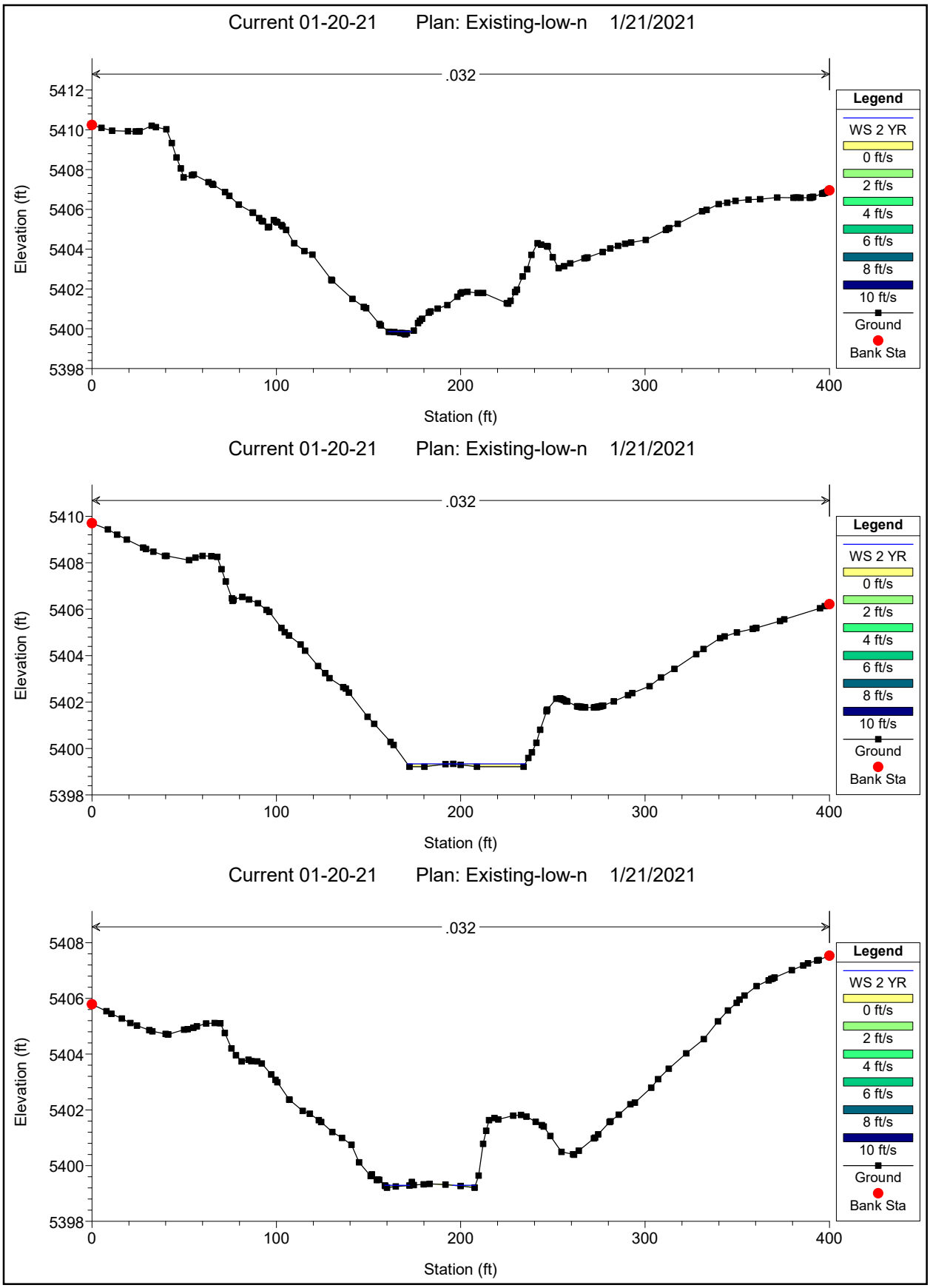
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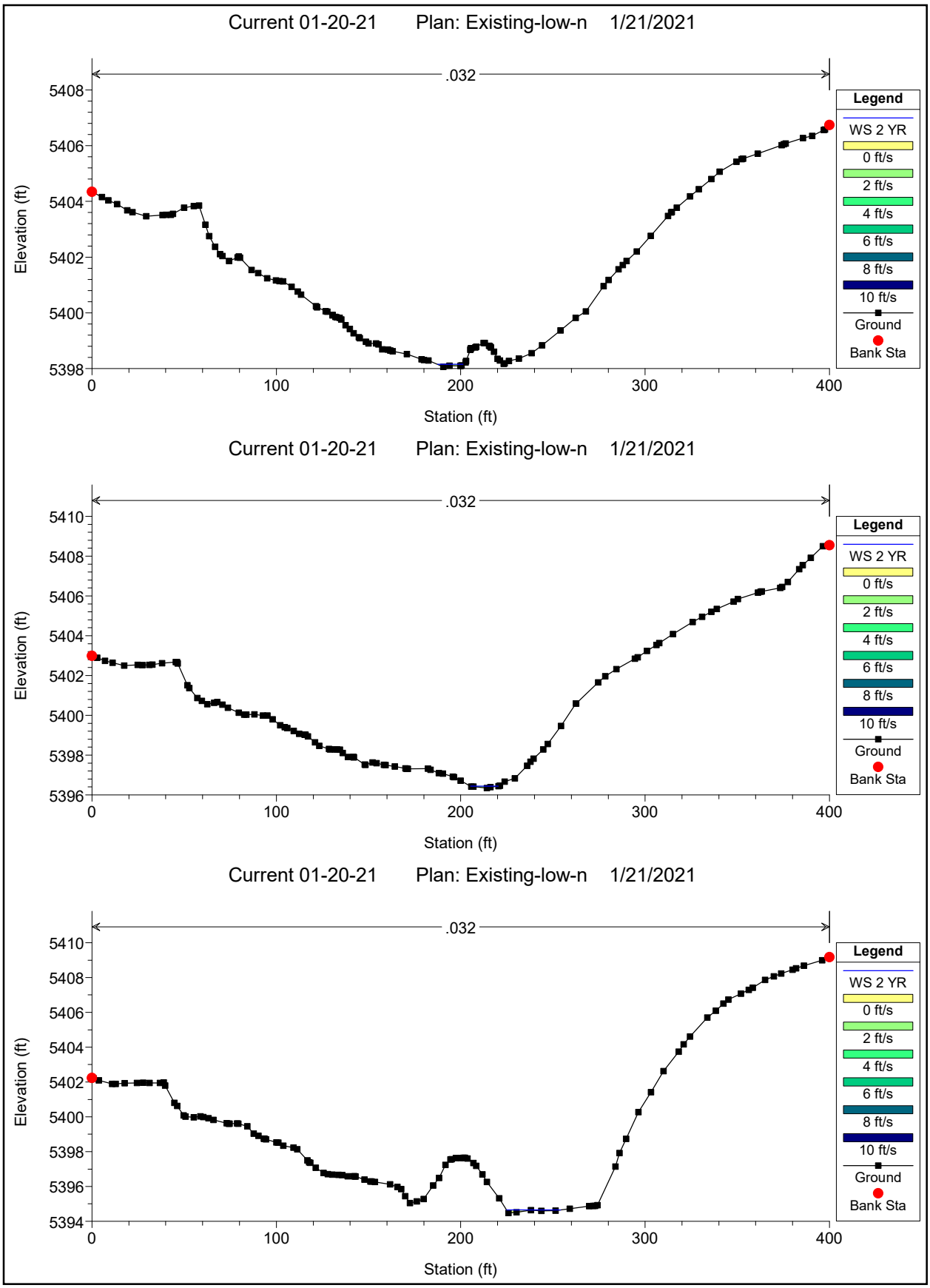
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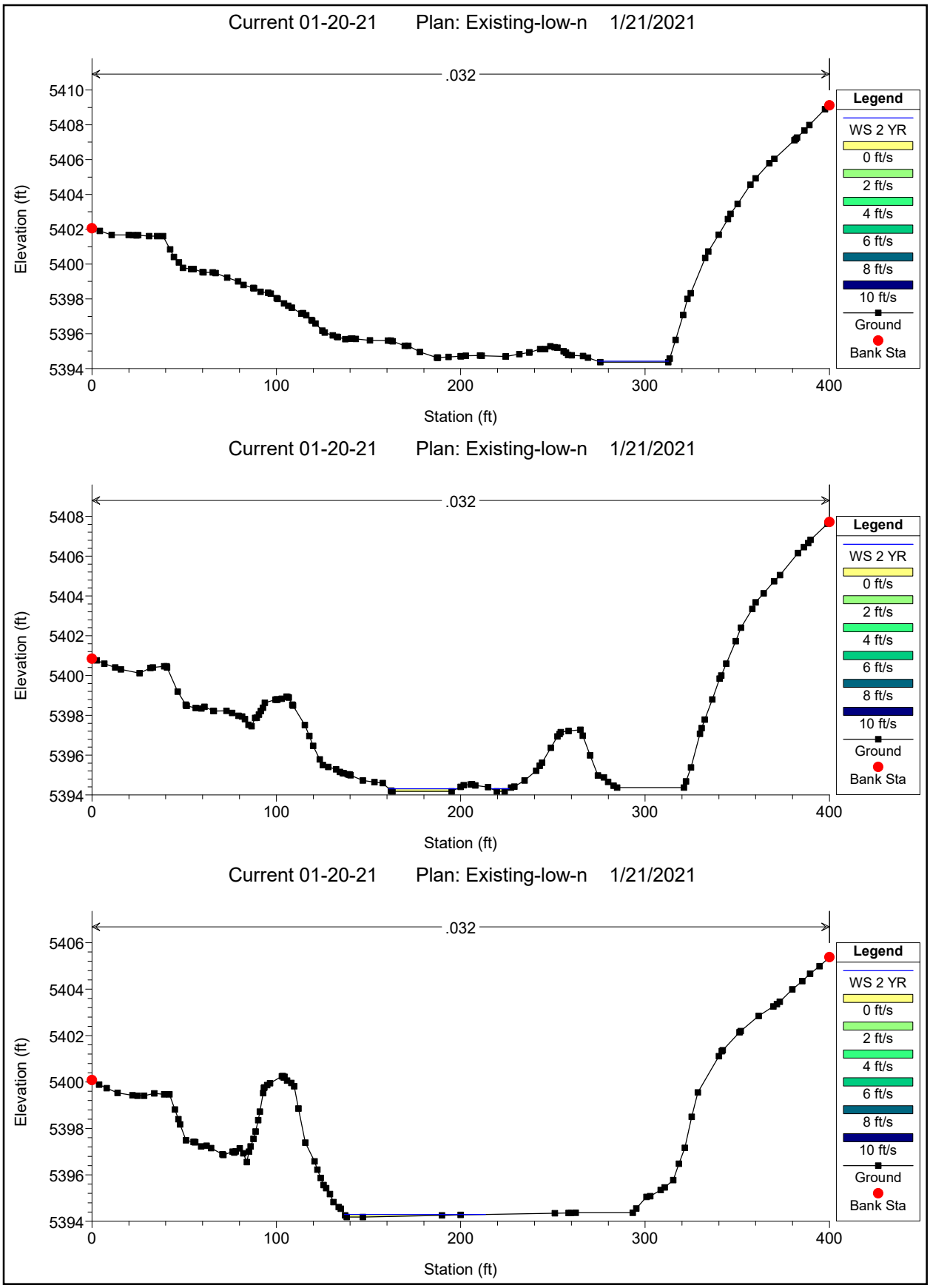
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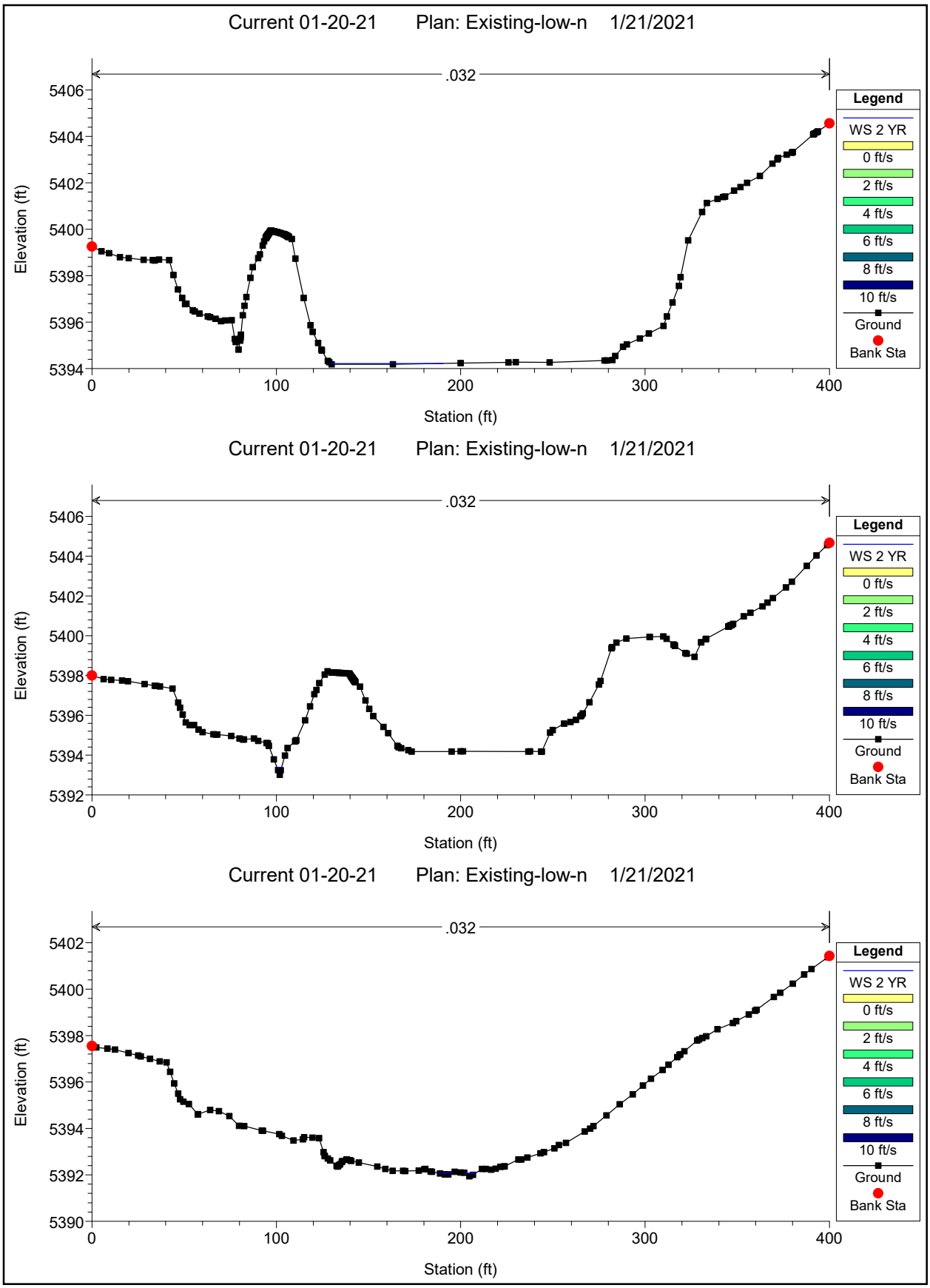
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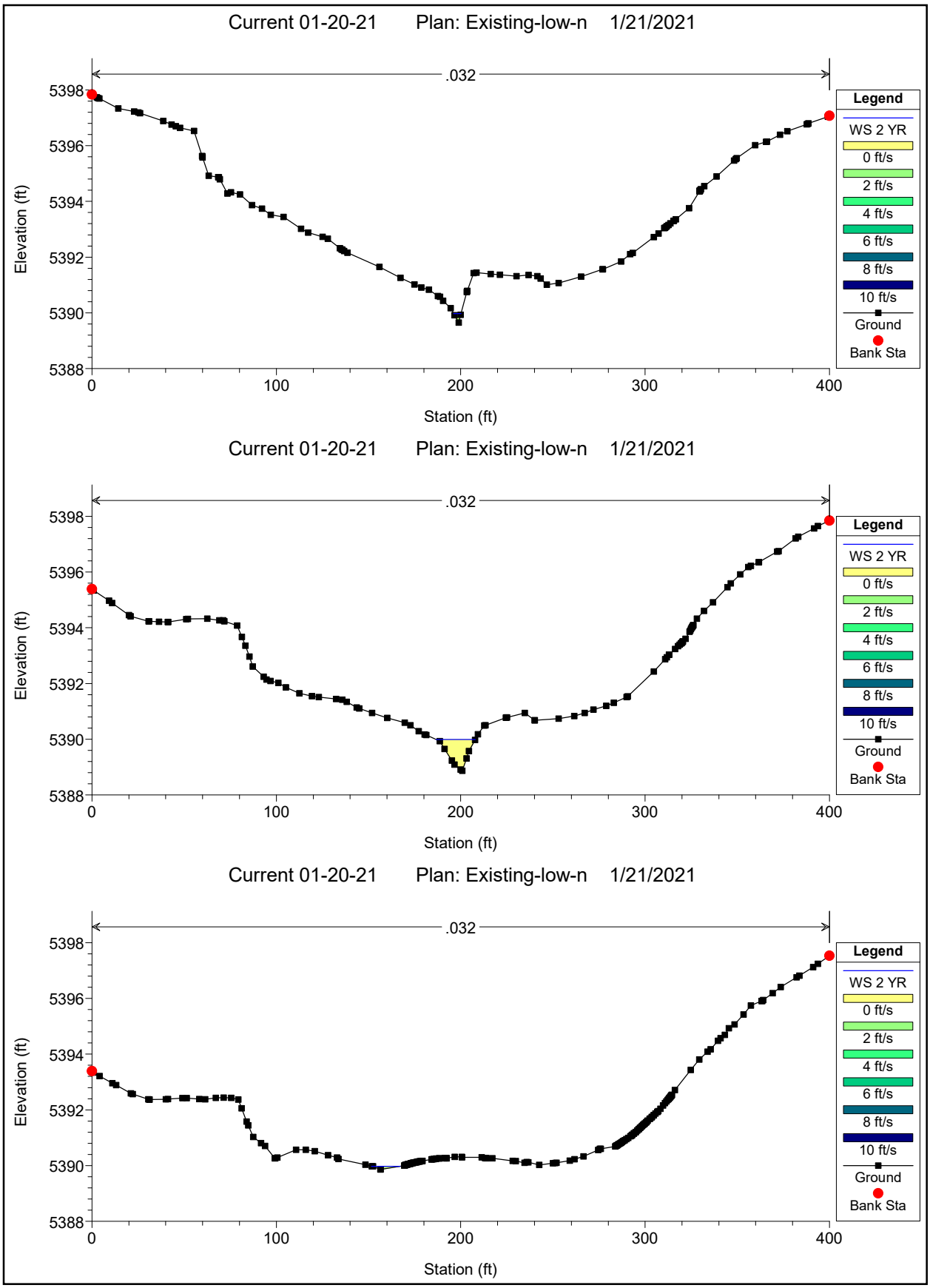
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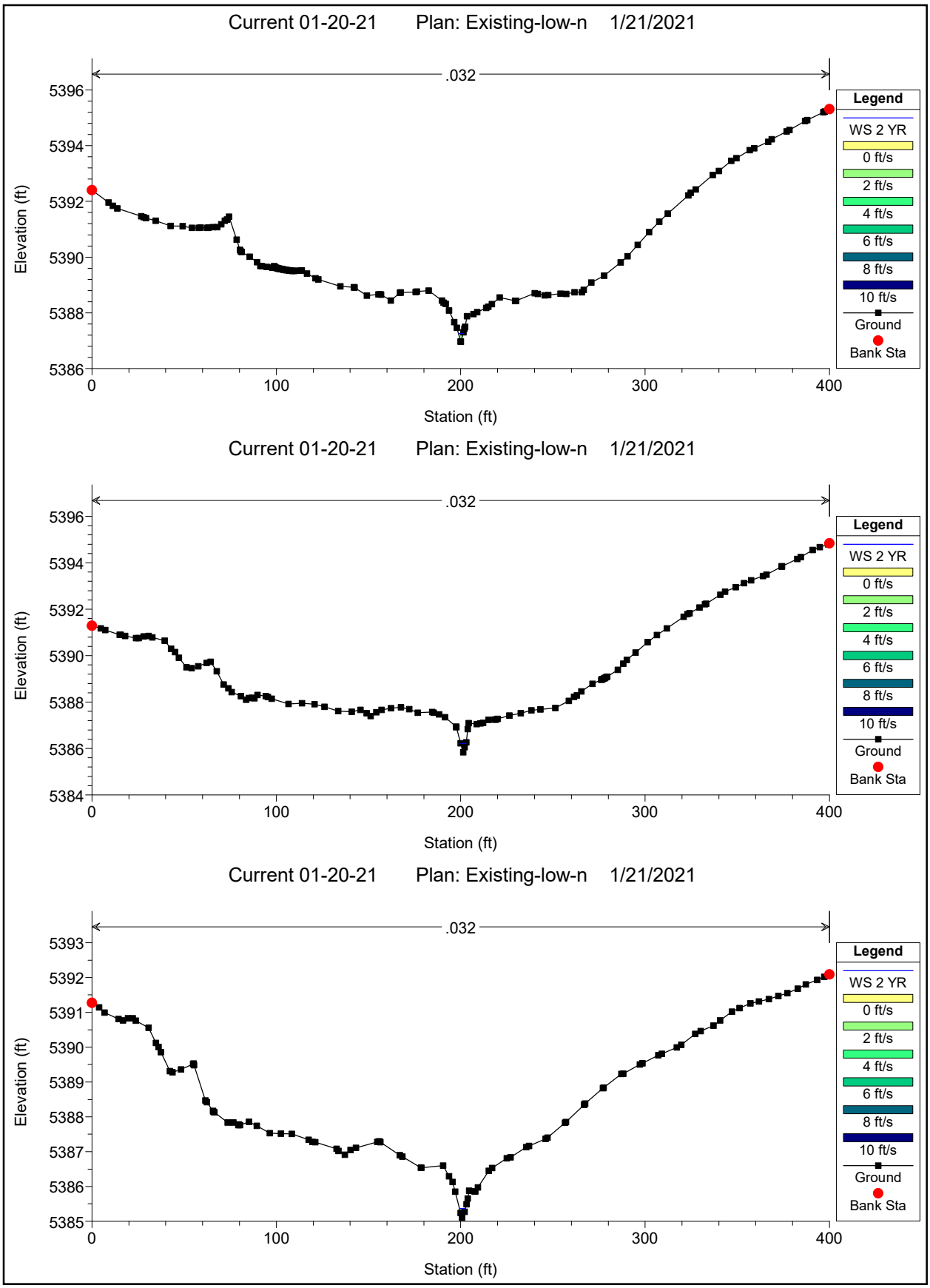
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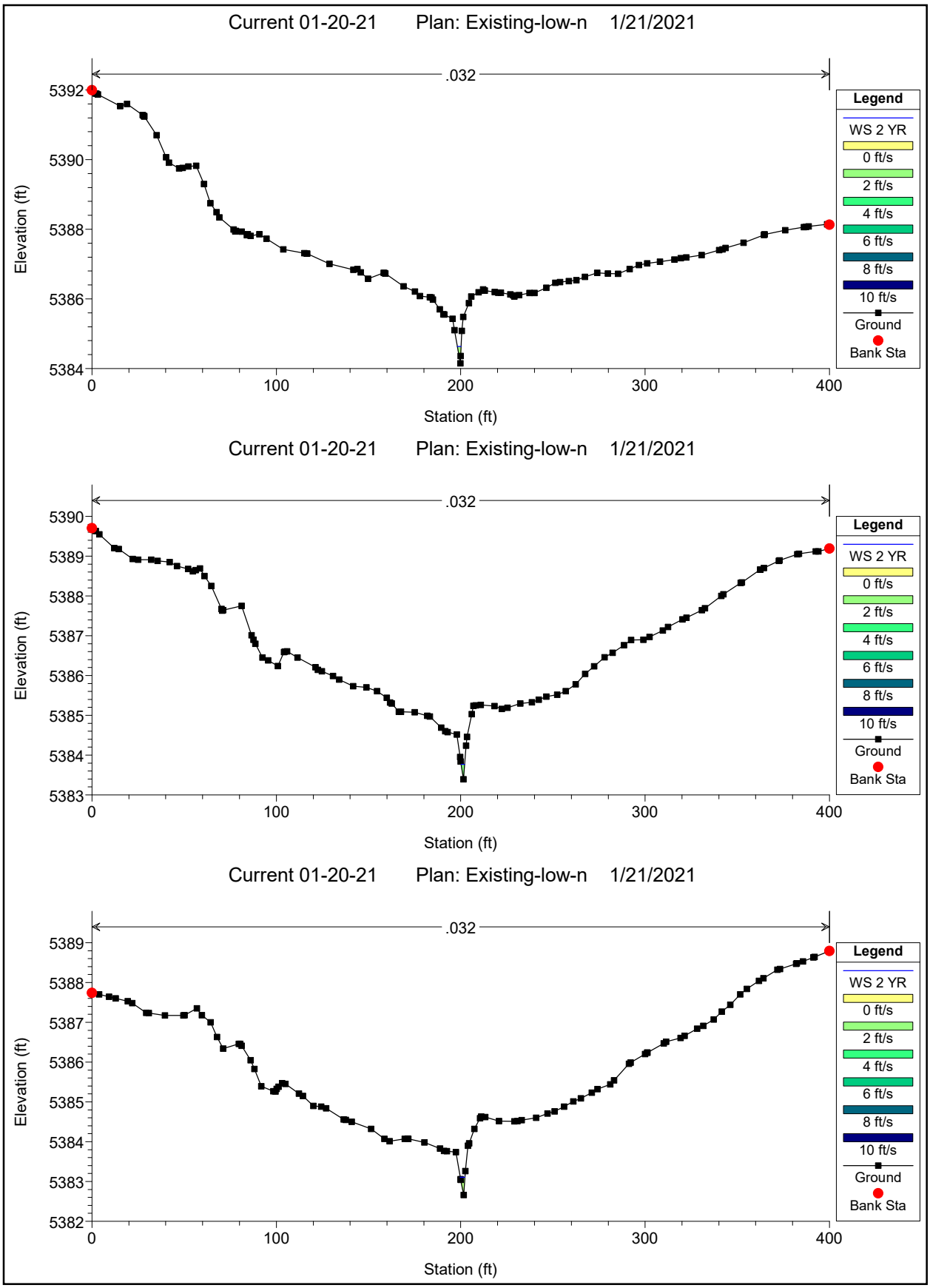
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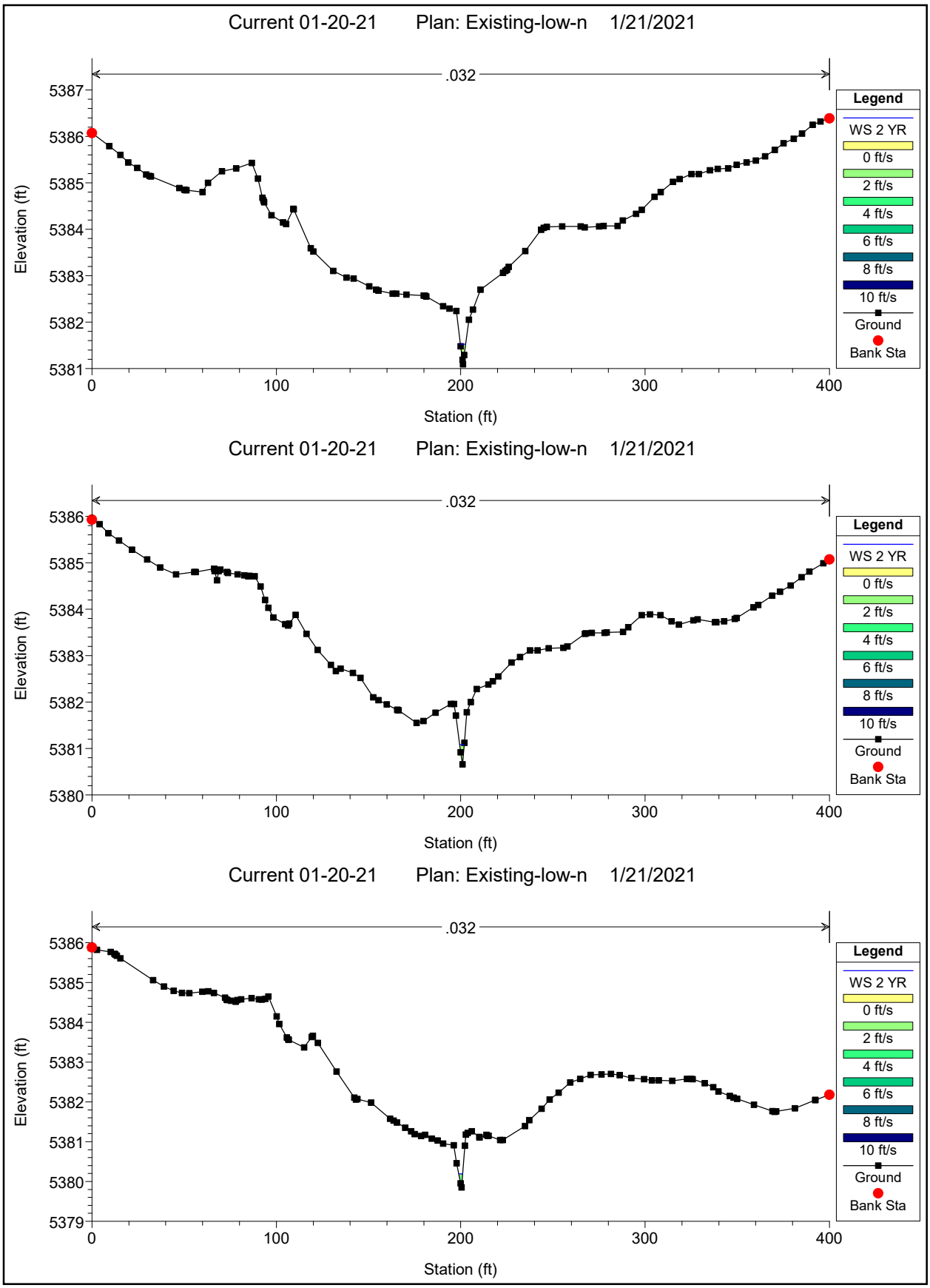
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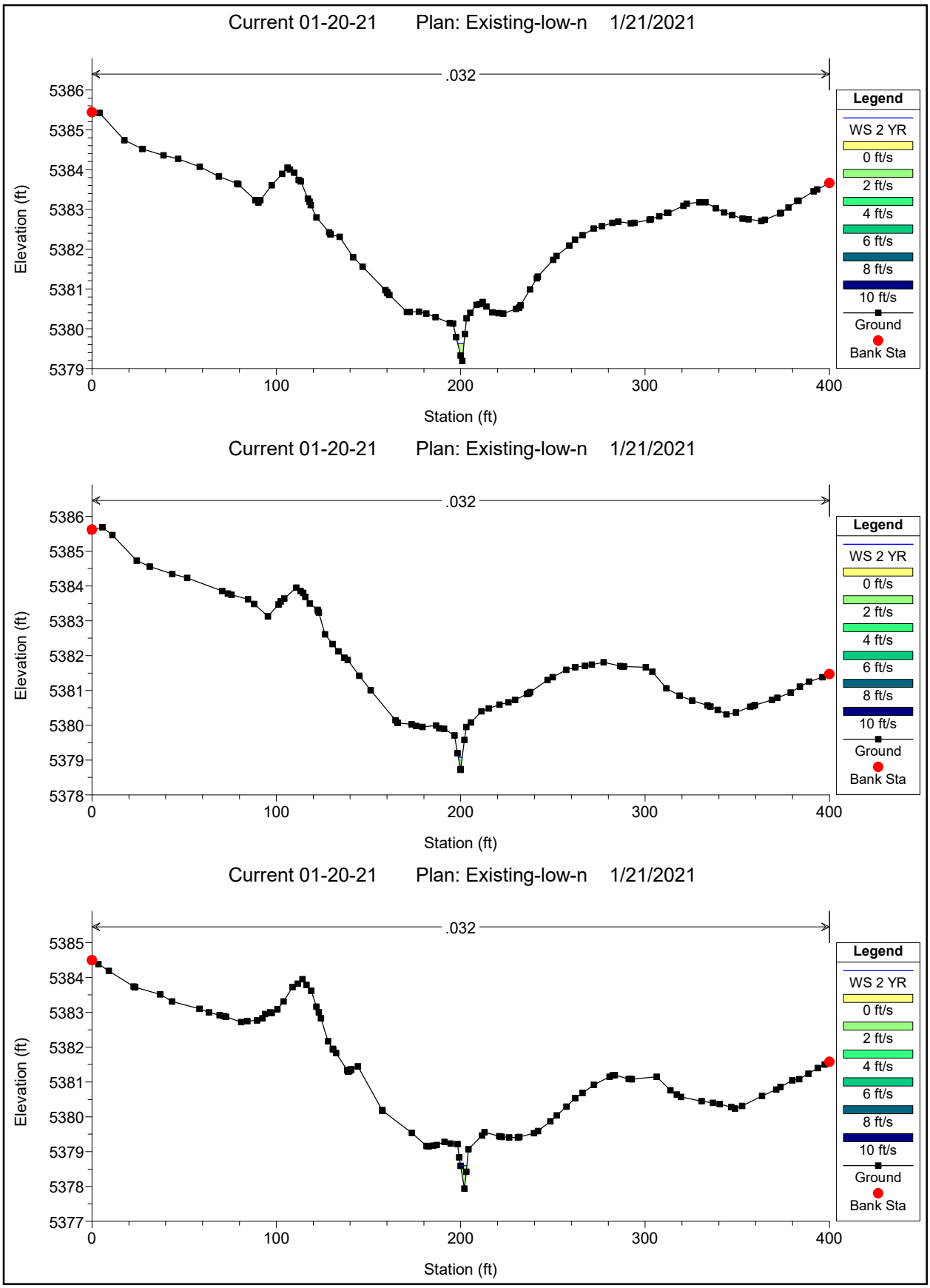
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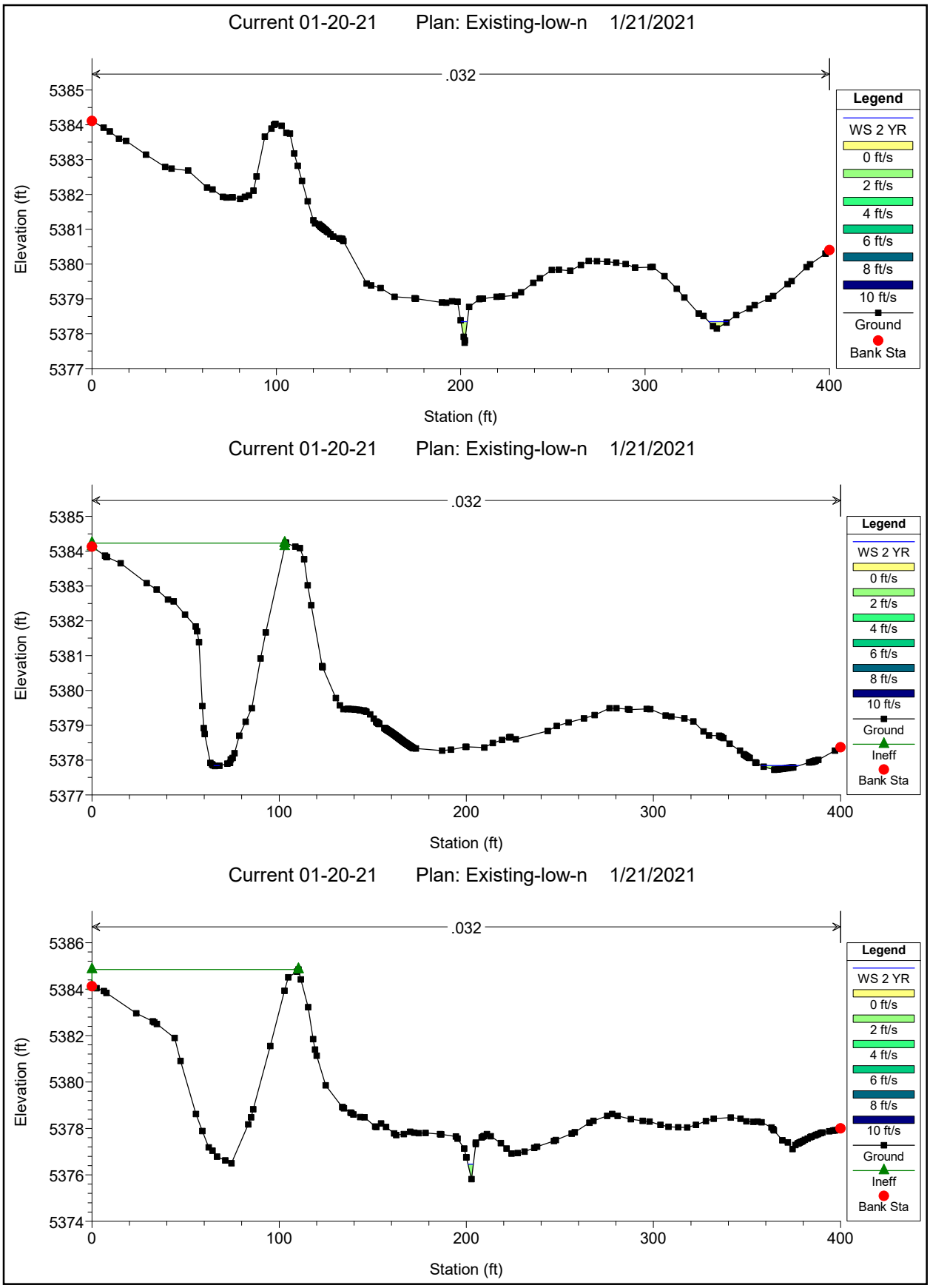
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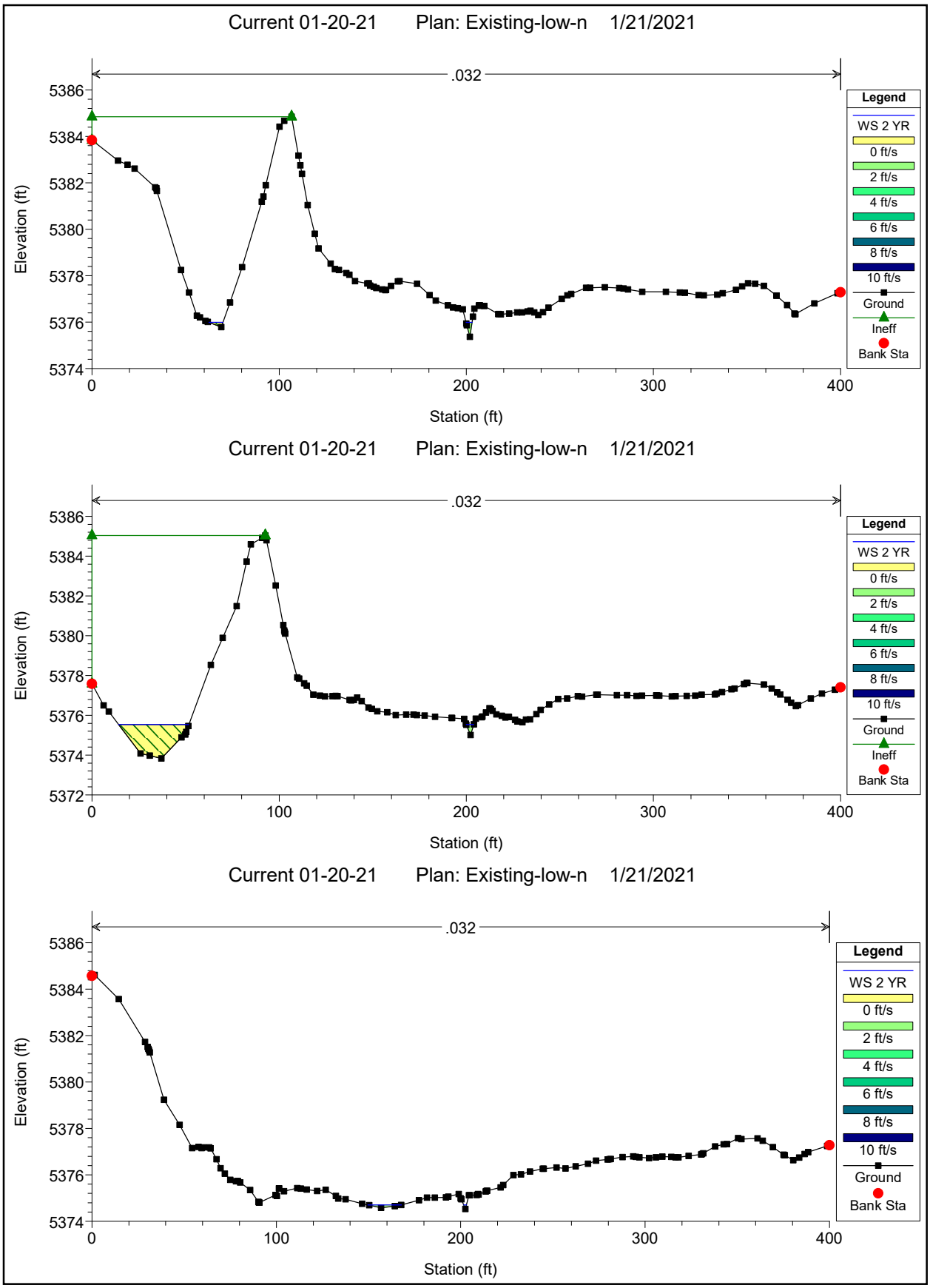
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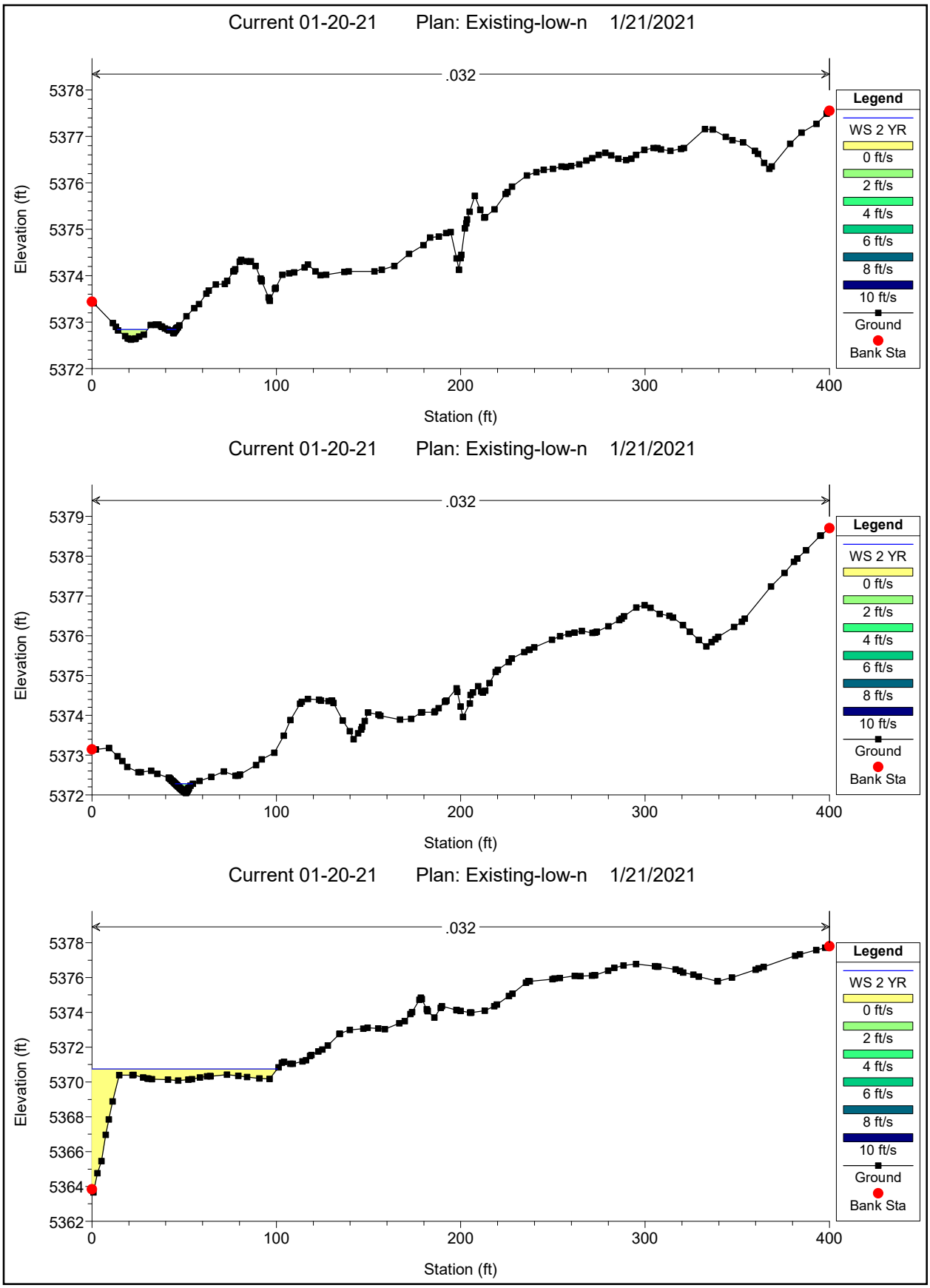
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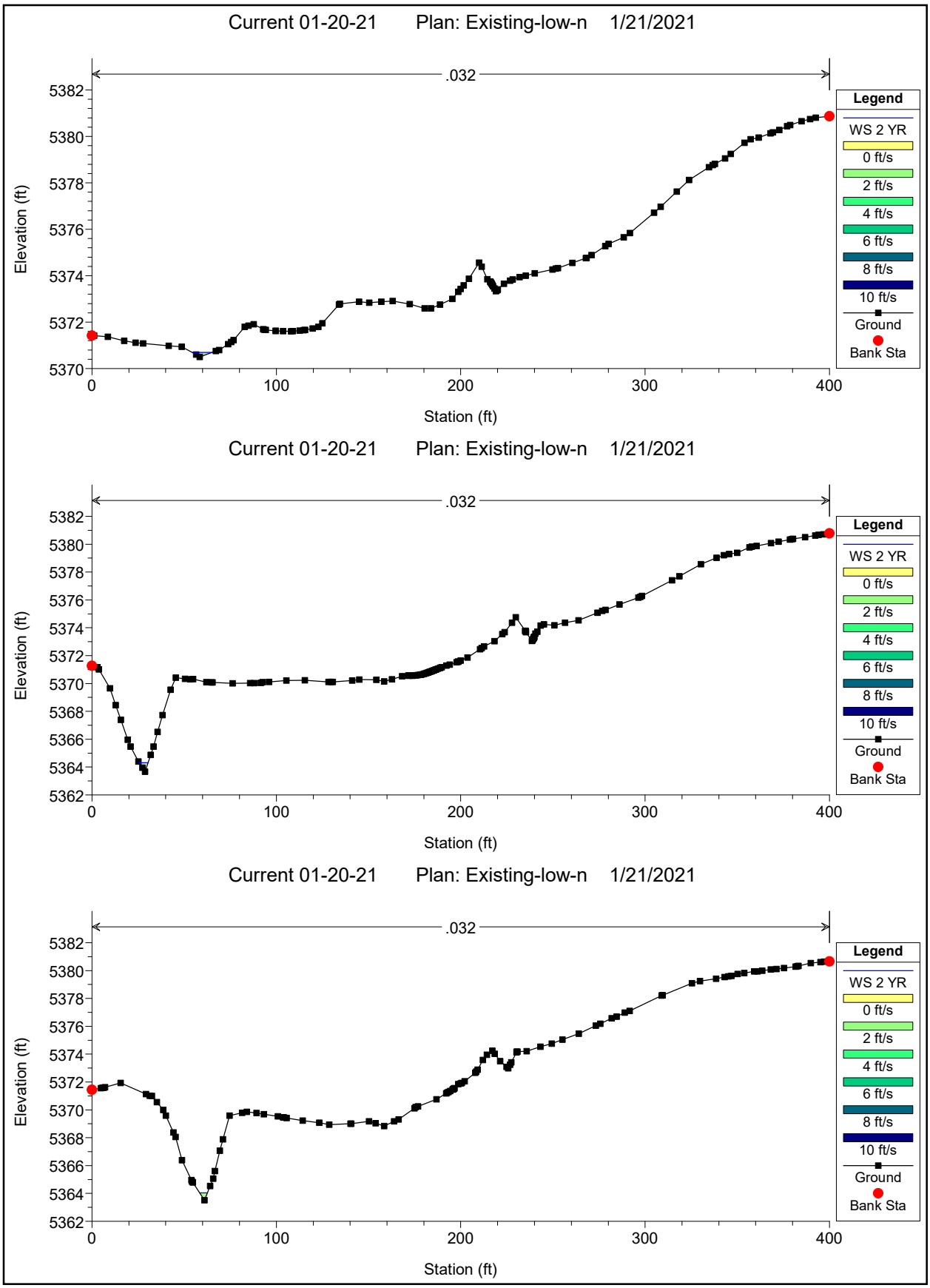
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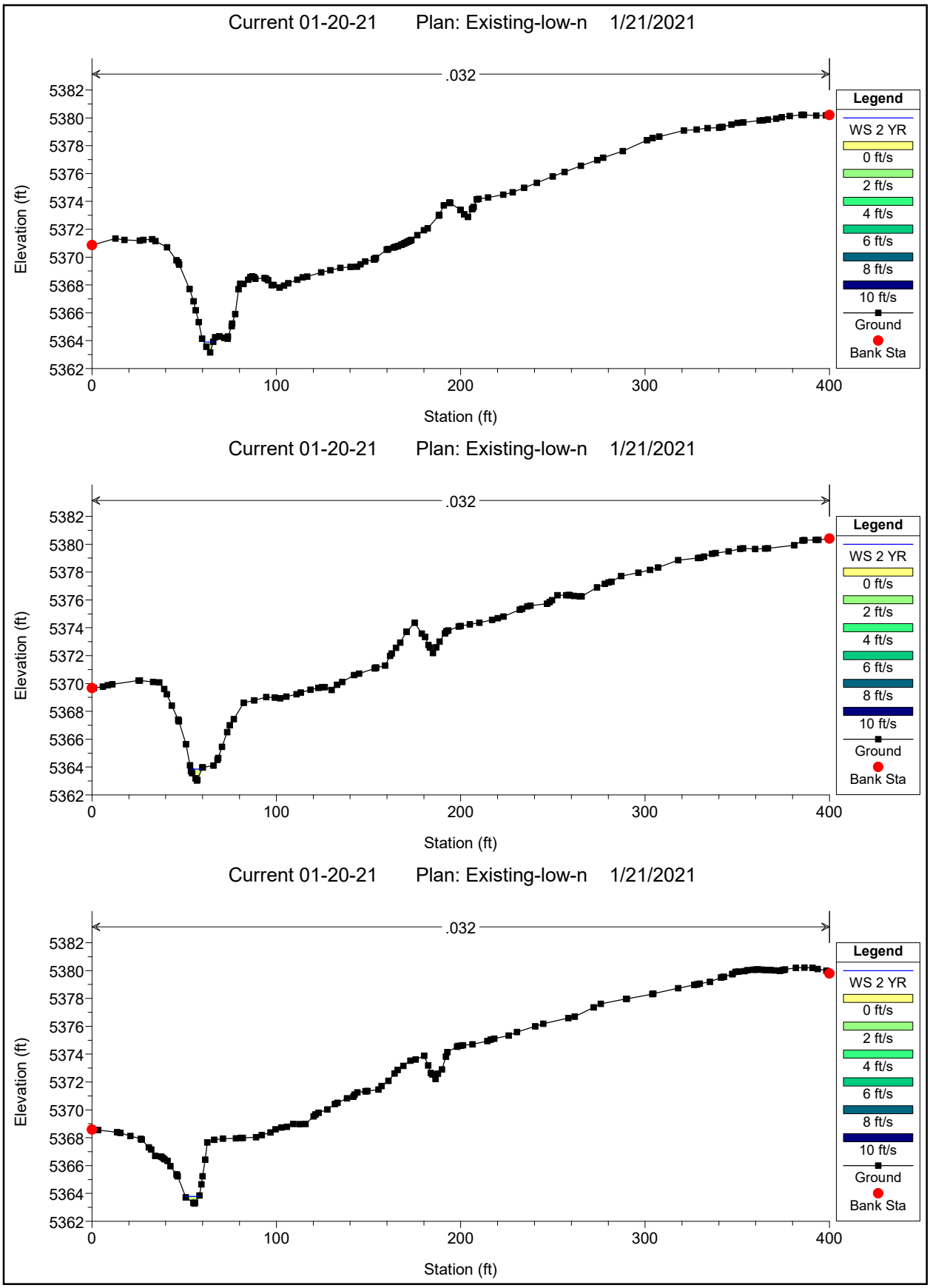
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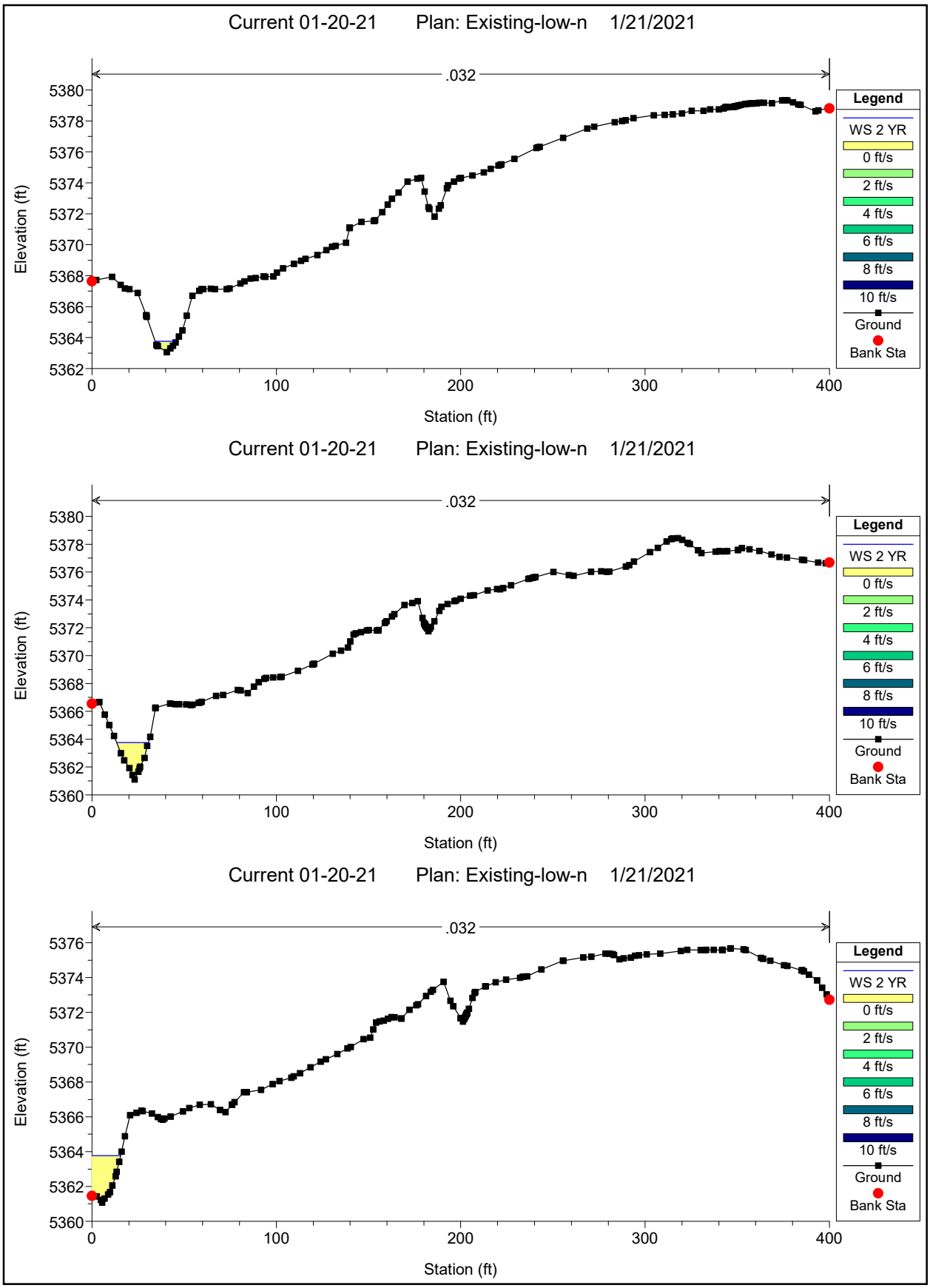
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 01-20-21 Plan: Existing-low-n 1/21/2021
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta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.032
Elevation (ft)
Station (ft)
Legend
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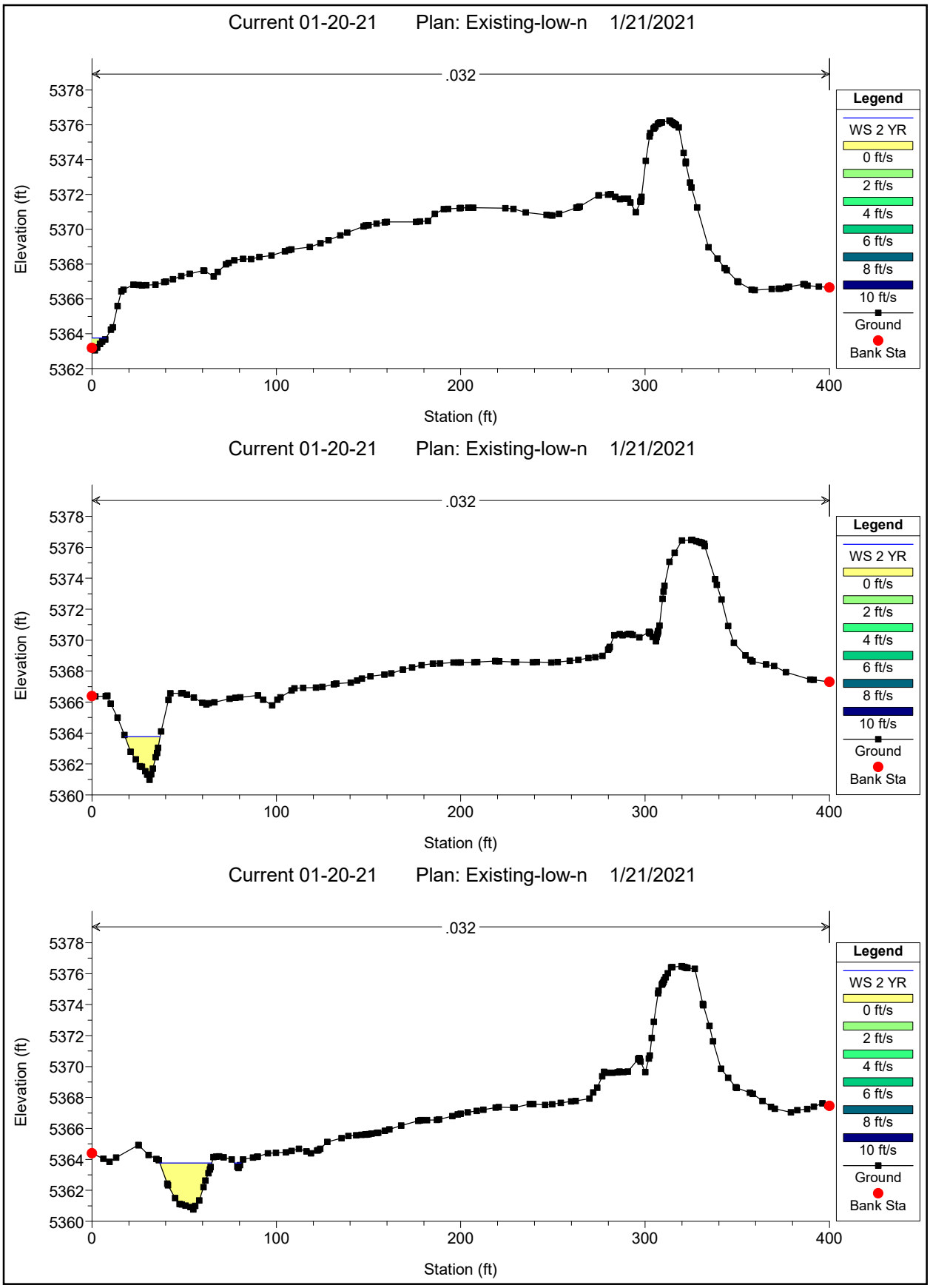
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 01-20-21 Plan: Existing-low-n 1/21/2021
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 01-20-21 Plan: Existing-low-n 1/21/2021
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta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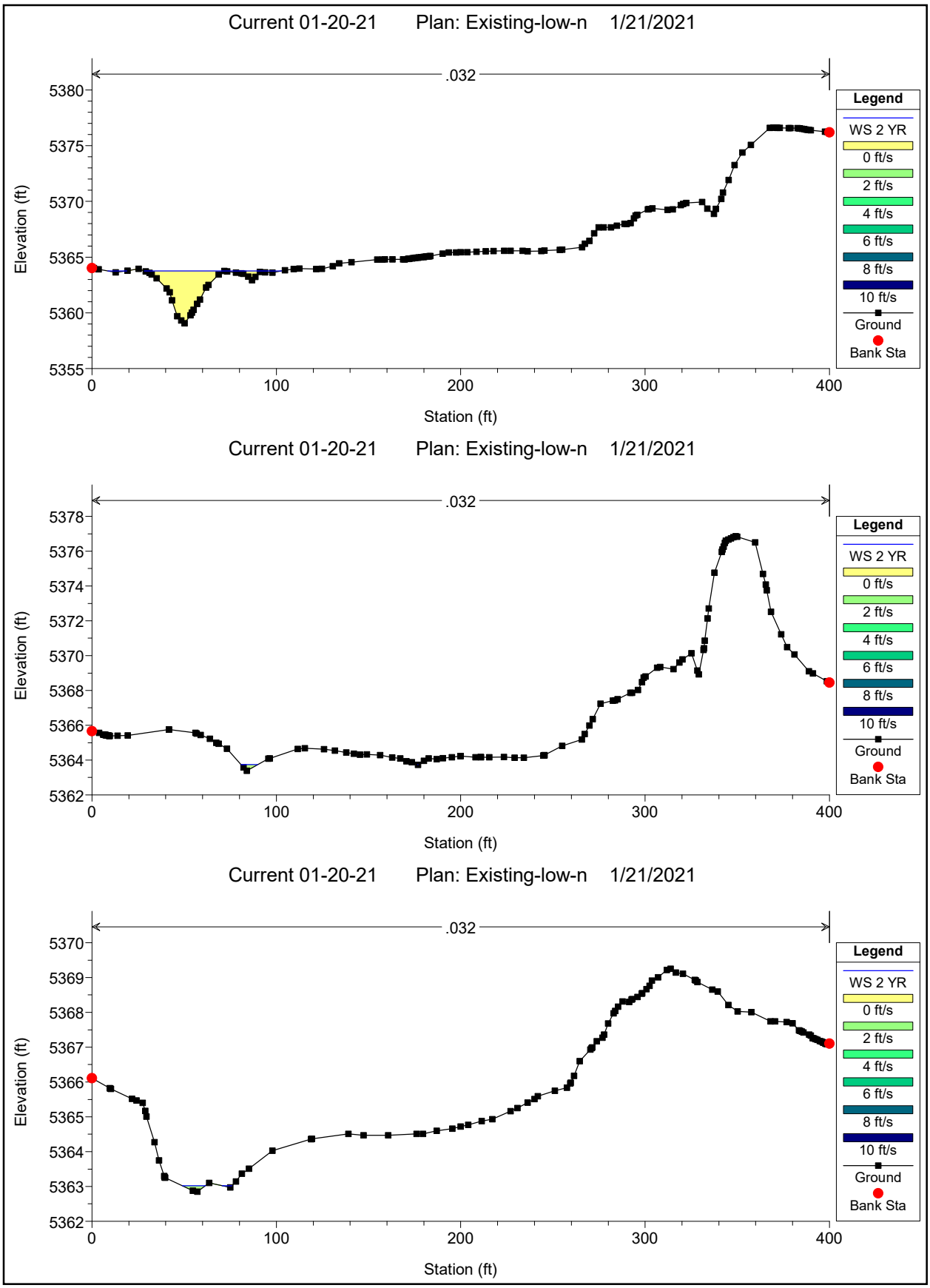
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 01-20-21 Plan: Existing-low-n 1/21/2021
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 01-20-21 Plan: Existing-low-n 1/21/2021
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta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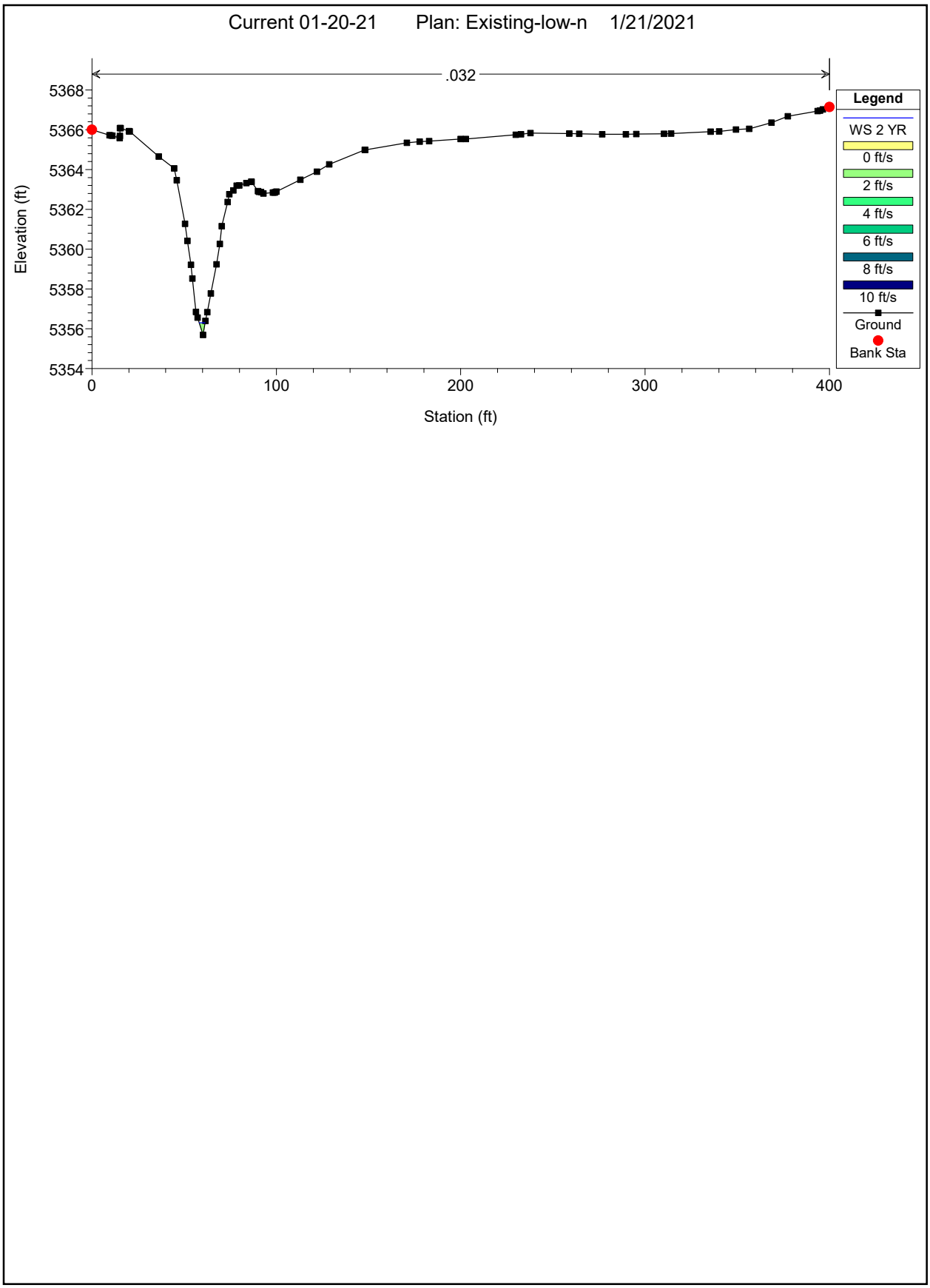
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 01-20-21 Plan: Existing-low-n 1/21/2021
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 01-20-21 Plan: Existing-low-n 1/21/2021
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta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.032
Elevation (ft)
5368
5366
5364
5362
5360
5358
5356
5354
0
100
200
300
400
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

HEC-RAS Plan: EX-low-n River: PR Channel w EX Reach: PR Channel w EX Profile: 10 YR

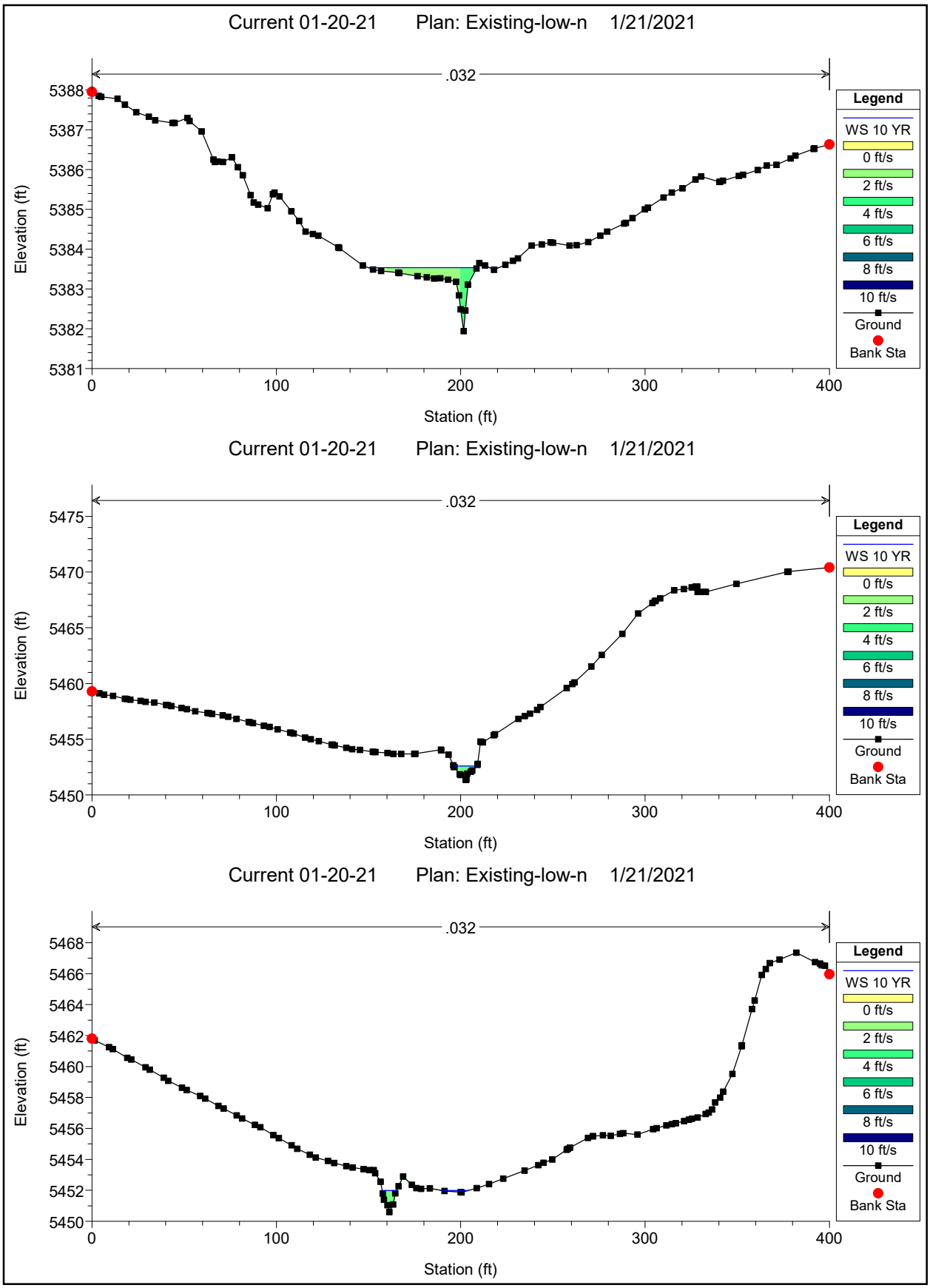
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
PR Channel w EX	5800	10 YR	20.67	5451.37	5452.60		5452.72	0.008134	2.85	7.25	12.50	0.66	0.29
PR Channel w EX	5750	10 YR	20.67	5450.60	5452.00	5451.77	5452.13	0.019188	2.91	7.10	22.70	0.92	0.37
PR Channel w EX	5700	10 YR	20.67	5450.44	5451.06	5451.04	5451.13	0.019671	2.13	9.72	51.56	0.86	0.23
PR Channel w EX	5650	10 YR	20.67	5449.59	5449.87	5449.87	5449.93	0.030473	2.03	10.16	80.66	1.01	0.24
PR Channel w EX	5600	10 YR	20.67	5448.20	5448.44	5448.43	5448.52	0.023735	2.23	9.27	53.27	0.94	0.26
PR Channel w EX	5550	10 YR	20.67	5446.73	5447.18	5447.18	5447.29	0.025411	2.55	8.11	40.14	1.00	0.32
PR Channel w EX	5500	10 YR	20.67	5445.70	5446.21		5446.27	0.008514	1.91	10.85	36.57	0.62	0.16
PR Channel w EX	5450	10 YR	20.67	5445.18	5445.56	5445.54	5445.66	0.019402	2.47	8.35	35.29	0.90	0.29
PR Channel w EX	5400	10 YR	20.67	5444.02	5444.46	5444.46	5444.57	0.024450	2.71	7.62	33.40	1.00	0.35
PR Channel w EX	5350	10 YR	20.67	5443.50	5443.85		5443.89	0.008027	1.69	12.25	47.43	0.59	0.13
PR Channel w EX	5300	10 YR	20.67	5443.06	5443.35		5443.40	0.012474	1.80	11.48	56.10	0.70	0.16
PR Channel w EX	5250	10 YR	20.67	5442.30	5442.57	5442.55	5442.64	0.019134	2.04	10.15	56.78	0.85	0.21
PR Channel w EX	5200	10 YR	20.67	5441.16	5441.44	5441.44	5441.53	0.026188	2.47	8.36	44.32	1.00	0.31
PR Channel w EX	5150	10 YR	20.67	5440.47	5441.22		5441.23	0.000288	0.52	40.13	75.89	0.12	0.01
PR Channel w EX	5100	10 YR	20.67	5438.22	5441.22		5441.22	0.000003	0.11	191.21	109.57	0.01	0.00
PR Channel w EX	5050	10 YR	20.67	5440.75	5441.10	5441.10	5441.21	0.024340	2.67	7.75	34.64	0.99	0.34
PR Channel w EX	5000	10 YR	20.67	5438.11	5438.75	5438.75	5438.86	0.024373	2.70	7.65	33.61	1.00	0.35
PR Channel w EX	4950	10 YR	20.67	5437.46	5437.90	5437.84	5437.97	0.013139	2.07	9.99	41.19	0.74	0.20
PR Channel w EX	4900	10 YR	20.67	5436.63	5436.97	5436.97	5437.07	0.025069	2.55	8.11	39.72	0.99	0.32
PR Channel w EX	4850	10 YR	20.67	5435.74	5436.19		5436.23	0.006371	1.55	13.32	49.17	0.53	0.11
PR Channel w EX	4800	10 YR	20.67	5435.30	5435.67	5435.64	5435.73	0.016860	1.99	10.39	54.84	0.81	0.20
PR Channel w EX	4750	10 YR	20.67	5434.70	5434.98	5434.93	5435.02	0.011963	1.73	11.97	60.34	0.68	0.15
PR Channel w EX	4700	10 YR	20.67	5434.00	5434.31	5434.27	5434.35	0.014669	1.79	11.56	64.43	0.74	0.16
PR Channel w EX	4650	10 YR	20.67	5433.19	5433.46	5433.44	5433.53	0.018127	2.11	9.80	50.02	0.84	0.22
PR Channel w EX	4600	10 YR	20.67	5432.42	5432.73		5432.78	0.012674	1.89	10.93	50.20	0.71	0.17
PR Channel w EX	4550	10 YR	20.67	5431.42	5431.81	5431.81	5431.92	0.024791	2.59	7.98	37.82	0.99	0.33
PR Channel w EX	4500	10 YR	20.67	5430.16	5431.11		5431.14	0.001807	1.43	14.48	23.43	0.32	0.07
PR Channel w EX	4450	10 YR	20.67	5430.58	5430.83	5430.83	5430.90	0.029449	2.22	9.30	63.07	1.02	0.27
PR Channel w EX	4400	10 YR	20.67	5428.93	5429.32	5429.30	5429.40	0.018901	2.32	8.91	40.66	0.87	0.26
PR Channel w EX	4350	10 YR	20.67	5427.79	5428.18	5428.18	5428.29	0.026218	2.74	7.53	34.14	1.03	0.36
PR Channel w EX	4300	10 YR	20.67	5426.79	5427.18		5427.25	0.015691	2.06	10.02	47.45	0.79	0.21
PR Channel w EX	4250	10 YR	20.67	5426.01	5426.34	5426.31	5426.41	0.018014	2.08	9.92	51.33	0.84	0.22
PR Channel w EX	4200	10 YR	20.67	5425.01	5425.38	5425.35	5425.44	0.020663	2.10	9.83	55.63	0.88	0.23
PR Channel w EX	4150	10 YR	20.67	5424.35	5424.66		5424.69	0.011251	1.58	13.08	72.01	0.65	0.13
PR Channel w EX	4100	10 YR	20.67	5423.68	5423.94	5423.92	5423.98	0.018992	1.71	12.11	87.87	0.81	0.16
PR Channel w EX	4050	10 YR	20.67	5422.77	5423.12	5423.08	5423.18	0.014017	1.88	11.00	54.99	0.74	0.17
PR Channel w EX	4000	10 YR	20.67	5422.17	5422.48		5422.52	0.012141	1.70	12.19	63.89	0.68	0.14
PR Channel w EX	3950	10 YR	20.67	5421.53	5421.90	5421.84	5421.94	0.011052	1.59	13.02	70.18	0.65	0.13
PR Channel w EX	3900	10 YR	20.67	5420.98	5421.27		5421.31	0.014266	1.70	12.14	71.37	0.73	0.15
PR Channel w EX	3850	10 YR	20.67	5420.39	5420.80	5420.73	5420.82	0.007133	1.26	16.42	90.27	0.52	0.08
PR Channel w EX	3800	10 YR	20.67	5419.85	5420.18	5420.17	5420.25	0.022015	1.98	10.43	67.57	0.89	0.21
PR Channel w EX	3750	10 YR	20.67	5418.83	5419.30	5419.25	5419.35	0.014535	1.88	11.02	56.76	0.75	0.18
PR Channel w EX	3700	10 YR	20.67	5417.94	5418.42	5418.40	5418.48	0.020644	2.03	10.16	60.31	0.87	0.22
PR Channel w EX	3650	10 YR	20.67	5416.94	5417.23	5417.21	5417.28	0.027732	1.82	11.36	99.62	0.95	0.20
PR Channel w EX	3600	10 YR	20.67	5415.54	5415.83	5415.83	5415.90	0.027141	2.19	9.44	61.64	0.99	0.26
PR Channel w EX	3550	10 YR	20.67	5414.52	5414.82	5414.76	5414.87	0.011680	1.84	11.23	50.50	0.69	0.16
PR Channel w EX	3500	10 YR	20.67	5413.69	5413.91	5413.91	5413.98	0.029114	2.15	9.63	68.35	1.01	0.26
PR Channel w EX	3450	10 YR	20.67	5412.61	5412.99		5413.02	0.007461	1.42	14.51	68.57	0.55	0.10
PR Channel w EX	3400	10 YR	38.19	5411.86	5412.20	5412.20	5412.30	0.023396	2.51	15.19	72.11	0.97	0.31
PR Channel w EX	3350	10 YR	38.19	5411.23	5411.67		5411.71	0.006725	1.63	23.47	84.00	0.54	0.12
PR Channel w EX	3300	10 YR	38.19	5410.86	5411.38		5411.42	0.005267	1.54	24.76	79.92	0.49	0.10
PR Channel w EX	3250	10 YR	38.19	5408.73	5410.74	5410.74	5410.93	0.021639	3.41	11.20	68.06	1.01	0.48
PR Channel w EX	3225		Culvert										
PR Channel w EX	3150	10 YR	38.19	5408.50	5409.28	5409.28	5409.58	0.019755	4.44	8.60	14.70	1.02	0.69
PR Channel w EX	3100	10 YR	38.19	5407.06	5407.81		5407.84	0.005171	1.40	27.33	100.90	0.47	0.09
PR Channel w EX	3050	10 YR	38.19	5407.04	5407.54		5407.58	0.005276	1.56	24.46	77.63	0.49	0.10
PR Channel w EX	3000	10 YR	38.19	5406.60	5406.96	5406.96	5407.08	0.024526	2.80	13.64	57.13	1.01	0.37
PR Channel w EX	2950	10 YR	38.19	5404.92	5405.61	5405.59	5405.73	0.018444	2.78	13.76	47.08	0.91	0.34
PR Channel w EX	2900	10 YR	38.19	5403.66	5404.51	5404.51	5404.68	0.024056	3.36	11.36	35.57	1.05	0.48
PR Channel w EX	2850	10 YR	38.19	5402.27	5403.35	5403.35	5403.53	0.022015	3.45	11.06	31.04	1.02	0.49
PR Channel w EX	2800	10 YR	38.19	5400.99	5401.94	5401.94	5402.09	0.025467	3.02	12.64	48.28	1.04	0.41
PR Channel w EX	2750	10 YR	38.19	5399.72	5400.37	5400.37	5400.59	0.019664	3.77	10.12	22.89	1.00	0.54
PR Channel w EX	2700	10 YR	38.19	5399.21	5399.81		5399.82	0.001108	1.01	37.84	71.64	0.24	0.04
PR Channel w EX	2650	10 YR	38.19	5399.21	5399.57	5399.55	5399.68	0.017405	2.54	15.02	56.15	0.87	0.29
PR Channel w EX	2600	10 YR	38.19	5398.06	5398.53	5398.53	5398.65	0.024343	2.88	13.25	52.79	1.01	0.38
PR Channel w EX	2550	10 YR	38.19	5396.34	5396.89	5396.89	5397.06	0.021836	3.34	11.42	33.56	1.01	0.46
PR Channel w EX	2500	10 YR	38.19	5394.48	5395.10		5395.15	0.004664	1.72	22.17	55.27	0.48	0.12
PR Channel w EX	2450	10 YR	38.19	5394.37	5394.82		5394.85	0.007456	1.53	24.95	105.65	0.56	0.11
PR Channel w EX	2400	10 YR	38.19	5394.18	5394.69		5394.70	0.001558	0.89	42.89	126.59	0.27	0.03
PR Channel w EX	2350	10 YR	38.19	5394.18	5394.63		5394.63	0.001068	0.72	53.07	162.46	0.22	0.02
PR Channel w EX	2300	10 YR	38.19	5394.18	5394.57		5394.58	0.001204	0.75	50.61	157.92	0.23	0.02
PR Channel w EX	2250	10 YR	38.19	5393.01	5394.31	5394.31	5394.41	0.029729	2.53	15.12	85.01	1.06	0.33
PR Channel w EX	2200	10 YR	38.19	5391.94	5392.38	5392.38	5392.48	0.025766	2.61	14.66	70.87	1.01	0.33
PR Channel w EX	2150	10 YR	38.19	5389.65	5390.79	5390.79	5391.04	0.020483	4.03	9.47	19.86	1.03	0.60
PR Channel w EX	2100	10 YR	38.19	5388.87	5390.51		5390.54	0.001442	1.35	28.20	41.70	0.29	0.06
PR Channel w EX	2050	10 YR	38.19	5389.86	5390.27	5390.27	5390.35	0.027864	2.24	17.05	109.72	1.00	0.27
PR Channel w EX	2000	10 YR	38.19	5386.96	5388.29	5388.26	5388.49	0.017524	3.54	10.79	24.42	0.94	0.48
PR Channel w EX	1950	10 YR	38.19	5385.84	5387.36	5387.36	5387.53	0.020740	3.32	11.50	32.37	0.98	0.45
PR Channel w EX	1900	10 YR	38.19	5385.10	5386.61		5386.68	0.007099	2.15	17.73	43.19	0.59	0.18
PR Channel w EX	1850	10 YR	38.19	5384.15	5385.91	5385.88	5386.14	0.017189	3.87	9.86	18.66	0.94	0.54
PR Channel w EX	1800	10 YR	38.19	5383.39	5384.94	5384.94	5385.18	0.022078	3.96	9.63	21.61	1.05	0.60
PR Channel w EX	1750	10 YR	38.19	5382.66	5384.20		5384.28	0.010507	2.25	16.97	51.74	0.69	0.21
PR Channel w EX	1700	10 YR	38.19	5381.94	5383.53	5383.49	5383.62	0.016775	2.38	16.02	63.70	0.84	0.26
PR Channel w EX	1650	10 YR	38.19	5381.09	5382.65	5382.61	5382.76	0.017459	2.62	14.56	51.73	0.87	0.30
PR Channel w EX	1600	10 YR	38.19	5380.66	5382.08		5382.15	0.008919	2.13	17.97	52.79	0.64	0.19
PR Channel w EX	1550	10 YR	38.19	5379.85	5381.25	5381.25	5381.39	0.031282	3.03	12.60	55.72	1.12	0.44
PR Channel w EX	1500	10 YR	38.19	5379.19	5380.67		5380.71	0.006121	1.72	22.20	67.79	0.53	0.12
PR Channel w EX	1450	10 YR	38.19	5378.72	5380.26		5380.34	0.009105	2.26	16.90	46.01	0.66	0.21
PR Channel w EX	1400	10 YR	67.96	5377.94	5379.66		5379.77	0.013048	2.63	25.79	73.16	0.78	0.29
PR Channel w EX	1350	10 YR	67.96	5377.74	5379.06		5379.14	0.012190	2.27	29.93	101.10	0.74	0.22

HEC-RAS Plan: EX-low-n River: PR Channel w EX Reach: PR Channel w EX Profile: 10 YR (Continued)

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	Shear Chan
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
PR Channel w EX	1300	10 YR	67.96	5377.72	5378.42	5378.35	5378.50	0.012916	2.32	29.25	115.91	0.76	0.24
PR Channel w EX	1250	10 YR	67.96	5375.82	5377.54	5377.54	5377.70	0.020321	3.28	20.73	78.16	0.97	0.44
PR Channel w EX	1200	10 YR	67.96	5375.37	5376.89	5376.79	5376.97	0.008622	2.21	30.71	103.46	0.64	0.20
PR Channel w EX	1150	10 YR	67.96	5373.83	5376.19	5376.19	5376.33	0.020942	2.90	23.42	127.72	0.96	0.37
PR Channel w EX	1100	10 YR	67.96	5374.53	5375.15	5375.15	5375.28	0.021068	2.80	24.27	90.39	0.95	0.35
PR Channel w EX	1050	10 YR	67.96	5372.62	5373.43		5373.53	0.007359	2.43	27.93	58.47	0.62	0.22
PR Channel w EX	1000	10 YR	67.96	5372.05	5372.78	5372.78	5372.93	0.022078	3.11	21.84	72.10	1.00	0.42
PR Channel w EX	950	10 YR	67.96	5363.66	5371.46		5371.46	0.000046	0.39	174.98	117.93	0.06	0.00
PR Channel w EX	900	10 YR	67.96	5370.50	5371.26	5371.26	5371.43	0.022413	3.29	20.65	63.37	1.02	0.46
PR Channel w EX	850	10 YR	67.96	5363.67	5365.96		5366.18	0.005132	3.69	18.42	15.02	0.59	0.37
PR Channel w EX	800	10 YR	67.96	5363.51	5365.71		5365.92	0.005257	3.68	18.48	15.51	0.59	0.37
PR Channel w EX	750	10 YR	67.96	5363.16	5365.64		5365.73	0.001927	2.46	27.58	19.66	0.37	0.16
PR Channel w EX	700	10 YR	67.96	5363.03	5365.55		5365.64	0.001706	2.38	28.57	19.64	0.35	0.15
PR Channel w EX	650	10 YR	67.96	5363.27	5365.24		5365.48	0.005527	3.91	17.36	13.53	0.61	0.42
PR Channel w EX	600	10 YR	67.96	5363.06	5365.20		5365.29	0.001798	2.39	28.43	20.68	0.36	0.15
PR Channel w EX	550	10 YR	67.96	5361.10	5365.22		5365.24	0.000259	1.24	55.00	24.34	0.14	0.03
PR Channel w EX	500	10 YR	67.96	5361.07	5365.21		5365.23	0.000231	1.25	54.44	18.60	0.13	0.03
PR Channel w EX	450	10 YR	67.96	5363.05	5364.63	5364.63	5365.14	0.018358	5.76	11.80	11.86	1.02	1.00
PR Channel w EX	400	10 YR	67.96	5360.98	5364.43		5364.47	0.000519	1.58	43.14	22.47	0.20	0.06
PR Channel w EX	350	10 YR	67.96	5360.77	5364.44		5364.44	0.000258	0.74	92.11	92.34	0.13	0.02
PR Channel w EX	300	10 YR	67.96	5359.06	5364.44		5364.44	0.000051	0.39	173.58	134.01	0.06	0.00
PR Channel w EX	250	10 YR	67.96	5363.39	5364.36	5364.28	5364.42	0.010529	1.95	34.83	132.77	0.67	0.17
PR Channel w EX	200	10 YR	67.96	5362.85	5363.49	5363.49	5363.69	0.020158	3.60	18.86	46.64	1.00	0.51
PR Channel w EX	150	10 YR	67.96	5355.69	5358.04	5357.81	5358.46	0.010004	5.18	13.12	9.98	0.80	0.74

HEC-RAS Plan: EX-low-n River: PR Channel w EX Reach: PR Channel w EX Profile: 10 YR

Reach	River Sta	Profile	E.G. US.	W.S. US.	E.G. IC	E.G. OC	Min El Weir Flow	Q Culv Group	Q Weir	Delta WS	Culv Vel US	Culv Vel DS
			(ft)	(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(ft)	(ft/s)	(ft/s)
PR Channel w EX	3225 EX 7'x7'	10 YR	5410.33	5410.74	5410.33	5410.54	5425.01	38.19		1.47	5.60	5.69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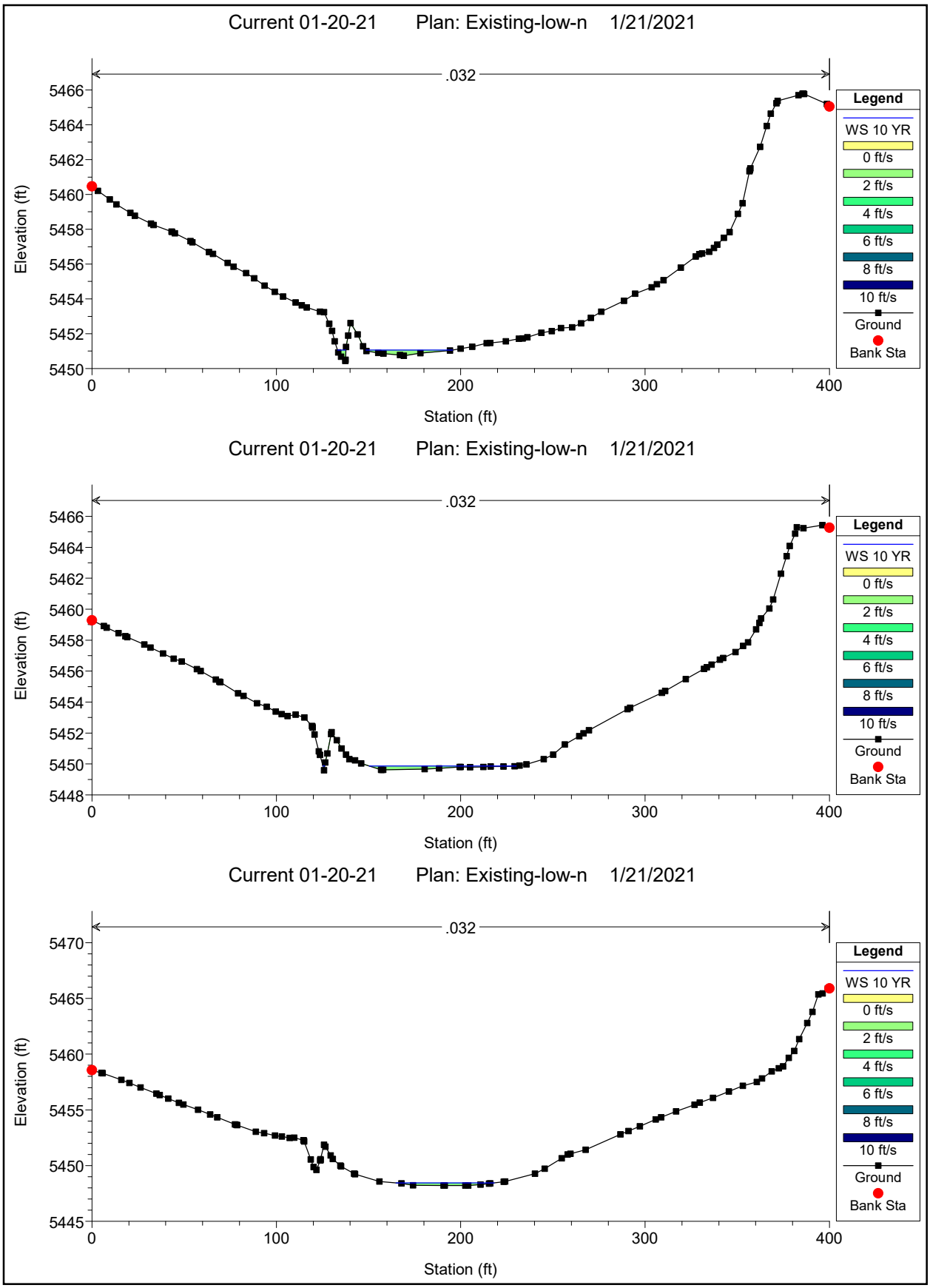
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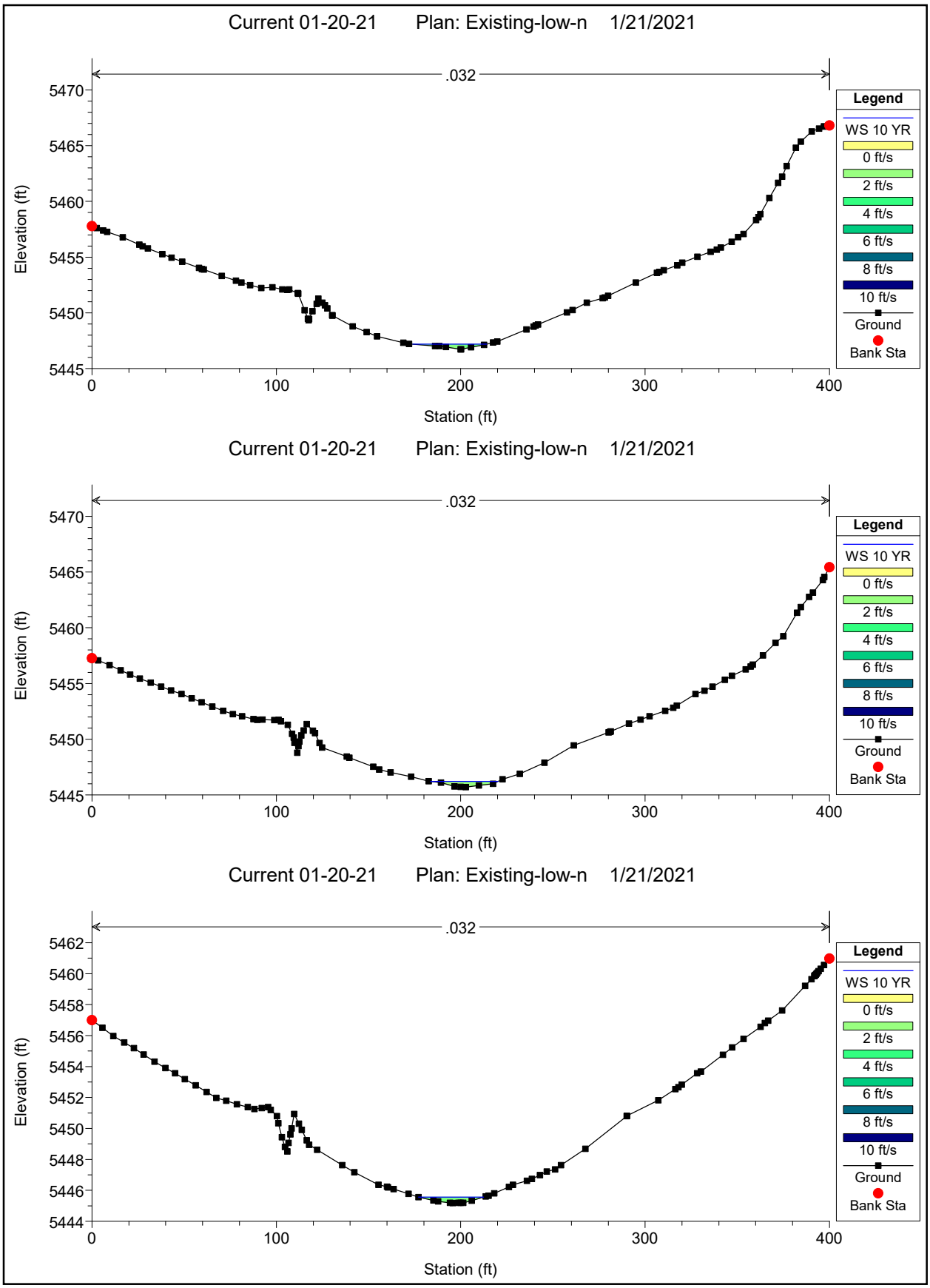
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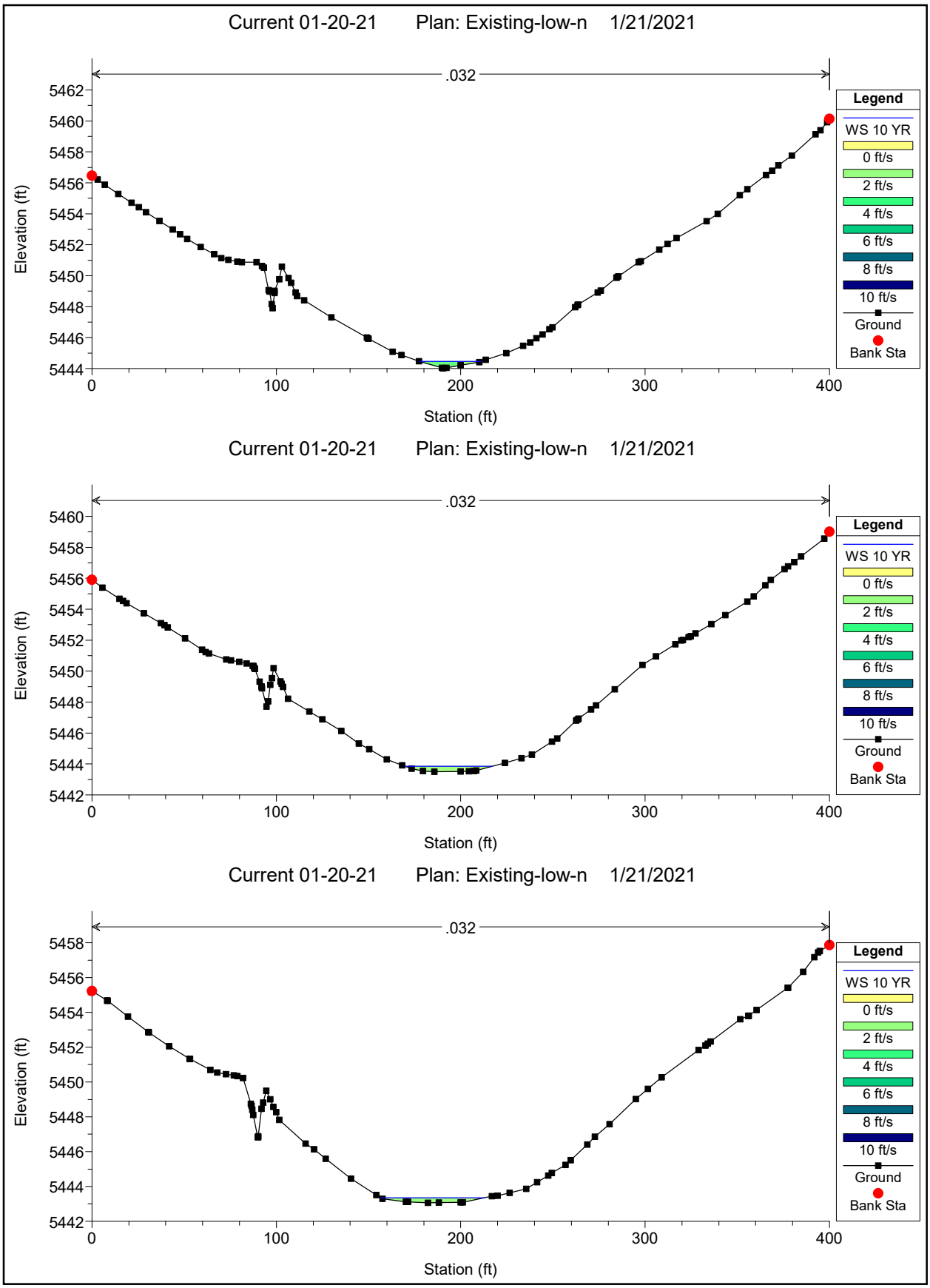
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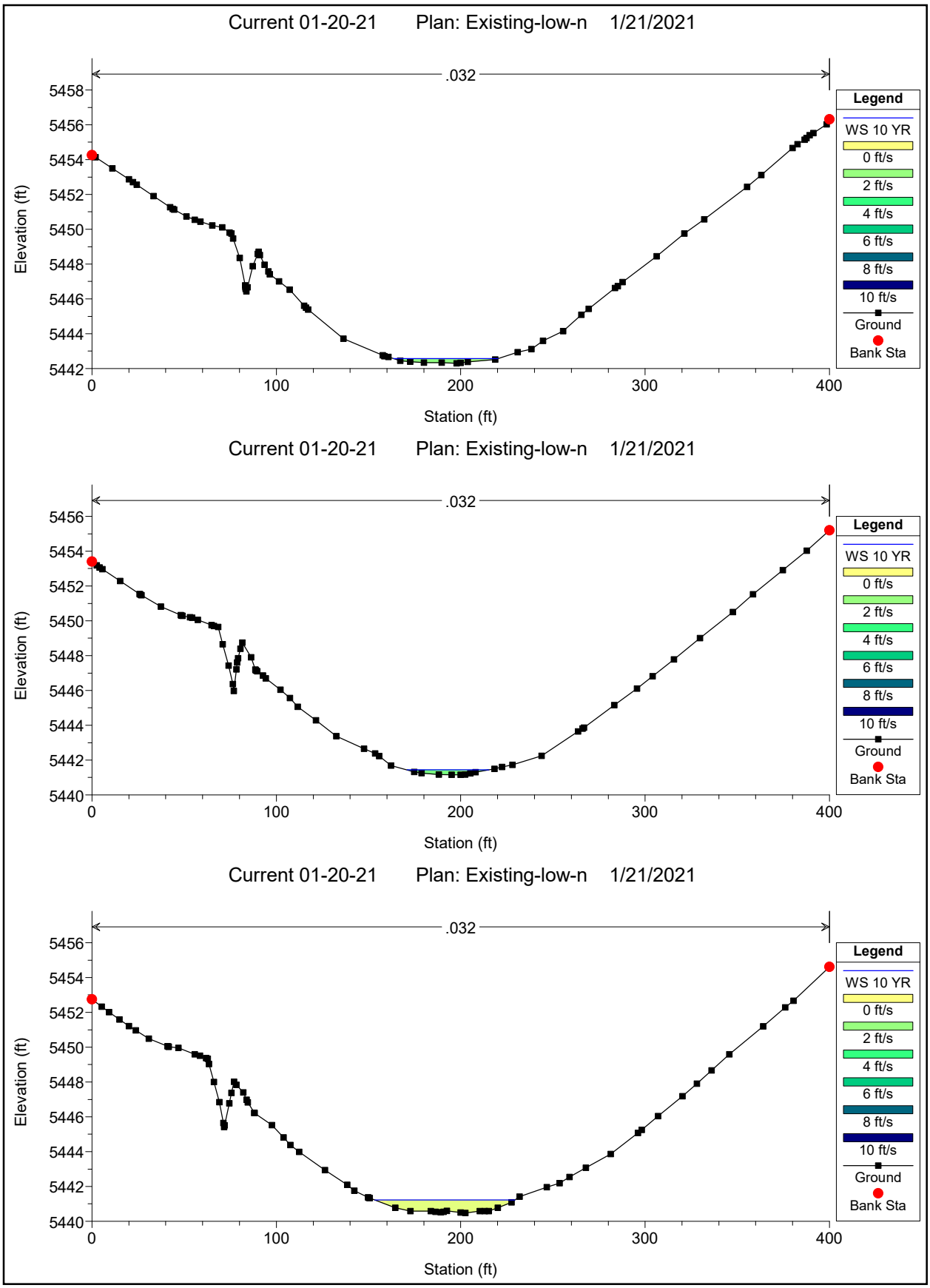
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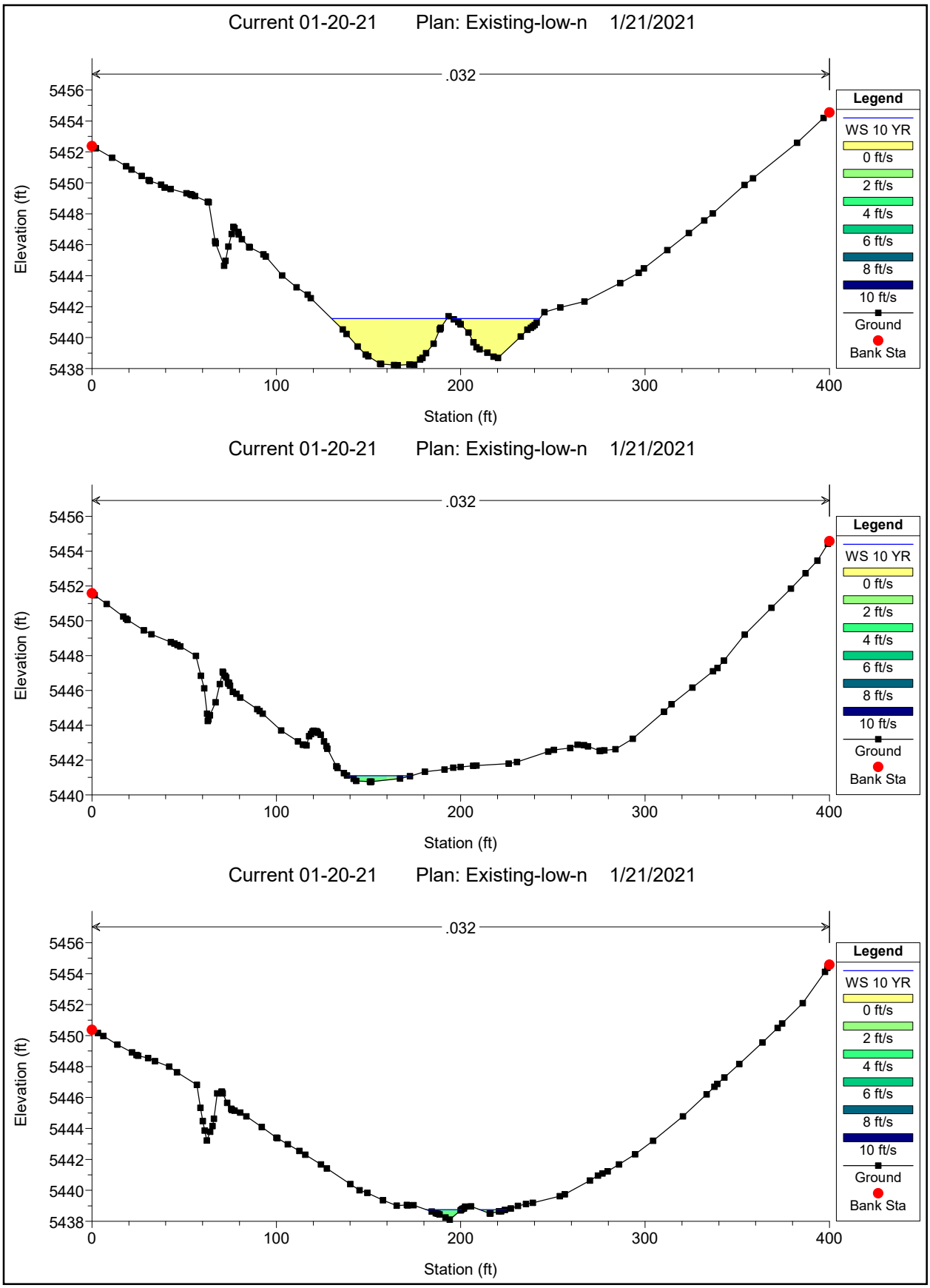
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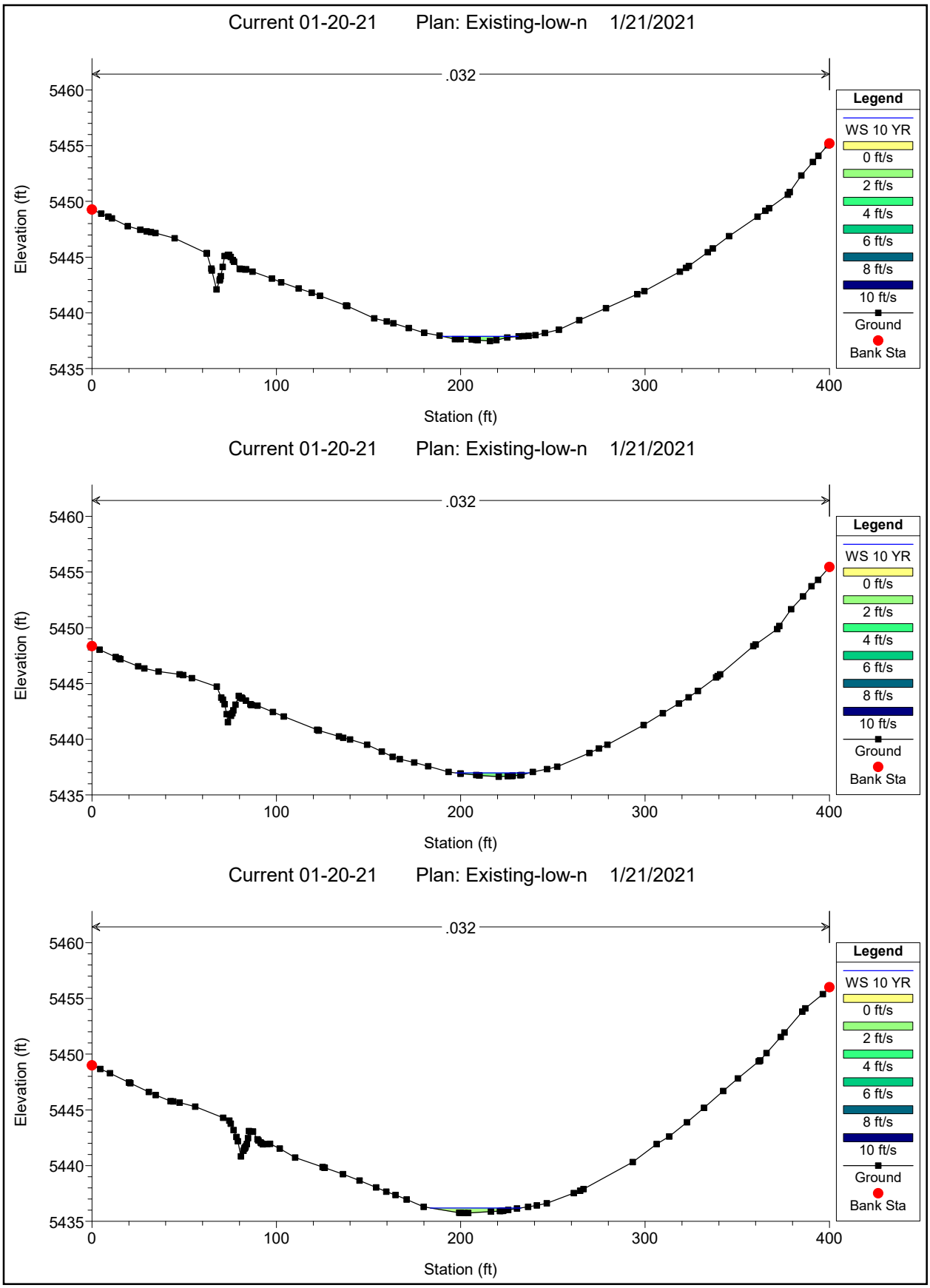
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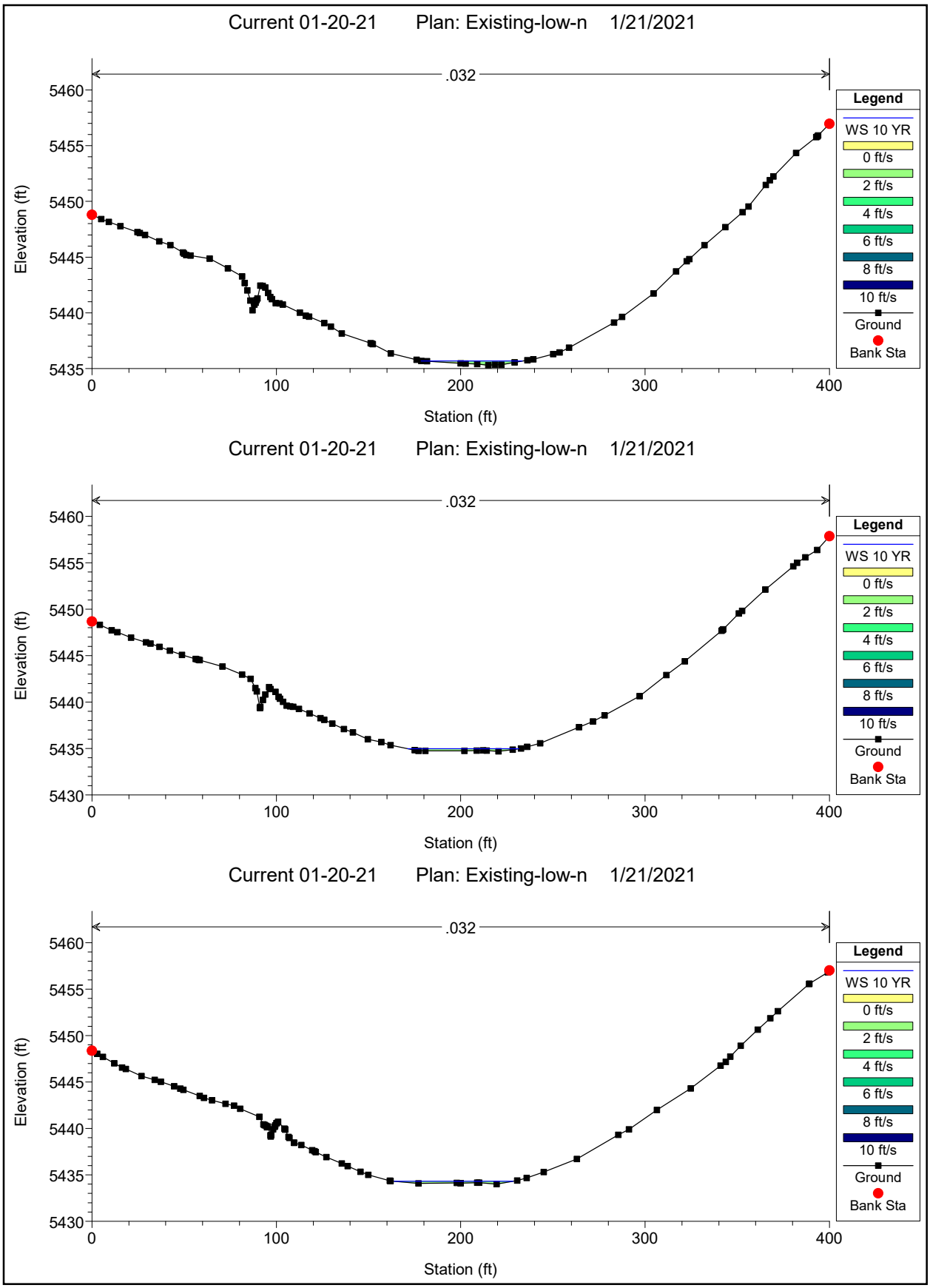
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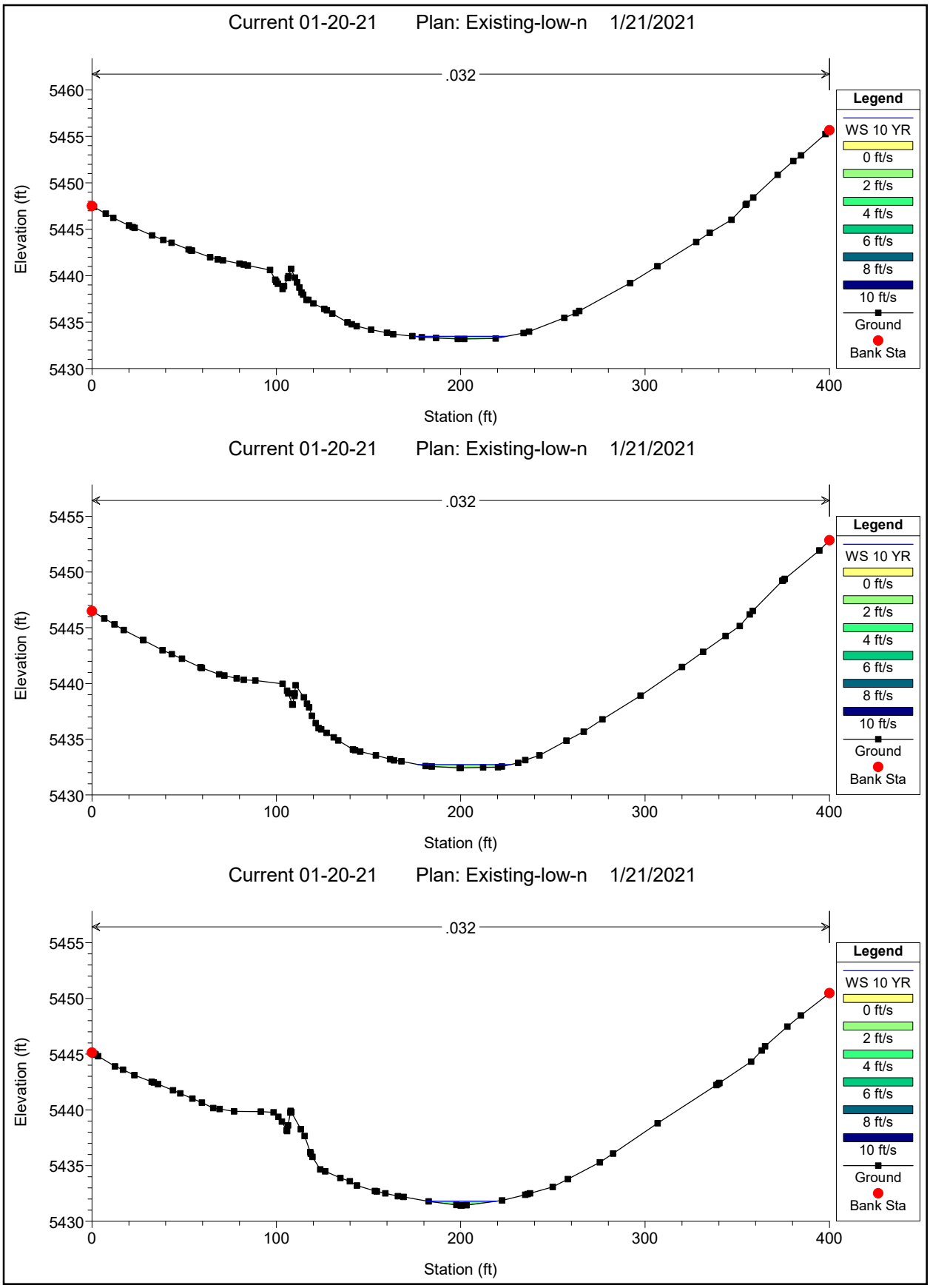
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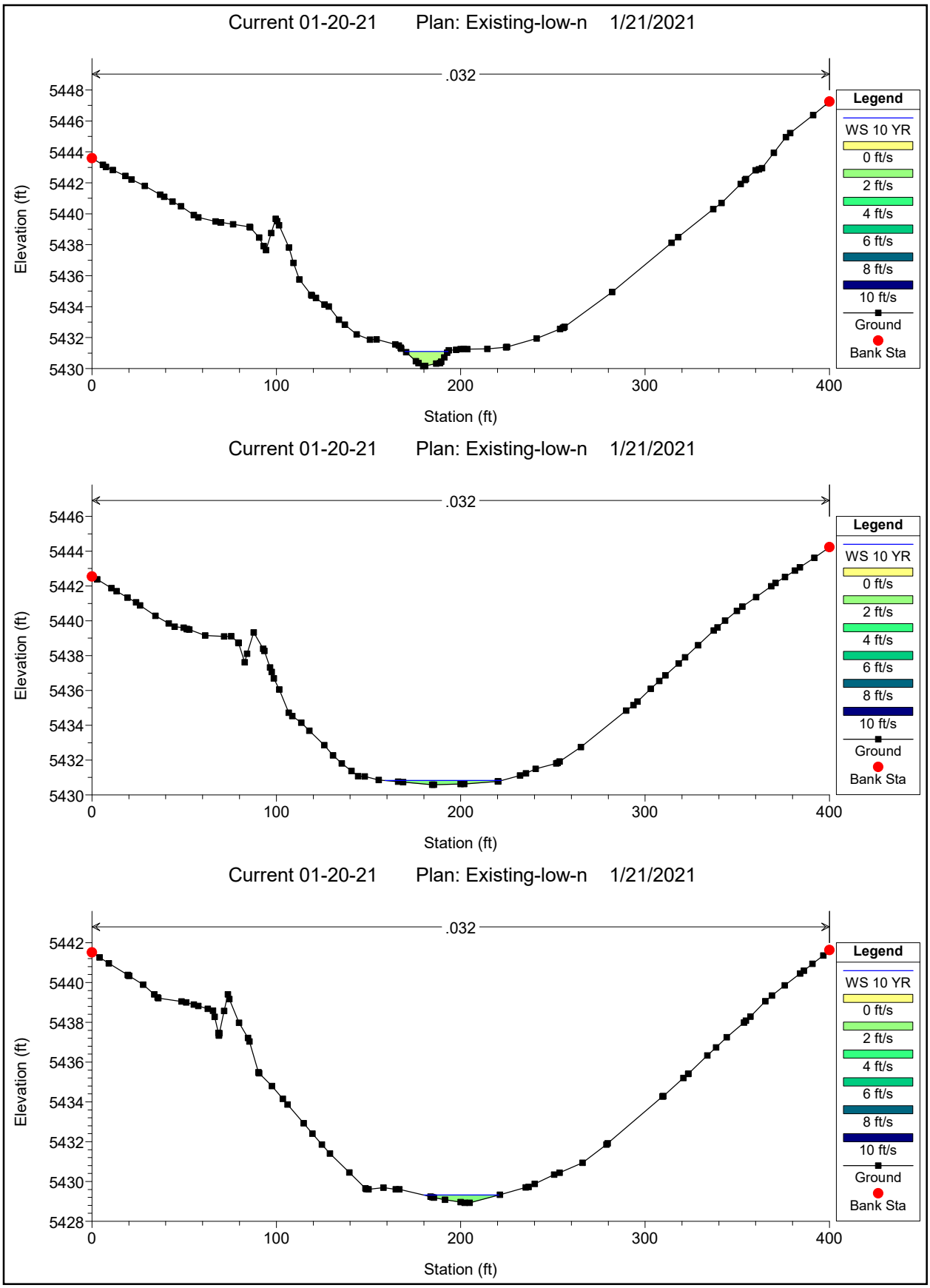
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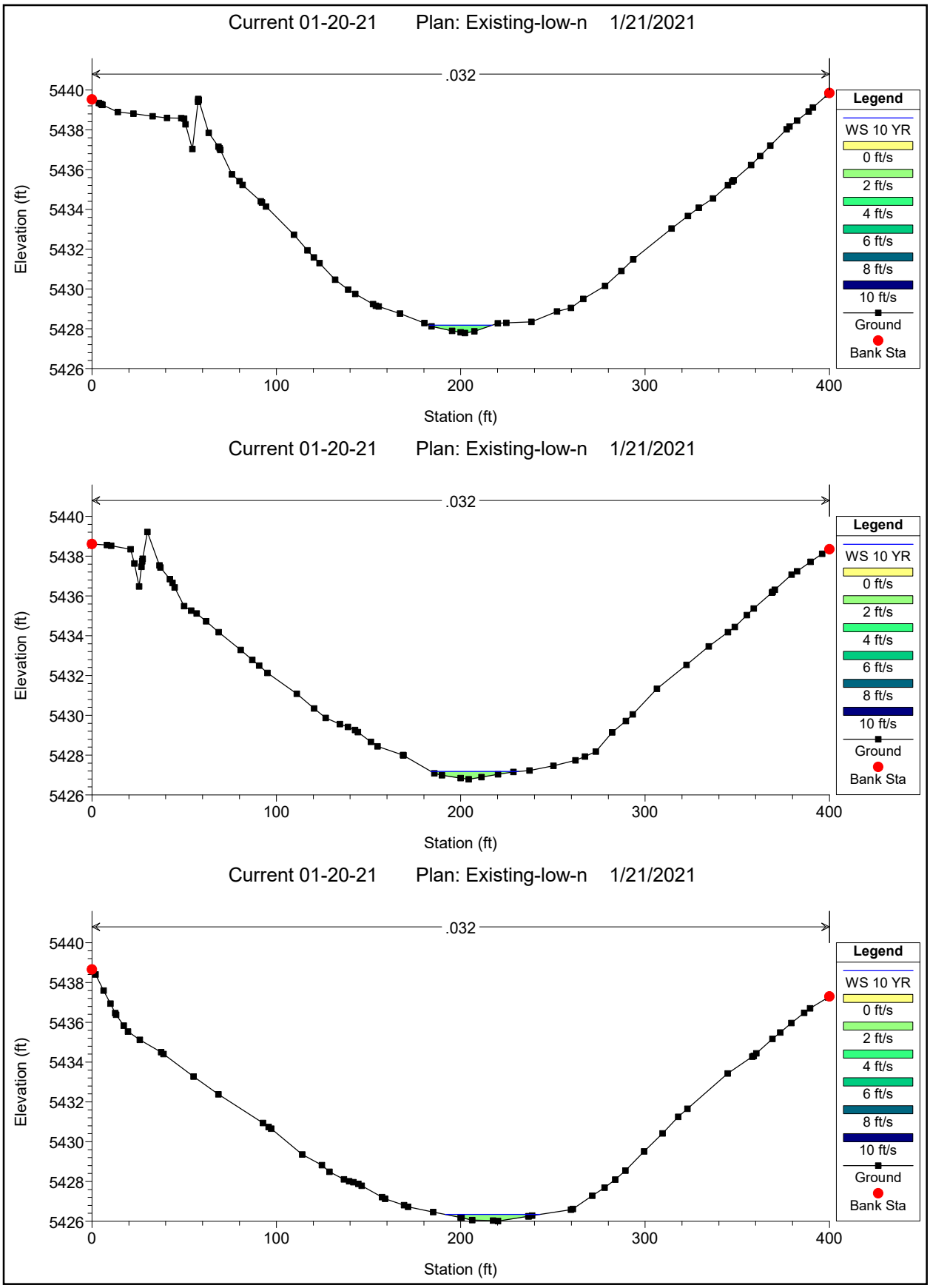
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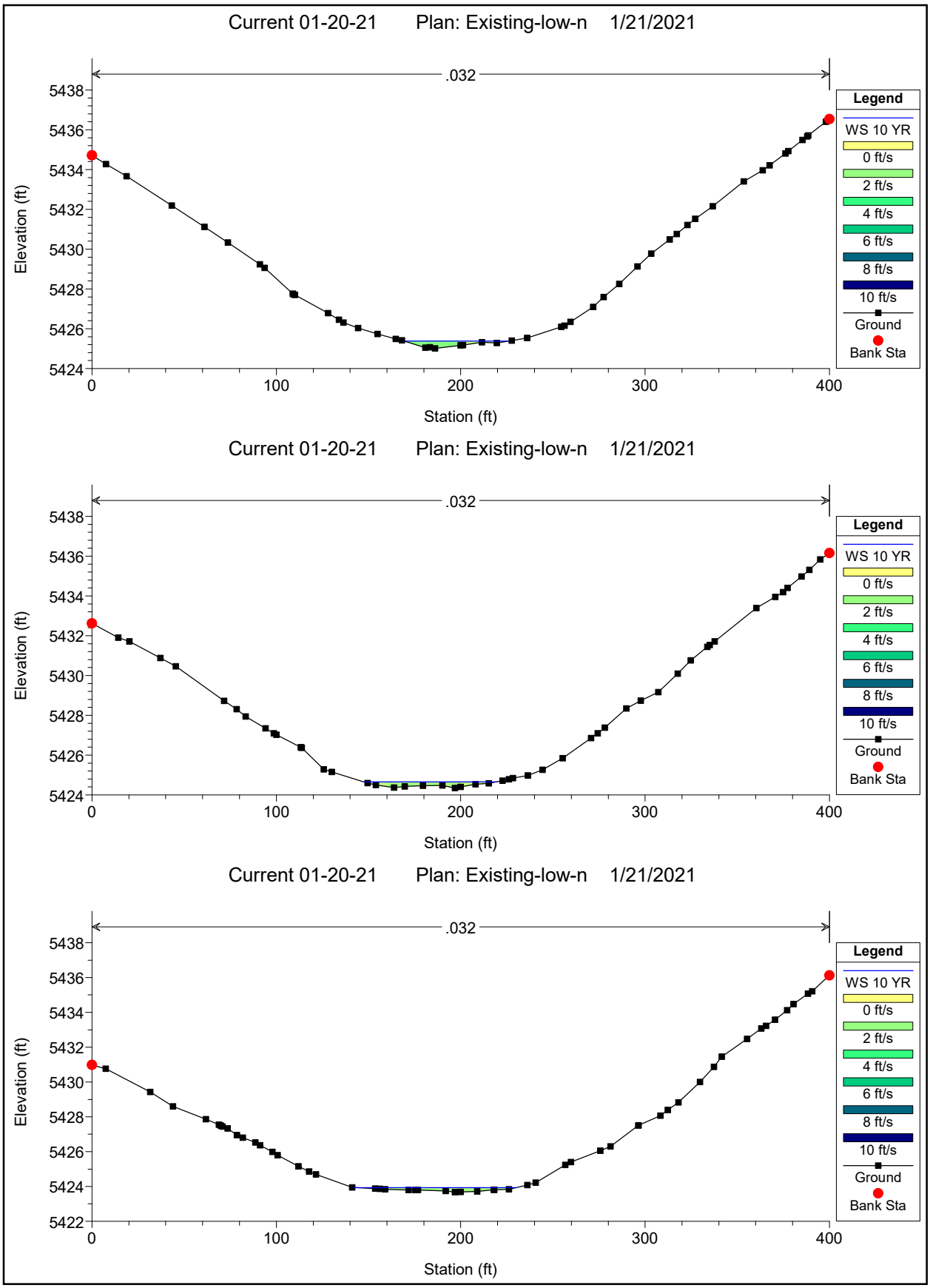
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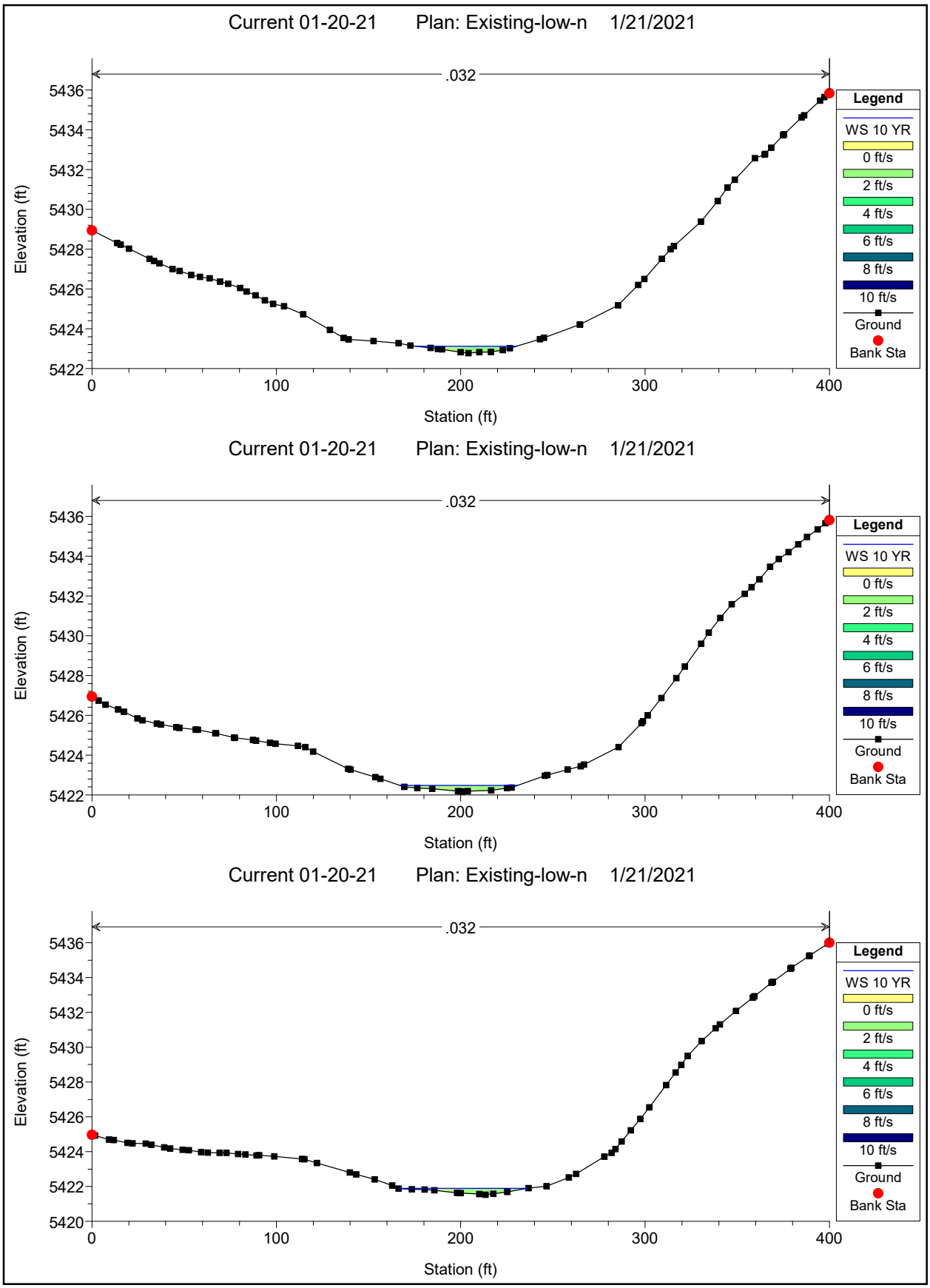
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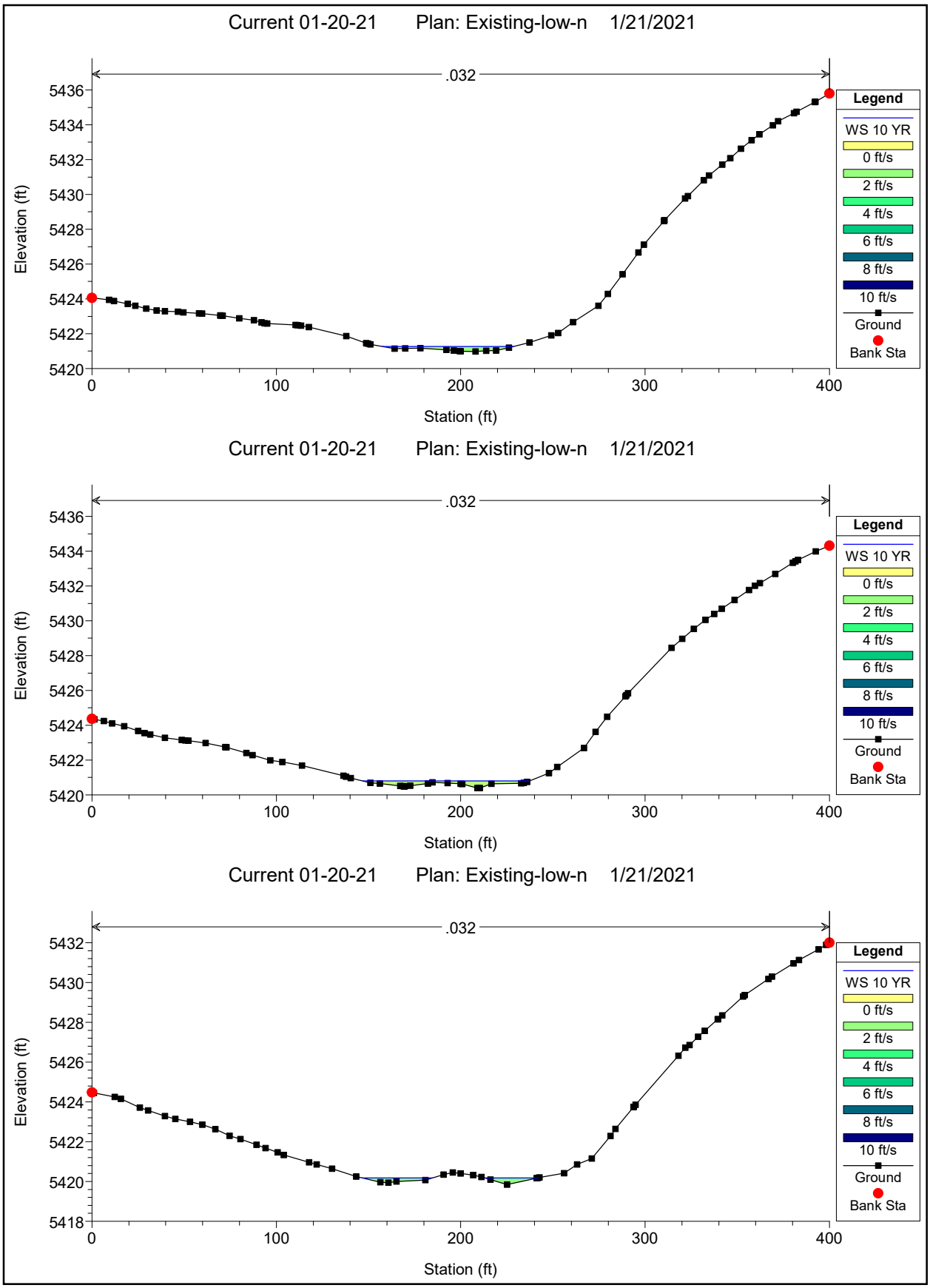
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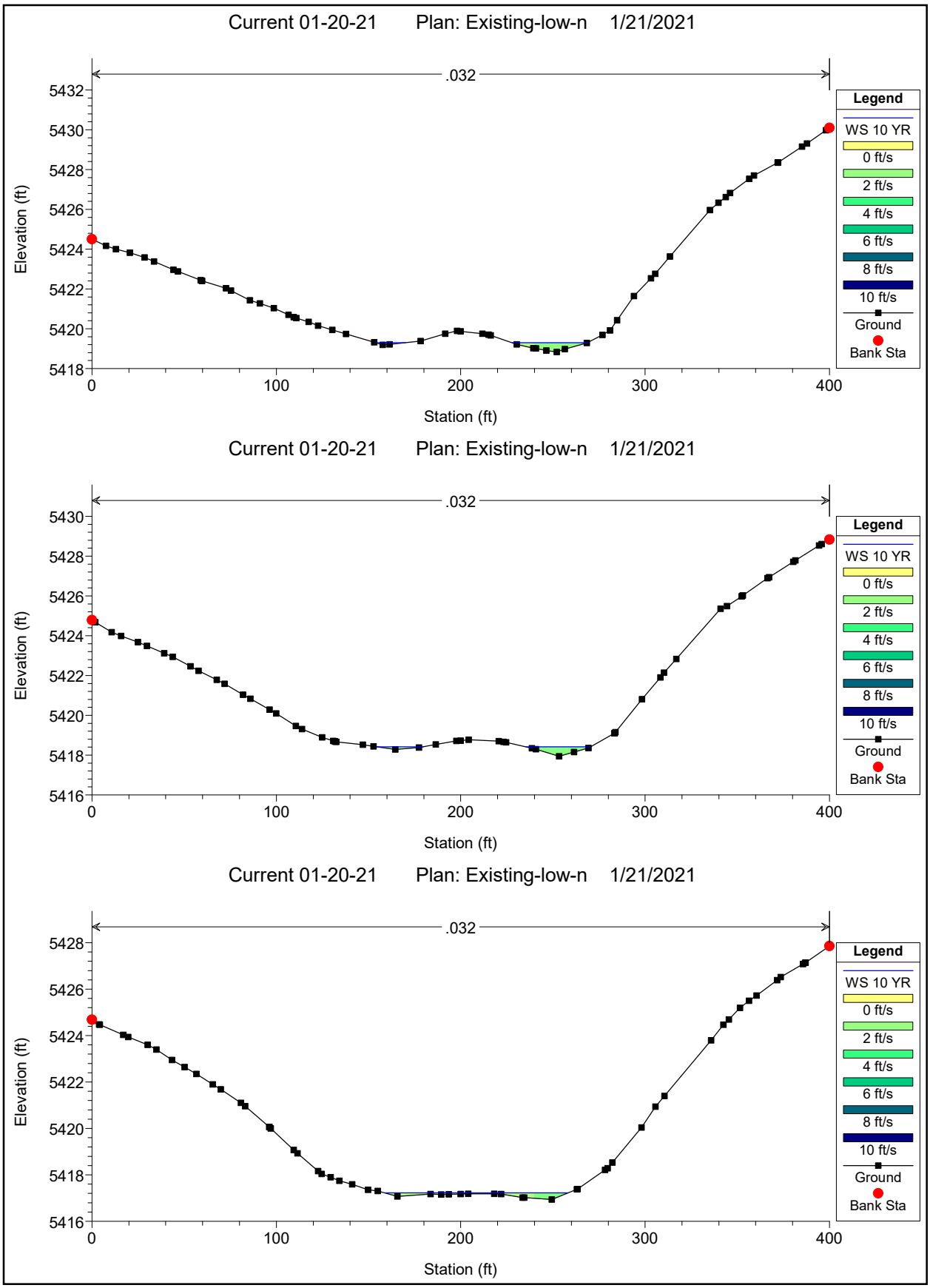
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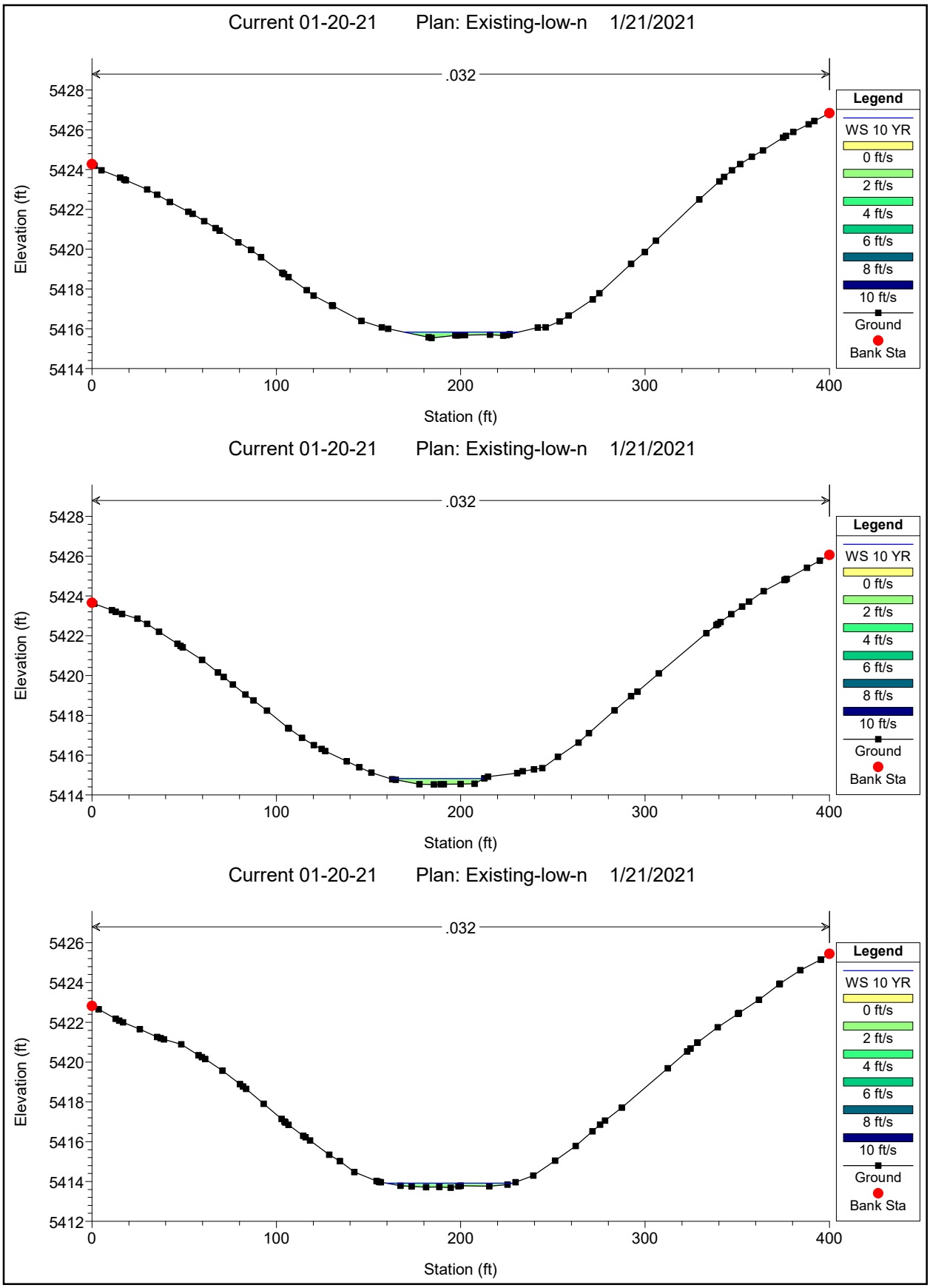
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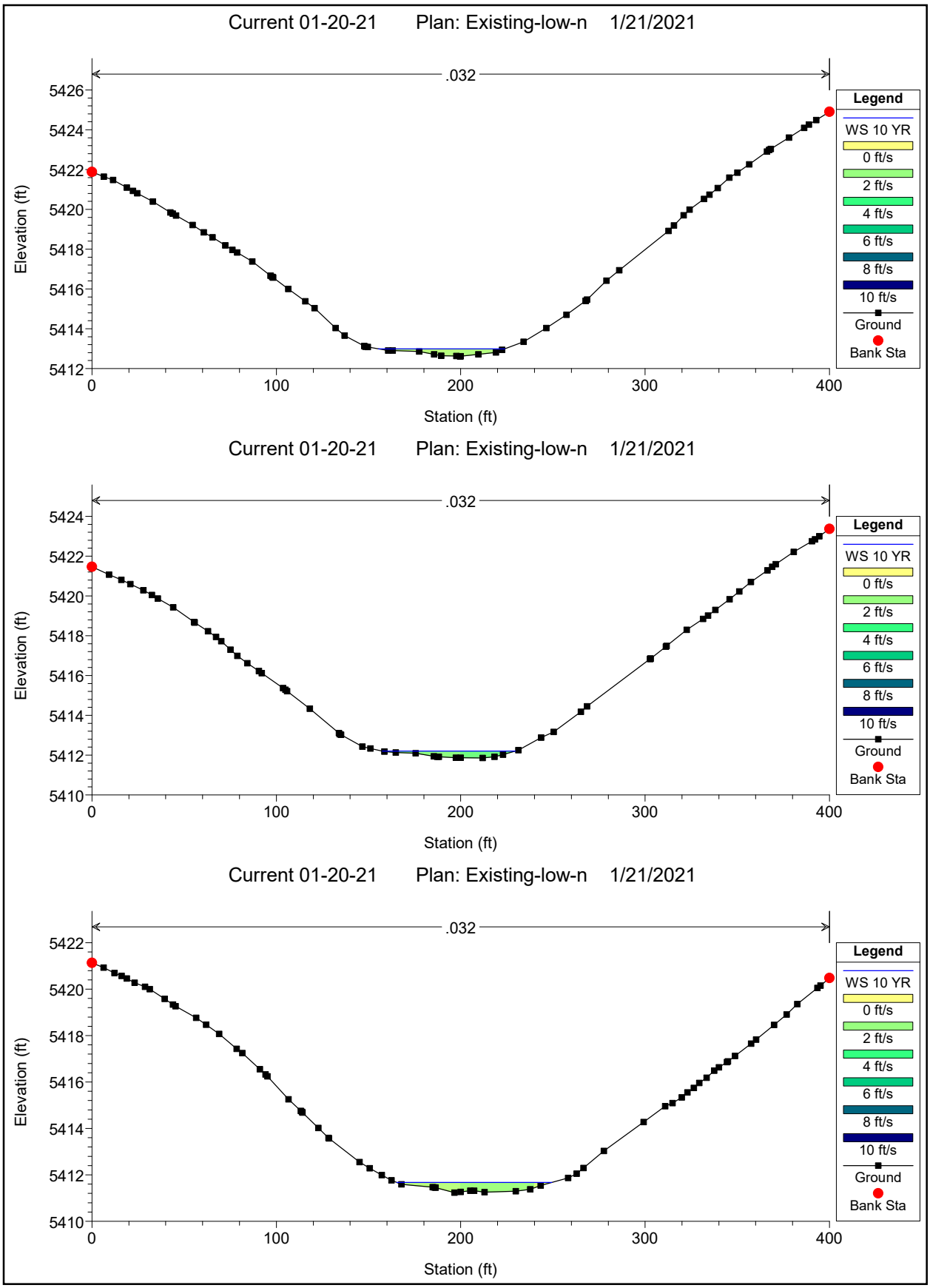
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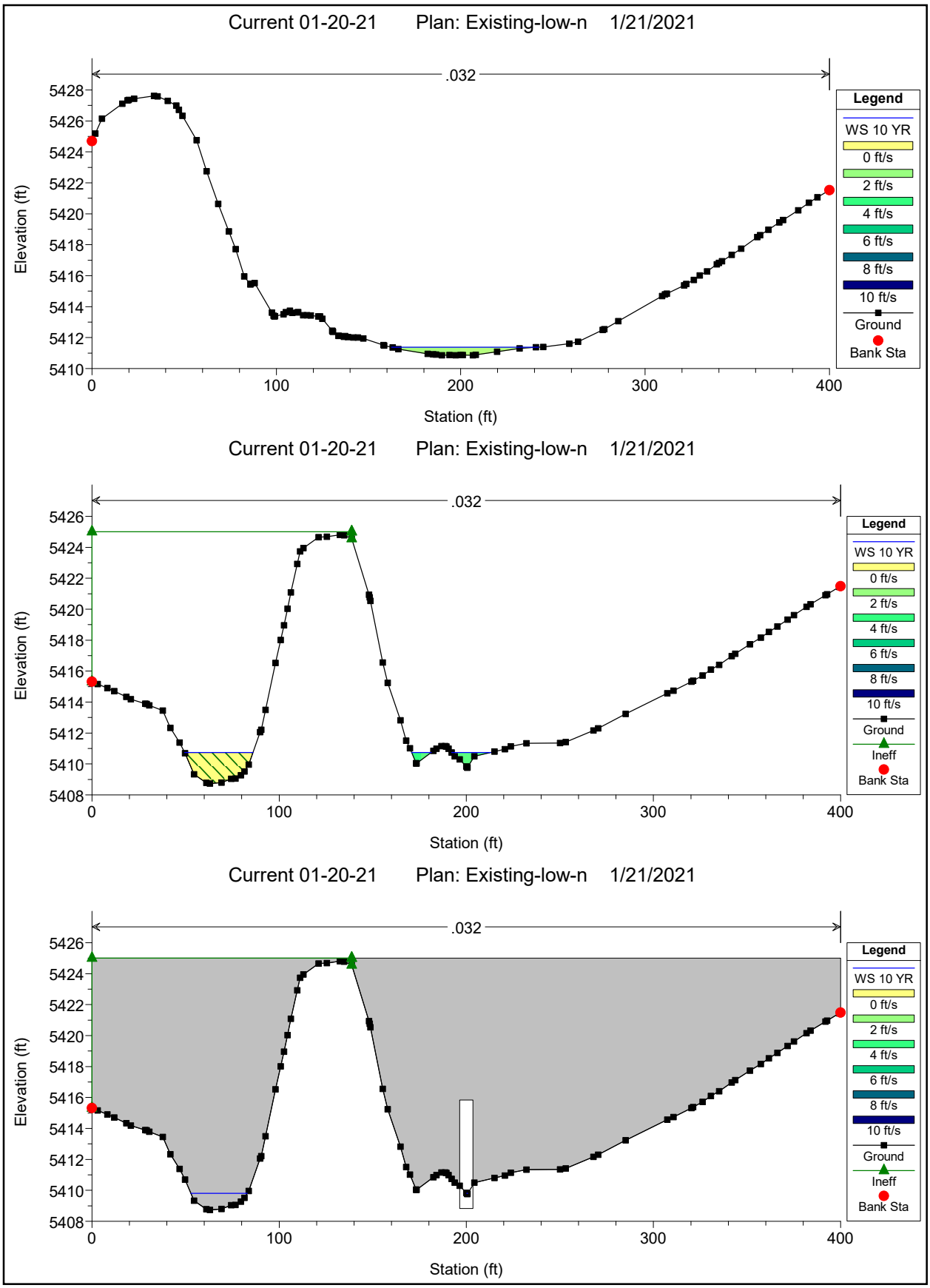
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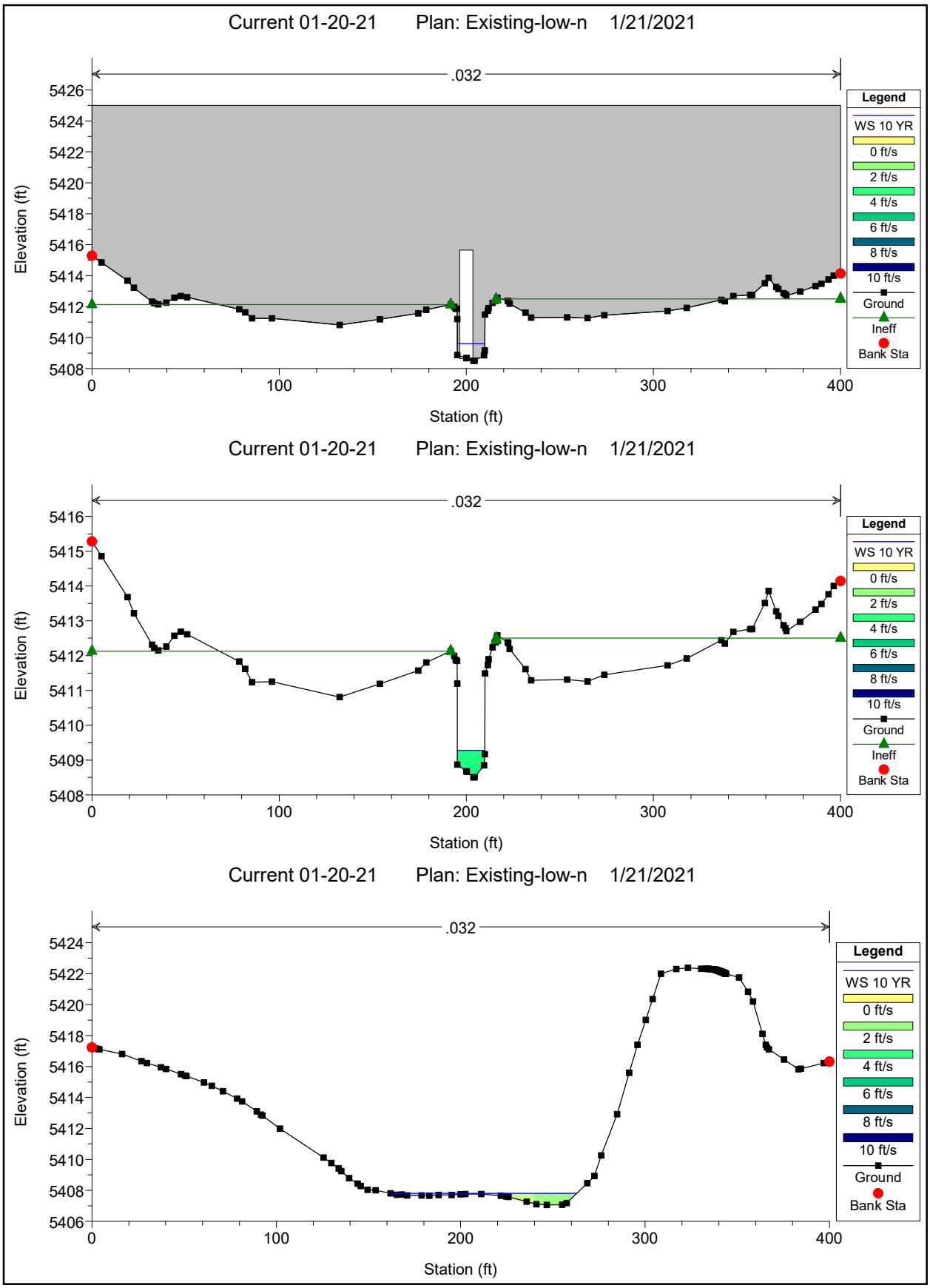
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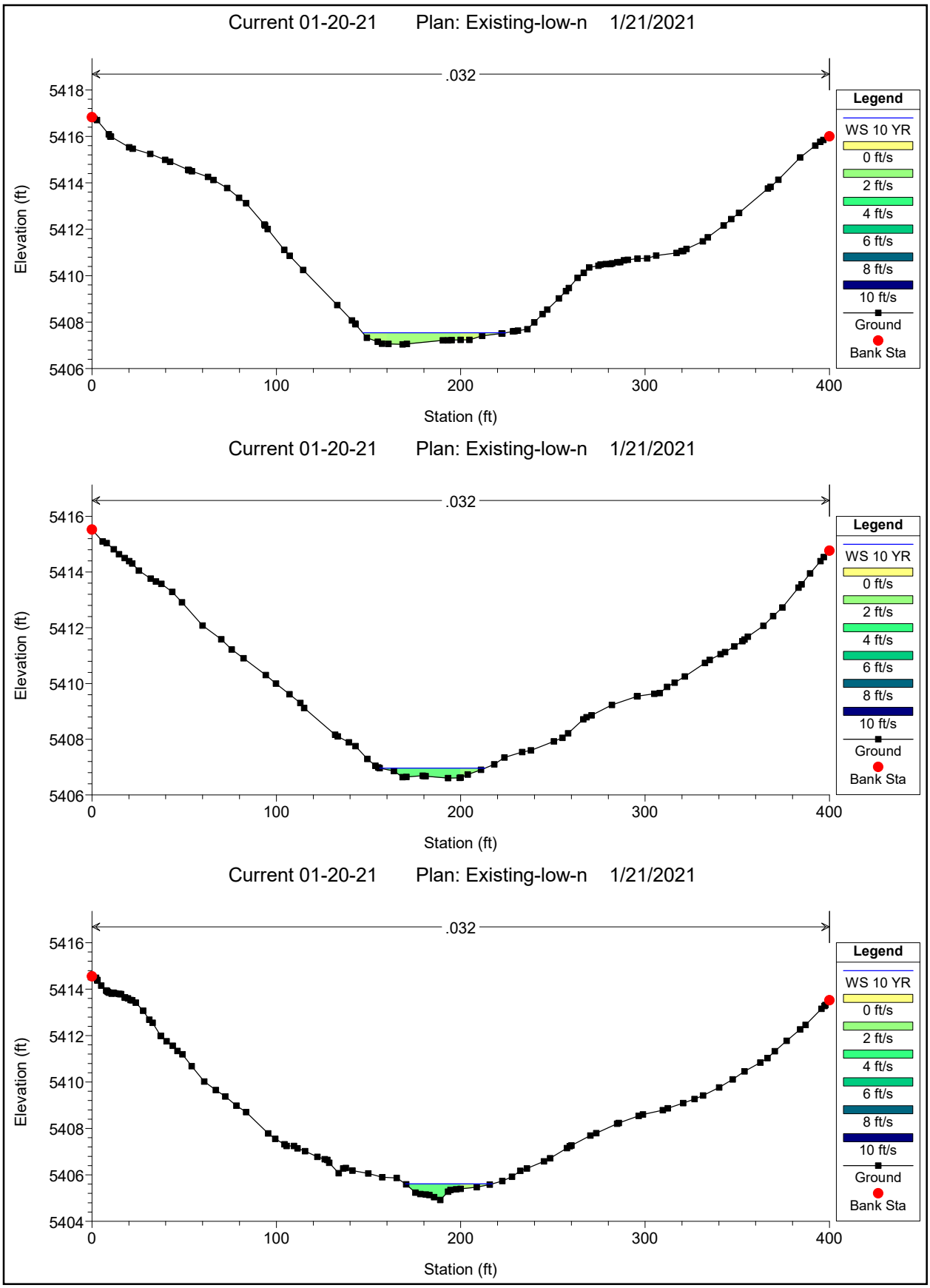
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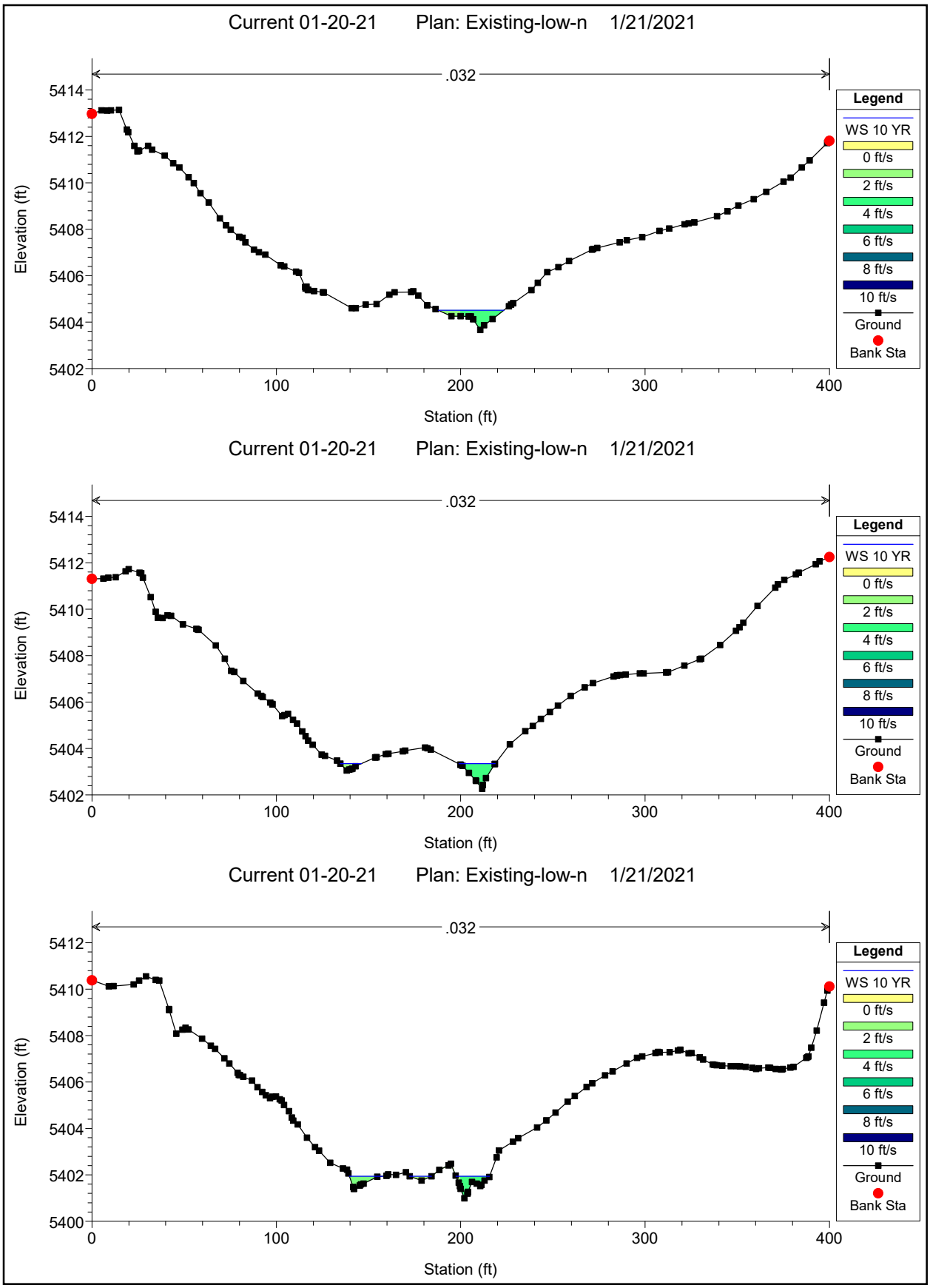
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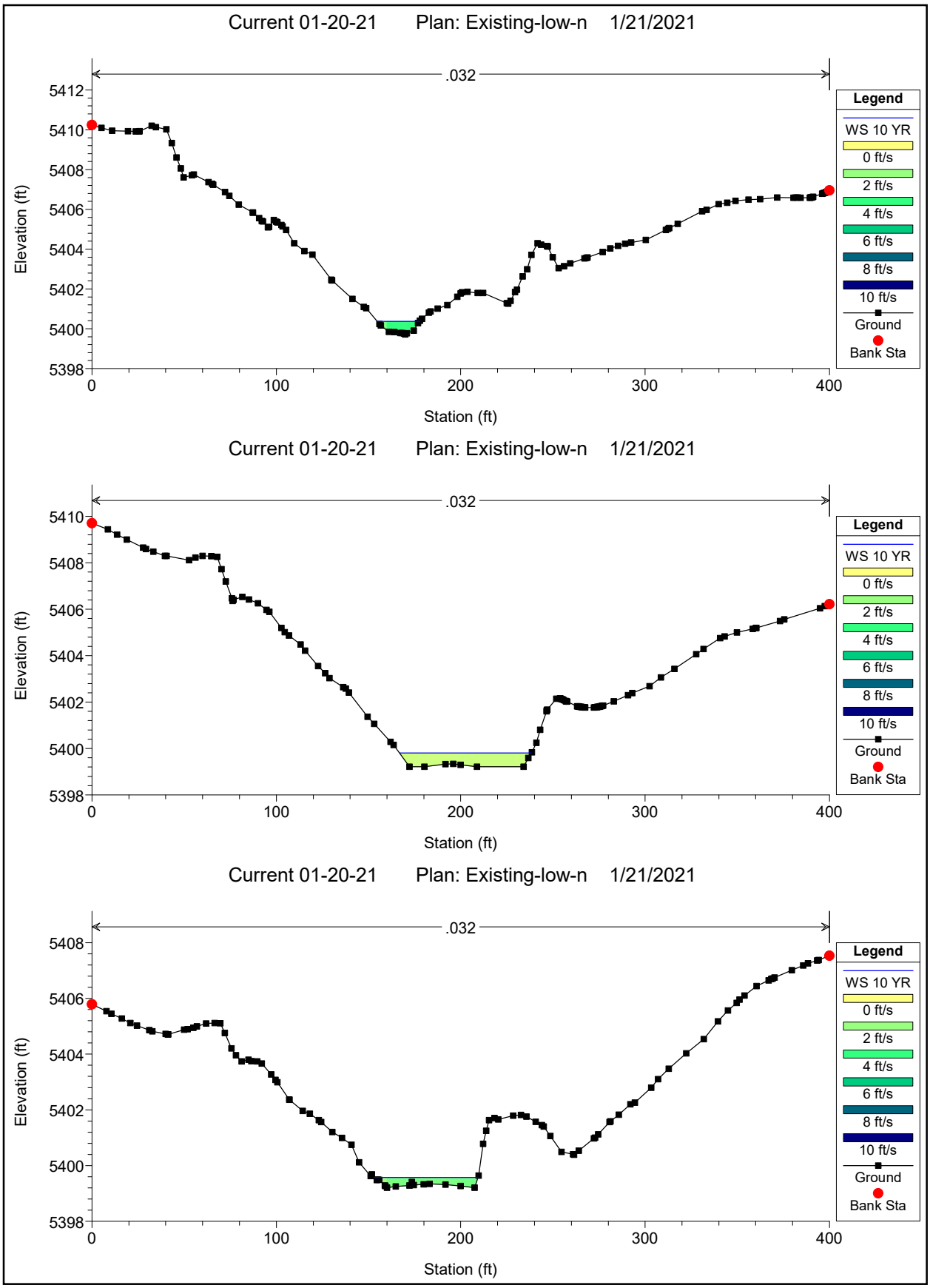
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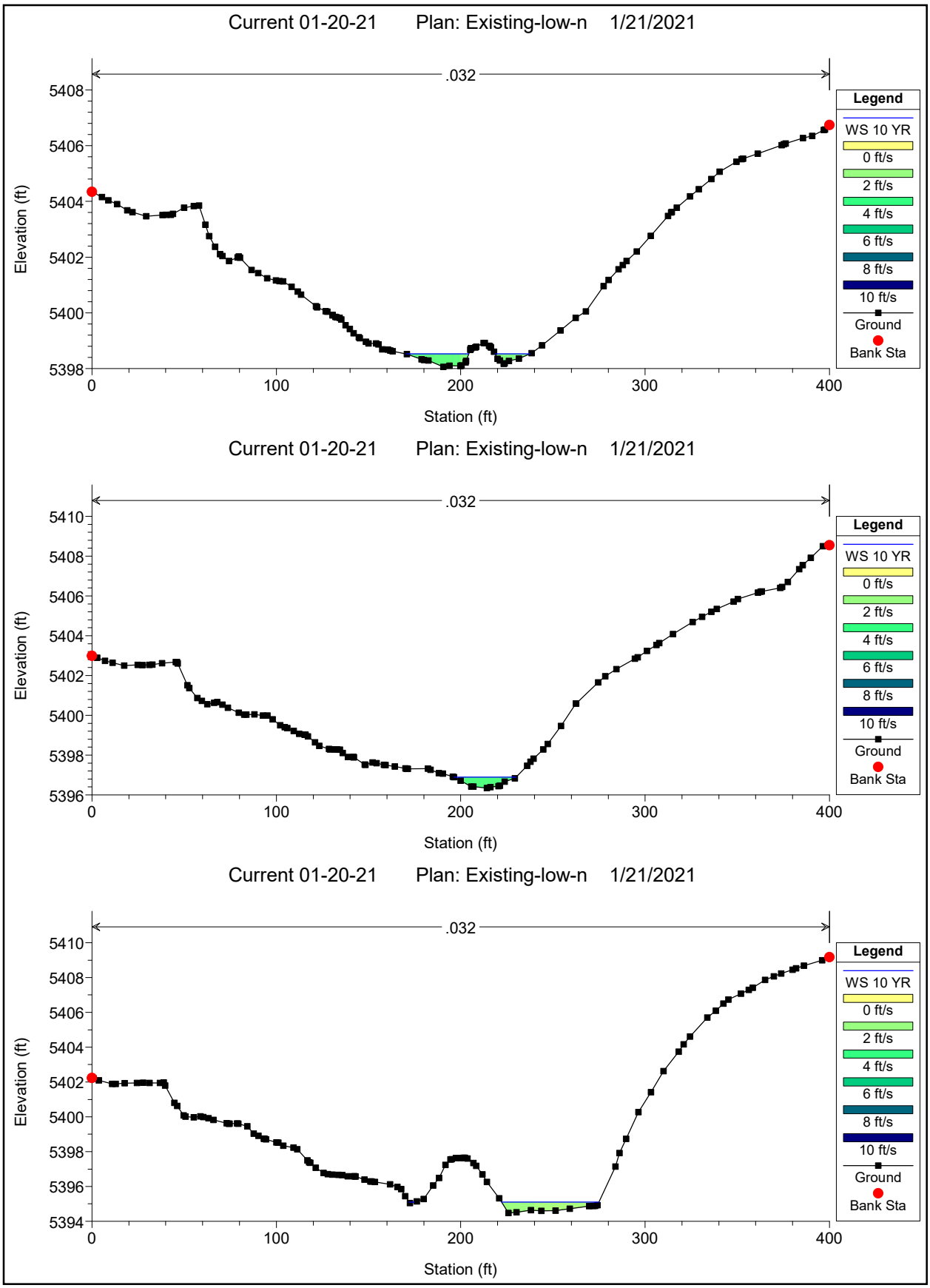
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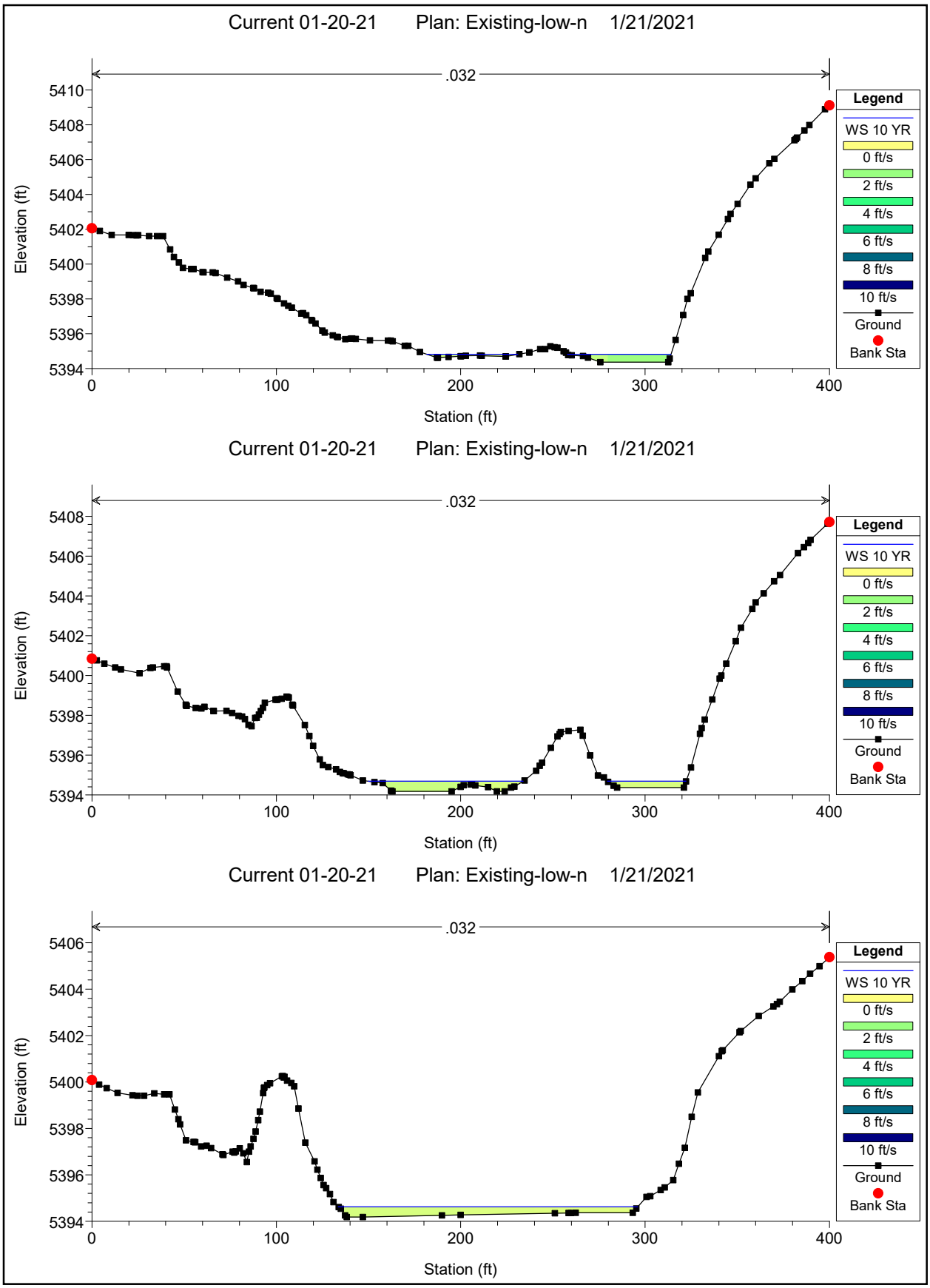
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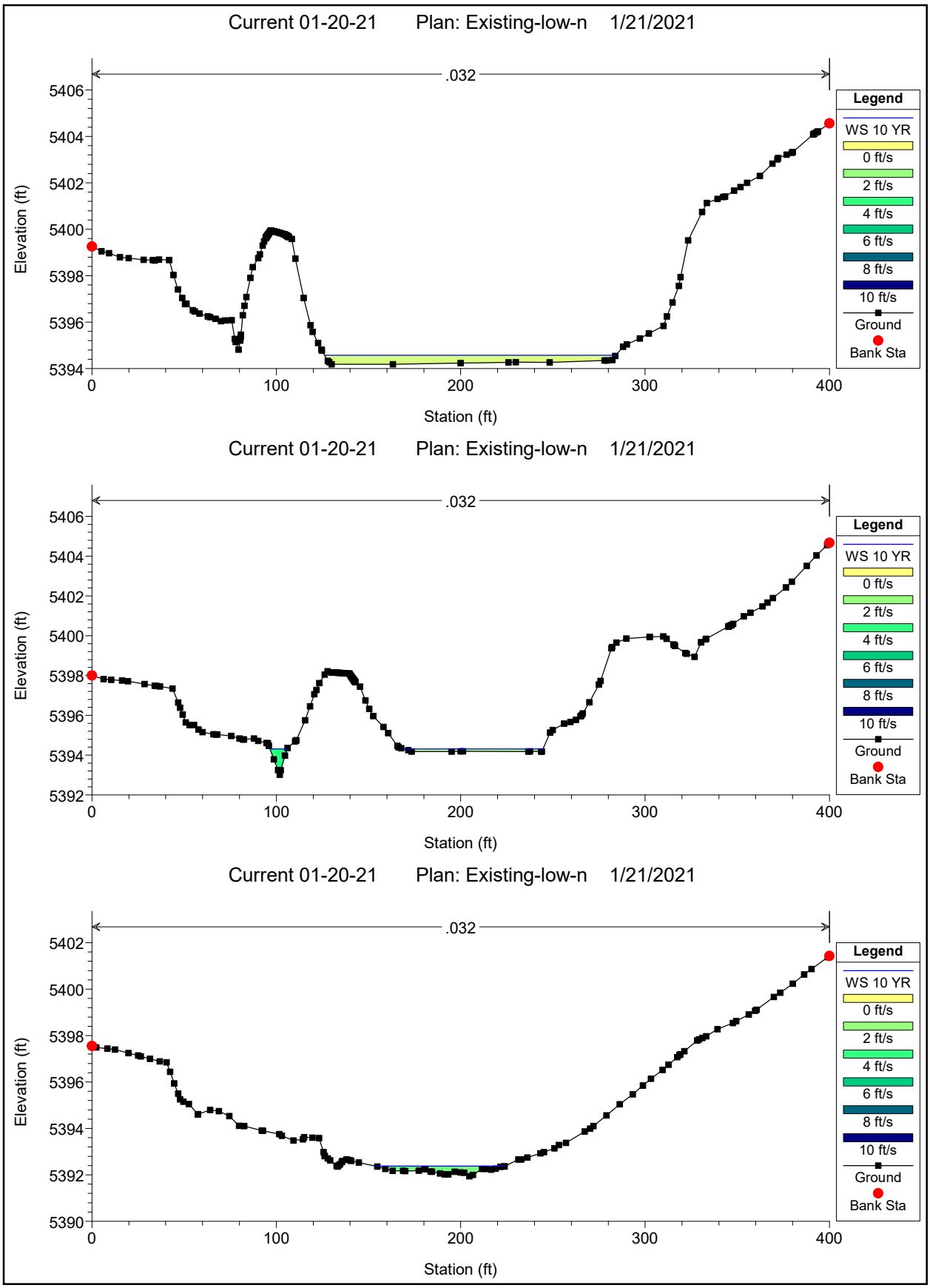
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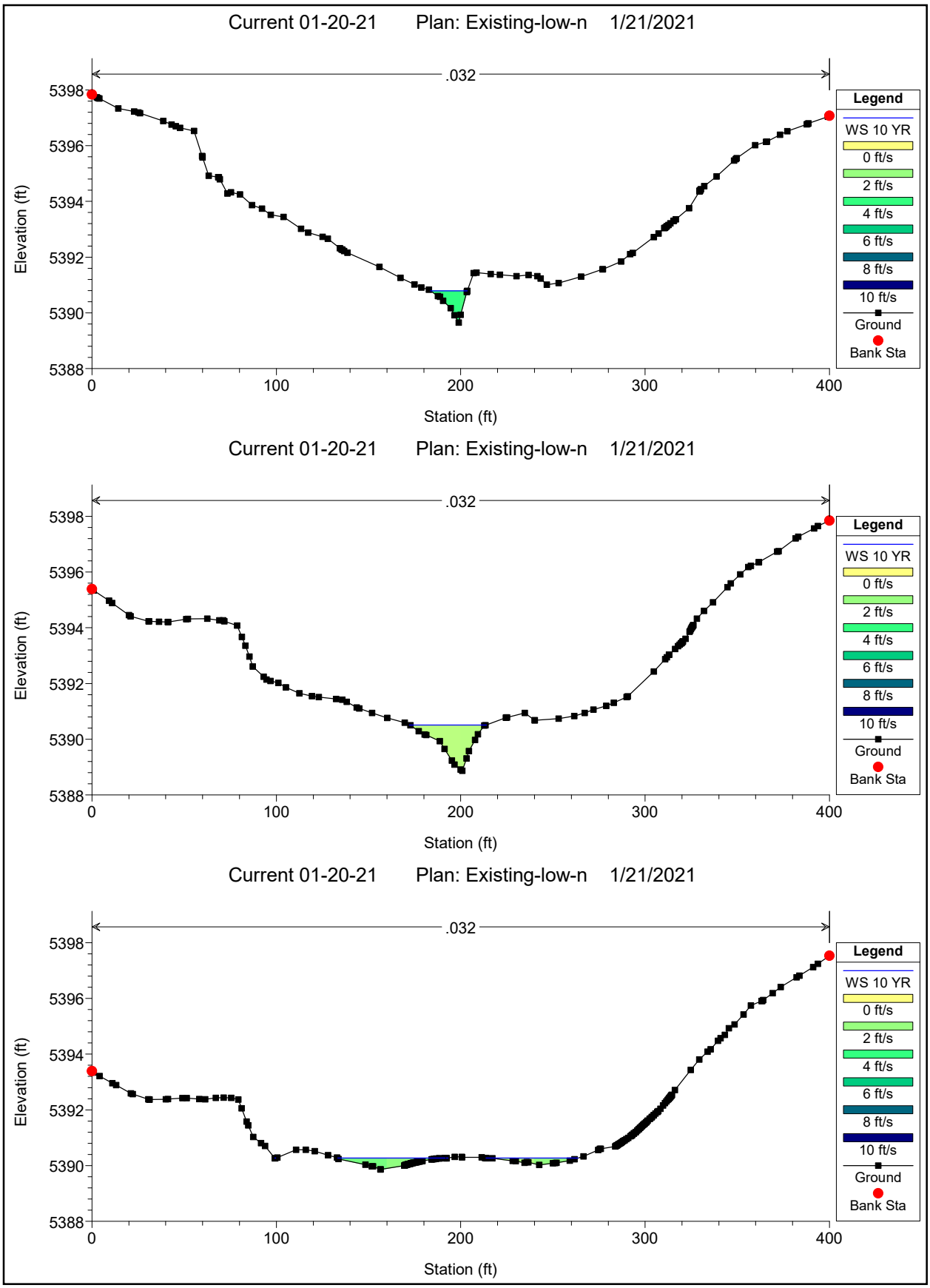
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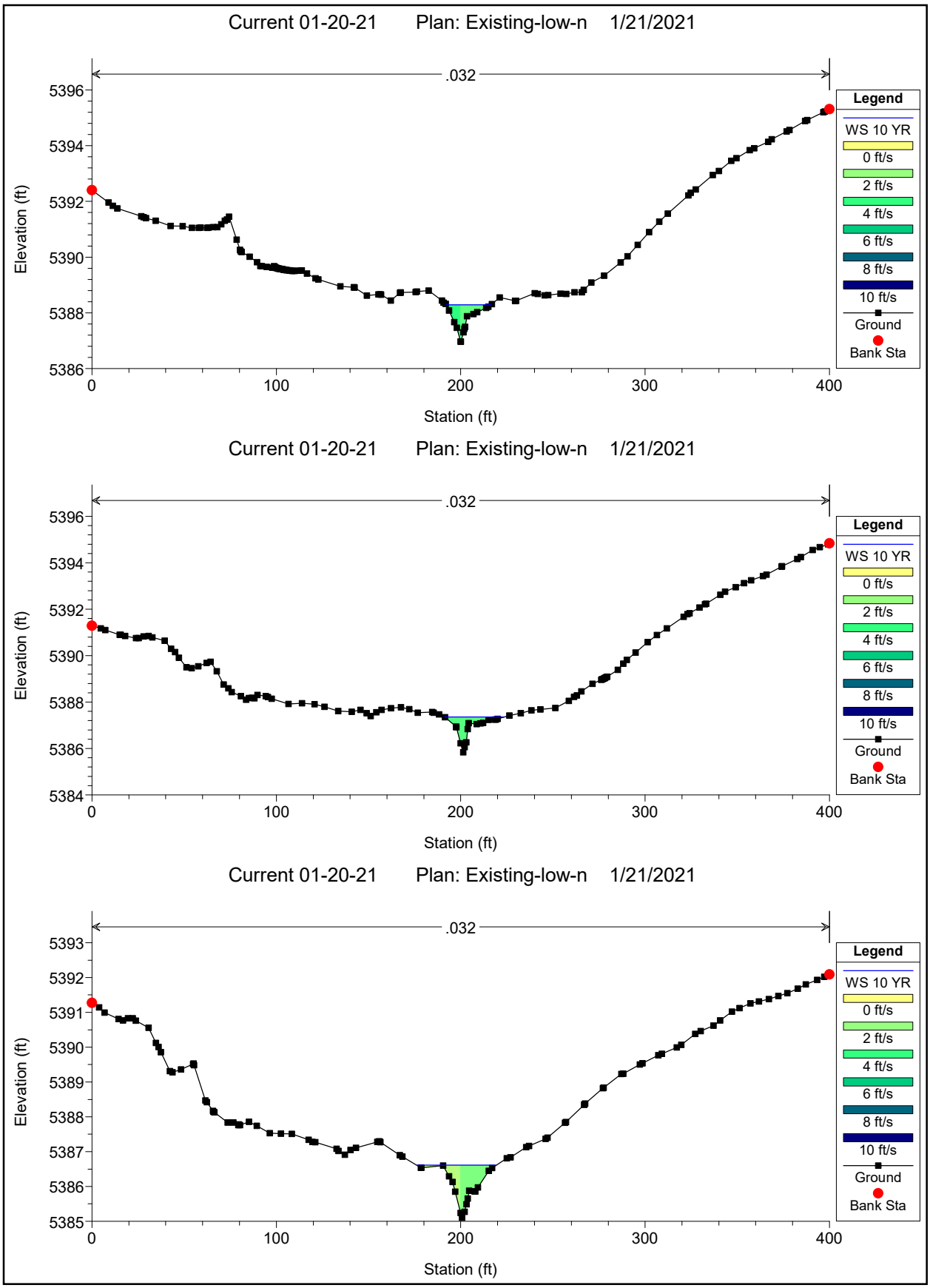
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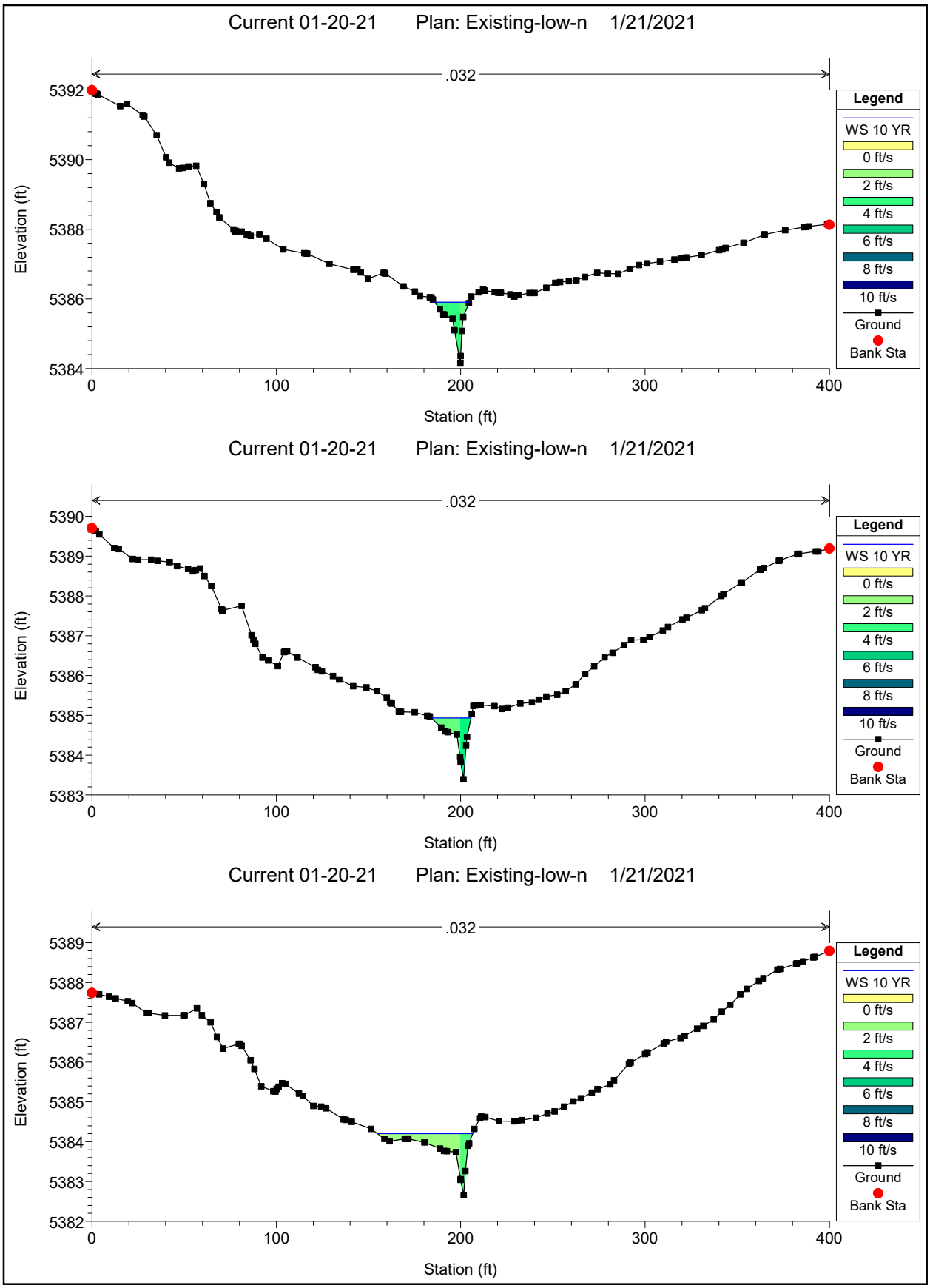
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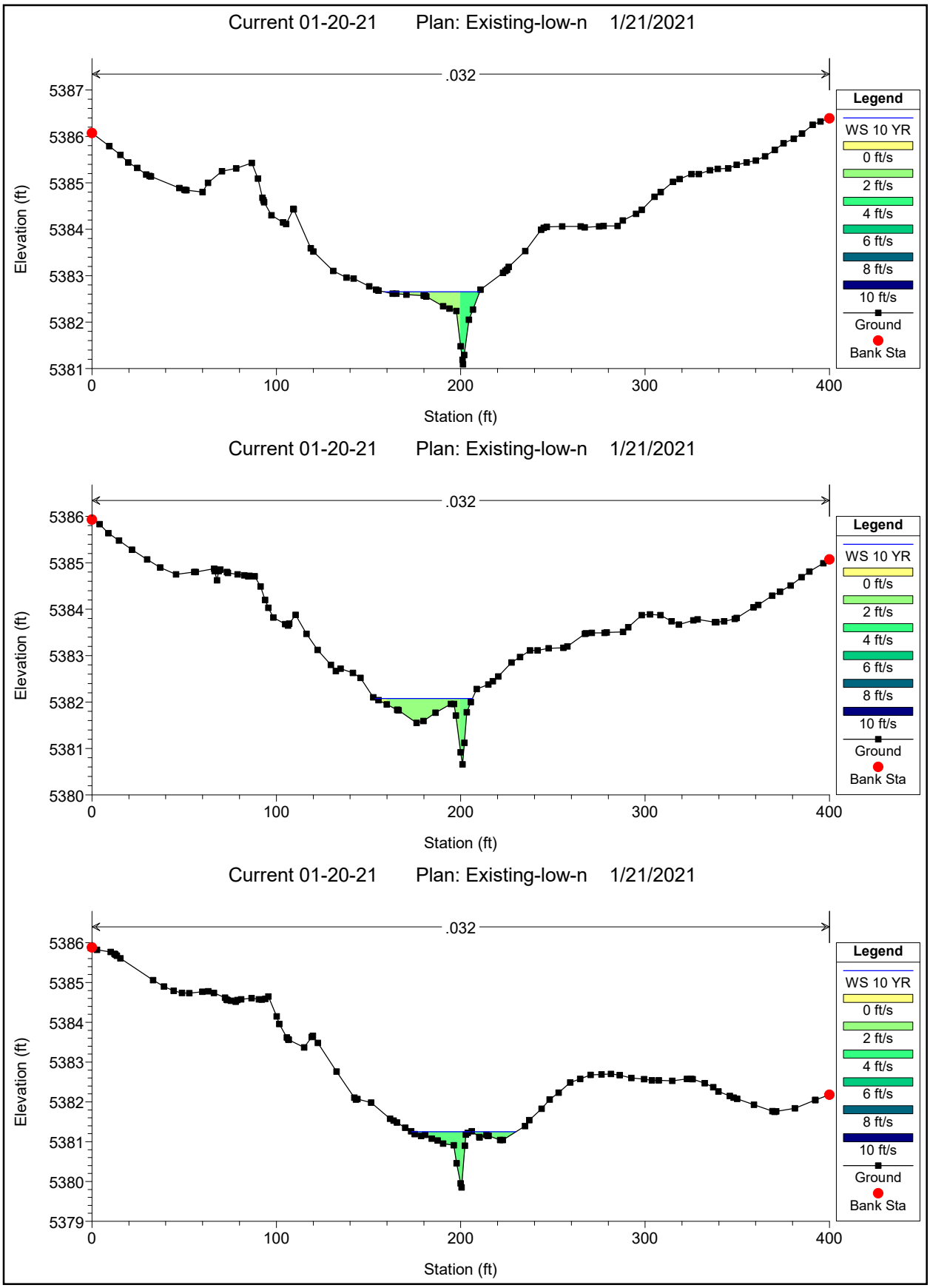
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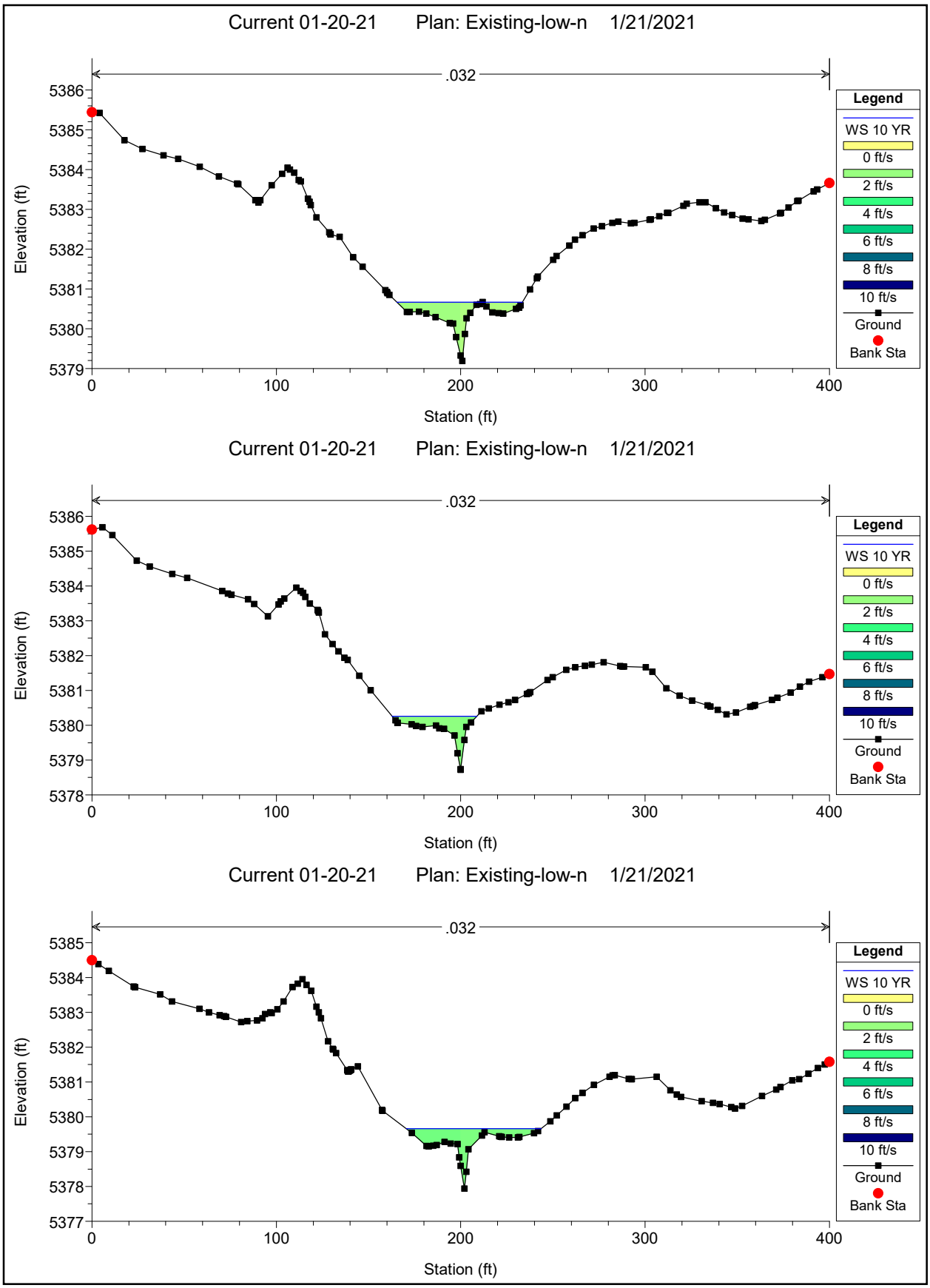
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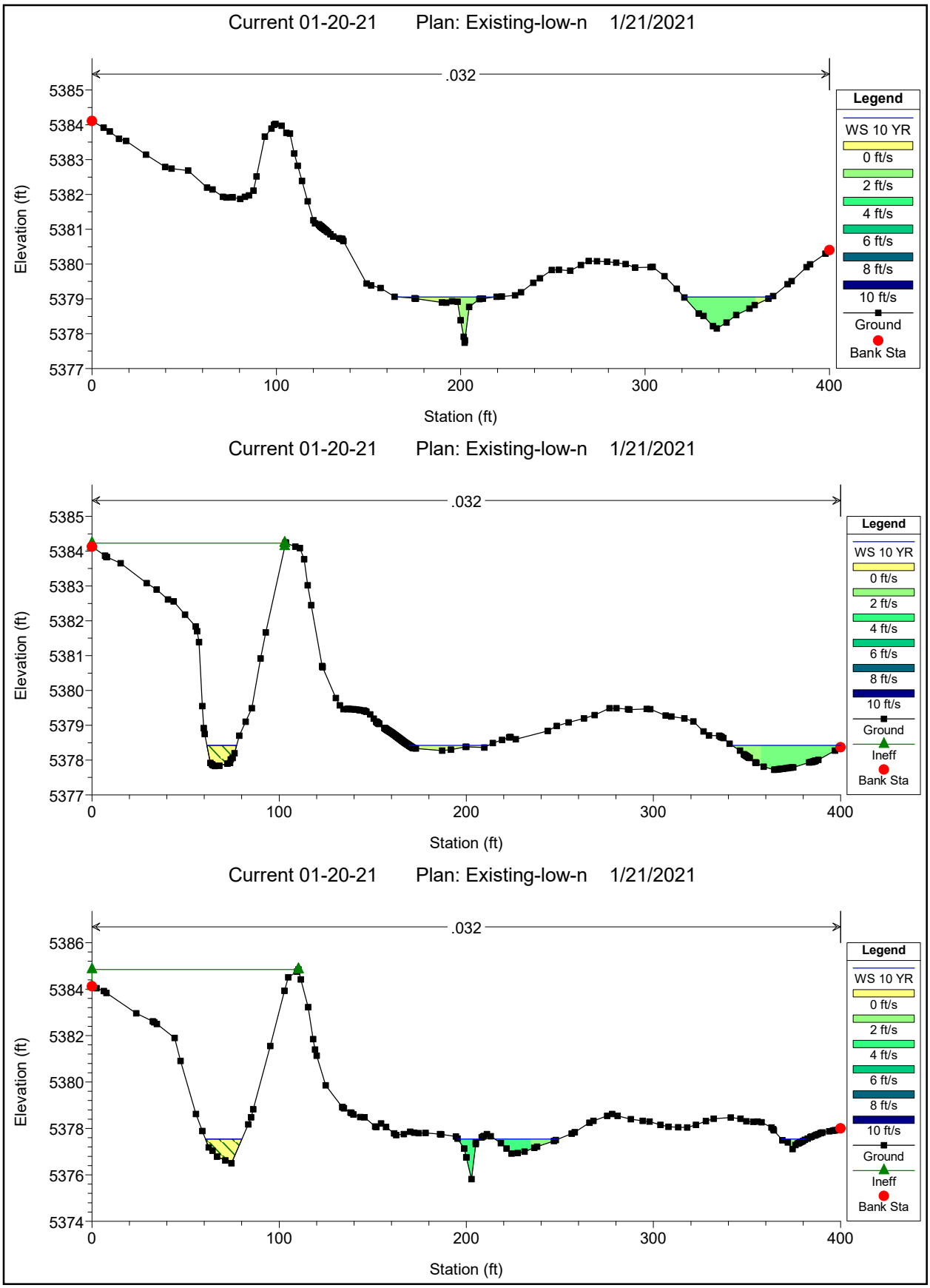
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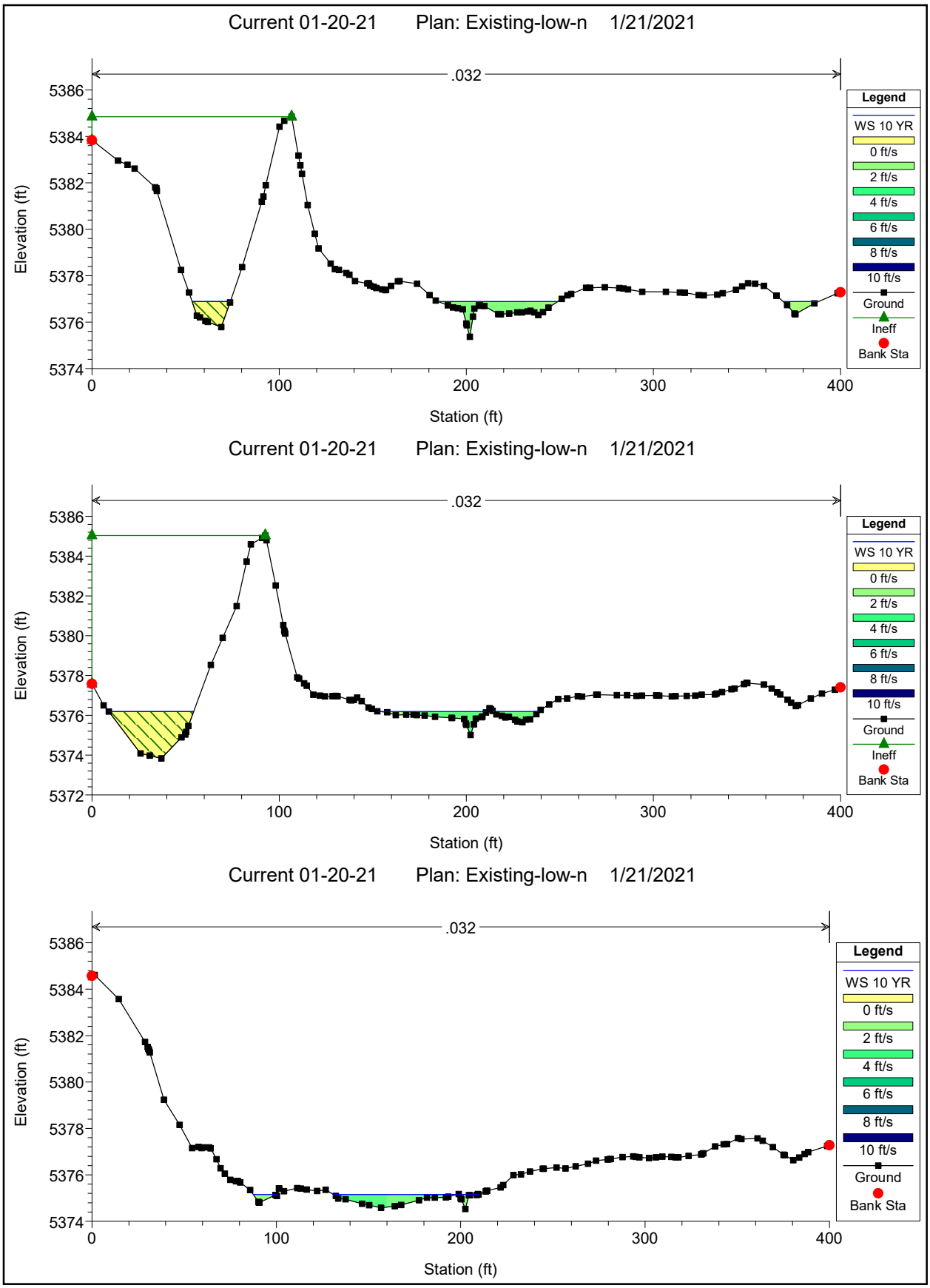
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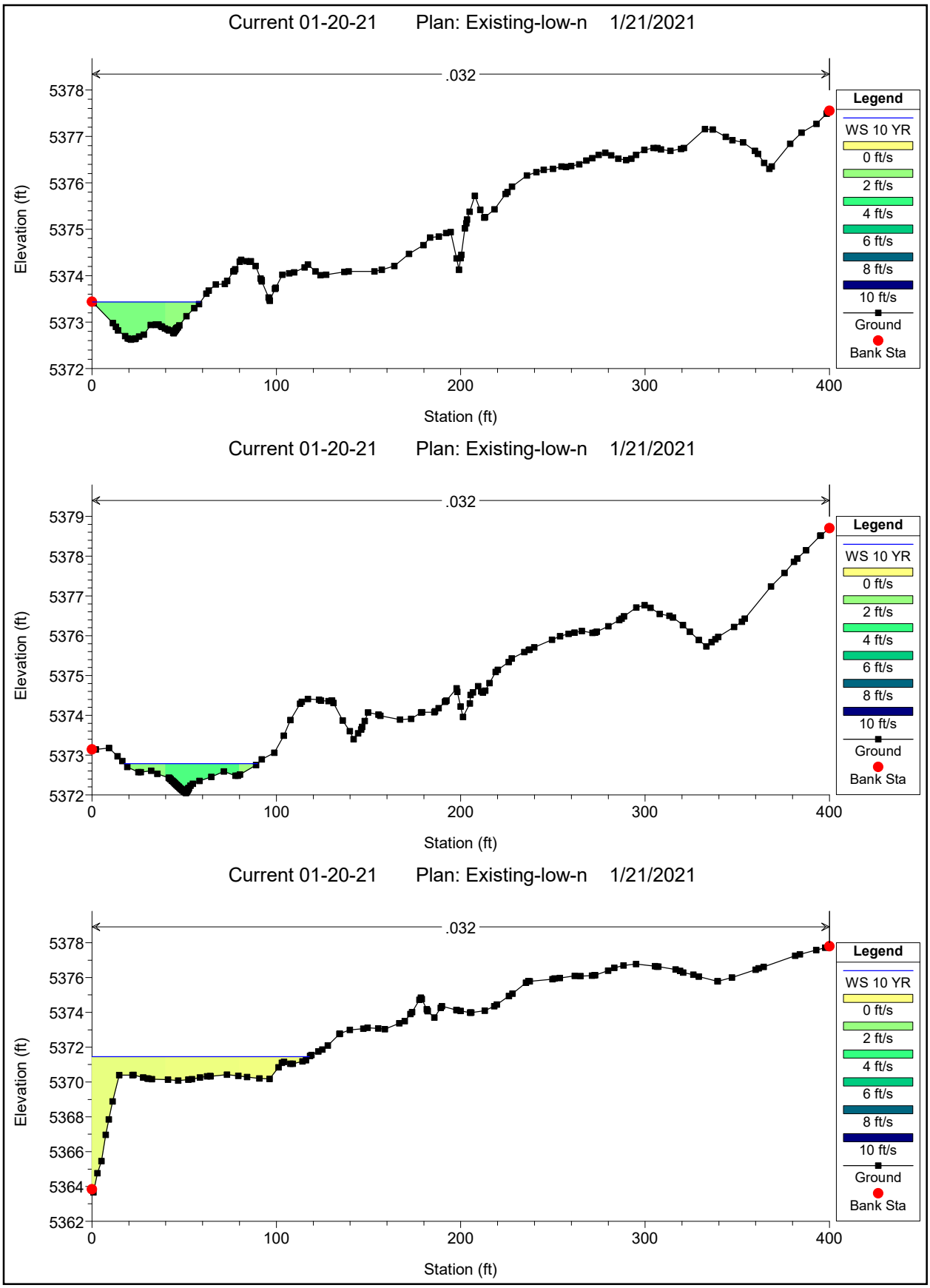
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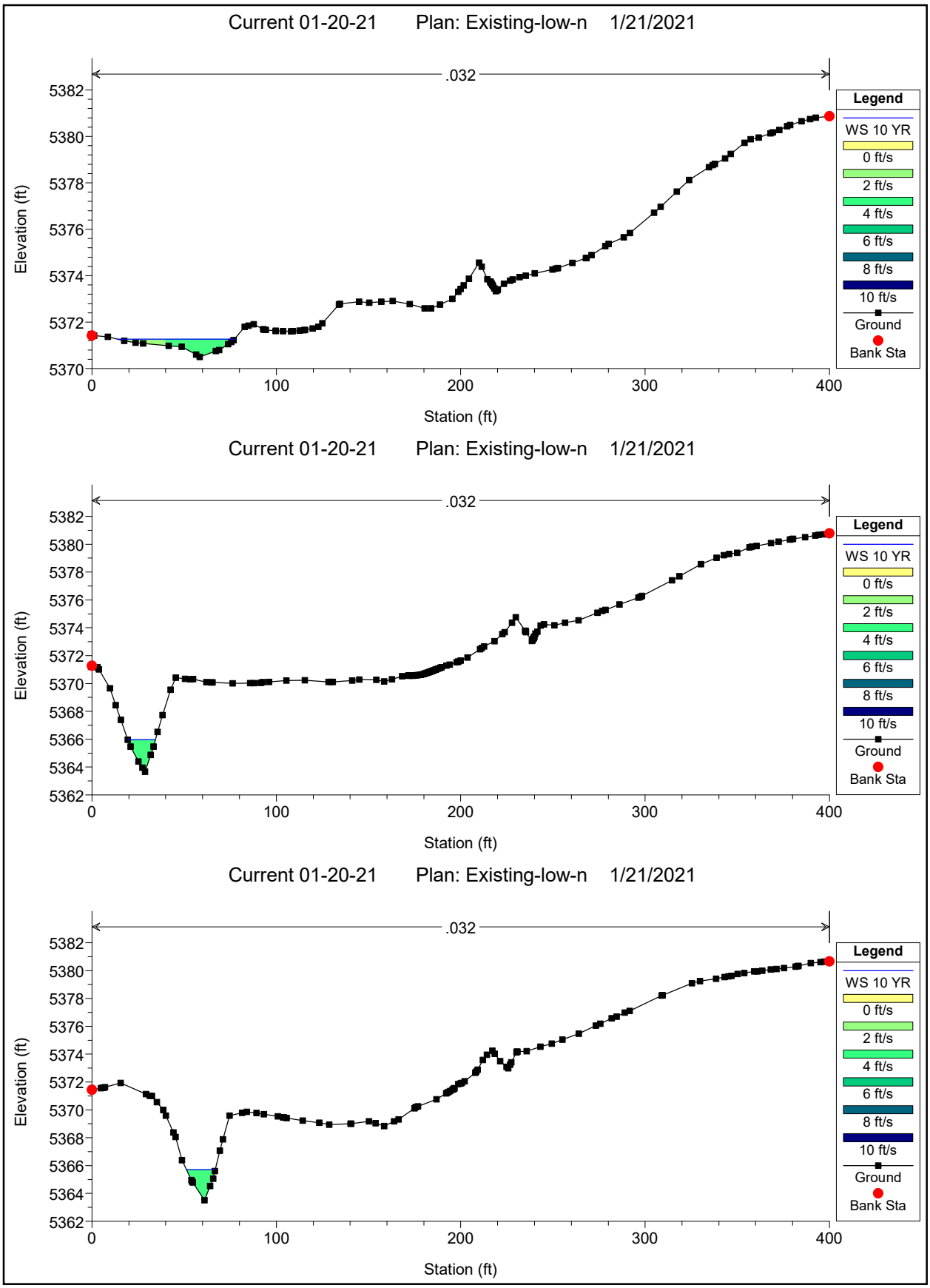
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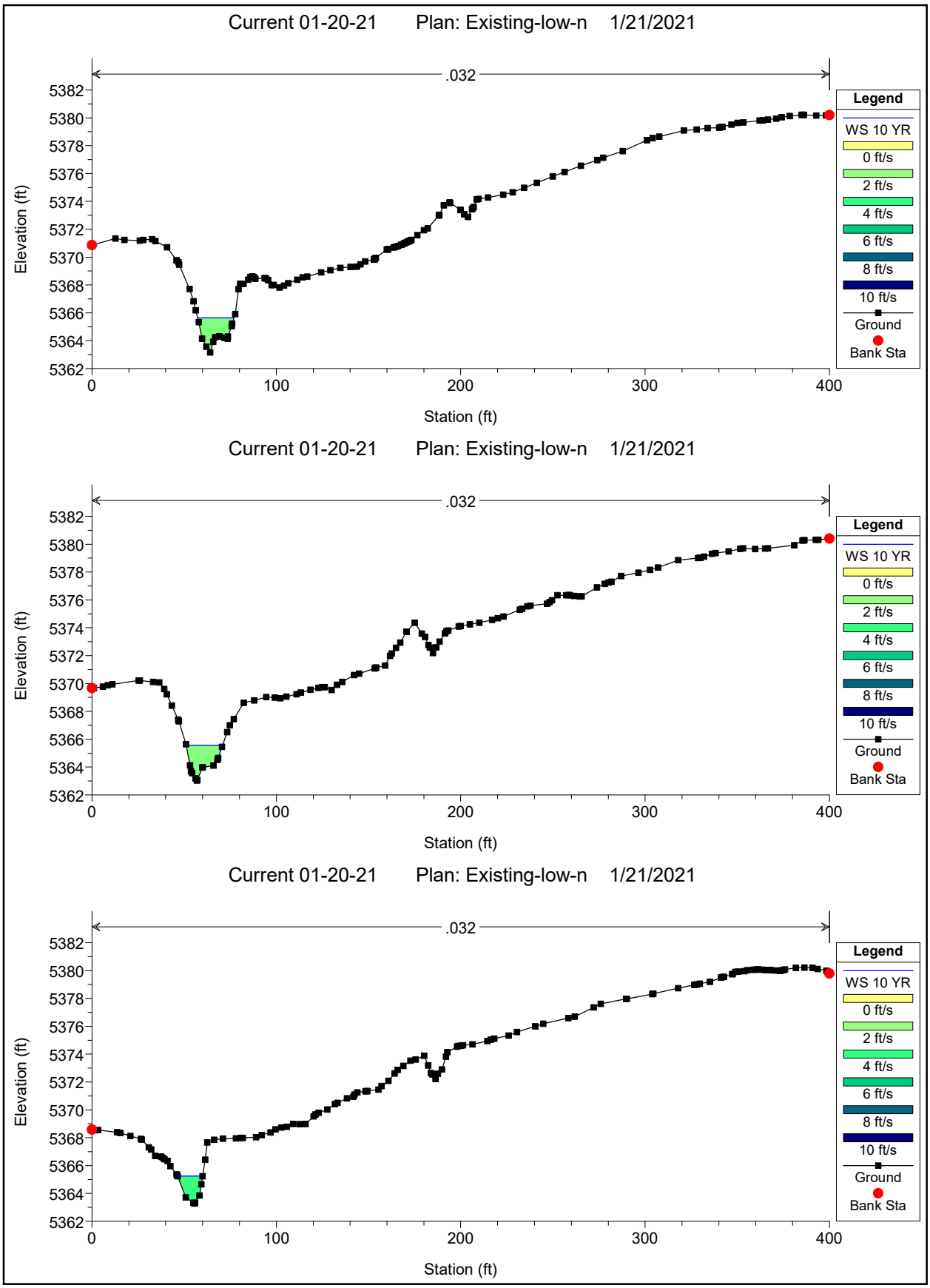
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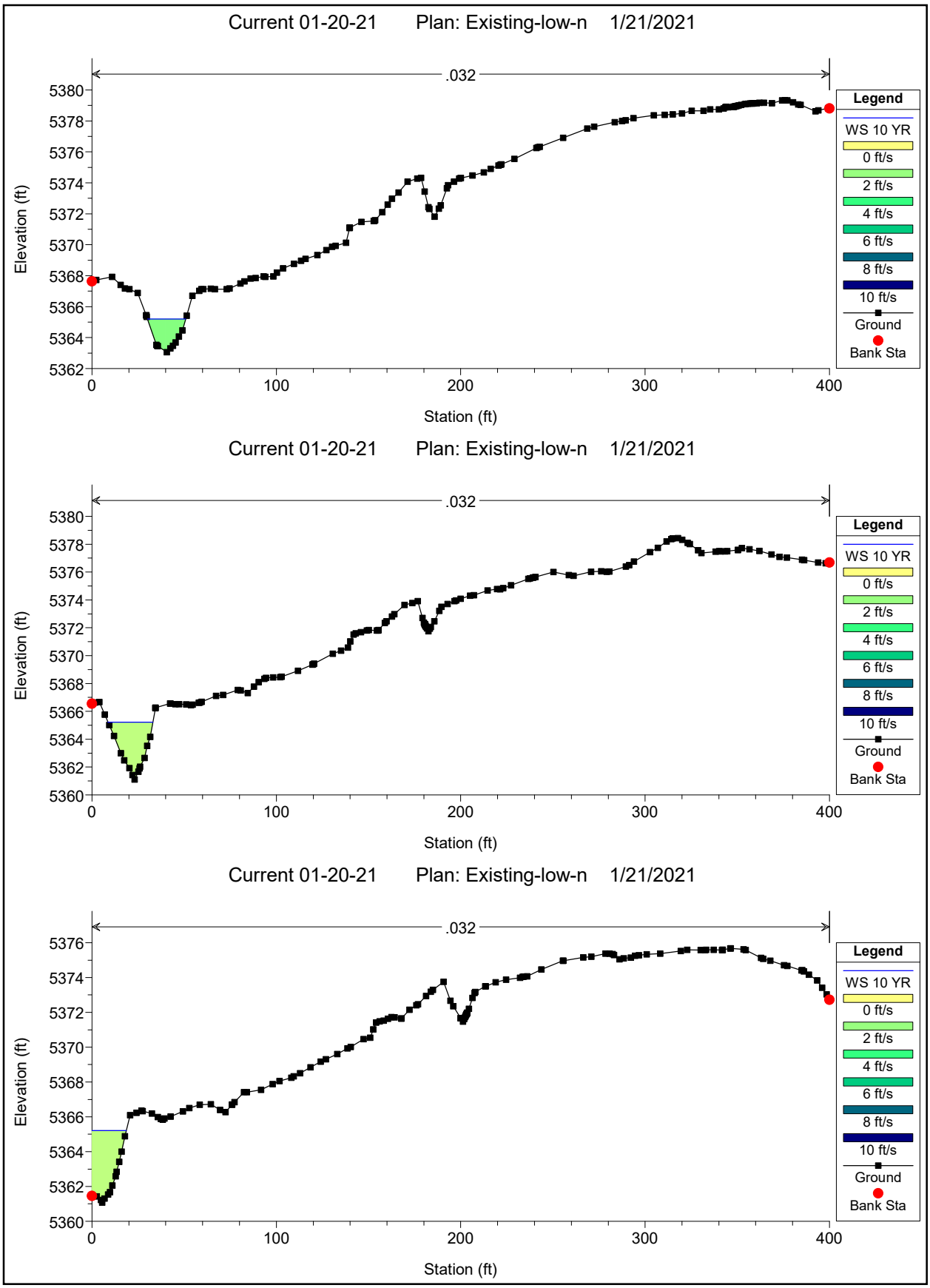
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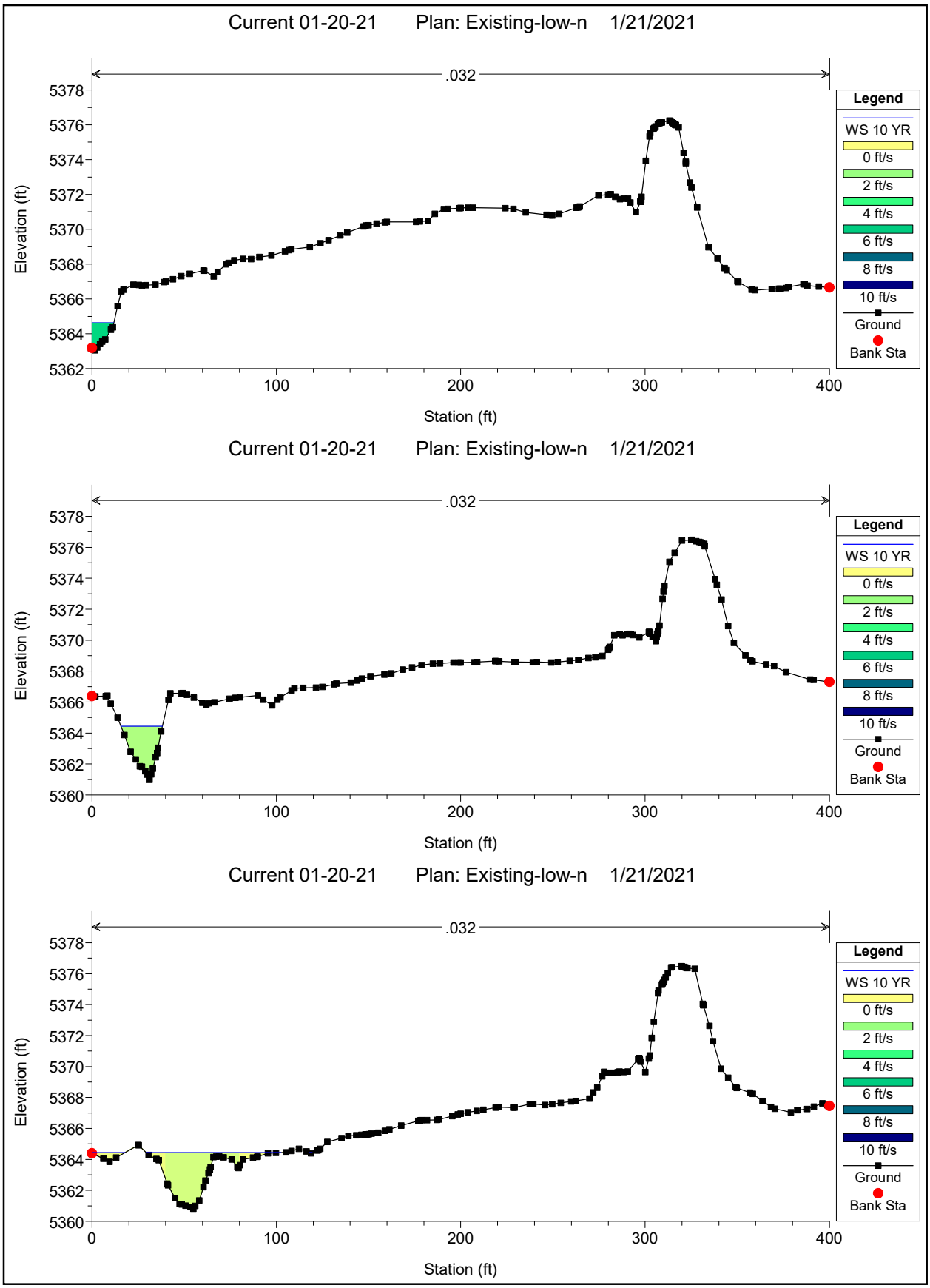
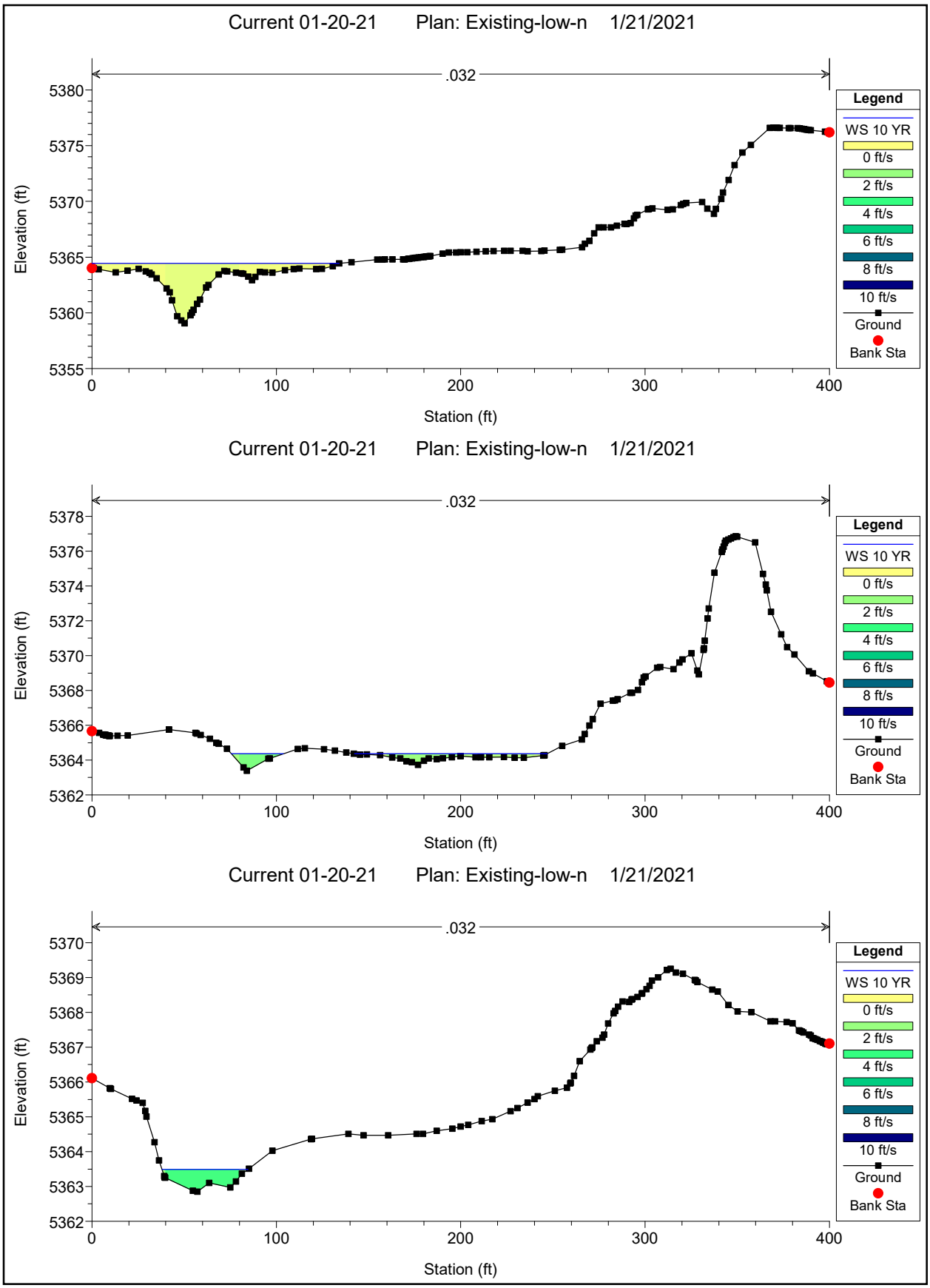
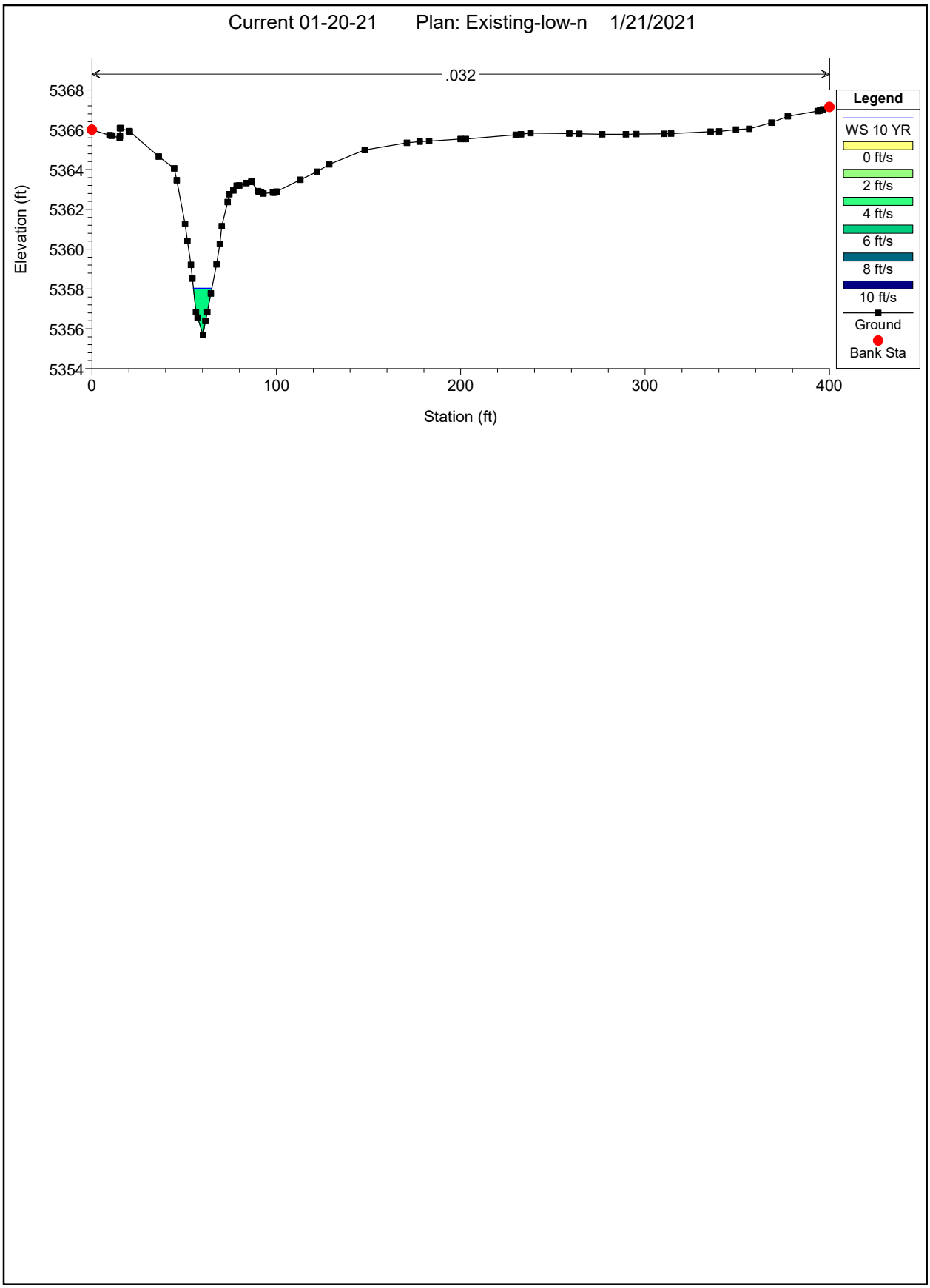

Current 01-20-21 Plan: Existing-low-n 1/21/2021
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 01-20-21 Plan: Existing-low-n 1/21/2021
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 01-20-21 Plan: Existing-low-n 1/21/2021
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta


Current 01-20-21 Plan: Existing-low-n 1/21/2021
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 01-20-21 Plan: Existing-low-n 1/21/2021
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 01-20-21 Plan: Existing-low-n 1/21/2021
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta


Current 01-20-21 Plan: Existing-low-n 1/21/2021
.032
Elevation (ft)
5368
5366
5364
5362
5360
5358
5356
5354
0
100
200
300
400
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

HEC-RAS Plan: EX-low-n River: PR Channel w EX Reach: PR Channel w EX Profile: 100 YR

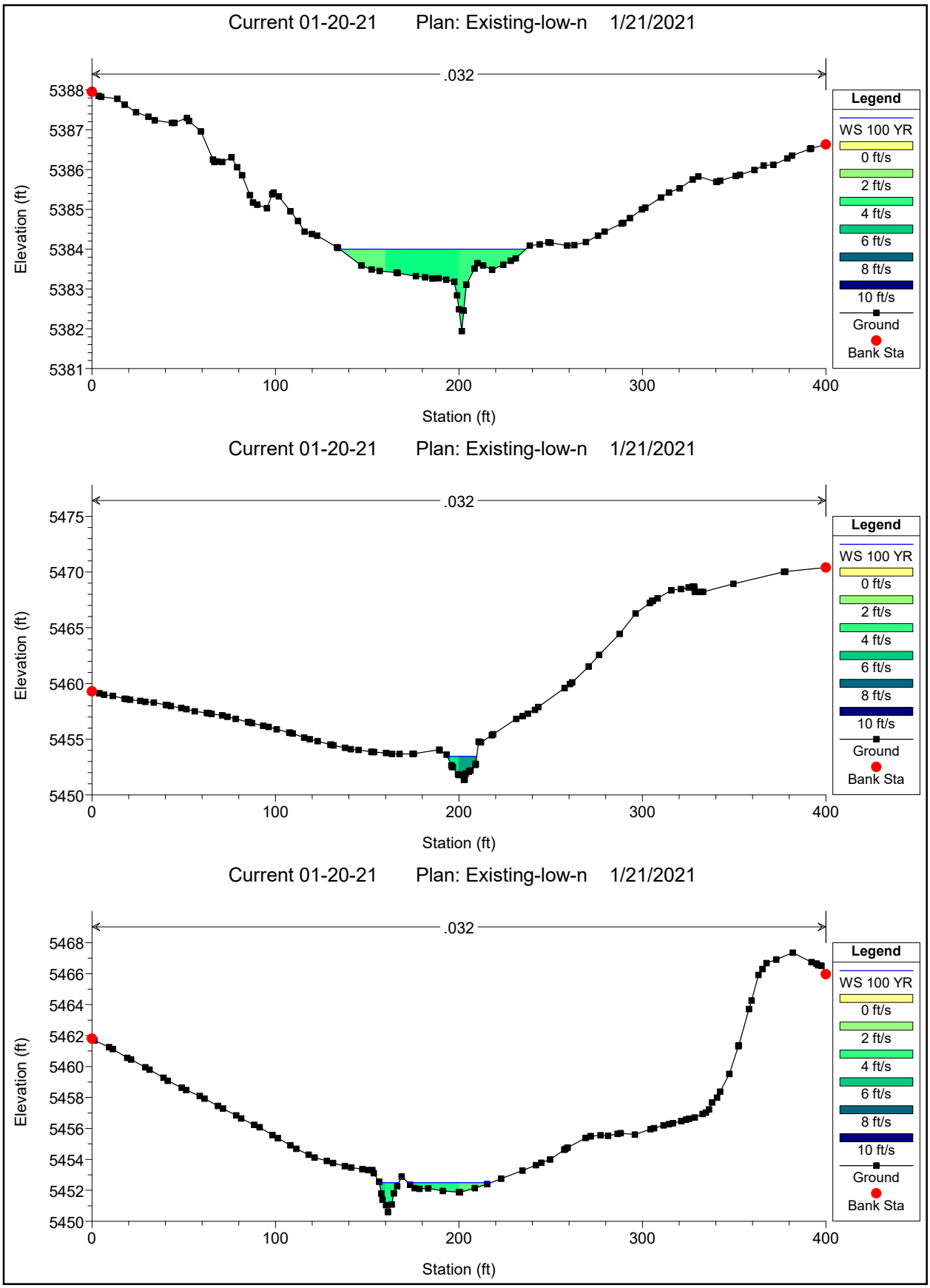
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
PR Channel w EX	5800	100 YR	124.43	5451.37	5453.46	5453.46	5454.08	0.015228	6.34	19.61	15.91	1.01	1.11
PR Channel w EX	5750	100 YR	124.43	5450.60	5452.50	5452.50	5452.79	0.020681	4.28	29.09	55.92	1.05	0.66
PR Channel w EX	5700	100 YR	124.43	5450.44	5451.43	5451.43	5451.65	0.019853	3.81	32.67	72.79	1.00	0.55
PR Channel w EX	5650	100 YR	124.43	5449.59	5450.15	5450.15	5450.34	0.021004	3.44	36.17	98.65	1.00	0.48
PR Channel w EX	5600	100 YR	124.43	5448.20	5448.79	5448.79	5449.01	0.019744	3.72	33.47	77.79	1.00	0.53
PR Channel w EX	5550	100 YR	124.43	5446.73	5447.62	5447.62	5447.87	0.019269	4.06	30.63	61.19	1.01	0.60
PR Channel w EX	5500	100 YR	124.43	5445.70	5446.78		5446.94	0.009065	3.24	38.39	61.11	0.72	0.36
PR Channel w EX	5450	100 YR	124.43	5445.18	5446.02	5446.02	5446.29	0.019177	4.17	29.85	57.15	1.02	0.62
PR Channel w EX	5400	100 YR	124.43	5444.02	5444.95	5444.95	5445.22	0.019165	4.15	29.96	57.64	1.02	0.62
PR Channel w EX	5350	100 YR	124.43	5443.50	5444.30		5444.46	0.010052	3.15	39.53	71.10	0.74	0.35
PR Channel w EX	5300	100 YR	124.43	5443.06	5443.75		5443.91	0.012234	3.18	39.18	80.54	0.80	0.37
PR Channel w EX	5250	100 YR	124.43	5442.30	5442.92	5442.92	5443.14	0.019806	3.76	33.13	76.00	1.00	0.54
PR Channel w EX	5200	100 YR	124.43	5441.16	5441.84	5441.84	5442.07	0.019319	3.83	32.50	71.10	1.00	0.55
PR Channel w EX	5150	100 YR	124.43	5440.47	5441.85		5441.88	0.000846	1.29	96.18	102.55	0.24	0.05
PR Channel w EX	5100	100 YR	124.43	5438.22	5441.86		5441.87	0.000038	0.47	266.50	126.99	0.06	0.00
PR Channel w EX	5050	100 YR	124.43	5440.75	5441.59	5441.59	5441.84	0.019034	3.94	31.59	65.50	1.00	0.57
PR Channel w EX	5000	100 YR	124.43	5438.11	5439.22	5439.22	5439.42	0.018591	3.62	34.36	79.35	0.97	0.50
PR Channel w EX	4950	100 YR	124.43	5437.46	5438.32	5438.27	5438.52	0.015473	3.59	34.70	70.94	0.90	0.47
PR Channel w EX	4900	100 YR	124.43	5436.63	5437.41	5437.41	5437.66	0.019189	4.00	31.11	63.41	1.01	0.59
PR Channel w EX	4850	100 YR	124.43	5435.74	5436.67		5436.80	0.007685	2.88	43.27	72.86	0.66	0.28
PR Channel w EX	4800	100 YR	124.43	5435.30	5436.04	5436.02	5436.25	0.016768	3.60	34.53	74.40	0.93	0.49
PR Channel w EX	4750	100 YR	124.43	5434.70	5435.35		5435.52	0.012631	3.26	38.13	77.06	0.82	0.39
PR Channel w EX	4700	100 YR	124.43	5434.00	5434.65	5434.61	5434.83	0.015376	3.42	36.36	79.33	0.89	0.44
PR Channel w EX	4650	100 YR	124.43	5433.19	5433.87	5433.83	5434.06	0.015616	3.51	35.49	75.53	0.90	0.46
PR Channel w EX	4600	100 YR	124.43	5432.42	5433.14		5433.32	0.013679	3.43	36.24	72.07	0.85	0.43
PR Channel w EX	4550	100 YR	124.43	5431.42	5432.26	5432.26	5432.50	0.019447	3.95	31.50	66.06	1.01	0.58
PR Channel w EX	4500	100 YR	124.43	5430.16	5431.74		5431.84	0.005590	2.56	48.57	76.47	0.57	0.22
PR Channel w EX	4450	100 YR	124.43	5430.58	5431.16	5431.16	5431.35	0.020292	3.54	35.17	89.90	1.00	0.50
PR Channel w EX	4400	100 YR	124.43	5428.93	5429.74	5429.74	5429.94	0.021151	3.59	34.68	89.51	1.02	0.51
PR Channel w EX	4350	100 YR	124.43	5427.79	5428.62	5428.62	5428.84	0.020020	3.80	32.74	74.39	1.01	0.55
PR Channel w EX	4300	100 YR	124.43	5426.79	5427.59	5427.54	5427.77	0.015120	3.40	36.54	79.34	0.88	0.43
PR Channel w EX	4250	100 YR	124.43	5426.01	5426.68	5426.68	5426.89	0.020942	3.60	34.54	87.99	1.01	0.51
PR Channel w EX	4200	100 YR	124.43	5425.01	5425.74	5425.71	5425.92	0.017221	3.40	36.62	87.94	0.93	0.45
PR Channel w EX	4150	100 YR	124.43	5424.35	5424.98	5424.93	5425.12	0.014509	3.07	40.55	99.75	0.85	0.37
PR Channel w EX	4100	100 YR	124.43	5423.68	5424.23	5424.19	5424.37	0.015343	3.03	41.03	107.16	0.86	0.37
PR Channel w EX	4050	100 YR	124.43	5422.77	5423.52	5423.46	5423.65	0.013395	2.91	42.78	107.45	0.81	0.33
PR Channel w EX	4000	100 YR	124.43	5422.17	5422.85		5423.00	0.012655	3.11	39.99	86.98	0.81	0.36
PR Channel w EX	3950	100 YR	124.43	5421.53	5422.24	5422.18	5422.38	0.012144	2.98	41.78	94.08	0.79	0.34
PR Channel w EX	3900	100 YR	124.43	5420.98	5421.61		5421.75	0.013007	3.01	41.27	96.07	0.81	0.35
PR Channel w EX	3850	100 YR	124.43	5420.39	5421.14		5421.23	0.008001	2.47	50.46	110.29	0.64	0.23
PR Channel w EX	3800	100 YR	124.43	5419.85	5420.50	5420.48	5420.64	0.018906	3.06	40.63	122.29	0.94	0.39
PR Channel w EX	3750	100 YR	124.43	5418.83	5419.66	5419.61	5419.80	0.015270	3.03	41.03	106.75	0.86	0.37
PR Channel w EX	3700	100 YR	124.43	5417.94	5418.74	5418.74	5418.89	0.022492	3.10	40.08	134.62	1.00	0.42
PR Channel w EX	3650	100 YR	124.43	5416.94	5417.47	5417.47	5417.64	0.022557	3.26	38.14	119.20	1.02	0.45
PR Channel w EX	3600	100 YR	124.43	5415.54	5416.16	5416.16	5416.35	0.021106	3.51	35.41	94.16	1.01	0.50
PR Channel w EX	3550	100 YR	124.43	5414.52	5415.18	5415.16	5415.37	0.017312	3.48	35.79	83.33	0.94	0.46
PR Channel w EX	3500	100 YR	124.43	5413.69	5414.23	5414.23	5414.43	0.020444	3.57	34.87	88.48	1.00	0.50
PR Channel w EX	3450	100 YR	124.43	5412.61	5414.14		5414.15	0.000405	0.98	126.54	117.07	0.17	0.03
PR Channel w EX	3400	100 YR	239.44	5411.86	5414.12		5414.14	0.000254	1.02	233.84	143.56	0.14	0.03
PR Channel w EX	3350	100 YR	239.44	5411.23	5414.12		5414.13	0.000083	0.68	354.48	175.04	0.08	0.01
PR Channel w EX	3300	100 YR	239.44	5410.86	5414.12		5414.13	0.000049	0.54	442.82	205.96	0.07	0.01
PR Channel w EX	3250	100 YR	239.44	5408.73	5414.12	5411.50	5414.12	0.000064	0.68	349.85	209.81	0.08	0.01
PR Channel w EX	3225		Culvert										
PR Channel w EX	3150	100 YR	239.44	5408.50	5410.72	5410.72	5411.72	0.015296	8.00	29.93	14.79	0.99	1.57
PR Channel w EX	3100	100 YR	239.44	5407.06	5408.42		5408.52	0.003765	2.44	98.26	124.14	0.48	0.19
PR Channel w EX	3050	100 YR	239.44	5407.04	5408.16		5408.29	0.005297	2.92	81.98	101.98	0.57	0.27
PR Channel w EX	3000	100 YR	239.44	5406.60	5407.52	5407.52	5407.83	0.017844	4.50	53.19	85.99	1.01	0.69
PR Channel w EX	2950	100 YR	239.44	5404.92	5406.21	5406.21	5406.50	0.018606	4.36	54.92	96.11	1.02	0.66
PR Channel w EX	2900	100 YR	239.44	5403.66	5405.17	5405.17	5405.47	0.017954	4.41	54.34	91.06	1.01	0.67
PR Channel w EX	2850	100 YR	239.44	5402.27	5404.05	5404.05	5404.33	0.018471	4.20	56.95	104.48	1.00	0.63
PR Channel w EX	2800	100 YR	239.44	5400.99	5402.51	5402.51	5402.82	0.018147	4.46	53.73	88.92	1.01	0.68
PR Channel w EX	2750	100 YR	239.44	5399.72	5401.38	5401.38	5401.79	0.016168	5.17	46.29	56.29	1.01	0.83
PR Channel w EX	2700	100 YR	239.44	5399.21	5400.65		5400.74	0.001876	2.30	104.03	84.78	0.37	0.14
PR Channel w EX	2650	100 YR	239.44	5399.21	5400.12	5400.12	5400.50	0.016834	4.92	48.71	65.90	1.01	0.77
PR Channel w EX	2600	100 YR	239.44	5398.06	5399.06	5399.06	5399.34	0.018996	4.28	55.98	102.33	1.02	0.65
PR Channel w EX	2550	100 YR	239.44	5396.34	5397.63	5397.63	5397.94	0.018563	4.45	53.84	91.27	1.02	0.68
PR Channel w EX	2500	100 YR	239.44	5394.48	5395.60	5395.53	5395.90	0.013066	4.42	54.22	71.21	0.89	0.62
PR Channel w EX	2450	100 YR	239.44	5394.37	5395.43		5395.51	0.003947	2.29	104.37	149.43	0.48	0.17
PR Channel w EX	2400	100 YR	239.44	5394.18	5395.32		5395.37	0.001861	1.77	135.11	162.12	0.34	0.10
PR Channel w EX	2350	100 YR	239.44	5394.18	5395.25		5395.29	0.001210	1.50	159.54	178.06	0.28	0.07
PR Channel w EX	2300	100 YR	239.44	5394.18	5395.19		5395.22	0.001378	1.57	152.23	174.43	0.30	0.07
PR Channel w EX	2250	100 YR	239.44	5393.01	5394.76	5394.76	5395.03	0.018482	4.20	57.05	104.72	1.00	0.63
PR Channel w EX	2200	100 YR	239.44	5391.94	5392.83	5392.83	5393.10	0.019824	4.16	57.55	113.28	1.03	0.63
PR Channel w EX	2150	100 YR	239.44	5389.65	5391.59	5391.59	5391.85	0.021175	4.14	57.83	120.30	1.05	0.63
PR Channel w EX	2100	100 YR	239.44	5388.87	5391.19		5391.29	0.005616	2.65	90.35	135.74	0.57	0.23
PR Channel w EX	2050	100 YR	239.44	5389.86	5390.60	5390.60	5390.79	0.021643	3.55	67.50	180.36	1.02	0.51
PR Channel w EX	2000	100 YR	239.44	5386.96	5388.97	5388.97	5389.21	0.020045	3.89	61.61	135.26	1.02	0.57
PR Channel w EX	1950	100 YR	239.44	5385.84	5387.95	5387.94	5388.17	0.020976	3.79	63.22	149.11	1.03	0.55
PR Channel w EX	1900	100 YR	239.44	5385.10	5387.40		5387.54	0.007936	2.97	80.70	132.59	0.67	0.30
PR Channel w EX	1850	100 YR	239.44	5384.15	5386.66	5386.66	5386.93	0.019997	4.16	57.54	113.27	1.03	0.63
PR Channel w EX	1800	100 YR	239.44	5383.39	5385.66	5385.66	5385.94	0.019570	4.23	56.57	106.98	1.03	0.64
PR Channel w EX	1750	100 YR	239.44	5382.66	5384.83	5384.73	5385.01	0.011839	3.40	70.39	126.93	0.81	0.41
PR Channel w EX	1700	100 YR	239.44	5381.94	5384.00	5384.00	5384.28	0.018052	4.22	56.74	101.49	0.99	0.63
PR Channel w EX	1650	100 YR	239.44	5381.09	5383.34		5383.52	0.009203	3.40	70.39	105.10	0.73	0.38
PR Channel w EX	1600	100 YR	239.44	5380.66	5382.66	5382.59	5382.94	0.014380	4.26	56.18	83.40	0.92	0.60
PR Channel w EX	1550	100 YR	239.44	5379.85	5381.83	5381.83	5382.12	0.019352	4.28	55.92	103.09	1.03	0.65
PR Channel w EX	1500	100 YR	239.44	5379.19	5381.31		5381.48	0.006643	3.29	72.88	89.72	0.64	0.34
PR Channel w EX	1450	100 YR	239.44	5378.72	5381.14		5381.21	0.003644	2.14	112.05	167.85	0.46	0.15
PR Channel w EX	1400	100 YR	441.42	5377.94	5380.35	5380.35	5380.74	0.016910	5.02	87.89	115.30	1.01	0.80
PR Channel w EX	1350	100 YR	441.42	5377.74	5379.65		5379.88	0.012008	3.89	113.48	169.30	0.84	0.50

HEC-RAS Plan: EX-low-n River: PR Channel w EX Reach: PR Channel w EX Profile: 100 YR (Continued)

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	Shear Chan
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
PR Channel w EX	1300	100 YR	441.42	5377.72	5379.02	5378.95	5379.26	0.012928	3.93	112.20	195.55	0.86	0.52
PR Channel w EX	1250	100 YR	441.42	5375.82	5378.23	5378.23	5378.51	0.017819	4.25	103.90	208.43	0.99	0.63
PR Channel w EX	1200	100 YR	441.42	5375.37	5377.68	5377.50	5377.81	0.007519	2.92	151.35	271.66	0.65	0.29
PR Channel w EX	1150	100 YR	441.42	5373.83	5376.85	5376.85	5377.22	0.018869	4.94	89.37	183.45	1.05	0.80
PR Channel w EX	1100	100 YR	441.42	5374.53	5375.73	5375.73	5376.06	0.017377	4.60	96.04	147.34	1.00	0.71
PR Channel w EX	1050	100 YR	441.42	5372.62	5374.36	5374.22	5374.58	0.010359	3.70	119.18	170.67	0.78	0.45
PR Channel w EX	1000	100 YR	441.42	5372.05	5373.48	5373.48	5373.90	0.016894	5.20	84.92	105.82	1.02	0.84
PR Channel w EX	950	100 YR	441.42	5363.66	5372.42		5372.46	0.000385	1.49	295.98	130.97	0.17	0.05
PR Channel w EX	900	100 YR	441.42	5370.50	5372.00	5372.00	5372.36	0.017029	4.87	90.72	125.41	1.01	0.77
PR Channel w EX	850	100 YR	441.42	5363.67	5368.60		5369.15	0.004719	5.90	74.79	27.93	0.64	0.74
PR Channel w EX	800	100 YR	441.42	5363.51	5368.41		5368.91	0.004237	5.70	77.37	27.99	0.60	0.69
PR Channel w EX	750	100 YR	441.42	5363.16	5368.34		5368.65	0.003928	4.49	98.22	48.59	0.56	0.47
PR Channel w EX	700	100 YR	441.42	5363.03	5368.18		5368.49	0.002554	4.44	99.42	36.28	0.47	0.41
PR Channel w EX	650	100 YR	441.42	5363.27	5367.79		5368.28	0.005976	5.65	78.14	37.55	0.69	0.74
PR Channel w EX	600	100 YR	441.42	5363.06	5367.77		5367.98	0.003424	3.64	121.24	76.82	0.51	0.33
PR Channel w EX	550	100 YR	441.42	5361.10	5367.75		5367.85	0.001145	2.47	178.98	87.62	0.30	0.14
PR Channel w EX	500	100 YR	441.42	5361.07	5367.70		5367.79	0.001139	2.35	187.62	94.67	0.29	0.13
PR Channel w EX	450	100 YR	441.42	5363.05	5367.15	5367.15	5367.61	0.018098	5.42	81.46	95.77	1.04	0.91
PR Channel w EX	400	100 YR	441.42	5360.98	5364.85	5364.85	5365.93	0.012494	8.32	53.03	24.69	1.00	1.58
PR Channel w EX	350	100 YR	441.42	5360.77	5365.29		5365.37	0.001452	2.26	195.17	132.97	0.33	0.13
PR Channel w EX	300	100 YR	441.42	5359.06	5365.29		5365.32	0.000472	1.40	314.91	189.52	0.19	0.05
PR Channel w EX	250	100 YR	441.42	5363.39	5365.16		5365.26	0.003572	2.53	174.49	200.31	0.48	0.19
PR Channel w EX	200	100 YR	441.42	5362.85	5364.56	5364.56	5364.89	0.018267	4.62	95.59	151.29	1.02	0.72
PR Channel w EX	150	100 YR	441.42	5355.69	5360.76	5360.49	5361.87	0.010008	8.42	52.42	18.71	0.89	1.52

HEC-RAS Plan: EX-low-n River: PR Channel w EX Reach: PR Channel w EX Profile: 100 YR

Reach	River Sta	Profile	E.G. US.	W.S. US.	E.G. IC	E.G. OC	Min El Weir Flow	Q Culv Group	Q Weir	Delta WS	Culv Vel US	Culv Vel DS
			(ft)	(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(ft)	(ft/s)	(ft/s)
PR Channel w EX	3225 EX 7'x7'	100 YR	5414.12	5414.12	5414.12	5414.57	5425.01	239.44		3.39	9.91	10.32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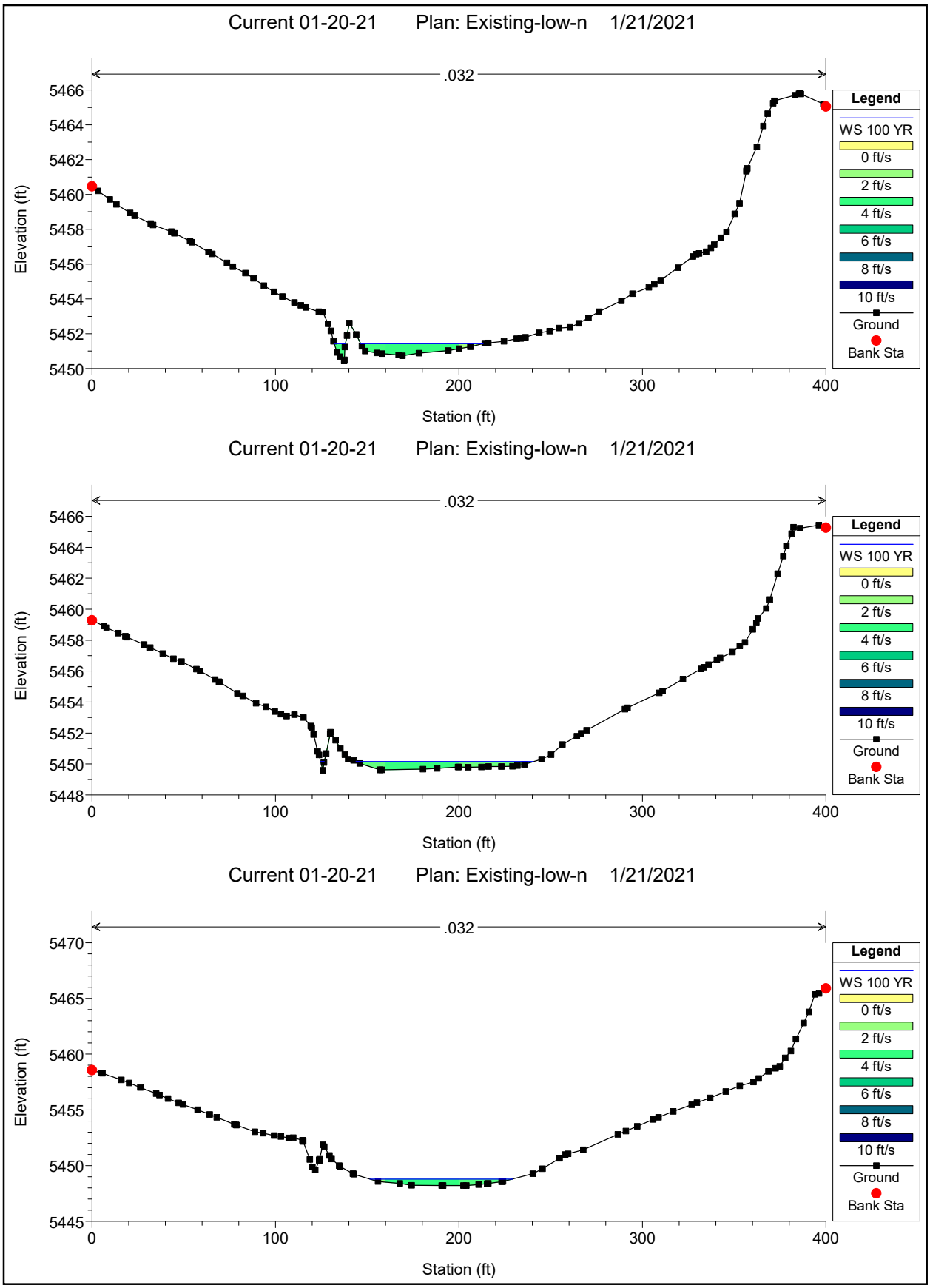
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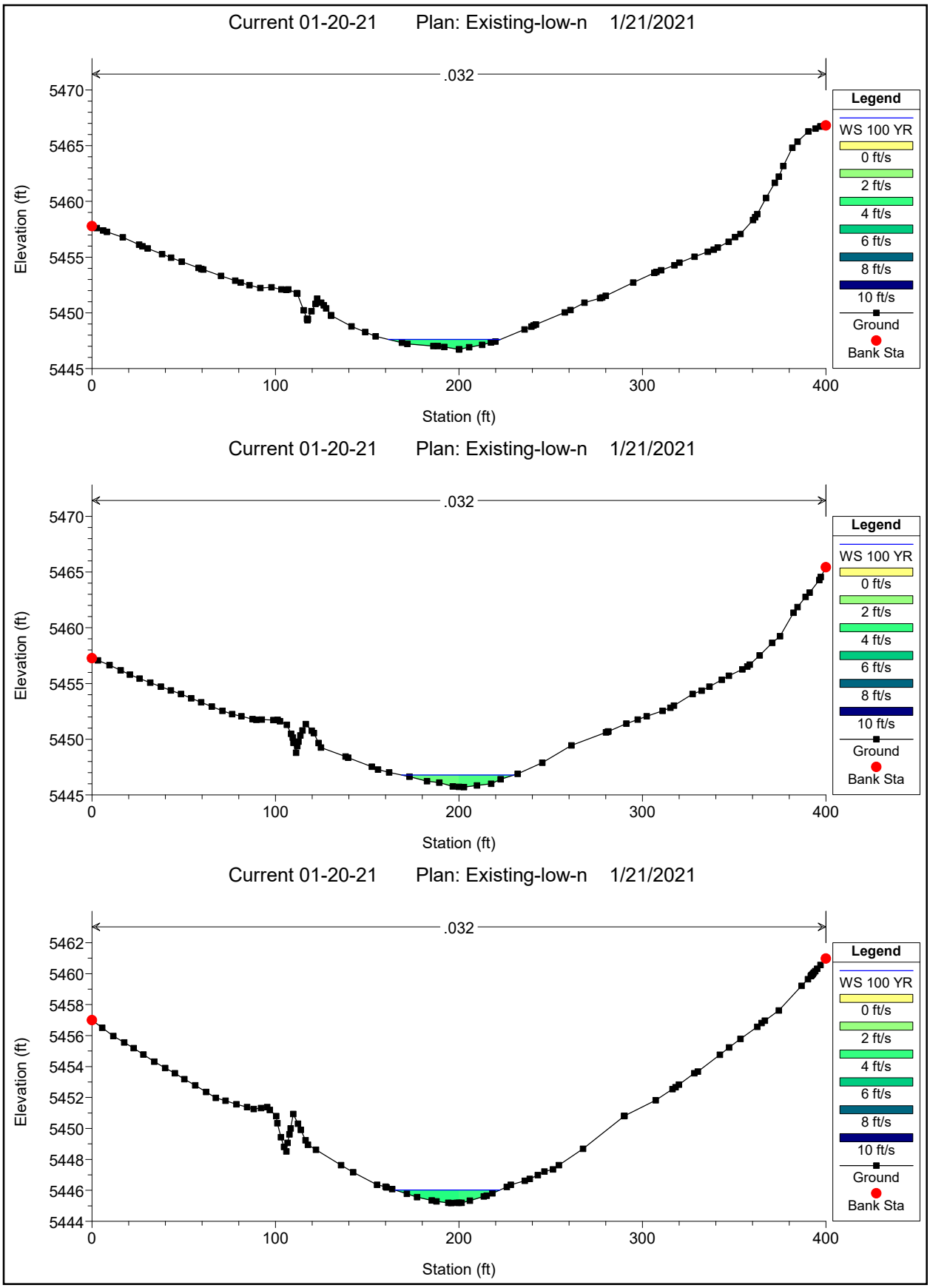
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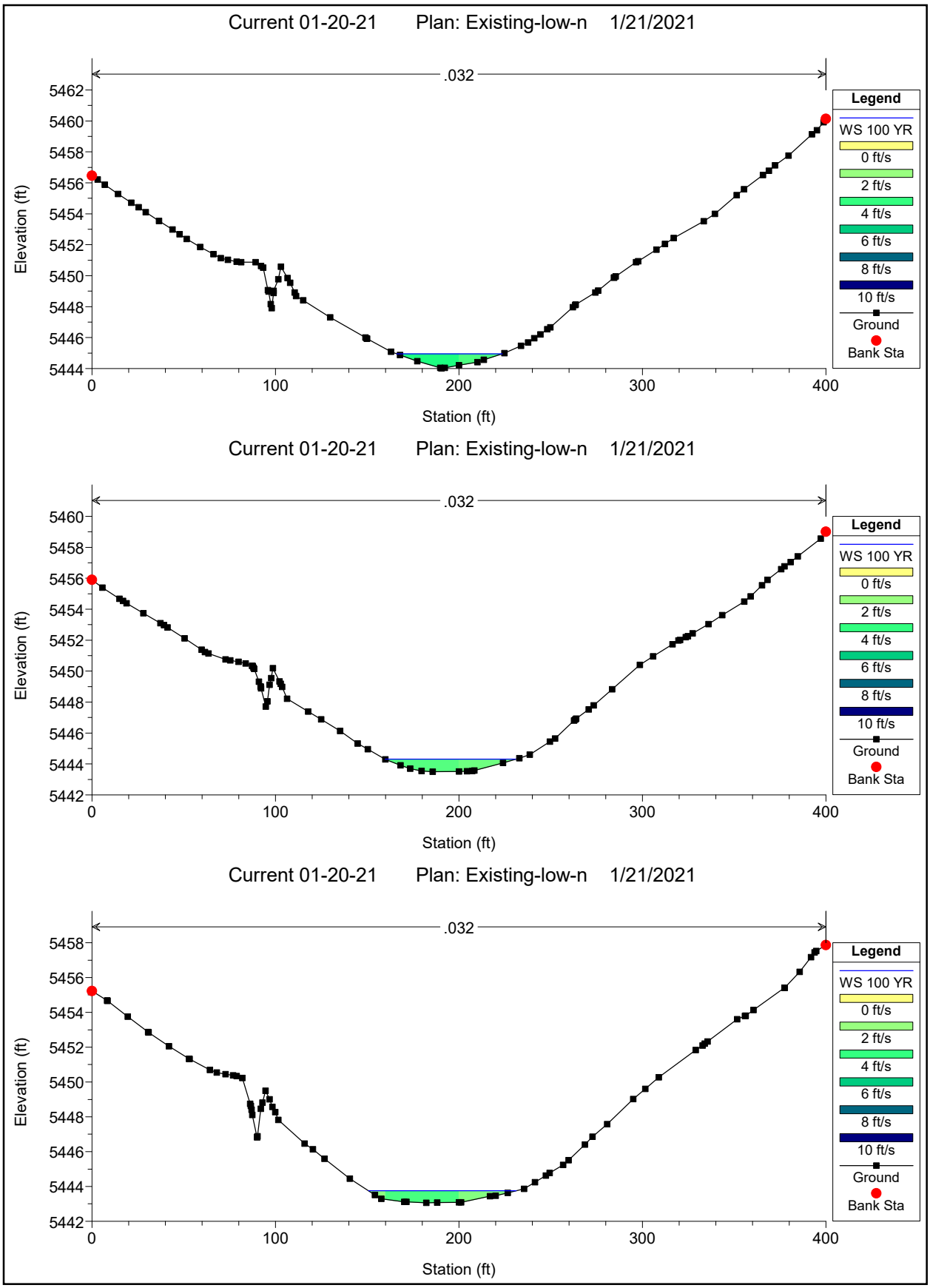
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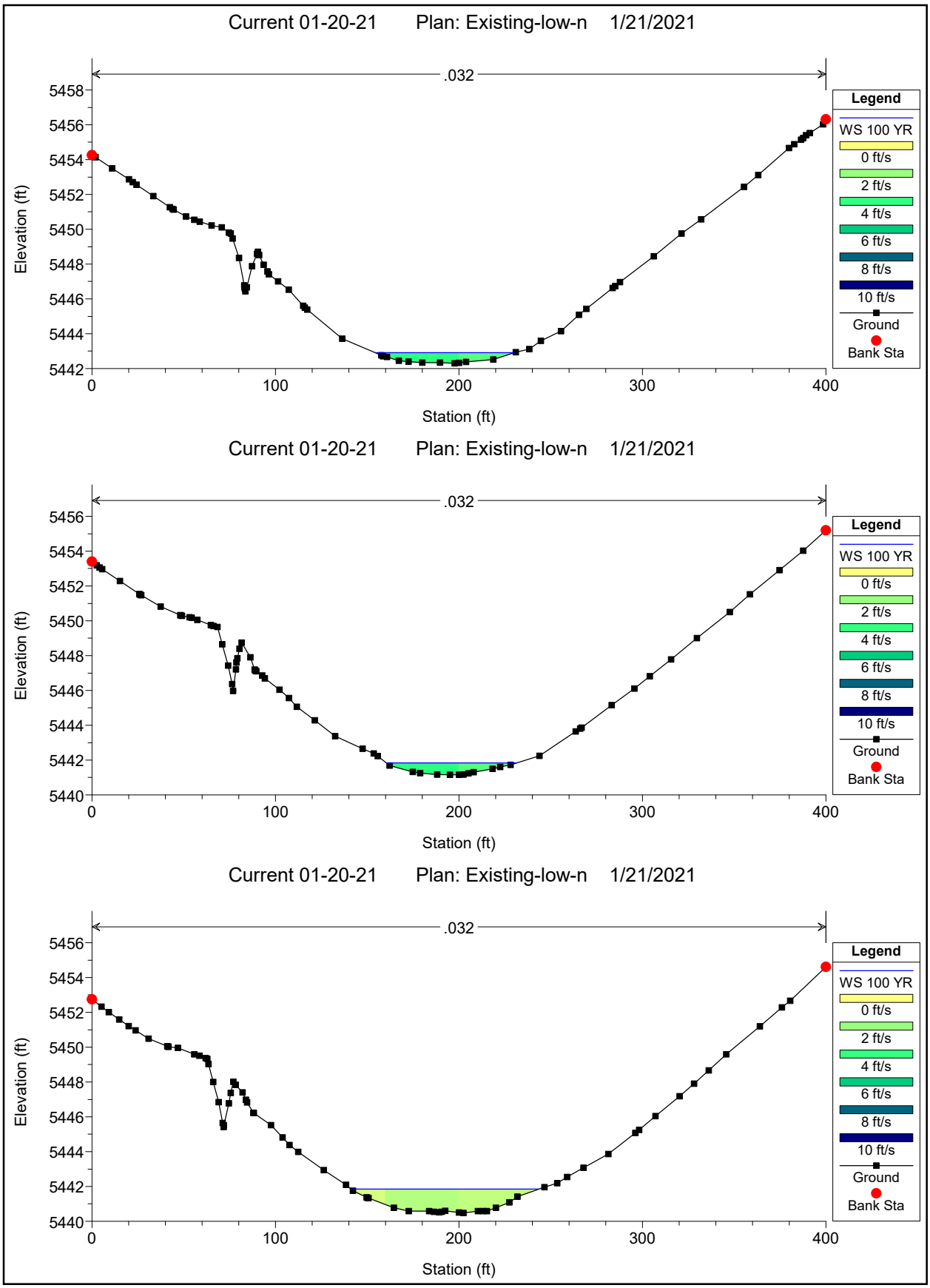
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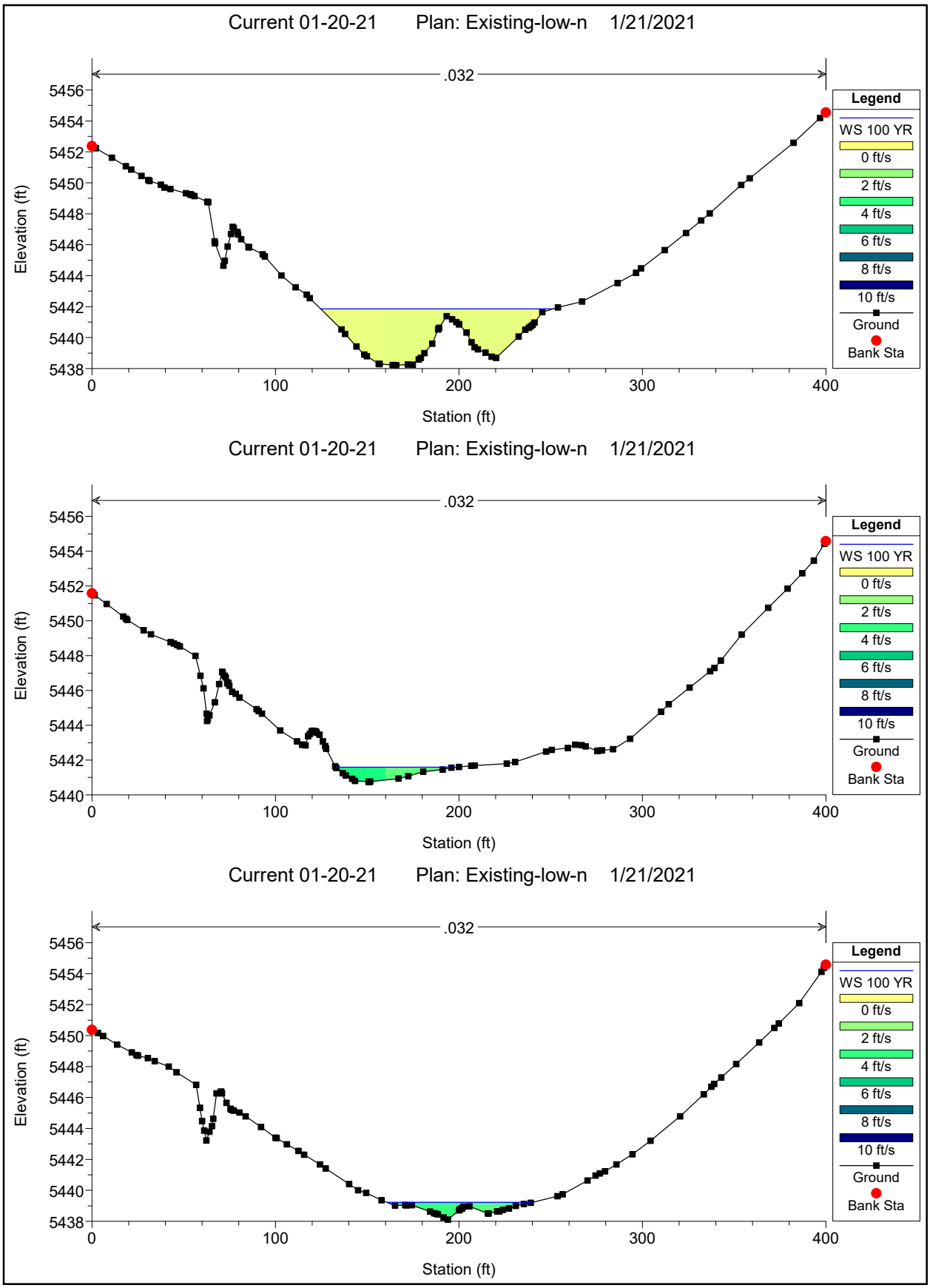
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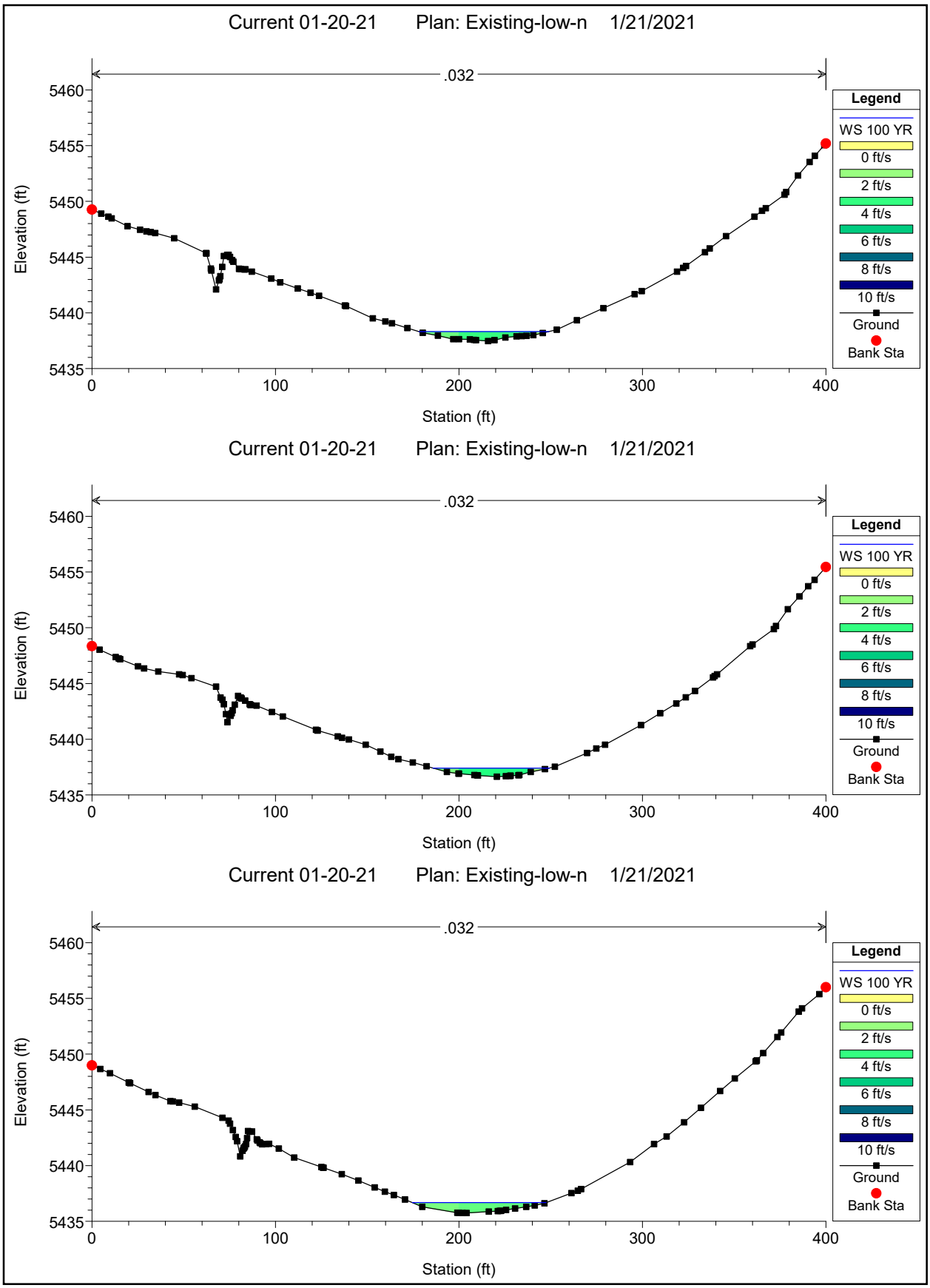
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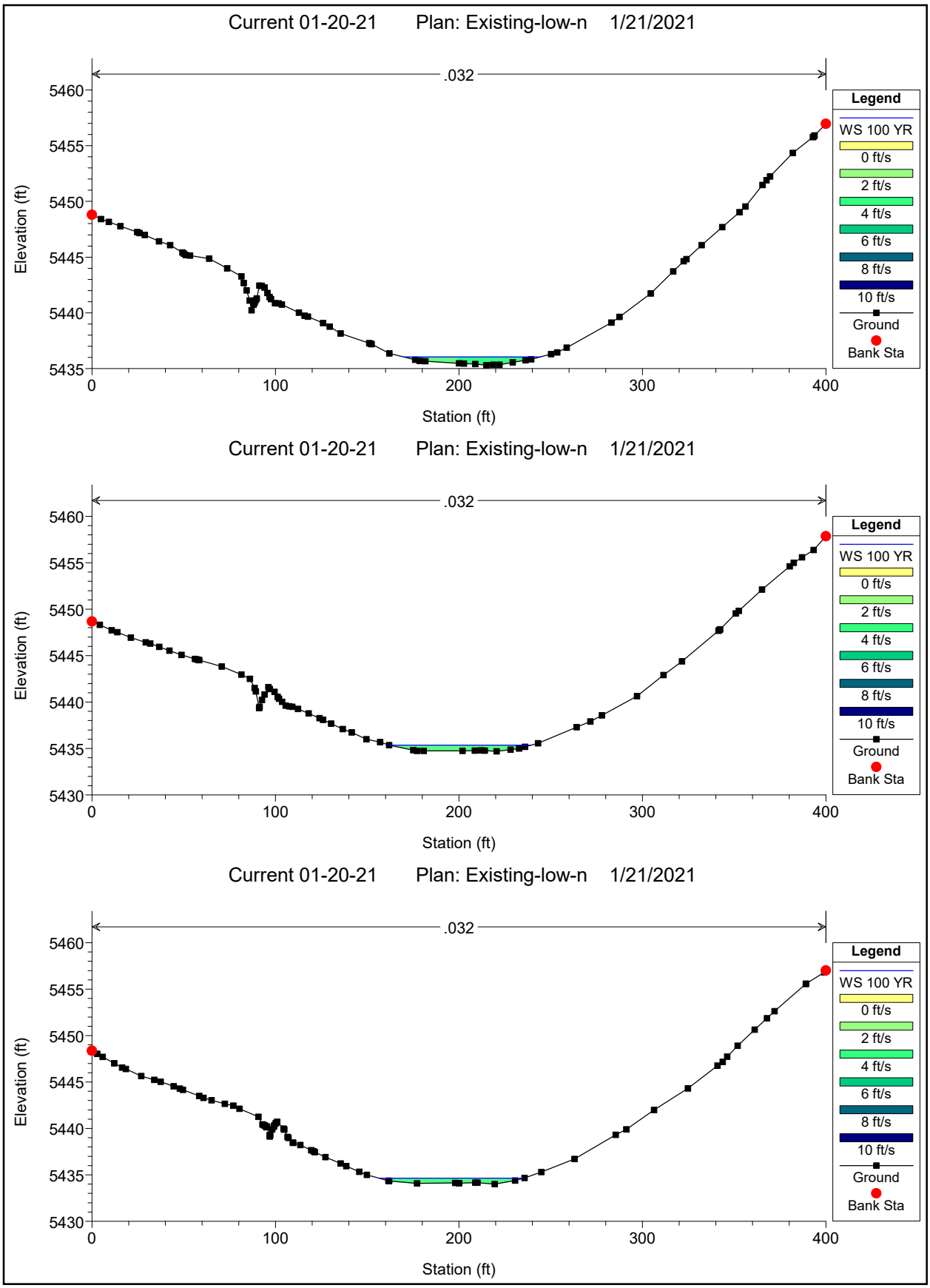
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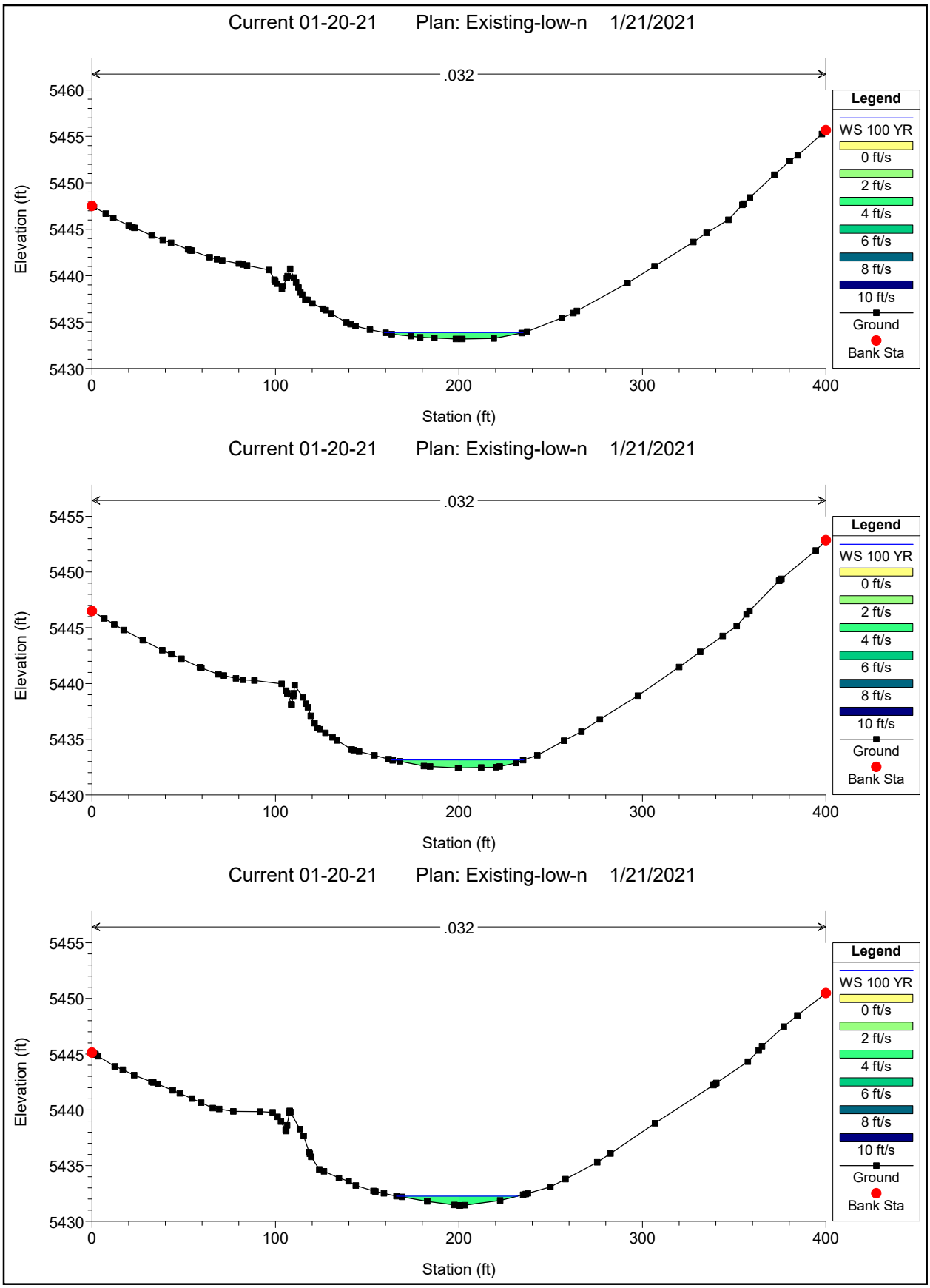
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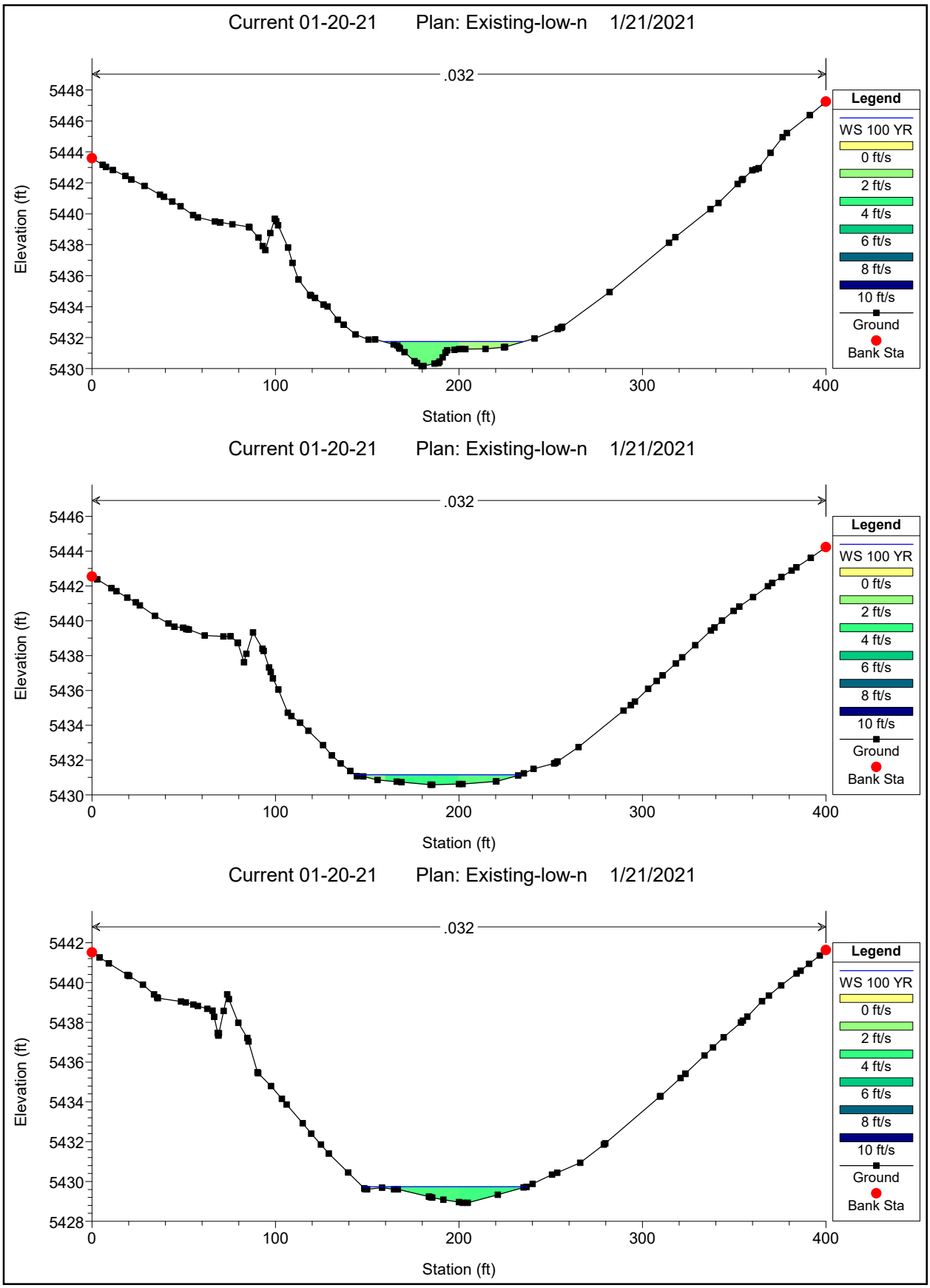
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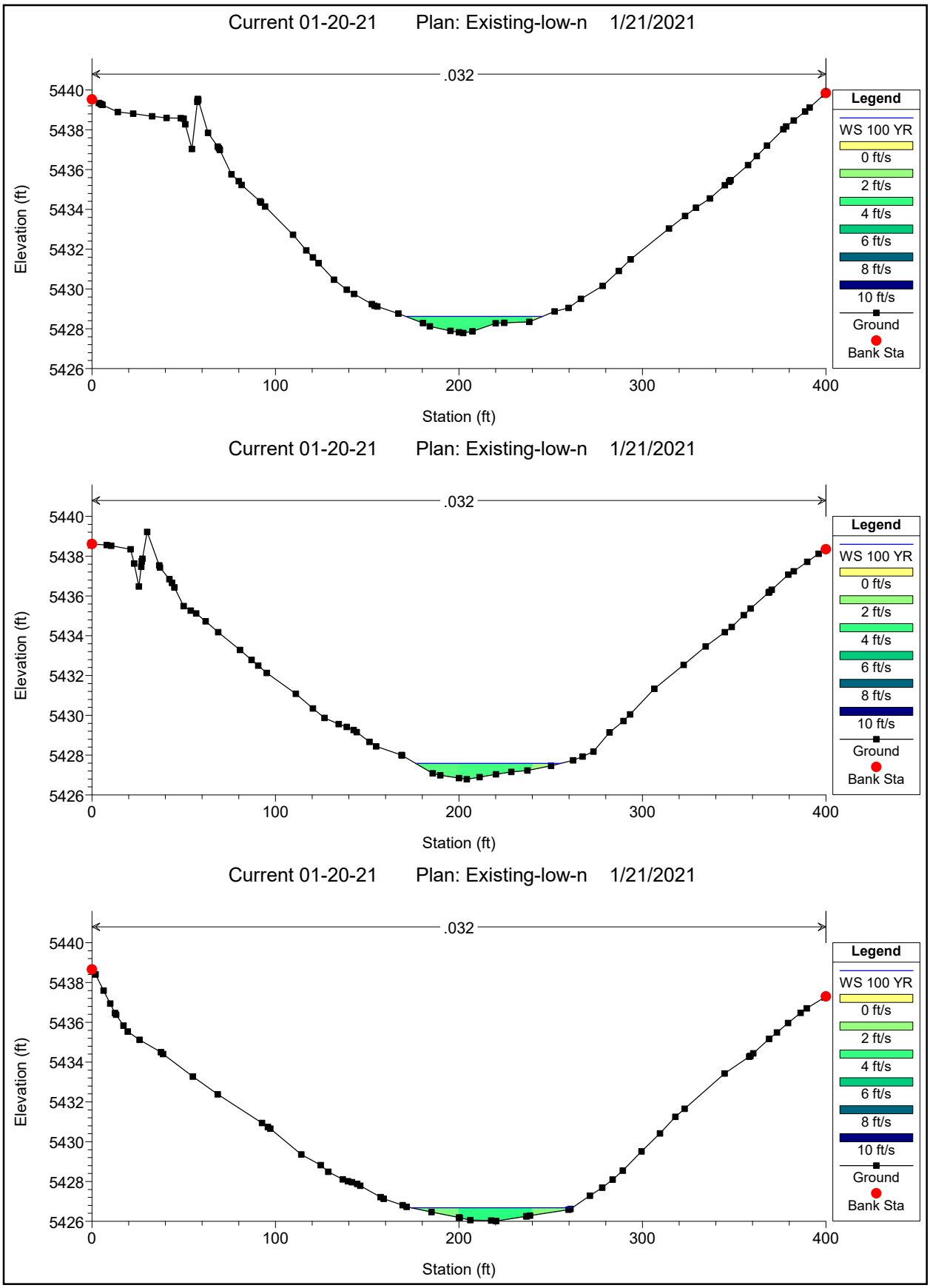
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Station (ft)
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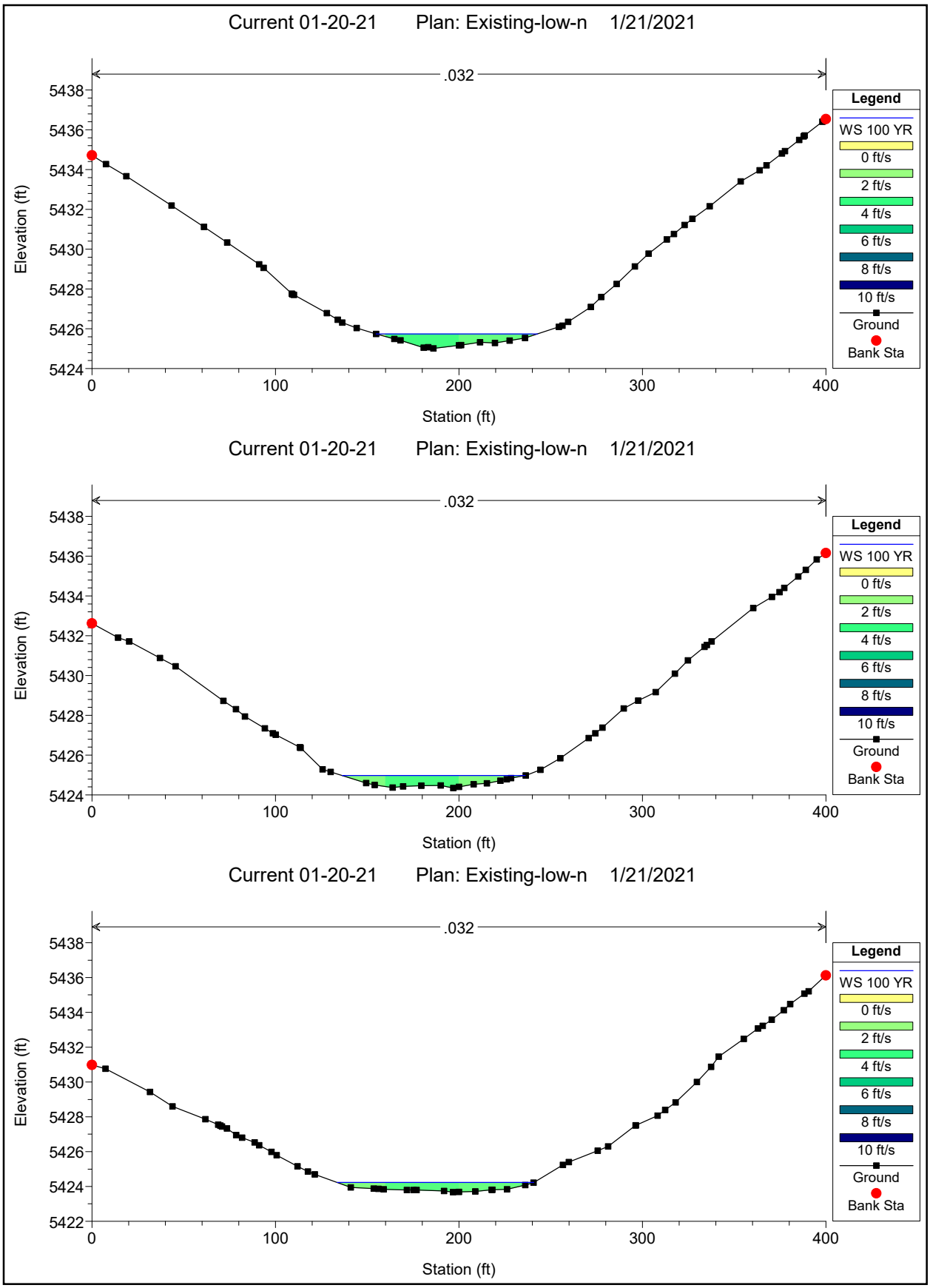
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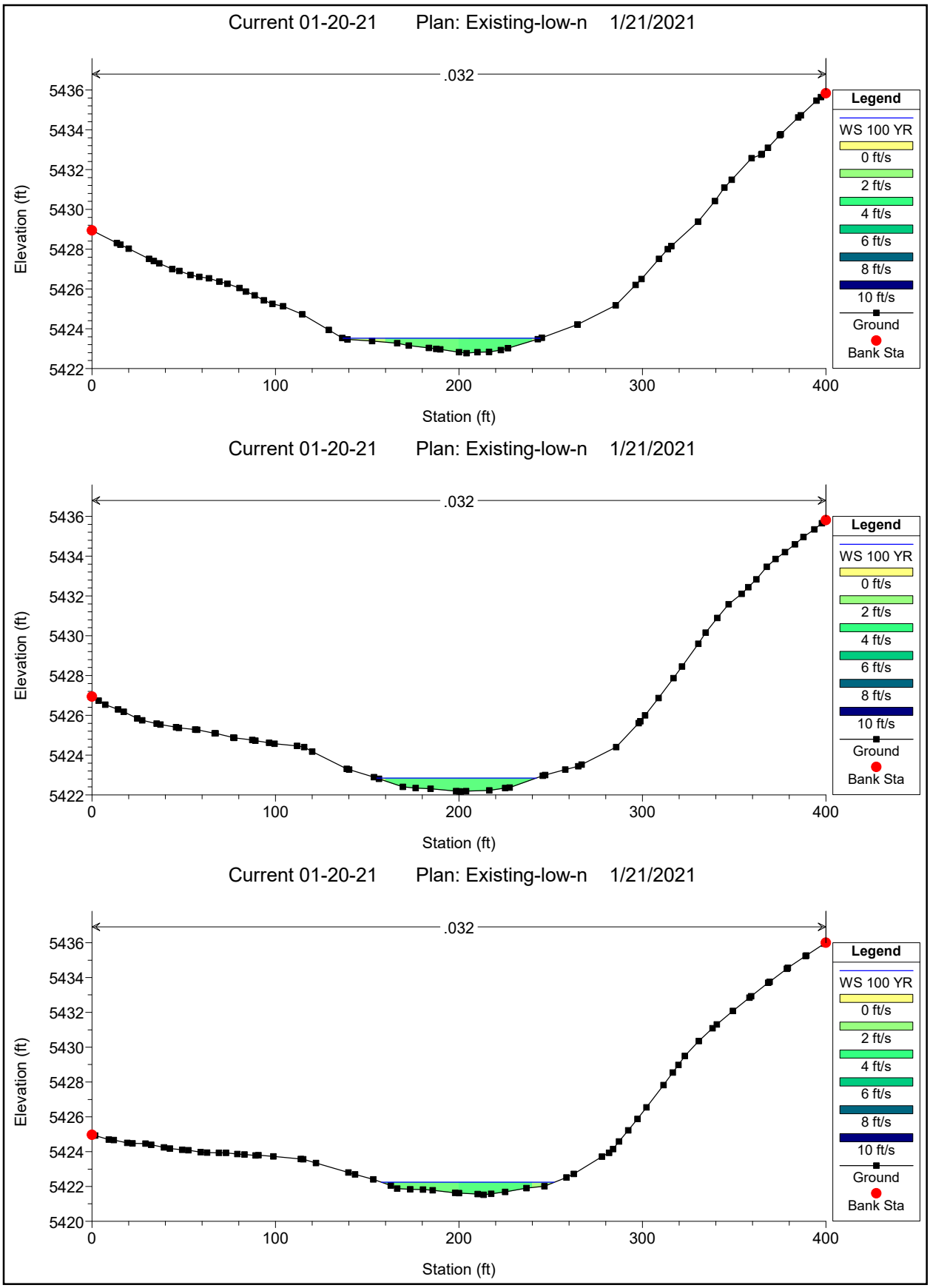
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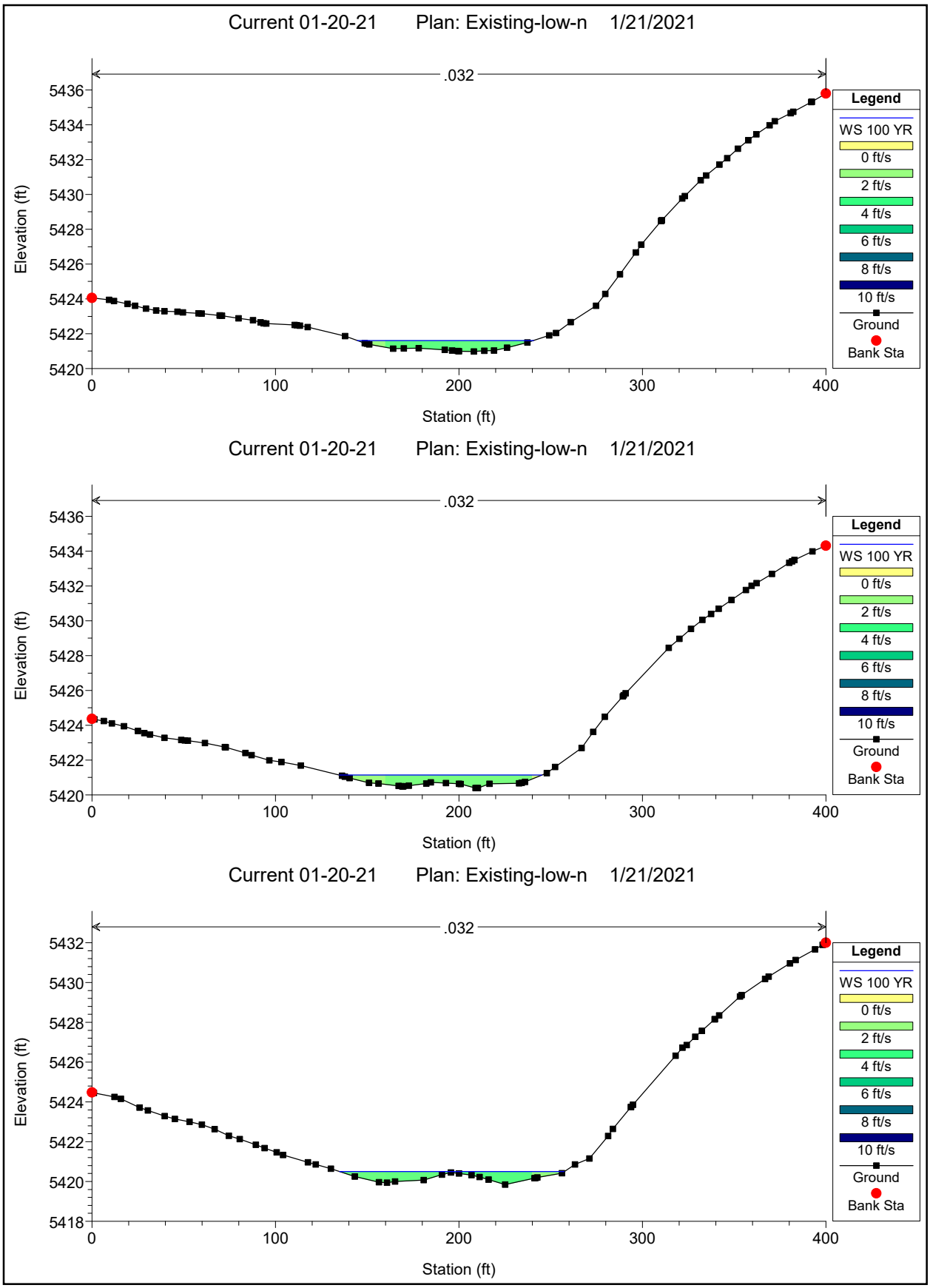
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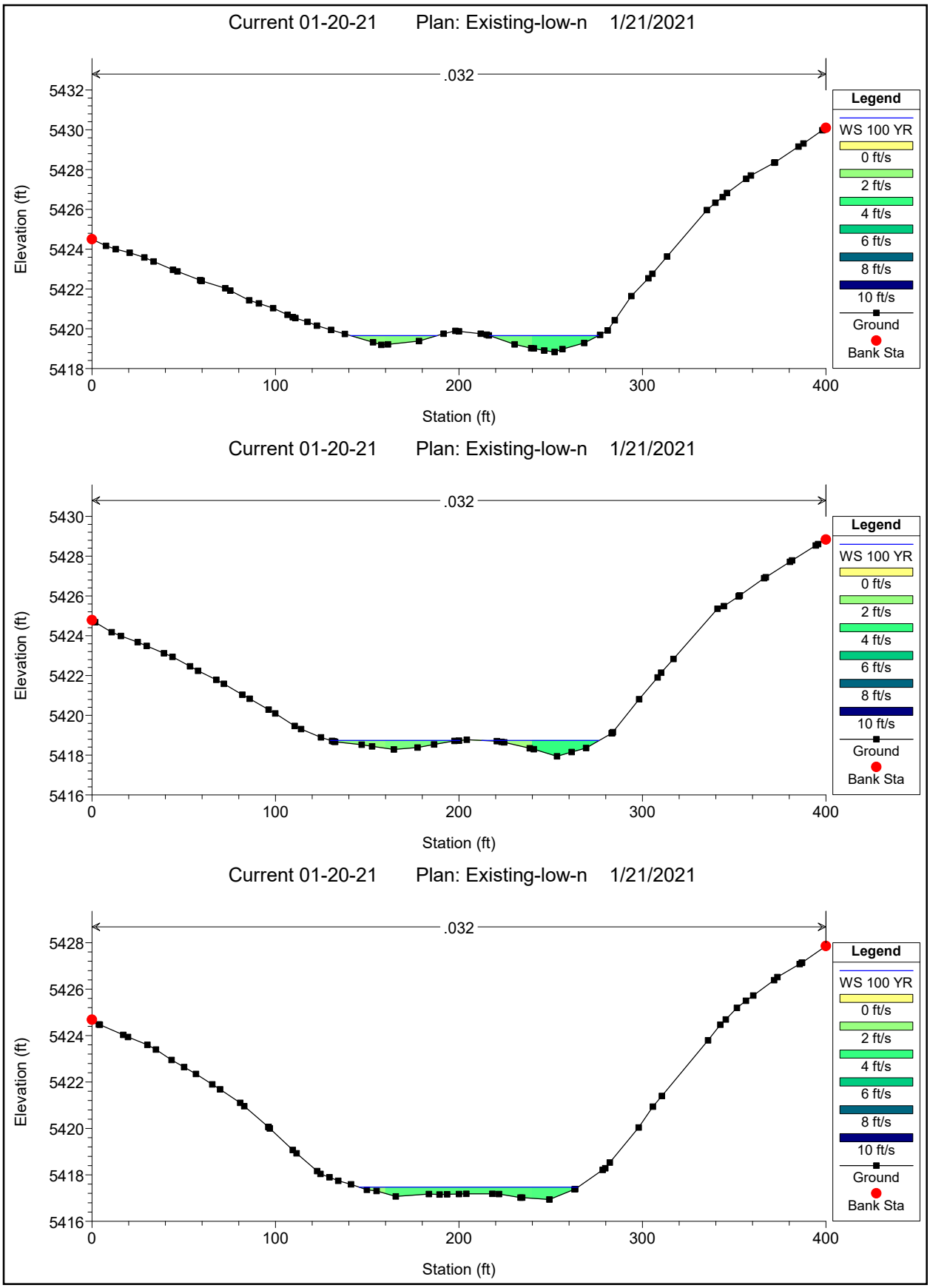
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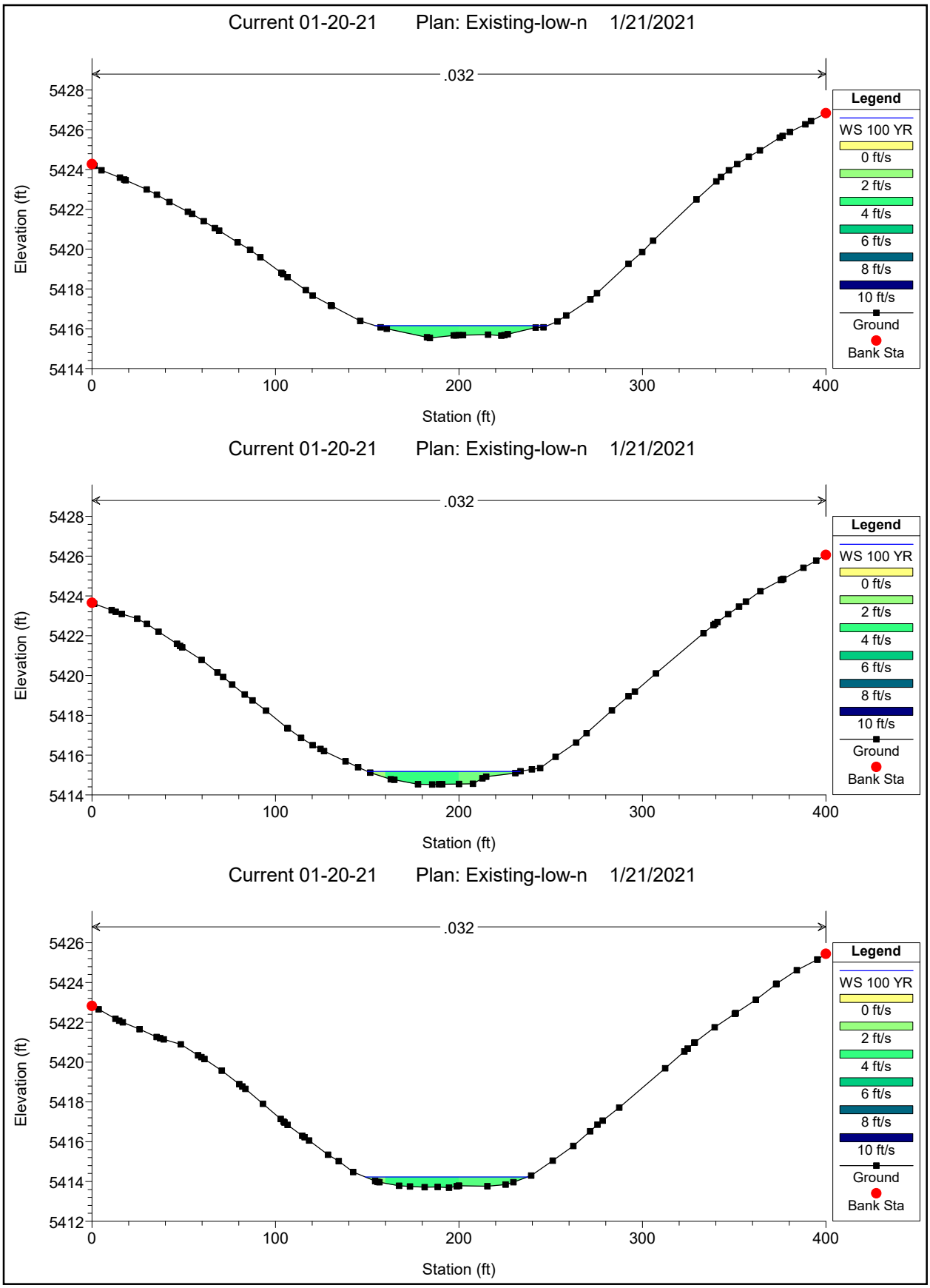
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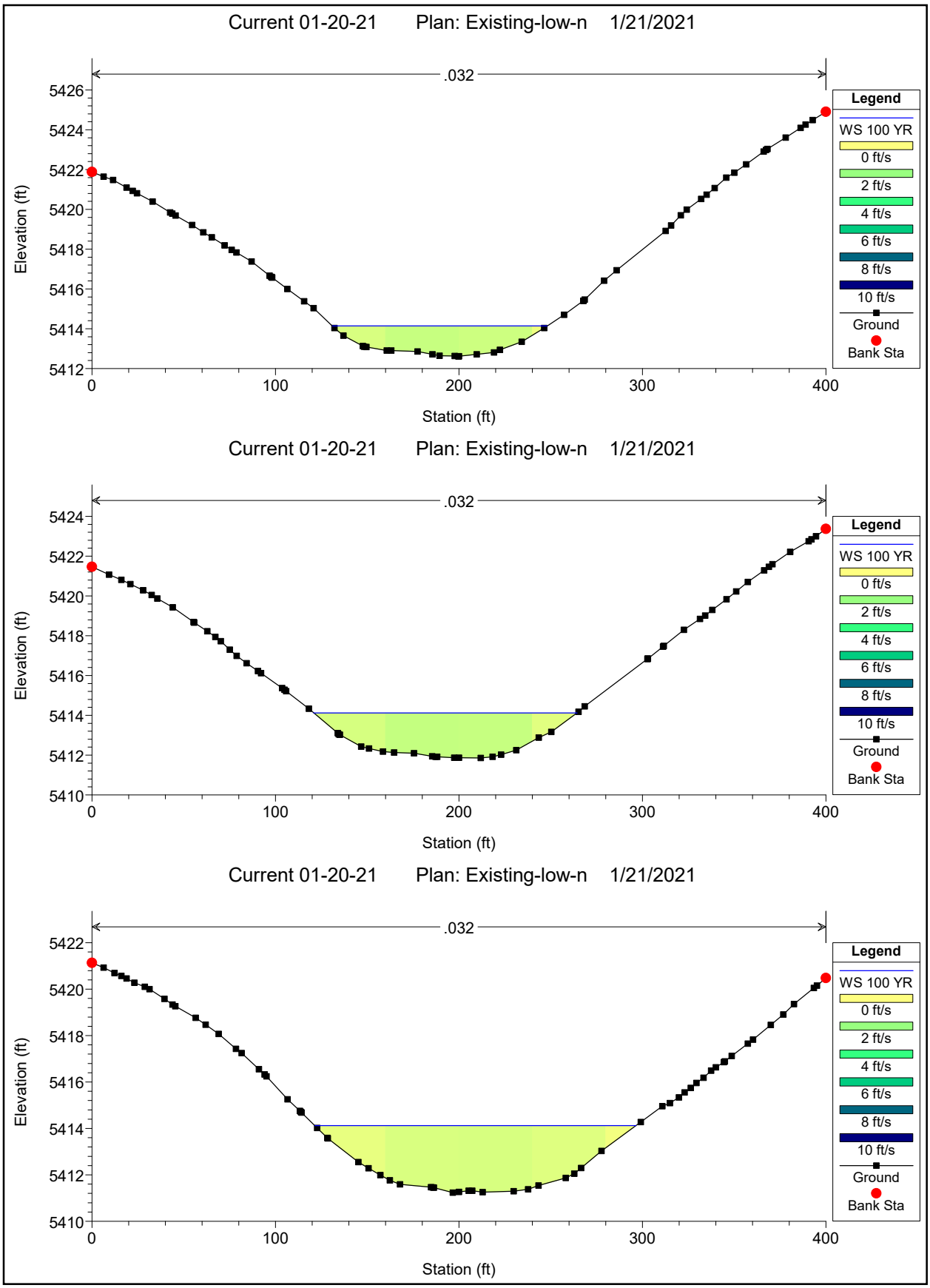
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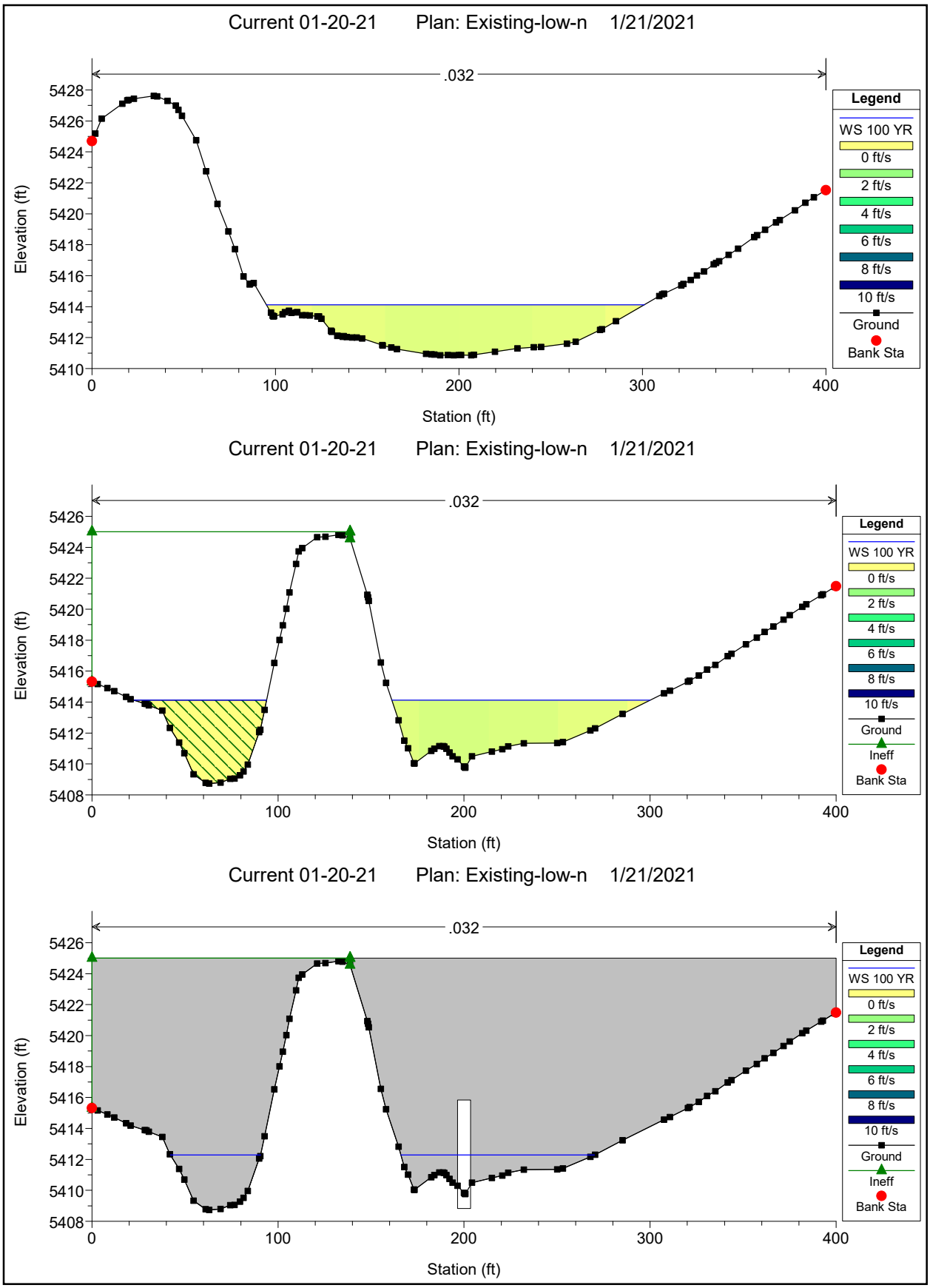
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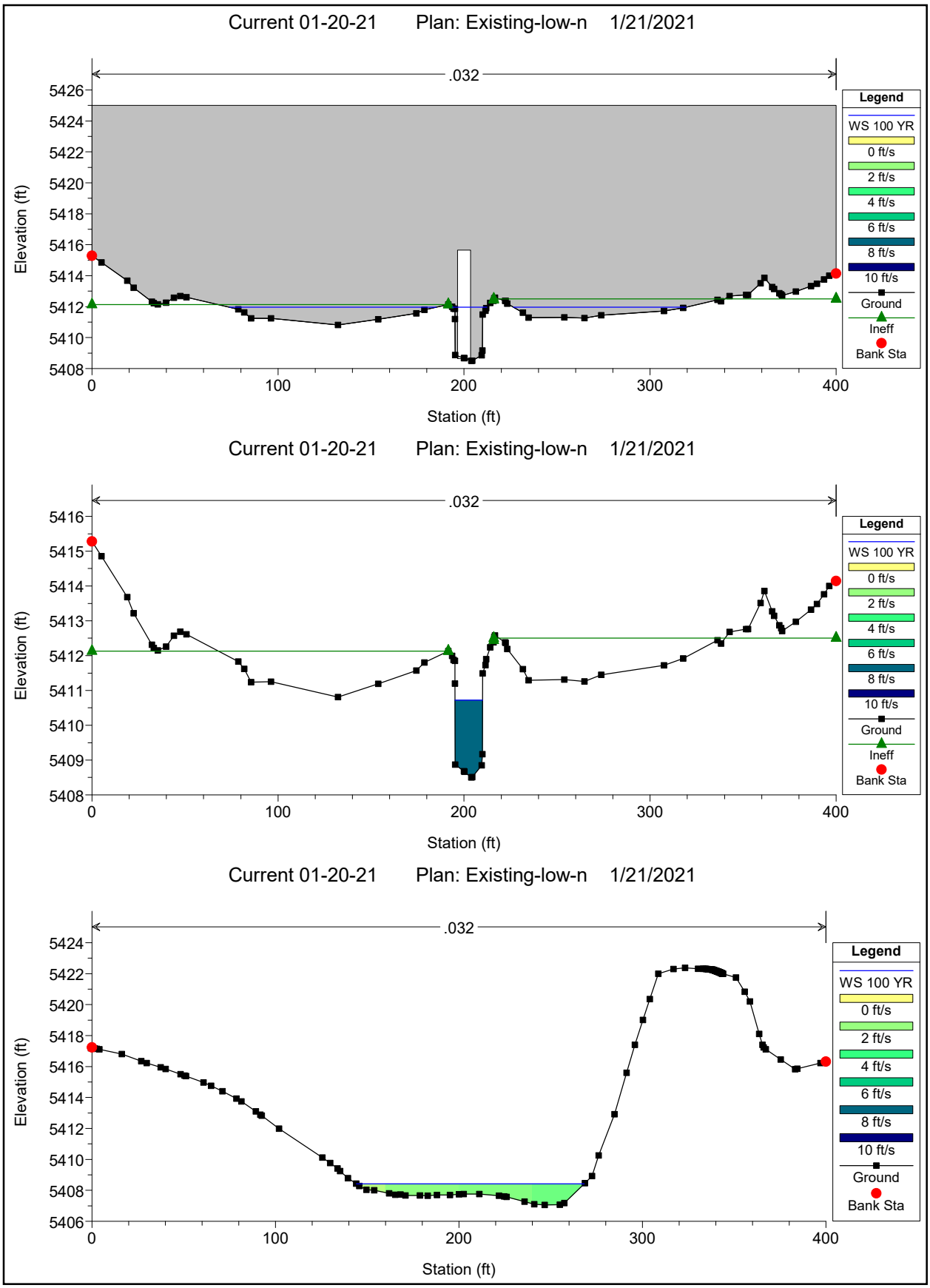
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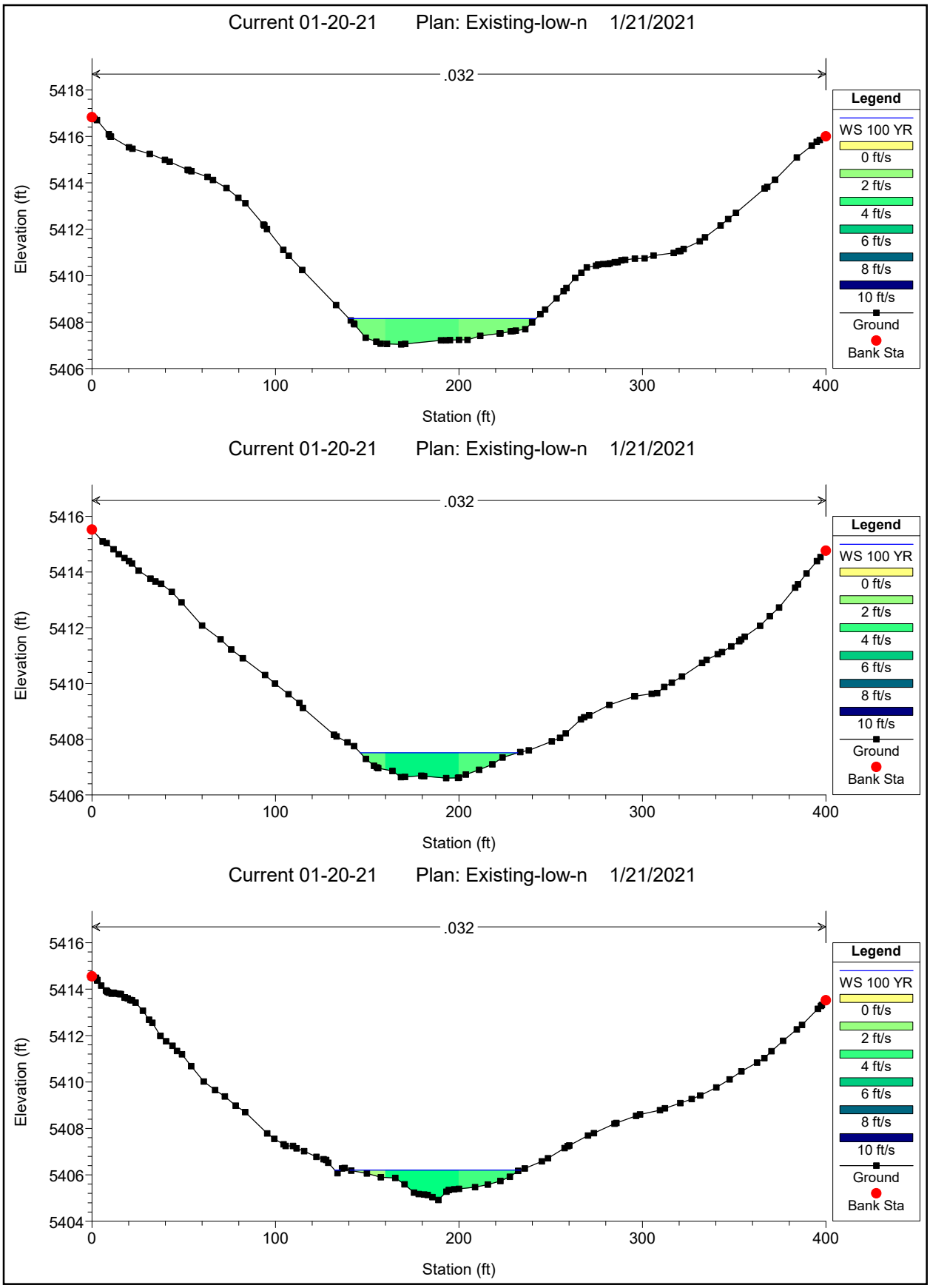
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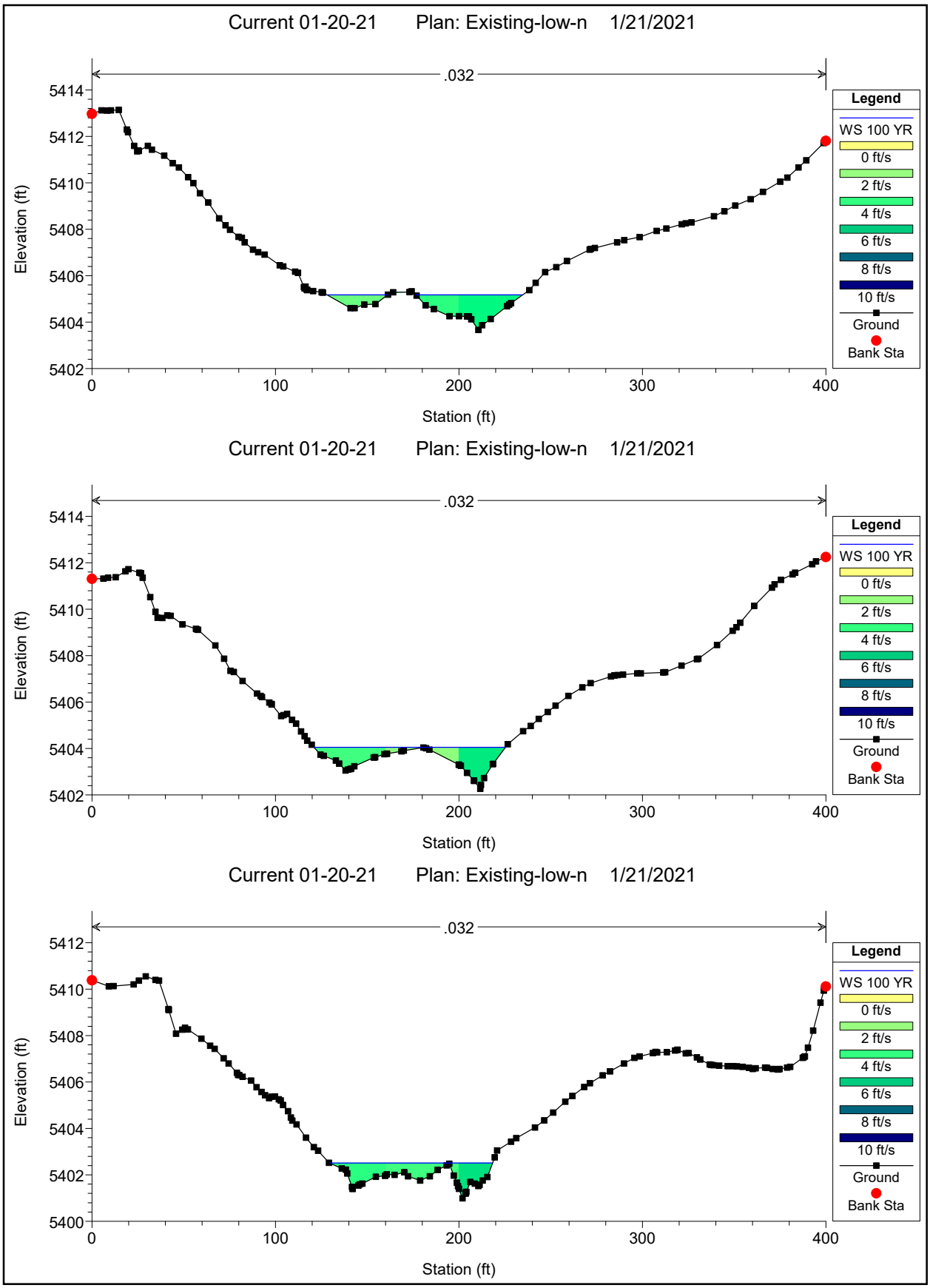
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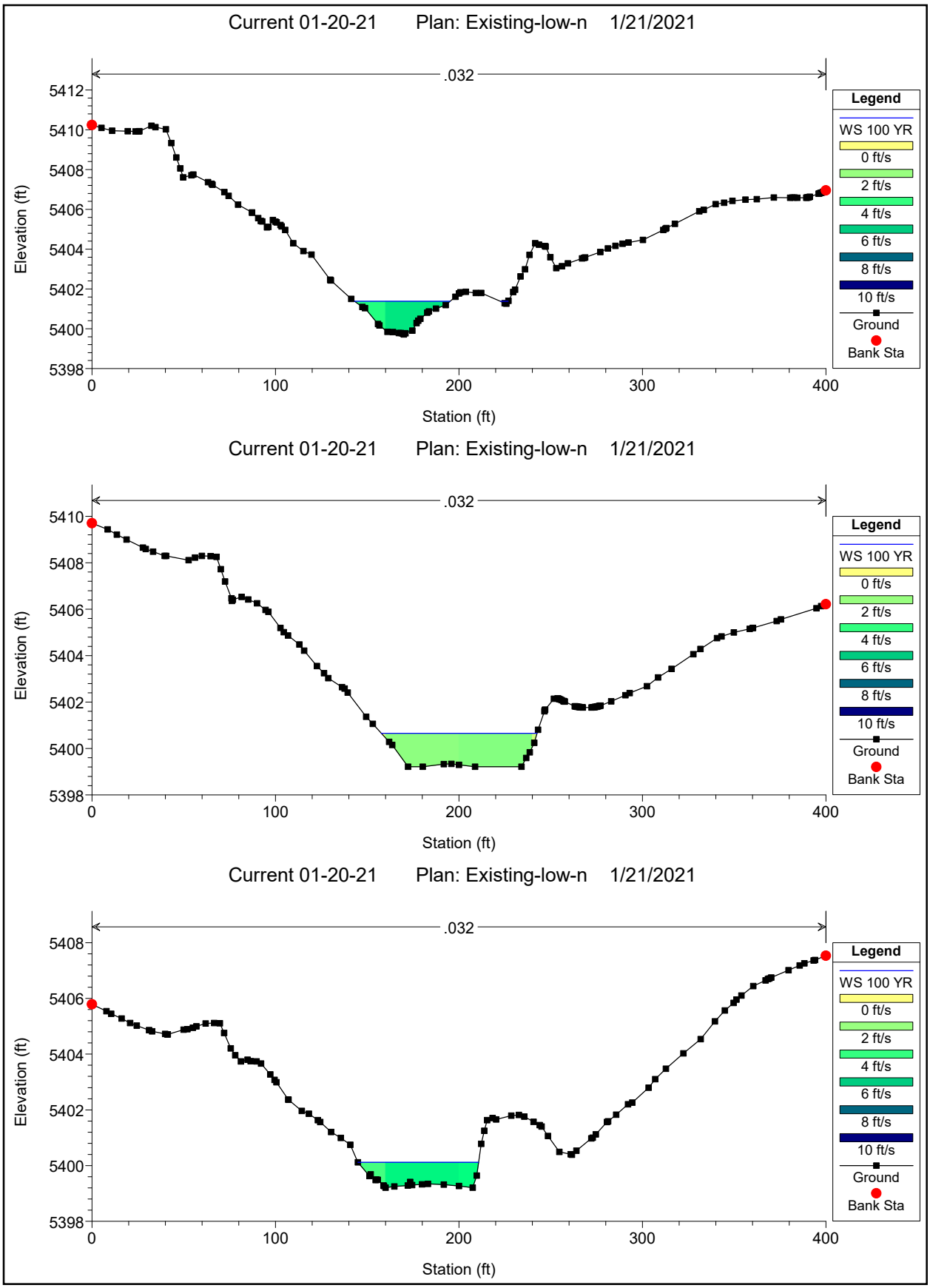
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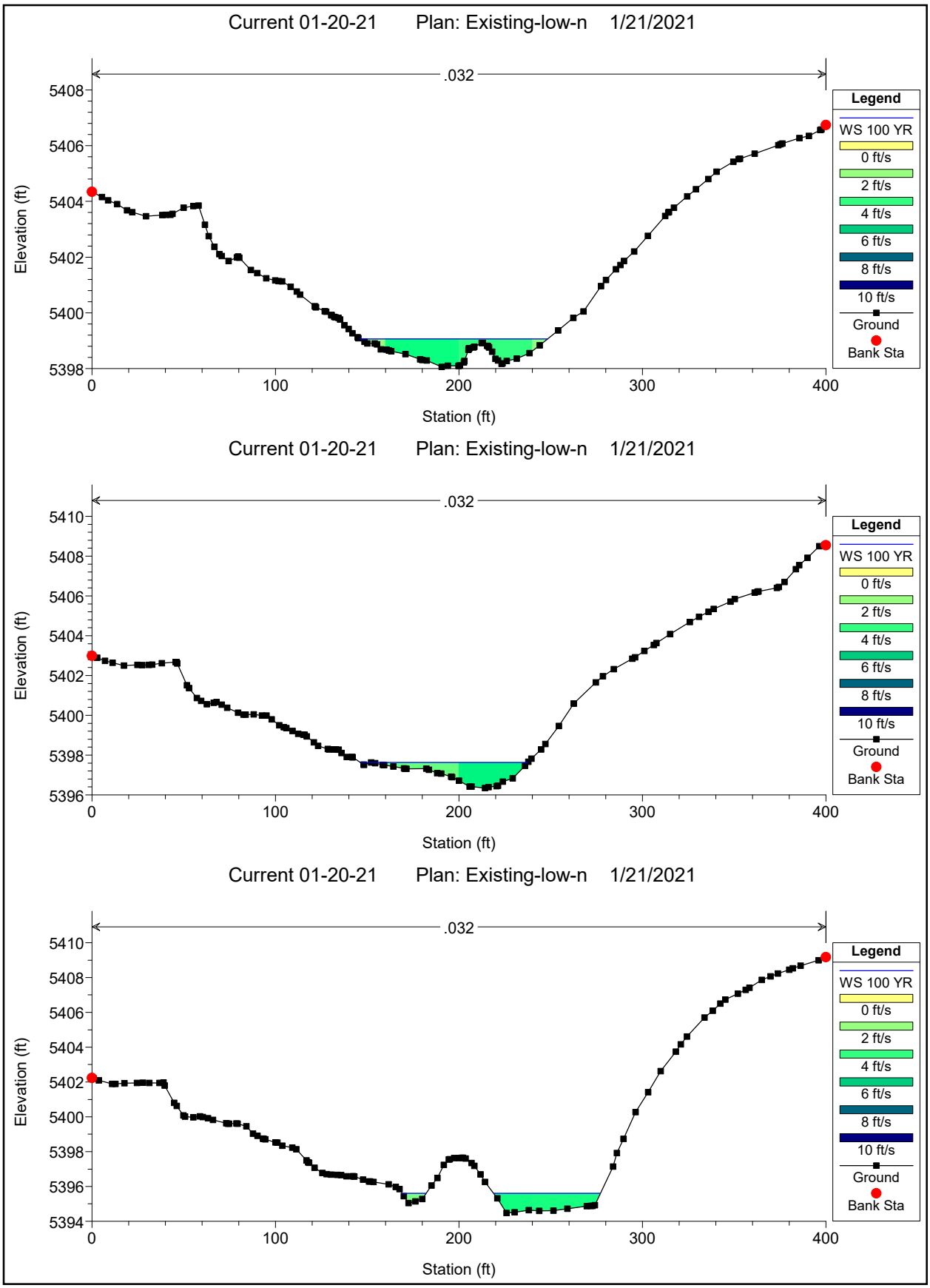
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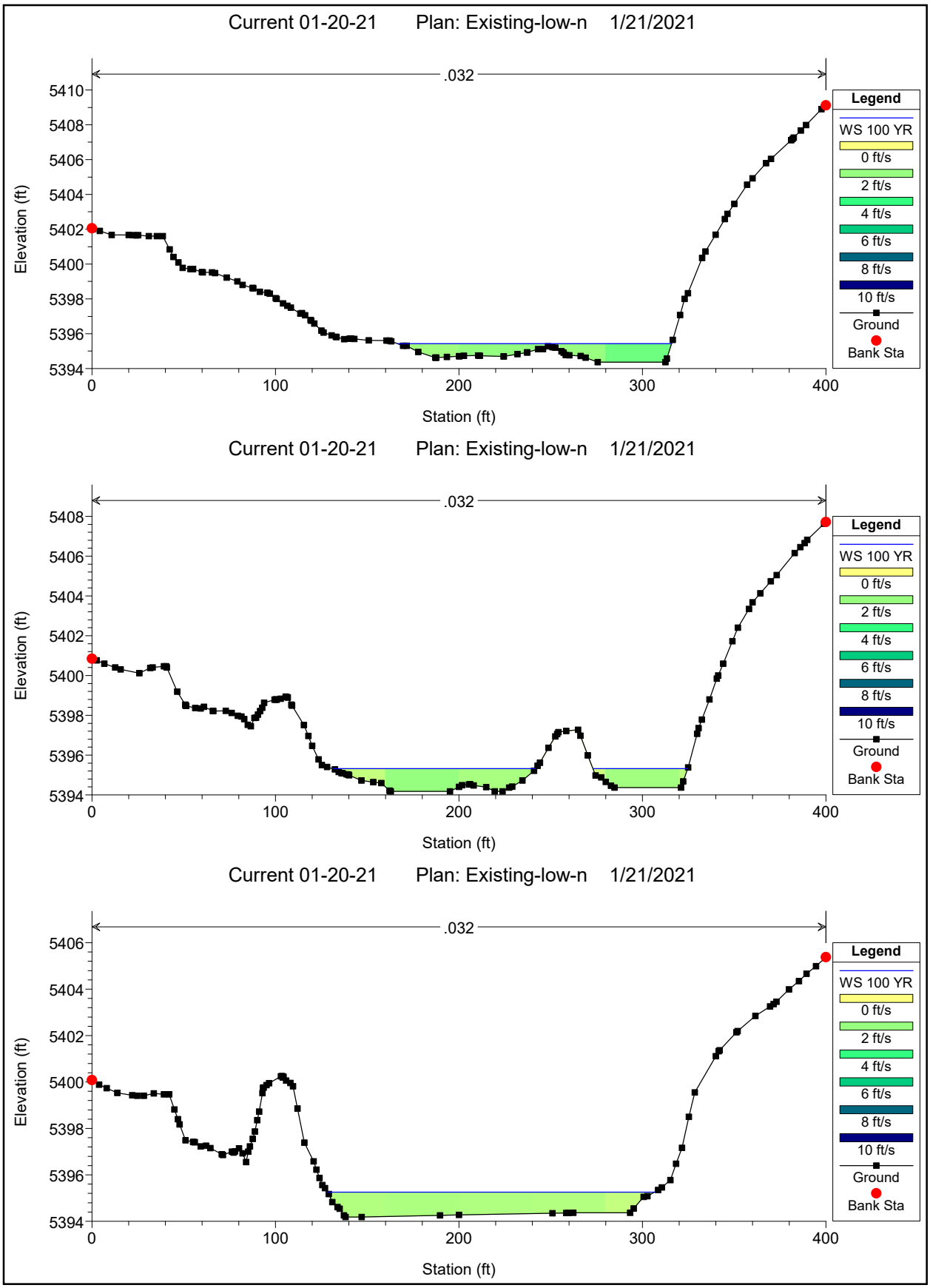
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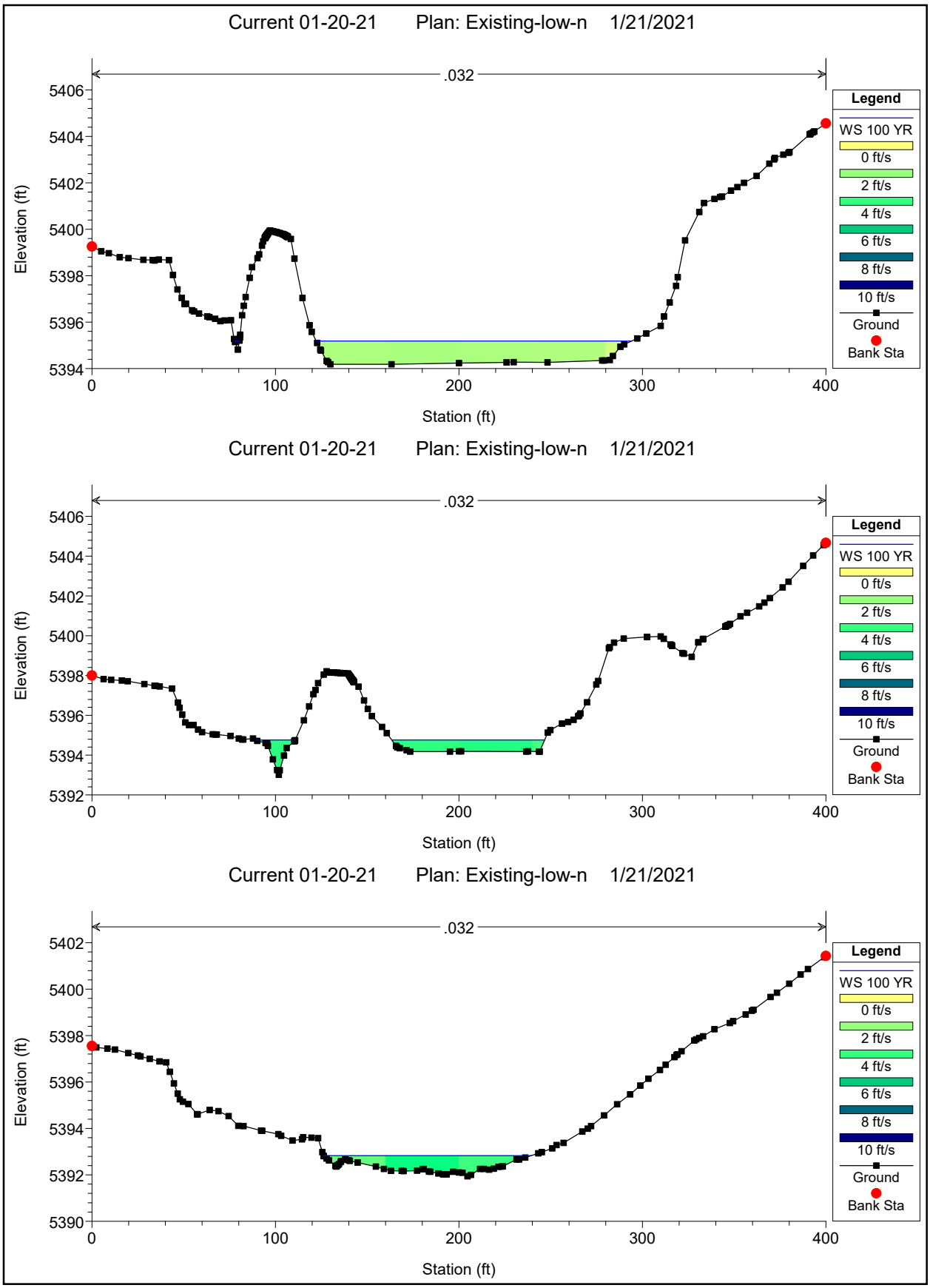
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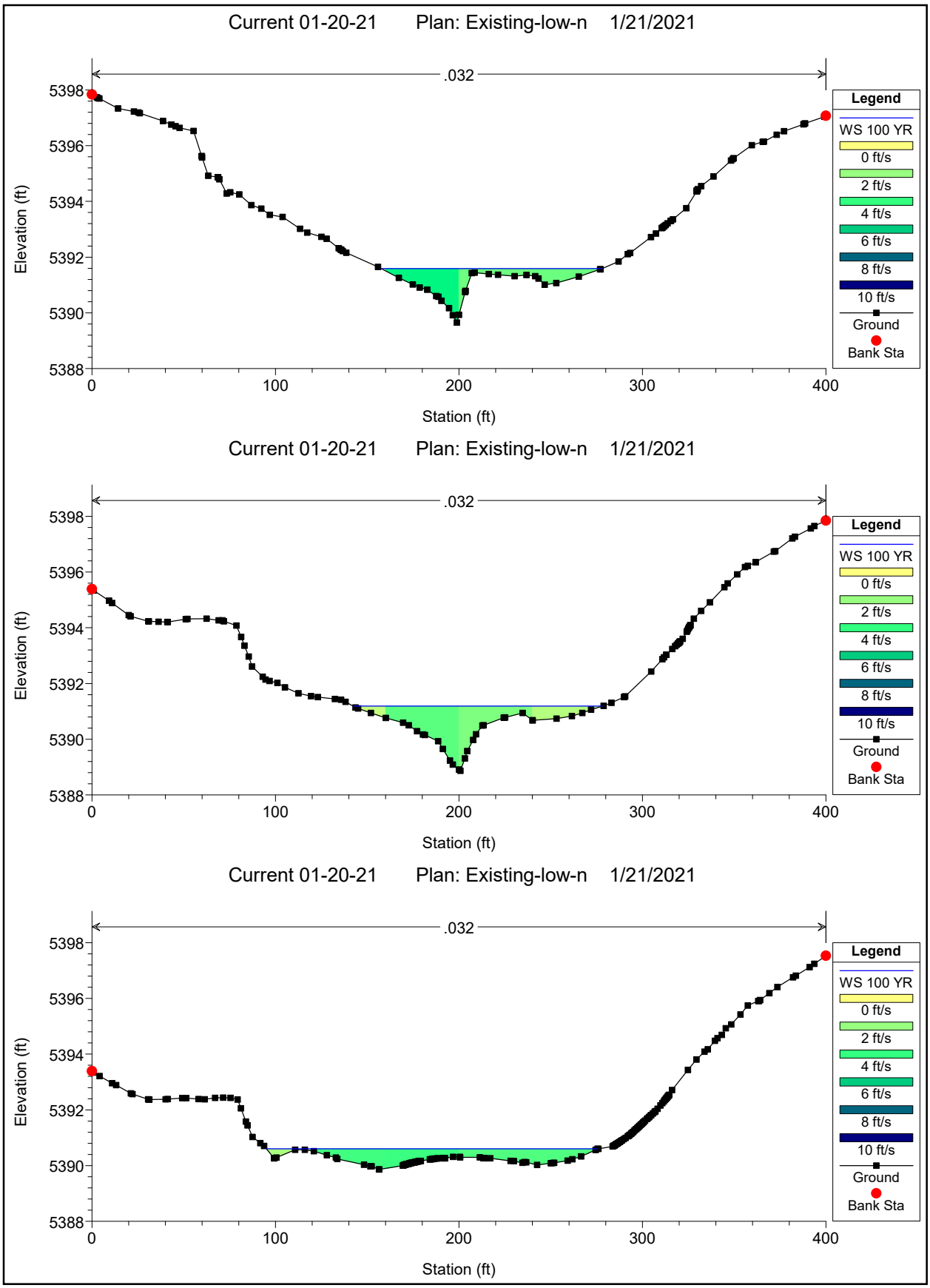
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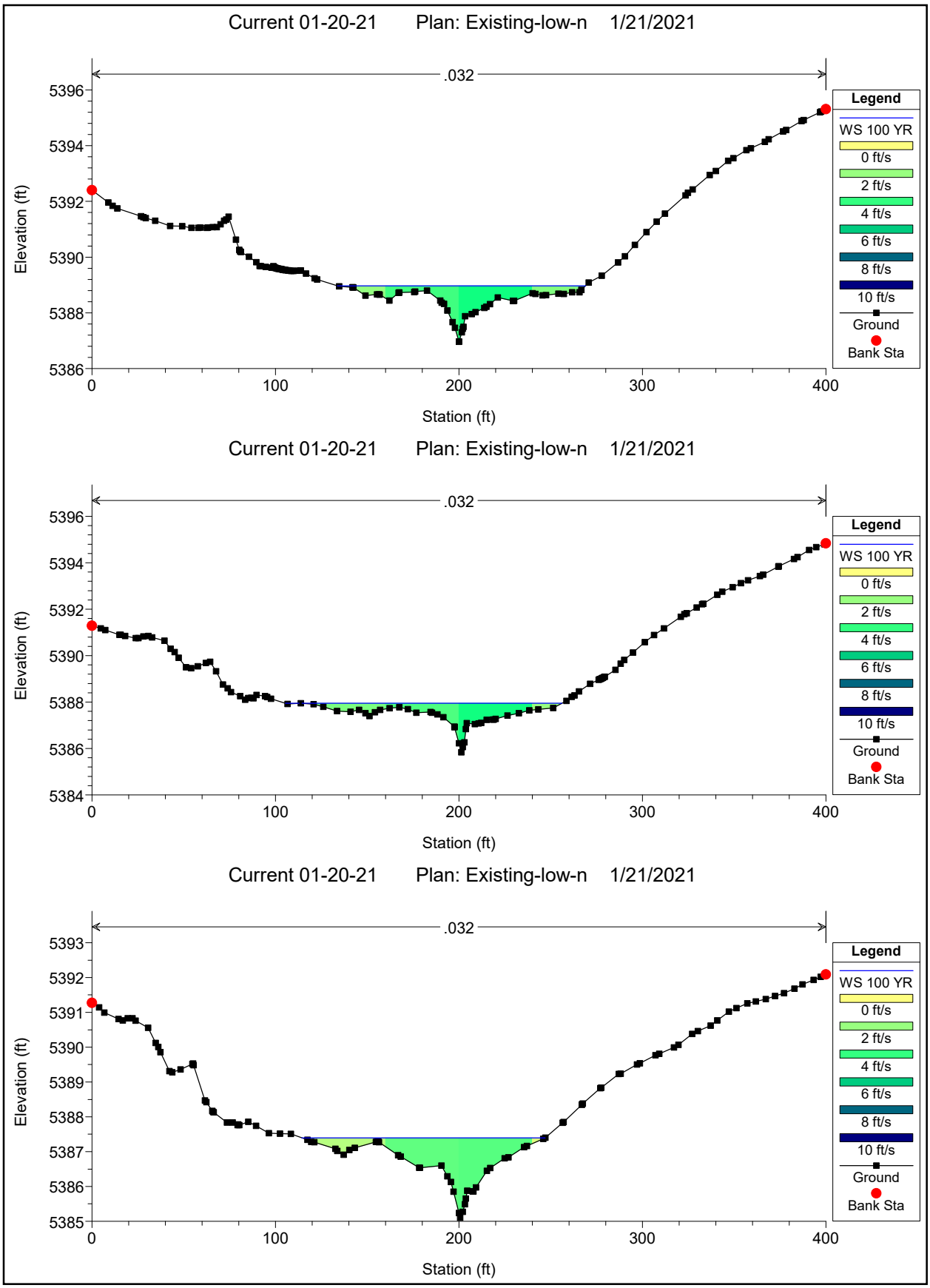
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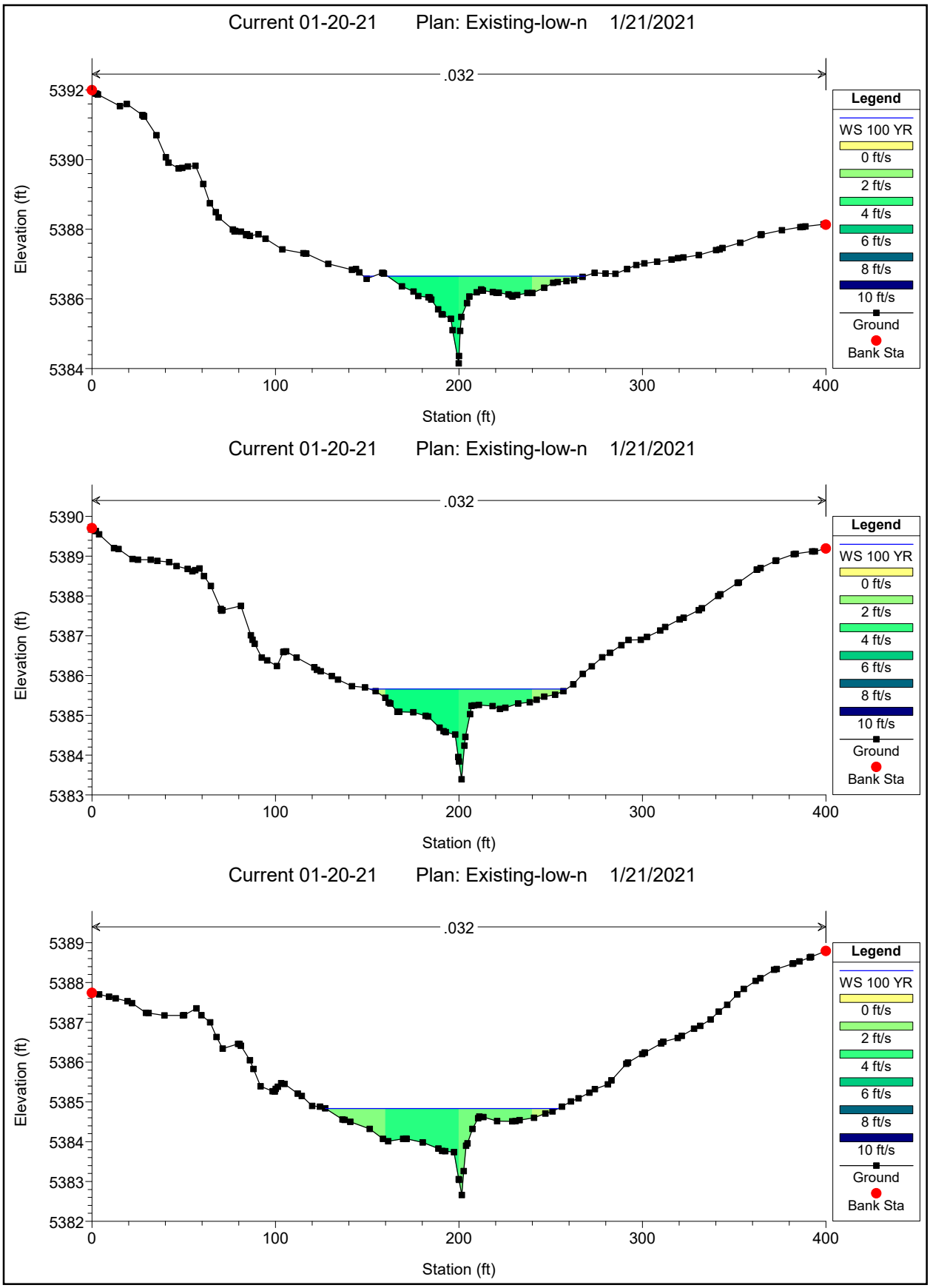
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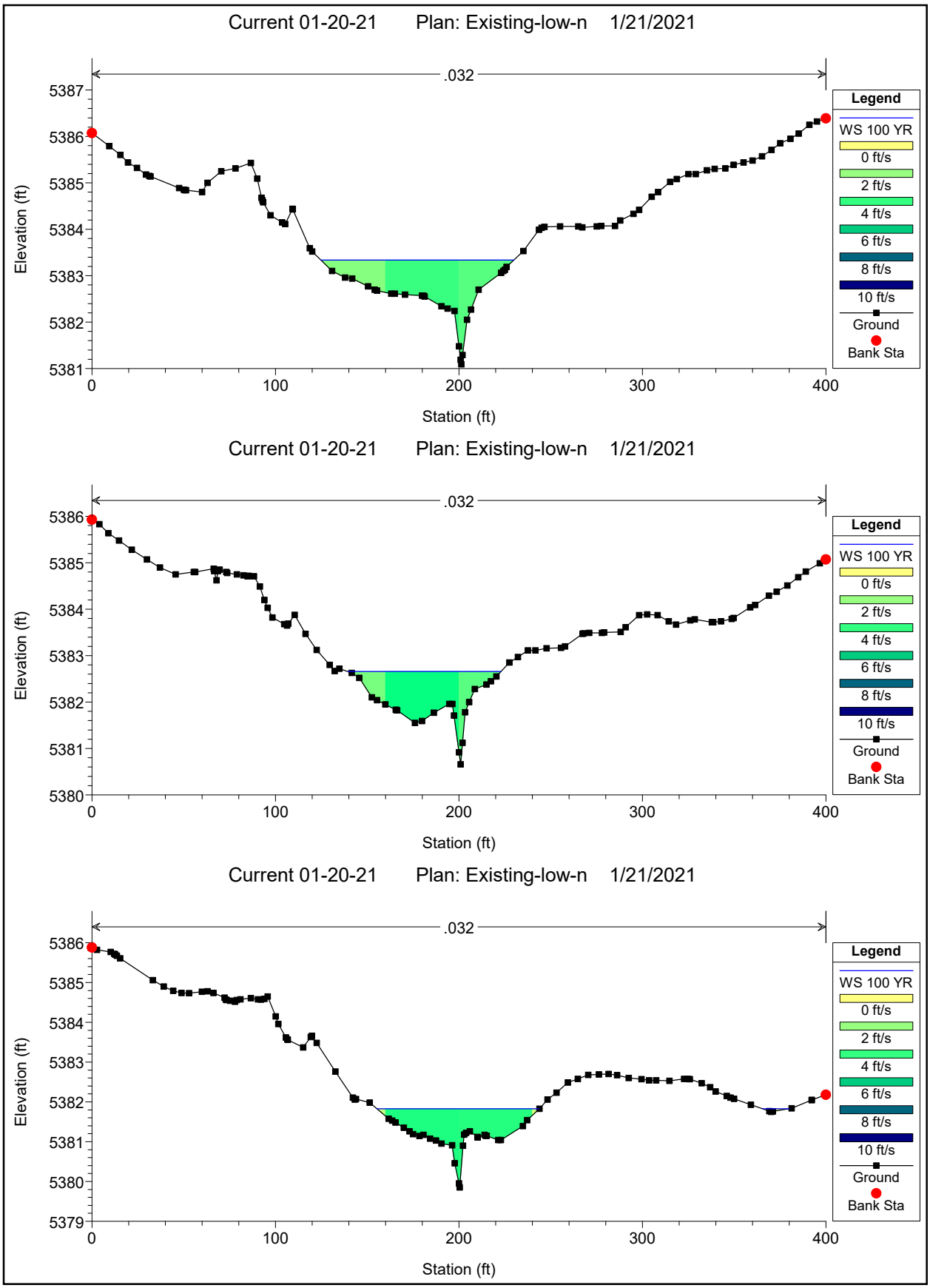
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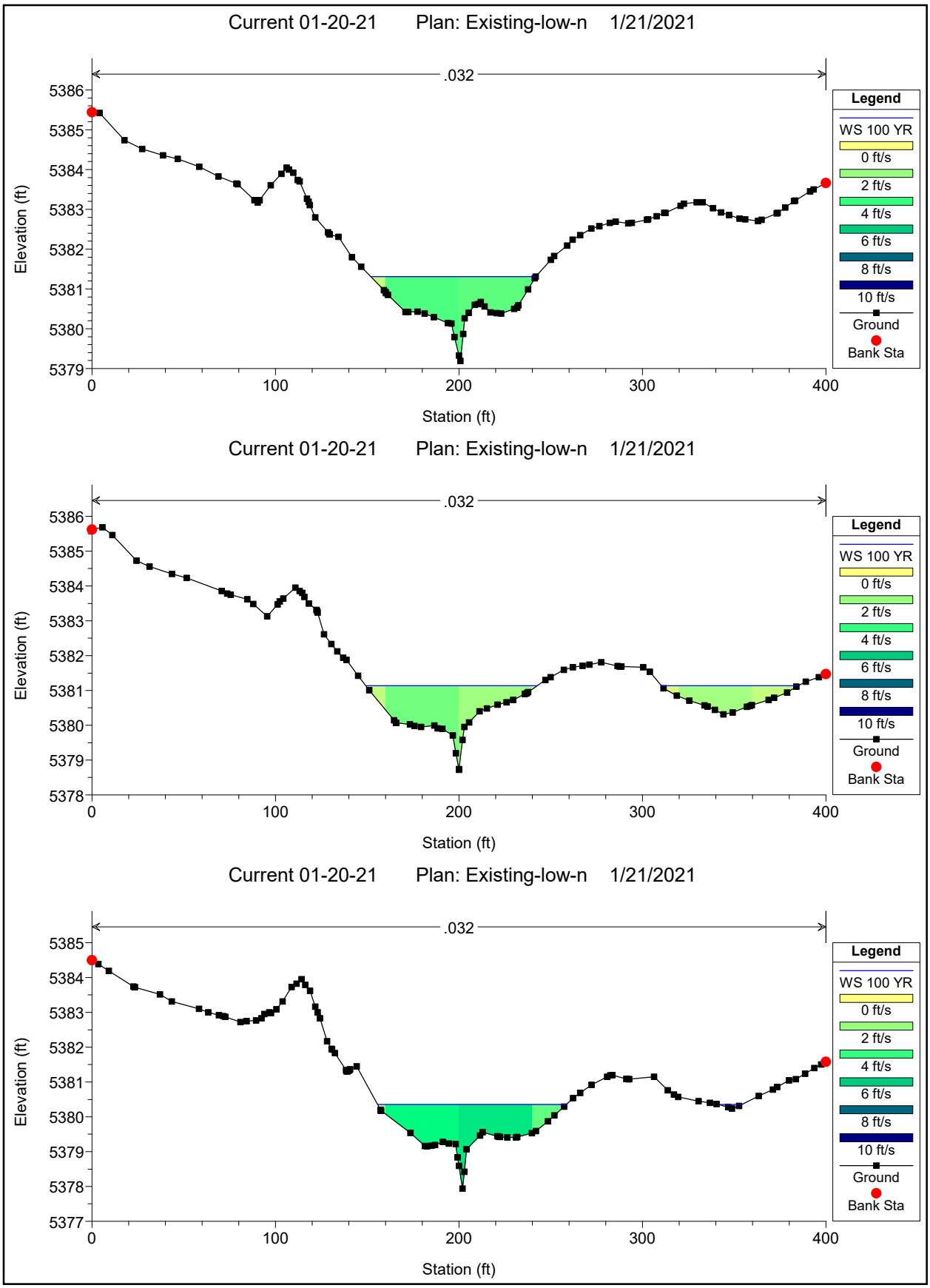
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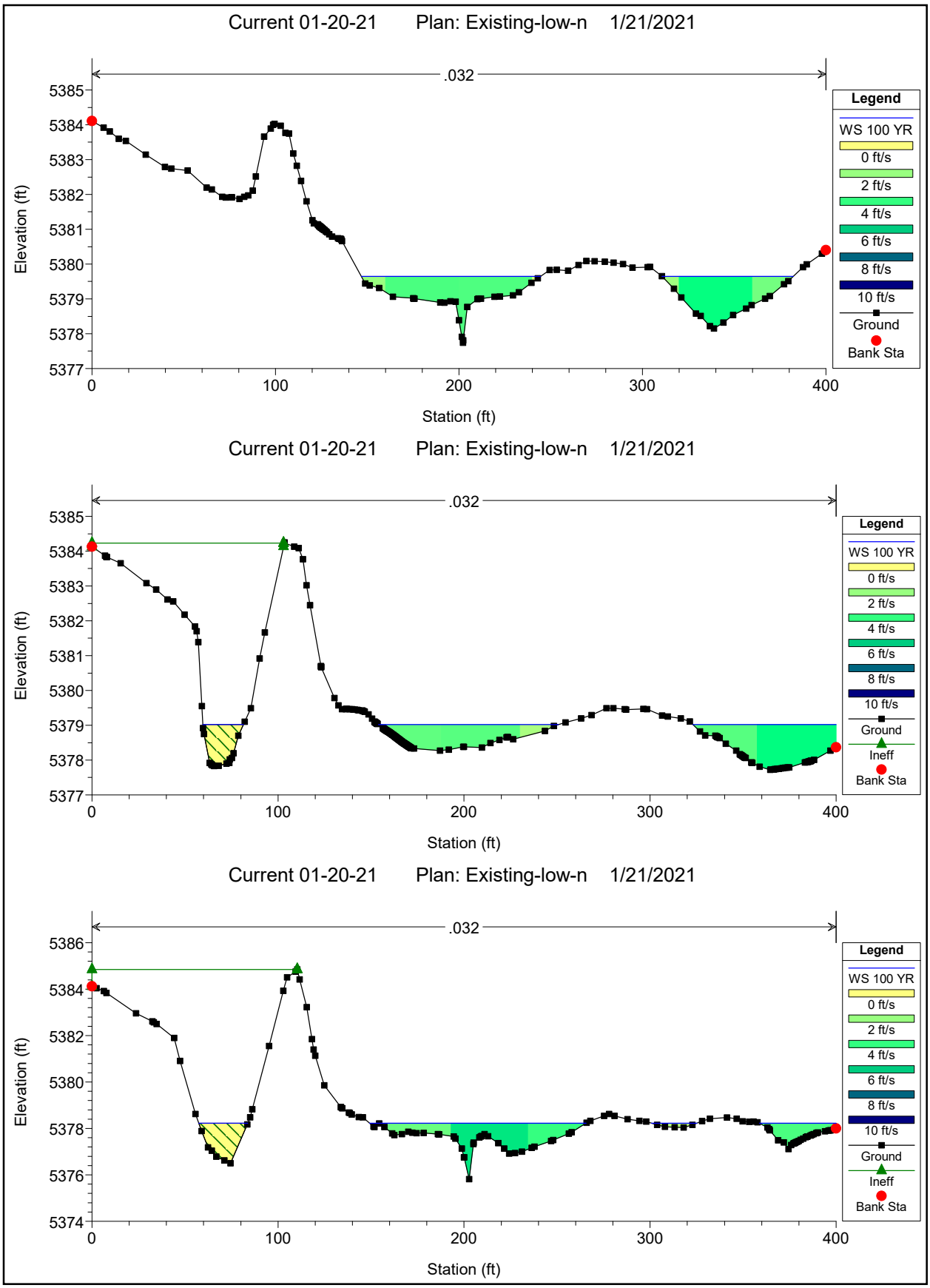
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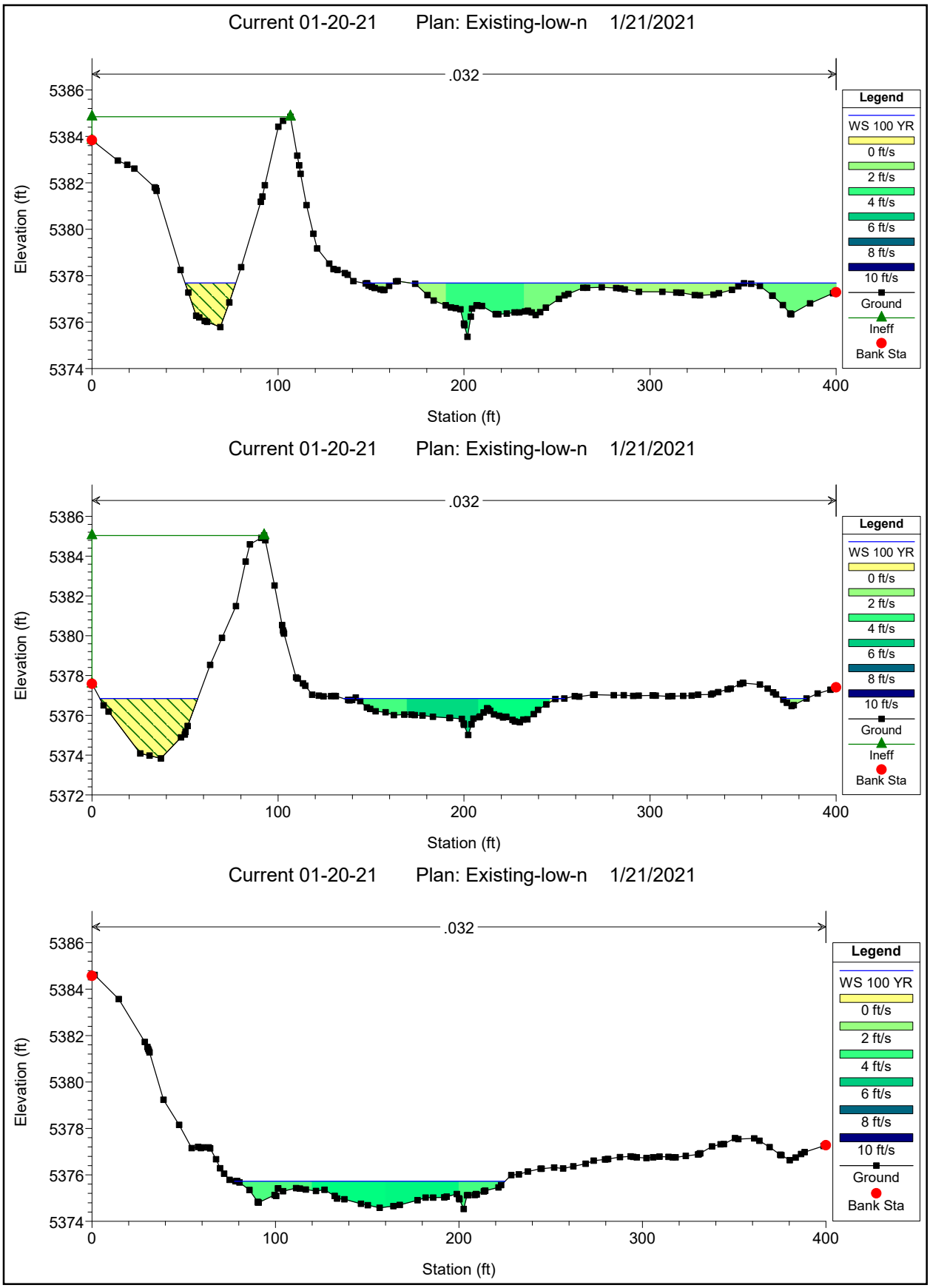
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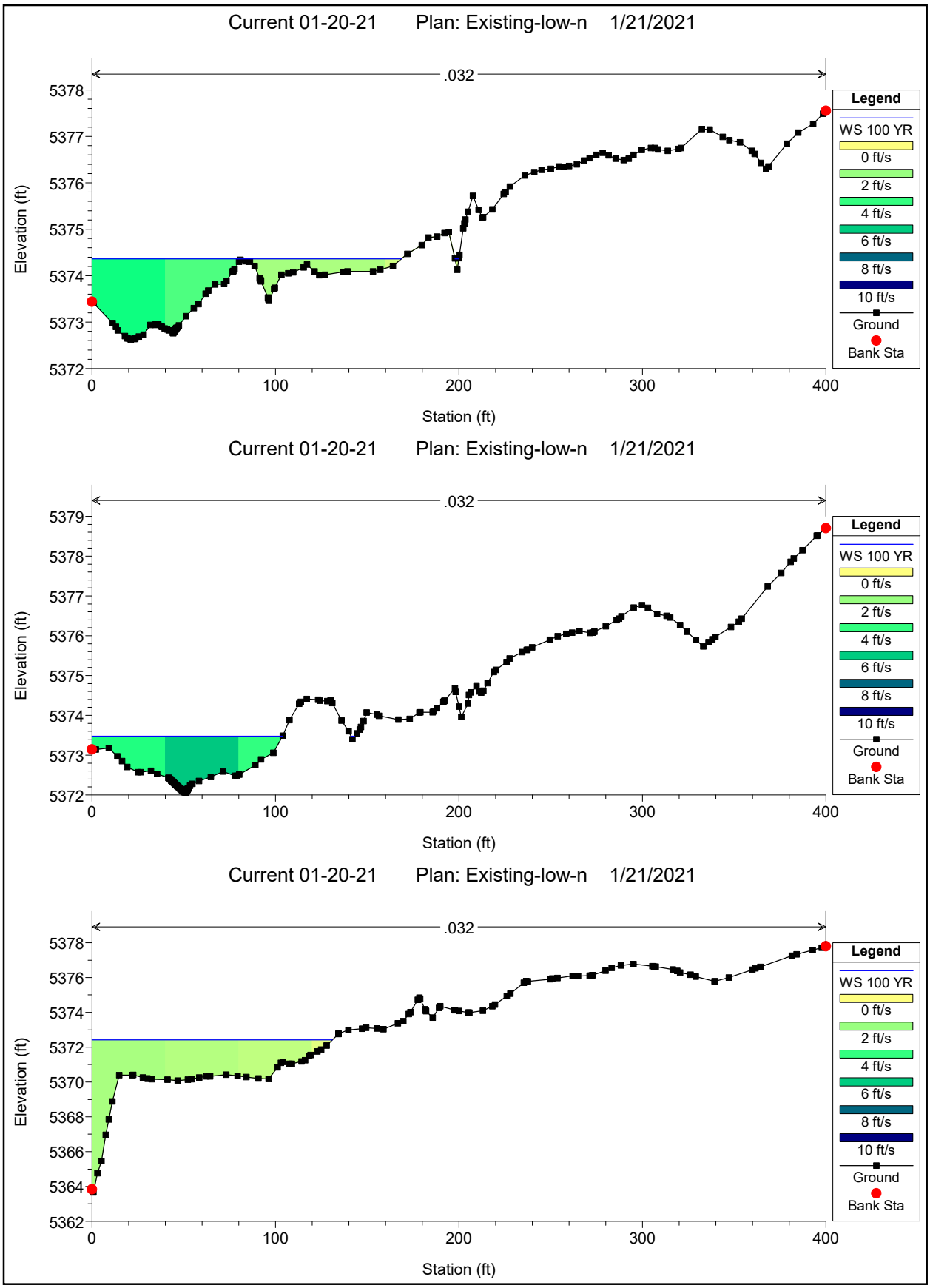
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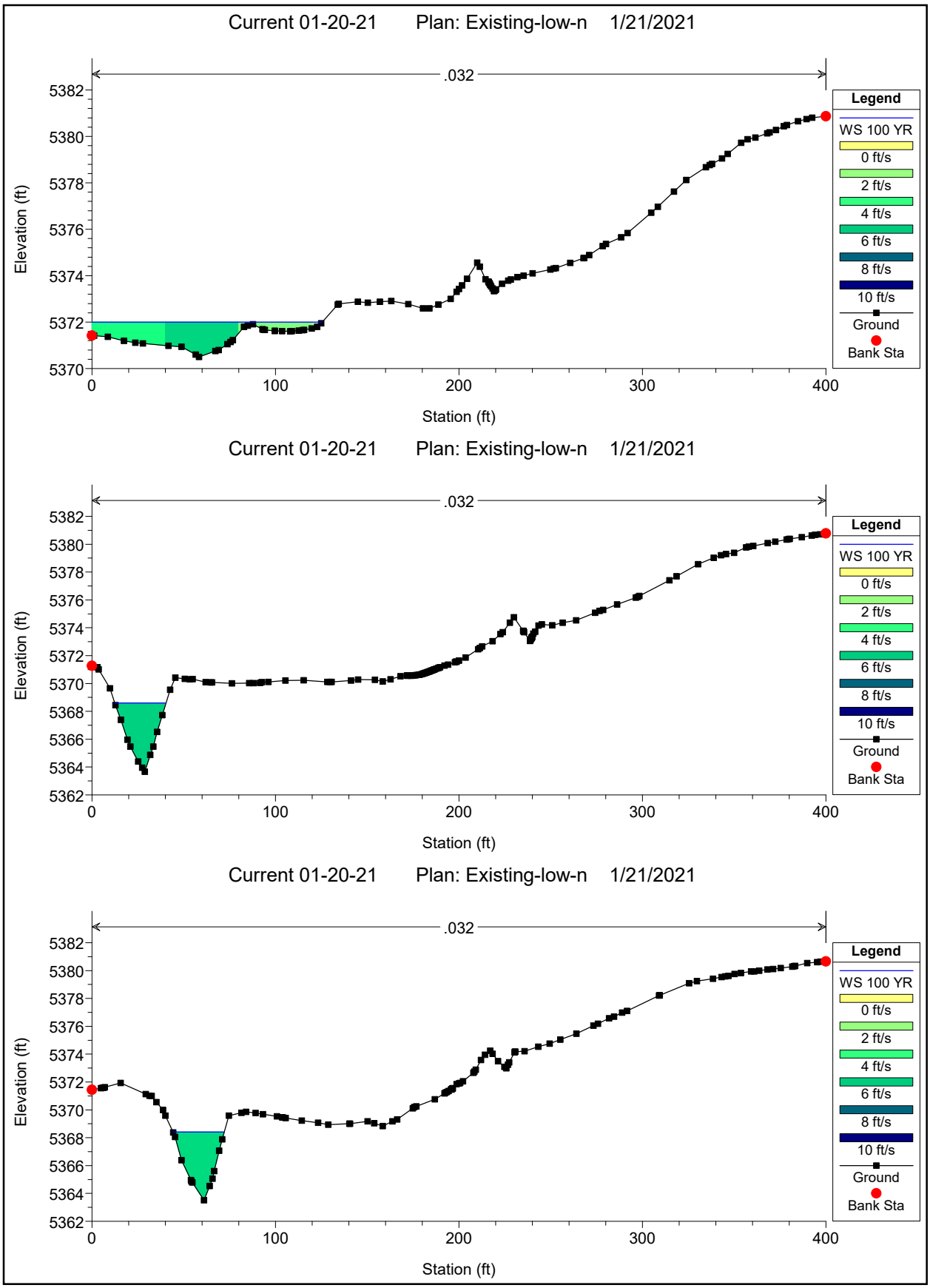
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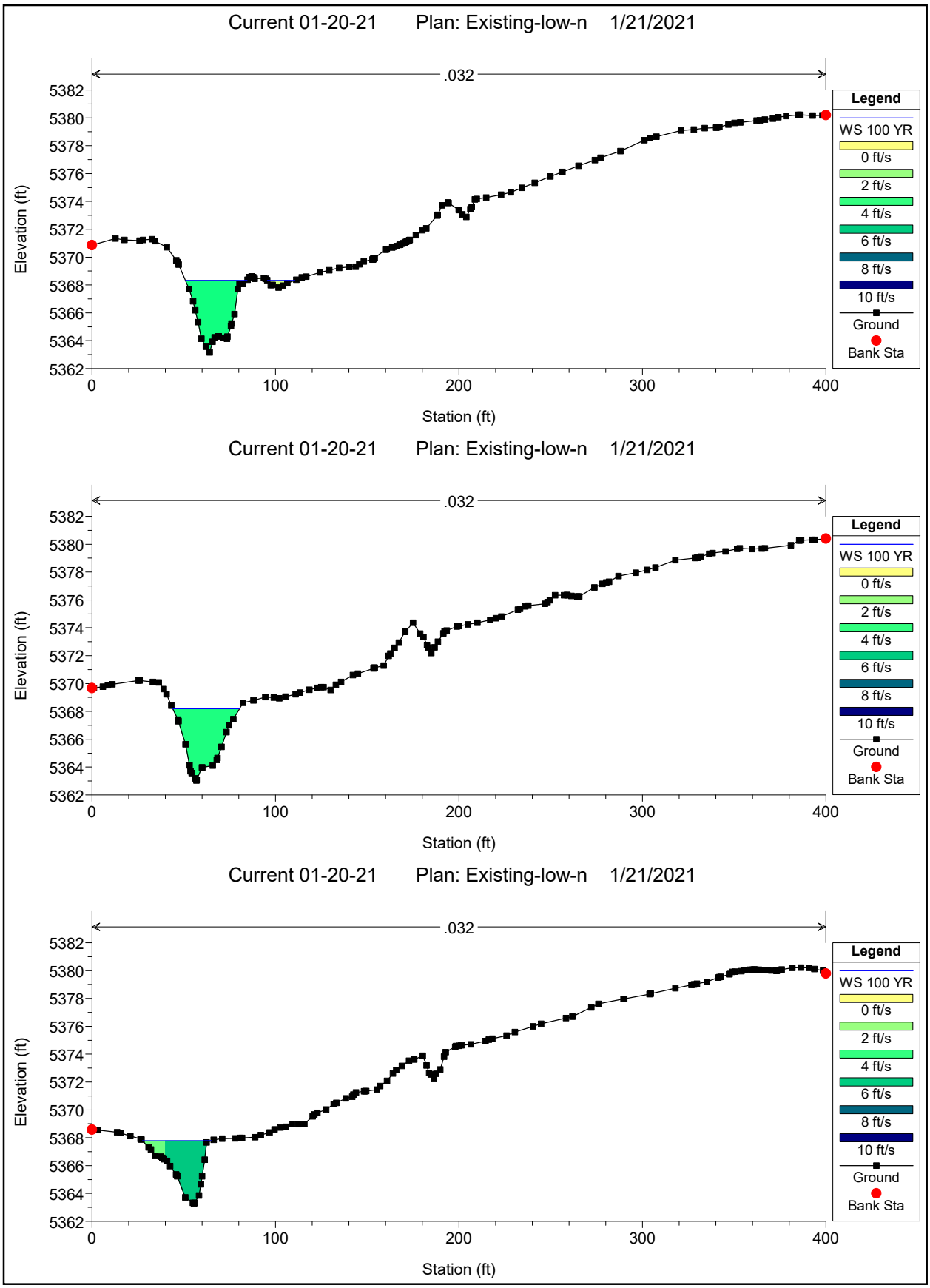
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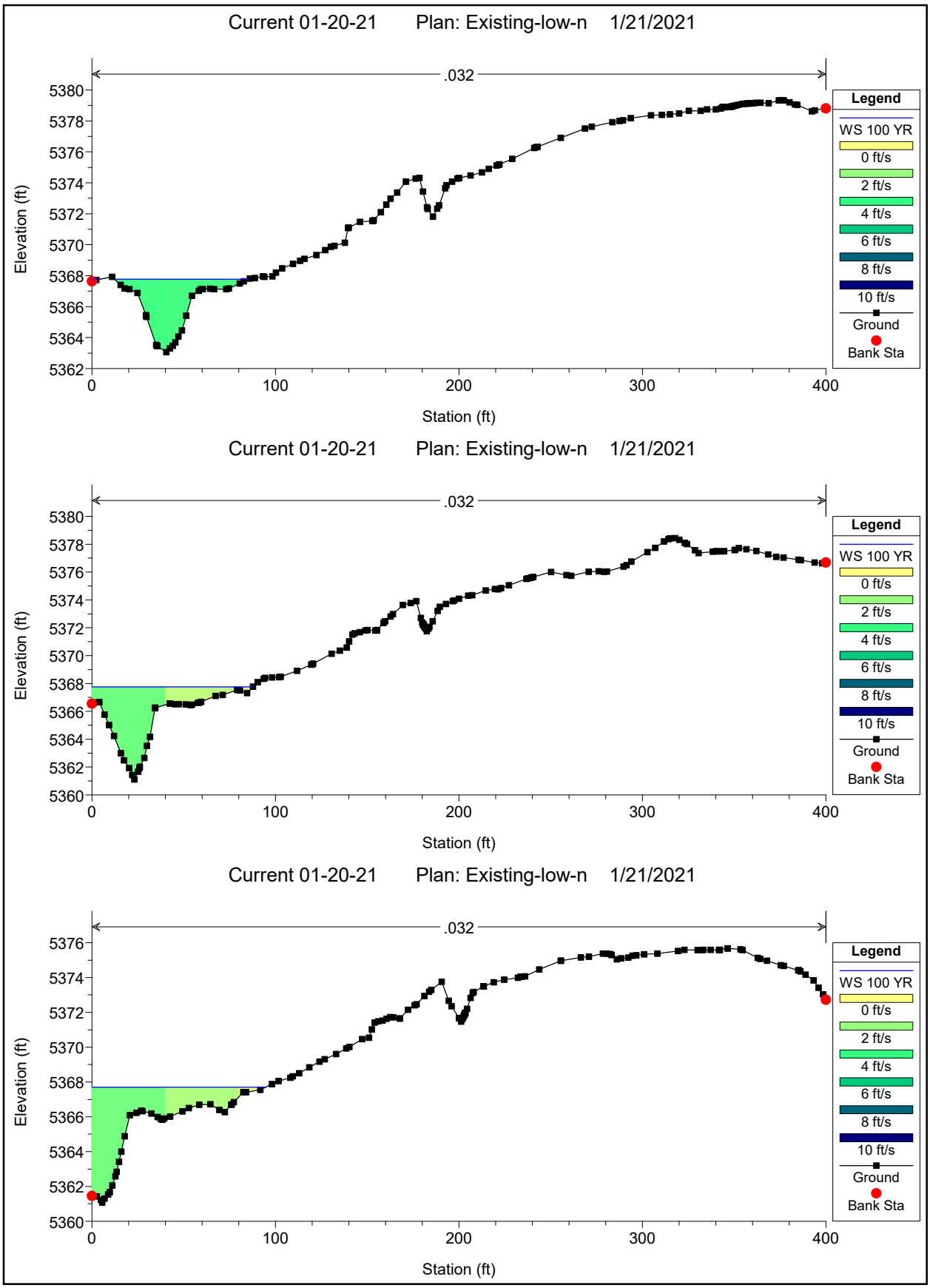
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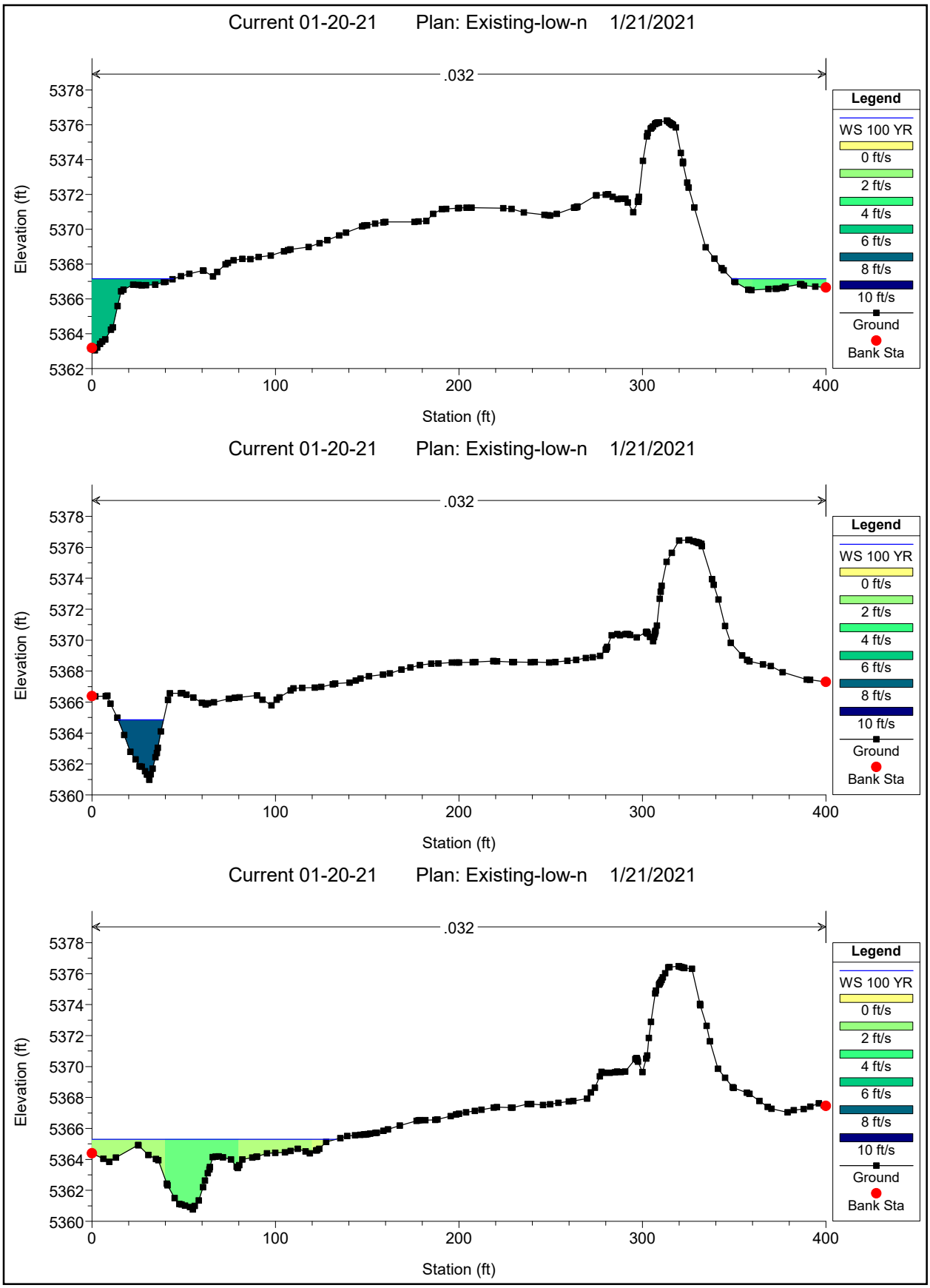
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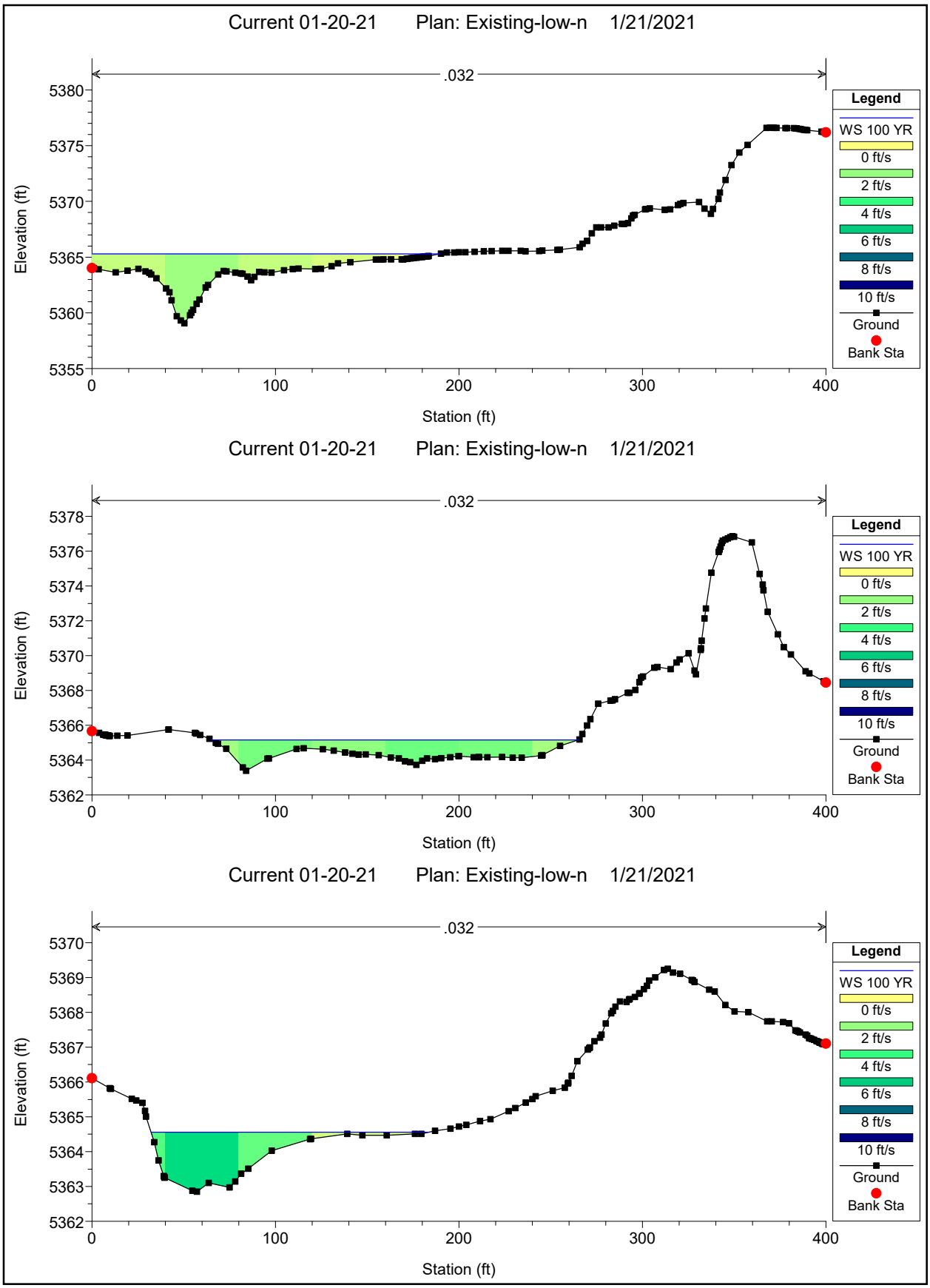
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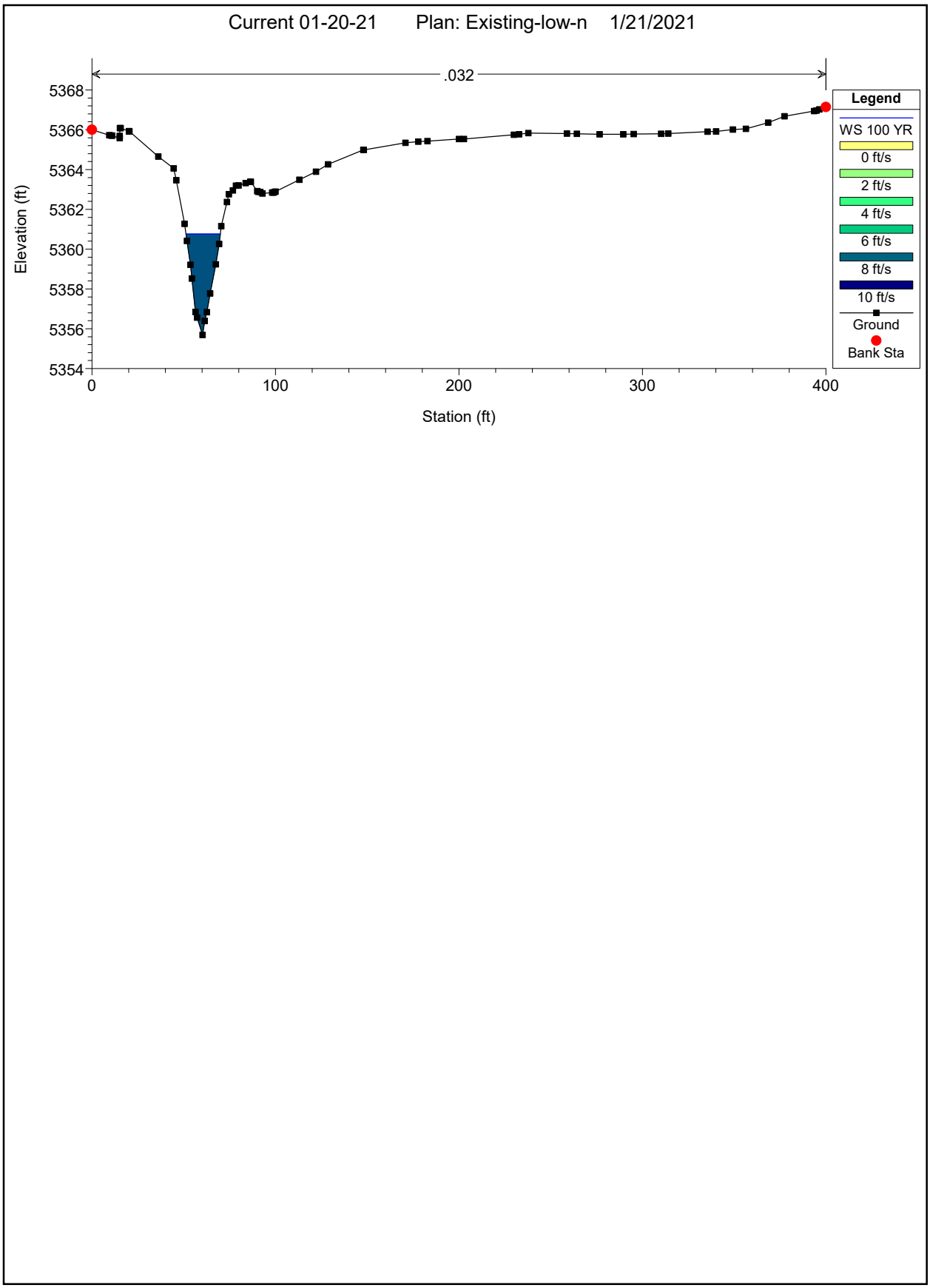
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 01-20-21 Plan: Existing-low-n 1/21/2021
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 01-20-21 Plan: Existing-low-n 1/21/2021
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta


Current 01-20-21 Plan: Existing-low-n 1/21/2021
.032
Elevation (ft)
5368
5366
5364
5362
5360
5358
5356
5354
0
100
200
300
400
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

HEC-RAS Plan: PR-Low-n River: Tributary - I Reach: PR - Tributary I Profile: 2 YR

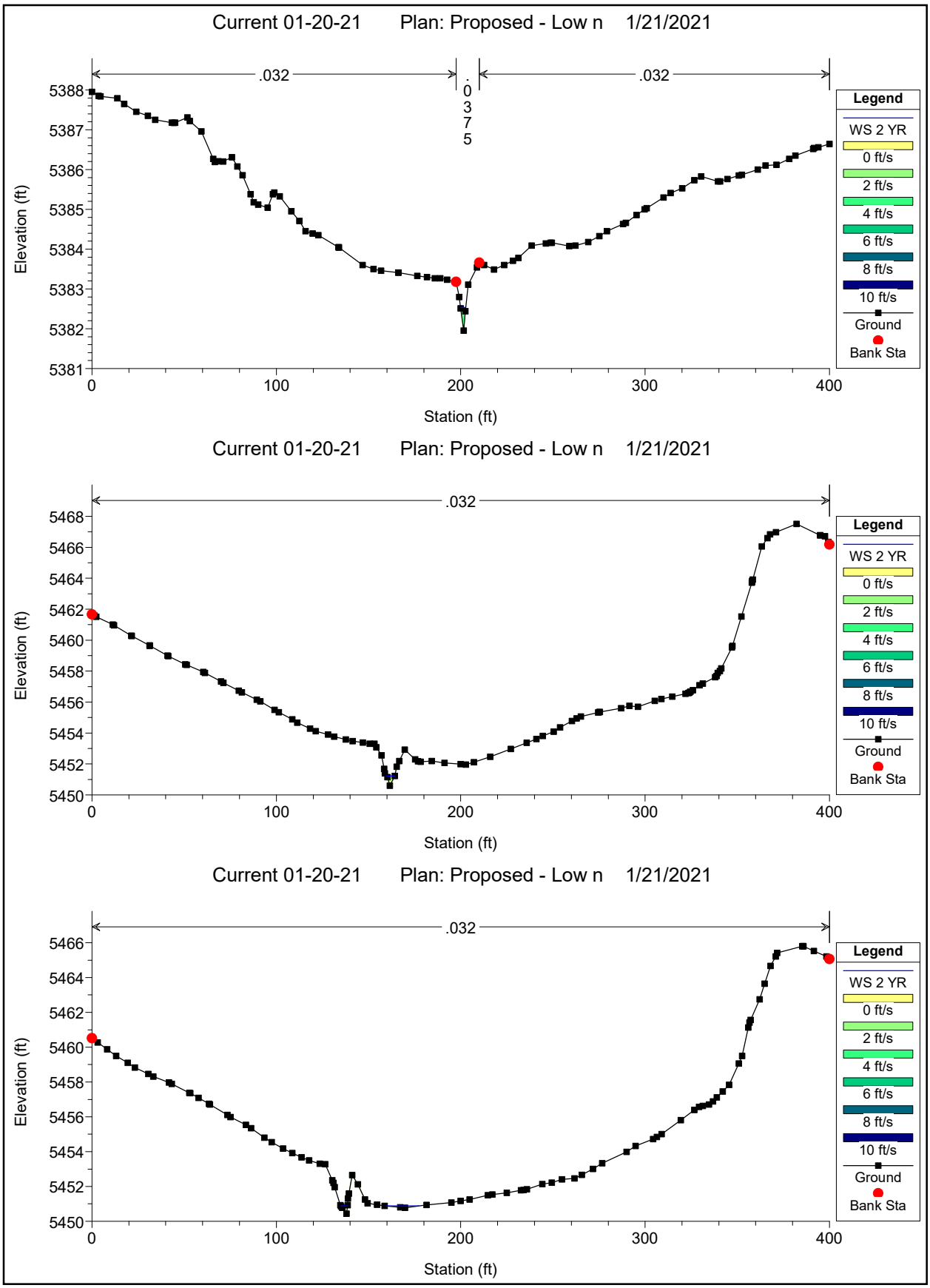
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
PR - Tributary I	5750	2 YR	1.79	5450.60	5451.23	5451.04	5451.26	0.004352	1.34	1.34	4.44	0.43	0.08
PR - Tributary I	5700	2 YR	1.79	5450.44	5450.88	5450.84	5450.90	0.014057	1.03	1.74	21.32	0.64	0.07
PR - Tributary I	5650	2 YR	1.79	5449.61	5449.75	5449.75	5449.77	0.040841	1.24	1.44	29.99	1.00	0.12
PR - Tributary I	5600	2 YR	1.79	5448.25	5448.32	5448.31	5448.33	0.022479	0.96	1.87	36.53	0.75	0.07
PR - Tributary I	5550	2 YR	1.79	5446.77	5446.95	5446.95	5446.99	0.032890	1.66	1.08	12.39	0.99	0.18
PR - Tributary I	5500	2 YR	1.79	5445.70	5445.90	5445.84	5445.91	0.005459	0.83	2.15	18.05	0.42	0.04
PR - Tributary I	5450	2 YR	1.79	5445.24	5445.35	5445.34	5445.38	0.028691	1.39	1.29	17.45	0.90	0.13
PR - Tributary I	5400	2 YR	1.79	5444.05	5444.23	5444.21	5444.26	0.017642	1.28	1.40	14.80	0.73	0.10
PR - Tributary I	5350	2 YR	1.79	5443.51	5443.61	5443.59	5443.62	0.009607	0.80	2.24	30.46	0.52	0.04
PR - Tributary I	5300	2 YR	1.79	5443.08	5443.18		5443.19	0.007549	0.70	2.56	35.47	0.46	0.03
PR - Tributary I	5250	2 YR	1.79	5442.33	5442.42	5442.42	5442.45	0.040080	1.19	1.50	32.81	0.98	0.11
PR - Tributary I	5200	2 YR	1.79	5441.18	5441.31	5441.27	5441.31	0.006188	0.71	2.52	29.39	0.43	0.03
PR - Tributary I	5150	2 YR	1.79	5440.49	5440.63	5440.63	5440.65	0.046354	1.29	1.39	29.99	1.06	0.13
PR - Tributary I	5100	2 YR	1.79	5438.27	5440.57	5438.37	5440.57	0.000000	0.01	120.73	86.77	0.00	0.00
PR - Tributary I	5050	2 YR	1.79	5440.42	5440.53	5440.53	5440.56	0.029985	1.38	1.29	18.15	0.91	0.13
PR - Tributary I	5000	2 YR	1.79	5438.12	5438.36	5438.39	5438.48	0.062114	2.77	0.65	5.49	1.42	0.45
PR - Tributary I	4950	2 YR	1.79	5437.50	5437.68	5437.65	5437.69	0.009661	0.86	2.08	25.26	0.53	0.05
PR - Tributary I	4900	2 YR	1.79	5436.66	5436.78	5436.78	5436.82	0.039549	1.48	1.21	19.01	1.03	0.16
PR - Tributary I	4850	2 YR	1.79	5435.75	5435.94	5435.89	5435.95	0.006555	0.77	2.33	25.21	0.45	0.04
PR - Tributary I	4800	2 YR	1.79	5435.31	5435.47		5435.48	0.014422	1.02	1.75	22.43	0.64	0.07
PR - Tributary I	4750	2 YR	1.79	5434.72	5434.83	5434.81	5434.83	0.011754	0.70	2.56	49.36	0.54	0.04
PR - Tributary I	4700	2 YR	1.79	5434.02	5434.17	5434.15	5434.17	0.014806	0.77	2.32	46.03	0.61	0.05
PR - Tributary I	4650	2 YR	1.79	5433.21	5433.30	5433.28	5433.31	0.019847	0.99	1.81	30.72	0.72	0.07
PR - Tributary I	4600	2 YR	1.79	5432.45	5432.55		5432.56	0.011864	0.82	2.19	33.61	0.57	0.05
PR - Tributary I	4550	2 YR	1.79	5431.45	5431.58	5431.58	5431.62	0.033997	1.53	1.17	15.45	0.98	0.16
PR - Tributary I	4500	2 YR	1.79	5430.22	5430.76	5430.39	5430.77	0.000159	0.30	6.02	16.55	0.09	0.00
PR - Tributary I	4450	2 YR	1.79	5430.61	5430.70	5430.70	5430.73	0.053870	1.40	1.28	27.26	1.14	0.16
PR - Tributary I	4400	2 YR	1.79	5428.99	5429.11	5429.11	5429.14	0.031639	1.43	1.25	17.23	0.94	0.14
PR - Tributary I	4350	2 YR	1.79	5427.82	5427.98		5428.00	0.017284	1.22	1.47	16.56	0.72	0.10
PR - Tributary I	4300	2 YR	1.79	5426.83	5426.97		5427.00	0.024050	1.25	1.44	19.97	0.82	0.11
PR - Tributary I	4250	2 YR	1.79	5426.04	5426.16		5426.17	0.012032	0.91	1.96	25.81	0.58	0.06
PR - Tributary I	4200	2 YR	1.79	5425.05	5425.17	5425.17	5425.21	0.036412	1.46	1.23	18.44	0.99	0.15
PR - Tributary I	4150	2 YR	1.79	5424.36	5424.51	5424.48	5424.52	0.007109	0.59	3.02	51.47	0.43	0.03
PR - Tributary I	4100	2 YR	1.79	5423.72	5423.81	5423.81	5423.83	0.037338	1.10	1.63	37.97	0.94	0.10
PR - Tributary I	4050	2 YR	1.79	5422.79	5422.94	5422.89	5422.95	0.009865	0.84	2.13	27.31	0.53	0.05
PR - Tributary I	4000	2 YR	1.79	5422.19	5422.30		5422.31	0.016449	0.92	1.94	31.91	0.66	0.06
PR - Tributary I	3950	2 YR	1.79	5421.55	5421.70	5421.66	5421.71	0.009458	0.81	2.22	29.47	0.52	0.04
PR - Tributary I	3900	2 YR	1.79	5420.99	5421.09		5421.11	0.016017	0.95	1.89	29.26	0.66	0.06
PR - Tributary I	3850	2 YR	1.79	5420.41	5420.62	5420.56	5420.62	0.006404	0.70	2.54	30.80	0.43	0.03
PR - Tributary I	3800	2 YR	1.79	5419.89	5420.04		5420.06	0.025062	1.05	1.70	31.37	0.80	0.08
PR - Tributary I	3750	2 YR	1.79	5418.86	5419.04		5419.06	0.016233	1.18	1.52	17.18	0.70	0.09
PR - Tributary I	3700	2 YR	1.79	5417.97	5418.16	5418.13	5418.19	0.018661	1.33	1.34	13.95	0.76	0.11
PR - Tributary I	3650	2 YR	1.79	5416.98	5417.10	5417.08	5417.12	0.024970	1.22	1.47	21.61	0.83	0.11
PR - Tributary I	3600	2 YR	1.79	5415.58	5415.71	5415.70	5415.73	0.031528	1.25	1.43	24.07	0.91	0.12
PR - Tributary I	3550	2 YR	1.79	5414.55	5414.63		5414.64	0.015914	0.88	2.03	34.78	0.64	0.06
PR - Tributary I	3500	2 YR	1.79	5413.71	5413.82	5413.82	5413.83	0.016287	0.77	2.33	49.77	0.63	0.05
PR - Tributary I	3450	2 YR	1.79	5412.64	5412.78	5412.73	5412.79	0.006158	0.70	2.56	30.53	0.43	0.03
PR - Tributary I	3400	2 YR	2.51	5411.88	5411.96	5411.96	5411.99	0.048758	1.45	1.73	32.63	1.11	0.16
PR - Tributary I	3350	2 YR	2.51	5411.24	5411.40	5411.33	5411.40	0.003250	0.55	4.53	47.34	0.32	0.02
PR - Tributary I	3300	2 YR	2.51	5410.87	5410.96	5410.96	5410.99	0.042561	1.49	1.69	27.66	1.06	0.16
PR - Tributary I	3250	2 YR	2.51	5409.78	5410.28	5410.14	5410.30	0.005181	1.13	2.22	8.88	0.40	0.08
PR - Tributary I	3232.13	2 YR	2.51	5409.65	5409.97	5409.97	5410.09	0.037209	2.77	0.91	4.06	1.04	0.51
PR - Tributary I	3205.03	2 YR	2.51	5405.01	5405.07	5405.13	5405.41	0.721426	4.69	0.54	10.29	3.62	2.34
PR - Tributary I	3181.99	2 YR	2.51	5404.79	5404.91	5404.91	5404.97	0.048559	2.05	1.22	10.72	1.07	0.35
PR - Tributary I	3140.22	2 YR	2.51	5399.18	5399.23	5399.32	5399.65	0.851332	5.17	0.49	9.06	3.94	2.82
PR - Tributary I	3140		Culvert										
PR - Tributary I	2909.93	2 YR	2.51	5398.72	5398.84	5398.84	5398.92	0.050261	2.17	1.16	9.40	1.09	0.38
PR - Tributary I	2850	2 YR	2.51	5398.60	5399.36		5399.38	0.002052	1.02	2.47	5.54	0.27	0.05
PR - Tributary I	2800	2 YR	2.51	5398.50	5399.26		5399.27	0.002032	1.01	2.48	5.54	0.27	0.05
PR - Tributary I	2750	2 YR	2.51	5398.40	5399.15		5399.17	0.002092	1.03	2.45	5.51	0.27	0.06
PR - Tributary I	2700	2 YR	2.51	5398.30	5399.05		5399.06	0.002174	1.04	2.41	5.47	0.28	0.06
PR - Tributary I	2650	2 YR	2.51	5398.20	5398.93	5398.60	5398.95	0.002474	1.09	2.30	5.37	0.29	0.06
PR - Tributary I	2600	2 YR	2.51	5398.10	5398.50	5398.50	5398.63	0.033369	2.86	0.88	3.39	0.99	0.52
PR - Tributary I	2550	2 YR	2.51	5396.43	5397.63	5396.59	5397.63	0.000004	0.06	44.76	86.83	0.01	0.00
PR - Tributary I	2500	2 YR	2.51	5394.51	5397.63		5397.63	0.000000	0.01	291.81	167.85	0.00	0.00
PR - Tributary I	2450	2 YR	2.51	5394.37	5397.63		5397.63	0.000000	0.00	532.13	214.86	0.00	0.00
PR - Tributary I	2400	2 YR	2.51	5394.18	5397.63		5397.63	0.000000	0.00	571.09	220.02	0.00	0.00
PR - Tributary I	2350	2 YR	2.51	5394.18	5397.63		5397.63	0.000000	0.00	644.40	245.13	0.00	0.00
PR - Tributary I	2300	2 YR	2.51	5394.18	5397.63		5397.63	0.000000	0.00	677.74	245.00	0.00	0.00
PR - Tributary I	2218.78	2 YR	2.51	5397.49	5397.60	5397.60	5397.63	0.044483	1.24	2.02	35.44	0.91	0.16
PR - Tributary I	2198.89	2 YR	2.51	5392.12	5392.26	5392.51	5394.71	2.017008	12.55	0.20	1.86	6.74	13.26
PR - Tributary I	2150	2 YR	2.51	5391.10	5391.56	5391.49	5391.64	0.016618	2.19	1.15	3.94	0.72	0.29
PR - Tributary I	2100	2 YR	2.51	5390.07	5390.49	5390.47	5390.60	0.027034	2.65	0.95	3.52	0.90	0.44
PR - Tributary I	2050	2 YR	2.51	5389.03	5389.51	5389.43	5389.58	0.015792	2.17	1.16	3.85	0.70	0.28
PR - Tributary I	2000	2 YR	2.51	5388.00	5388.41	5388.39	5388.53	0.028922	2.71	0.92	3.48	0.93	0.46
PR - Tributary I	1950	2 YR	2.51	5386.96	5387.44	5387.35	5387.51	0.014714	2.11	1.19	3.95	0.68	0.27
PR - Tributary I	1900	2 YR	2.51	5385.93	5386.33	5386.33	5386.46	0.031591	2.80	0.90	3.44	0.97	0.49
PR - Tributary I	1850	2 YR	2.51	5384.89	5385.37	5385.28	5385.43	0.013860	2.04	1.23	4.13	0.66	0.25
PR - Tributary I	1800	2 YR	2.51	5383.85	5384.25	5384.25	5384.38	0.034517	2.90	0.87	3.37	1.01	0.53
PR - Tributary I	1750	2 YR	2.51	5382.66	5383.37	5383.20	5383.42	0.007824	1.69	1.49	4.19	0.50	0.16
PR - Tributary I	1700	2 YR	2.51	5381.95	5382.54	5382.54	5382.68	0.034113	3.04	0.83	2.84	0.99	0.57
PR - Tributary I	1650	2 YR	2.51	5381.09	5381.79	5381.61	5381.83	0.006975	1.59	1.58	4.52	0.47	0.15
PR - Tributary I	1600	2 YR	2.51	5380.66	5381.34	5381.21	5381.40	0.010578	1.91	1.31	3.84	0.58	0.21
PR - Tributary I	1550	2 YR	2.51	5379.85	5380.38	5380.38	5380.51	0.034598	2.91	0.86	3.28	1.00	0.54

HEC-RAS Plan: PR-Low-n River: Tributary - I Reach: PR - Tributary I Profile: 2 YR (Continued)

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	Shear Chan
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
PR - Tributary I	1500	2 YR	2.51	5379.19	5379.87	5379.65	5379.90	0.004600	1.29	1.95	5.71	0.39	0.10
PR - Tributary I	1450	2 YR	2.51	5378.72	5379.26	5379.26	5379.40	0.034478	2.97	0.85	3.12	1.00	0.55
PR - Tributary I	1400	2 YR	2.51	5377.93	5379.07	5378.49	5379.08	0.000845	0.75	3.33	5.85	0.18	0.03
PR - Tributary I	1350	2 YR	10.37	5377.94	5378.75		5378.84	0.009740	2.43	4.26	8.48	0.61	0.30
PR - Tributary I	1300	2 YR	10.37	5377.44	5378.24		5378.34	0.010212	2.47	4.19	8.43	0.62	0.31
PR - Tributary I	1250	2 YR	10.37	5376.94	5377.75		5377.84	0.009877	2.44	4.24	8.48	0.61	0.30
PR - Tributary I	1200	2 YR	10.37	5376.44	5377.25		5377.34	0.010066	2.46	4.21	8.45	0.61	0.31
PR - Tributary I	1150	2 YR	10.37	5375.94	5376.75		5376.84	0.009807	2.44	4.26	8.49	0.61	0.30
PR - Tributary I	1100	2 YR	10.37	5375.44	5376.23		5376.33	0.010748	2.52	4.12	8.40	0.63	0.32
PR - Tributary I	1050	2 YR	10.37	5374.94	5375.76		5375.85	0.008619	2.31	4.49	8.85	0.57	0.27
PR - Tributary I	1000	2 YR	10.37	5374.44	5375.19		5375.31	0.013896	2.77	3.74	7.99	0.71	0.40
PR - Tributary I	950	2 YR	10.37	5373.93	5374.78		5374.84	0.006172	1.98	5.23	10.10	0.49	0.20
PR - Tributary I	900	2 YR	10.37	5373.44	5374.09	5374.07	5374.28	0.025722	3.49	2.98	7.16	0.95	0.65
PR - Tributary I	838.96	2 YR	10.37	5372.83	5373.29	5373.13	5373.36	0.009212	2.15	4.82	10.52	0.56	0.24
PR - Tributary I	838.25		Culvert										
PR - Tributary I	598.1	2 YR	10.37	5370.41	5370.94		5371.00	0.006832	1.98	5.25	10.36	0.49	0.20
PR - Tributary I	550	2 YR	10.37	5369.65	5370.37		5370.50	0.016718	2.97	3.49	7.73	0.78	0.46
PR - Tributary I	500	2 YR	10.37	5368.85	5369.59	5369.49	5369.71	0.014933	2.85	3.64	7.88	0.74	0.42
PR - Tributary I	450	2 YR	10.37	5368.05	5368.68		5368.83	0.020786	3.07	3.38	8.44	0.86	0.51
PR - Tributary I	400	2 YR	10.37	5367.25	5368.02		5368.10	0.010059	2.39	4.34	9.13	0.61	0.29
PR - Tributary I	350	2 YR	10.37	5366.46	5367.10	5367.10	5367.30	0.028207	3.60	2.88	7.06	1.00	0.70
PR - Tributary I	300	2 YR	10.37	5365.67	5365.52	5365.37	5365.58	0.006305		5.27	13.40	0.00	
PR - Tributary I	250	2 YR	10.37	5364.86	5364.88	5364.88	5365.02	0.023847	0.23	3.45	14.63	0.48	0.01
PR - Tributary I	194.84	2 YR	10.37	5363.99	5364.38	5364.21	5364.41	0.004594	1.36	7.65	20.71	0.39	0.10
PR - Tributary I	194.59		Culvert										
PR - Tributary I	113.93	2 YR	10.37	5363.86	5364.18	5364.06	5364.22	0.007502	1.55	6.69	21.58	0.49	0.14
PR - Tributary I	101	2 YR	10.37	5363.73	5363.94	5363.94	5364.02	0.042258	2.26	4.59	31.43	1.04	0.39

HEC-RAS Plan: PR-Low-n River: Tributary - I Reach: PR - Tributary I Profile: 2 YR

Reach	River Sta	Profile	E.G. US.	W.S. US.	E.G. IC	E.G. OC	Min El Weir Flow	Q Culv Group	Q Weir	Delta WS	Culv Vel US	Culv Vel DS
			(ft)	(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(ft)	(ft/s)	(ft/s)
PR - Tributary I	3140 West Ped	2 YR					5414.00					
PR - Tributary I	3140 West 10YR	2 YR					5414.00					
PR - Tributary I	838.25 10-YR East	2 YR	5373.37	5373.29	5373.37	5373.47	5387.51	10.37		2.35	3.47	2.48
PR - Tributary I	838.25 West-Ped	2 YR	5373.37	5373.29			5387.51			2.35		
PR - Tributary I	194.59 Double	2 YR	5364.41	5364.38	5364.35	5364.41	5369.61	10.37		0.20	1.99	2.08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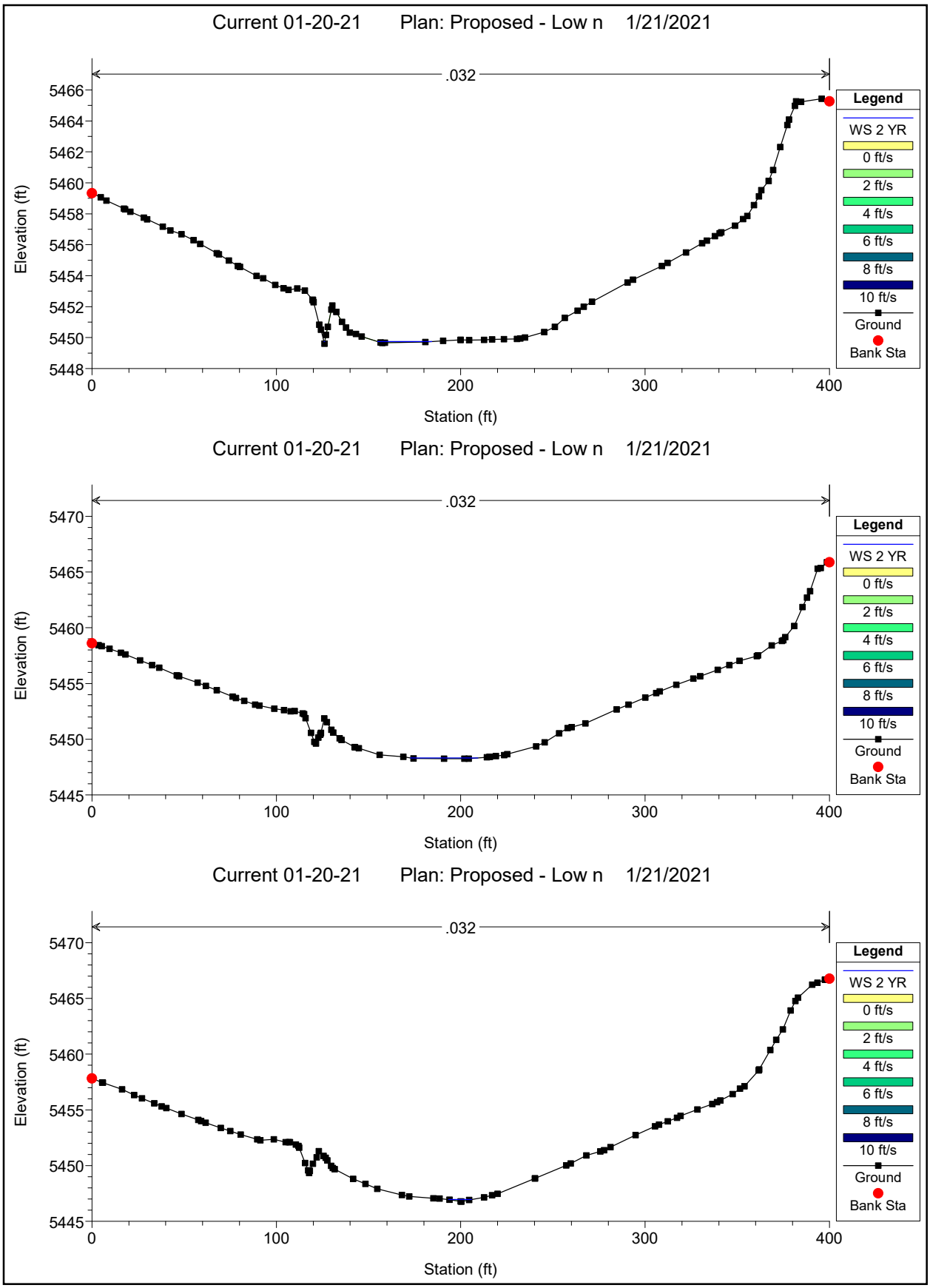
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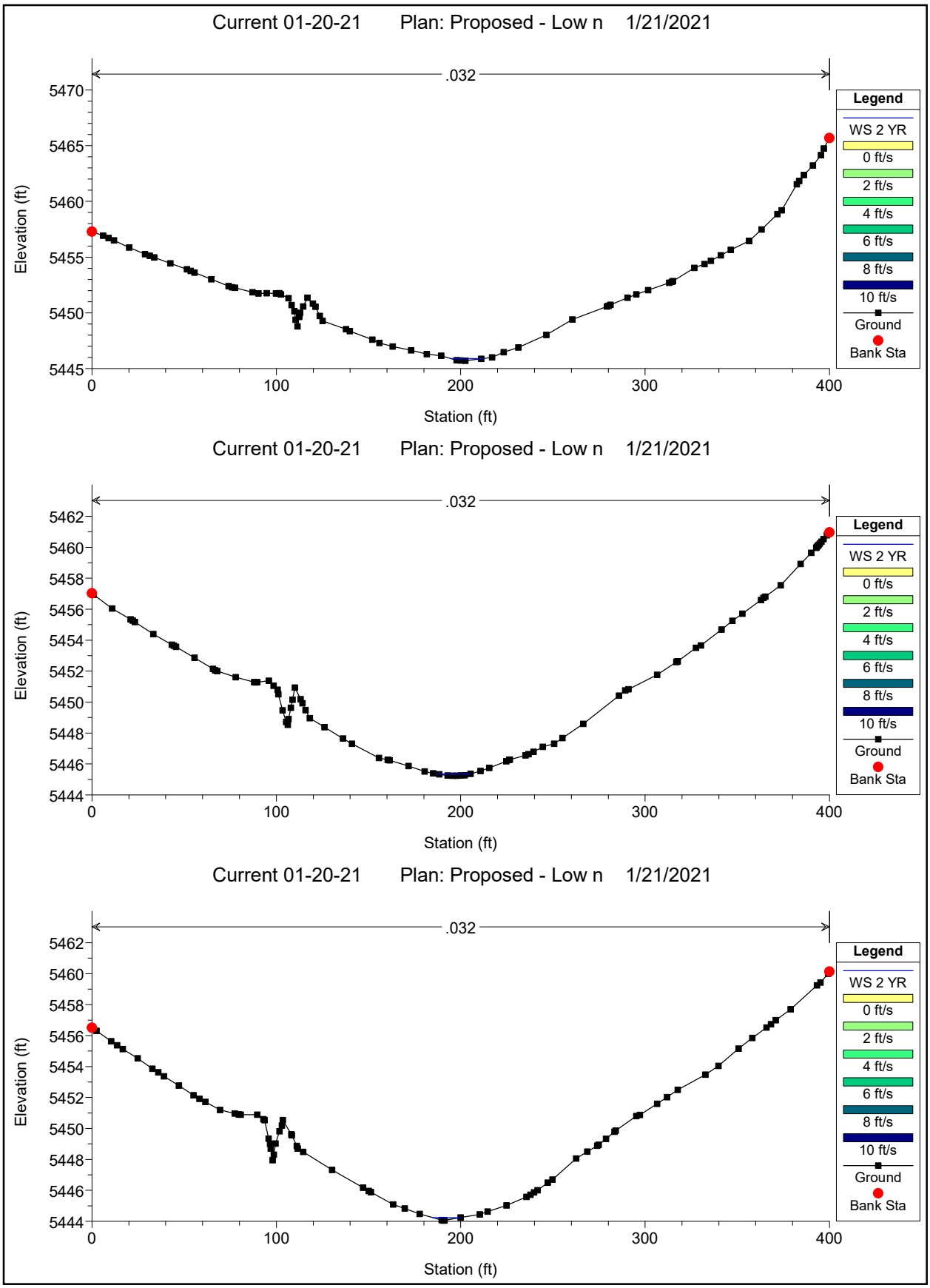
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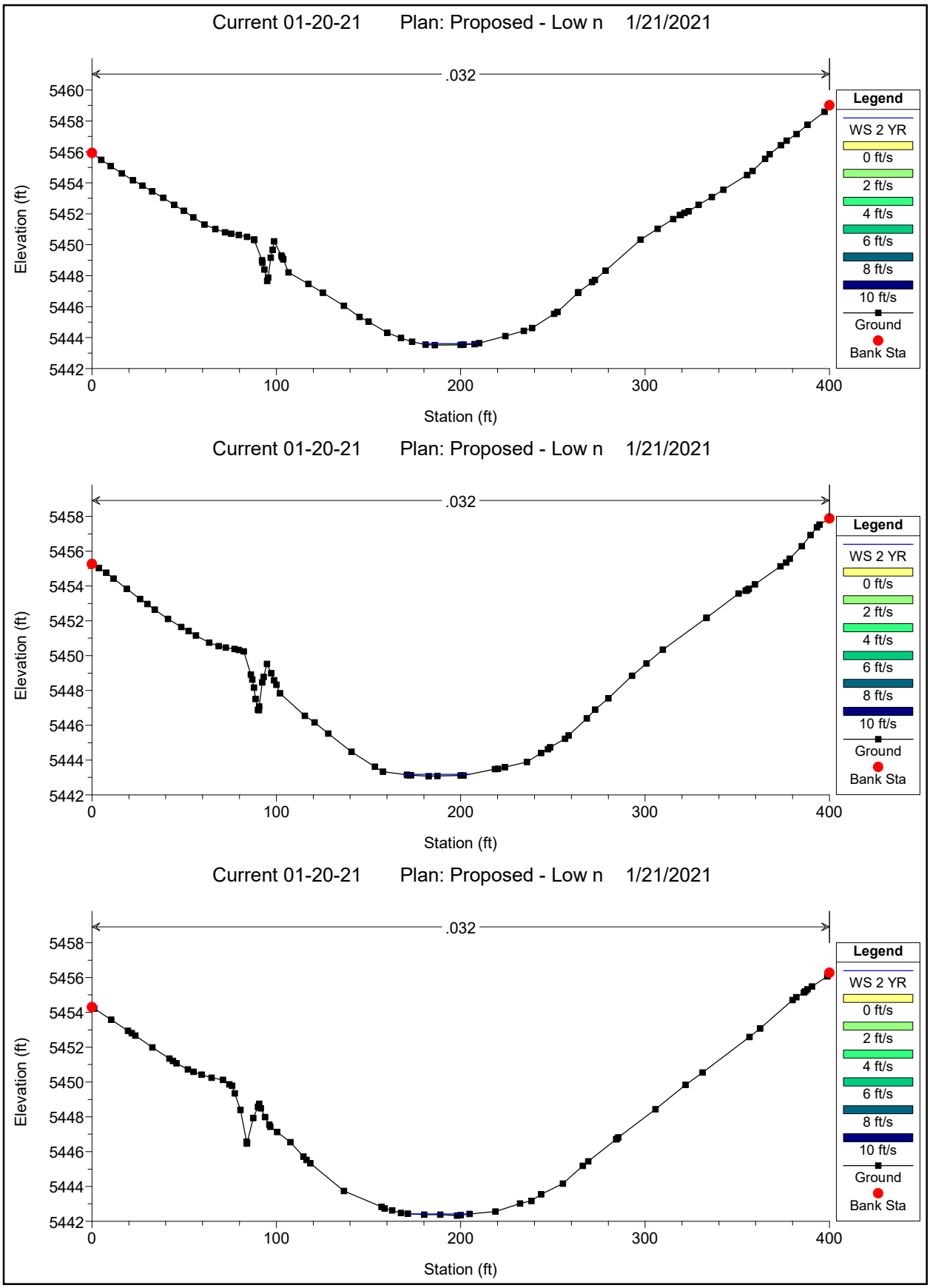
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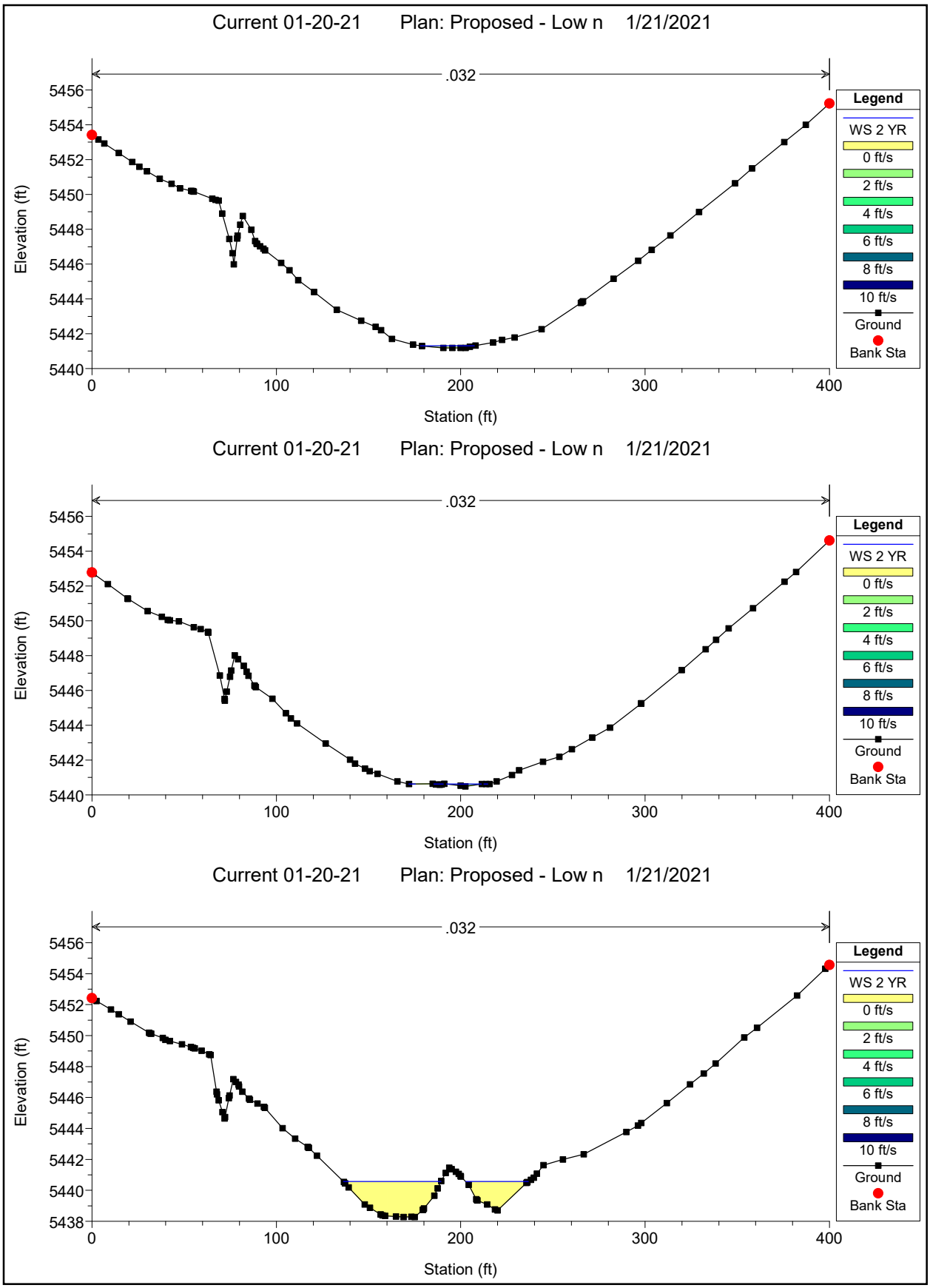
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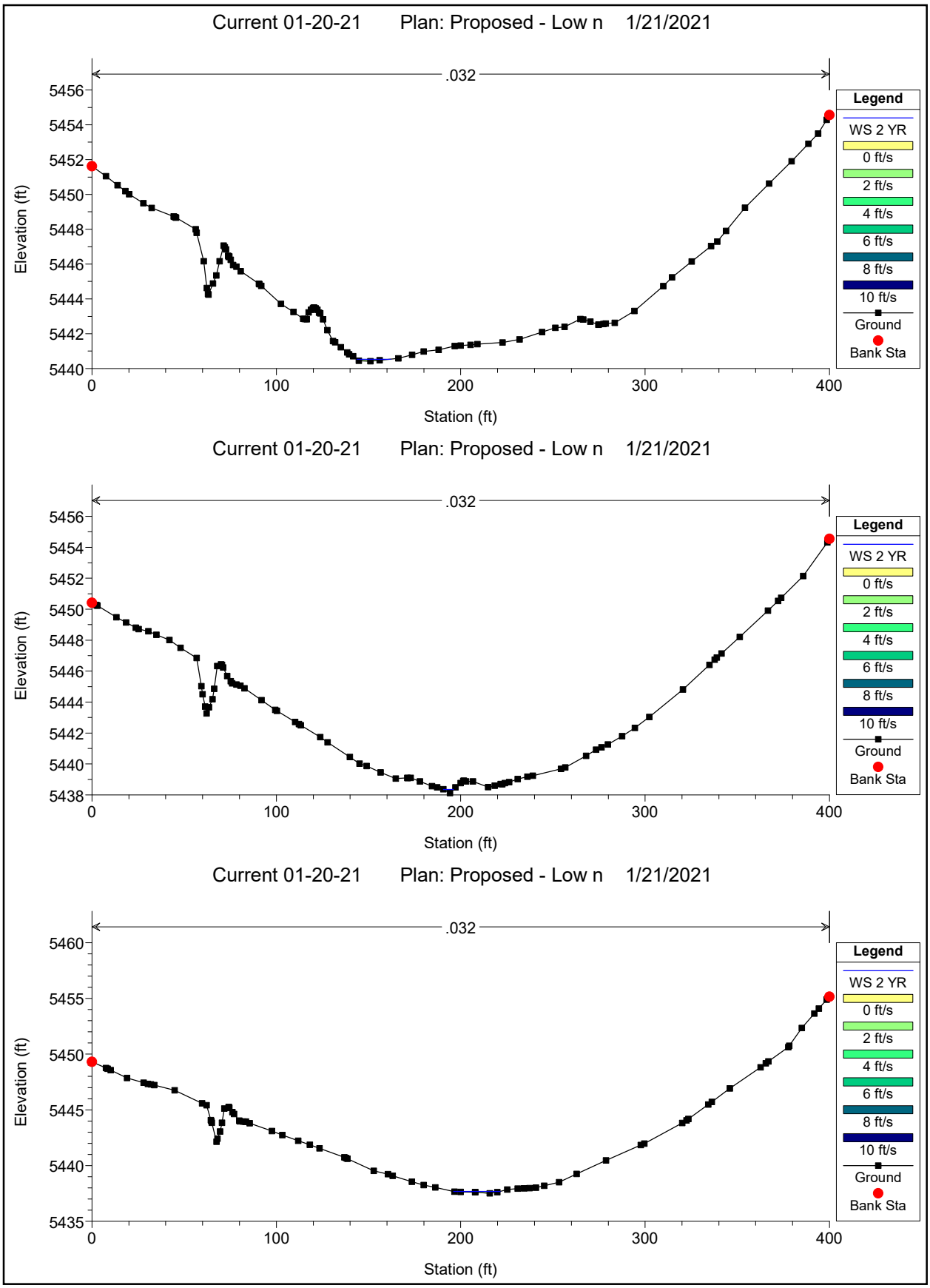
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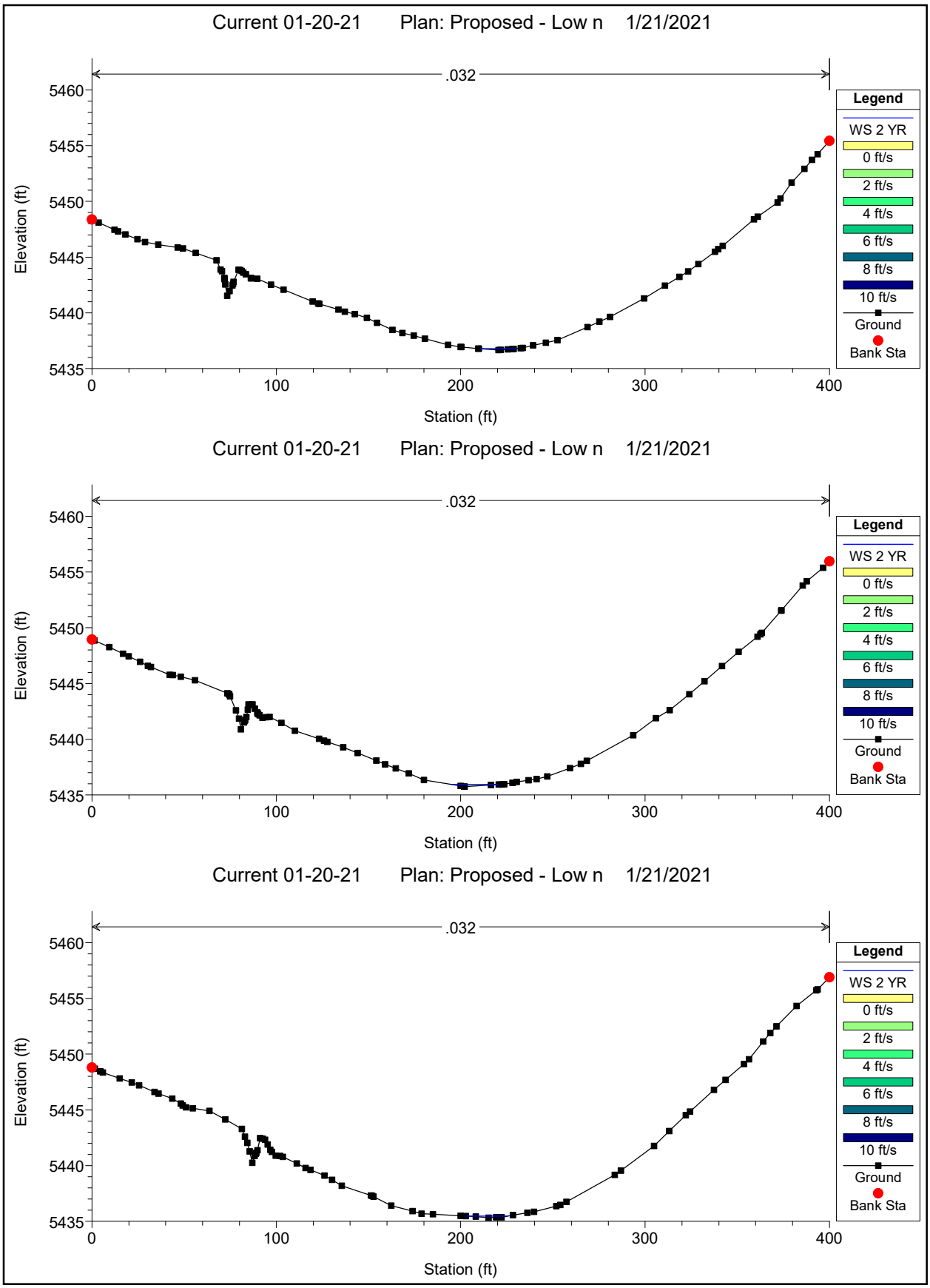
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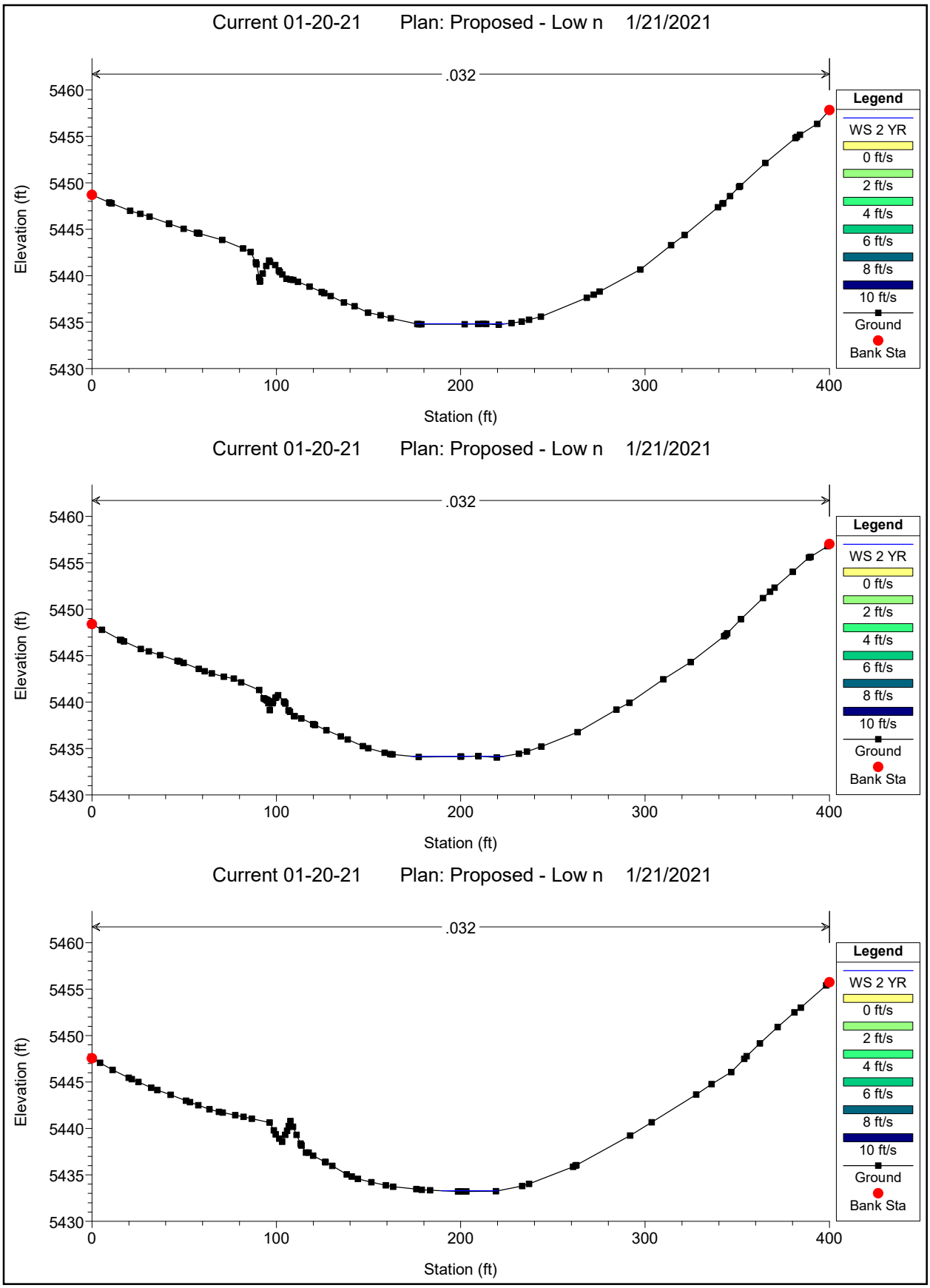
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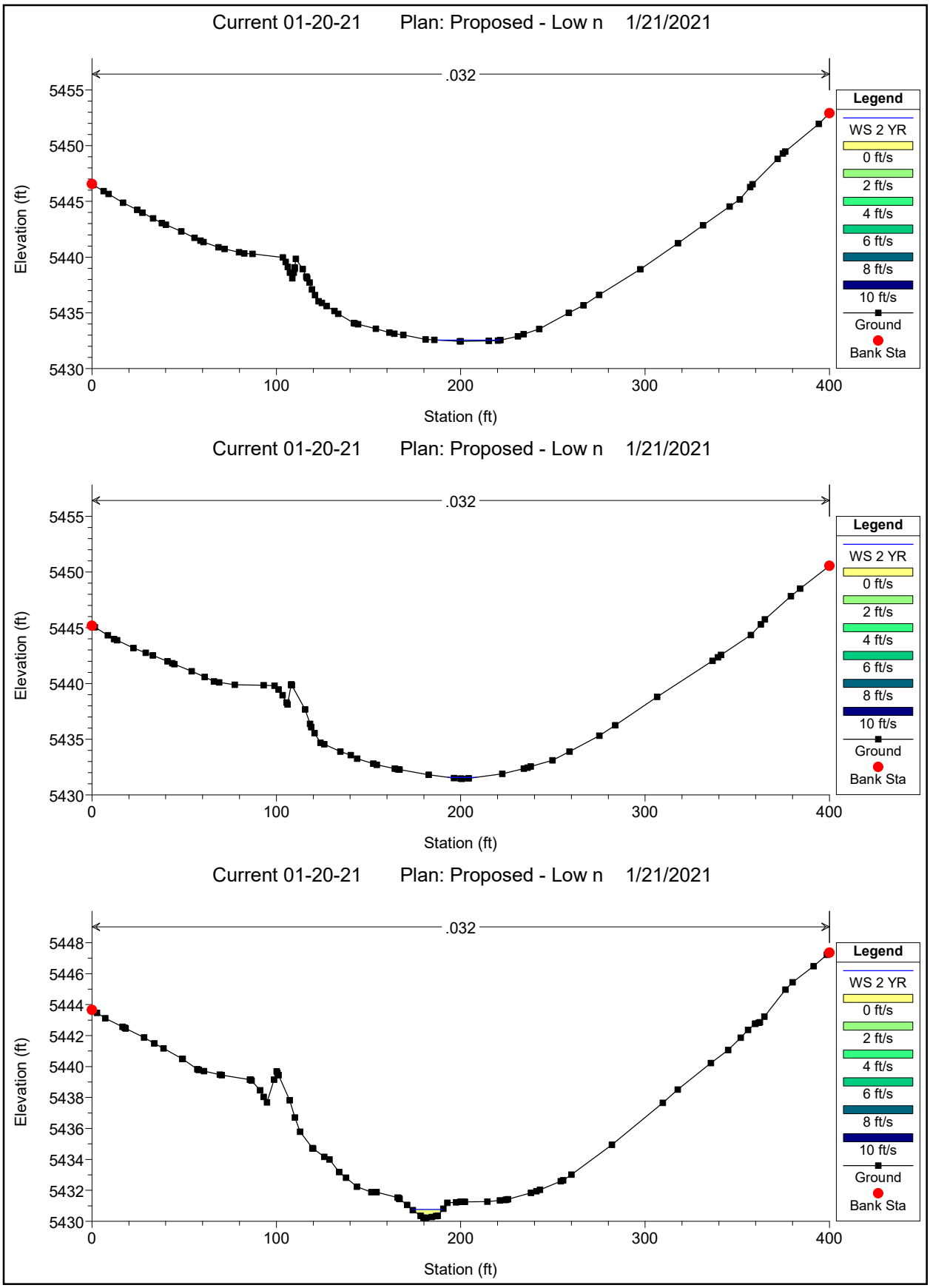
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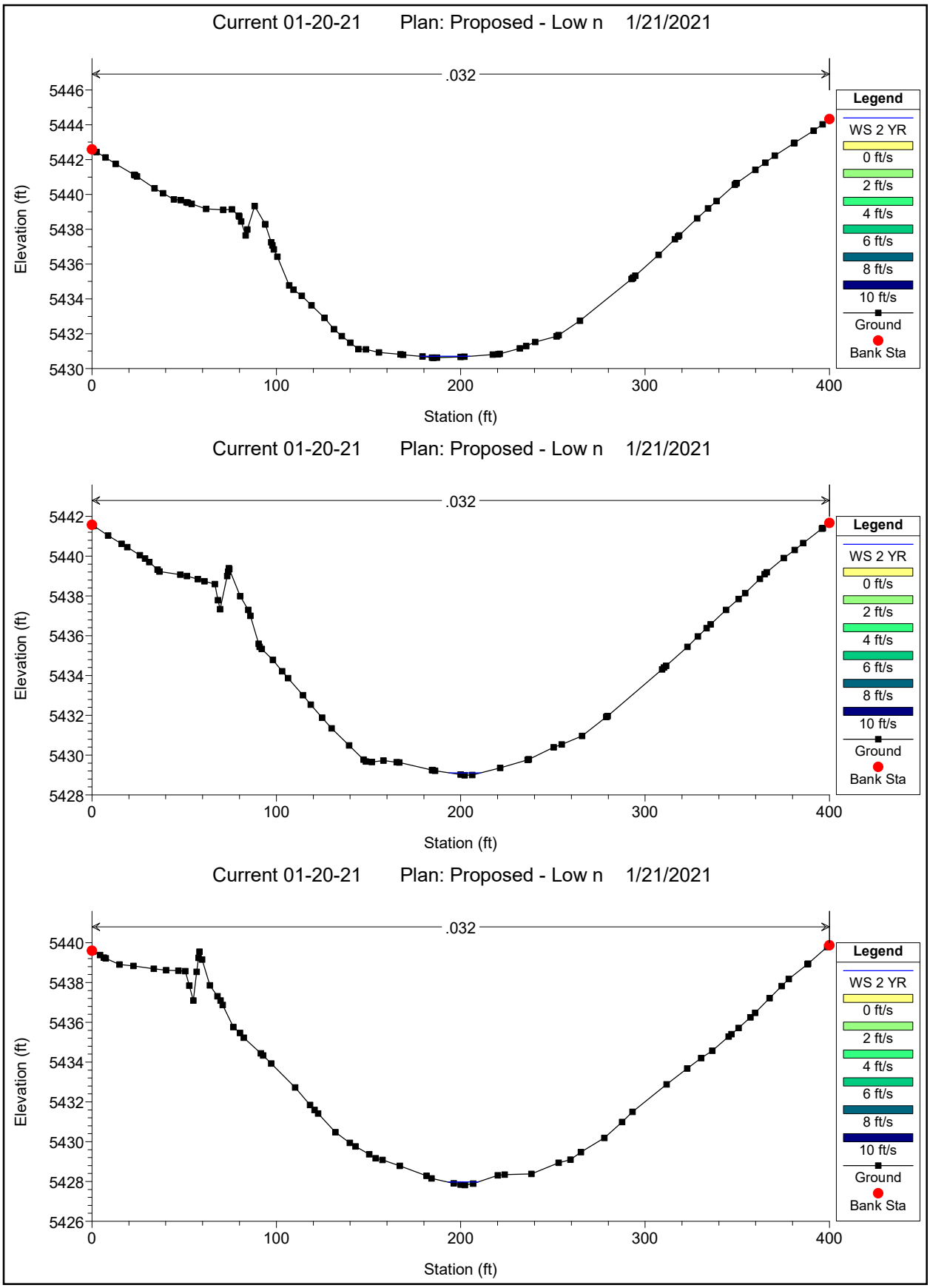
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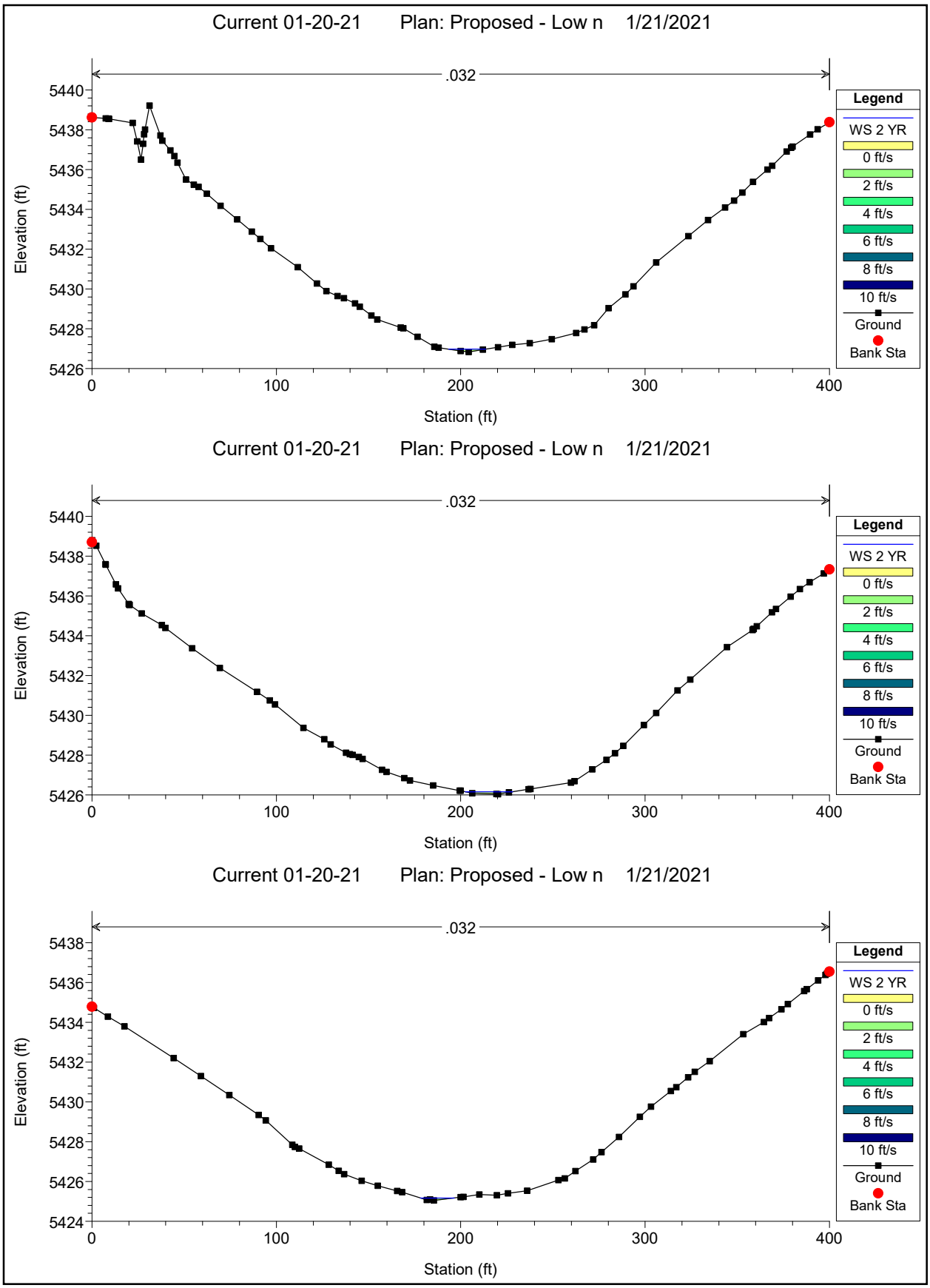
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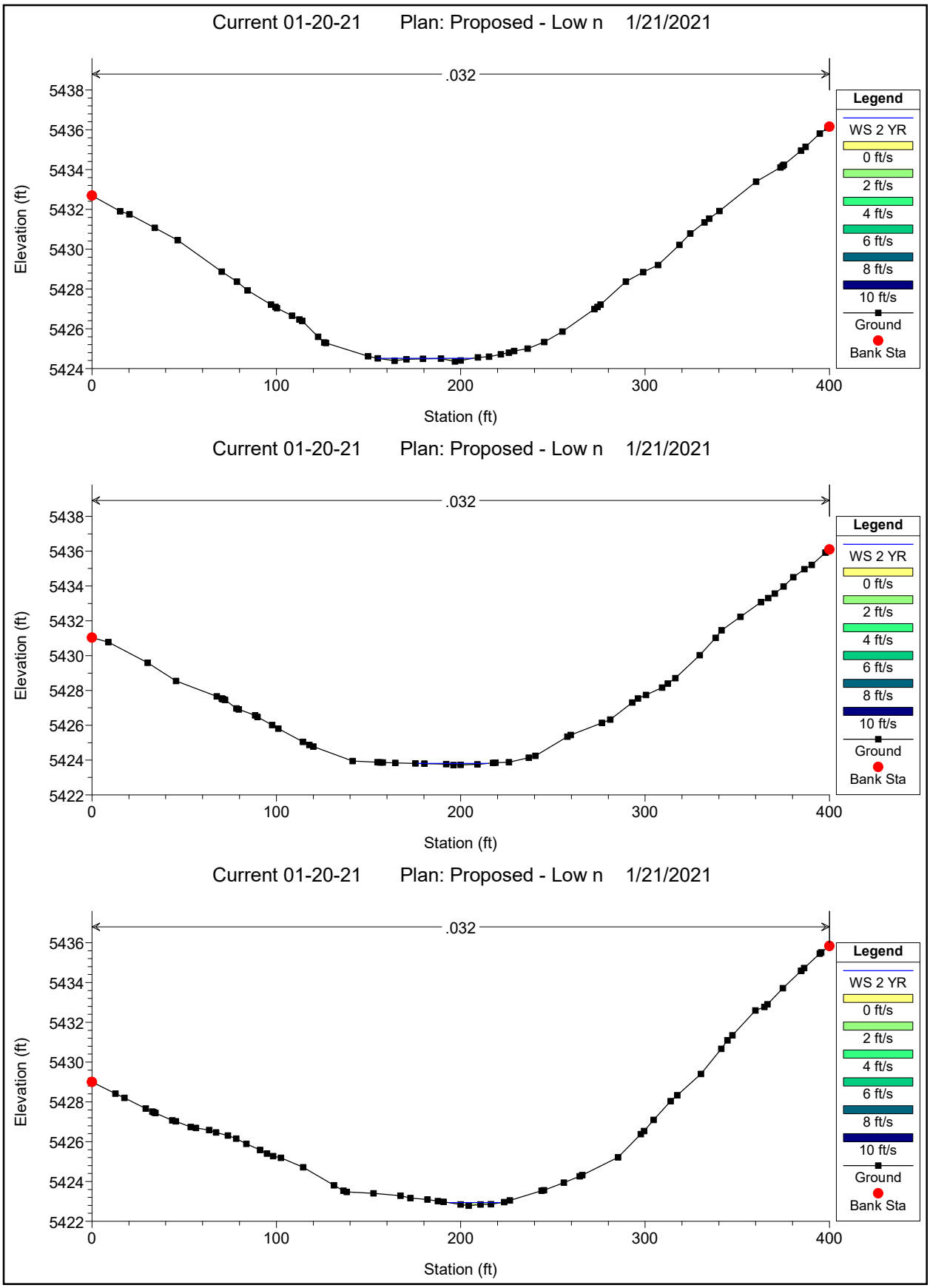
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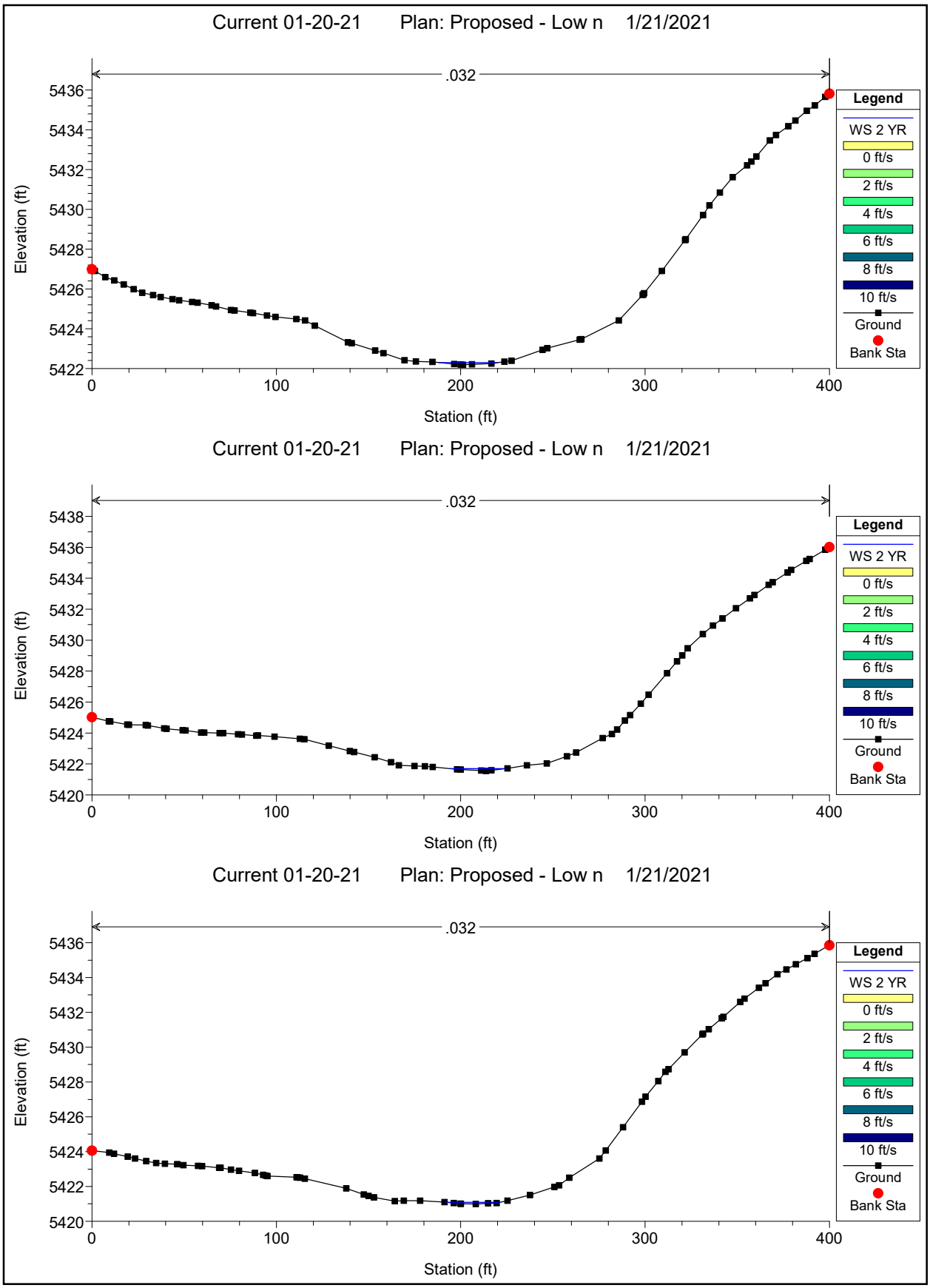
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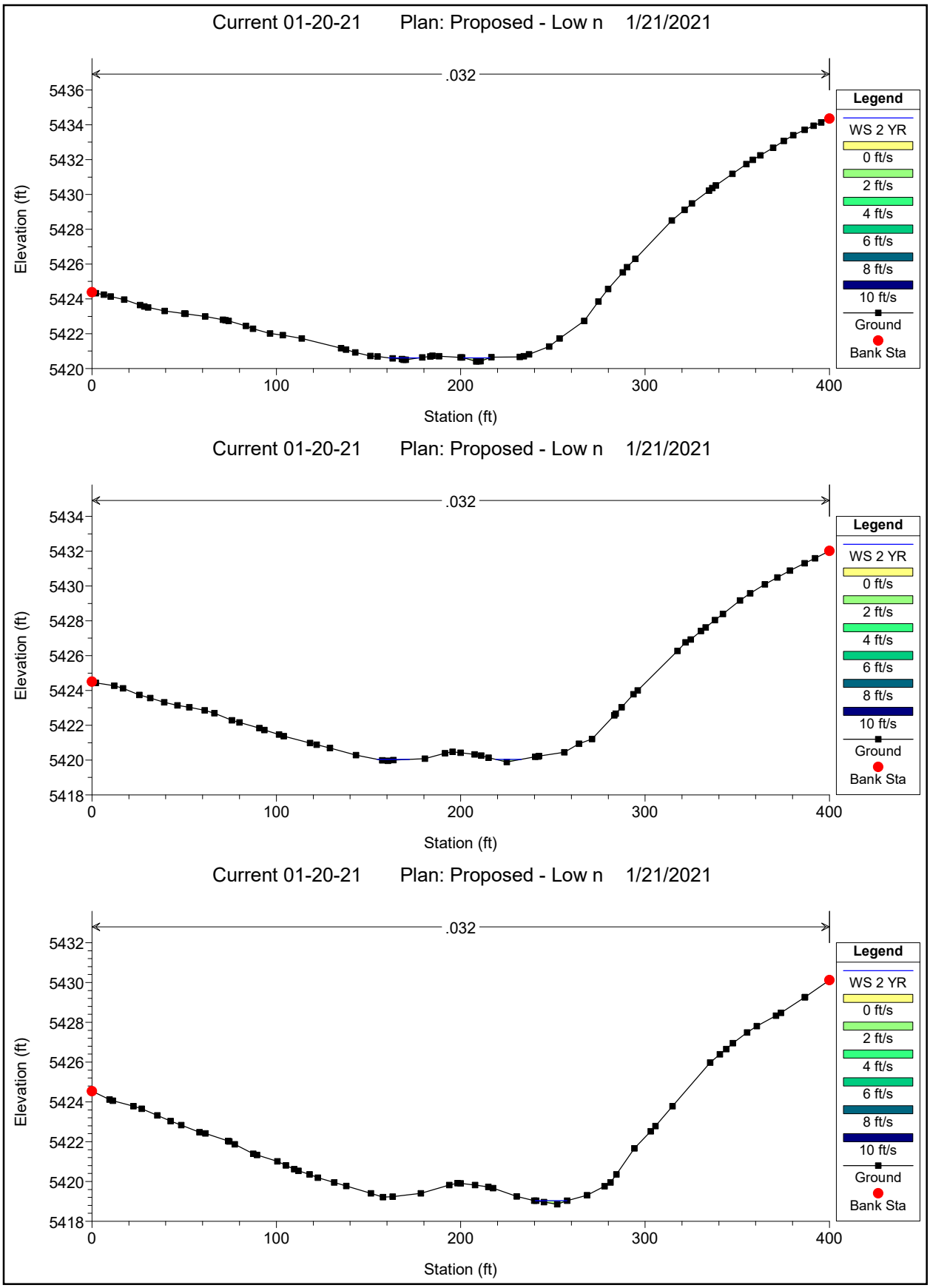
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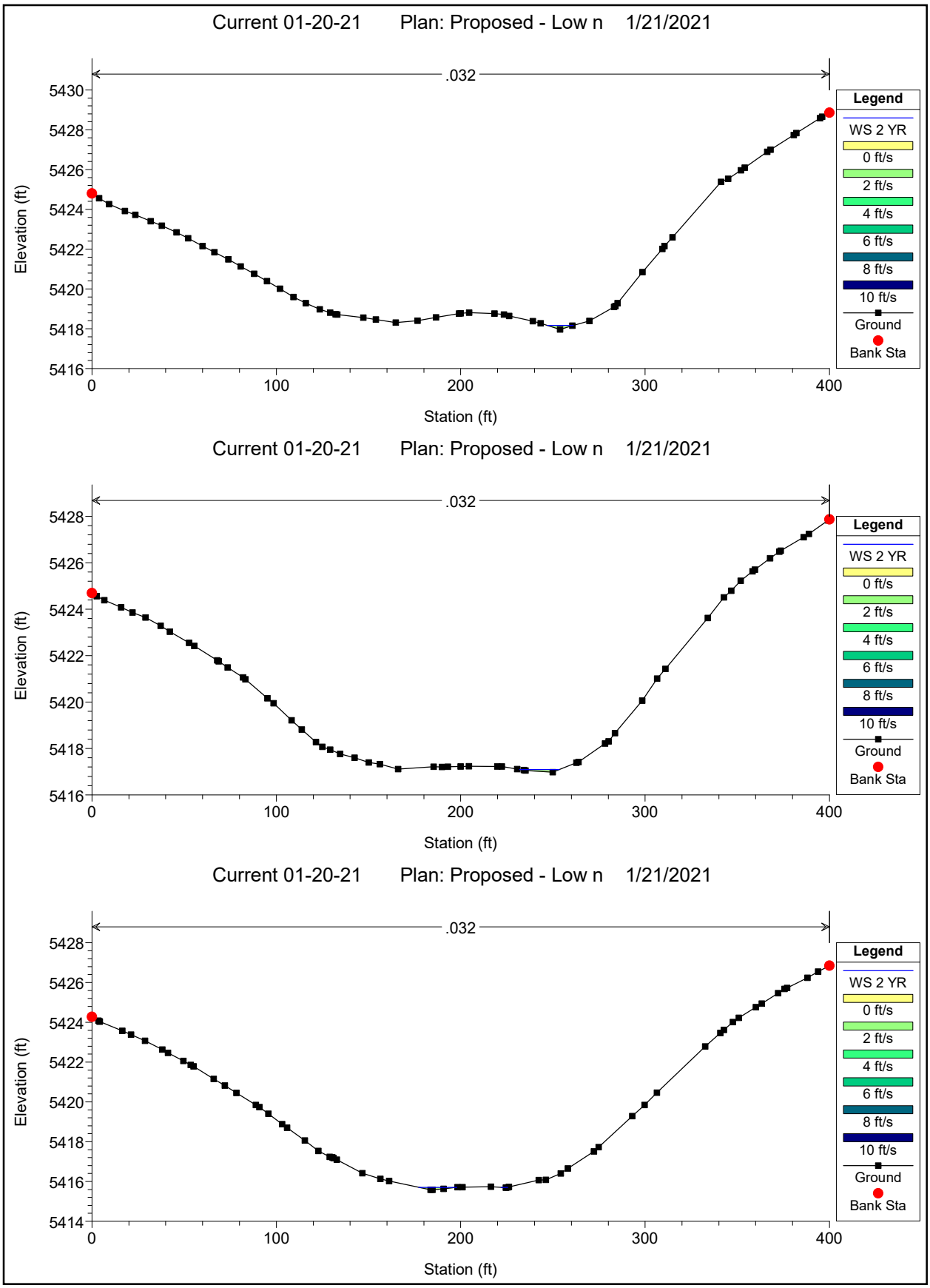
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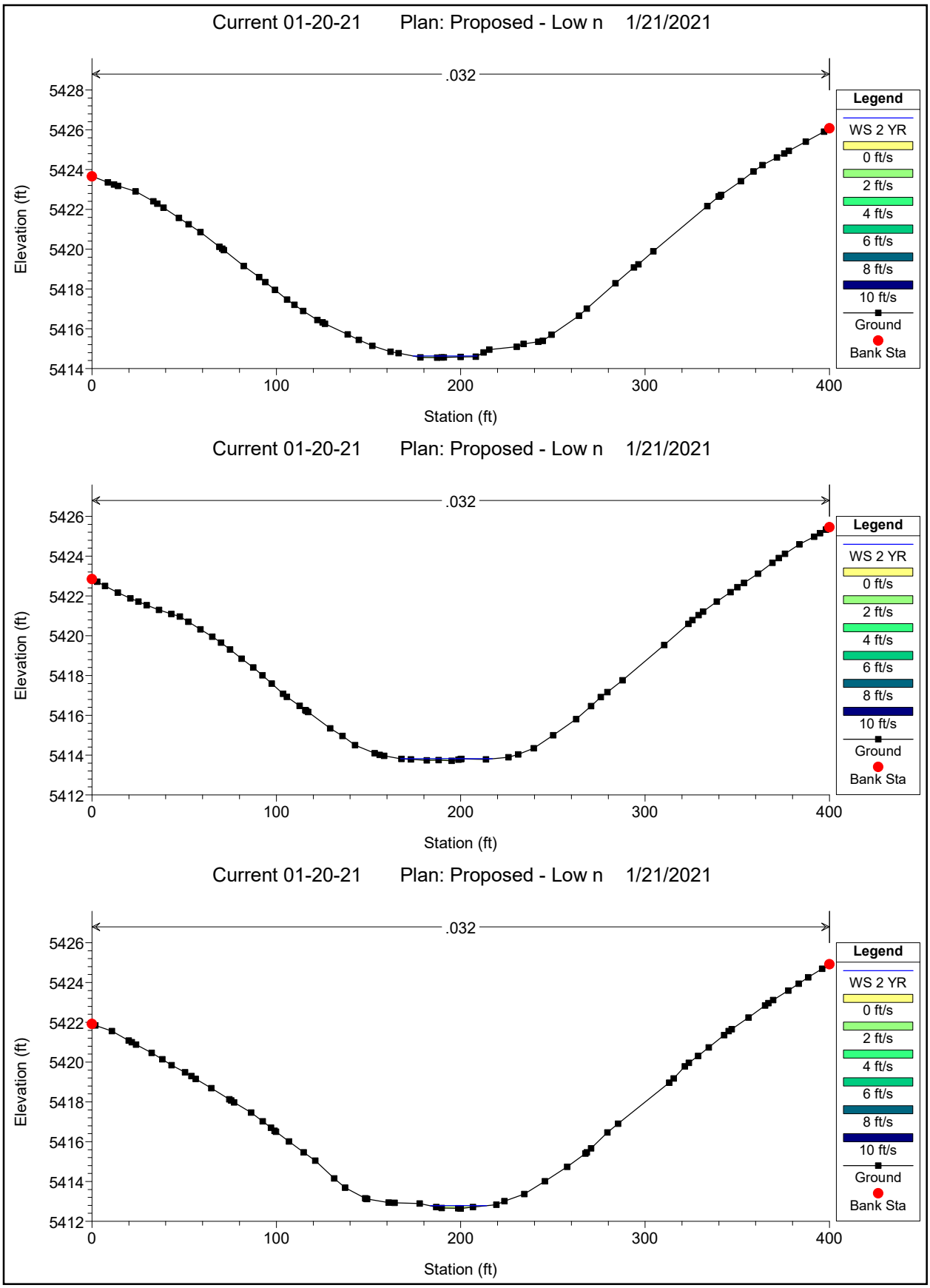
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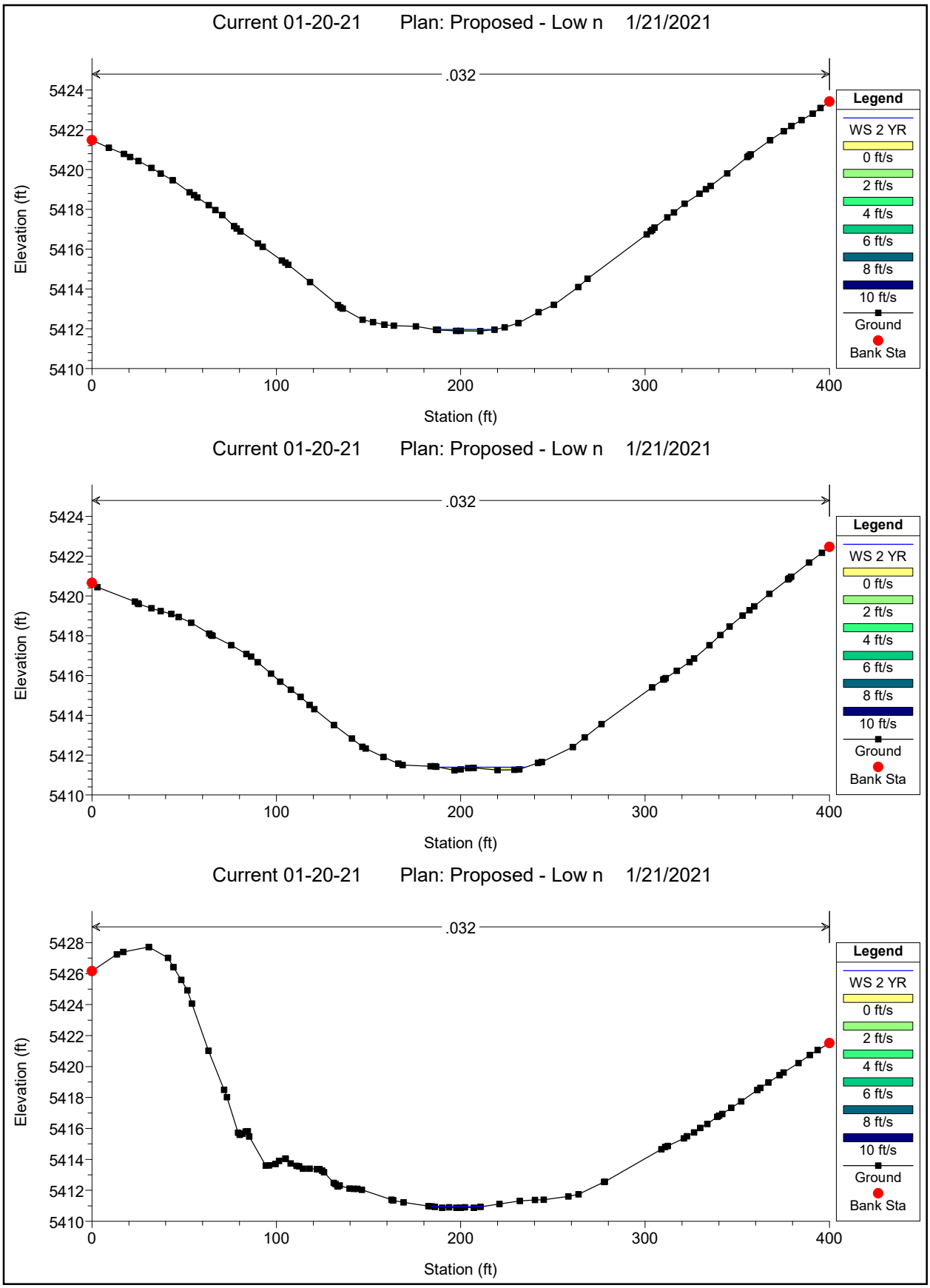
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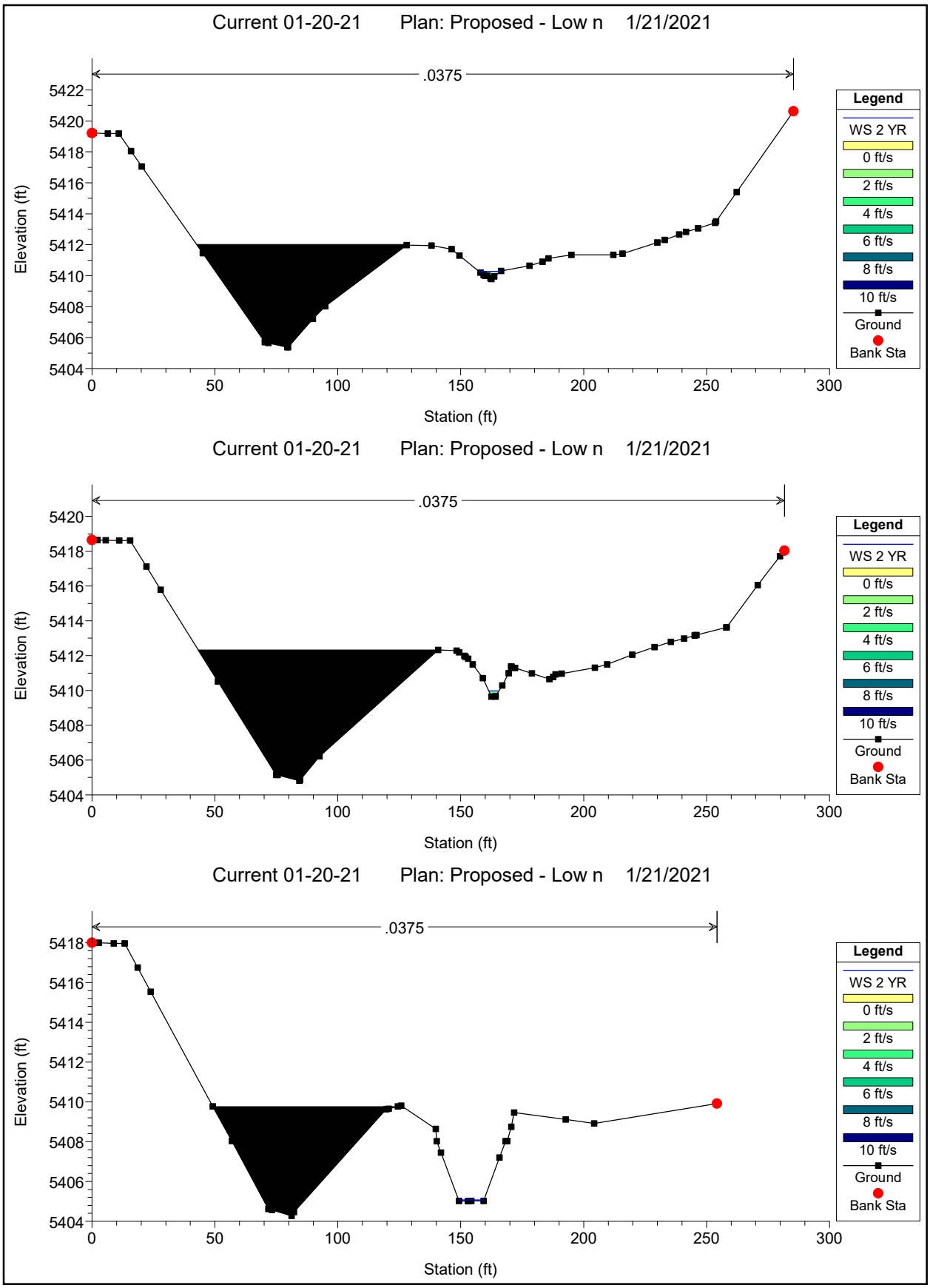
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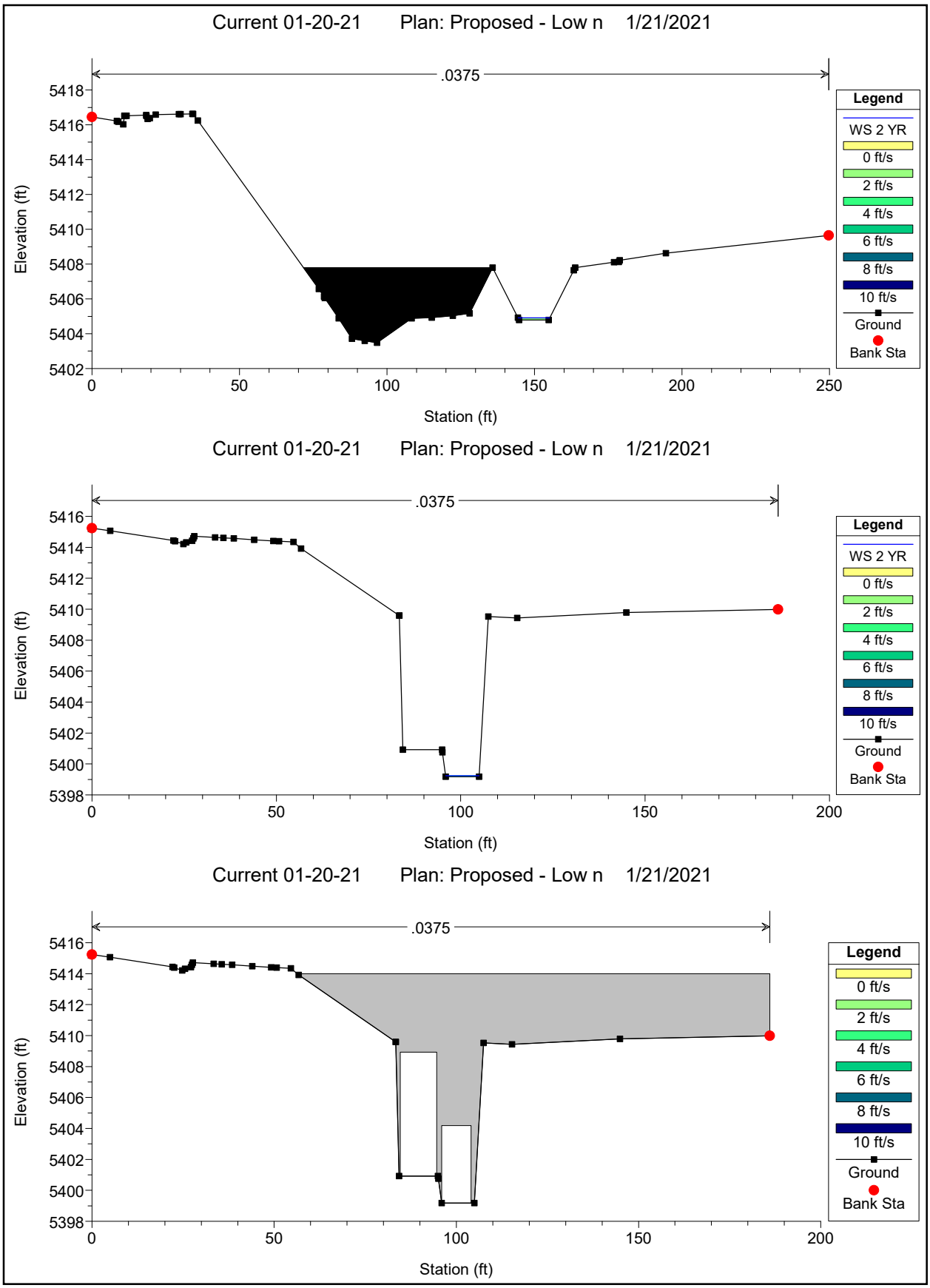
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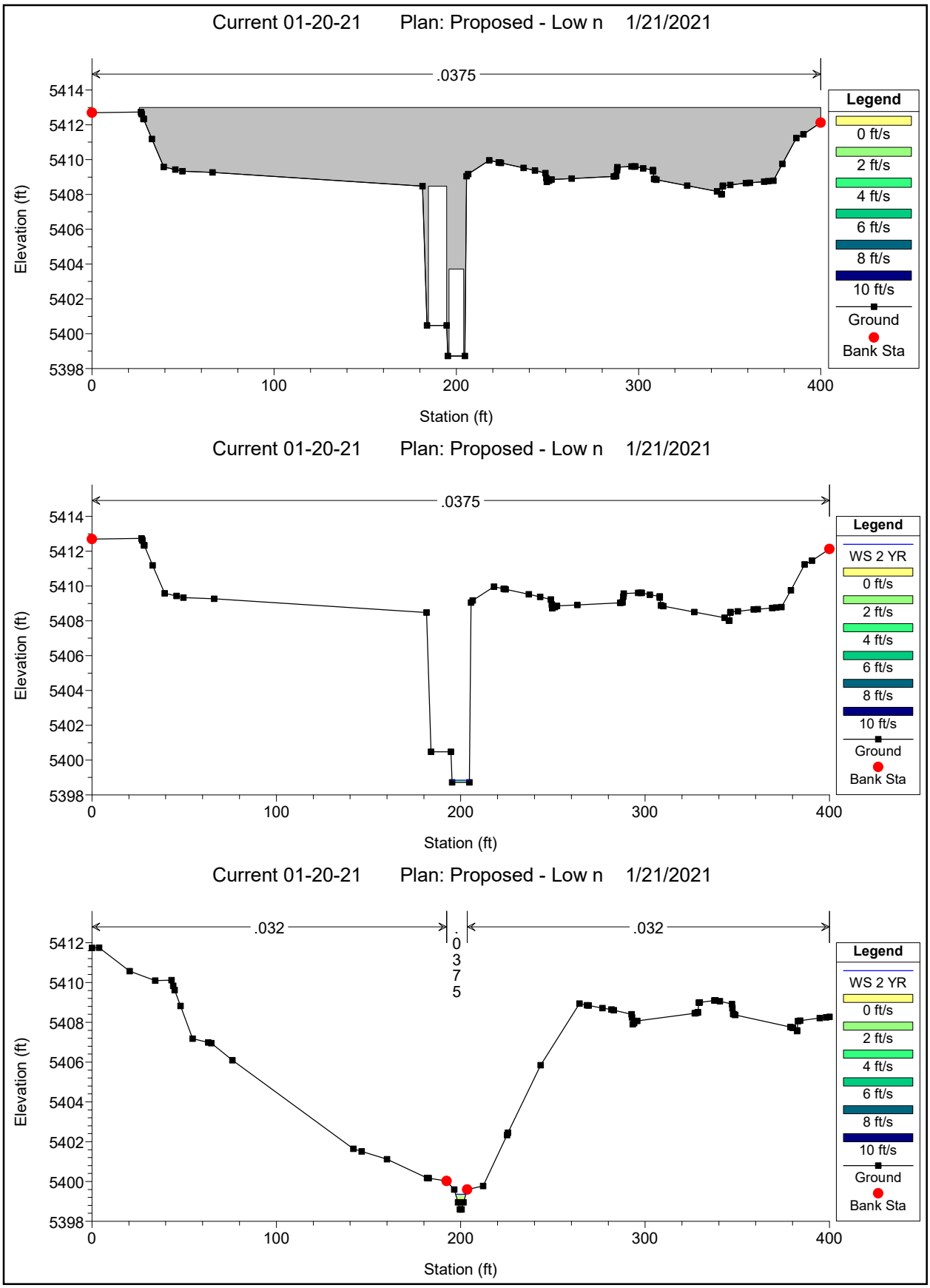
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Ground
Bank Sta
Current 01-20-21 Plan: Proposed - Low n 1/21/2021
.0375
Elevation (ft)
Station (ft)
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4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 01-20-21 Plan: Proposed - Low n 1/21/2021
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.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
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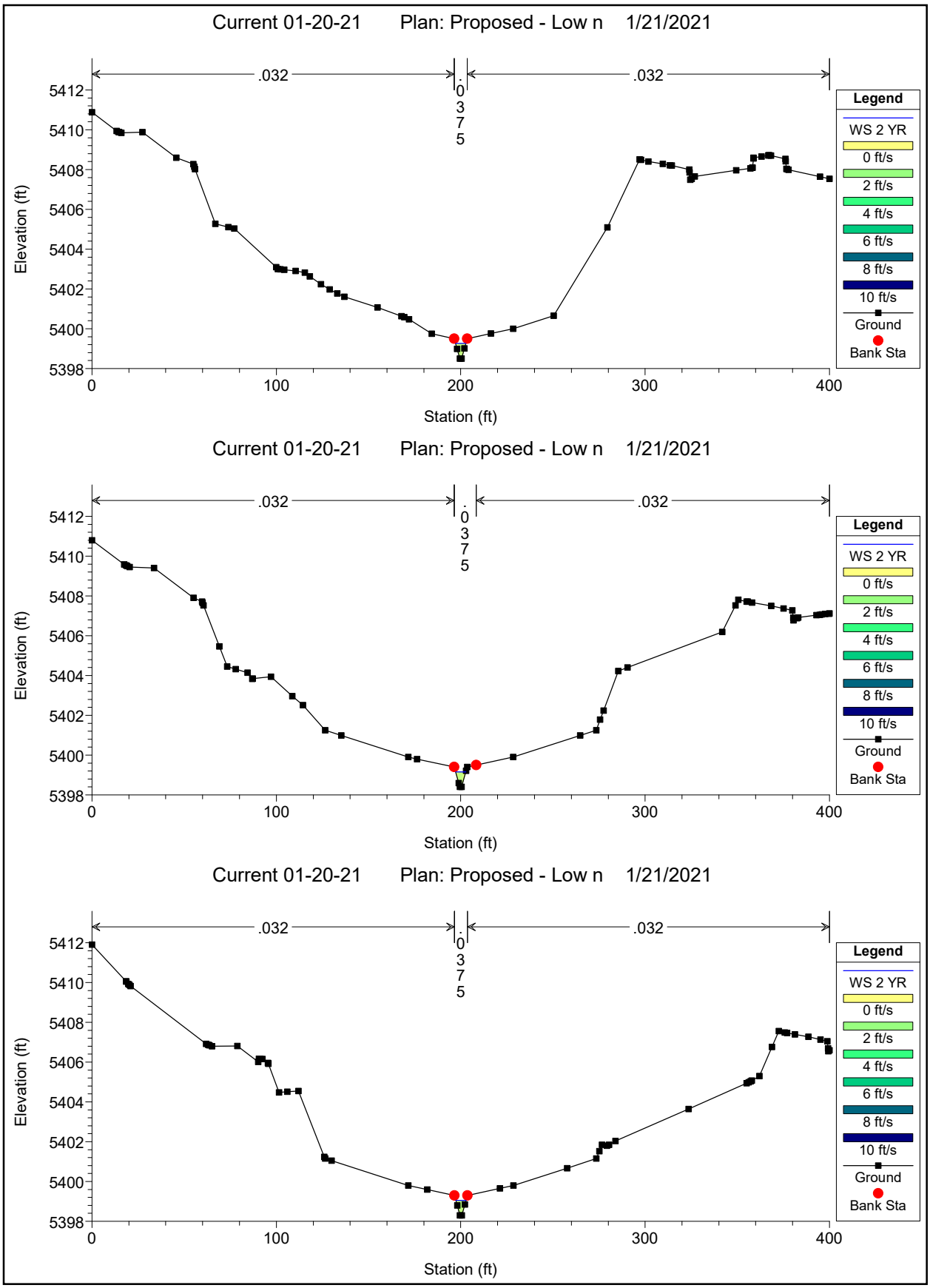
Bank Sta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Elevation (ft)
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Station (ft)
Legend
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Bank Sta
Current 01-20-21 Plan: Proposed - Low n 1/21/2021
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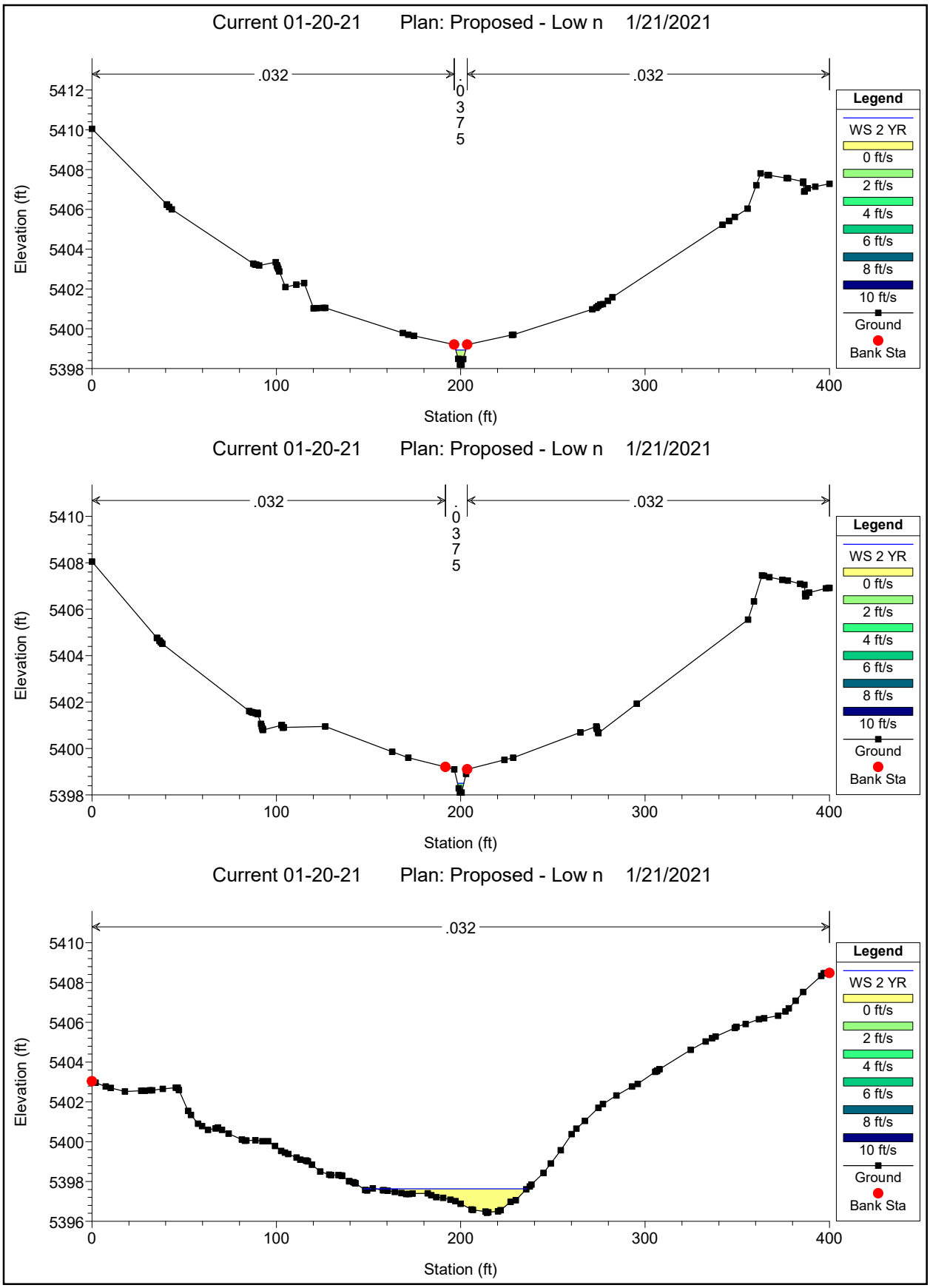
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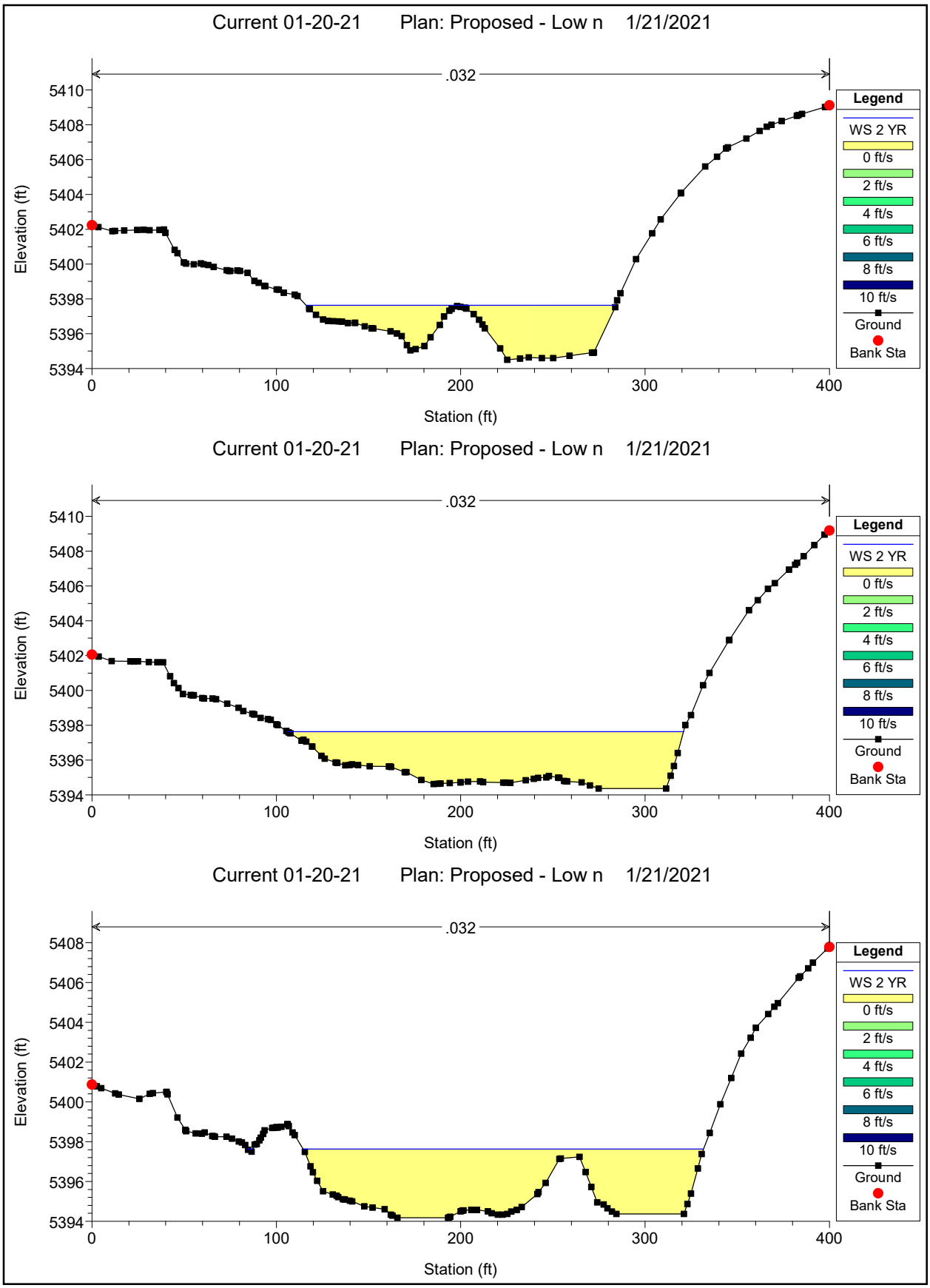
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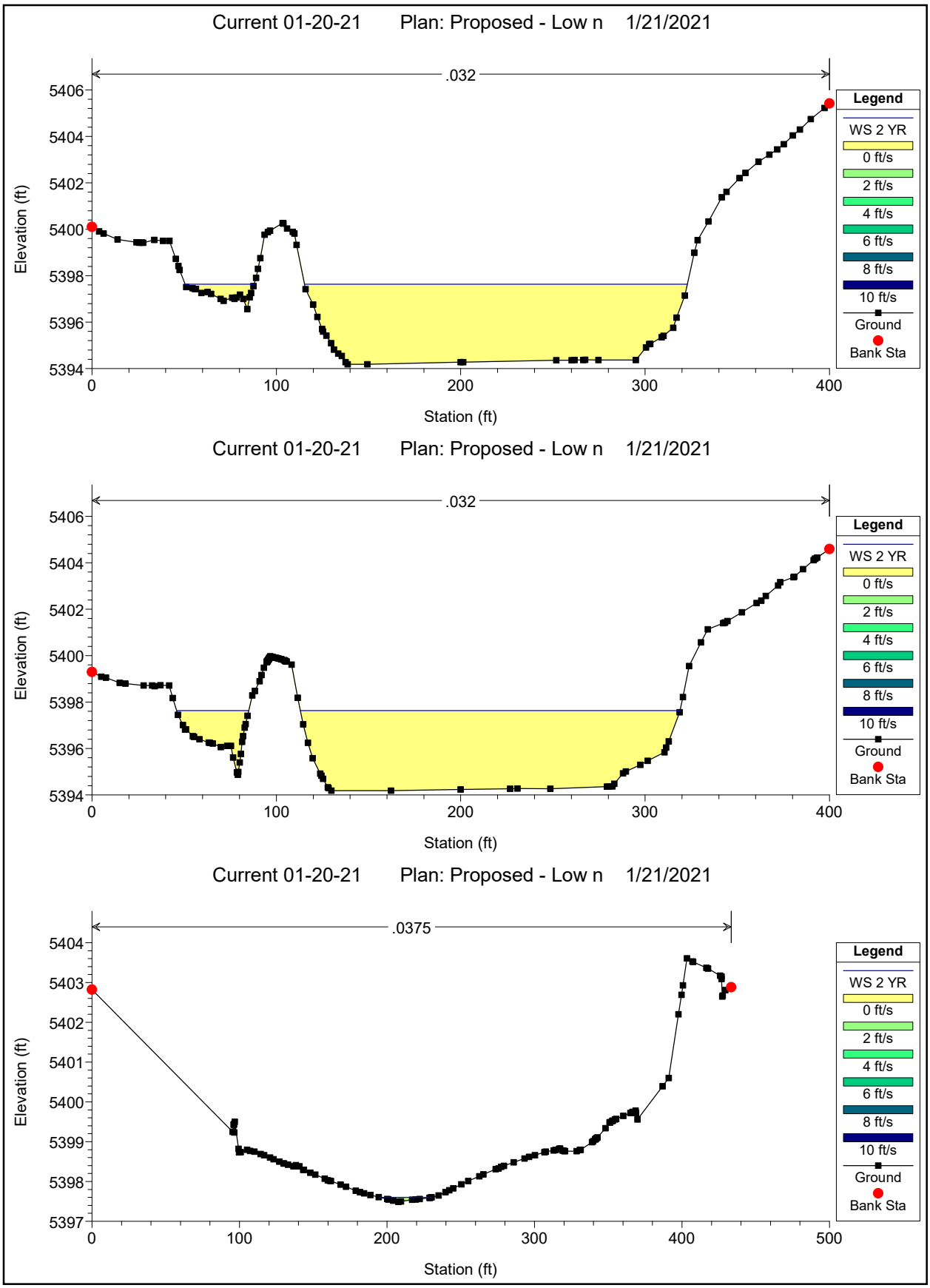
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Bank Sta
Current 01-20-21 Plan: Proposed - Low n 1/21/2021
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Elevation (ft)
Station (ft)
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Ground
Bank Sta
Current 01-20-21 Plan: Proposed - Low n 1/21/2021
.0375
Elevation (ft)
Station (ft)
Legend
WS 2 YR
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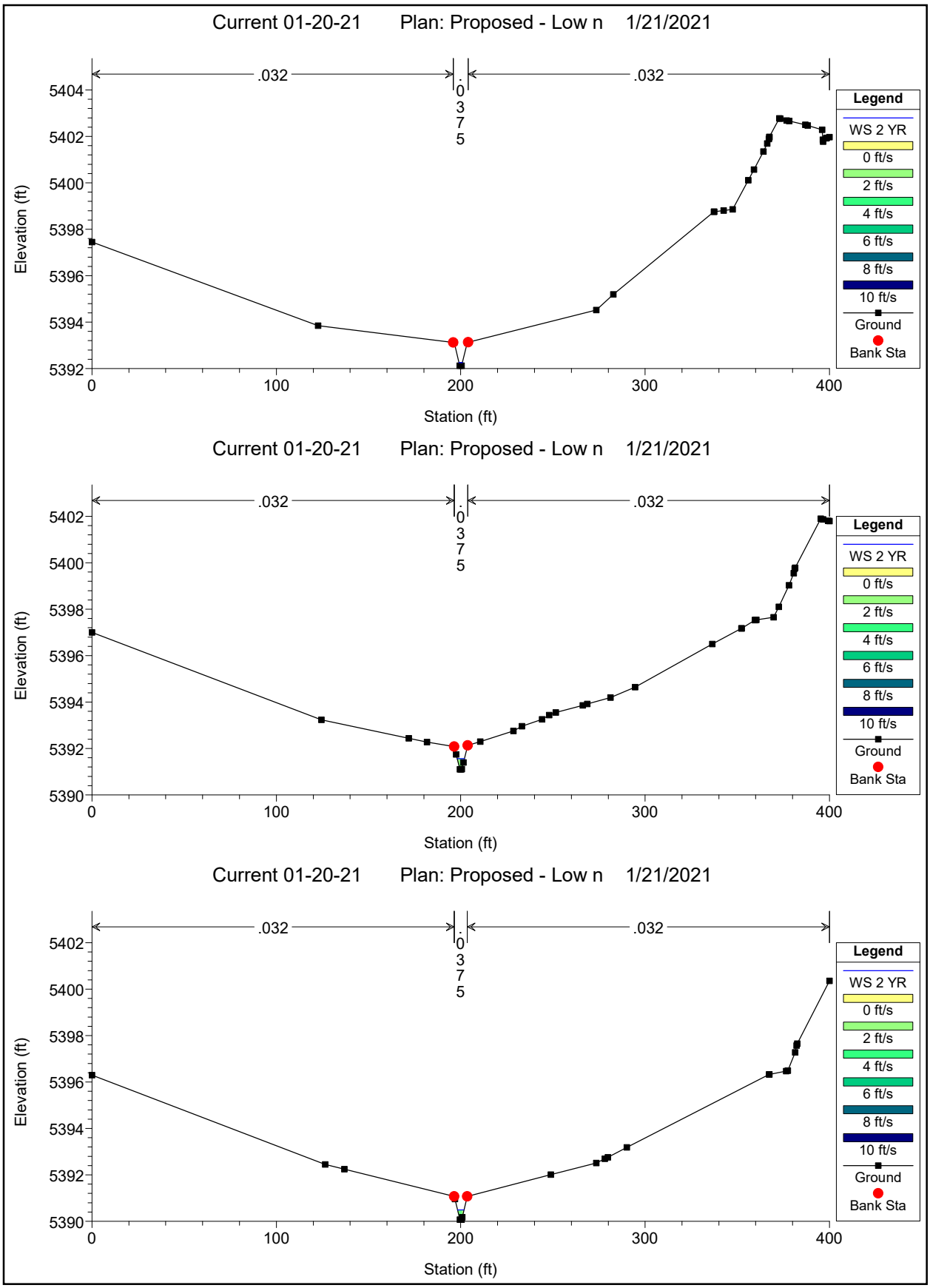
Ground
Bank Sta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.032
Elevation (ft)
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5392
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Station (ft)
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Ground
Bank Sta
Current 01-20-21 Plan: Proposed - Low n 1/21/2021
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Elevation (ft)
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Station (ft)
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Current 01-20-21 Plan: Proposed - Low n 1/21/2021
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Elevation (ft)
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Station (ft)
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Ground
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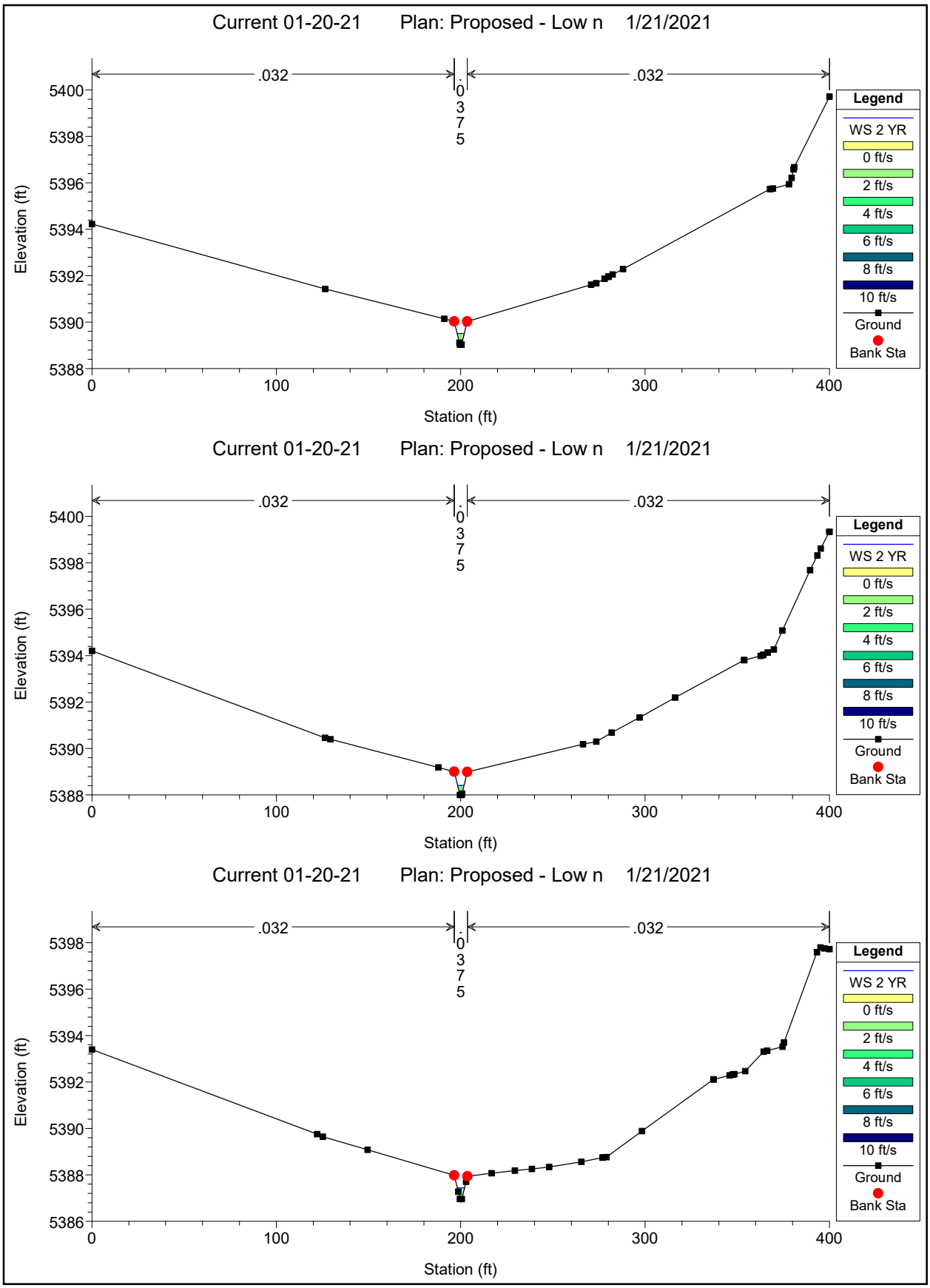
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Elevation (ft)
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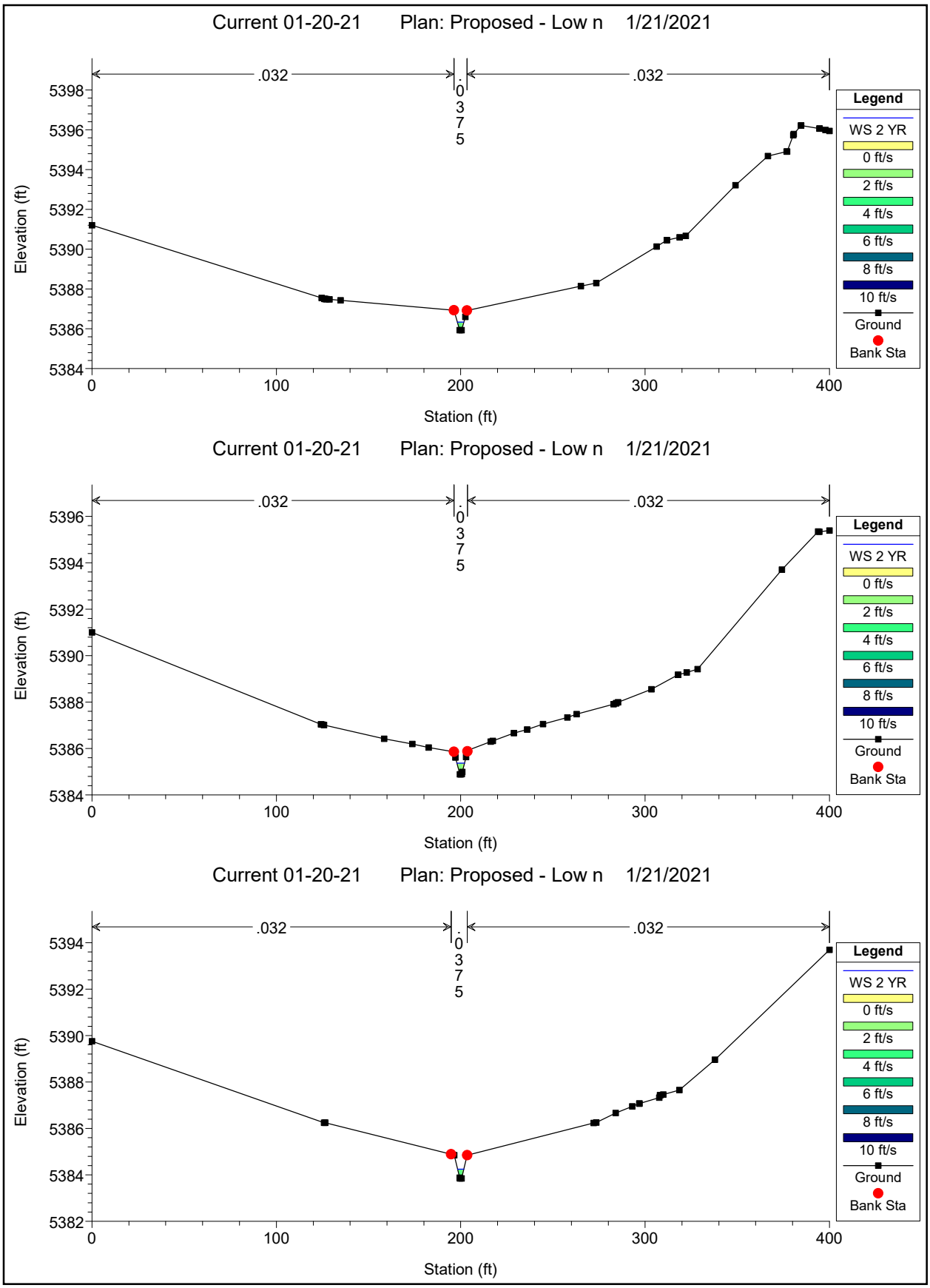
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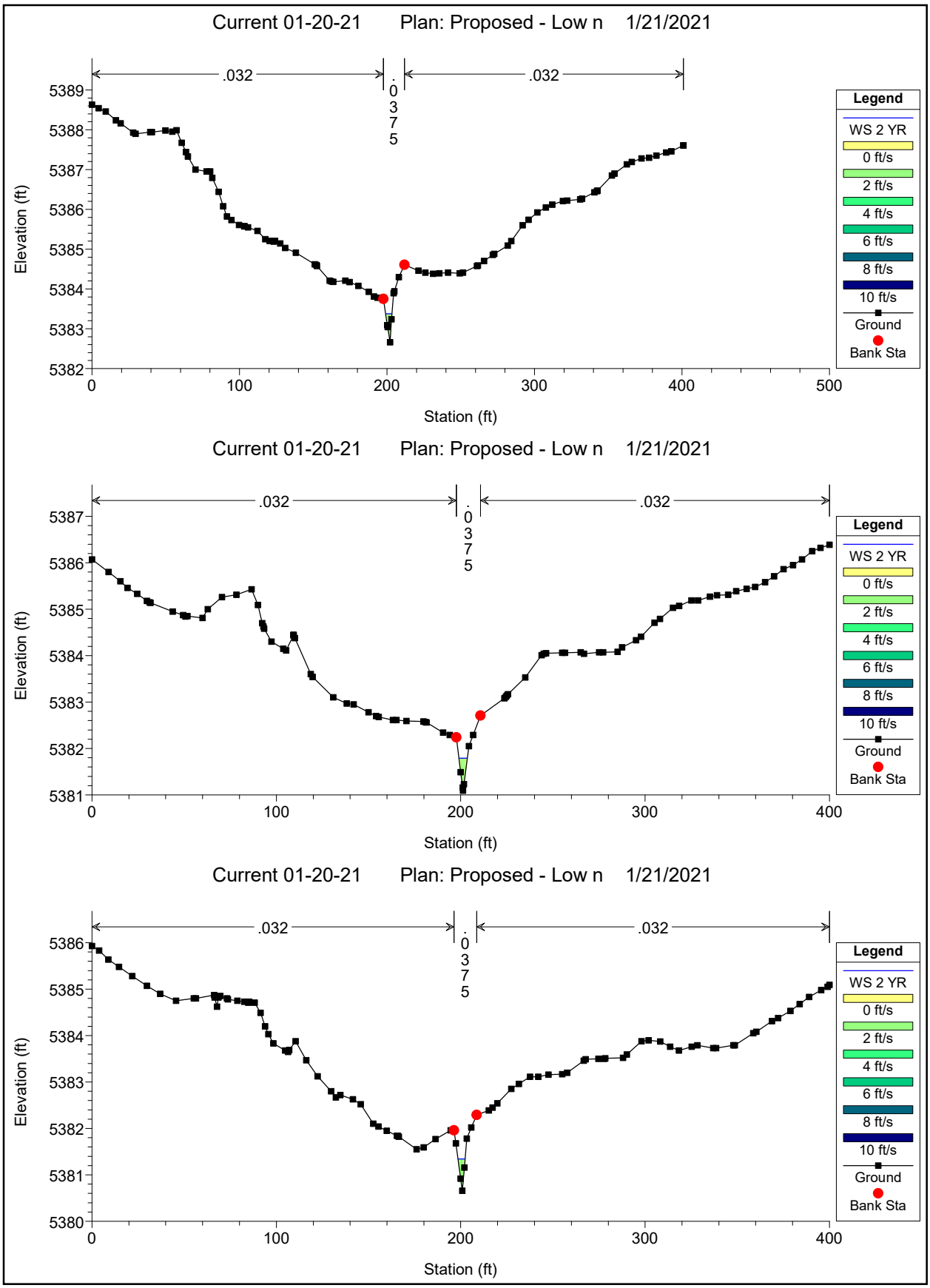
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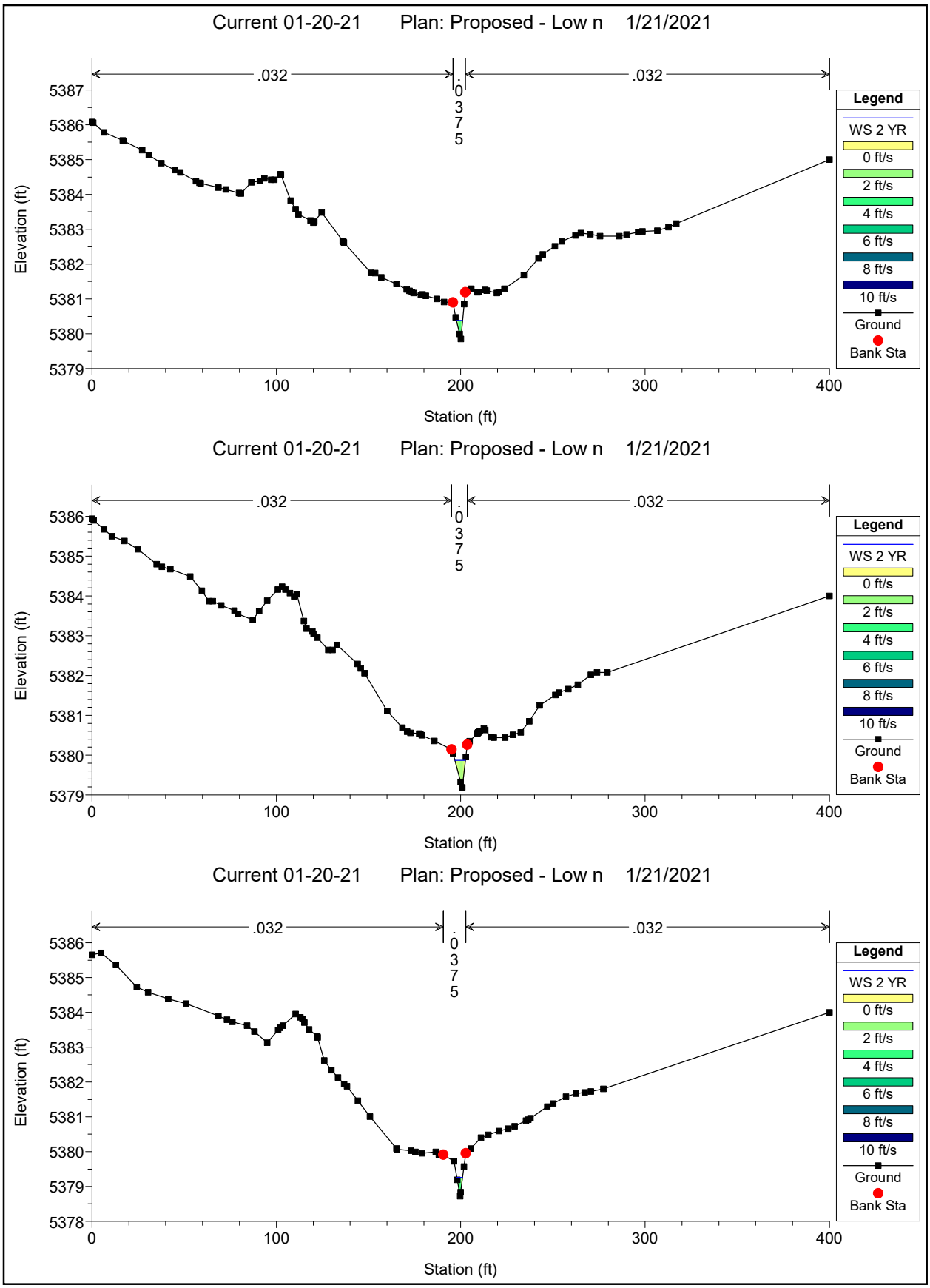
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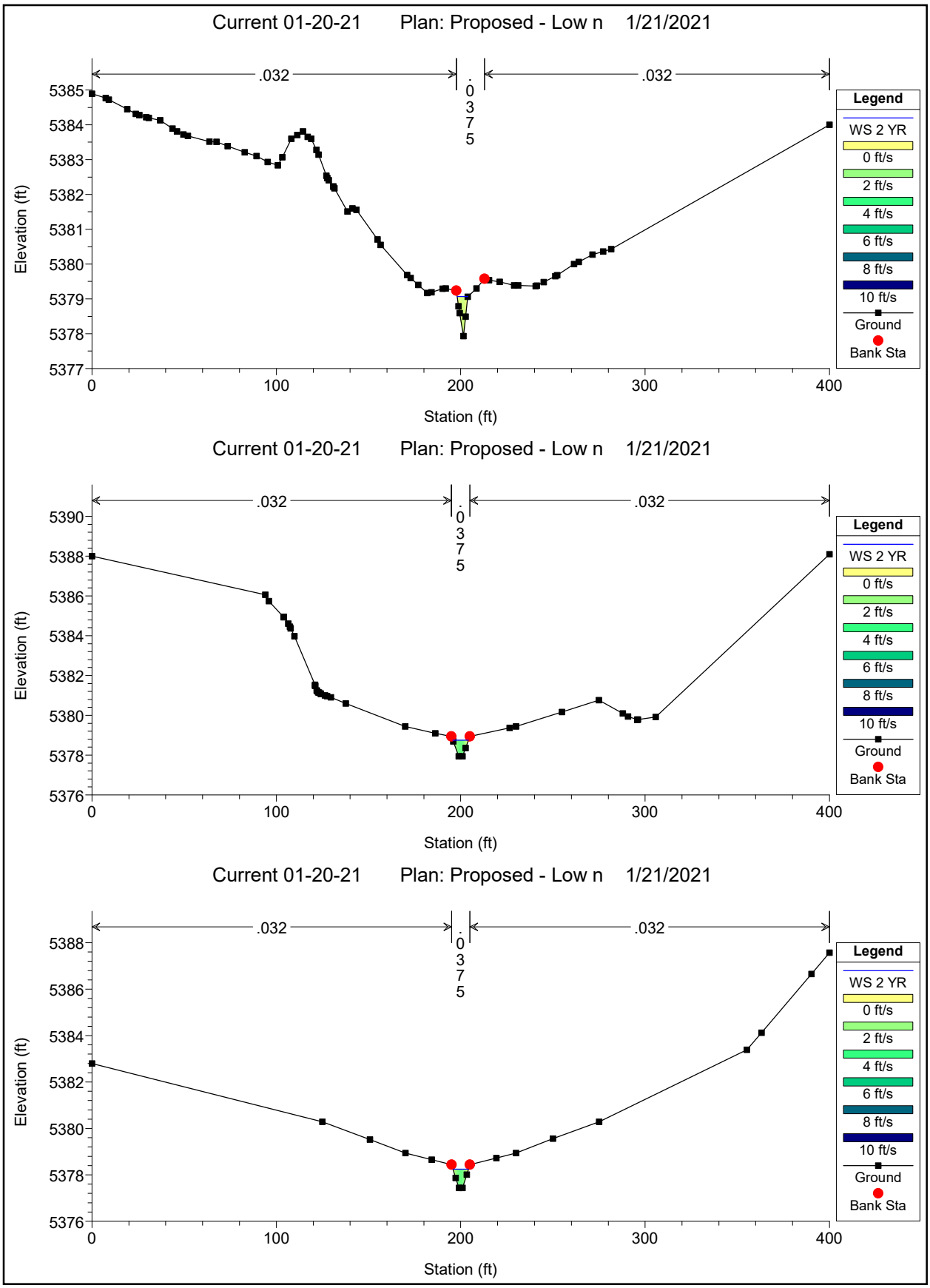
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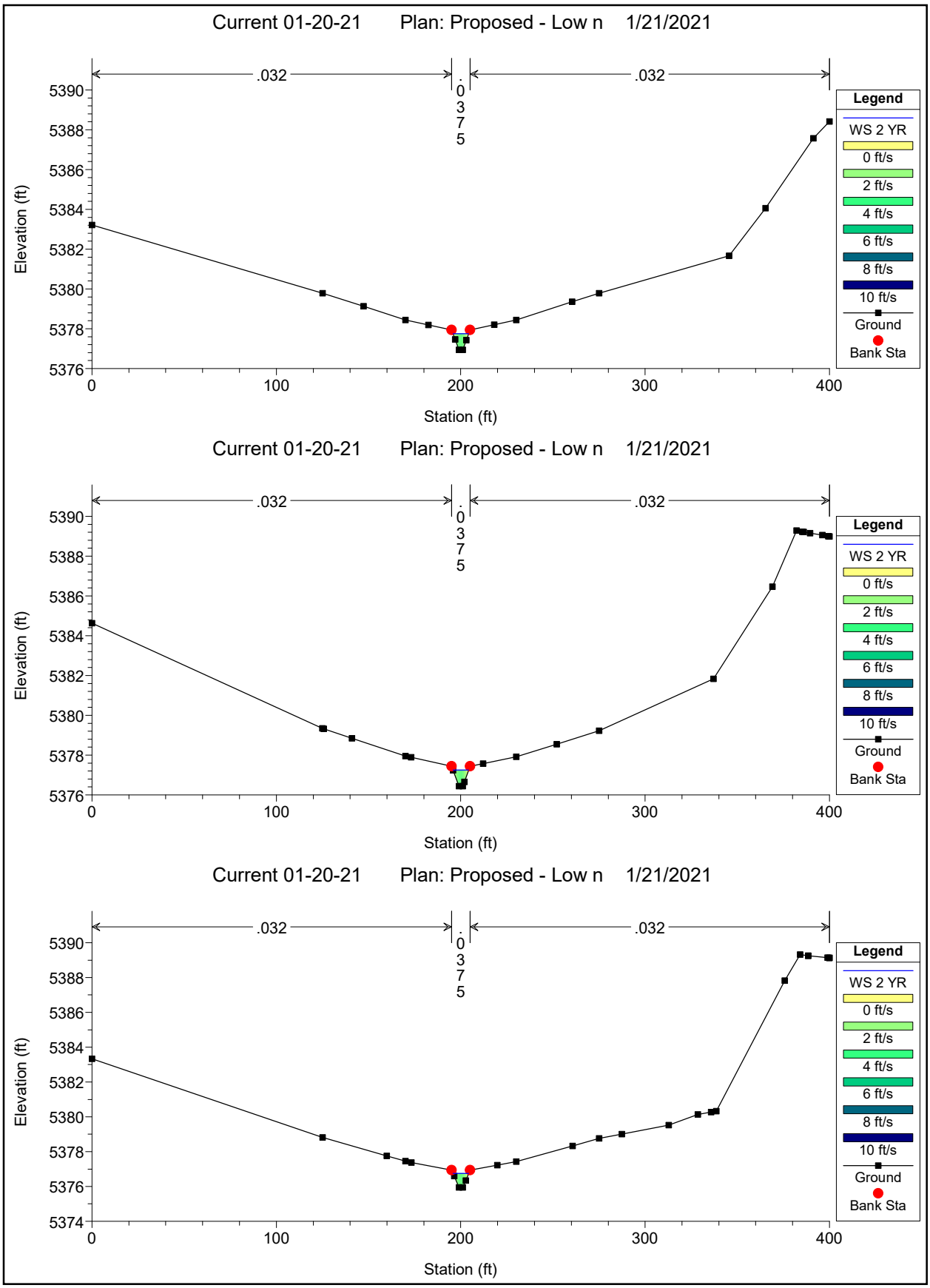
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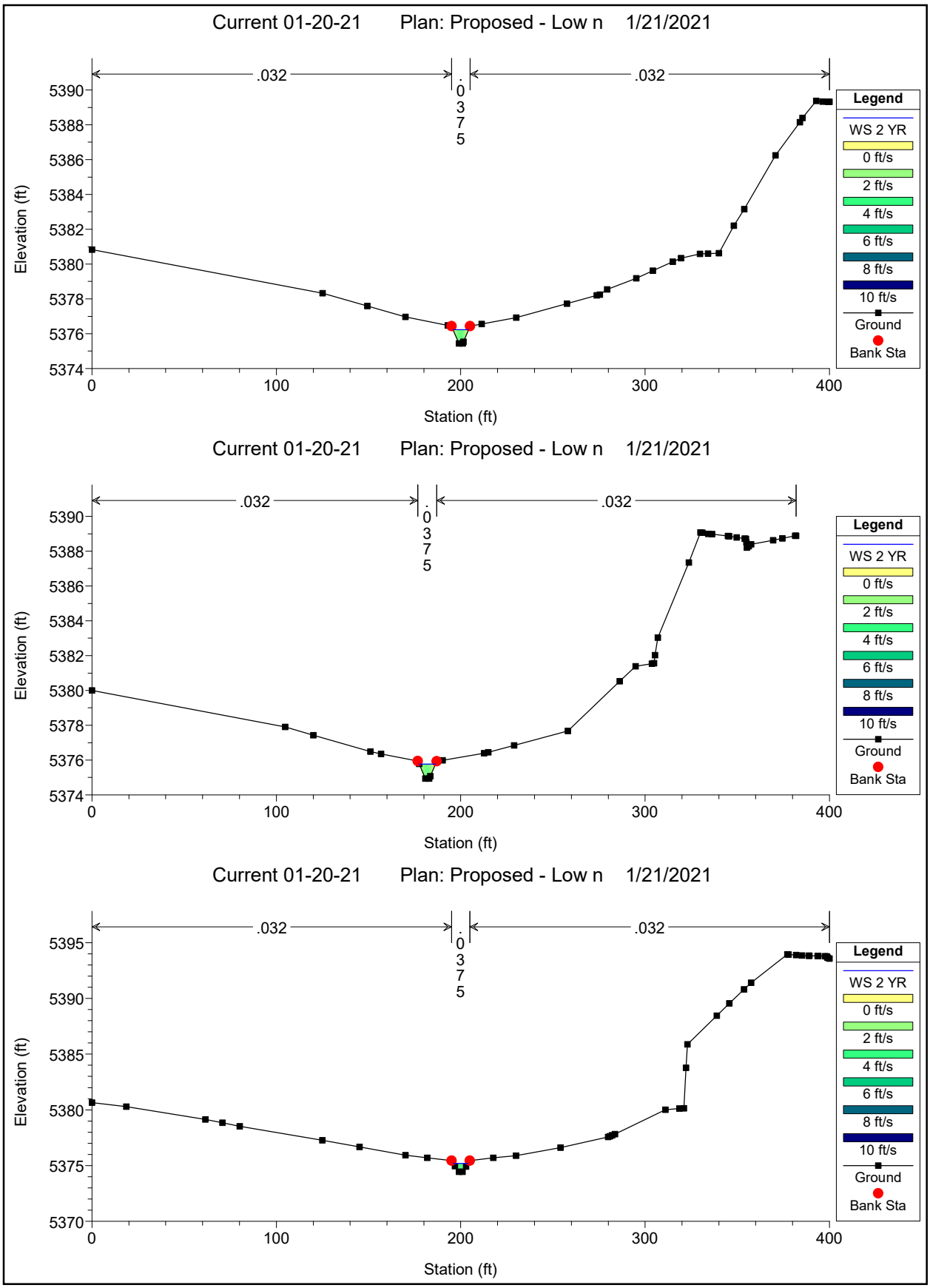
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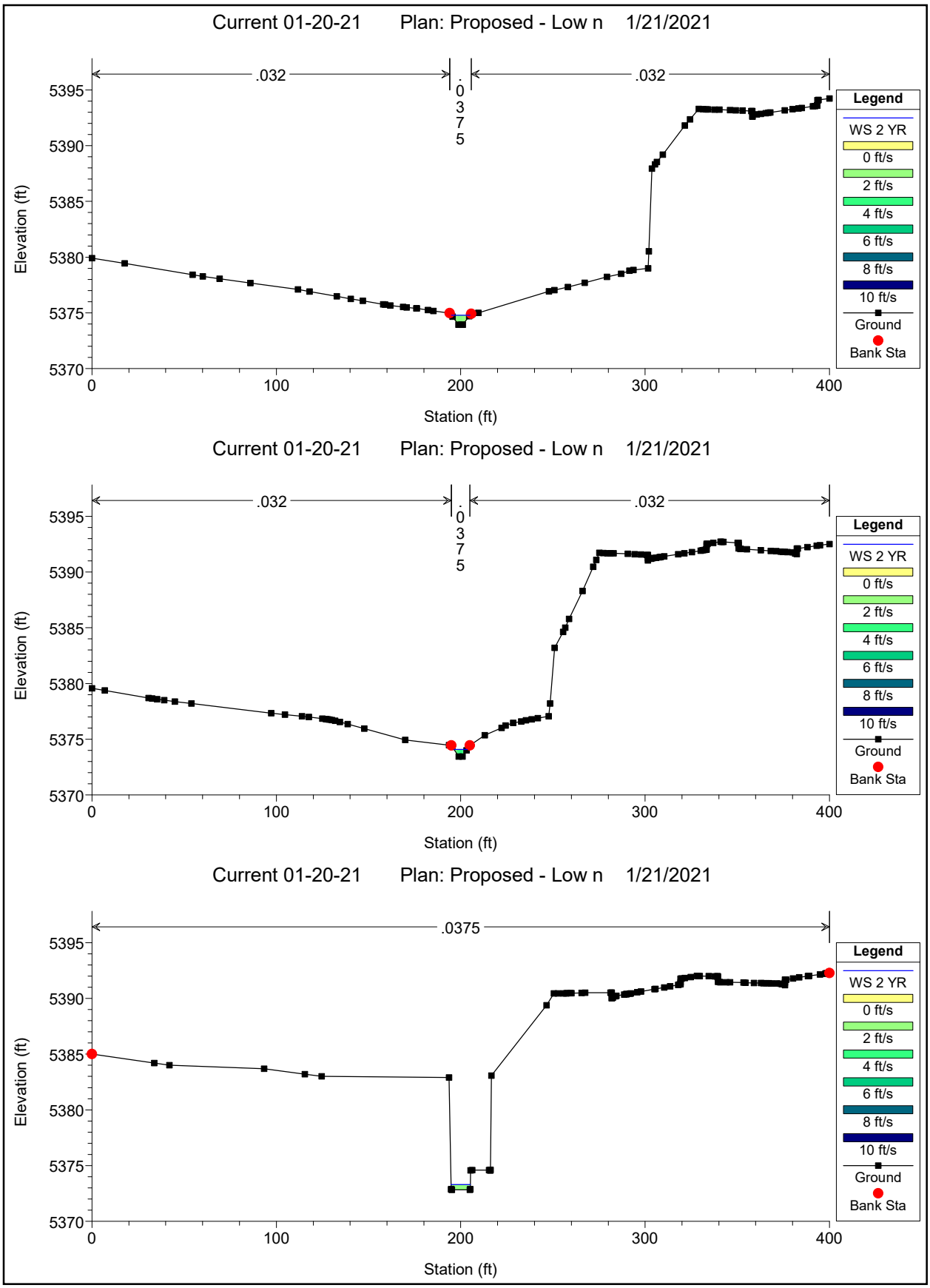
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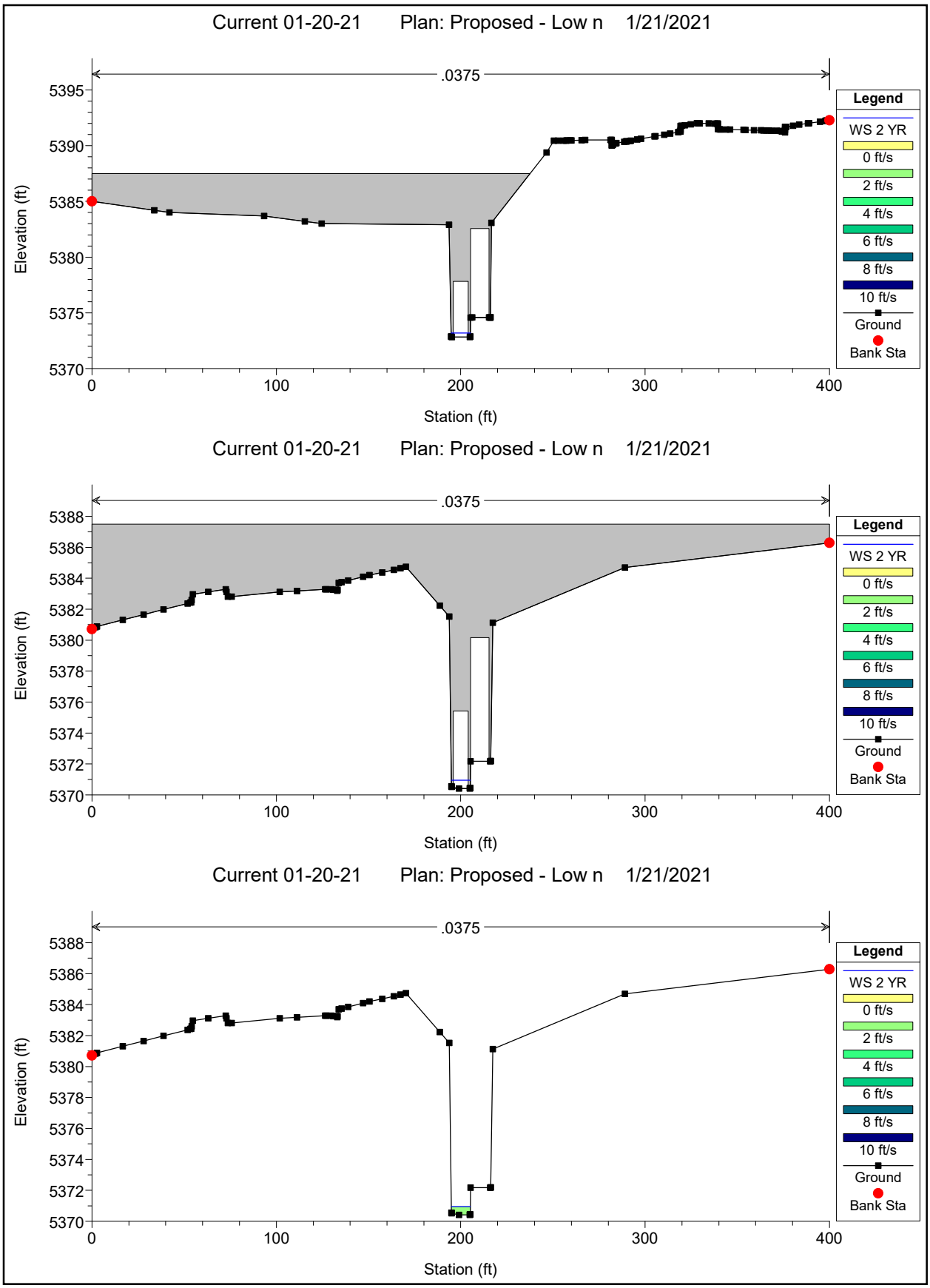
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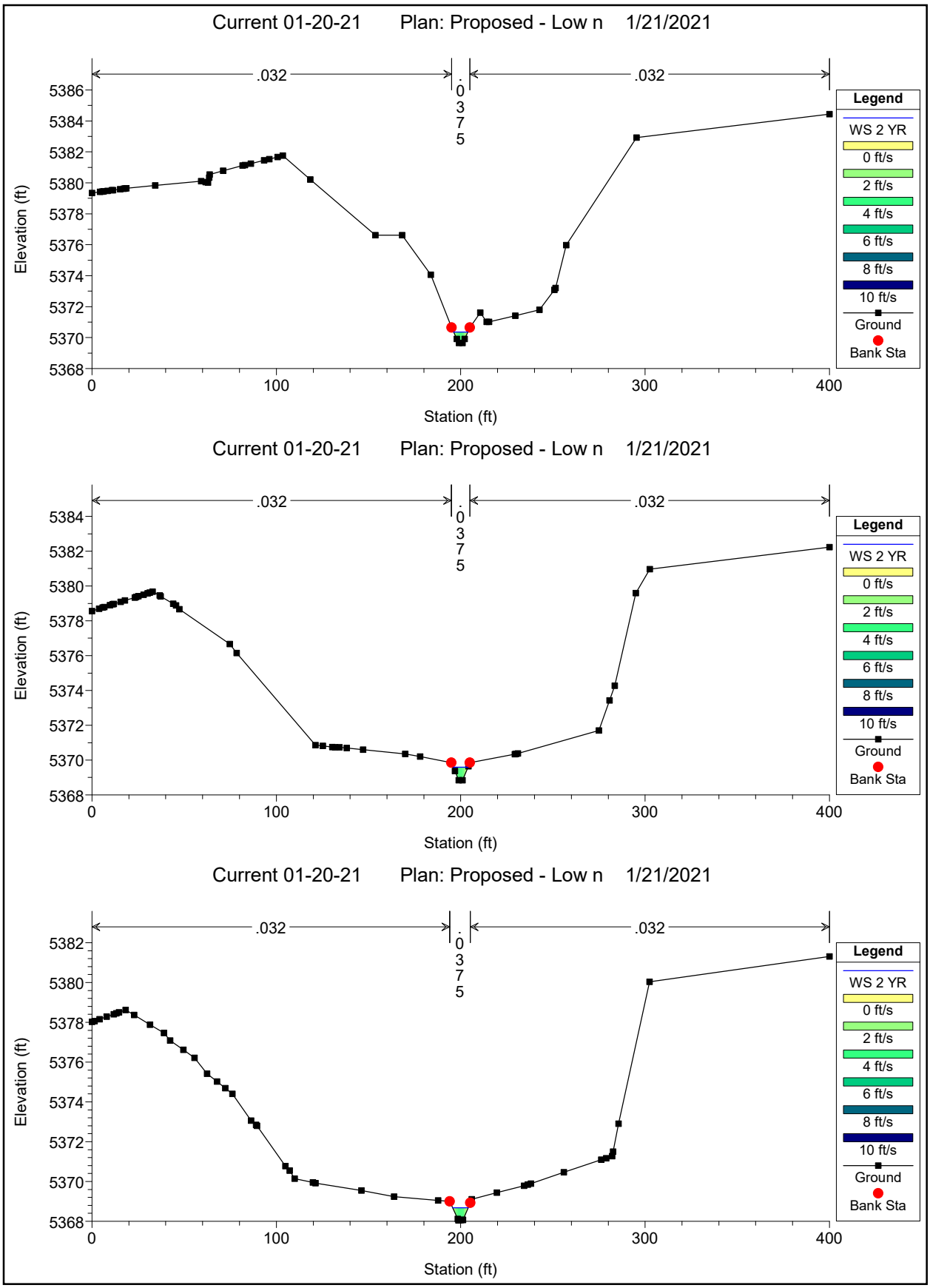
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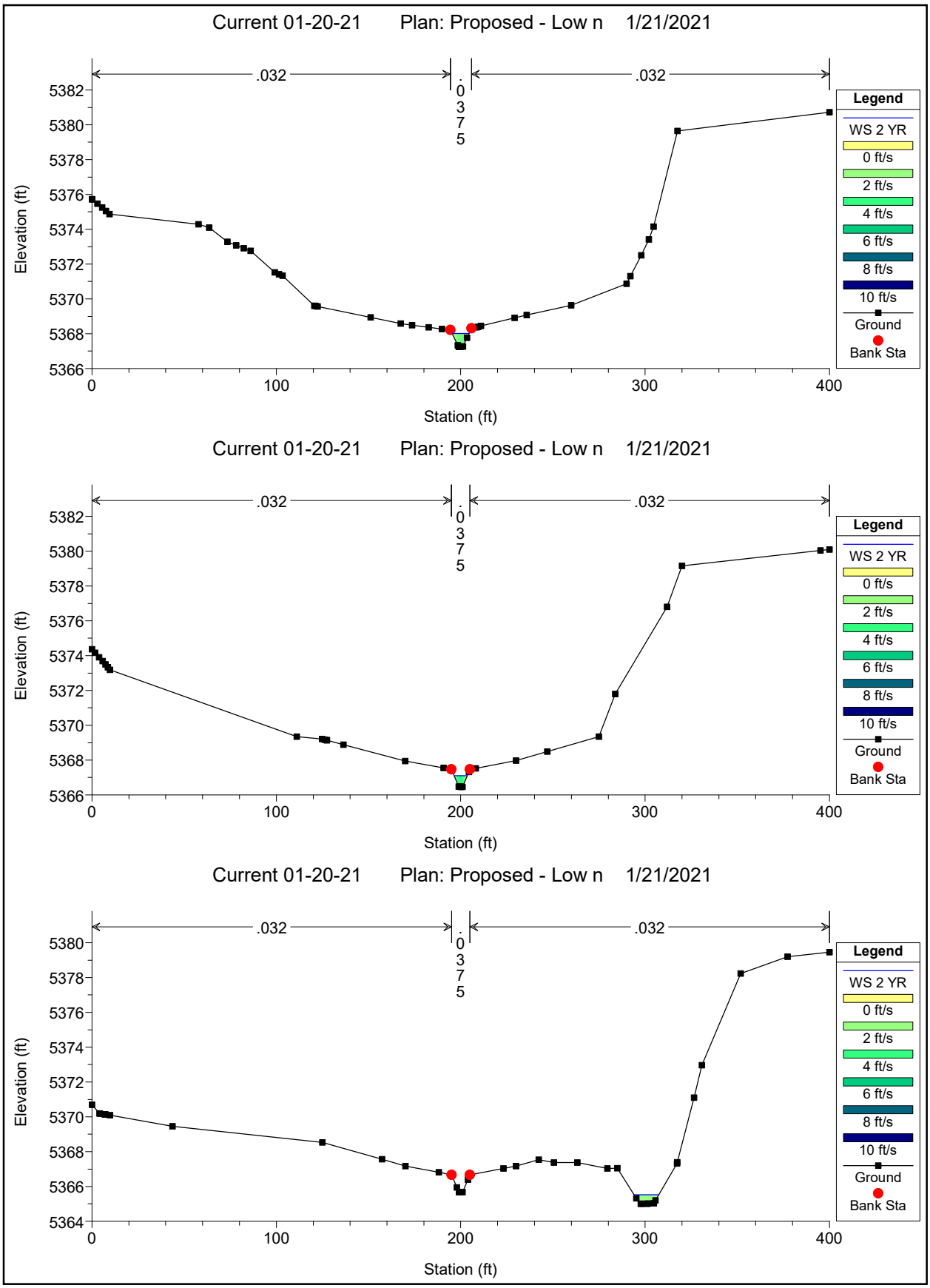
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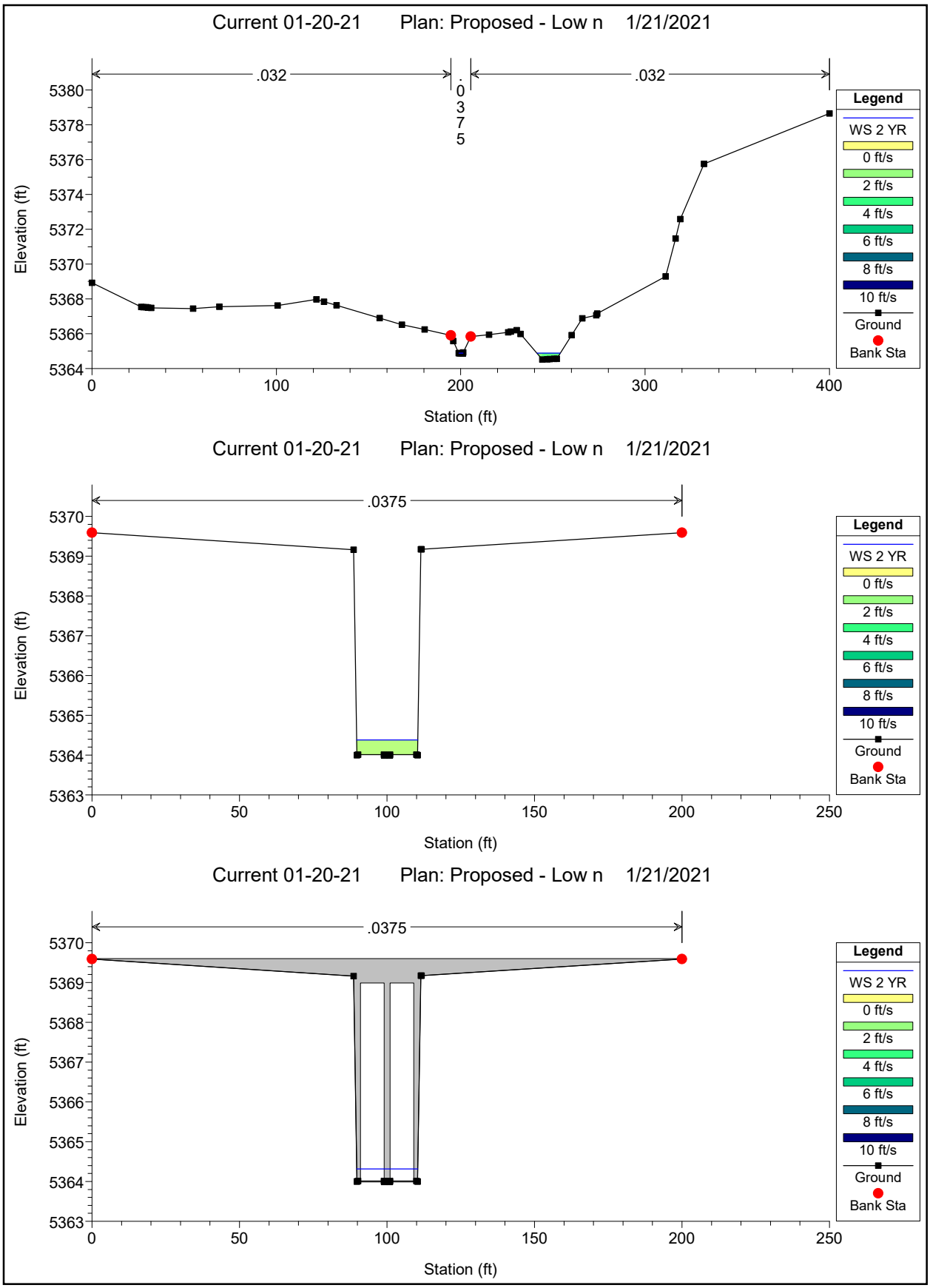
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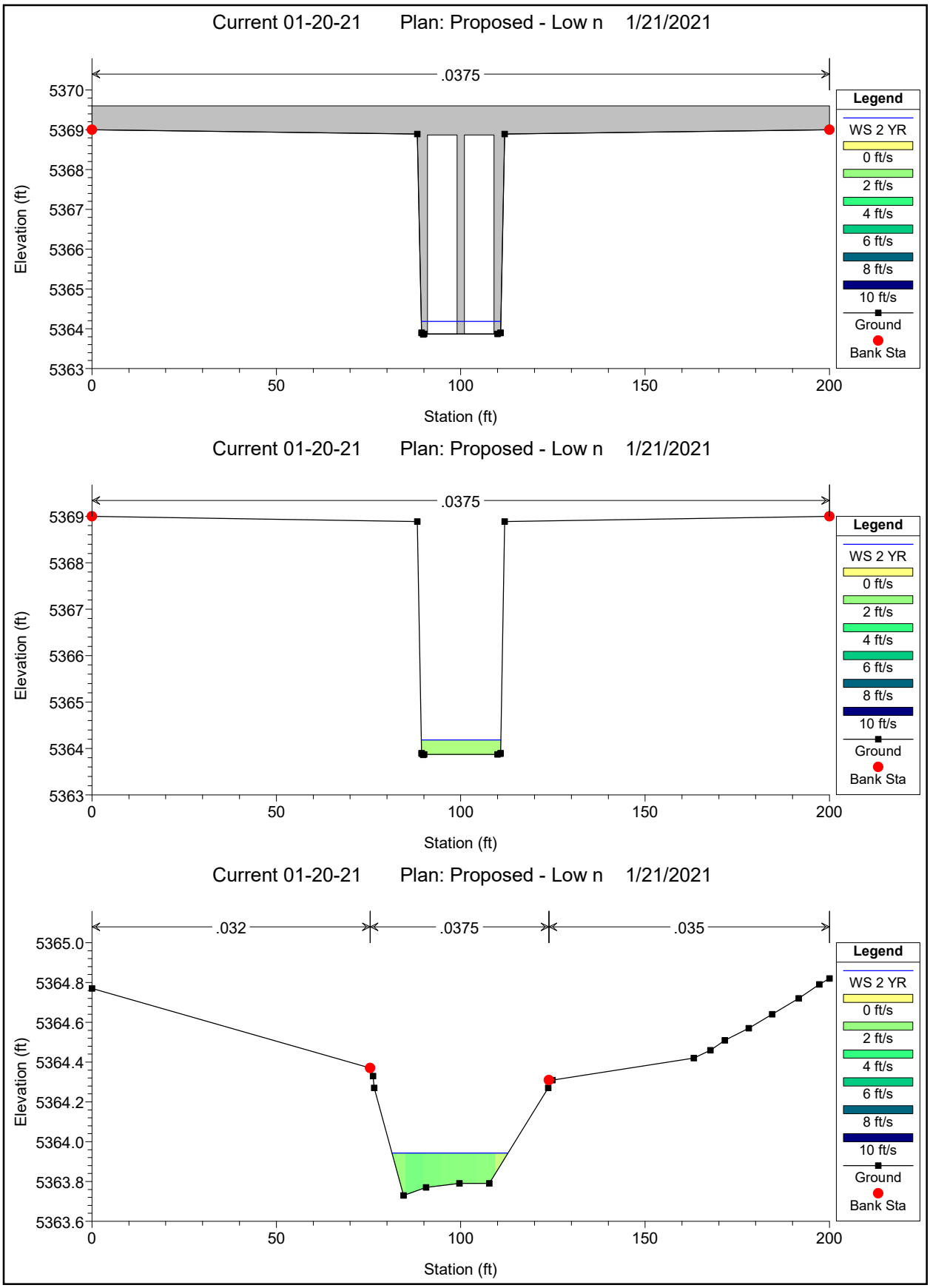
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Bank Sta
Current 01-20-21 Plan: Proposed - Low n 1/21/2021
.0375
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 01-20-21 Plan: Proposed - Low n 1/21/2021
.032
.0375
.035
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

HEC-RAS Plan: PR-Low-n River: Tributary - I Reach: PR - Tributary I Profile: 10 YR

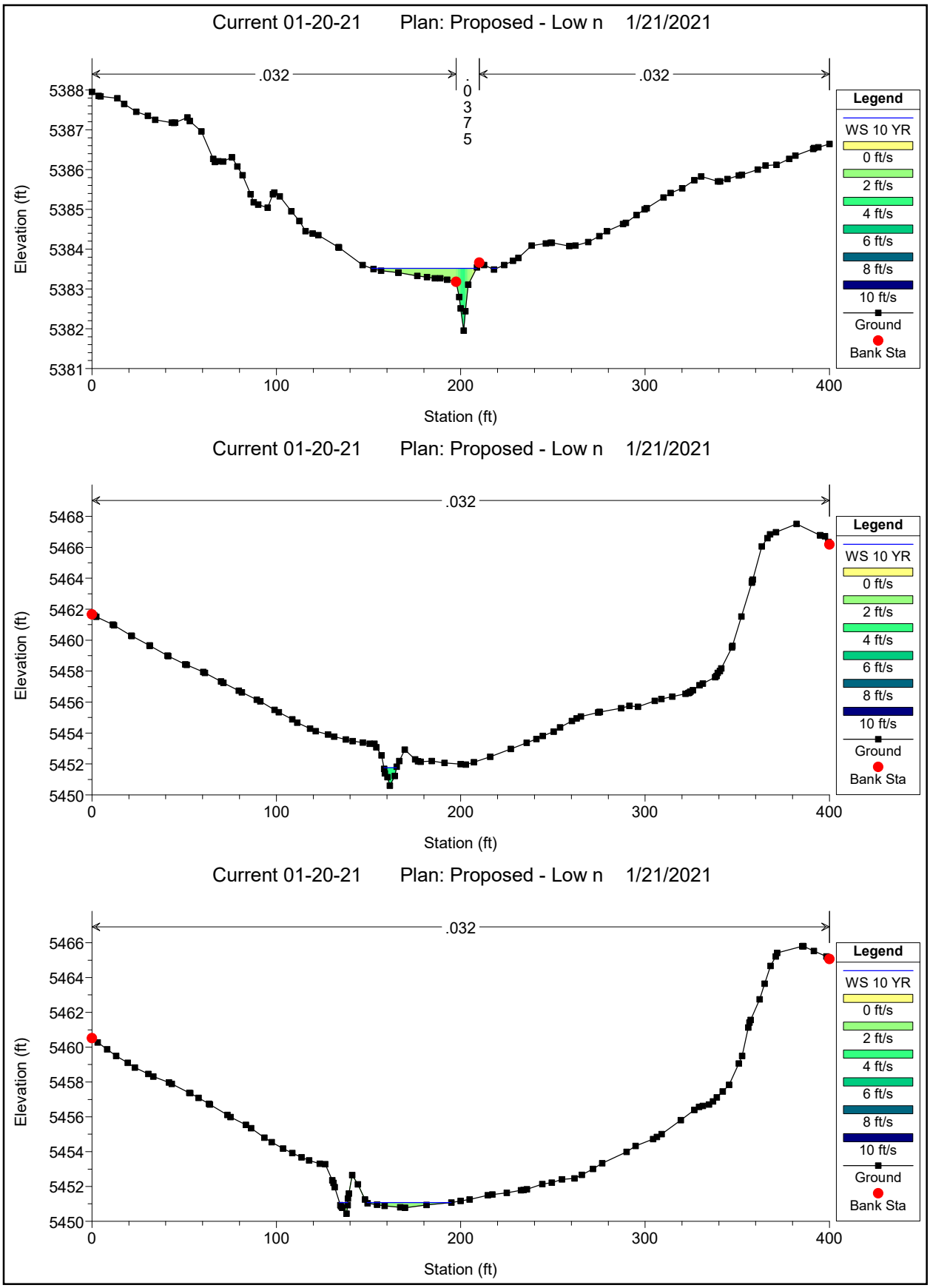
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
PR - Tributary I	5750	10 YR	18.02	5450.60	5451.76	5451.70	5452.02	0.014544	4.04	4.46	6.82	0.88	0.56
PR - Tributary I	5700	10 YR	18.02	5450.44	5451.08	5451.05	5451.14	0.018584	2.00	8.99	50.09	0.83	0.21
PR - Tributary I	5650	10 YR	18.02	5449.61	5449.90	5449.90	5449.96	0.030894	1.97	9.13	76.61	1.01	0.23
PR - Tributary I	5600	10 YR	18.02	5448.25	5448.42	5448.46	5448.56	0.066197	3.03	5.95	46.59	1.49	0.53
PR - Tributary I	5550	10 YR	18.02	5446.77	5447.20	5447.20	5447.29	0.025727	2.46	7.31	38.41	1.00	0.31
PR - Tributary I	5500	10 YR	18.02	5445.70	5446.20	5446.09	5446.25	0.007670	1.81	9.96	33.58	0.59	0.14
PR - Tributary I	5450	10 YR	18.02	5445.24	5445.59		5445.68	0.019039	2.39	7.55	33.25	0.88	0.27
PR - Tributary I	5400	10 YR	18.02	5444.05	5444.46	5444.46	5444.57	0.025677	2.64	6.84	32.43	1.01	0.34
PR - Tributary I	5350	10 YR	18.02	5443.51	5443.84	5443.76	5443.88	0.007930	1.62	11.14	45.56	0.58	0.12
PR - Tributary I	5300	10 YR	18.02	5443.08	5443.36		5443.40	0.011799	1.69	10.69	55.38	0.68	0.14
PR - Tributary I	5250	10 YR	18.02	5442.33	5442.59	5442.58	5442.65	0.019401	1.95	9.23	55.72	0.85	0.20
PR - Tributary I	5200	10 YR	18.02	5441.18	5441.45	5441.45	5441.53	0.026331	2.37	7.60	43.11	0.99	0.29
PR - Tributary I	5150	10 YR	18.02	5440.49	5440.85	5440.77	5440.88	0.007139	1.43	12.59	57.13	0.54	0.10
PR - Tributary I	5100	10 YR	18.02	5438.27	5440.87		5440.87	0.000004	0.12	148.52	96.56	0.02	0.00
PR - Tributary I	5050	10 YR	18.02	5440.42	5440.75	5440.75	5440.86	0.024239	2.63	6.86	31.35	0.99	0.33
PR - Tributary I	5000	10 YR	18.02	5438.12	5438.65	5438.73	5438.90	0.071605	3.98	4.53	24.90	1.65	0.81
PR - Tributary I	4950	10 YR	18.02	5437.50	5437.90	5437.85	5437.96	0.013182	2.01	8.94	38.50	0.74	0.19
PR - Tributary I	4900	10 YR	18.02	5436.66	5436.98	5436.98	5437.08	0.025351	2.45	7.35	38.43	0.99	0.30
PR - Tributary I	4850	10 YR	18.02	5435.75	5436.20	5436.07	5436.23	0.006414	1.50	11.98	46.61	0.52	0.10
PR - Tributary I	4800	10 YR	18.02	5435.31	5435.67	5435.64	5435.73	0.016837	1.90	9.46	53.22	0.80	0.19
PR - Tributary I	4750	10 YR	18.02	5434.72	5434.98	5434.93	5435.02	0.011653	1.64	11.01	59.00	0.67	0.14
PR - Tributary I	4700	10 YR	18.02	5434.02	5434.31	5434.28	5434.36	0.015472	1.74	10.35	62.50	0.75	0.16
PR - Tributary I	4650	10 YR	18.02	5433.21	5433.47	5433.45	5433.53	0.017281	1.98	9.12	49.47	0.81	0.20
PR - Tributary I	4600	10 YR	18.02	5432.45	5432.73		5432.79	0.012781	1.81	9.94	48.96	0.71	0.16
PR - Tributary I	4550	10 YR	18.02	5431.45	5431.81	5431.81	5431.91	0.025242	2.51	7.17	36.08	0.99	0.31
PR - Tributary I	4500	10 YR	18.02	5430.22	5431.14	5430.73	5431.17	0.001721	1.36	13.29	22.38	0.31	0.06
PR - Tributary I	4450	10 YR	18.02	5430.61	5430.86	5430.86	5430.93	0.032524	2.22	8.11	59.39	1.06	0.28
PR - Tributary I	4400	10 YR	18.02	5428.99	5429.34	5429.33	5429.42	0.020596	2.26	7.96	40.22	0.90	0.25
PR - Tributary I	4350	10 YR	18.02	5427.82	5428.20	5428.20	5428.30	0.024556	2.58	6.99	33.13	0.99	0.32
PR - Tributary I	4300	10 YR	18.02	5426.83	5427.19	5427.16	5427.26	0.017657	2.09	8.61	43.61	0.83	0.22
PR - Tributary I	4250	10 YR	18.02	5426.04	5426.35		5426.41	0.016245	1.94	9.29	49.45	0.79	0.19
PR - Tributary I	4200	10 YR	18.02	5425.05	5425.39	5425.38	5425.46	0.022622	2.06	8.73	54.33	0.91	0.23
PR - Tributary I	4150	10 YR	18.02	5424.36	5424.66		5424.70	0.010928	1.49	12.06	70.55	0.64	0.12
PR - Tributary I	4100	10 YR	18.02	5423.72	5423.95	5423.93	5423.99	0.018260	1.60	11.28	87.85	0.79	0.15
PR - Tributary I	4050	10 YR	18.02	5422.79	5423.13	5423.09	5423.18	0.014399	1.83	9.83	52.09	0.74	0.17
PR - Tributary I	4000	10 YR	18.02	5422.19	5422.48		5422.52	0.011815	1.60	11.24	62.76	0.67	0.13
PR - Tributary I	3950	10 YR	18.02	5421.55	5421.90	5421.84	5421.94	0.011477	1.54	11.68	67.68	0.65	0.12
PR - Tributary I	3900	10 YR	18.02	5420.99	5421.27		5421.31	0.014149	1.62	11.11	69.85	0.72	0.14
PR - Tributary I	3850	10 YR	18.02	5420.41	5420.80		5420.82	0.007017	1.19	15.10	88.78	0.51	0.07
PR - Tributary I	3800	10 YR	18.02	5419.89	5420.19	5420.19	5420.25	0.022265	1.91	9.41	64.78	0.89	0.20
PR - Tributary I	3750	10 YR	18.02	5418.86	5419.30	5419.25	5419.35	0.014897	1.84	9.81	53.14	0.75	0.17
PR - Tributary I	3700	10 YR	18.02	5417.97	5418.43	5418.41	5418.49	0.020641	1.99	9.06	55.60	0.87	0.21
PR - Tributary I	3650	10 YR	18.02	5416.98	5417.26	5417.26	5417.31	0.027654	1.72	10.47	99.42	0.94	0.18
PR - Tributary I	3600	10 YR	18.02	5415.58	5415.84	5415.84	5415.91	0.028121	2.10	8.59	61.42	0.99	0.25
PR - Tributary I	3550	10 YR	18.02	5414.55	5414.83	5414.77	5414.87	0.011739	1.76	10.24	49.46	0.68	0.15
PR - Tributary I	3500	10 YR	18.02	5413.71	5413.93	5413.93	5413.99	0.028818	2.05	8.81	66.65	0.99	0.24
PR - Tributary I	3450	10 YR	18.02	5412.64	5413.01	5412.92	5413.03	0.006803	1.32	13.62	67.11	0.52	0.09
PR - Tributary I	3400	10 YR	34.56	5411.88	5412.21	5412.21	5412.30	0.025428	2.50	13.82	70.38	1.00	0.31
PR - Tributary I	3350	10 YR	34.56	5411.24	5411.66	5411.55	5411.70	0.006092	1.55	22.33	79.97	0.52	0.11
PR - Tributary I	3300	10 YR	34.56	5410.87	5411.37		5411.41	0.005224	1.51	22.96	76.42	0.48	0.10
PR - Tributary I	3250	10 YR	34.56	5409.78	5411.22		5411.25	0.002071	1.35	25.67	39.65	0.29	0.08
PR - Tributary I	3232.13	10 YR	34.56	5409.65	5410.89	5410.89	5411.13	0.027767	3.95	8.75	18.59	1.01	0.80
PR - Tributary I	3205.03	10 YR	34.56	5405.01	5405.24	5405.68	5408.57	1.112246	14.64	2.36	11.31	5.65	14.40
PR - Tributary I	3181.99	10 YR	34.56	5404.79	5405.44	5405.46	5405.75	0.027842	4.44	7.78	13.91	1.05	0.96
PR - Tributary I	3140.22	10 YR	34.56	5399.18	5399.46	5399.94	5402.28	0.675297	13.48	2.56	9.25	4.51	11.22
PR - Tributary I	3140		Culvert										
PR - Tributary I	2909.93	10 YR	34.56	5398.72	5399.46	5399.46	5399.83	0.026960	4.88	7.08	9.69	1.01	1.09
PR - Tributary I	2850	10 YR	34.56	5398.60	5400.24		5400.31	0.003987	2.32	17.11	34.14	0.43	0.22
PR - Tributary I	2800	10 YR	34.56	5398.50	5400.12		5400.16	0.002127	1.99	25.06	54.49	0.32	0.15
PR - Tributary I	2750	10 YR	34.56	5398.40	5400.02		5400.05	0.002048	1.69	27.53	65.21	0.31	0.12
PR - Tributary I	2700	10 YR	34.56	5398.30	5399.91		5399.95	0.002079	1.96	26.75	64.59	0.32	0.15
PR - Tributary I	2650	10 YR	34.56	5398.20	5399.81	5399.58	5399.84	0.002154	1.99	26.37	64.07	0.32	0.15
PR - Tributary I	2600	10 YR	34.56	5398.10	5399.44	5399.44	5399.61	0.014517	3.55	12.11	40.76	0.77	0.58
PR - Tributary I	2550	10 YR	34.56	5396.43	5397.93	5396.99	5397.93	0.000157	0.48	72.20	96.63	0.10	0.01
PR - Tributary I	2500	10 YR	34.56	5394.51	5397.93		5397.93	0.000002	0.10	342.31	171.27	0.01	0.00
PR - Tributary I	2450	10 YR	34.56	5394.37	5397.93		5397.93	0.000000	0.06	596.87	219.81	0.01	0.00
PR - Tributary I	2400	10 YR	34.56	5394.18	5397.93		5397.93	0.000000	0.05	637.68	228.32	0.01	0.00
PR - Tributary I	2350	10 YR	34.56	5394.18	5397.93		5397.93	0.000000	0.05	718.04	249.30	0.00	0.00
PR - Tributary I	2300	10 YR	34.56	5394.18	5397.93		5397.93	0.000000	0.05	751.25	248.60	0.00	0.00
PR - Tributary I	2218.78	10 YR	34.56	5397.49	5397.82	5397.82	5397.92	0.035079	2.53	13.67	68.77	1.00	0.44
PR - Tributary I	2198.89	10 YR	34.56	5392.12	5392.87	5393.45	5395.97	0.397404	14.12	2.45	5.51	3.74	10.55
PR - Tributary I	2150	10 YR	34.56	5391.10	5392.36	5392.45	5392.64	0.018830	4.65	9.88	35.96	0.90	0.93
PR - Tributary I	2100	10 YR	34.56	5390.07	5391.33	5391.43	5391.65	0.020742	4.91	9.24	32.91	0.95	1.03
PR - Tributary I	2050	10 YR	34.56	5389.03	5390.30	5390.40	5390.62	0.020538	4.90	9.20	31.83	0.94	1.03
PR - Tributary I	2000	10 YR	34.56	5388.00	5389.26	5389.38	5389.58	0.021275	4.94	9.20	33.18	0.96	1.05
PR - Tributary I	1950	10 YR	34.56	5386.96	5388.19	5388.31	5388.50	0.021835	4.89	9.78	42.41	0.97	1.04
PR - Tributary I	1900	10 YR	34.56	5385.93	5387.16	5387.26	5387.44	0.020098	4.73	10.55	48.17	0.93	0.97
PR - Tributary I	1850	10 YR	34.56	5384.89	5386.12	5386.23	5386.43	0.020473	4.81	9.31	32.88	0.94	1.00
PR - Tributary I	1800	10 YR	34.56	5383.85	5385.13	5385.21	5385.40	0.020391	4.50	9.78	34.67	0.92	0.90
PR - Tributary I	1750	10 YR	34.56	5382.66	5384.09	5384.15	5384.35	0.021773	4.44	9.45	26.48	0.94	0.90
PR - Tributary I	1700	10 YR	34.56	5381.95	5383.52	5383.52	5383.63	0.012744	3.19	14.74	59.69	0.71	0.48
PR - Tributary I	1650	10 YR	34.56	5381.09	5382.65	5382.52	5382.78	0.010641	3.15	14.17	51.06	0.67	0.45
PR - Tributary I	1600	10 YR	34.56	5380.66	5381.98	5381.98	5382.11	0.017352	3.44	13.01	46.92	0.81	0.58
PR - Tributary I	1550	10 YR	34.56	5379.85	5381.31	5381.31	5381.45	0.010568	3.59	13.96	54.64	0.67	0.55

HEC-RAS Plan: PR-Low-n River: Tributary - I Reach: PR - Tributary I Profile: 10 YR (Continued)

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	Shear Chan
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
PR - Tributary I	1500	10 YR	34.56	5379.19	5380.65	5380.54	5380.73	0.005133	2.70	19.06	63.87	0.49	0.30
PR - Tributary I	1450	10 YR	34.56	5378.72	5380.16	5380.16	5380.32	0.015141	3.49	12.38	42.69	0.78	0.57
PR - Tributary I	1400	10 YR	34.56	5377.93	5379.70	5379.48	5379.72	0.002179	1.44	30.20	82.14	0.30	0.09
PR - Tributary I	1350	10 YR	46.78	5377.94	5379.31	5379.29	5379.49	0.009713	3.76	16.61	47.12	0.67	0.57
PR - Tributary I	1300	10 YR	46.78	5377.44	5378.80	5378.79	5378.99	0.010136	3.82	16.27	46.46	0.69	0.59
PR - Tributary I	1250	10 YR	46.78	5376.94	5378.31	5378.30	5378.49	0.009907	3.79	16.44	46.81	0.68	0.58
PR - Tributary I	1200	10 YR	46.78	5376.44	5377.80	5377.80	5377.99	0.010073	3.82	16.32	46.69	0.69	0.59
PR - Tributary I	1150	10 YR	46.78	5375.94	5377.31	5377.29	5377.49	0.009701	3.76	16.60	47.21	0.67	0.57
PR - Tributary I	1100	10 YR	46.78	5375.44	5376.80	5376.80	5376.99	0.010383	3.86	15.98	45.34	0.70	0.61
PR - Tributary I	1050	10 YR	46.78	5374.94	5376.31	5376.28	5376.48	0.009039	3.64	17.20	49.11	0.65	0.54
PR - Tributary I	1000	10 YR	46.78	5374.44	5375.80	5375.80	5375.99	0.010486	3.88	16.06	47.59	0.70	0.61
PR - Tributary I	950	10 YR	46.78	5373.93	5375.36	5375.22	5375.50	0.006602	3.22	18.03	39.38	0.56	0.41
PR - Tributary I	900	10 YR	46.78	5373.44	5374.80	5374.80	5375.05	0.012318	4.22	13.43	31.30	0.76	0.72
PR - Tributary I	838.96	10 YR	46.78	5372.83	5374.48	5373.68	5374.60	0.003288	2.67	17.50	10.73	0.37	0.26
PR - Tributary I	838.25		Culvert										
PR - Tributary I	598.1	10 YR	46.78	5370.41	5371.73		5371.92	0.007170	3.47	13.46	10.49	0.54	0.47
PR - Tributary I	550	10 YR	46.78	5369.65	5370.94	5370.94	5371.35	0.020733	5.19	9.26	12.60	0.97	1.12
PR - Tributary I	500	10 YR	46.78	5368.85	5370.14	5370.20	5370.42	0.015516	4.50	13.10	38.67	0.84	0.84
PR - Tributary I	450	10 YR	46.78	5368.05	5369.21	5369.33	5369.53	0.020166	4.77	11.96	42.18	0.94	0.98
PR - Tributary I	400	10 YR	46.78	5367.25	5368.54	5368.55	5368.75	0.011674	3.89	15.22	44.40	0.73	0.63
PR - Tributary I	350	10 YR	46.78	5366.46	5367.74	5367.82	5368.04	0.016804	4.63	12.62	37.98	0.87	0.90
PR - Tributary I	300	10 YR	46.78	5365.67	5365.60	5365.88	5366.44	0.074119		6.37	14.32	0.00	
PR - Tributary I	250	10 YR	46.78	5364.86	5365.32	5365.32	5365.57	0.017746	2.35	12.11	24.77	0.75	0.33
PR - Tributary I	194.84	10 YR	46.78	5363.99	5365.02	5364.54	5365.10	0.003467	2.22	21.05	20.99	0.39	0.20
PR - Tributary I	194.59		Culvert										
PR - Tributary I	113.93	10 YR	46.78	5363.86	5364.41	5364.40	5364.66	0.024686	4.01	11.65	21.68	0.97	0.80
PR - Tributary I	101	10 YR	46.78	5363.73	5364.34	5364.20	5364.42	0.009987	2.26	20.83	58.37	0.61	0.27

HEC-RAS Plan: PR-Low-n River: Tributary - I Reach: PR - Tributary I Profile: 10 YR

Reach	River Sta	Profile	E.G. US.	W.S. US.	E.G. IC	E.G. OC	Min El Weir Flow	Q Culv Group	Q Weir	Delta WS	Culv Vel US	Culv Vel DS
			(ft)	(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(ft)	(ft/s)	(ft/s)
PR - Tributary I	3140 West Ped	10 YR					5414.00					
PR - Tributary I	3140 West 10YR	10 YR					5414.00					
PR - Tributary I	838.25 10-YR East	10 YR	5374.60	5374.48	5374.39	5374.60	5387.51	46.58		2.75	5.72	8.24
PR - Tributary I	838.25 West-Ped	10 YR	5374.60	5374.48	5374.57	5374.61	5387.51	0.20		2.75	0.87	1.05
PR - Tributary I	194.59 Double	10 YR	5365.10	5365.02	5364.99	5365.10	5369.61	46.78		0.61	3.64	4.55


Current 01-20-21 Plan: Proposed - Low n 1/21/2021
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 01-20-21 Plan: Proposed - Low n 1/21/2021
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 01-20-21 Plan: Proposed - Low n 1/21/2021
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
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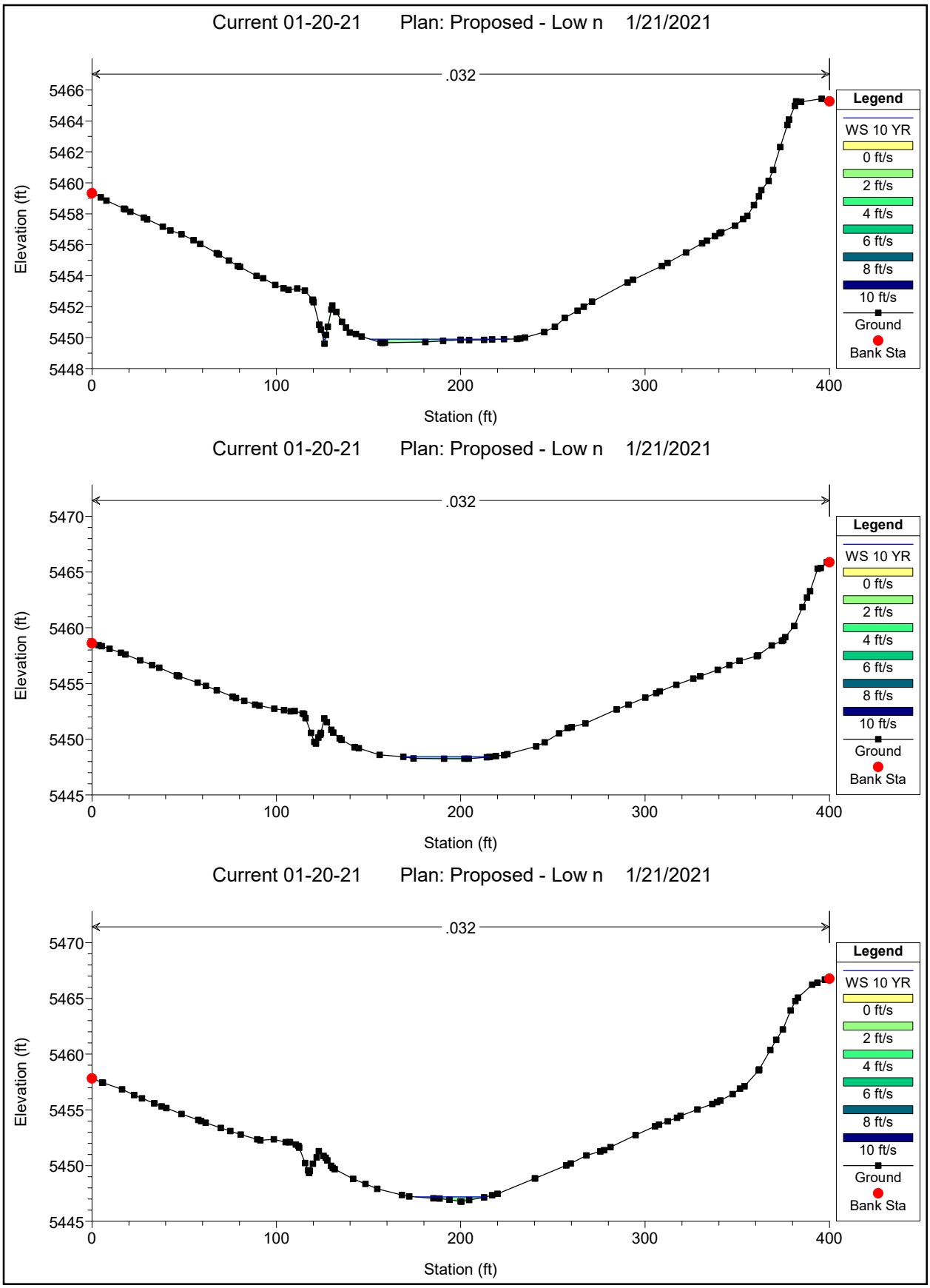
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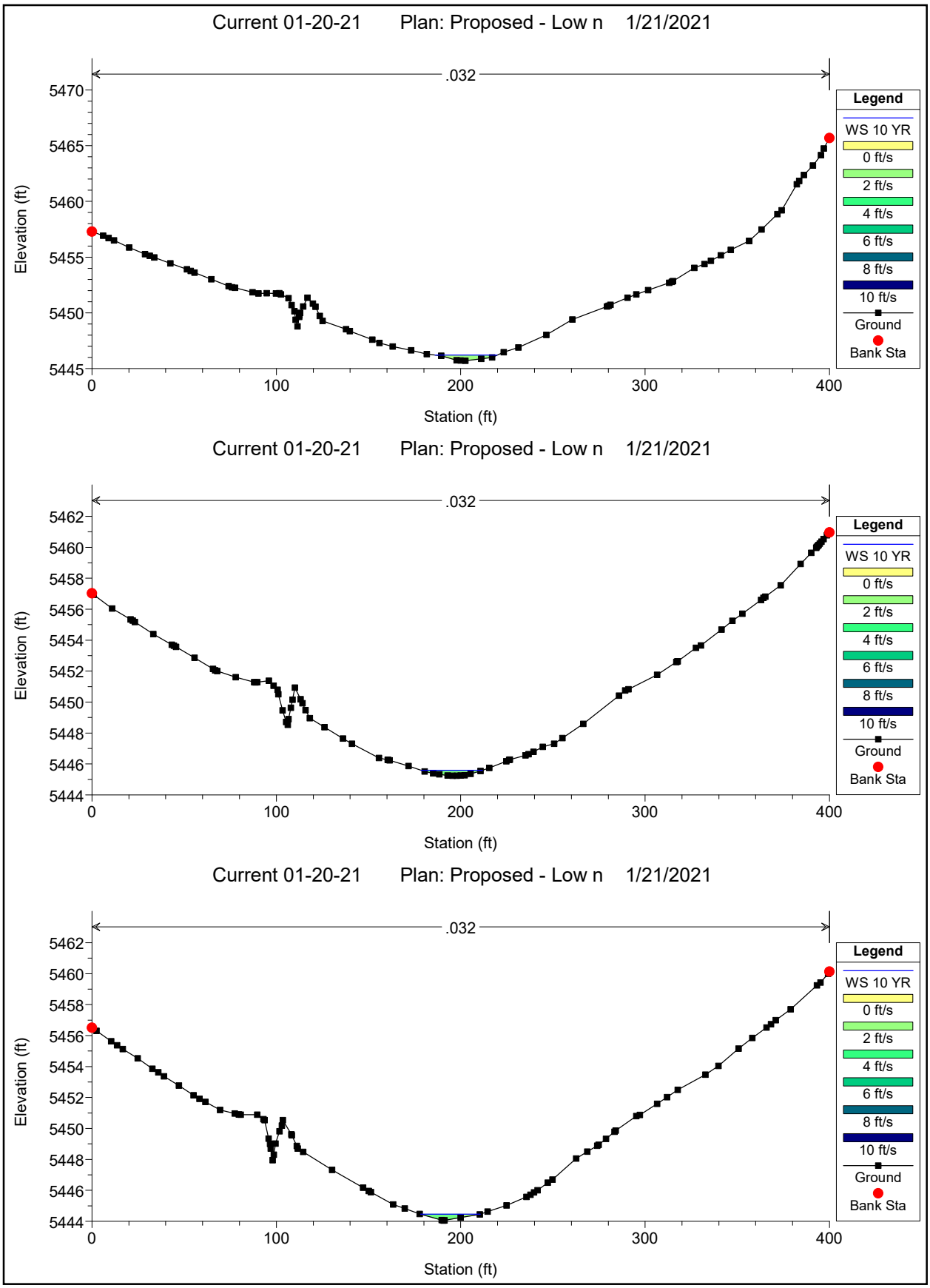
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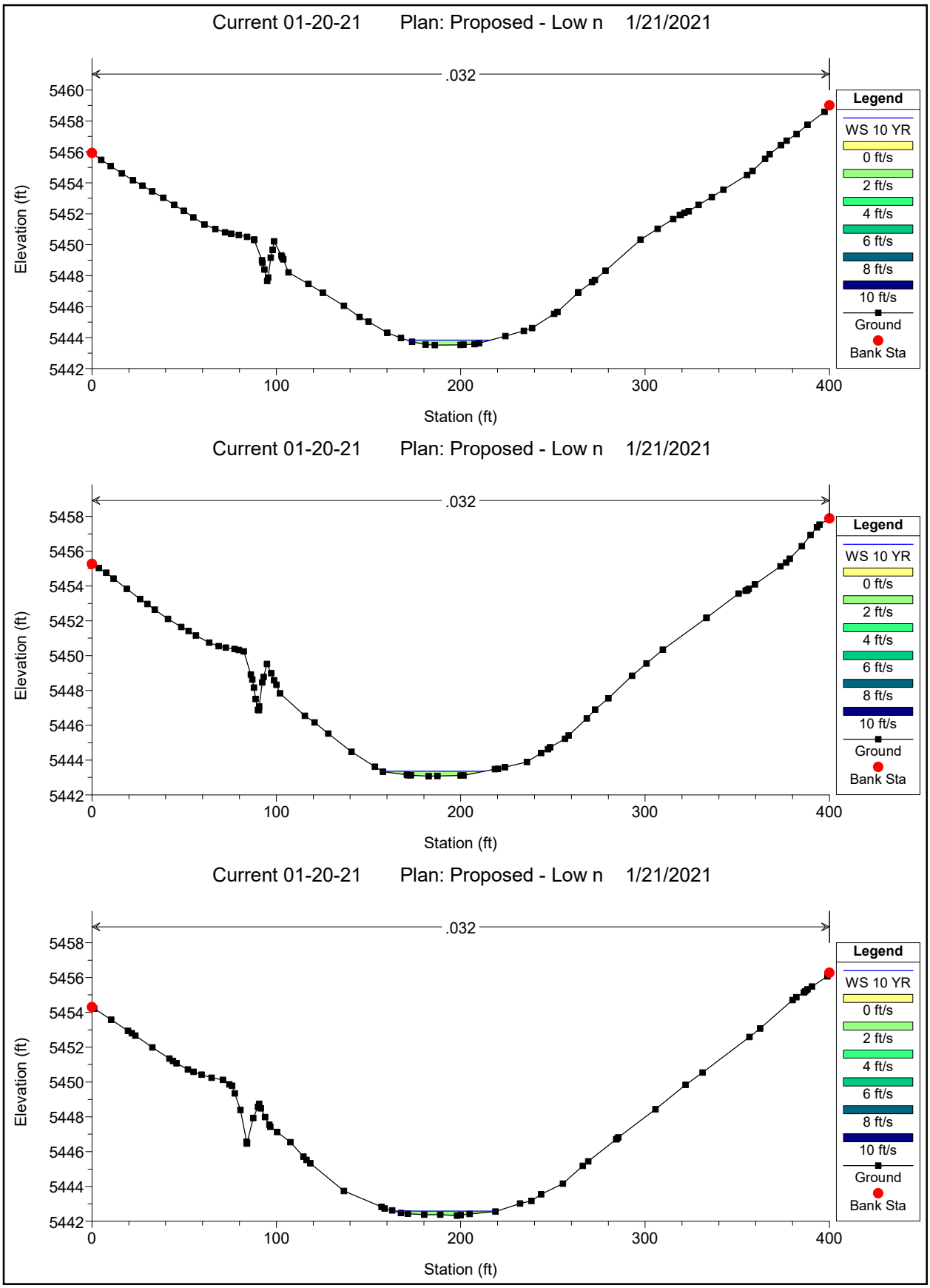
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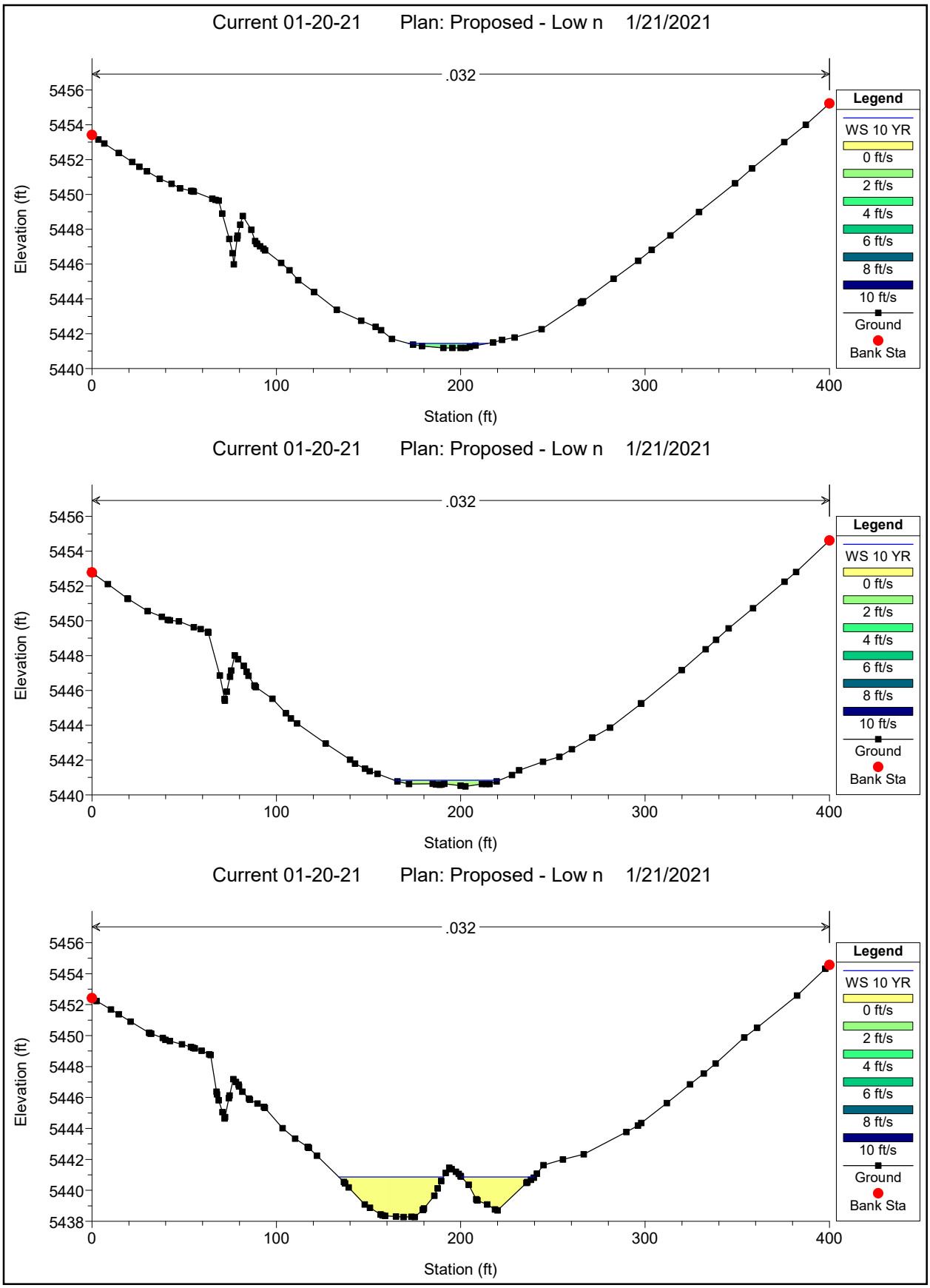
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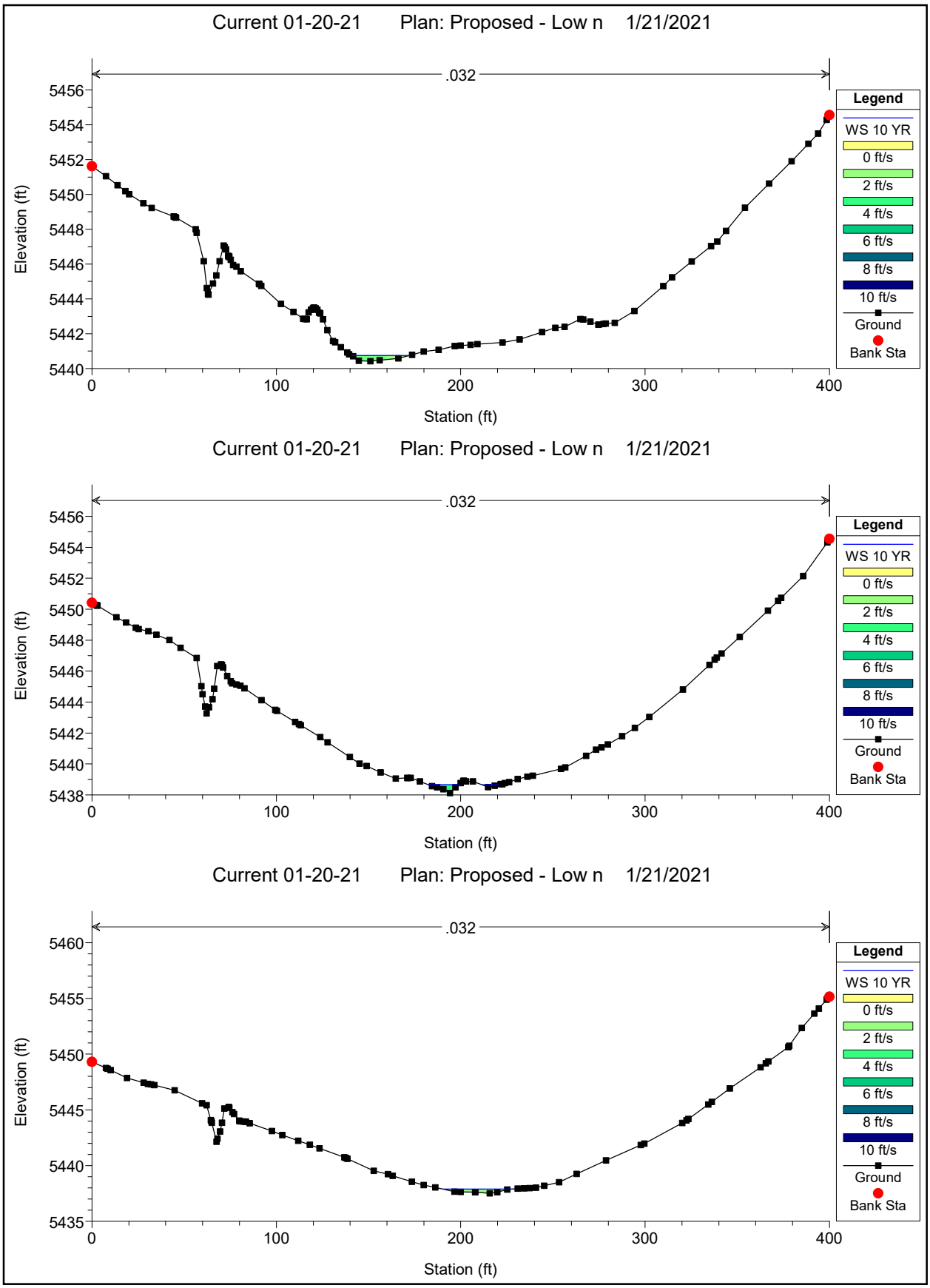
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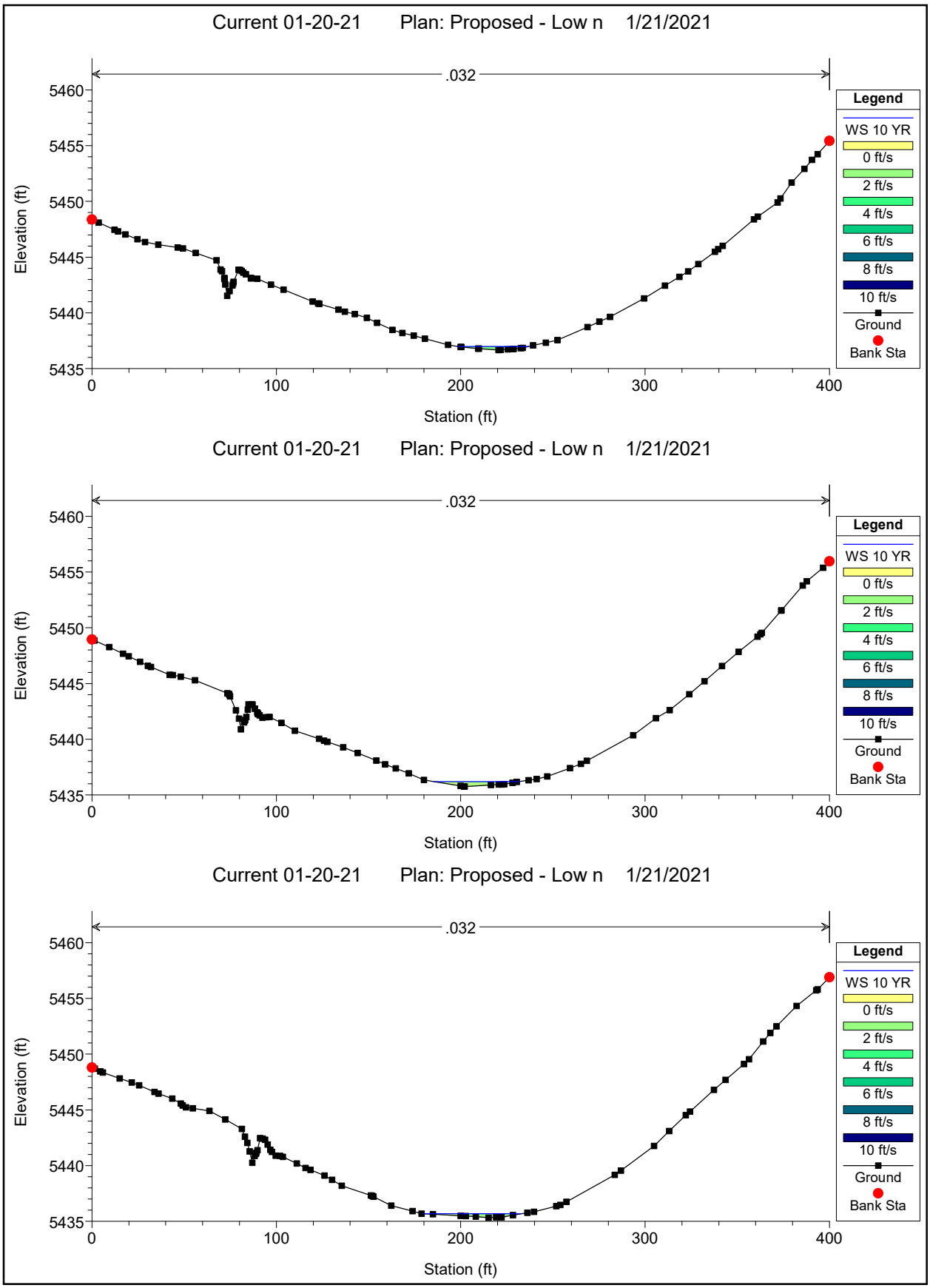
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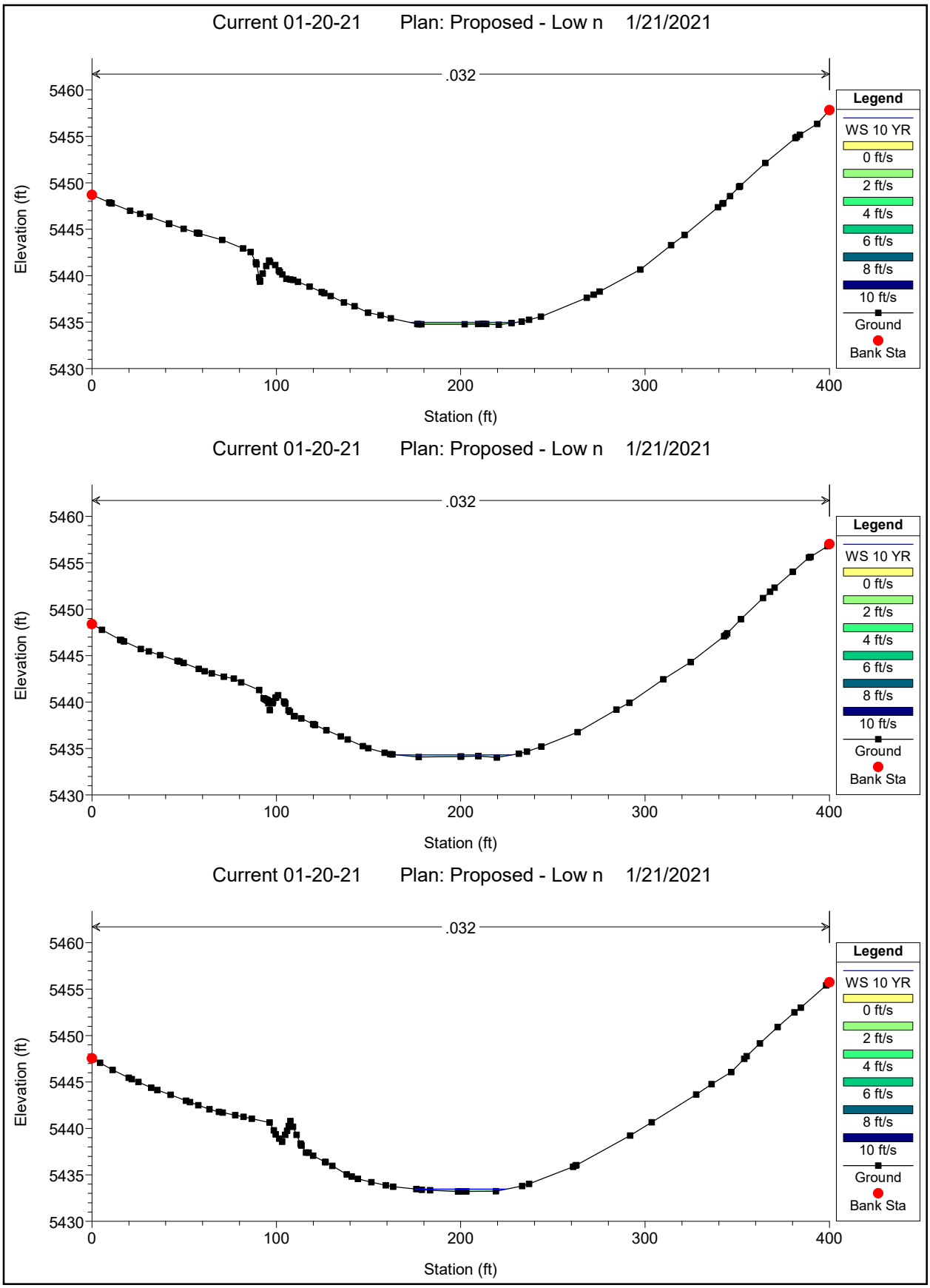
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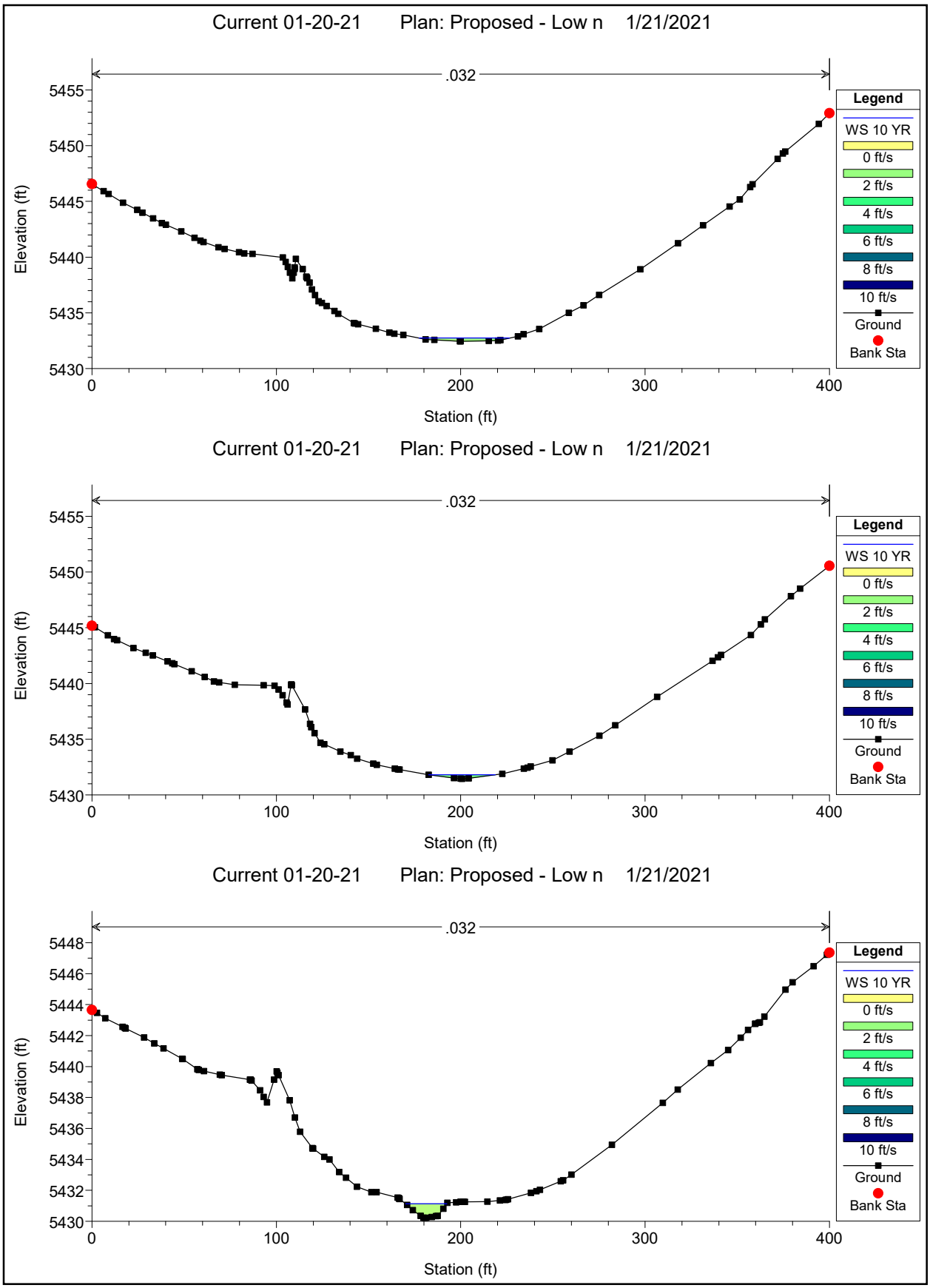
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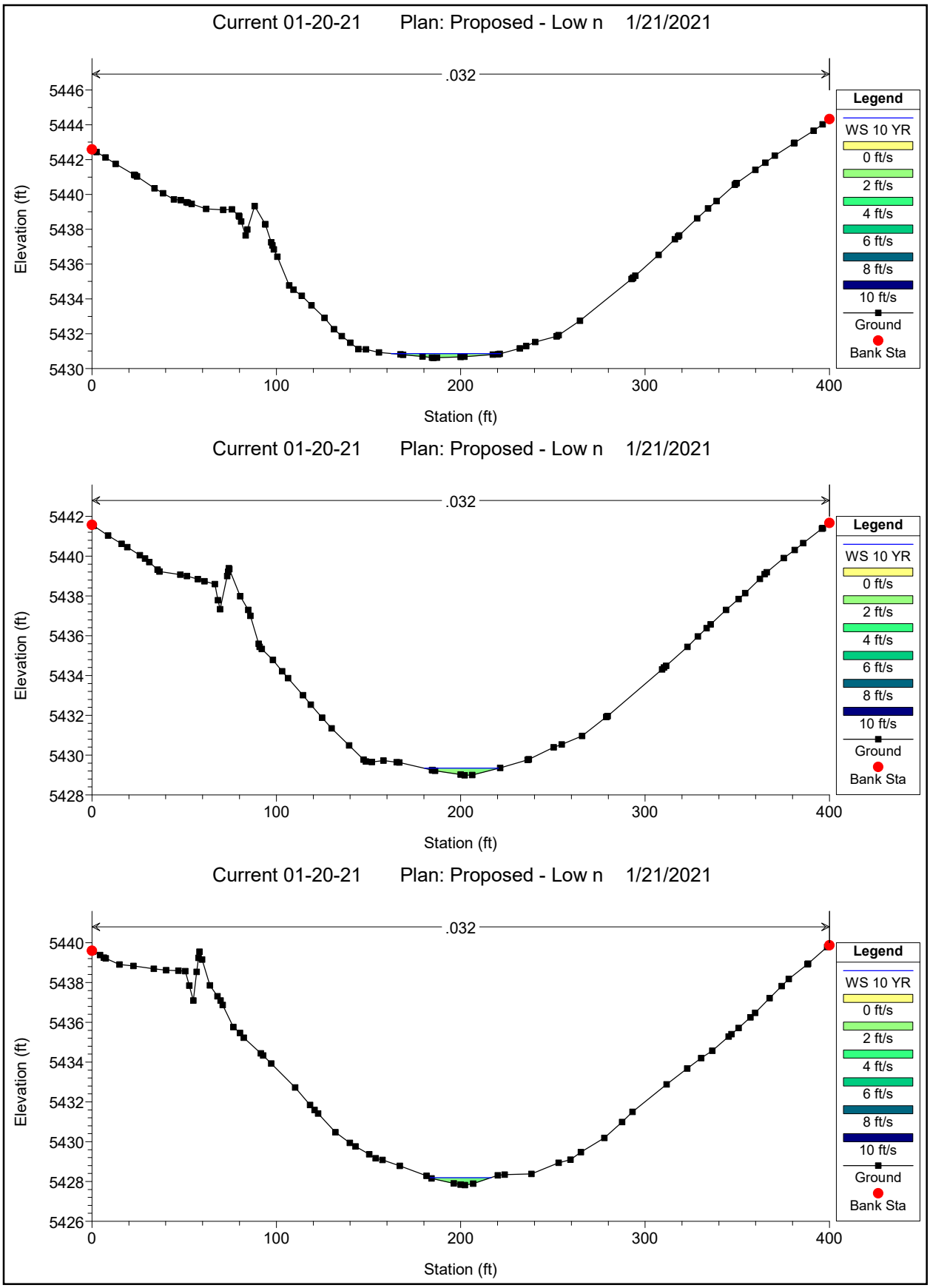
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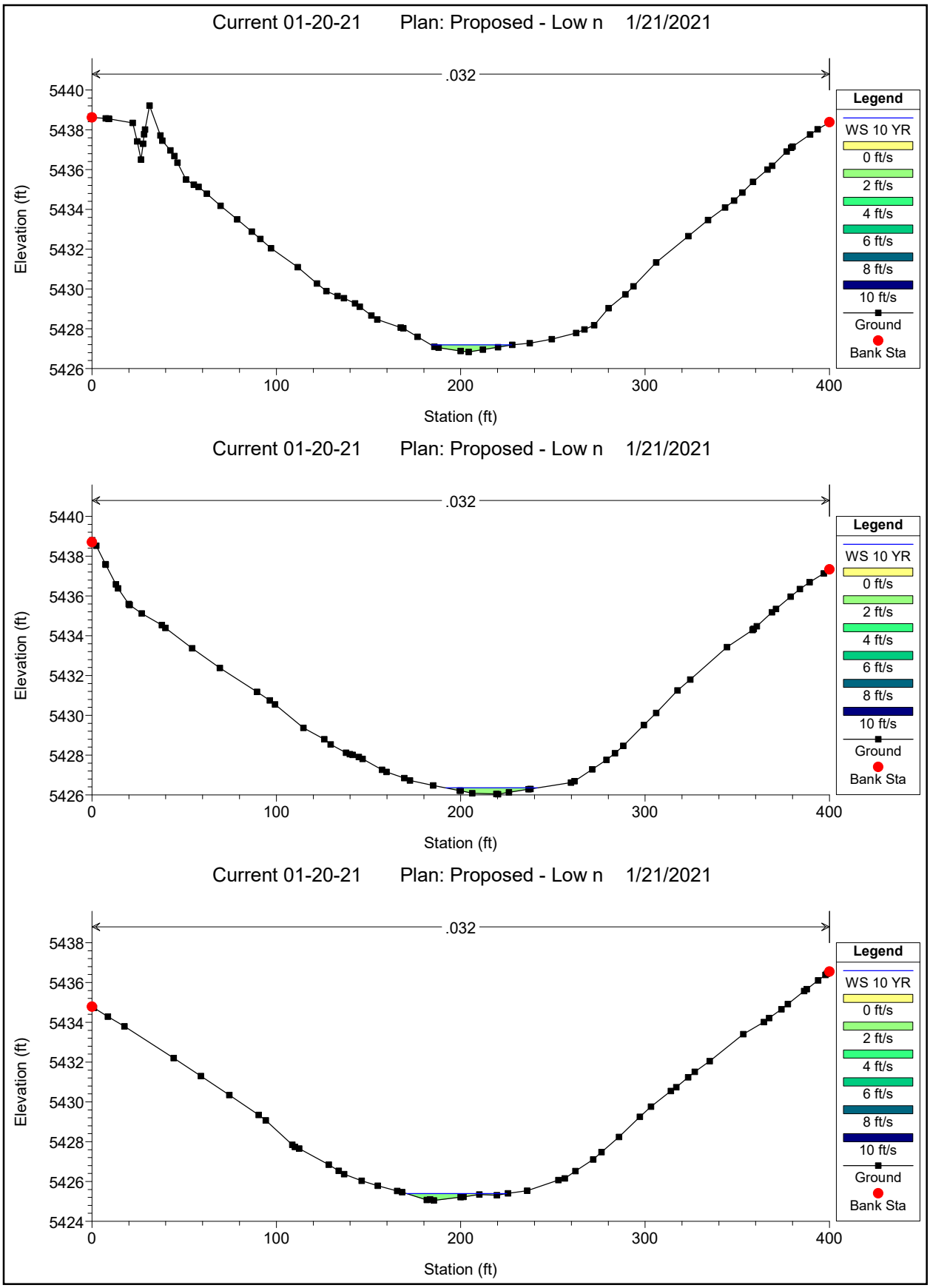
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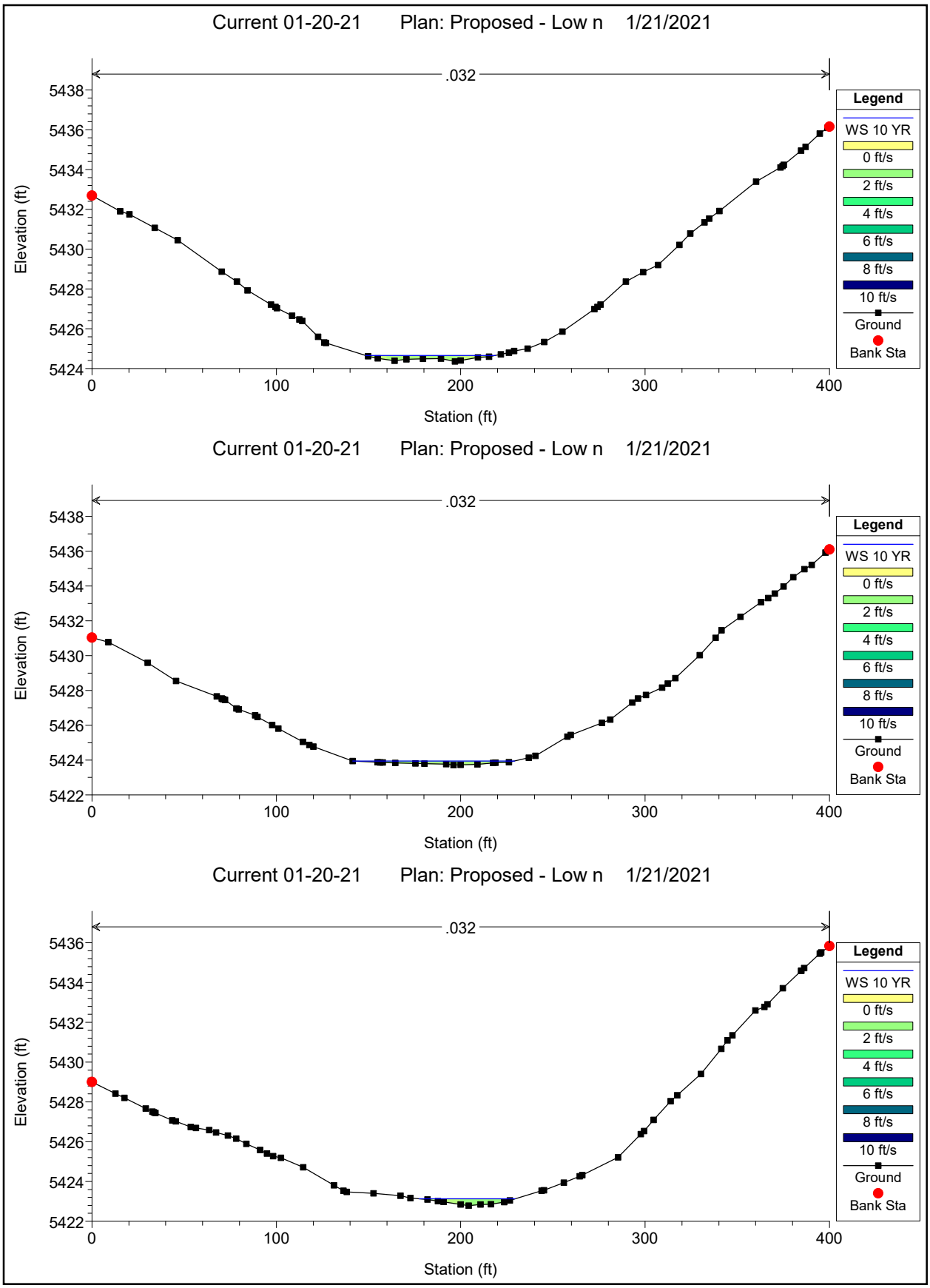
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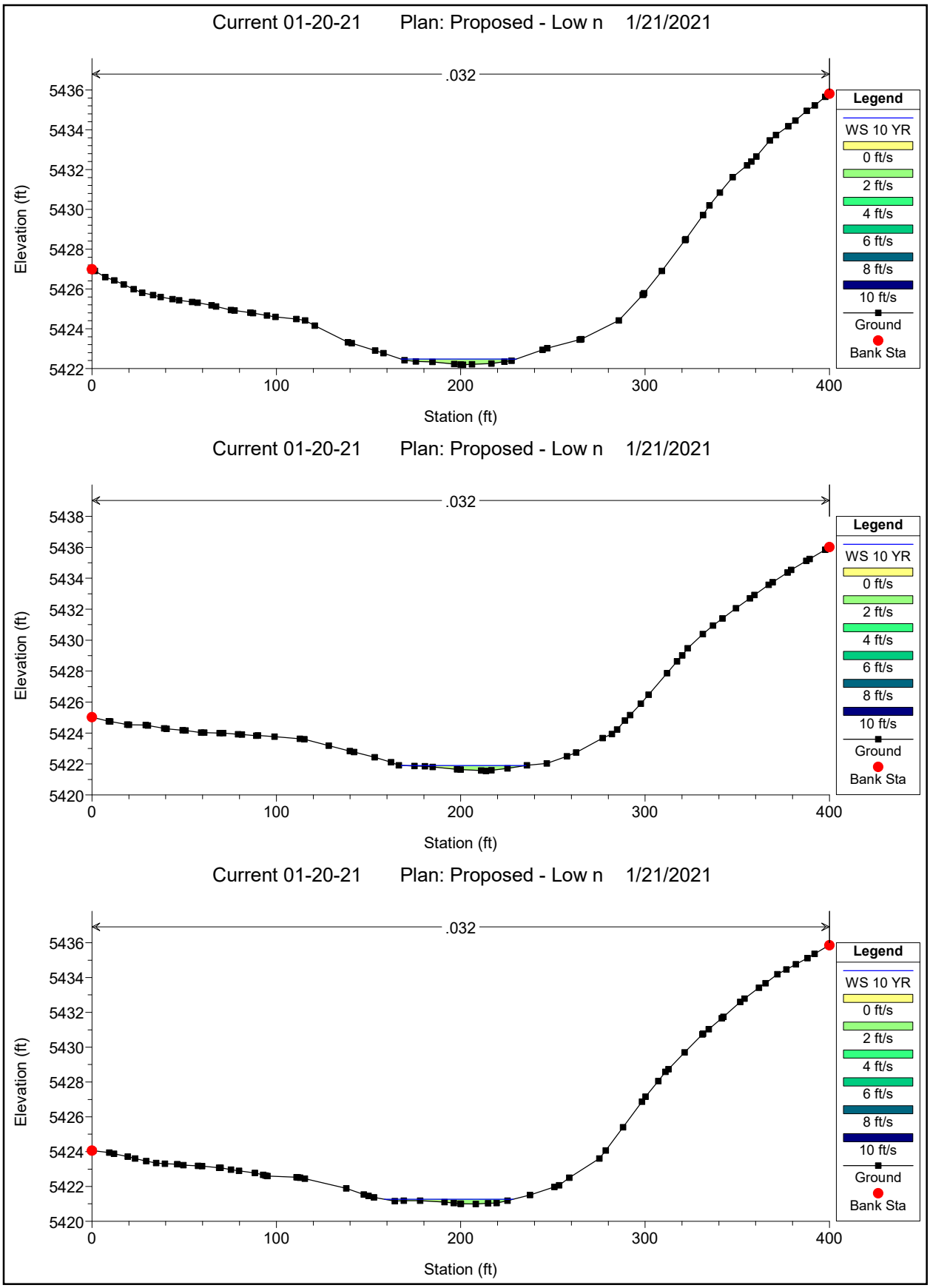
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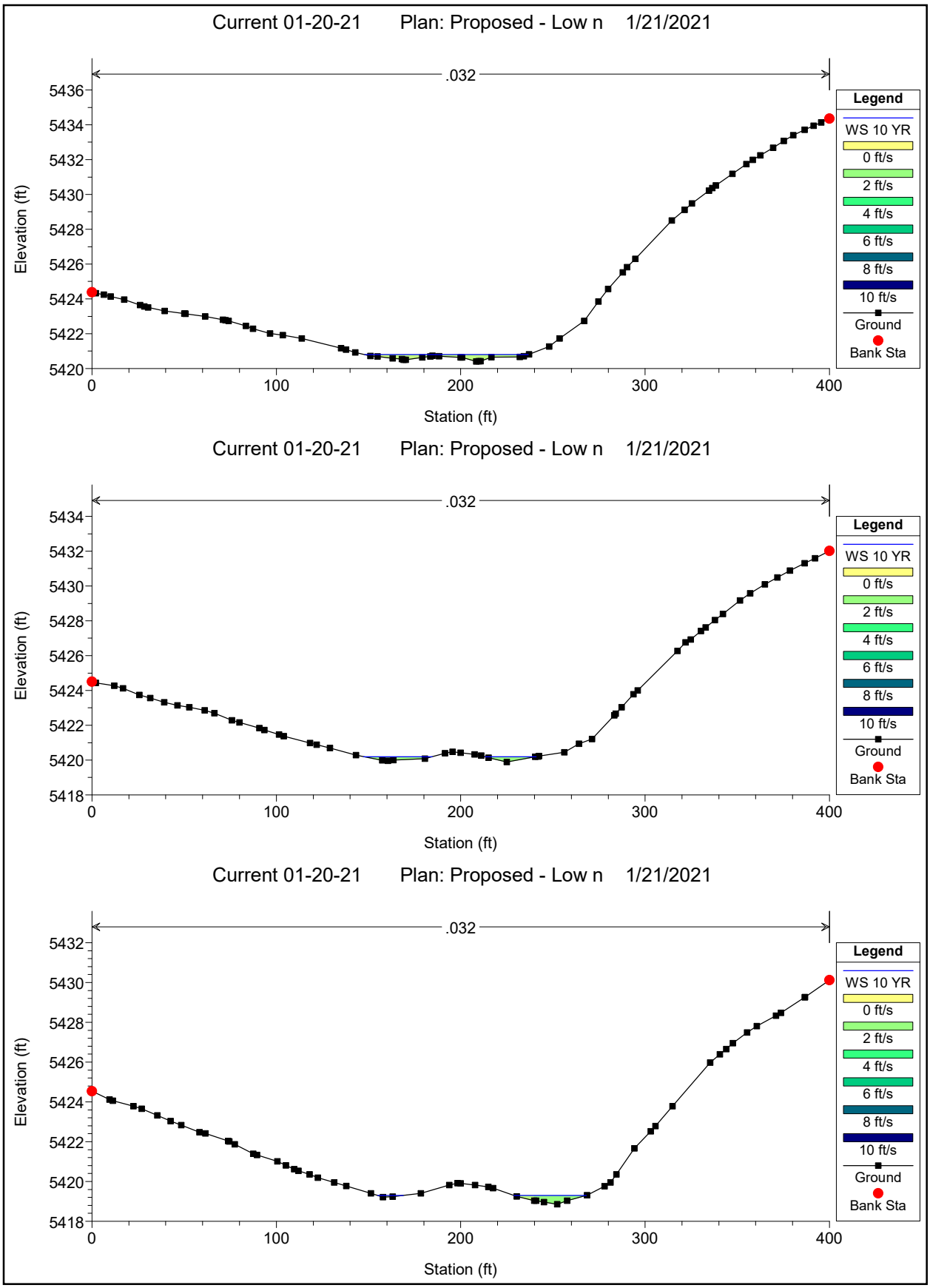
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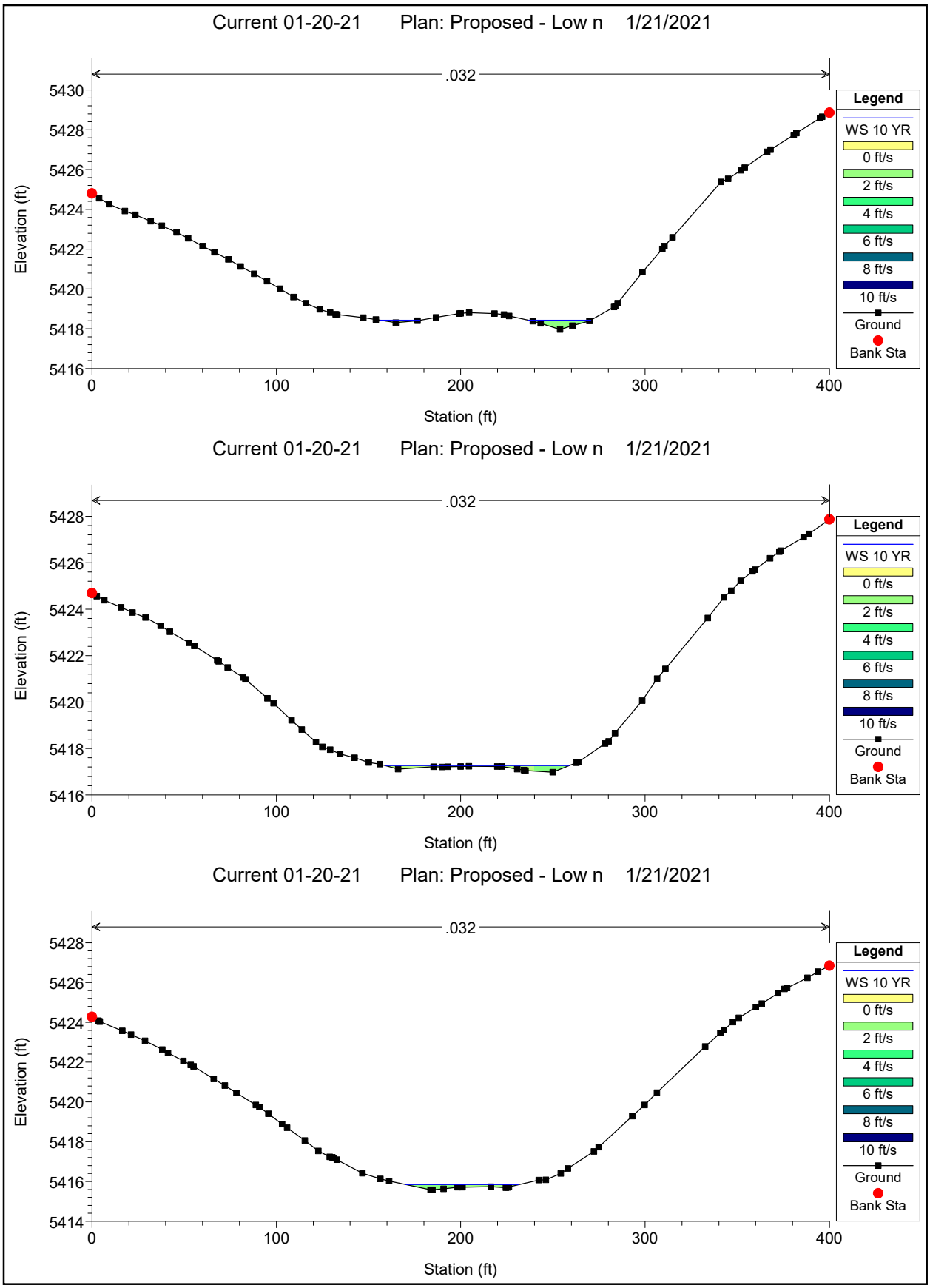
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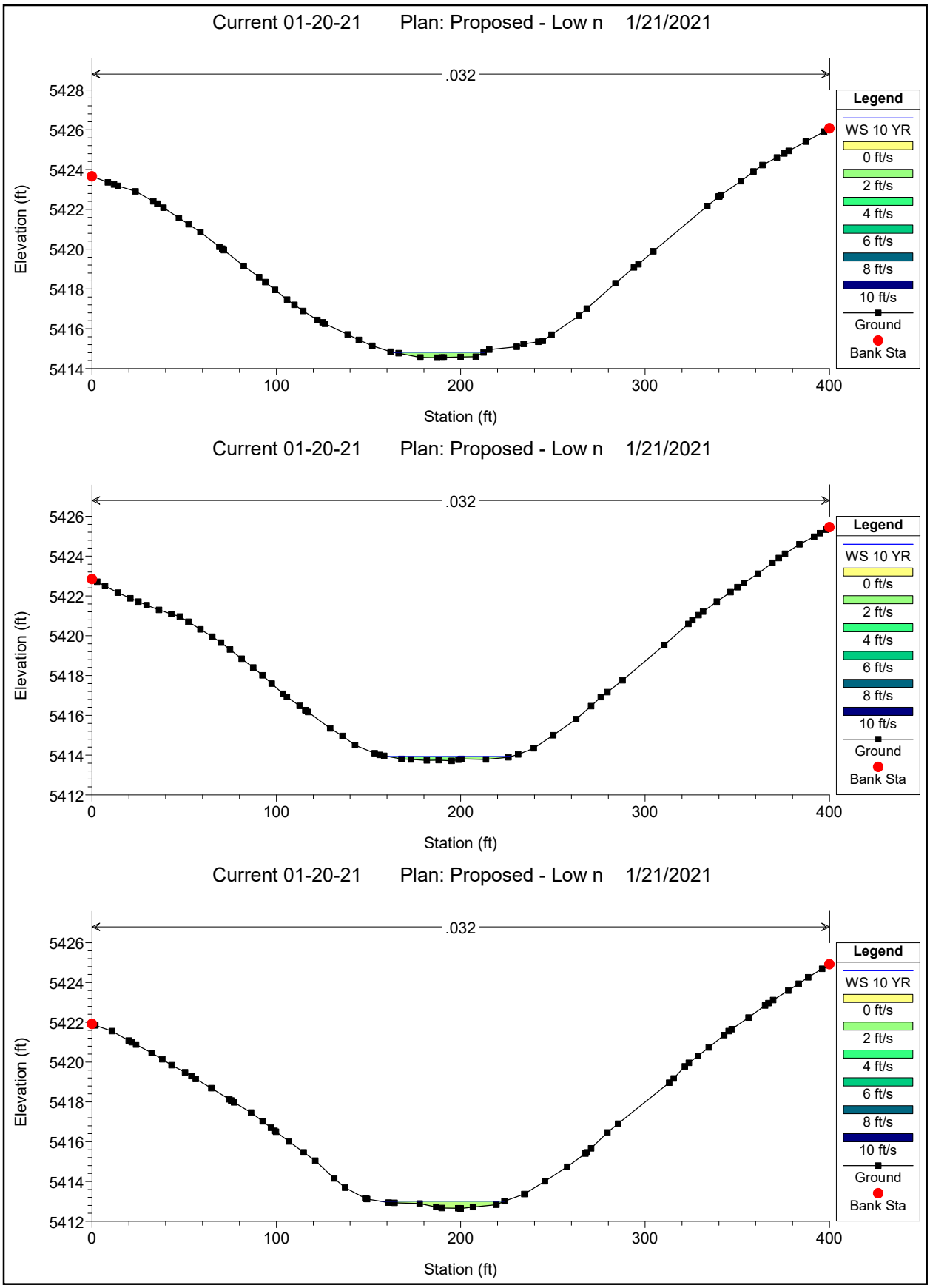
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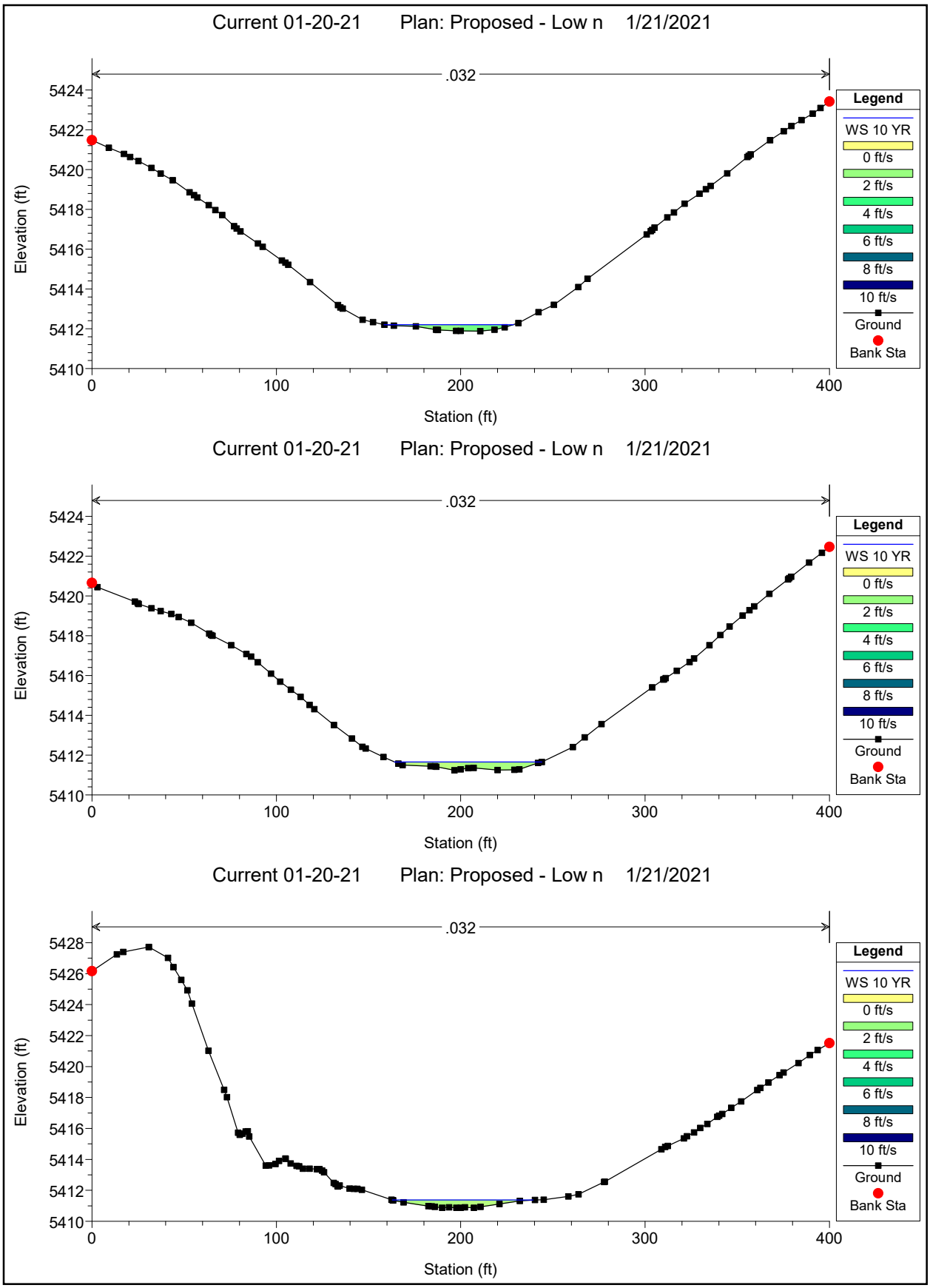
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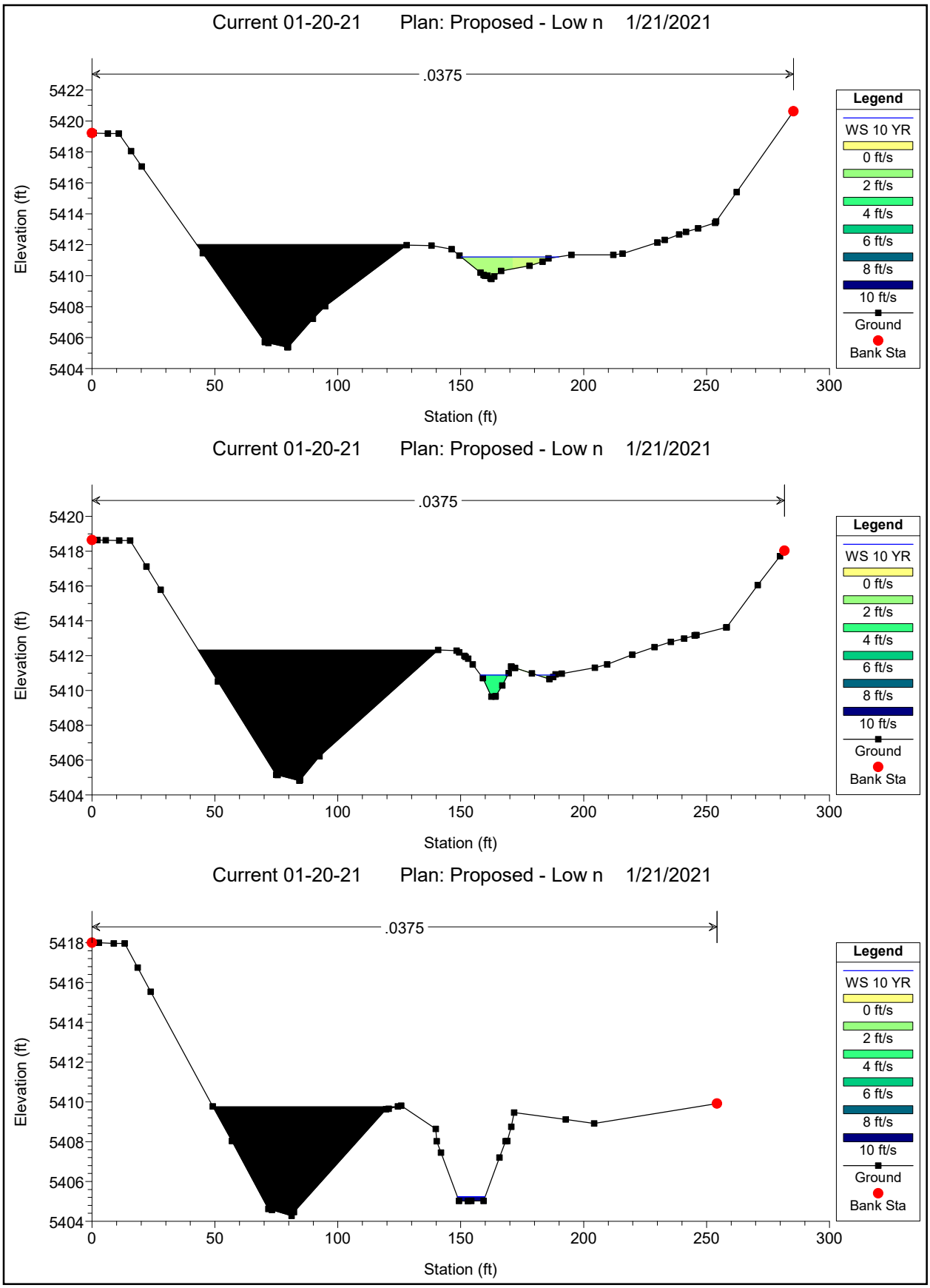
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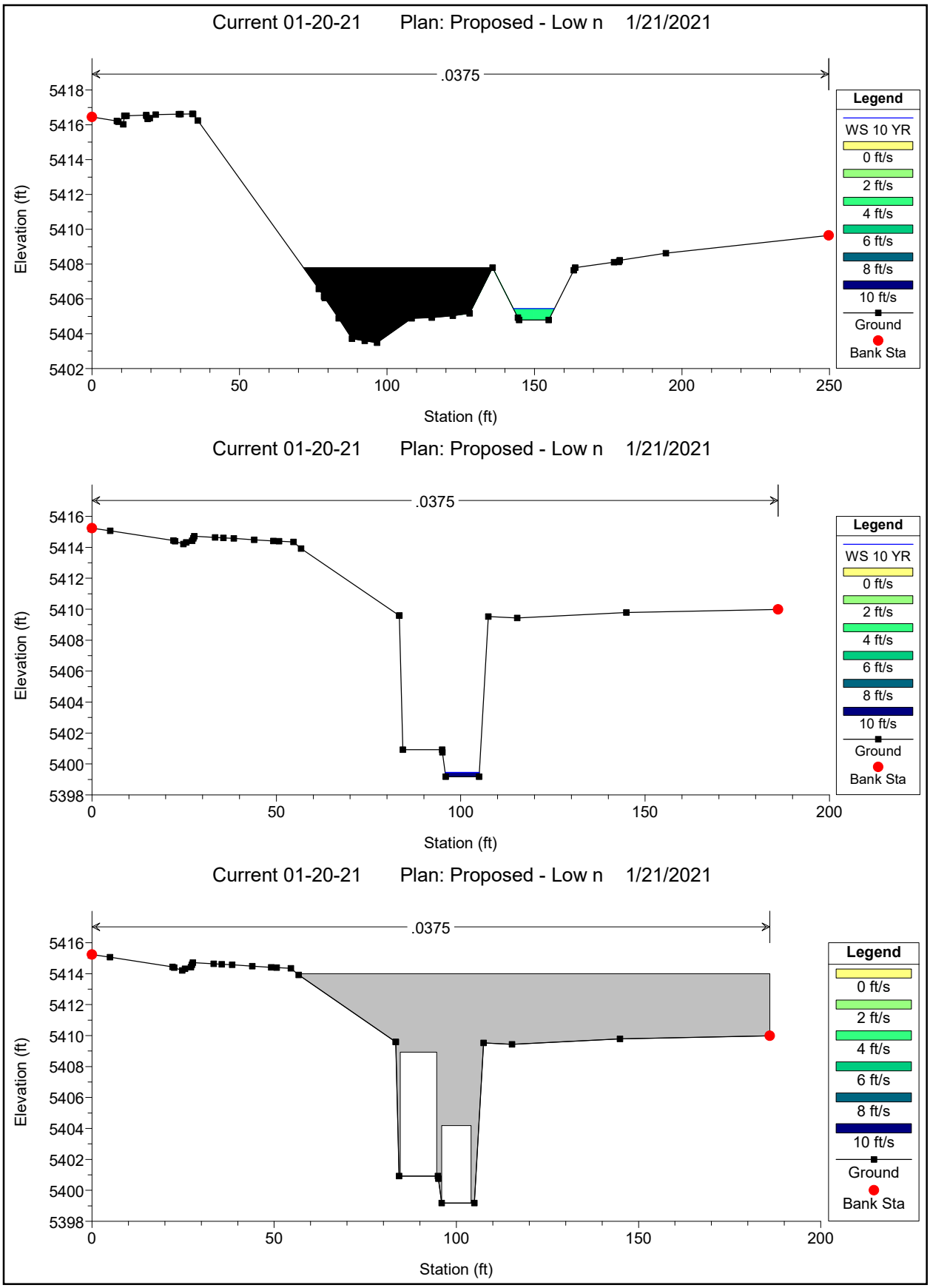
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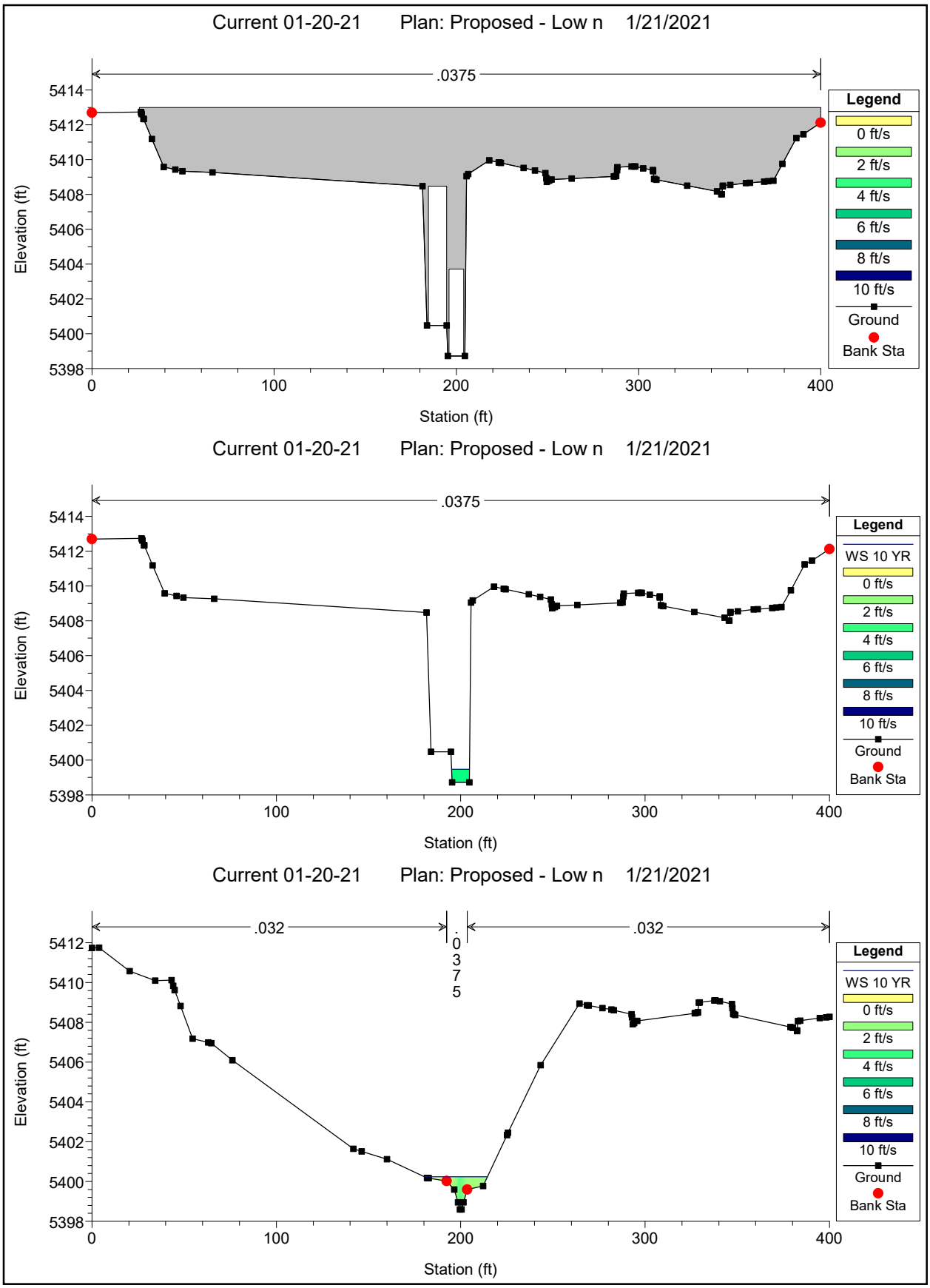
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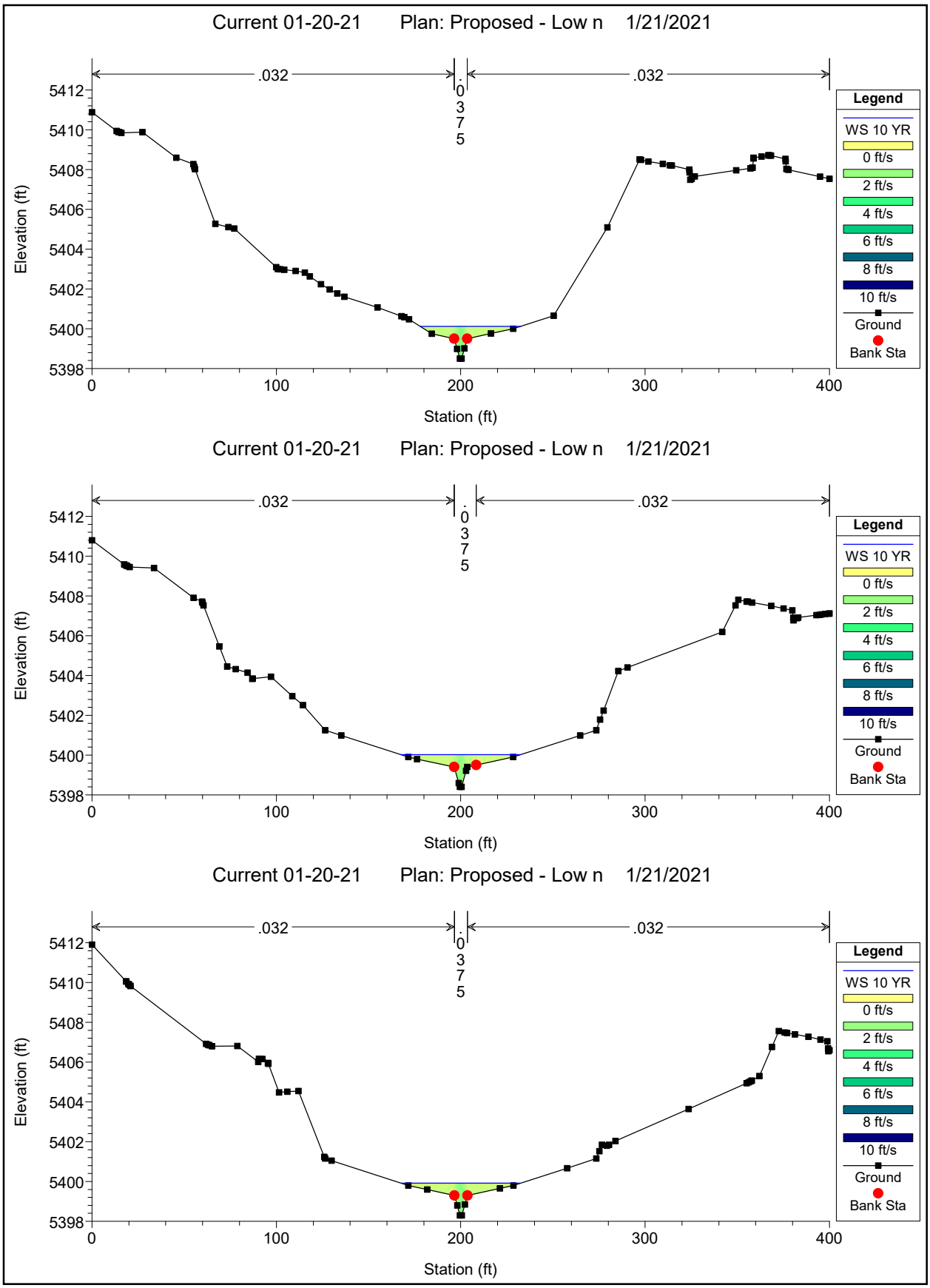
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Station (ft)
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WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 01-20-21 Plan: Proposed - Low n 1/21/2021
.032
.0375
.032
Elevation (ft)
5412
5410
5408
5406
5404
5402
5400
5398
0
100
200
300
400
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 01-20-21 Plan: Proposed - Low n 1/21/2021
.032
.0375
.032
Elevation (ft)
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5406
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5400
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Station (ft)
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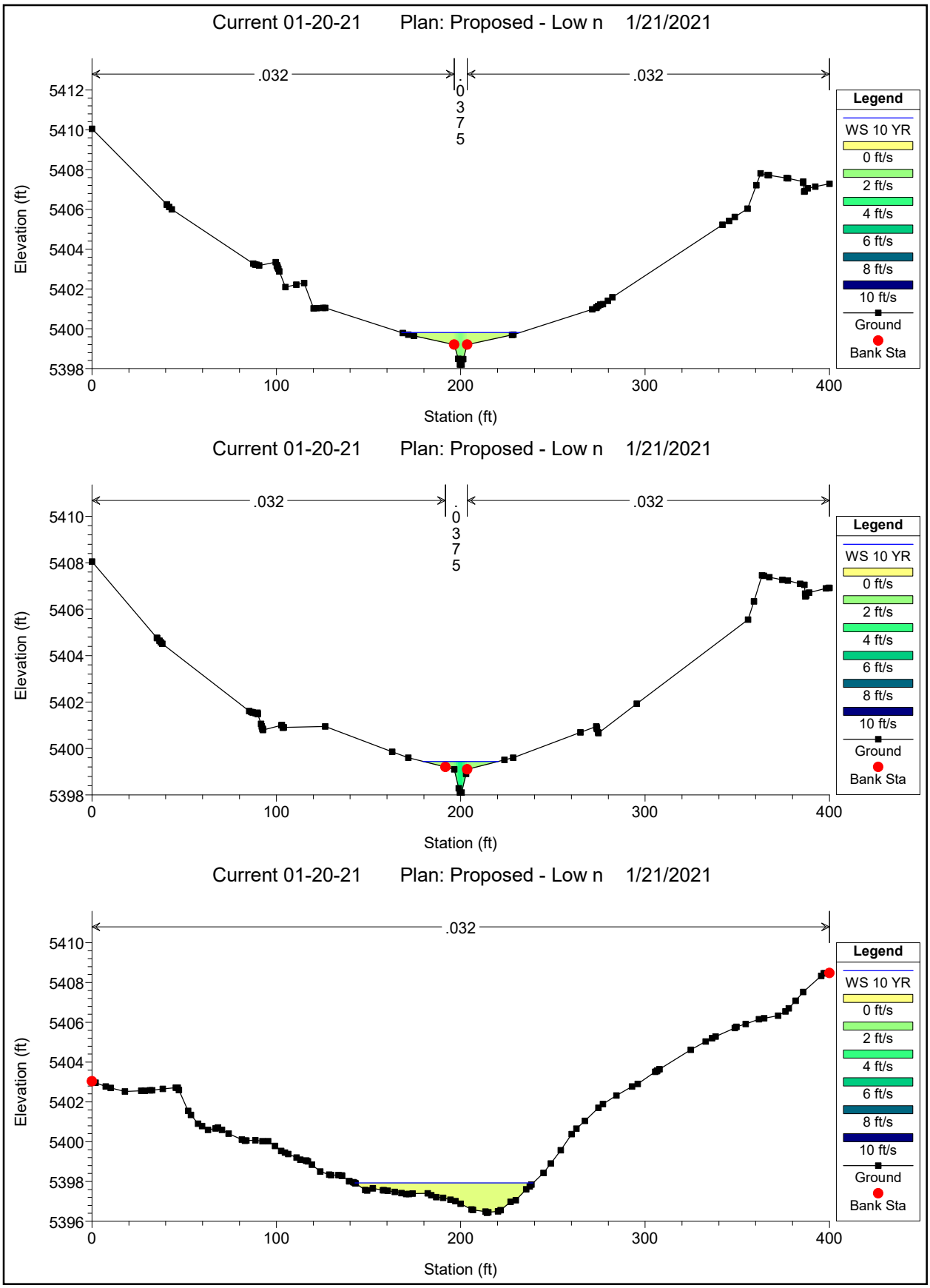
Ground
Bank Sta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Station (ft)
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Ground
Bank Sta
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.0375
.032
Elevation (ft)
Station (ft)
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WS 10 YR
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Ground
Bank Sta
Current 01-20-21 Plan: Proposed - Low n 1/21/2021
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Elevation (ft)
Station (ft)
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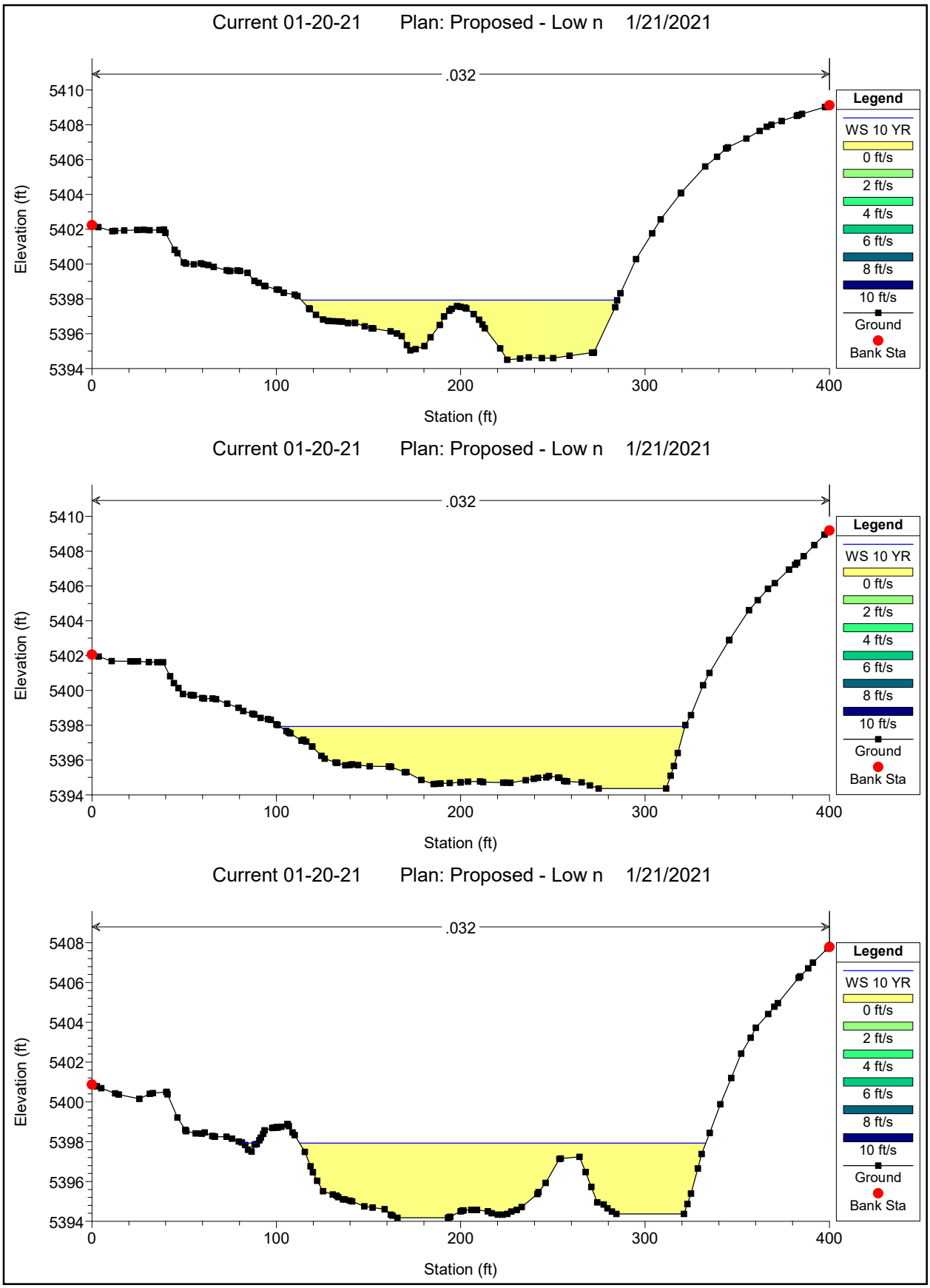
Bank Sta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Bank Sta
Current 01-20-21 Plan: Proposed - Low n 1/21/2021
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Station (ft)
Legend
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Ground
Bank Sta
Current 01-20-21 Plan: Proposed - Low n 1/21/2021
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Elevation (ft)
Station (ft)
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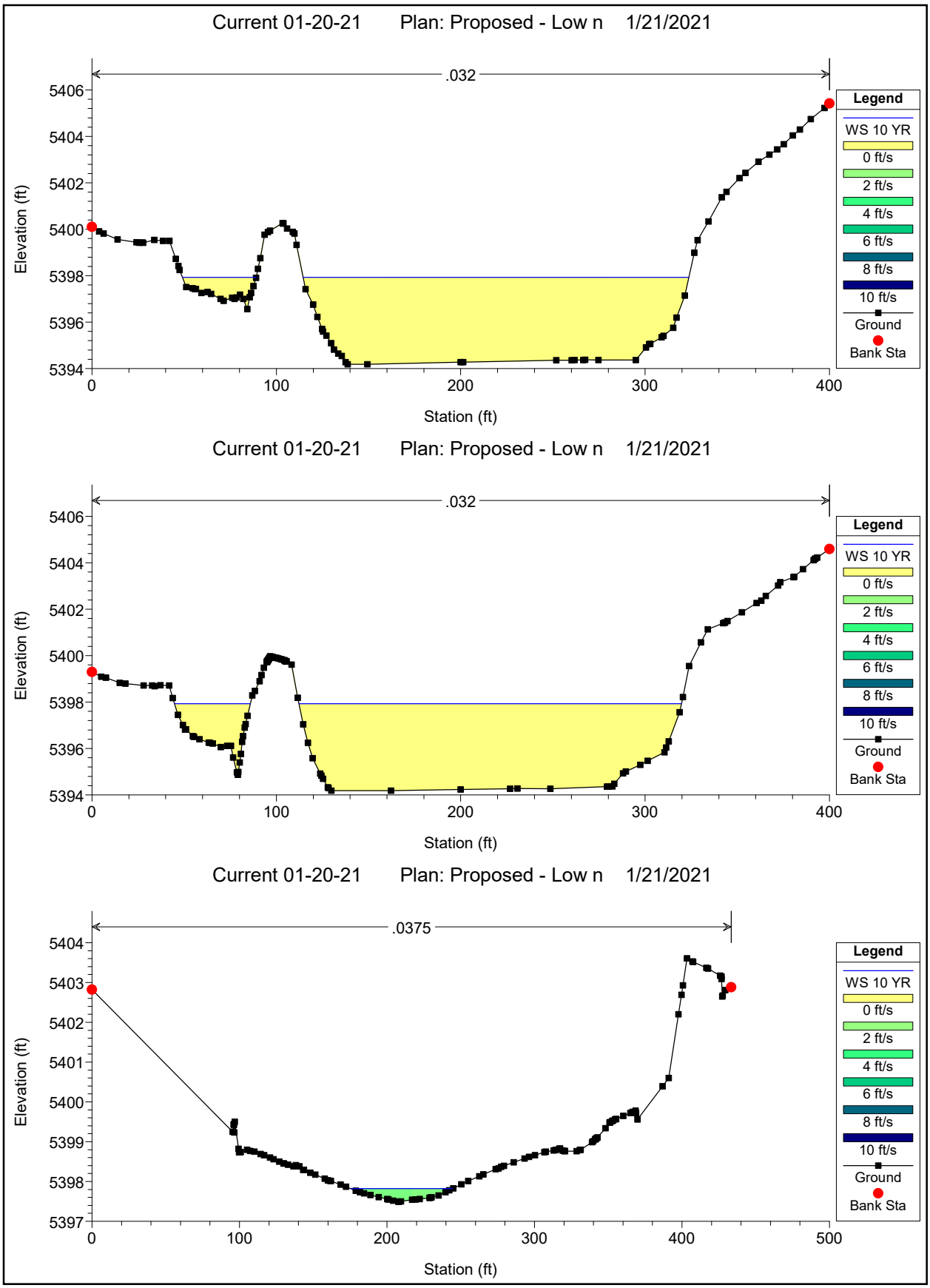
Ground
Bank Sta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Ground
Bank Sta
Current 01-20-21 Plan: Proposed - Low n 1/21/2021
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Elevation (ft)
Station (ft)
Legend
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Ground
Bank Sta
Current 01-20-21 Plan: Proposed - Low n 1/21/2021
.0375
Elevation (ft)
Station (ft)
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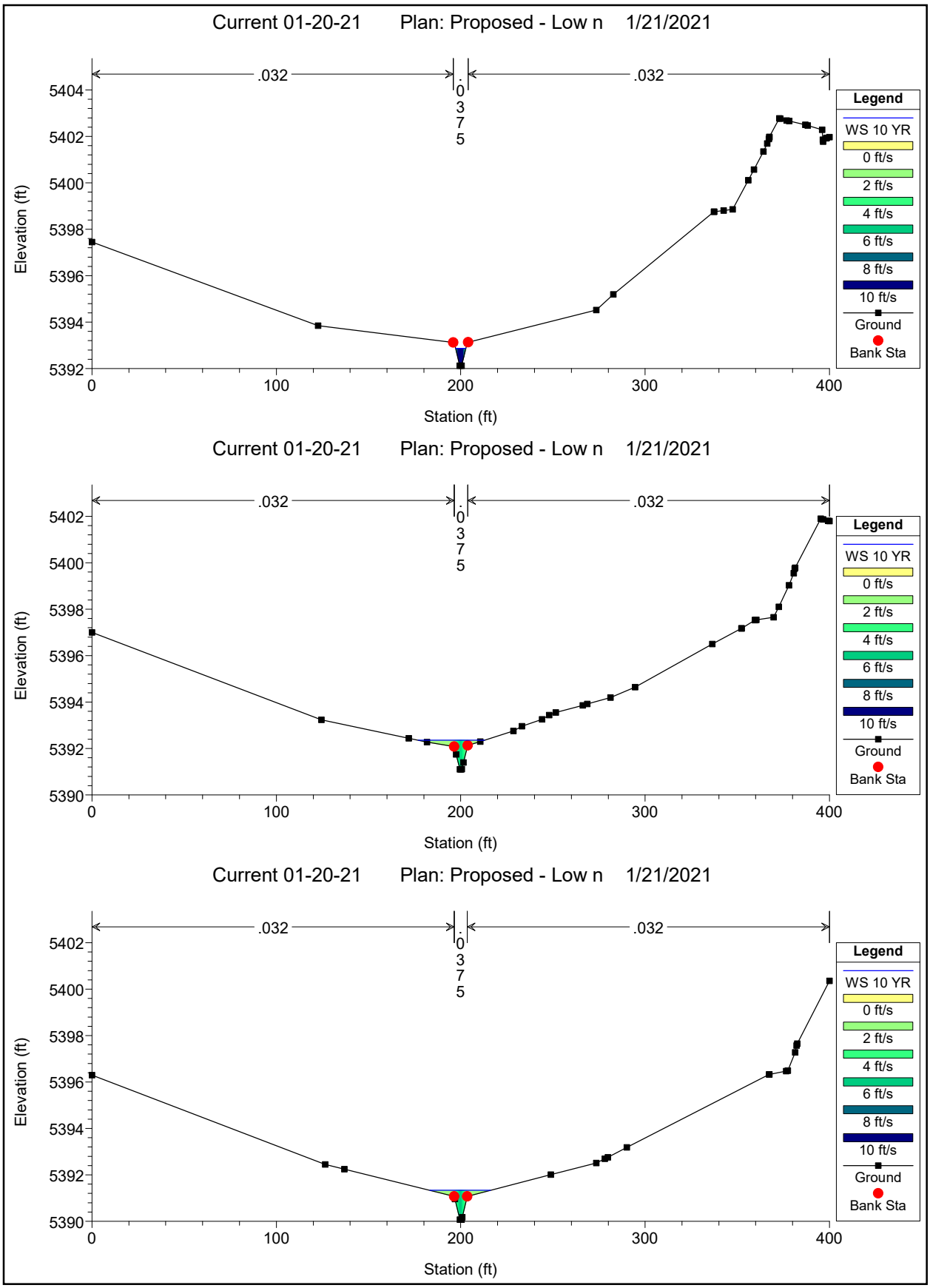
10 ft/s
Ground
Bank Sta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.037
5
.032
Elevation (ft)
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5402
5400
5398
5396
5394
5392
0
100
200
300
400
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 01-20-21 Plan: Proposed - Low n 1/21/2021
.032
.037
5
.032
Elevation (ft)
5402
5400
5398
5396
5394
5392
5390
0
100
200
300
400
Station (ft)
Legend
WS 10 YR
0 ft/s
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4 ft/s
6 ft/s
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Ground
Bank Sta
Current 01-20-21 Plan: Proposed - Low n 1/21/2021
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.037
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.032
Elevation (ft)
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5400
5398
5396
5394
5392
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100
200
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Station (ft)
Legend
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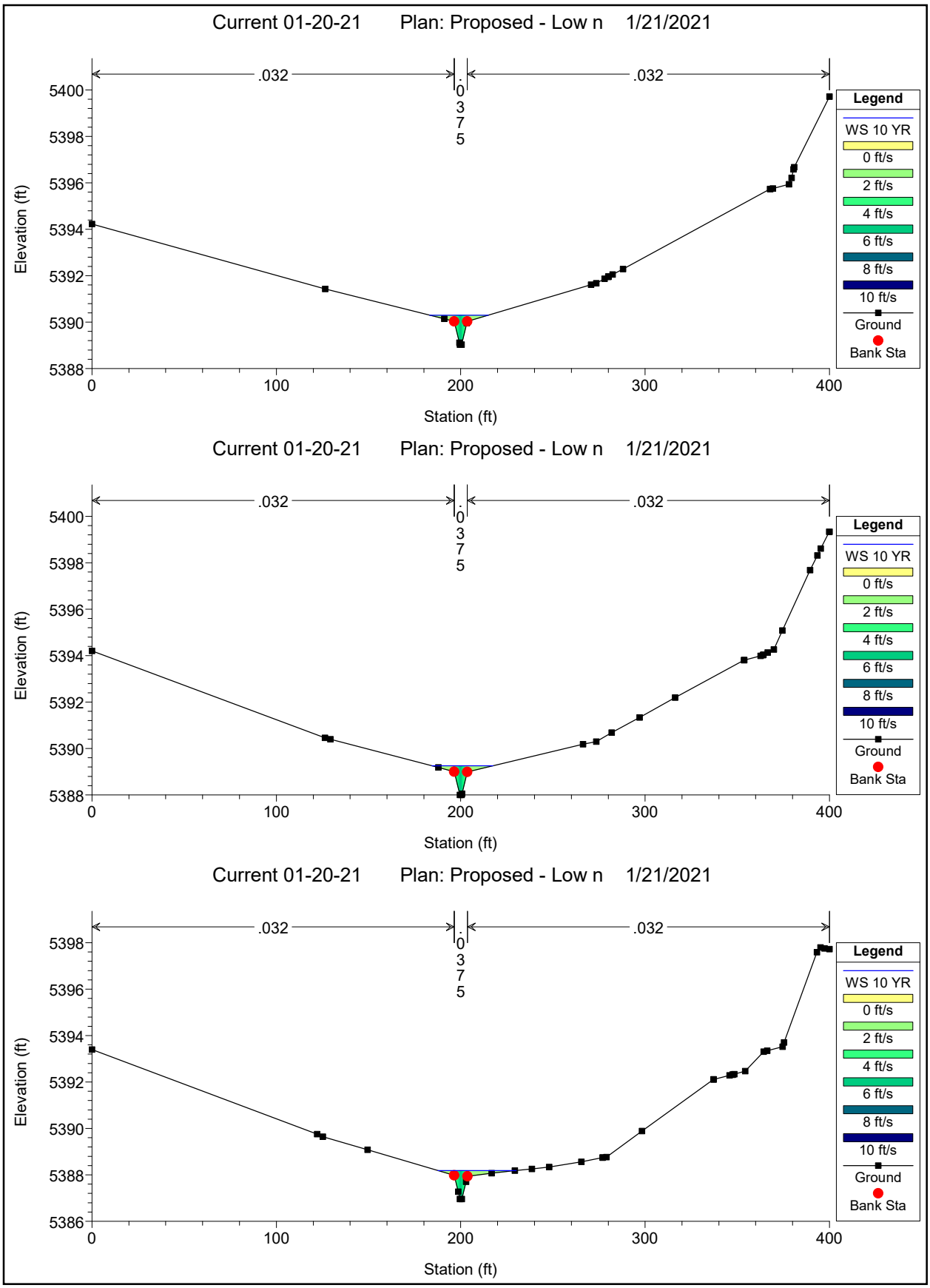
Bank Sta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10 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)
5400
5398
5396
5394
5392
5390
5388
0
100
200
300
400
Current 01-20-21 Plan: Proposed - Low n 1/21/2021
.032
.037
5
.032
Legend
WS 10 YR
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4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)
5400
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0
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Current 01-20-21 Plan: Proposed - Low n 1/21/2021
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.032
Legend
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8 ft/s
10 ft/s
Ground
Bank Sta
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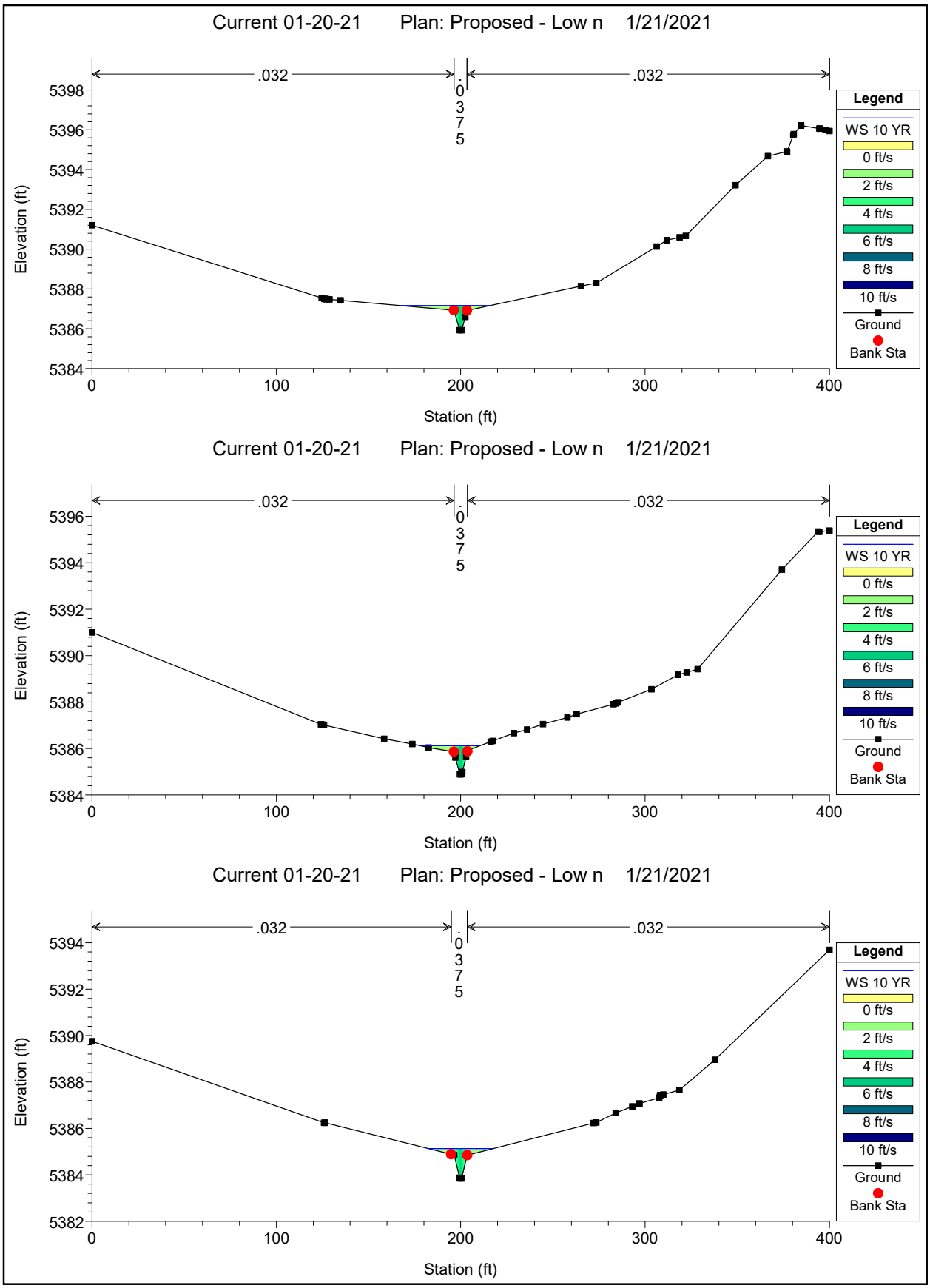
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Elevation (ft)
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Ground
Bank Sta
Current 01-20-21 Plan: Proposed - Low n 1/21/2021
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.0375
.032
Elevation (ft)
Station (ft)
Legend
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Ground
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Current 01-20-21 Plan: Proposed - Low n 1/21/2021
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Elevation (ft)
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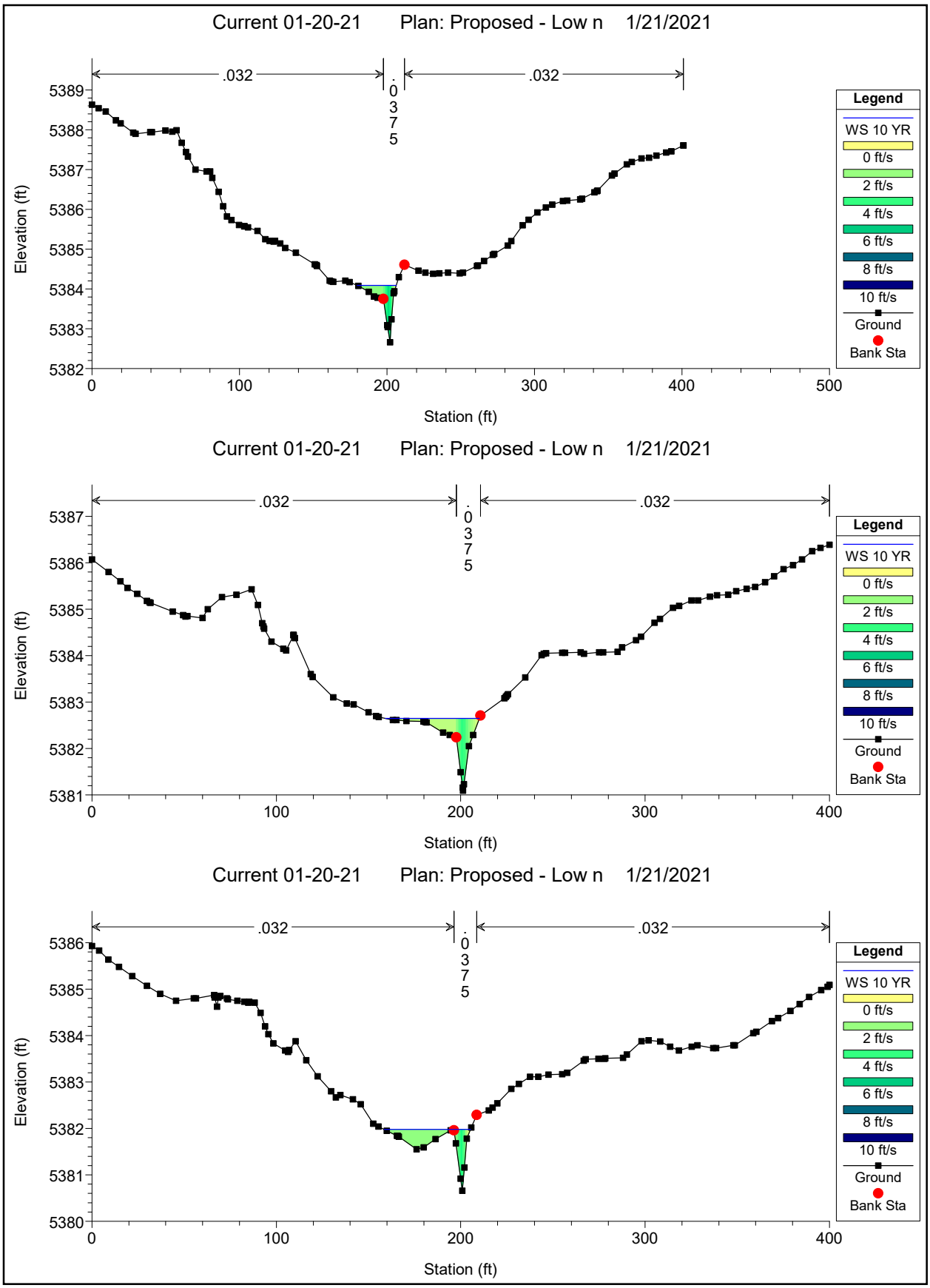
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Elevation (ft)
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Current 01-20-21 Plan: Proposed - Low n 1/21/2021
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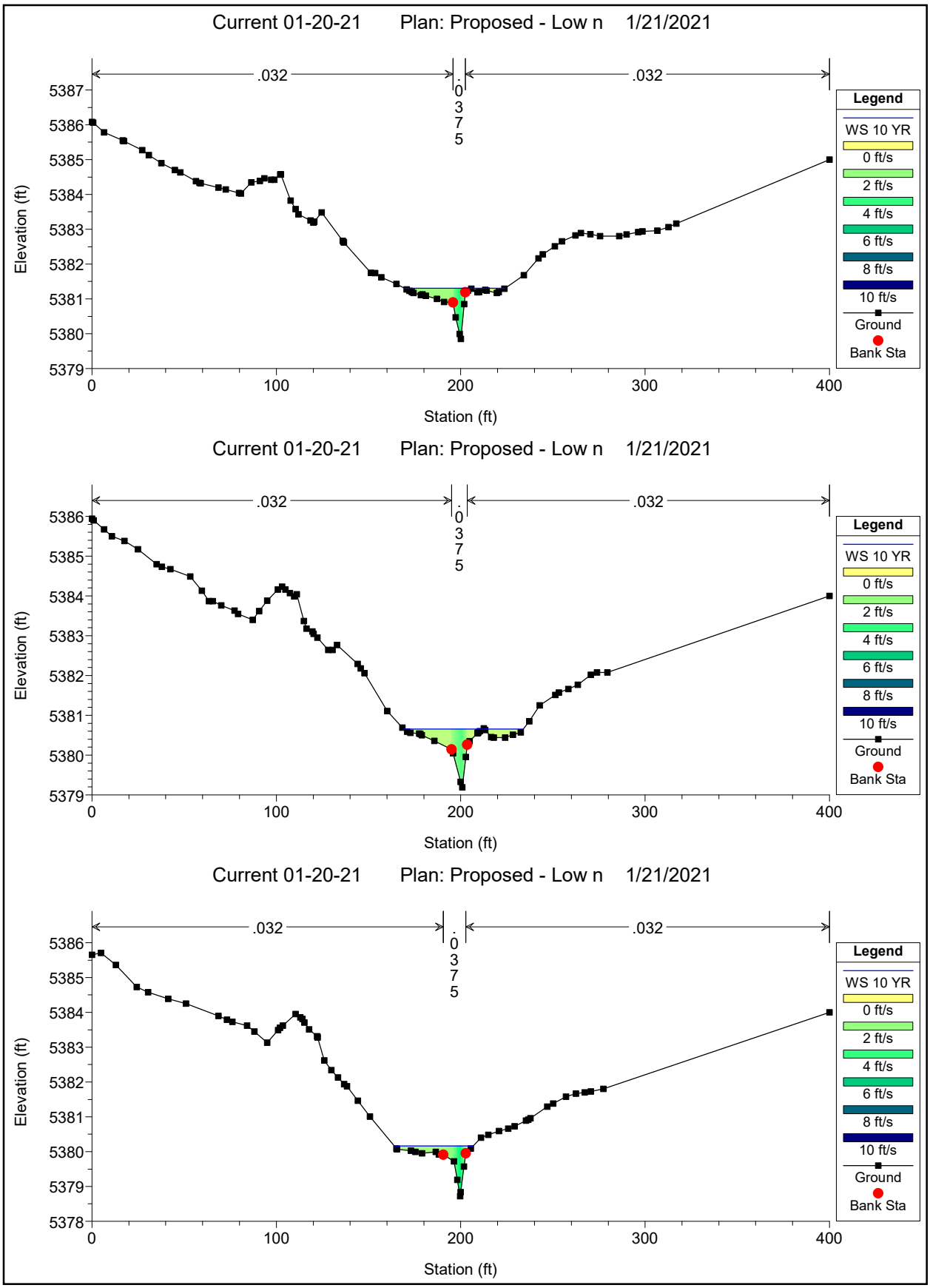
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Current 01-20-21 Plan: Proposed - Low n 1/21/2021
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Current 01-20-21 Plan: Proposed - Low n 1/21/2021
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Elevation (ft)
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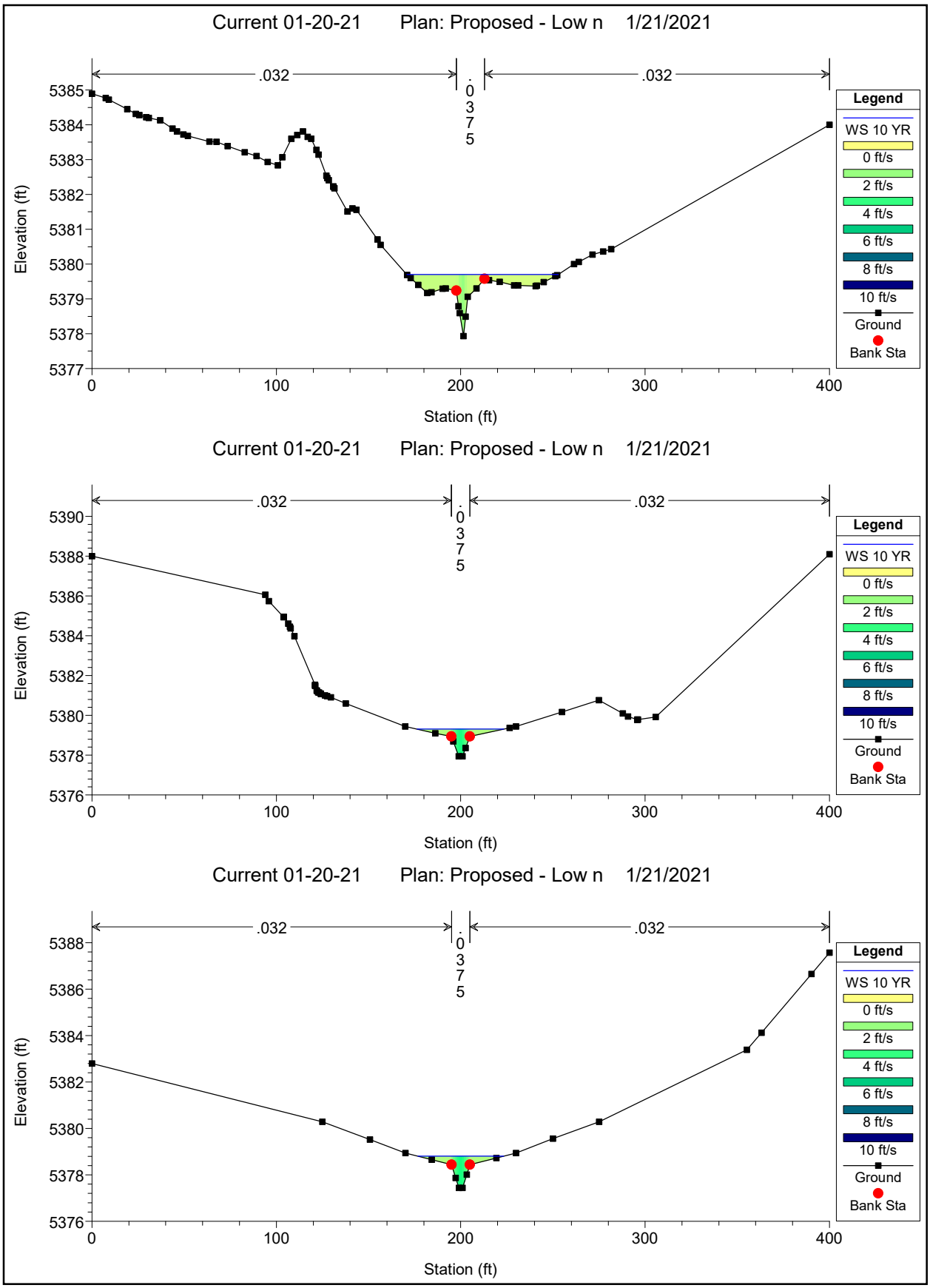
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Current 01-20-21 Plan: Proposed - Low n 1/21/2021
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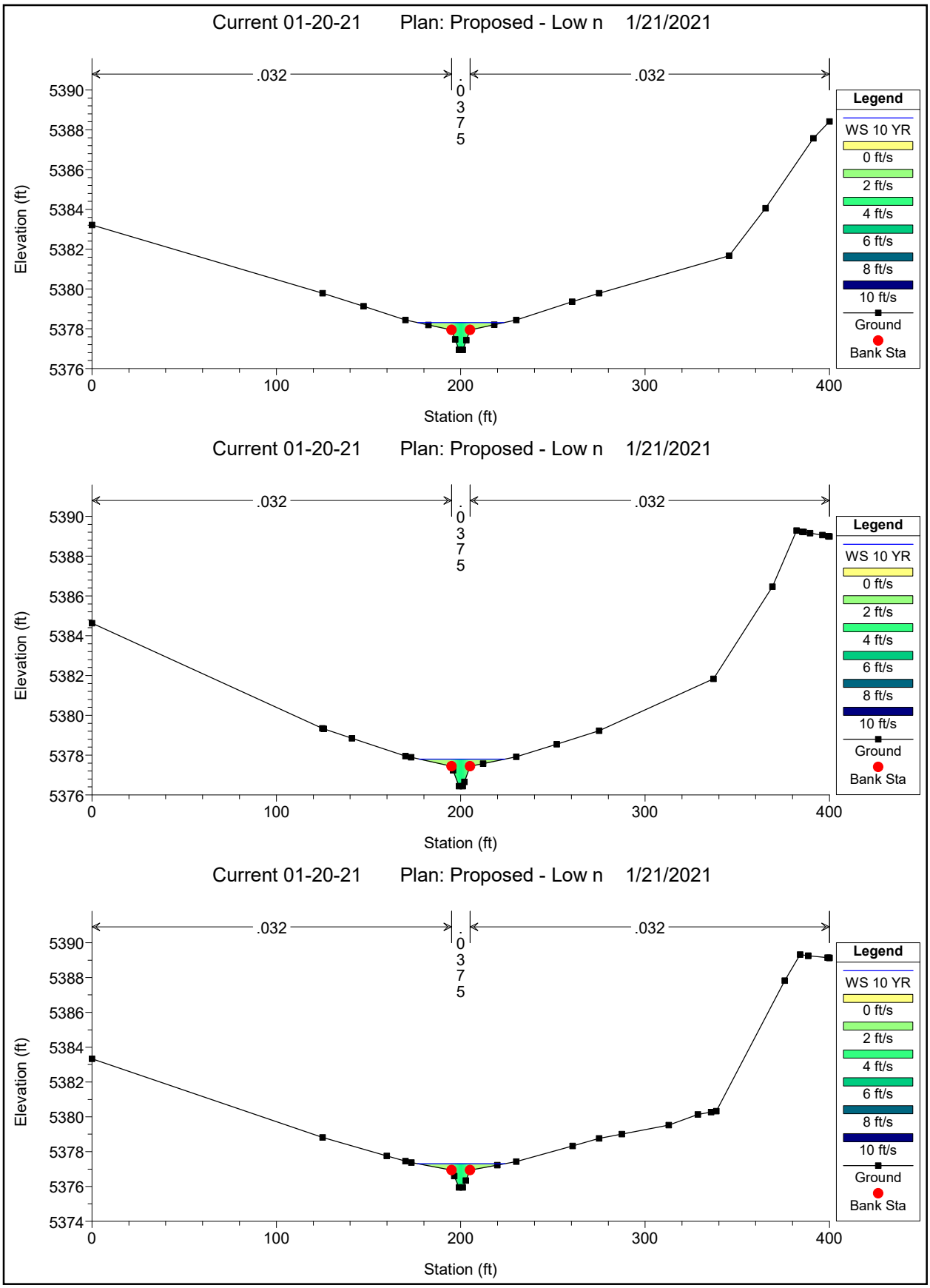
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Current 01-20-21 Plan: Proposed - Low n 1/21/2021
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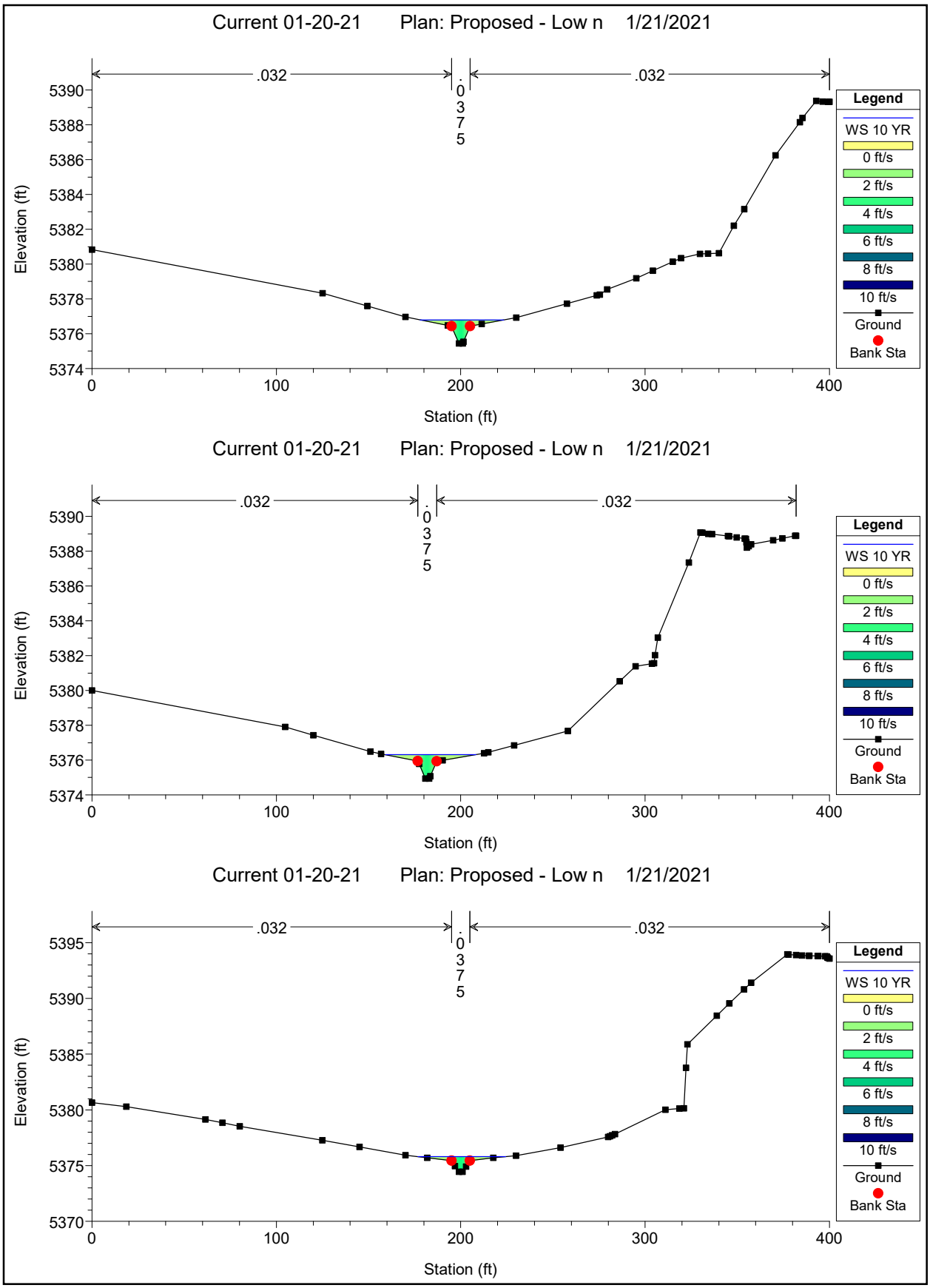
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Current 01-20-21 Plan: Proposed - Low n 1/21/2021
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Elevation (ft)
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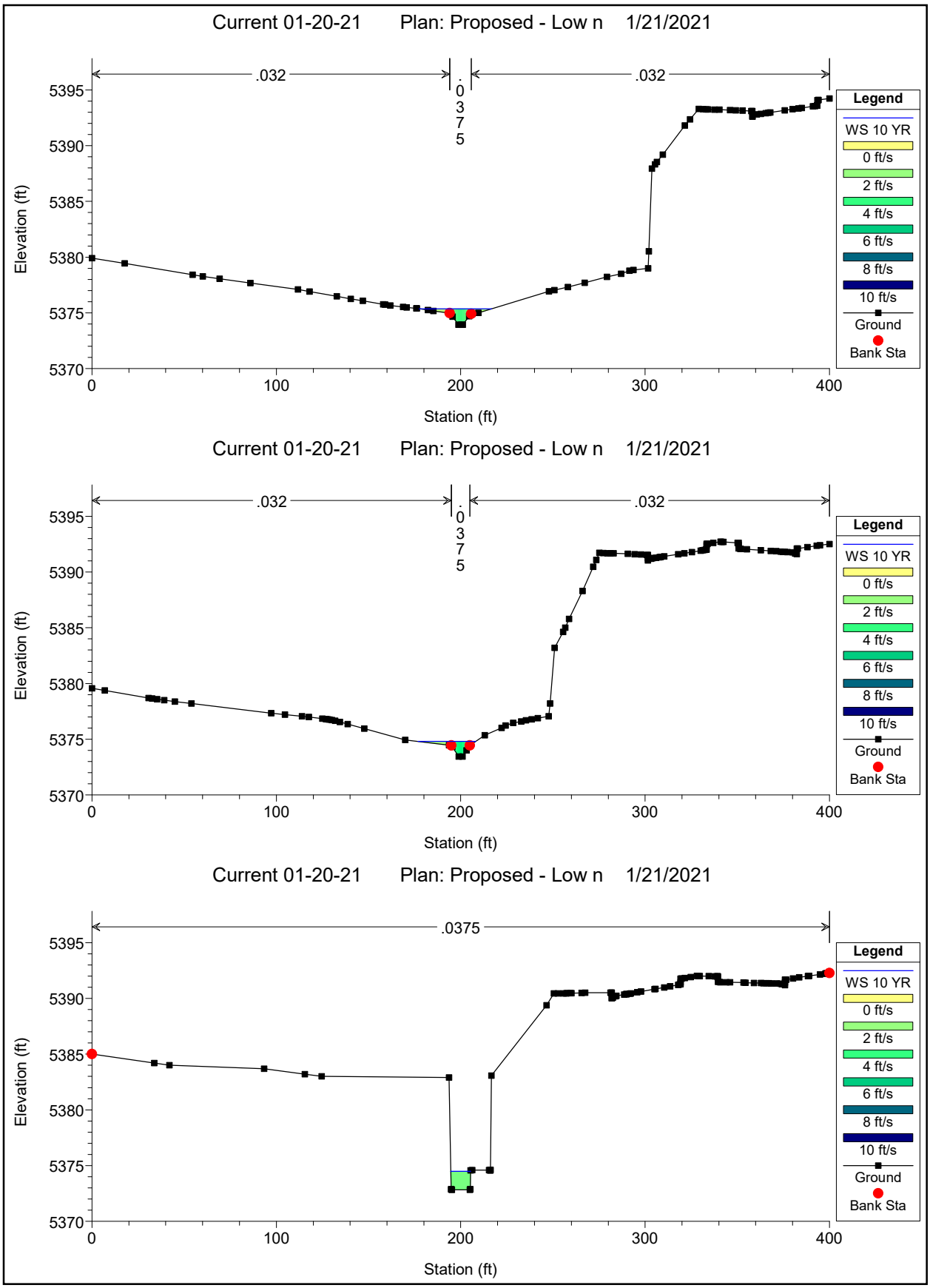
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Elevation (ft)
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5375
5370
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Station (ft)
Legend
WS 10 YR
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4 ft/s
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Ground
Bank Sta
Current 01-20-21 Plan: Proposed - Low n 1/21/2021
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Elevation (ft)
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Station (ft)
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Ground
Bank Sta
Current 01-20-21 Plan: Proposed - Low n 1/21/2021
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Elevation (ft)
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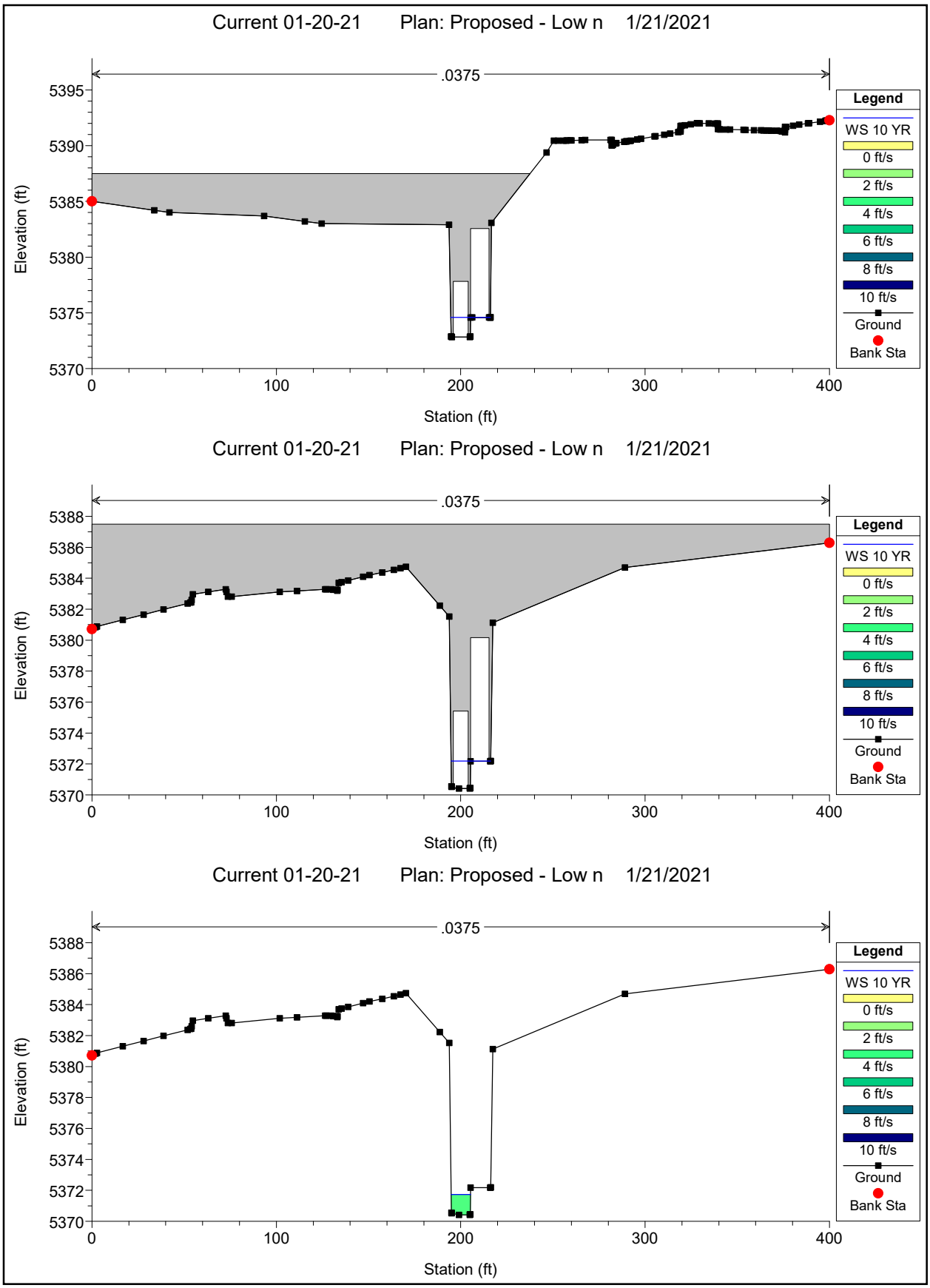
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Elevation (ft)
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Bank Sta
Current 01-20-21 Plan: Proposed - Low n 1/21/2021
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Elevation (ft)
Station (ft)
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Bank Sta
Current 01-20-21 Plan: Proposed - Low n 1/21/2021
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Elevation (ft)
Station (ft)
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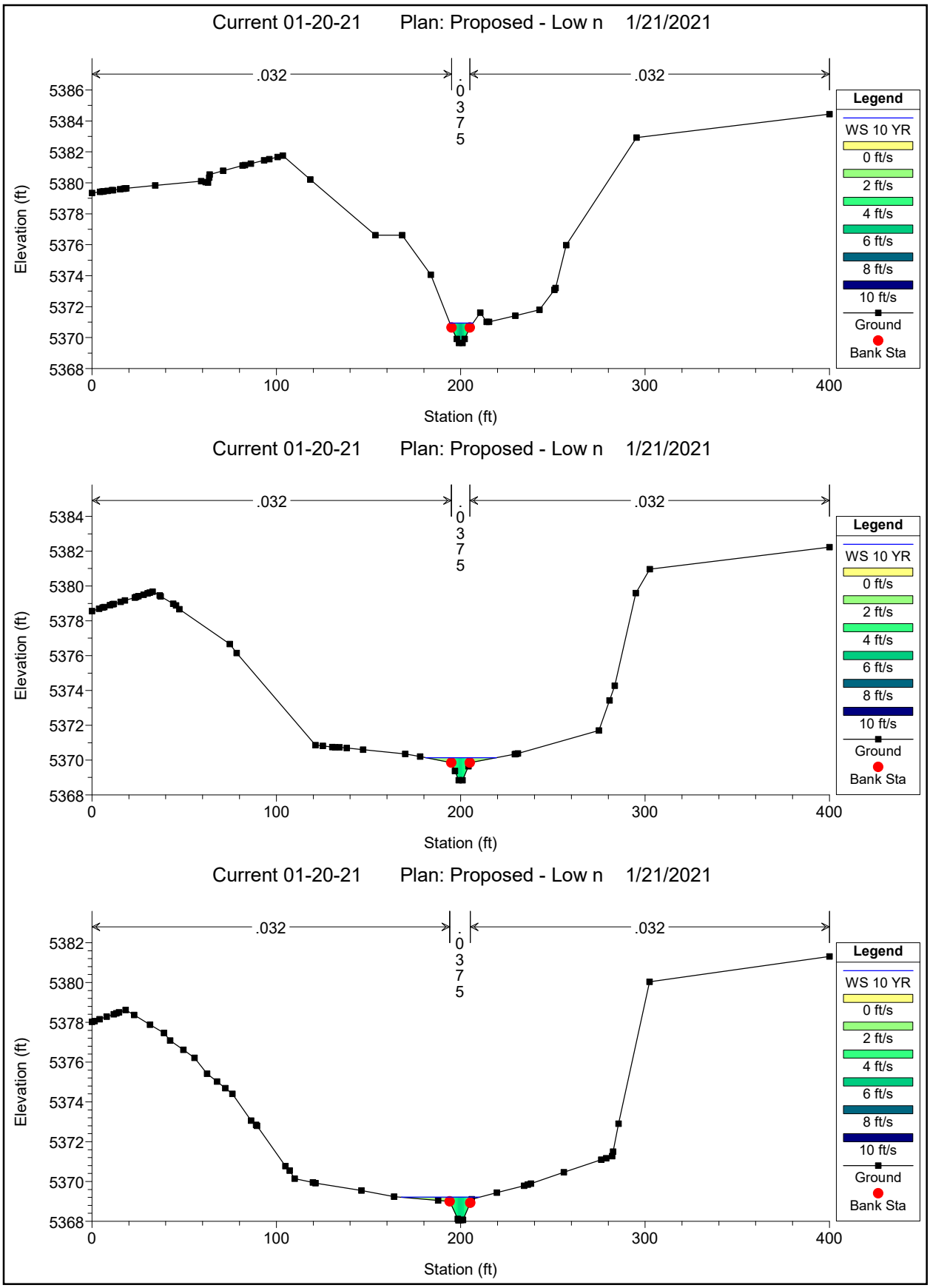
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Current 01-20-21 Plan: Proposed - Low n 1/21/2021
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Station (ft)
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Current 01-20-21 Plan: Proposed - Low n 1/21/2021
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Elevation (ft)
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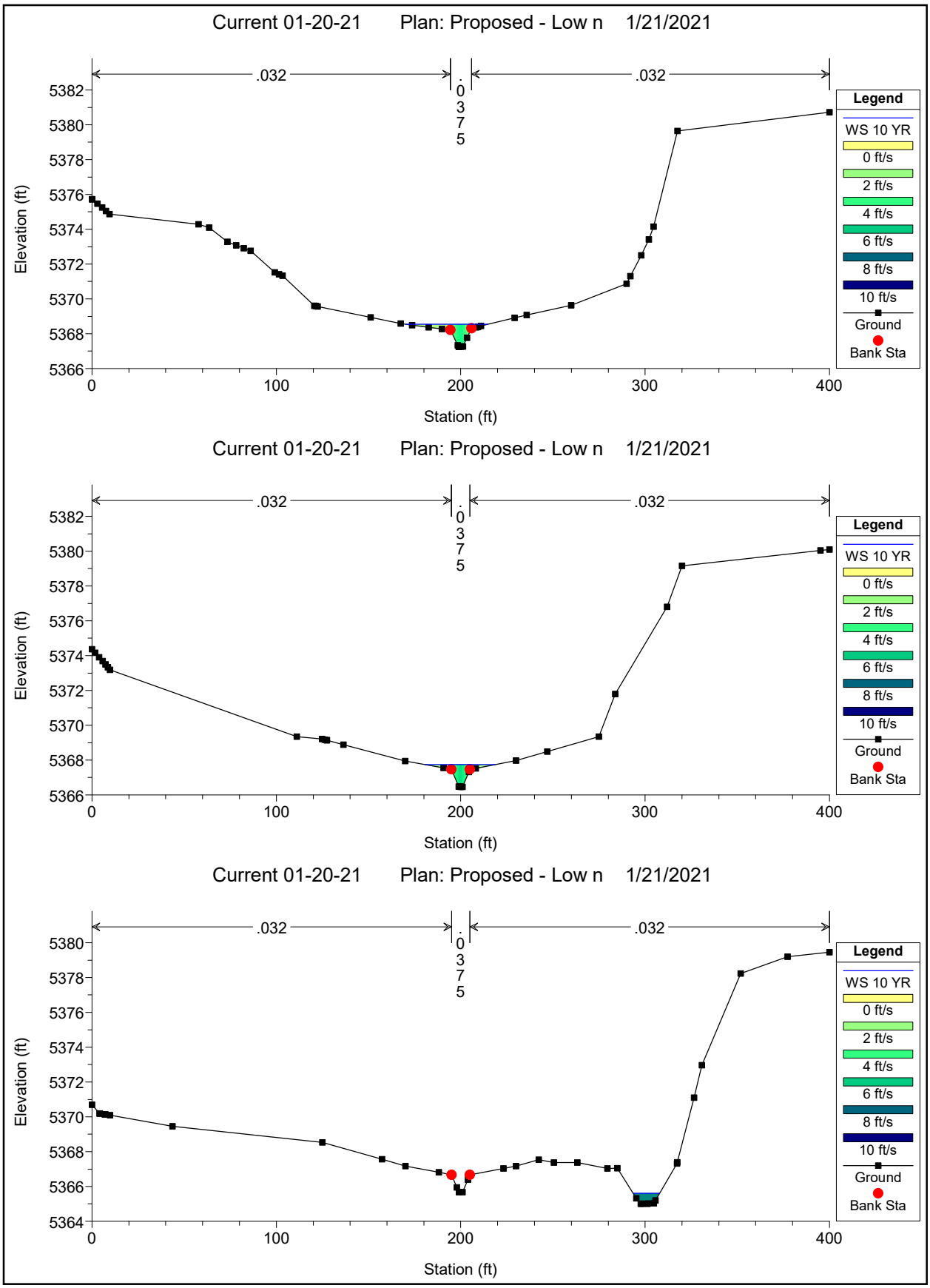
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Elevation (ft)
Station (ft)
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Current 01-20-21 Plan: Proposed - Low n 1/21/2021
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.0375
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Elevation (ft)
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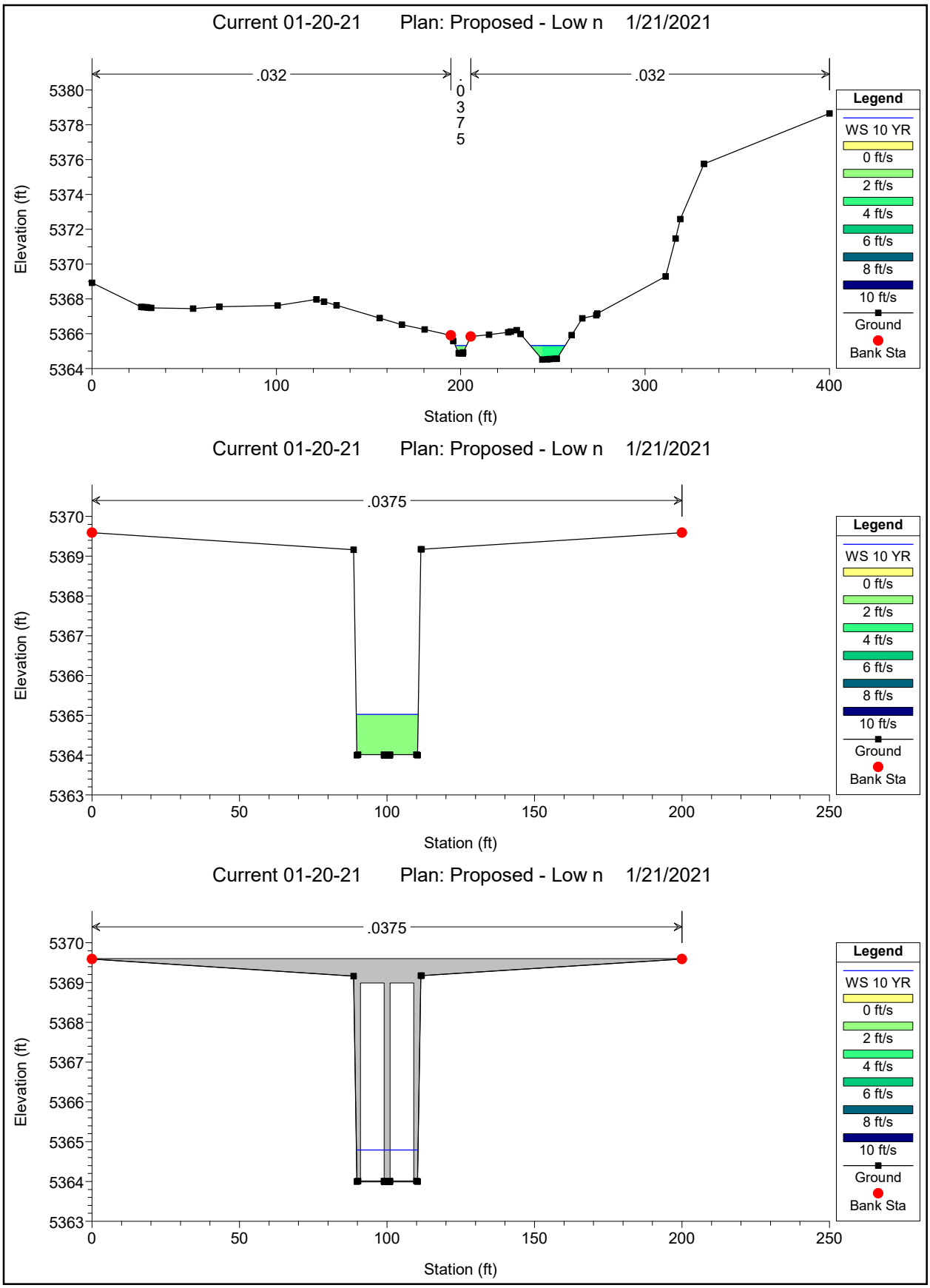
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Elevation (ft)
Station (ft)
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Bank Sta
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Elevation (ft)
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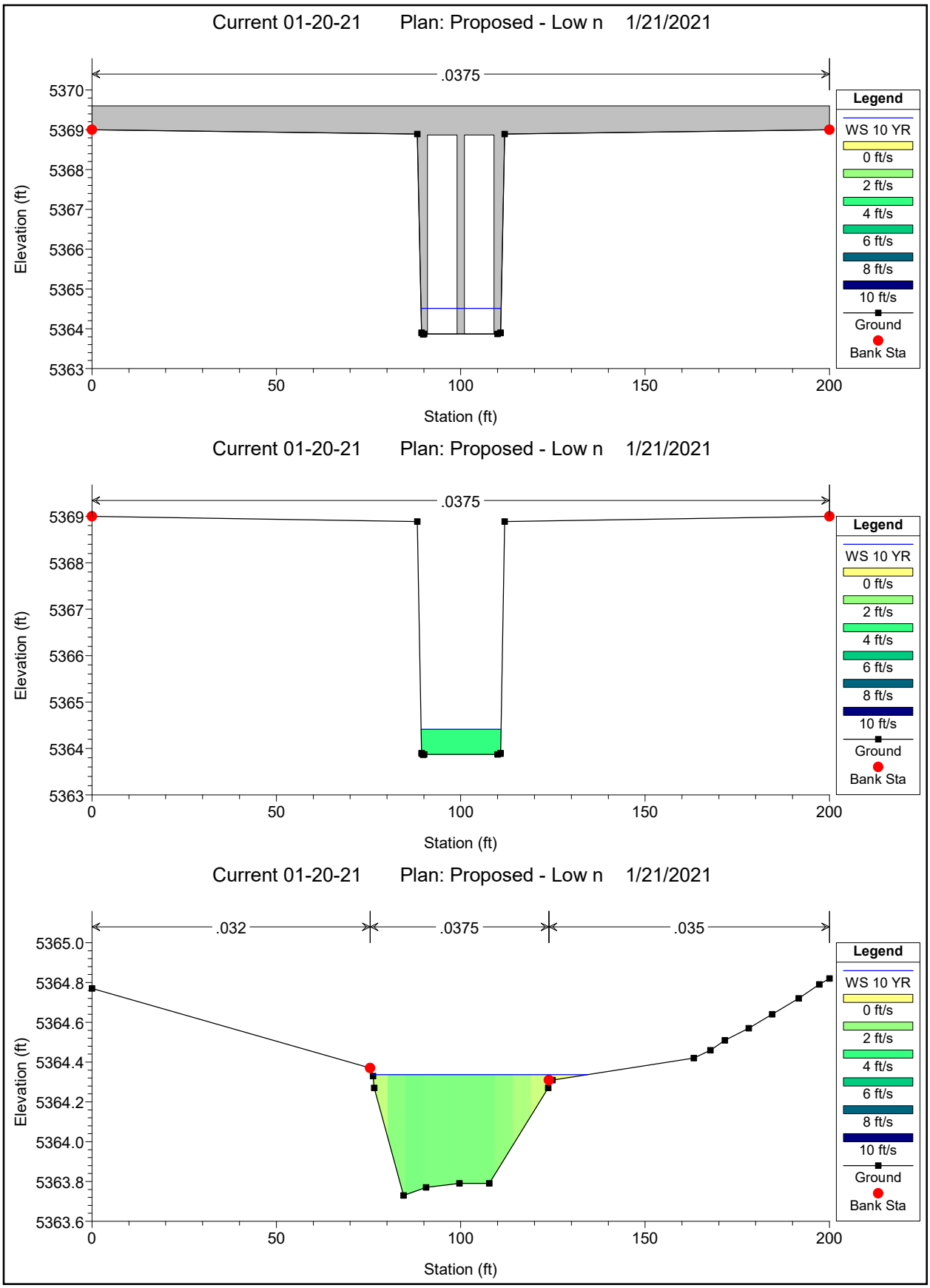
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Elevation (ft)
Station (ft)
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.035
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Station (ft)
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Ground
Bank Sta

HEC-RAS Plan: PR-Low-n River: Tributary - I Reach: PR - Tributary I Profile: 100 YR

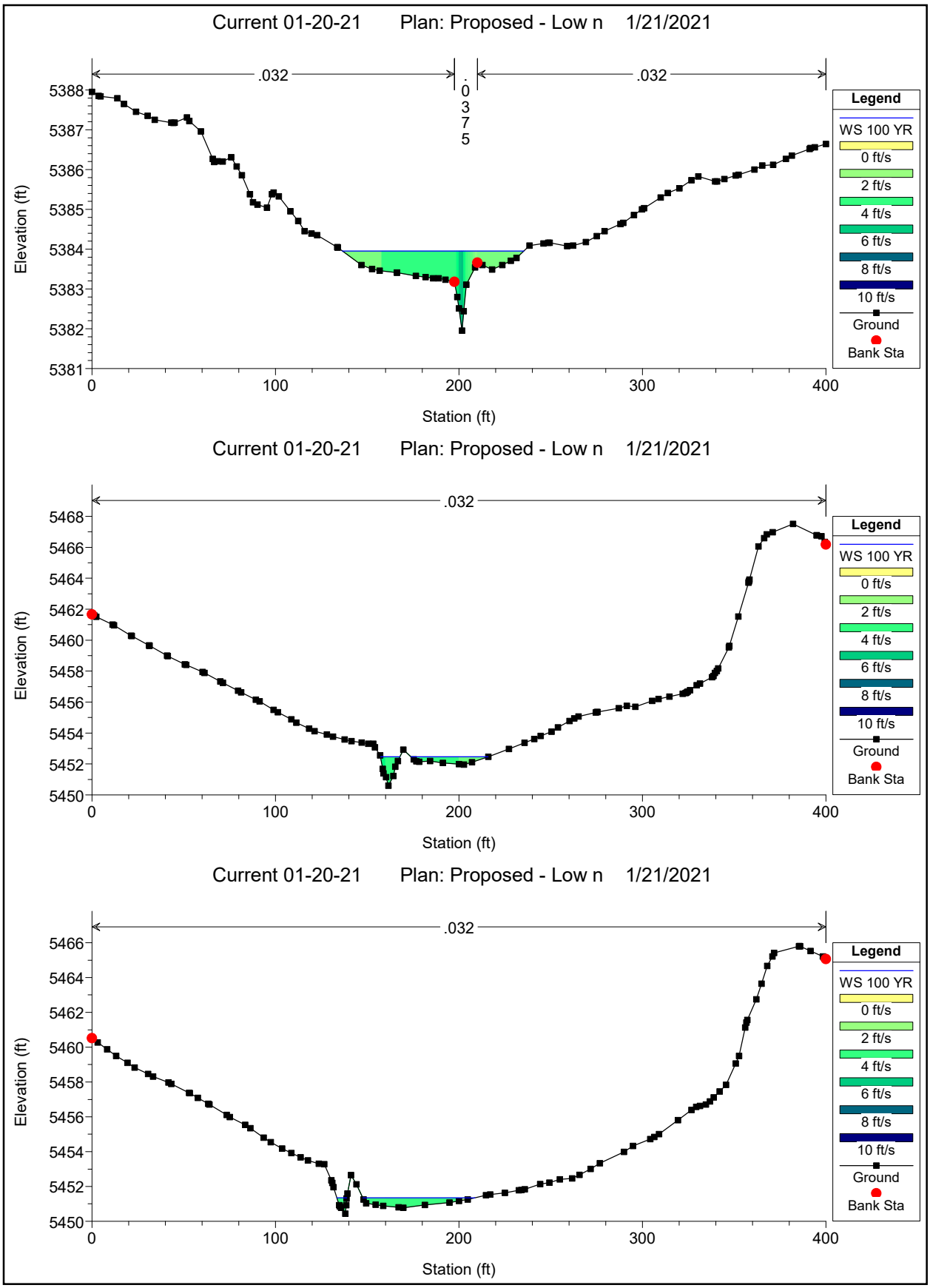
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
PR - Tributary I	5750	100 YR	93.32	5450.60	5452.46	5452.46	5452.70	0.020364	3.89	23.98	52.51	1.02	0.57
PR - Tributary I	5700	100 YR	93.32	5450.44	5451.35	5451.37	5451.57	0.025110	3.78	24.68	66.41	1.09	0.58
PR - Tributary I	5650	100 YR	93.32	5449.61	5450.12	5450.13	5450.29	0.025533	3.30	28.25	94.77	1.07	0.47
PR - Tributary I	5600	100 YR	93.32	5448.25	5448.72	5448.75	5448.94	0.028352	3.79	24.61	72.85	1.15	0.60
PR - Tributary I	5550	100 YR	93.32	5446.77	5447.53	5447.55	5447.77	0.022753	3.91	23.86	57.16	1.07	0.59
PR - Tributary I	5500	100 YR	93.32	5445.70	5446.69	5446.53	5446.82	0.008373	2.93	31.89	55.75	0.68	0.30
PR - Tributary I	5450	100 YR	93.32	5445.24	5445.97	5445.97	5446.21	0.019411	3.88	24.06	51.78	1.00	0.56
PR - Tributary I	5400	100 YR	93.32	5444.05	5444.83	5444.87	5445.11	0.025114	4.24	22.01	50.30	1.13	0.69
PR - Tributary I	5350	100 YR	93.32	5443.51	5444.22	5444.11	5444.35	0.009940	2.88	32.37	65.87	0.72	0.30
PR - Tributary I	5300	100 YR	93.32	5443.08	5443.69		5443.82	0.011718	2.87	32.55	75.56	0.77	0.32
PR - Tributary I	5250	100 YR	93.32	5442.33	5442.87	5442.87	5443.05	0.020518	3.47	26.91	71.49	1.00	0.48
PR - Tributary I	5200	100 YR	93.32	5441.18	5441.77	5441.78	5441.98	0.022440	3.66	25.48	66.71	1.04	0.54
PR - Tributary I	5150	100 YR	93.32	5440.49	5441.39	5441.07	5441.44	0.003053	1.86	50.10	80.94	0.42	0.12
PR - Tributary I	5100	100 YR	93.32	5438.27	5441.42		5441.42	0.000044	0.45	205.57	113.50	0.06	0.00
PR - Tributary I	5050	100 YR	93.32	5440.42	5441.16	5441.16	5441.39	0.020333	3.81	24.49	56.04	1.02	0.55
PR - Tributary I	5000	100 YR	93.32	5438.12	5438.94	5439.14	5439.51	0.086331	6.04	15.45	52.38	1.96	1.59
PR - Tributary I	4950	100 YR	93.32	5437.50	5438.26	5438.22	5438.42	0.015022	3.23	28.85	67.31	0.87	0.40
PR - Tributary I	4900	100 YR	93.32	5436.66	5437.34	5437.34	5437.56	0.020128	3.73	25.03	58.74	1.01	0.54
PR - Tributary I	4850	100 YR	93.32	5435.75	5436.59	5436.44	5436.70	0.007784	2.63	35.46	68.87	0.65	0.25
PR - Tributary I	4800	100 YR	93.32	5435.31	5435.98	5435.94	5436.15	0.016244	3.26	28.66	70.19	0.90	0.41
PR - Tributary I	4750	100 YR	93.32	5434.72	5435.29		5435.43	0.012571	2.97	31.46	73.11	0.80	0.34
PR - Tributary I	4700	100 YR	93.32	5434.02	5434.59	5434.55	5434.74	0.015501	3.10	30.07	76.46	0.87	0.38
PR - Tributary I	4650	100 YR	93.32	5433.21	5433.80	5433.77	5433.96	0.015760	3.20	29.13	71.50	0.88	0.40
PR - Tributary I	4600	100 YR	93.32	5432.45	5433.08		5433.23	0.013349	3.11	29.96	67.70	0.83	0.37
PR - Tributary I	4550	100 YR	93.32	5431.45	5432.18	5432.18	5432.40	0.020558	3.73	25.02	59.64	1.02	0.54
PR - Tributary I	4500	100 YR	93.32	5430.22	5431.69	5431.43	5431.76	0.004736	2.22	42.10	72.75	0.51	0.17
PR - Tributary I	4450	100 YR	93.32	5430.61	5431.13	5431.13	5431.30	0.022326	3.28	28.42	87.26	1.01	0.45
PR - Tributary I	4400	100 YR	93.32	5428.99	5429.61	5429.70	5429.89	0.035621	4.31	21.63	62.60	1.29	0.77
PR - Tributary I	4350	100 YR	93.32	5427.82	5428.57	5428.57	5428.76	0.020954	3.52	26.54	70.12	1.01	0.49
PR - Tributary I	4300	100 YR	93.32	5426.83	5427.54	5427.49	5427.69	0.014905	3.10	30.06	74.16	0.86	0.38
PR - Tributary I	4250	100 YR	93.32	5426.04	5426.64	5426.63	5426.81	0.020936	3.28	28.43	83.27	0.99	0.45
PR - Tributary I	4200	100 YR	93.32	5425.05	5425.69	5425.66	5425.84	0.017640	3.14	29.76	82.07	0.92	0.40
PR - Tributary I	4150	100 YR	93.32	5424.36	5424.92		5425.04	0.014454	2.82	33.05	91.87	0.83	0.32
PR - Tributary I	4100	100 YR	93.32	5423.72	5424.19	5424.15	5424.31	0.014913	2.72	34.35	103.54	0.83	0.31
PR - Tributary I	4050	100 YR	93.32	5422.79	5423.46	5423.41	5423.58	0.014458	2.72	34.25	100.47	0.82	0.31
PR - Tributary I	4000	100 YR	93.32	5422.19	5422.78		5422.91	0.012514	2.83	32.93	81.68	0.79	0.31
PR - Tributary I	3950	100 YR	93.32	5421.55	5422.19	5422.12	5422.30	0.011413	2.65	35.26	90.45	0.75	0.28
PR - Tributary I	3900	100 YR	93.32	5420.99	5421.55		5421.67	0.013794	2.79	33.43	91.30	0.81	0.32
PR - Tributary I	3850	100 YR	93.32	5420.41	5421.09		5421.16	0.007196	2.17	43.09	105.66	0.60	0.18
PR - Tributary I	3800	100 YR	93.32	5419.89	5420.45	5420.44	5420.58	0.021839	2.92	31.91	114.70	0.98	0.38
PR - Tributary I	3750	100 YR	93.32	5418.86	5419.62	5419.56	5419.73	0.013687	2.70	34.58	98.74	0.80	0.30
PR - Tributary I	3700	100 YR	93.32	5417.97	5418.69	5418.69	5418.84	0.024314	3.06	30.45	110.57	1.03	0.42
PR - Tributary I	3650	100 YR	93.32	5416.98	5417.45	5417.45	5417.59	0.025619	3.05	30.57	116.10	1.05	0.42
PR - Tributary I	3600	100 YR	93.32	5415.58	5416.09	5416.11	5416.28	0.027003	3.46	26.98	88.43	1.10	0.51
PR - Tributary I	3550	100 YR	93.32	5414.55	5415.14	5415.11	5415.29	0.016273	3.10	30.08	79.34	0.89	0.39
PR - Tributary I	3500	100 YR	93.32	5413.71	5414.18	5414.18	5414.35	0.021580	3.30	28.31	84.25	1.00	0.45
PR - Tributary I	3450	100 YR	93.32	5412.64	5413.39	5413.20	5413.46	0.005176	2.08	44.92	91.57	0.52	0.16
PR - Tributary I	3400	100 YR	197.43	5411.88	5412.62	5412.62	5412.88	0.018885	4.08	48.34	94.36	1.01	0.60
PR - Tributary I	3350	100 YR	197.43	5411.24	5412.35	5411.95	5412.43	0.003141	2.23	88.46	111.35	0.44	0.16
PR - Tributary I	3300	100 YR	197.43	5410.87	5412.28		5412.32	0.001341	1.58	124.69	138.76	0.29	0.08
PR - Tributary I	3250	100 YR	197.43	5409.78	5412.15		5412.20	0.004582	1.84	107.16	187.97	0.43	0.16
PR - Tributary I	3232.13	100 YR	197.43	5409.65	5411.66	5411.66	5412.01	0.023479	4.78	41.32	58.65	1.00	1.02
PR - Tributary I	3205.03	100 YR	197.43	5405.01	5405.96	5406.90	5410.14	0.249318	16.41	12.03	15.62	3.30	11.76
PR - Tributary I	3181.99	100 YR	197.43	5404.79	5406.39	5406.67	5407.47	0.036004	8.37	23.60	19.58	1.34	2.64
PR - Tributary I	3140.22	100 YR	197.43	5399.18	5400.47	5401.51	5404.45	0.154352	16.00	12.34	10.07	2.55	10.04
PR - Tributary I	3140		Culvert										
PR - Tributary I	2909.93	100 YR	197.43	5398.72	5401.05	5401.05	5401.76	0.023547	6.76	29.19	21.13	1.01	1.72
PR - Tributary I	2850	100 YR	197.43	5398.60	5401.01		5401.27	0.007099	4.65	51.93	55.96	0.63	0.73
PR - Tributary I	2800	100 YR	197.43	5398.50	5400.91		5401.00	0.002881	3.25	83.67	92.43	0.41	0.34
PR - Tributary I	2750	100 YR	197.43	5398.40	5400.80		5400.87	0.002342	2.70	97.85	116.61	0.36	0.24
PR - Tributary I	2700	100 YR	197.43	5398.30	5400.67		5400.74	0.002545	3.01	94.54	115.01	0.38	0.29
PR - Tributary I	2650	100 YR	197.43	5398.20	5400.52	5400.13	5400.61	0.002980	3.21	89.08	111.74	0.41	0.34
PR - Tributary I	2600	100 YR	197.43	5398.10	5400.03	5400.03	5400.31	0.013897	5.31	50.15	85.35	0.84	1.05
PR - Tributary I	2550	100 YR	197.43	5396.43	5398.45	5397.66	5398.49	0.001001	1.54	128.38	119.71	0.26	0.07
PR - Tributary I	2500	100 YR	197.43	5394.51	5398.47		5398.48	0.000030	0.45	438.52	185.09	0.05	0.00
PR - Tributary I	2450	100 YR	197.43	5394.37	5398.47		5398.47	0.000008	0.27	719.42	233.78	0.03	0.00
PR - Tributary I	2400	100 YR	197.43	5394.18	5398.47		5398.47	0.000007	0.26	770.04	265.47	0.03	0.00
PR - Tributary I	2350	100 YR	197.43	5394.18	5398.47		5398.47	0.000005	0.23	855.27	256.07	0.02	0.00
PR - Tributary I	2300	100 YR	197.43	5394.18	5398.47		5398.47	0.000004	0.22	887.93	255.74	0.02	0.00
PR - Tributary I	2218.78	100 YR	197.43	5397.49	5398.23	5398.23	5398.45	0.027940	3.79	52.15	120.66	1.02	0.75
PR - Tributary I	2198.89	100 YR	197.43	5392.12	5393.48	5393.93	5396.87	0.258973	17.70	16.76	62.37	3.37	13.30
PR - Tributary I	2150	100 YR	197.43	5391.10	5392.88	5393.00	5393.32	0.023009	7.14	42.39	86.14	1.08	1.86
PR - Tributary I	2100	100 YR	197.43	5390.07	5391.94	5392.00	5392.29	0.017697	6.52	47.28	92.73	0.96	1.52
PR - Tributary I	2050	100 YR	197.43	5389.03	5390.88	5390.99	5391.30	0.021490	7.11	43.02	85.28	1.05	1.82
PR - Tributary I	2000	100 YR	197.43	5388.00	5389.82	5389.92	5390.23	0.021199	6.99	44.21	90.33	1.04	1.76
PR - Tributary I	1950	100 YR	197.43	5386.96	5388.64	5388.77	5389.06	0.025754	7.18	43.81	102.42	1.13	1.93
PR - Tributary I	1900	100 YR	197.43	5385.93	5387.63	5387.69	5387.93	0.018938	6.22	51.09	117.51	0.97	1.44
PR - Tributary I	1850	100 YR	197.43	5384.89	5386.76	5386.79	5387.07	0.015430	6.13	49.48	93.56	0.90	1.34
PR - Tributary I	1800	100 YR	197.43	5383.85	5385.66	5385.78	5386.10	0.024510	7.07	41.75	87.15	1.11	1.86
PR - Tributary I	1750	100 YR	197.43	5382.66	5384.67	5384.73	5384.96	0.019683	5.05	49.31	115.75	0.94	1.06
PR - Tributary I	1700	100 YR	197.43	5381.95	5383.96	5383.96	5384.20	0.015697	4.77	51.60	98.94	0.85	0.92
PR - Tributary I	1650	100 YR	197.43	5381.09	5383.23	5383.16	5383.43	0.009698	4.43	59.00	99.56	0.70	0.73
PR - Tributary I	1600	100 YR	197.43	5380.66	5382.54	5382.51	5382.83	0.014809	4.48	46.76	74.83	0.82	0.83
PR - Tributary I	1550	100 YR	197.43	5379.85	5381.81	5381.81	5382.09	0.014672	5.71	49.53	85.94	0.85	1.19

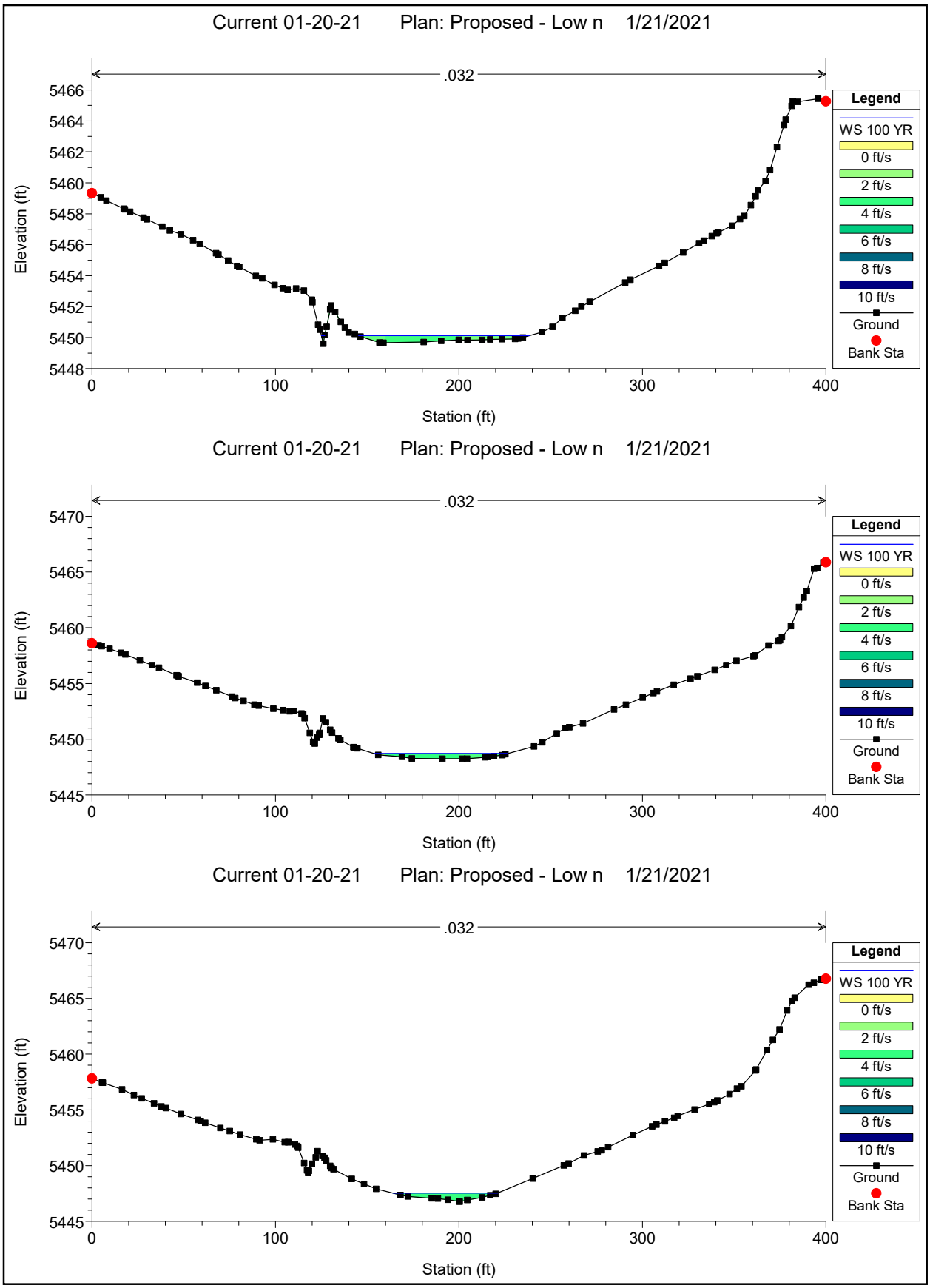
HEC-RAS Plan: PR-Low-n River: Tributary - I Reach: PR - Tributary I Profile: 100 YR (Continued)

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	Shear Chan
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
PR - Tributary I	1500	100 YR	197.43	5379.19	5381.34	5381.07	5381.47	0.004598	3.66	71.74	88.65	0.50	0.46
PR - Tributary I	1450	100 YR	197.43	5378.72	5380.78	5380.78	5381.08	0.013580	5.22	47.63	76.67	0.83	1.02
PR - Tributary I	1400	100 YR	197.43	5377.93	5380.72	5379.92	5380.75	0.000895	1.67	140.57	136.35	0.22	0.09
PR - Tributary I	1350	100 YR	412.82	5377.94	5380.30		5380.57	0.008567	5.66	107.42	139.78	0.71	1.03
PR - Tributary I	1300	100 YR	412.82	5377.44	5379.78	5379.71	5380.10	0.010089	6.09	96.94	115.35	0.77	1.19
PR - Tributary I	1250	100 YR	412.82	5376.94	5379.29		5379.60	0.009800	6.02	98.02	115.98	0.76	1.16
PR - Tributary I	1200	100 YR	412.82	5376.44	5378.76	5378.71	5379.09	0.010632	6.20	95.25	114.93	0.79	1.24
PR - Tributary I	1150	100 YR	412.82	5375.94	5378.39		5378.63	0.007103	5.30	111.04	123.83	0.65	0.89
PR - Tributary I	1100	100 YR	412.82	5375.44	5378.29		5378.40	0.002440	3.51	165.98	149.88	0.39	0.37
PR - Tributary I	1050	100 YR	412.82	5374.94	5378.27		5378.32	0.000801	2.26	248.47	177.66	0.23	0.14
PR - Tributary I	1000	100 YR	412.82	5374.44	5378.26		5378.29	0.000342	1.64	336.92	199.31	0.16	0.07
PR - Tributary I	950	100 YR	412.82	5373.93	5378.25		5378.27	0.000245	1.52	385.55	218.87	0.14	0.06
PR - Tributary I	900	100 YR	412.82	5373.44	5378.24		5378.26	0.000224	1.57	378.59	196.37	0.13	0.06
PR - Tributary I	838.96	100 YR	412.82	5372.83	5377.87	5375.97	5378.19	0.003252	4.58	90.19	22.13	0.40	0.59
PR - Tributary I	838.25		Culvert										
PR - Tributary I	598.1	100 YR	412.82	5370.41	5373.58	5373.58	5374.71	0.021573	8.51	48.50	21.83	1.01	2.38
PR - Tributary I	550	100 YR	412.82	5369.65	5372.03	5372.44	5373.39	0.033601	11.26	49.08	53.70	1.41	4.05
PR - Tributary I	500	100 YR	412.82	5368.85	5370.85	5371.08	5371.59	0.030975	9.38	69.10	124.34	1.31	3.01
PR - Tributary I	450	100 YR	412.82	5368.05	5370.10	5370.13	5370.48	0.014272	6.63	91.58	132.45	0.90	1.48
PR - Tributary I	400	100 YR	412.82	5367.25	5369.46	5369.47	5369.83	0.012673	6.51	92.44	124.71	0.86	1.40
PR - Tributary I	350	100 YR	412.82	5366.46	5368.66	5368.72	5369.12	0.015788	7.24	82.20	107.98	0.95	1.73
PR - Tributary I	300	100 YR	412.82	5365.67	5368.74	5367.37	5368.77	0.000360	1.42	335.13	214.48	0.15	0.06
PR - Tributary I	250	100 YR	412.82	5364.86	5368.74		5368.75	0.000126	1.01	523.72	298.00	0.10	0.03
PR - Tributary I	194.84	100 YR	412.82	5363.99	5368.41	5366.31	5368.71	0.002559	4.36	94.77	22.50	0.37	0.51
PR - Tributary I	194.59		Culvert										
PR - Tributary I	113.93	100 YR	412.82	5363.86	5366.10	5366.10	5367.21	0.019477	8.44	48.93	22.44	1.01	2.29
PR - Tributary I	101	100 YR	412.82	5363.73	5364.54	5364.93	5366.56	0.170241	11.99	40.79	131.37	2.67	6.67

HEC-RAS Plan: PR-Low-n River: Tributary - I Reach: PR - Tributary I Profile: 100 YR

Reach	River Sta	Profile	E.G. US.	W.S. US.	E.G. IC	E.G. OC	Min El Weir Flow	Q Culv Group	Q Weir	Delta WS	Culv Vel US	Culv Vel DS
			(ft)	(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(ft)	(ft/s)	(ft/s)
PR - Tributary I	3140 West Ped	100 YR					5414.00					
PR - Tributary I	3140 West 10YR	100 YR					5414.00					
PR - Tributary I	838.25 10-YR East	100 YR	5378.19	5377.87	5377.76	5378.20	5387.51	244.31		4.29	9.94	13.85
PR - Tributary I	838.25 West-Ped	100 YR	5378.19	5377.87	5377.78	5378.19	5387.51	168.51		4.29	8.15	11.91
PR - Tributary I	194.59 Double	100 YR	5368.71	5368.41	5368.40	5368.71	5369.61	412.82		2.31	8.08	9.40


Current 01-20-21 Plan: Proposed - Low n 1/21/2021
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 01-20-21 Plan: Proposed - Low n 1/21/2021
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 01-20-21 Plan: Proposed - Low n 1/21/2021
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta


Current 01-20-21 Plan: Proposed - Low n 1/21/2021
.032
Elevation (ft)
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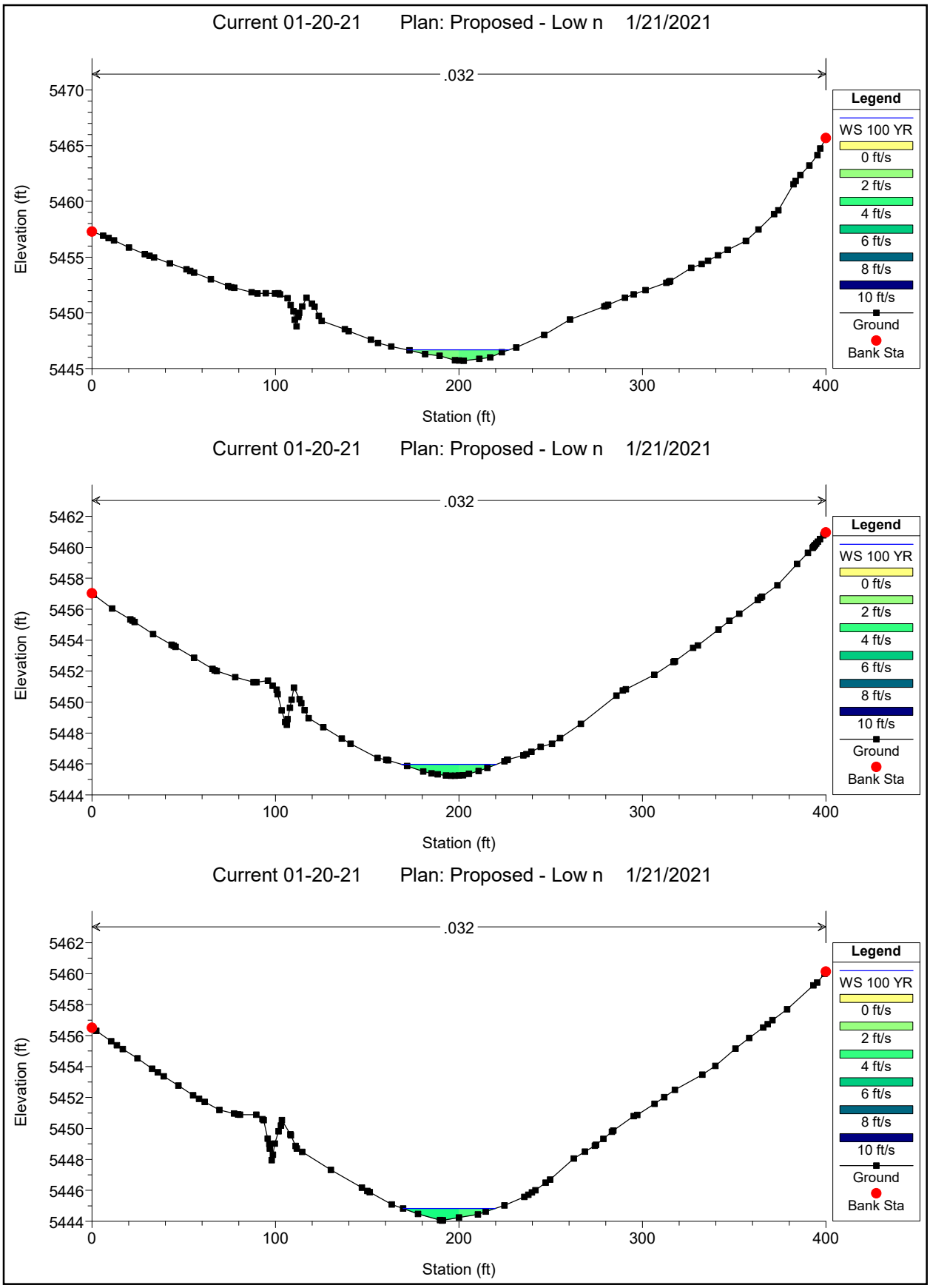
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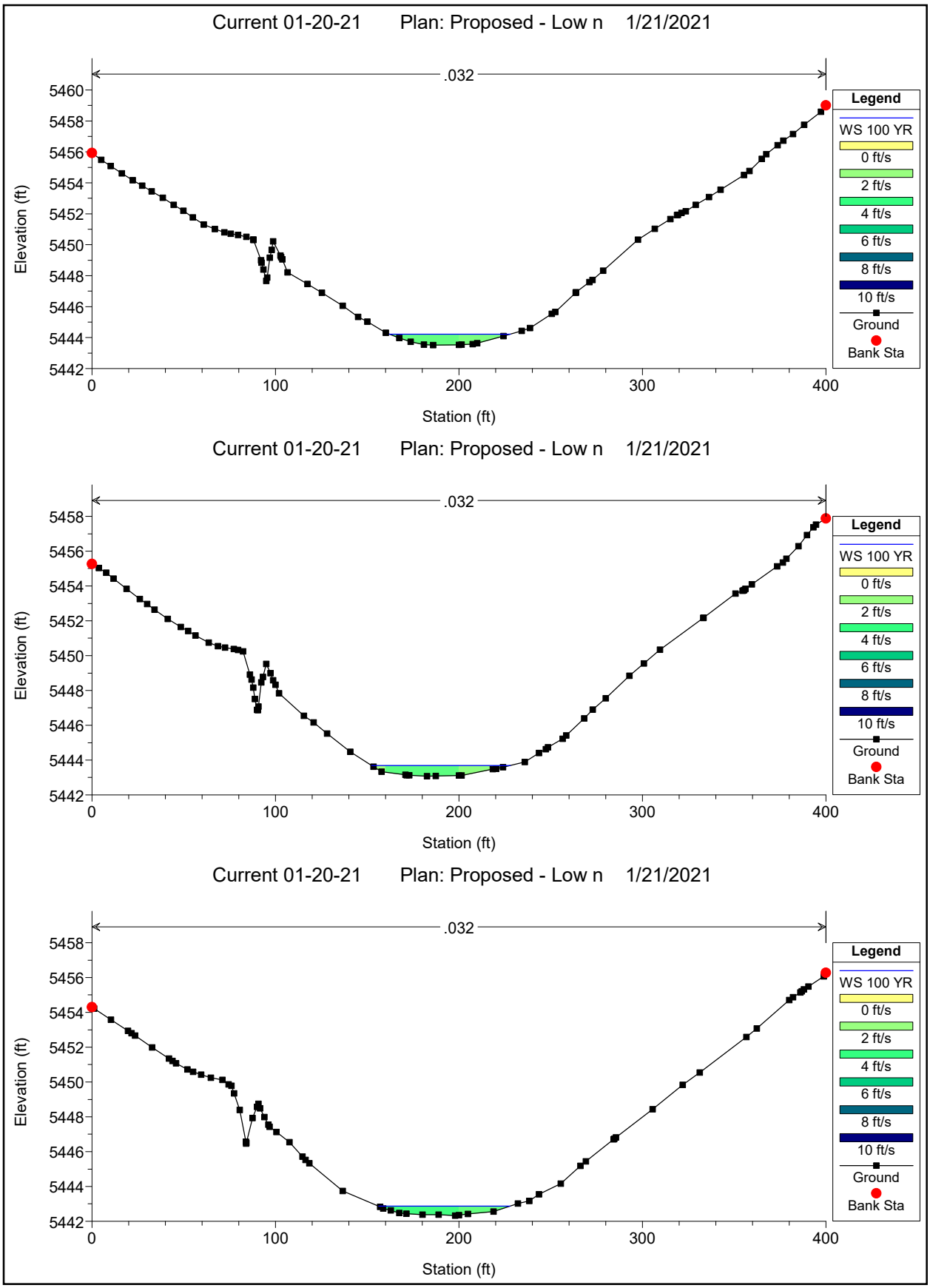
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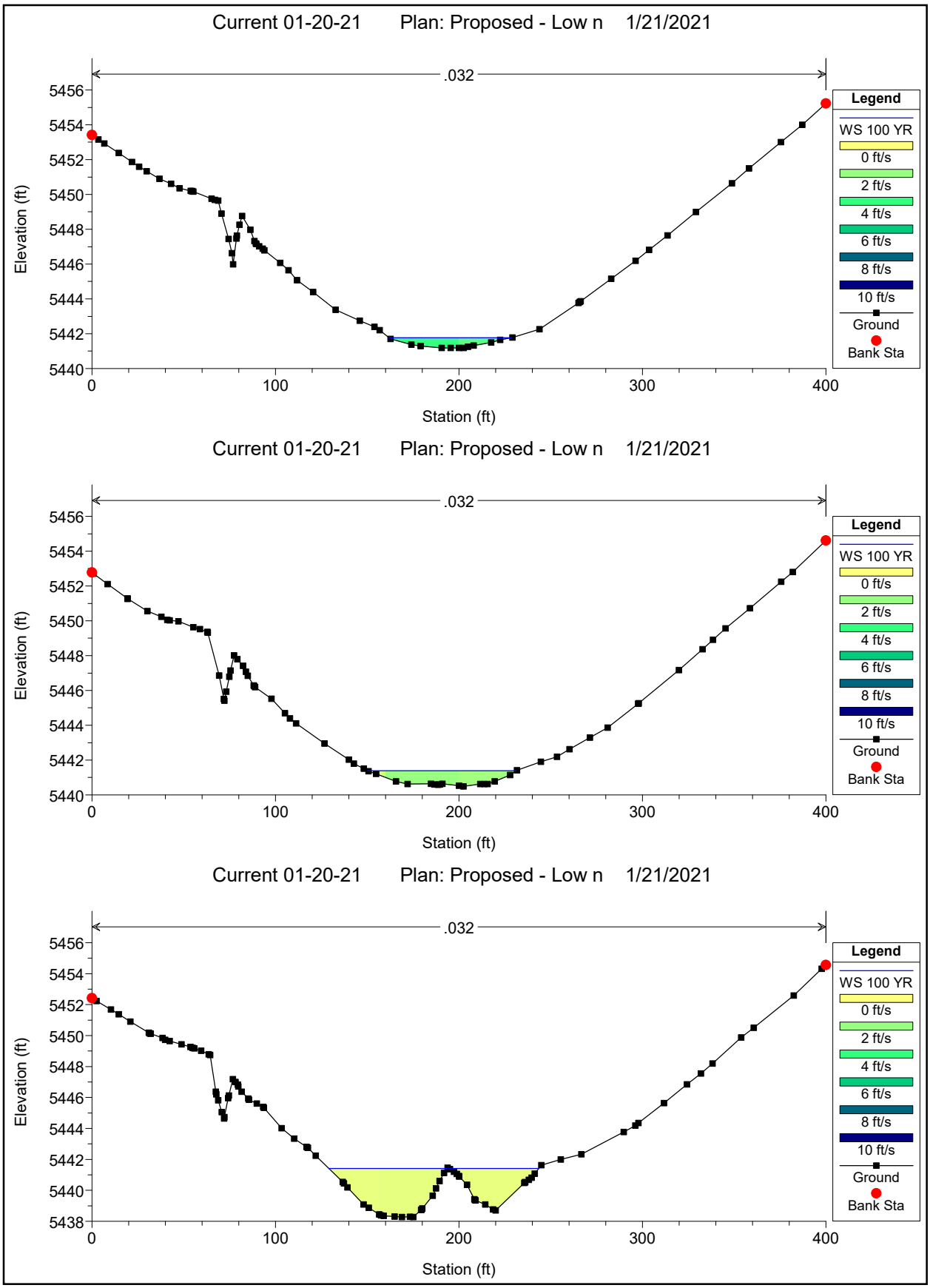
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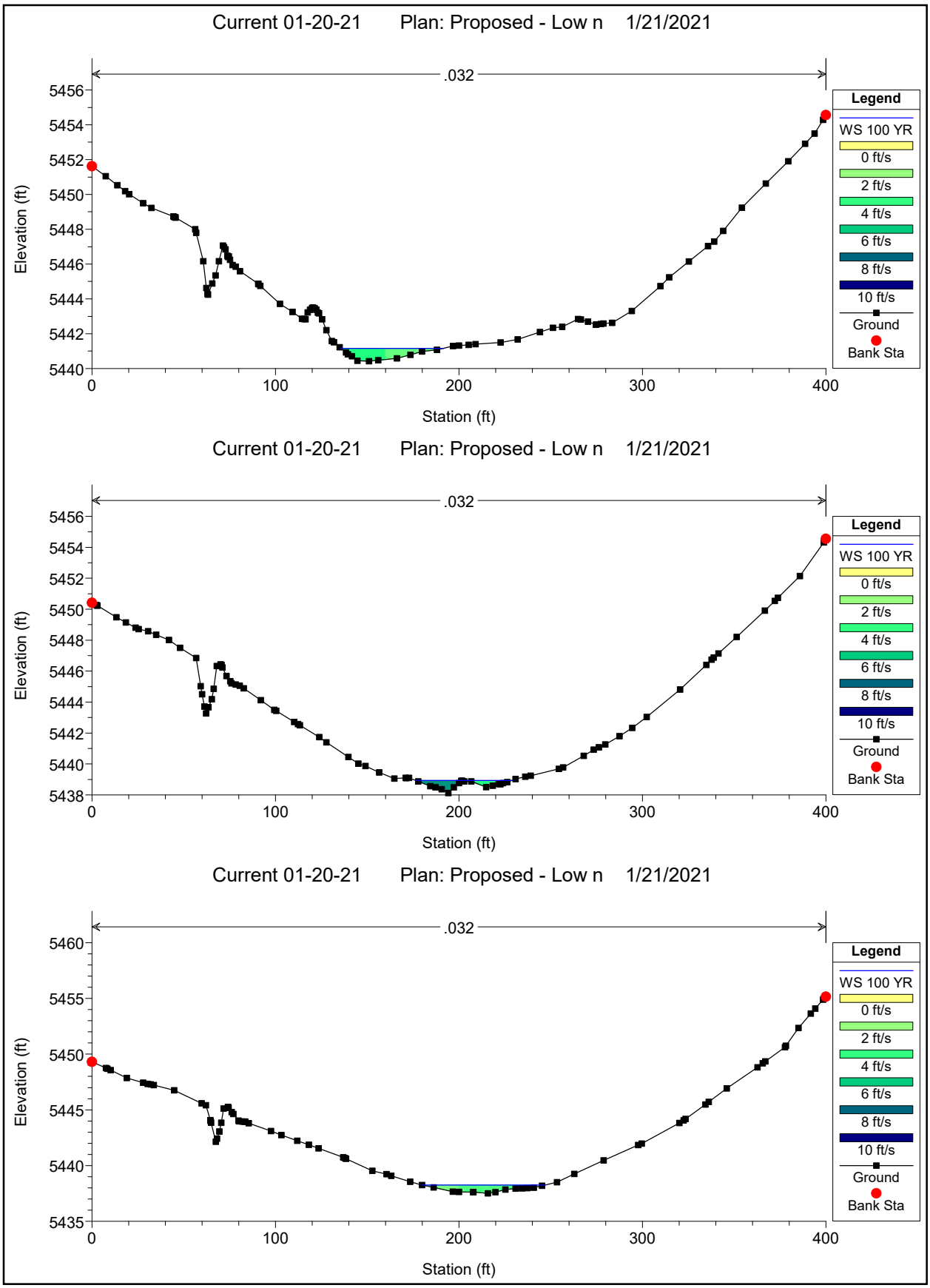
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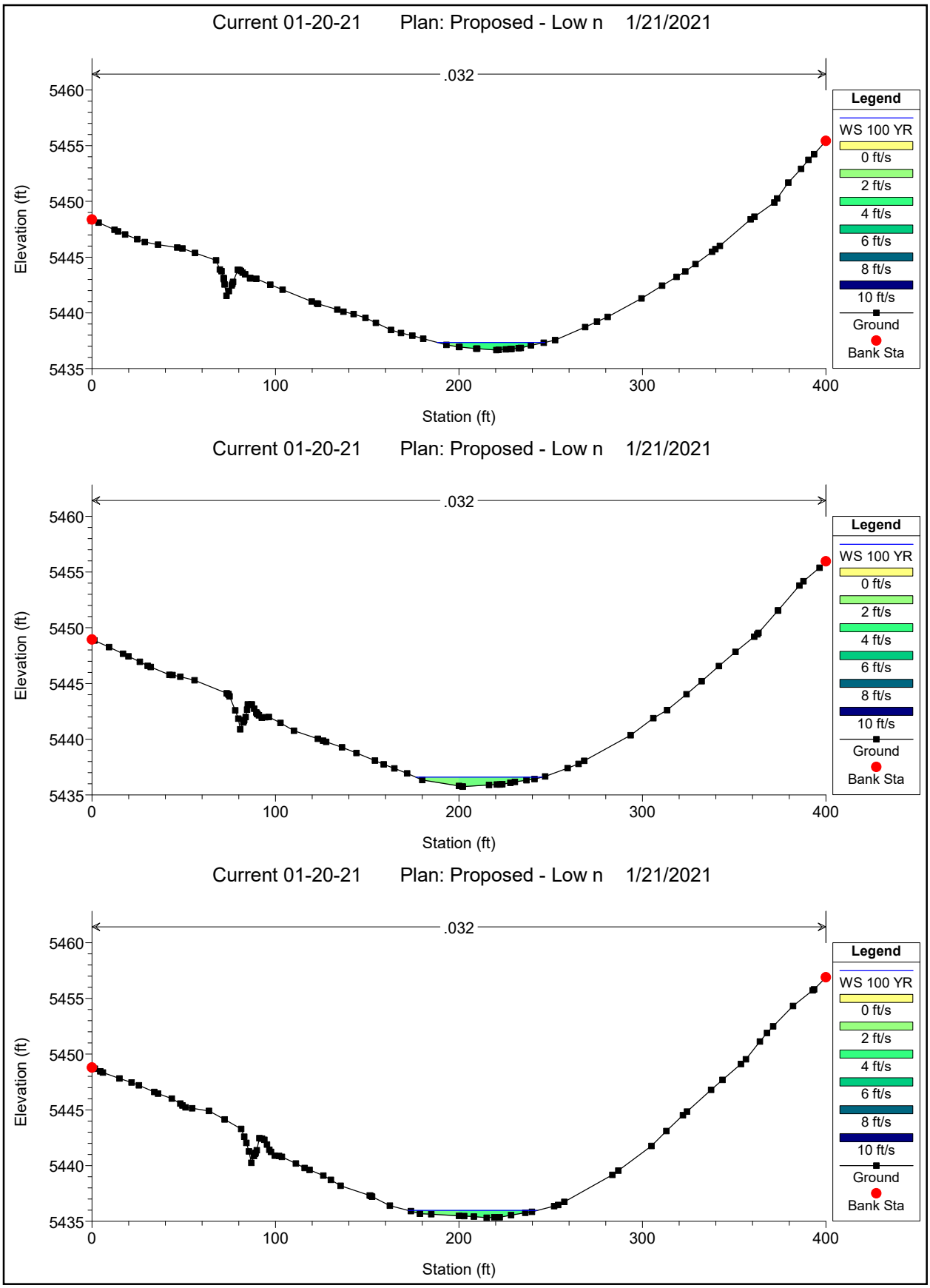
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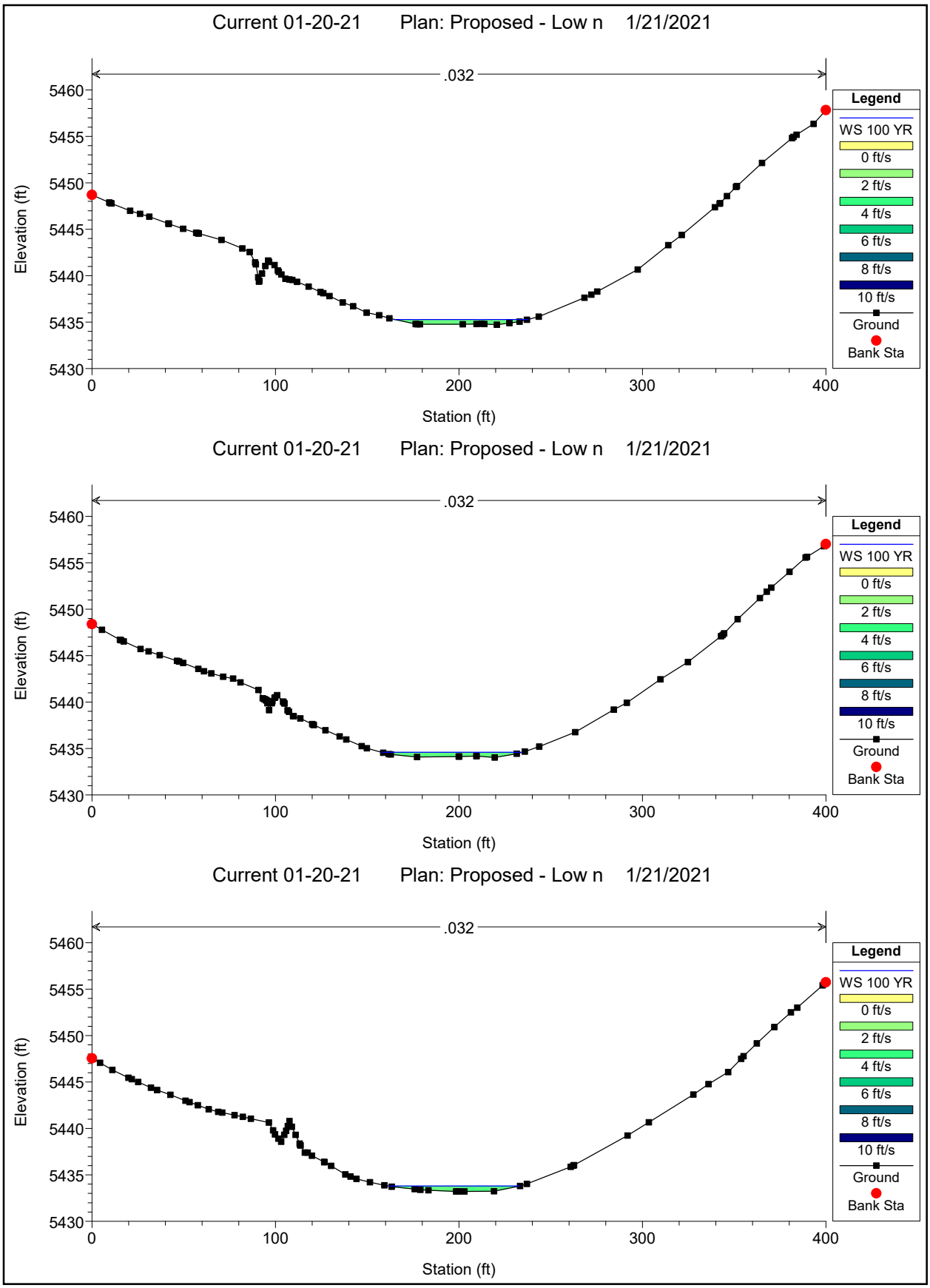
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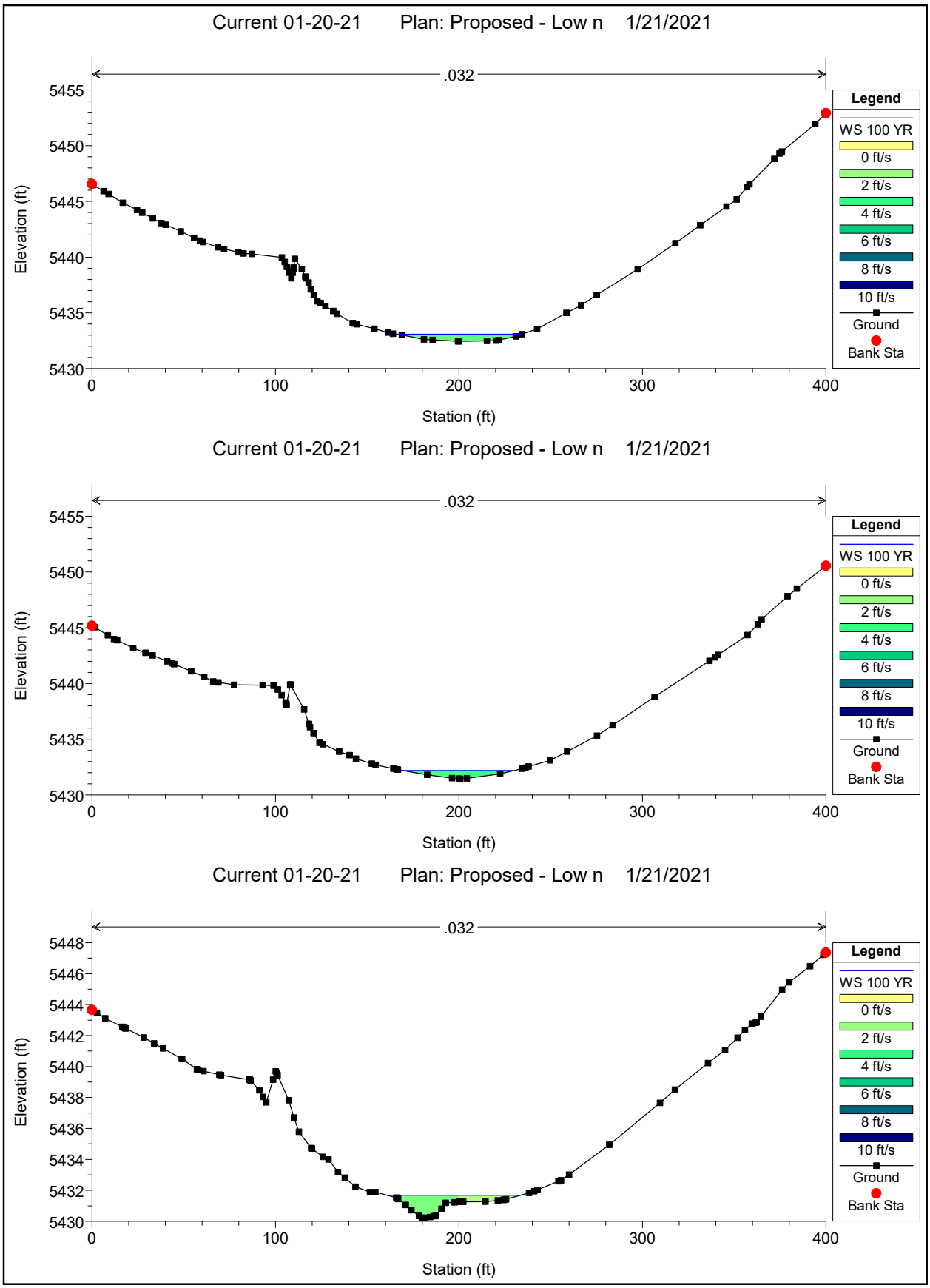
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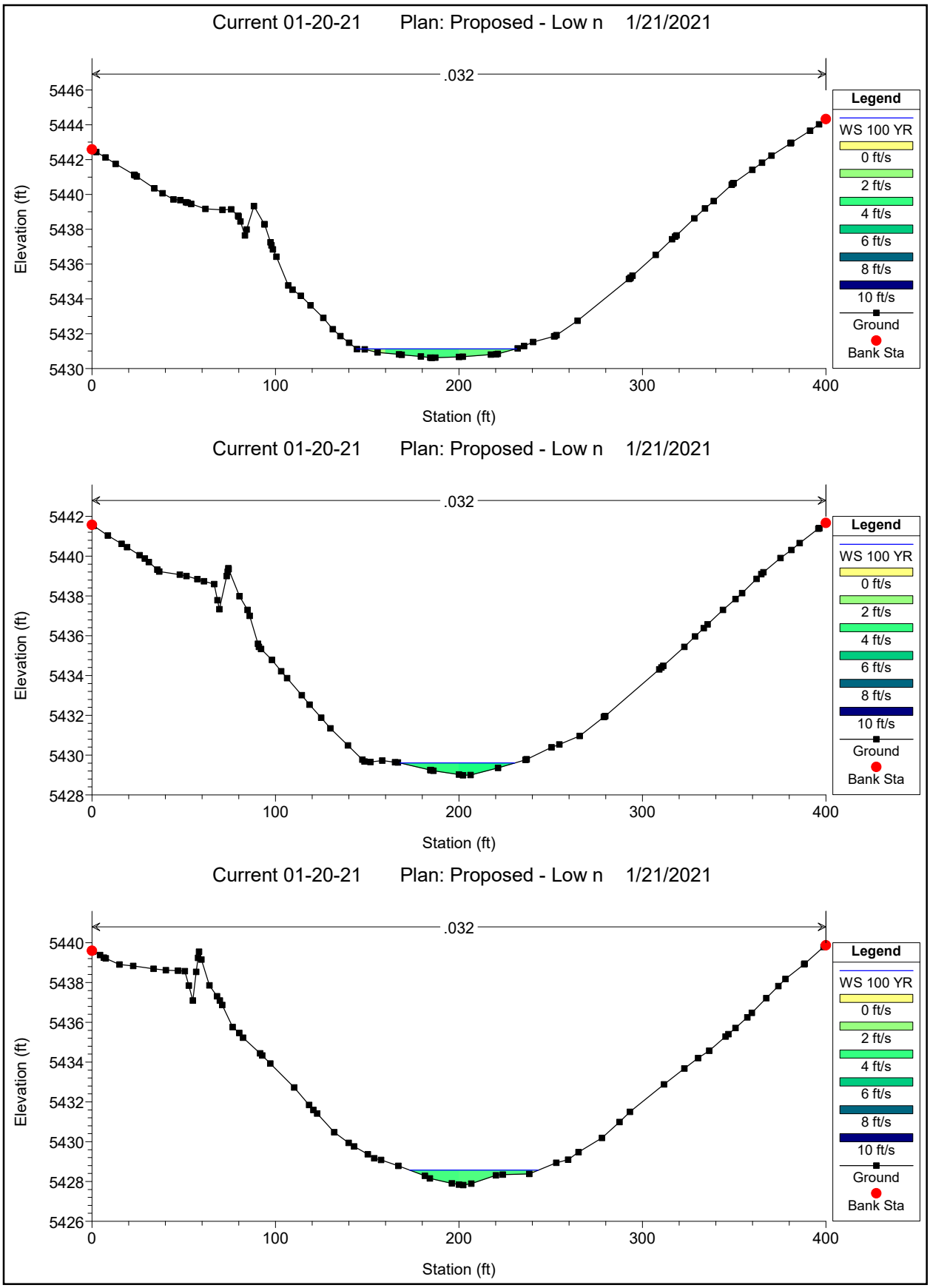
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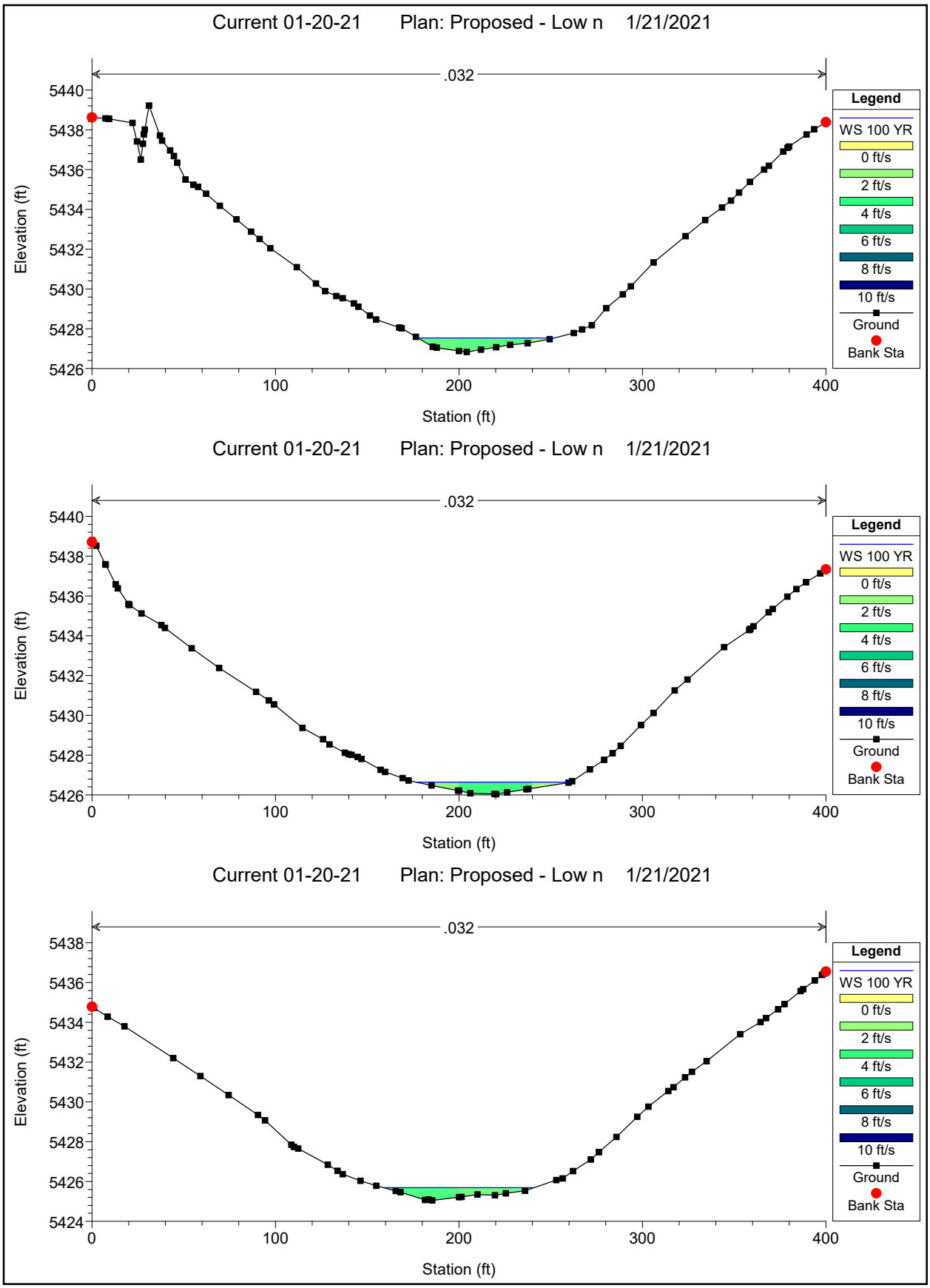
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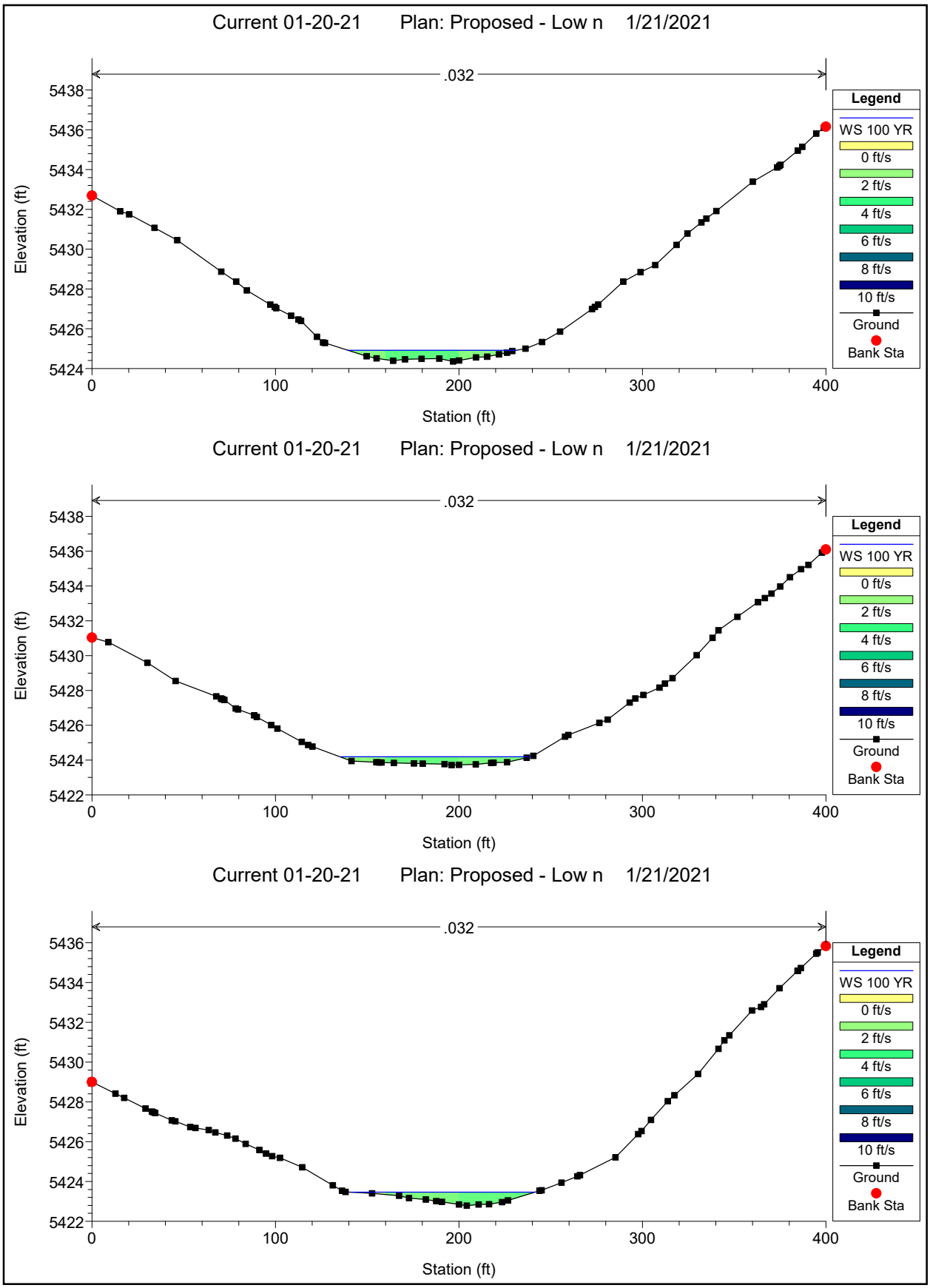
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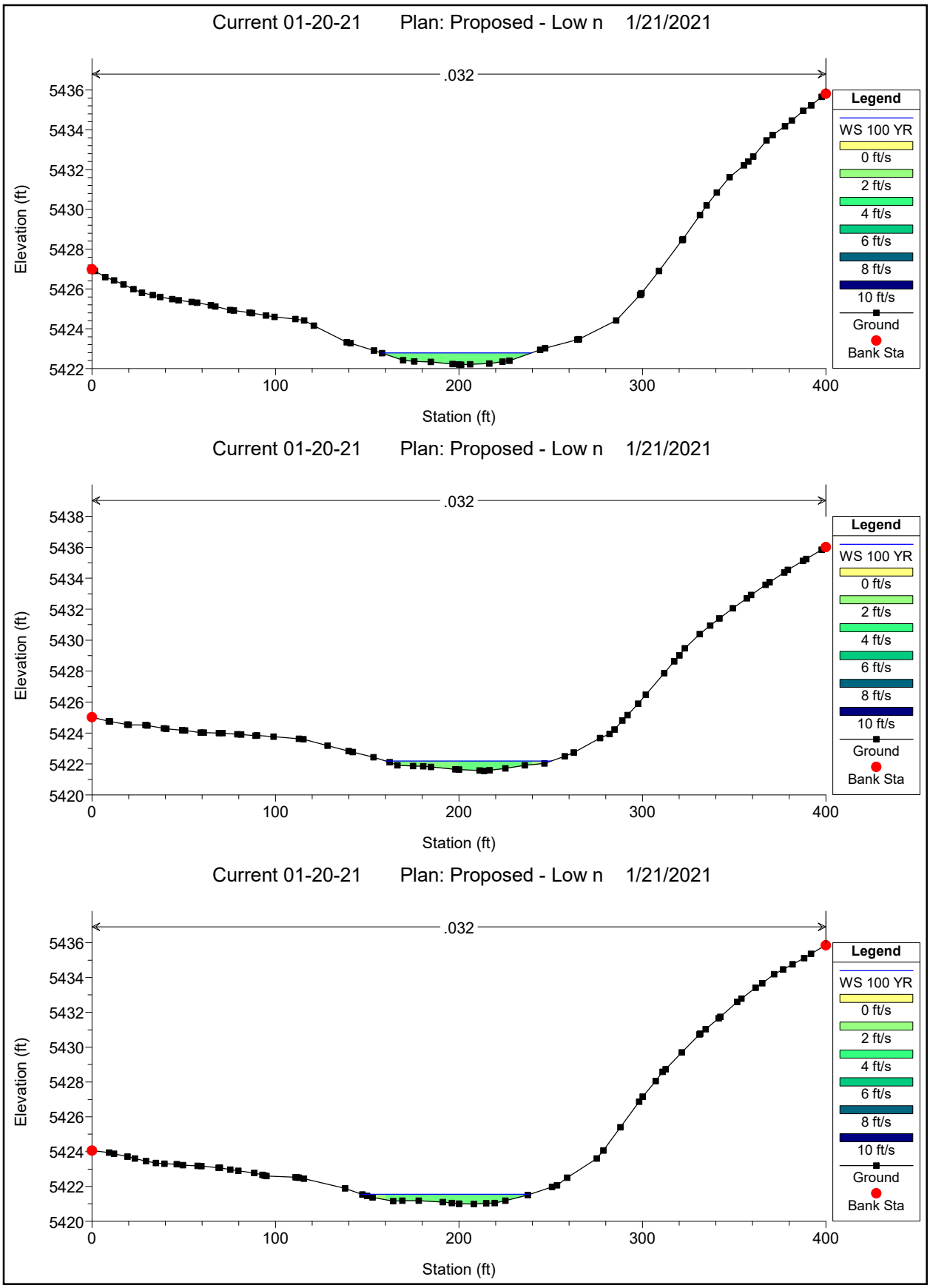
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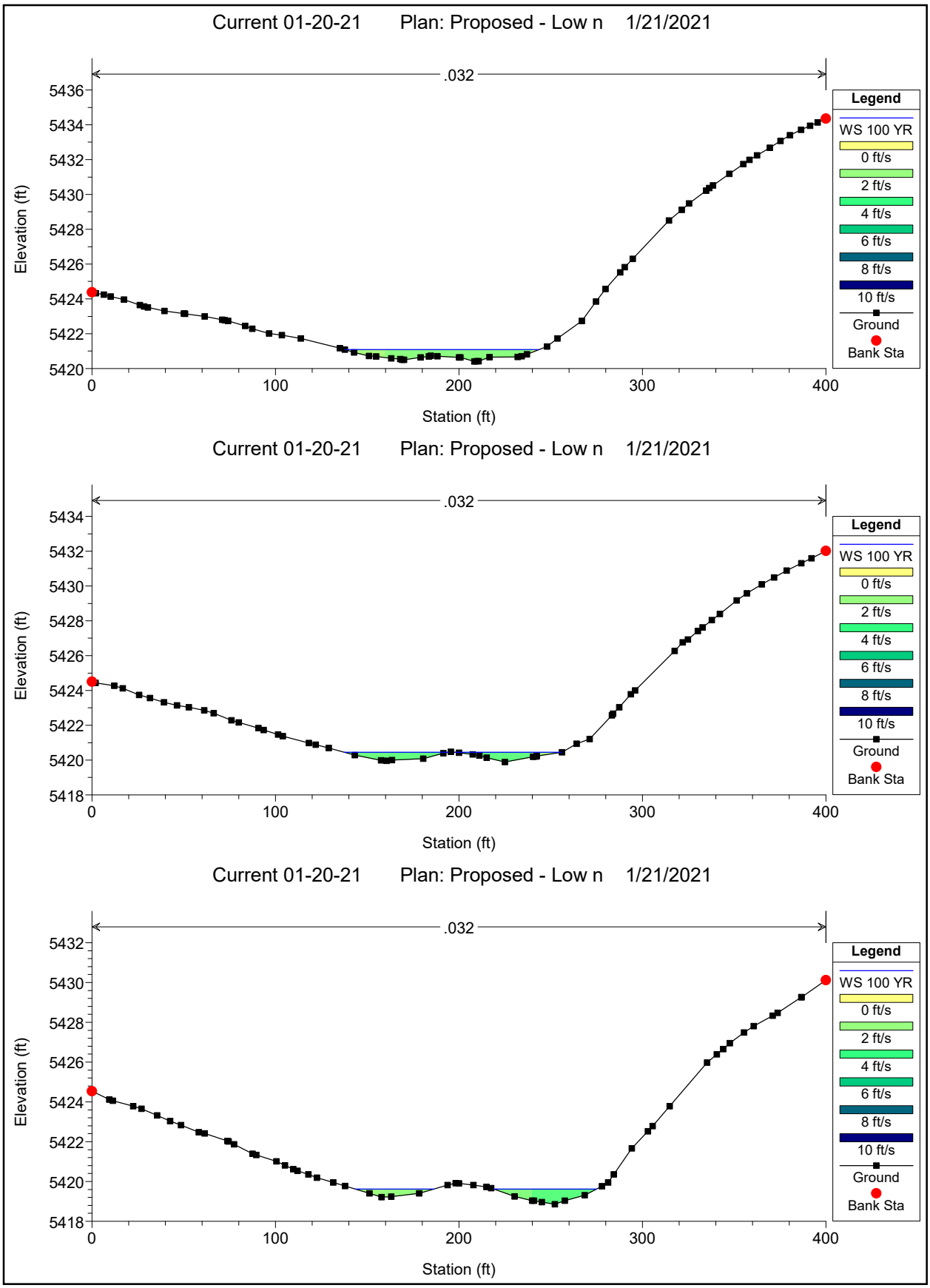
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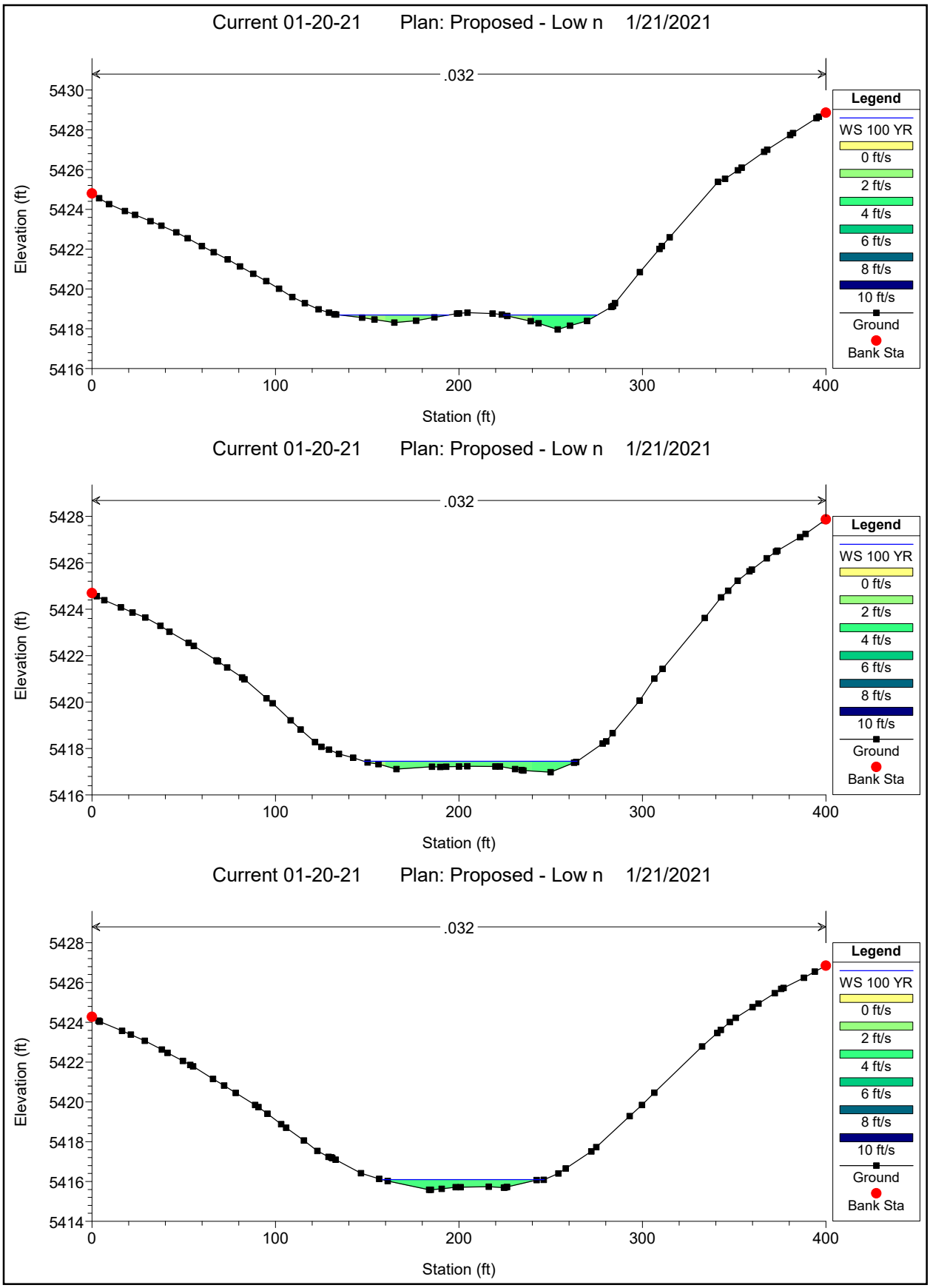
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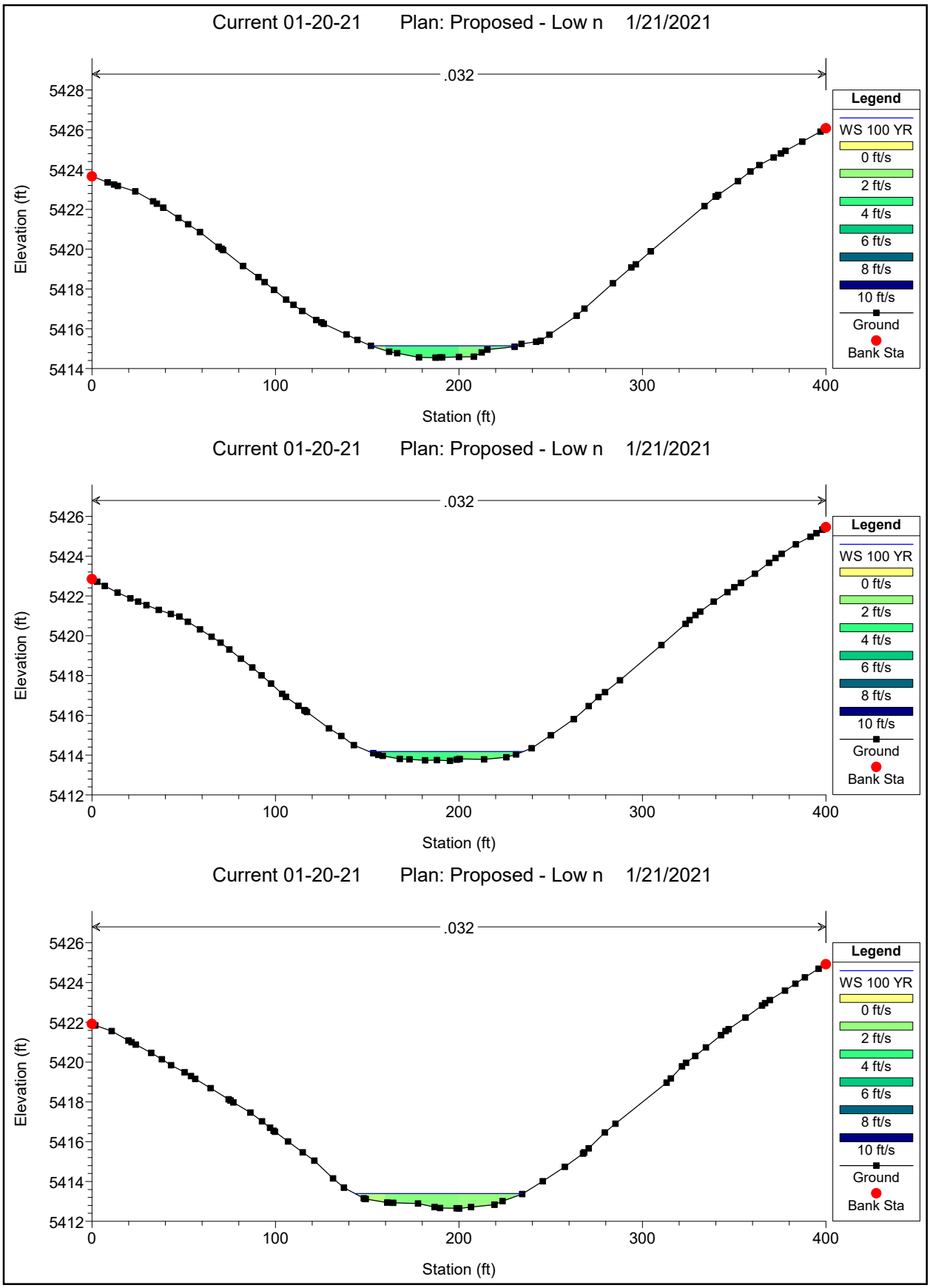
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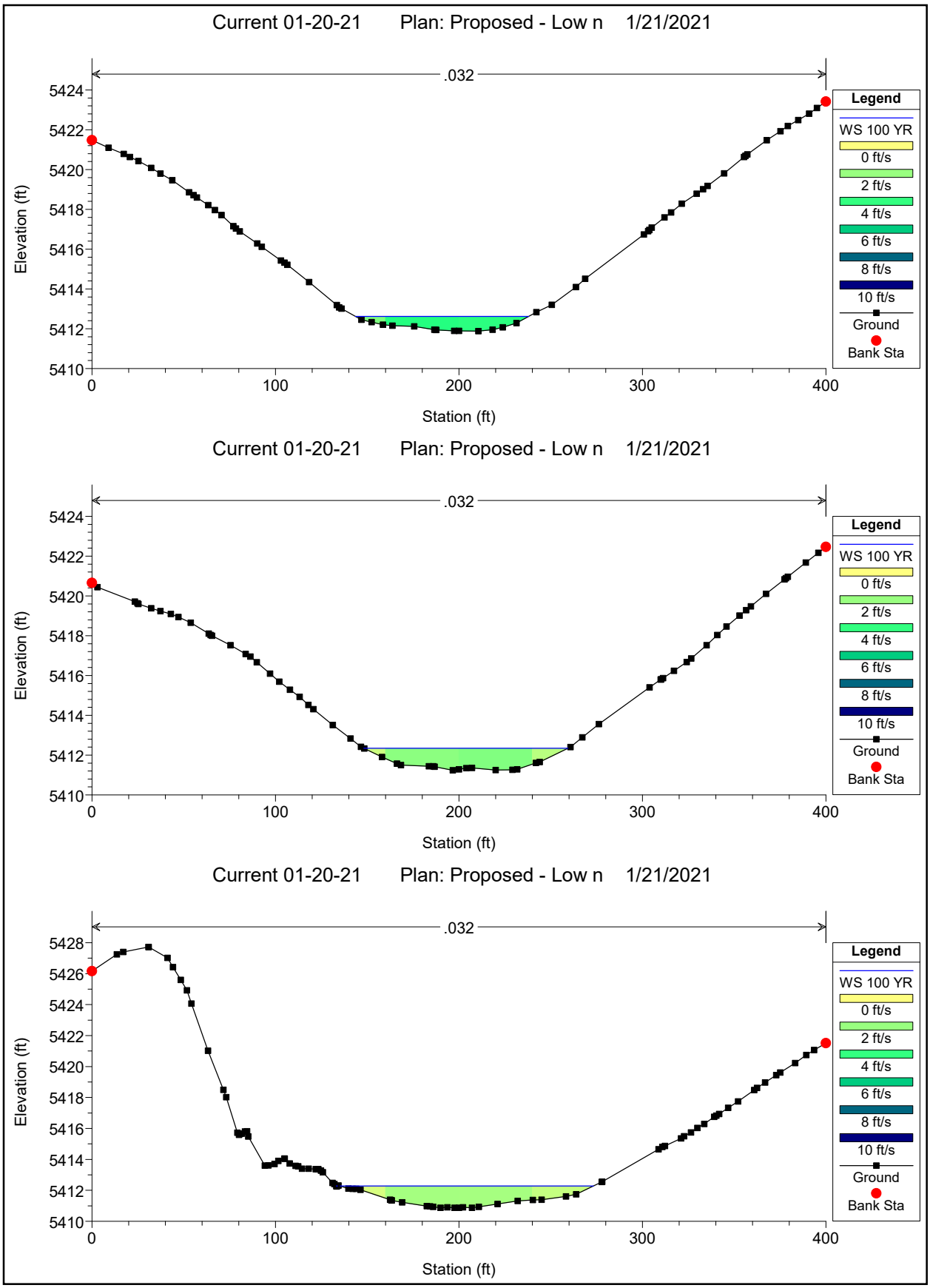
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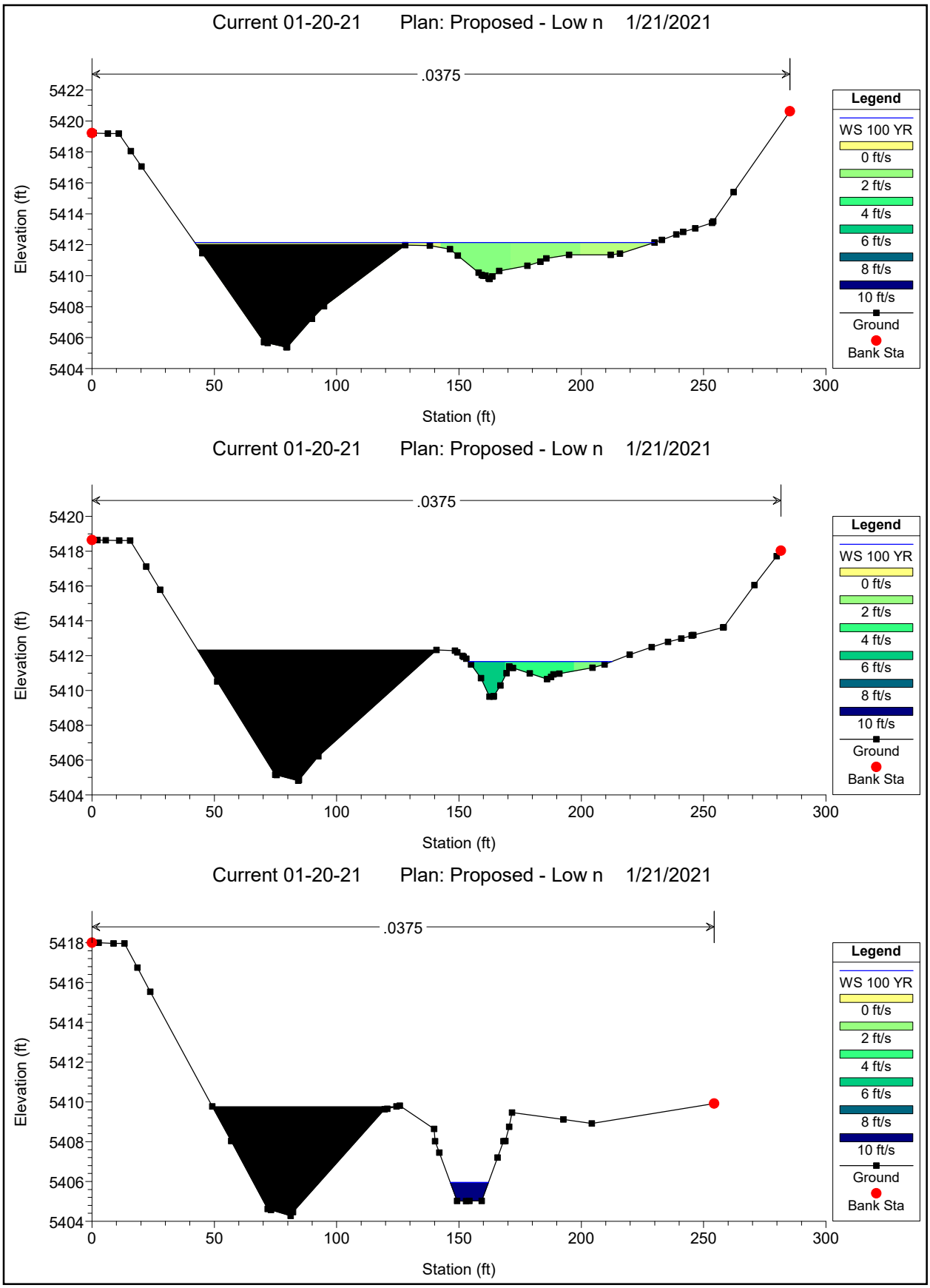
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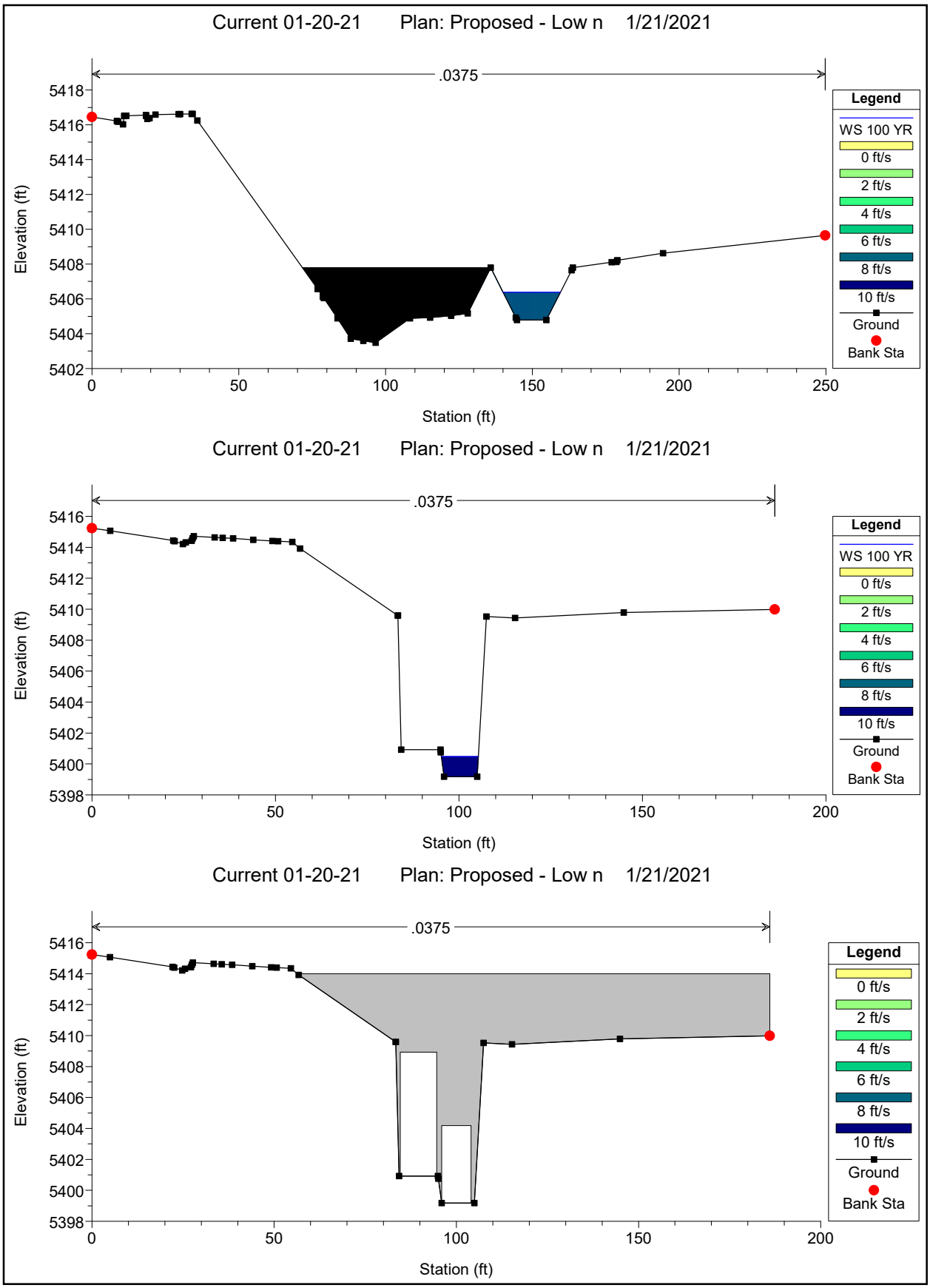
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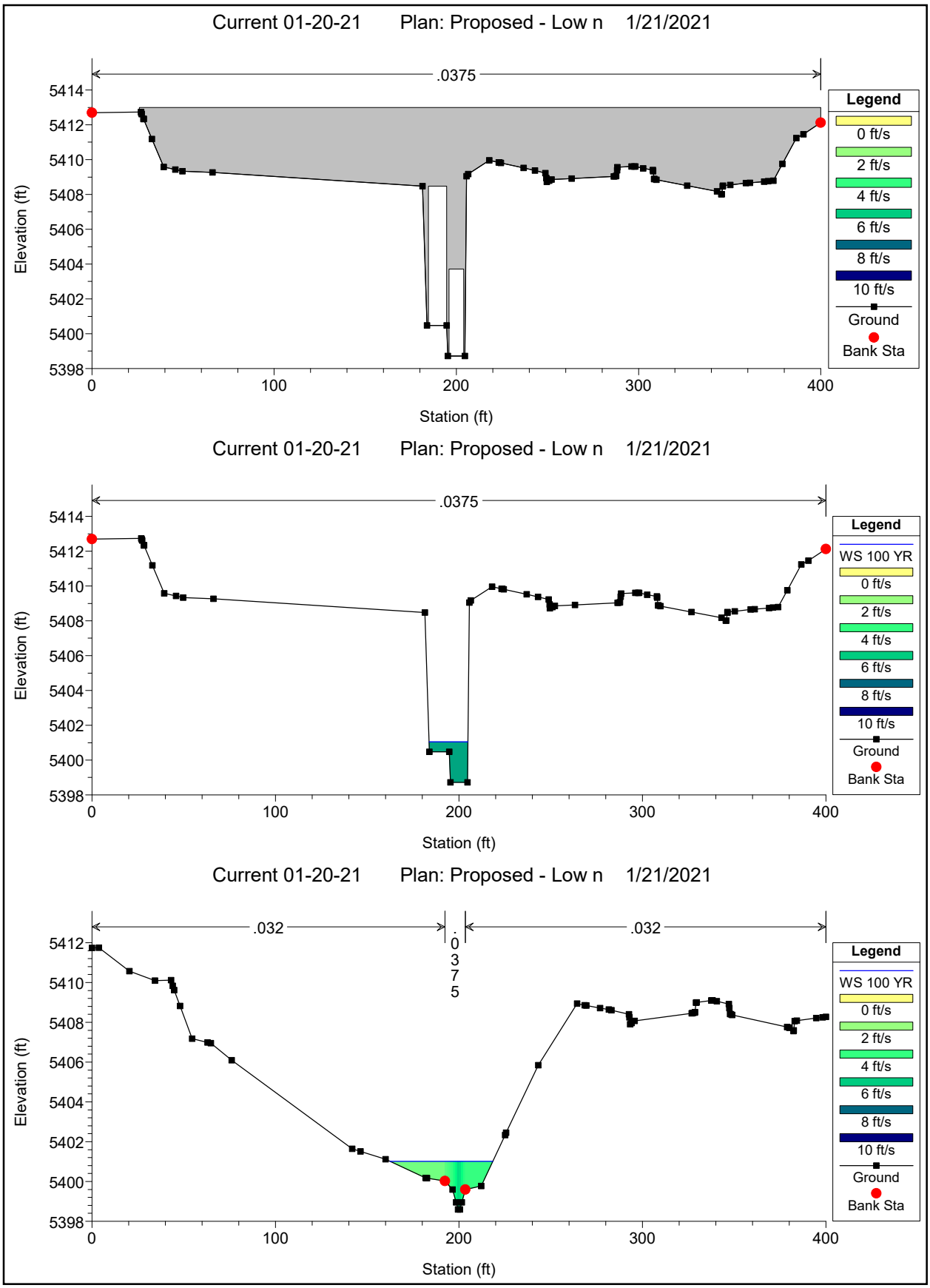
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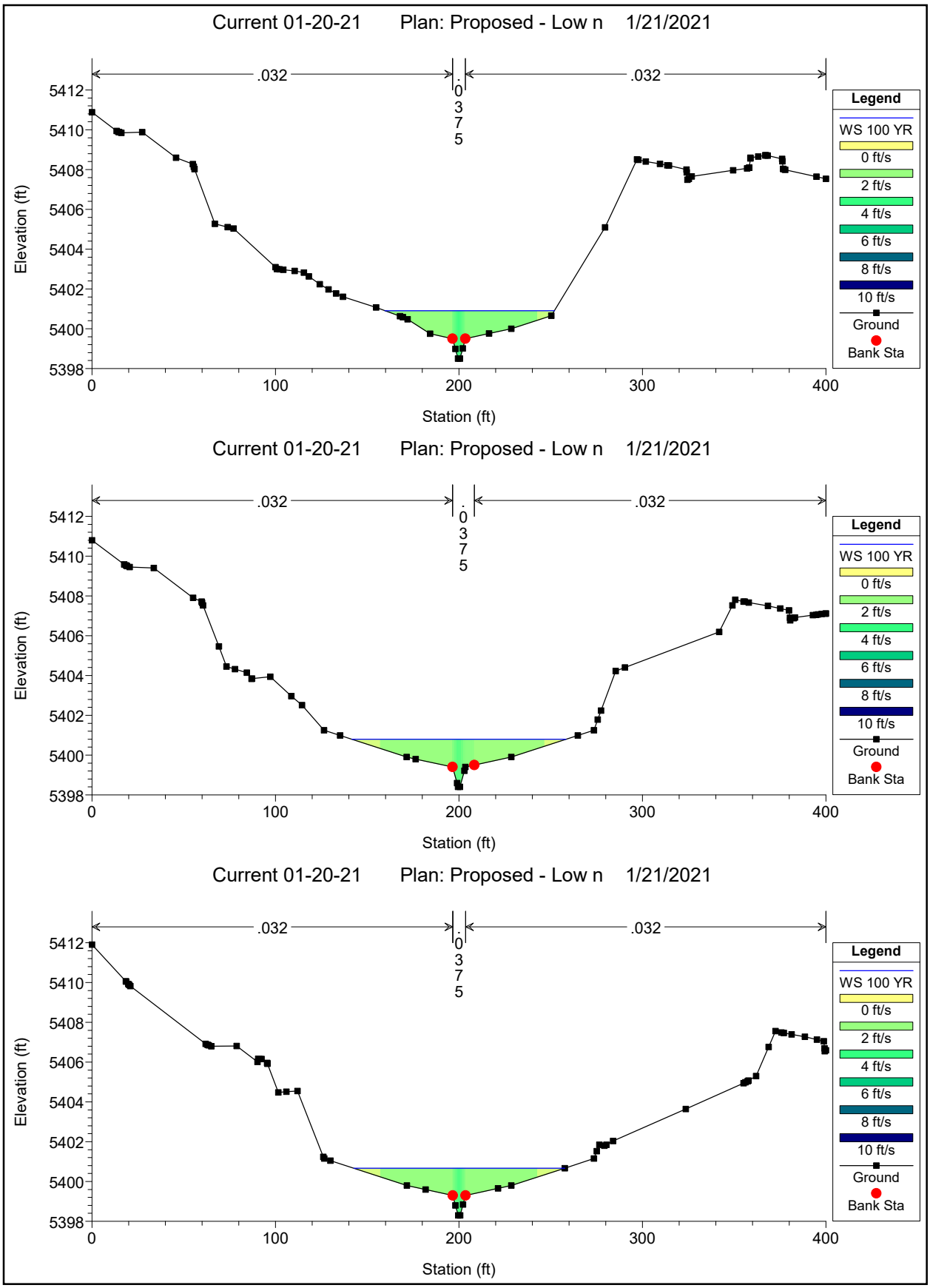
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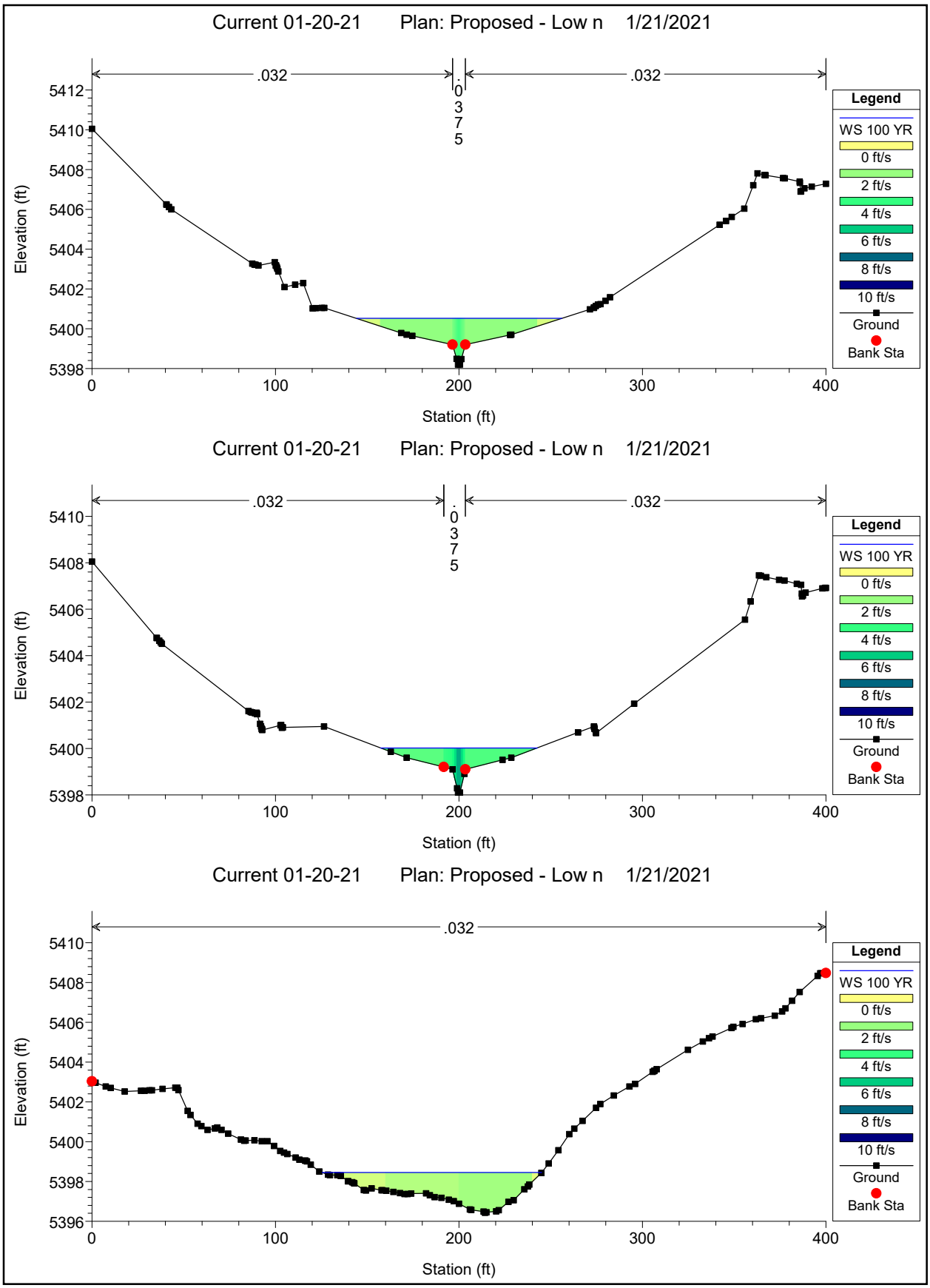
Current 01-20-21 Plan: Proposed - Low n 1/21/2021
.032
.0375
.032
Elevation (ft)
5412
5410
5408
5406
5404
5402
5400
5398
0
100
200
300
400
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta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.032
Elevation (ft)
Station (ft)
Legend
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4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 01-20-21 Plan: Proposed - Low n 1/21/2021
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
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4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 01-20-21 Plan: Proposed - Low n 1/21/2021
.032
Elevation (ft)
Station (ft)
Legend
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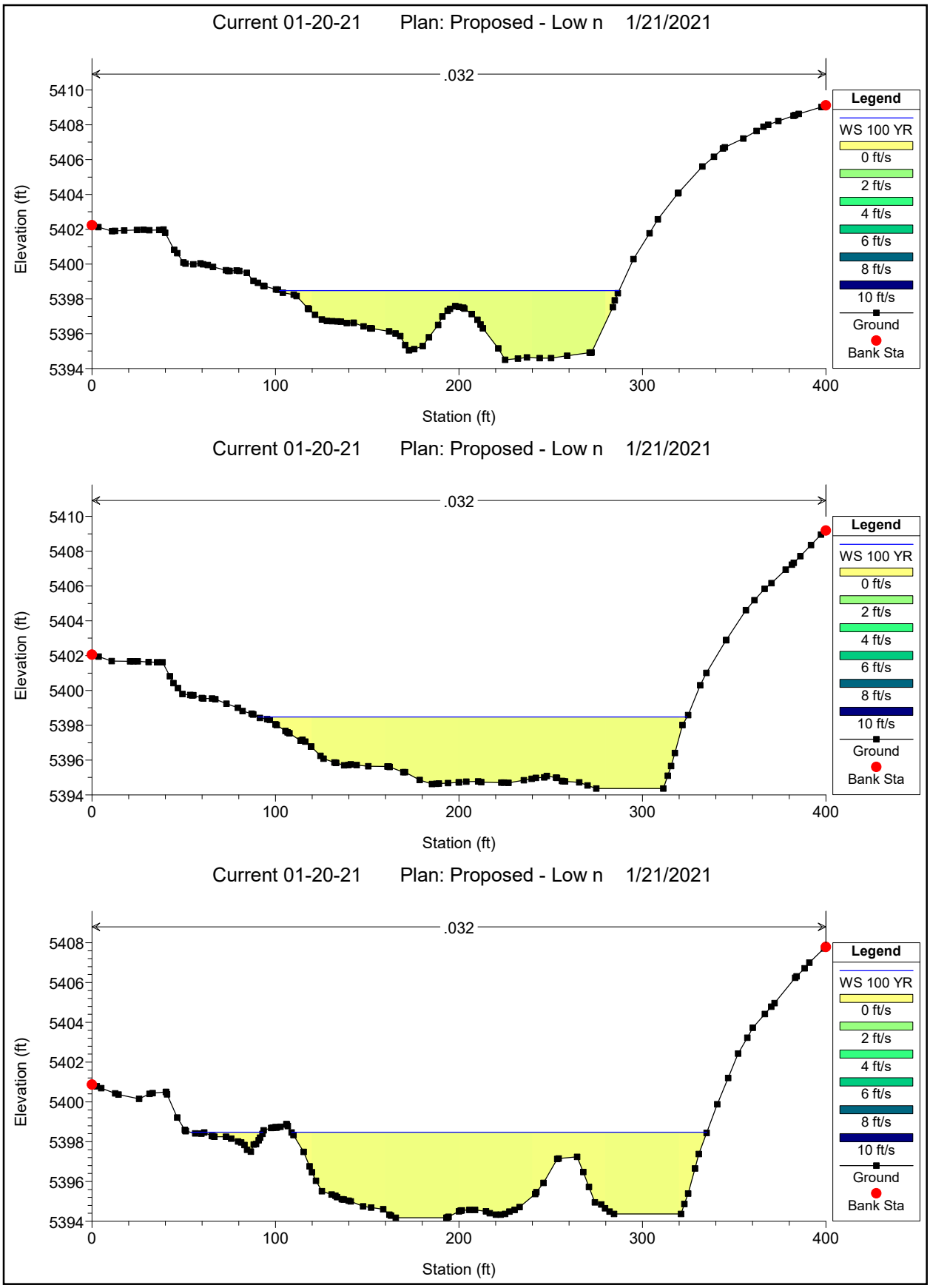
Ground
Bank Sta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Ground
Bank Sta
Current 01-20-21 Plan: Proposed - Low n 1/21/2021
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Elevation (ft)
Station (ft)
Legend
WS 100 YR
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6 ft/s
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10 ft/s
Ground
Bank Sta
Current 01-20-21 Plan: Proposed - Low n 1/21/2021
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Elevation (ft)
Station (ft)
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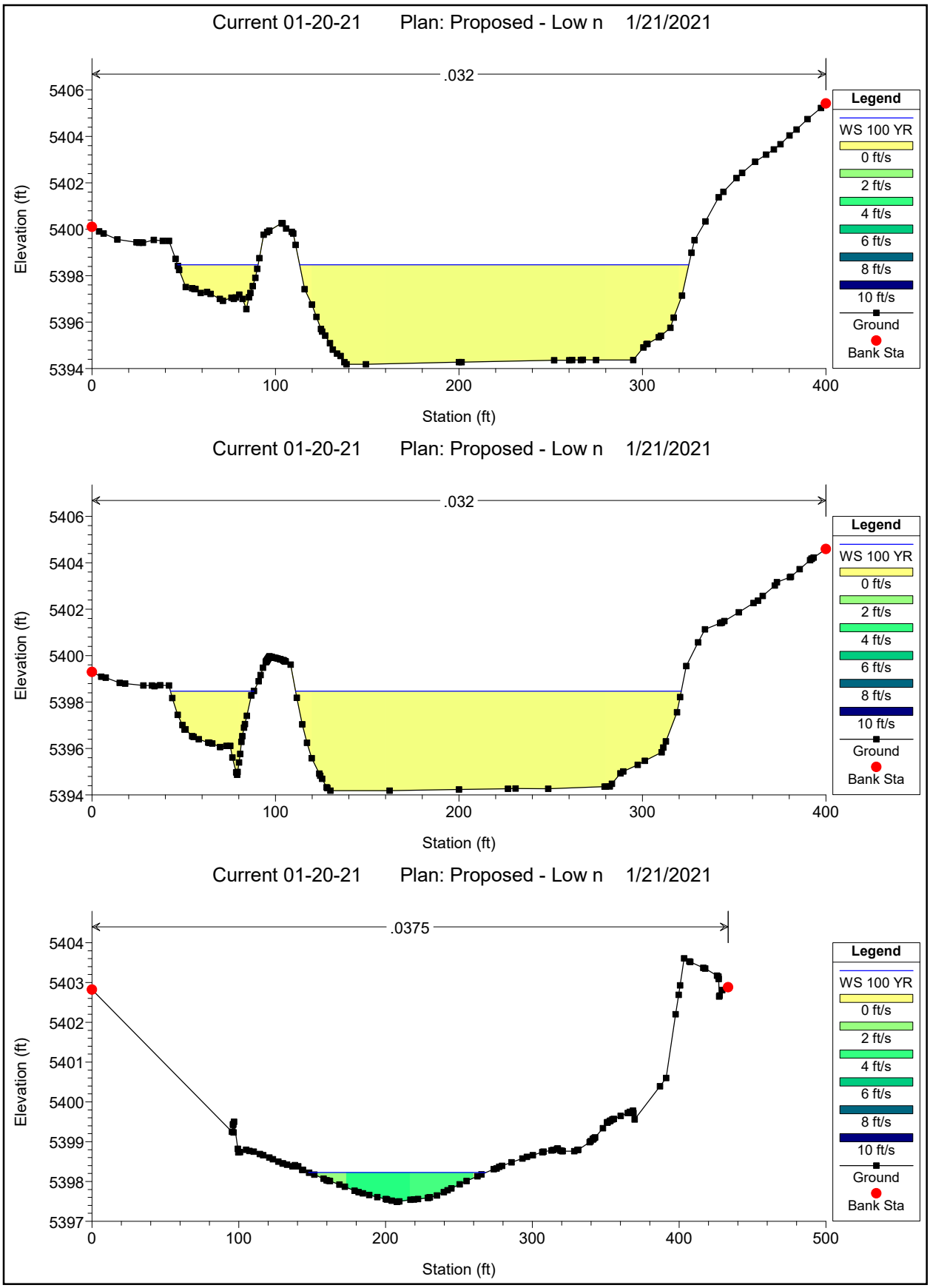
Ground
Bank Sta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Station (ft)
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10 ft/s
Ground
Bank Sta
Current 01-20-21 Plan: Proposed - Low n 1/21/2021
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 01-20-21 Plan: Proposed - Low n 1/21/2021
.0375
Elevation (ft)
Station (ft)
Legend
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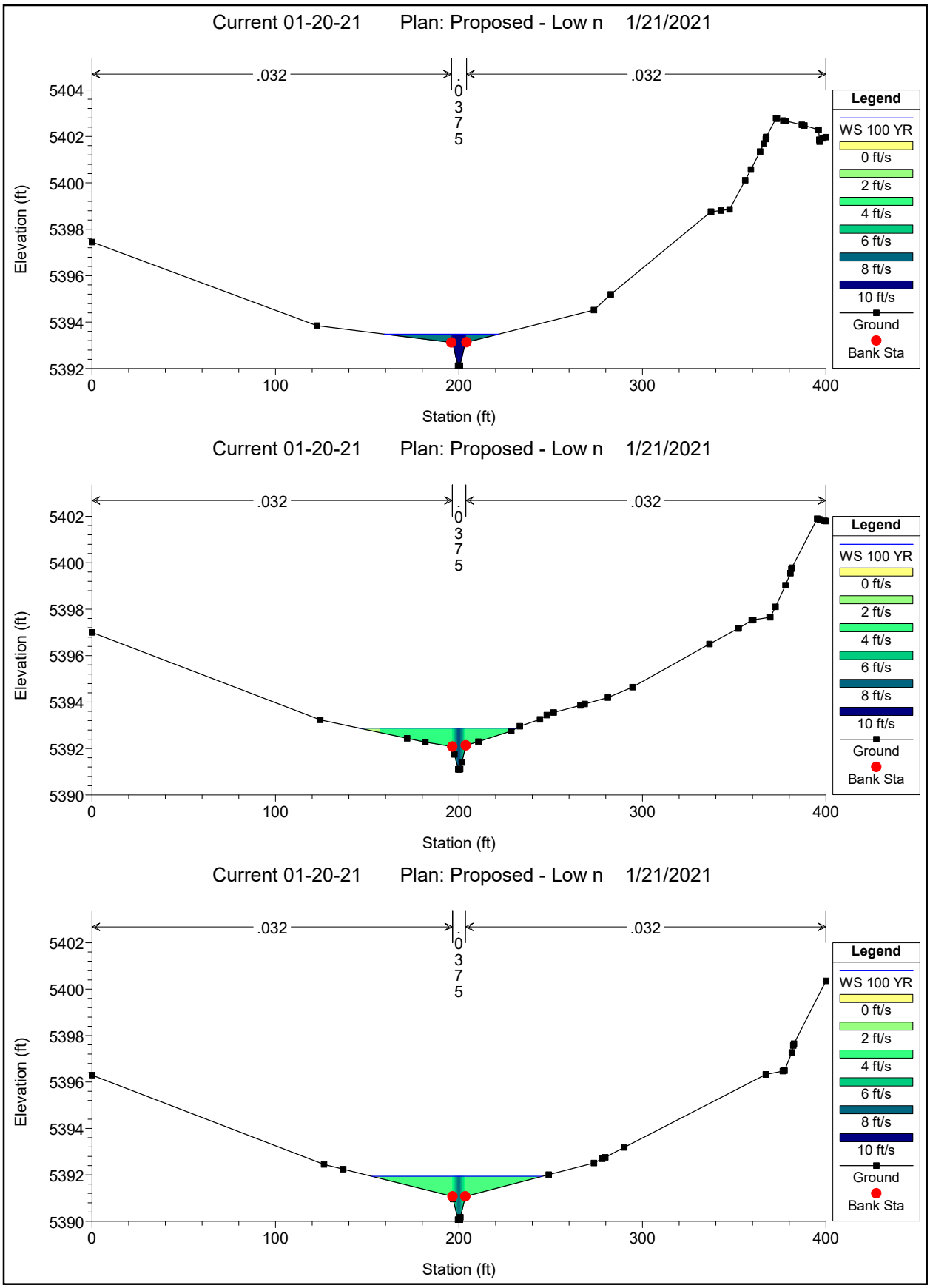
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta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.032
.037
.032
5404
5402
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5398
5396
5394
5392
Elevation (ft)
0
100
200
300
400
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 01-20-21 Plan: Proposed - Low n 1/21/2021
.032
.037
.032
5402
5400
5398
5396
5394
5392
5390
Elevation (ft)
0
100
200
300
400
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 01-20-21 Plan: Proposed - Low n 1/21/2021
.032
.037
.032
5402
5400
5398
5396
5394
5392
5390
Elevation (ft)
0
100
200
300
400
Station (ft)
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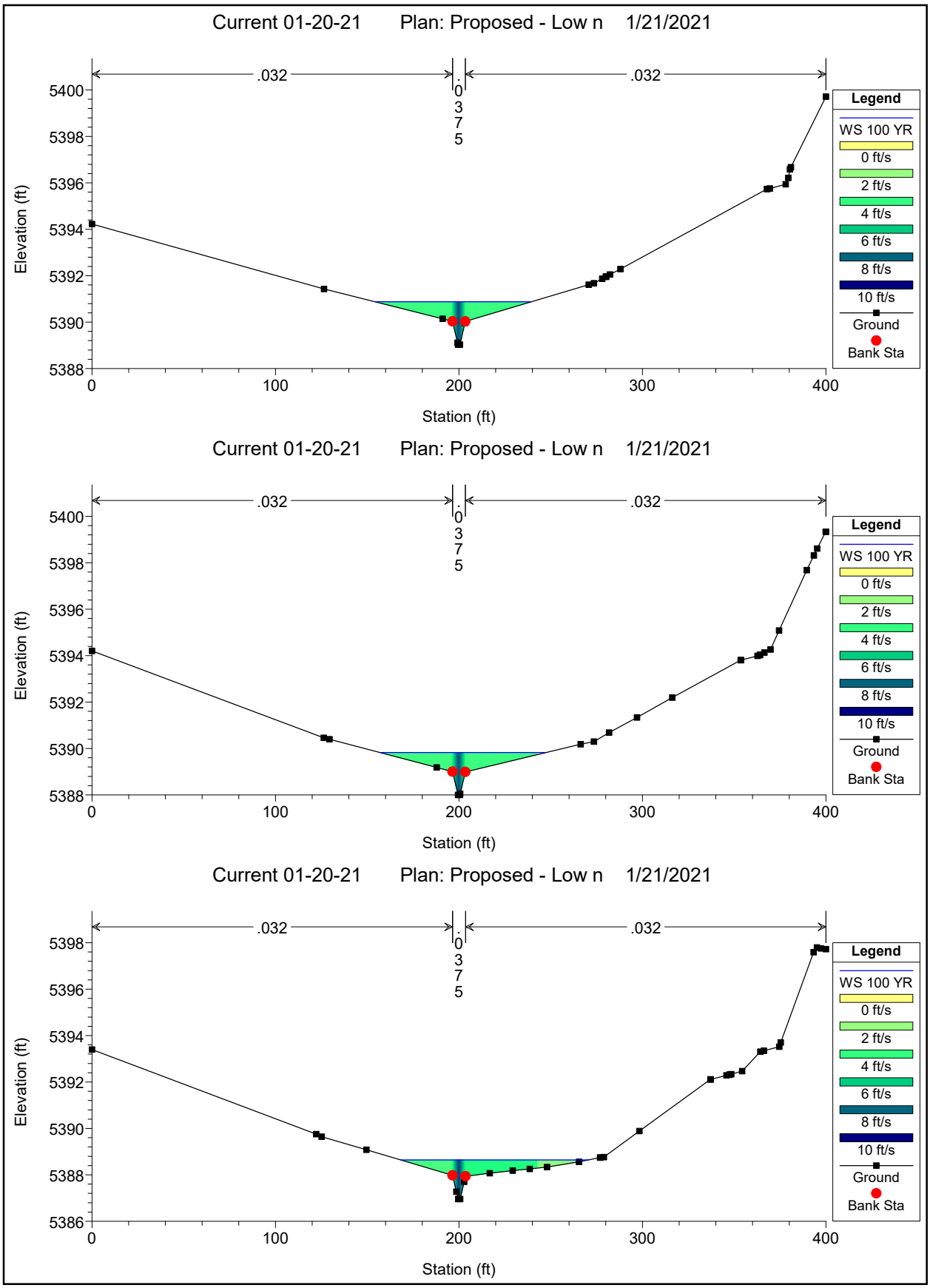
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta


Current 01-20-21 Plan: Proposed - Low n 1/21/2021
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.037
.032
5400
5398
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5394
5392
5390
5388
Elevation (ft)
0
100
200
300
400
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 01-20-21 Plan: Proposed - Low n 1/21/2021
.032
.037
.032
5400
5398
5396
5394
5392
5390
5388
Elevation (ft)
0
100
200
300
400
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 01-20-21 Plan: Proposed - Low n 1/21/2021
.032
.037
.032
5398
5396
5394
5392
5390
5388
5386
Elevation (ft)
0
100
200
300
400
Station (ft)
Legend
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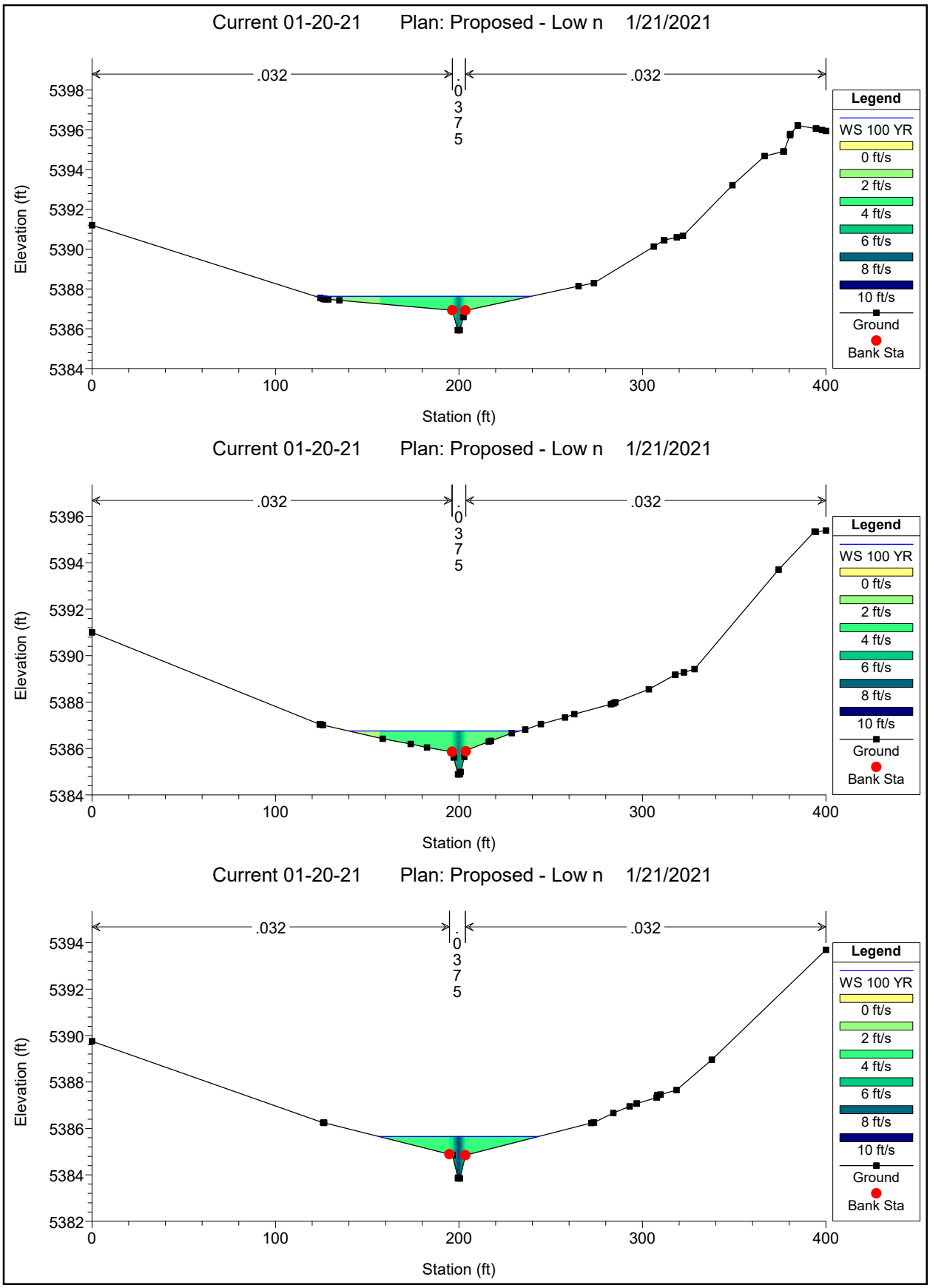
10 ft/s
Ground
Bank Sta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.0375
.032
Elevation (ft)
Station (ft)
Legend
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2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 01-20-21 Plan: Proposed - Low n 1/21/2021
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 01-20-21 Plan: Proposed - Low n 1/21/2021
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
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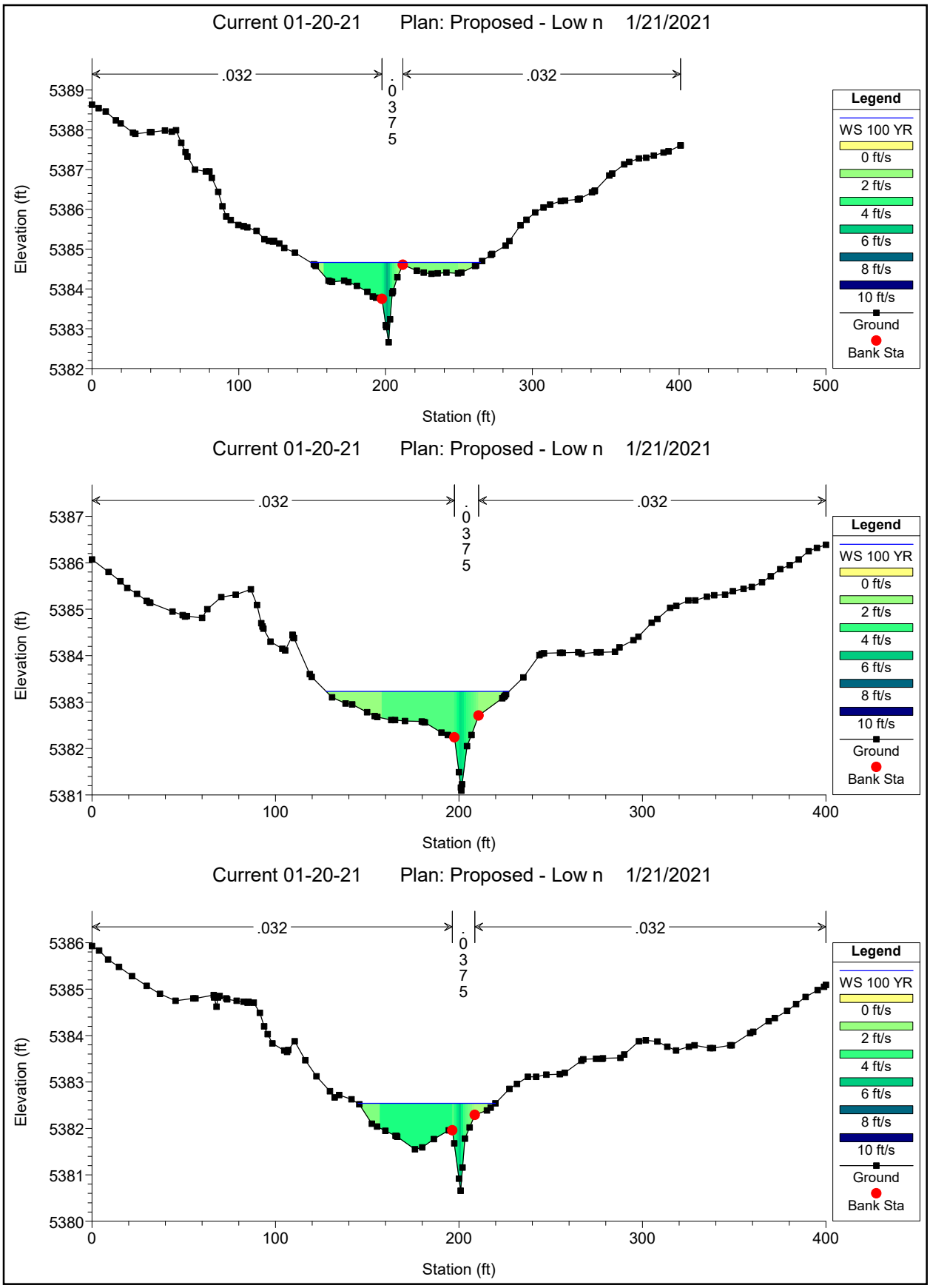
Ground
Bank Sta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Elevation (ft)
Station (ft)
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Ground
Bank Sta
Current 01-20-21 Plan: Proposed - Low n 1/21/2021
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.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
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Ground
Bank Sta
Current 01-20-21 Plan: Proposed - Low n 1/21/2021
.032
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Elevation (ft)
Station (ft)
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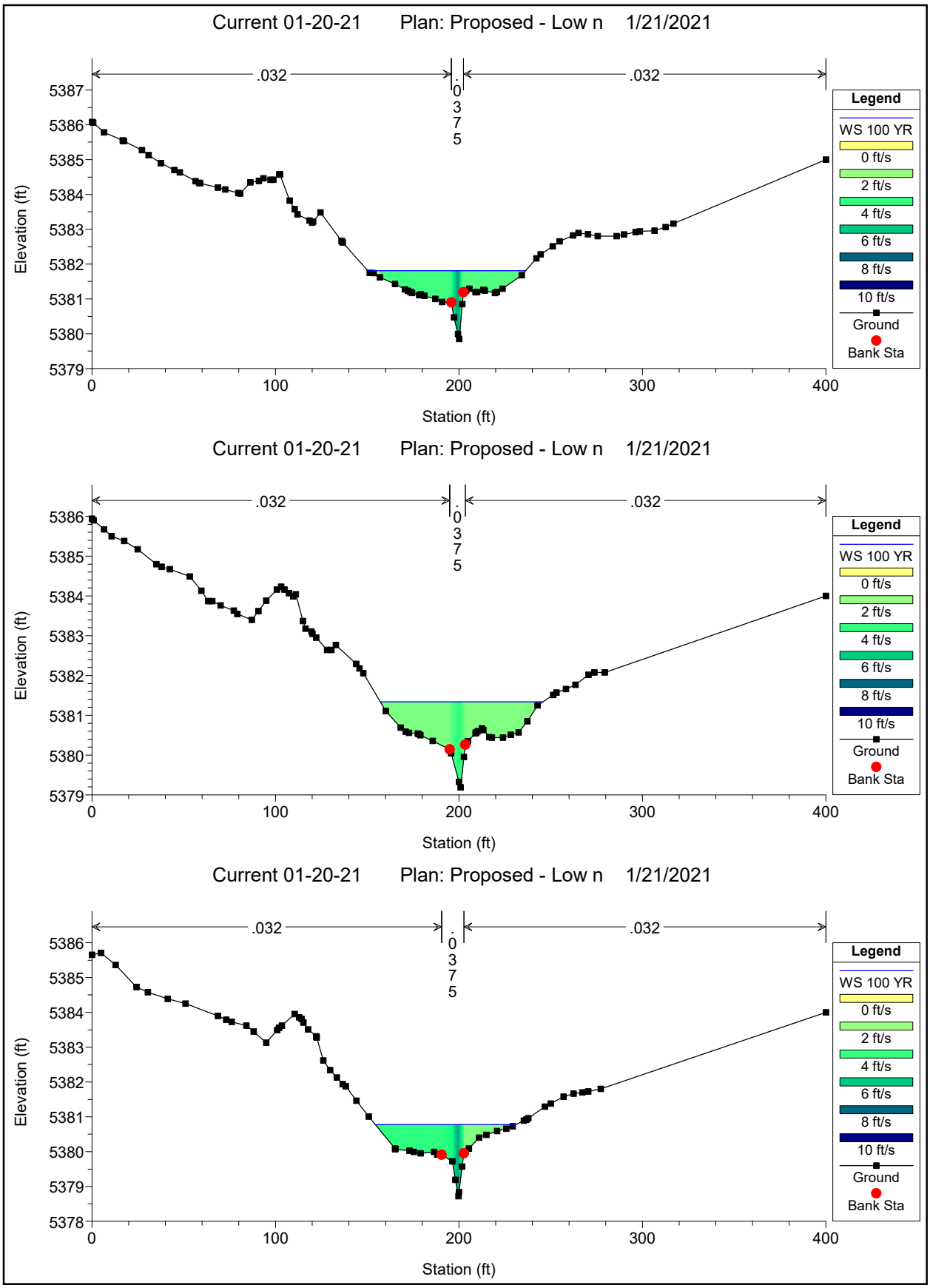
Ground
Bank Sta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Elevation (ft)
Station (ft)
Legend
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Ground
Bank Sta
Current 01-20-21 Plan: Proposed - Low n 1/21/2021
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Elevation (ft)
Station (ft)
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Bank Sta
Current 01-20-21 Plan: Proposed - Low n 1/21/2021
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Elevation (ft)
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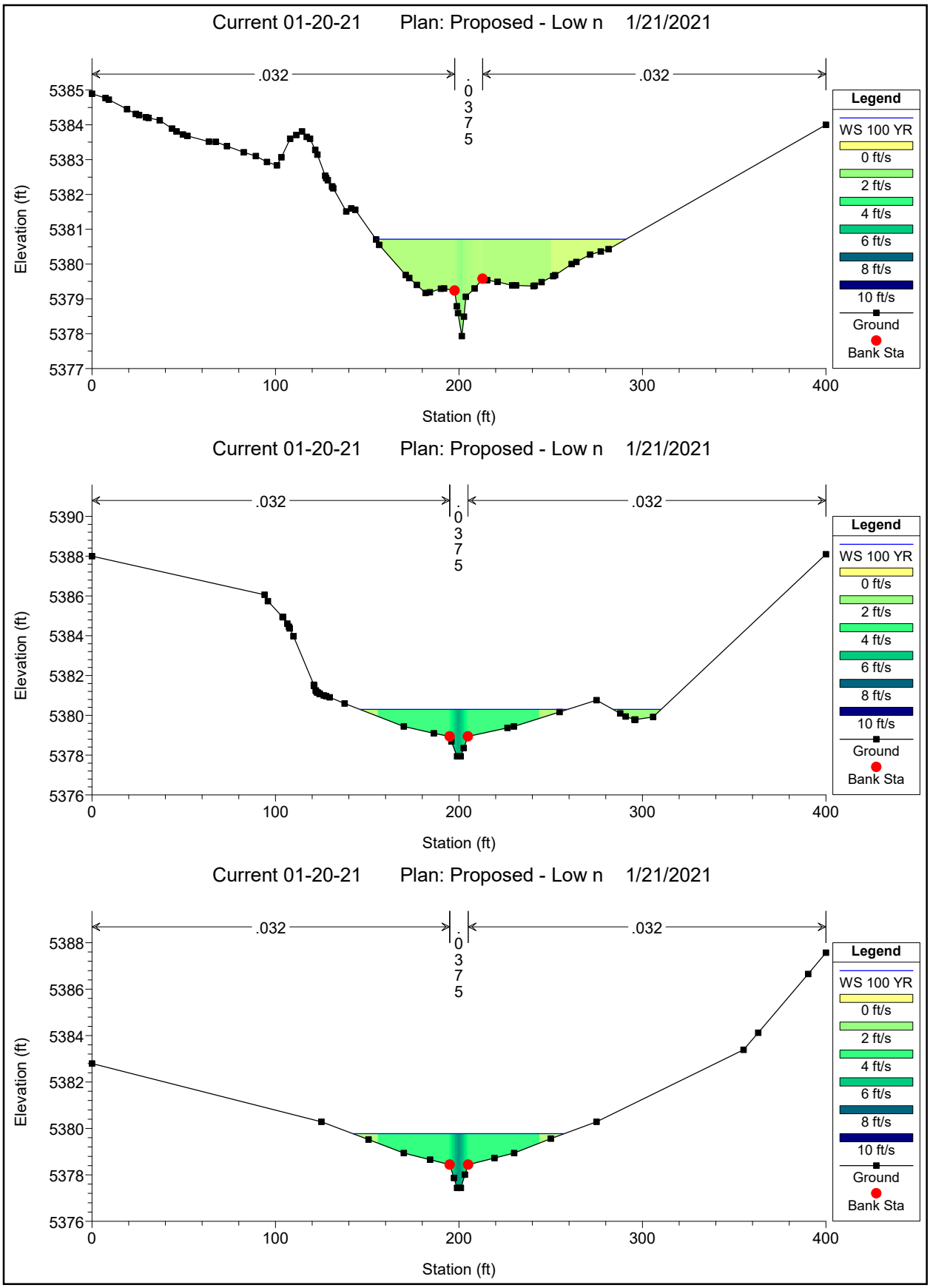
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Current 01-20-21 Plan: Proposed - Low n 1/21/2021
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Elevation (ft)
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Current 01-20-21 Plan: Proposed - Low n 1/21/2021
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Elevation (ft)
Station (ft)
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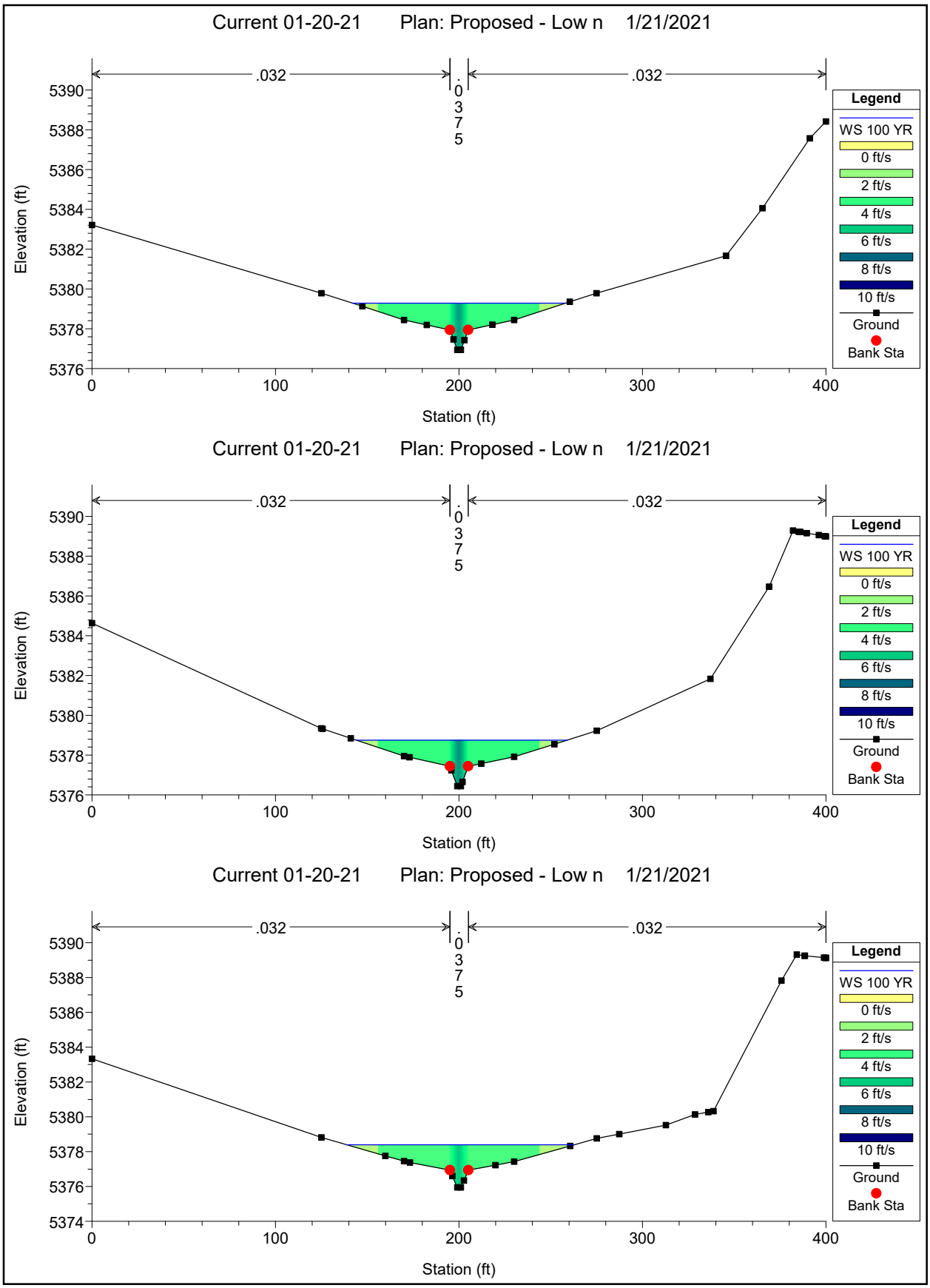
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Elevation (ft)
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Current 01-20-21 Plan: Proposed - Low n 1/21/2021
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Elevation (ft)
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Current 01-20-21 Plan: Proposed - Low n 1/21/2021
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Elevation (ft)
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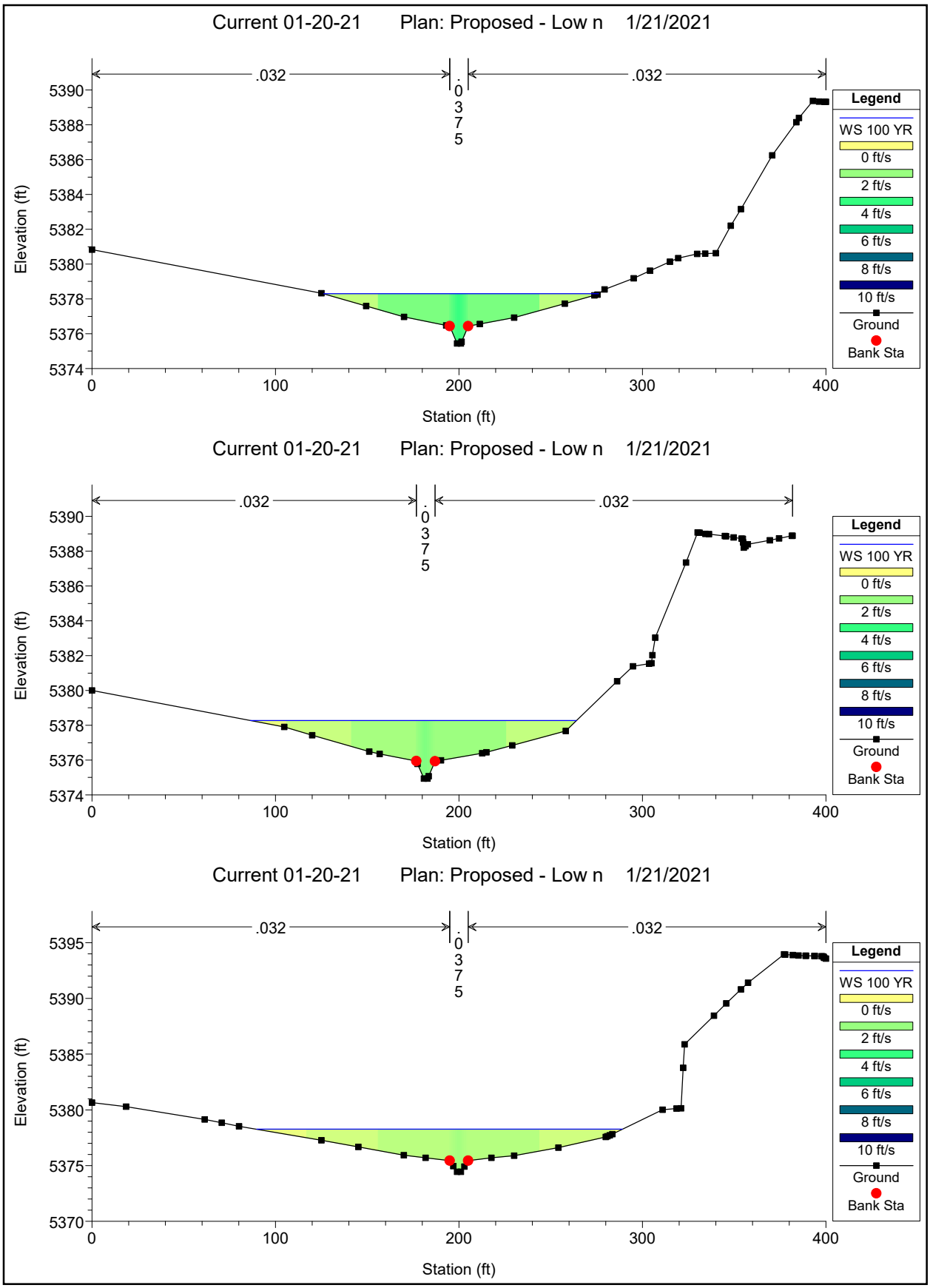
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Current 01-20-21 Plan: Proposed - Low n 1/21/2021
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Elevation (ft)
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Current 01-20-21 Plan: Proposed - Low n 1/21/2021
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Elevation (ft)
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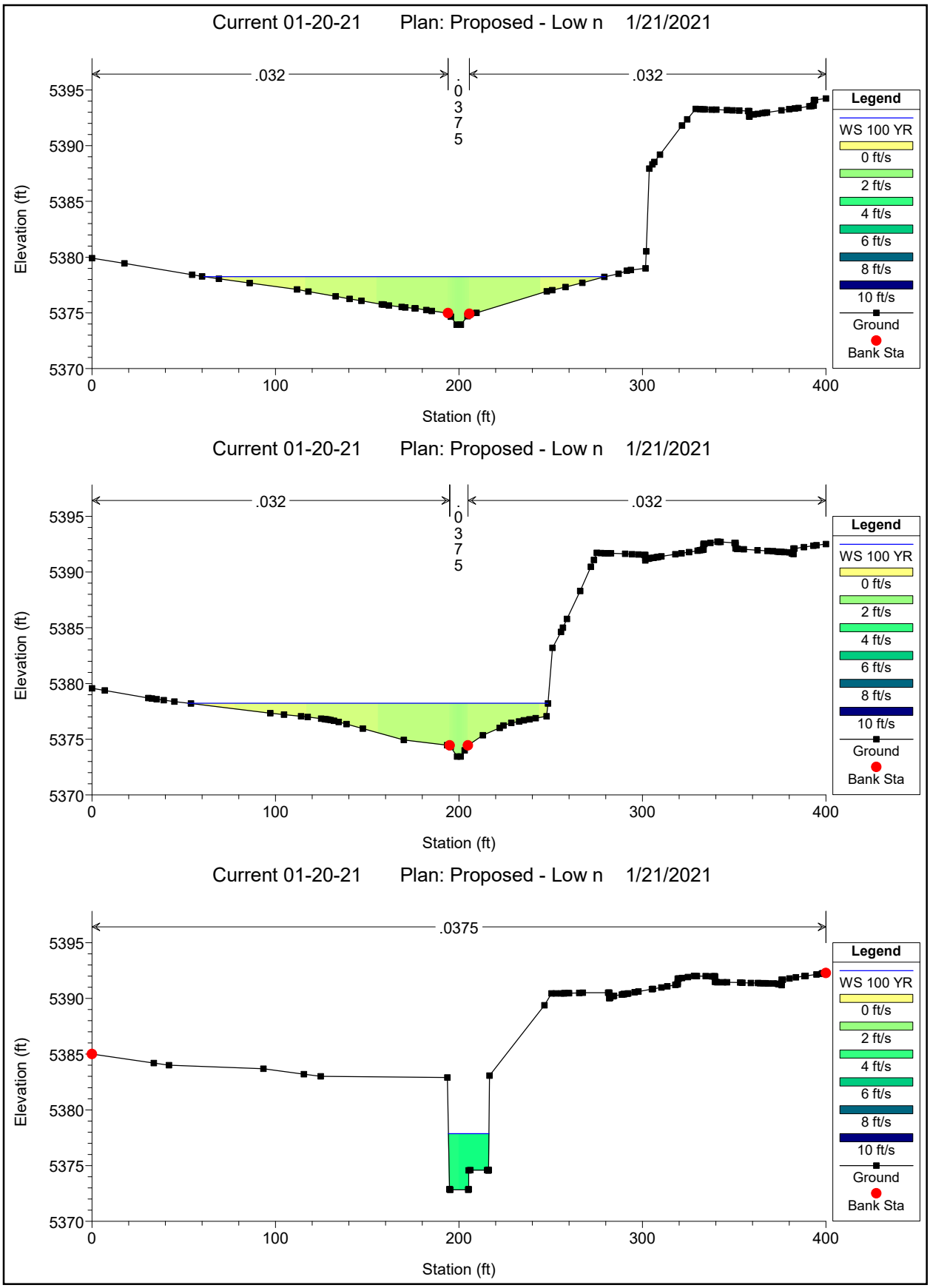
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Elevation (ft)
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Current 01-20-21 Plan: Proposed - Low n 1/21/2021
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Elevation (ft)
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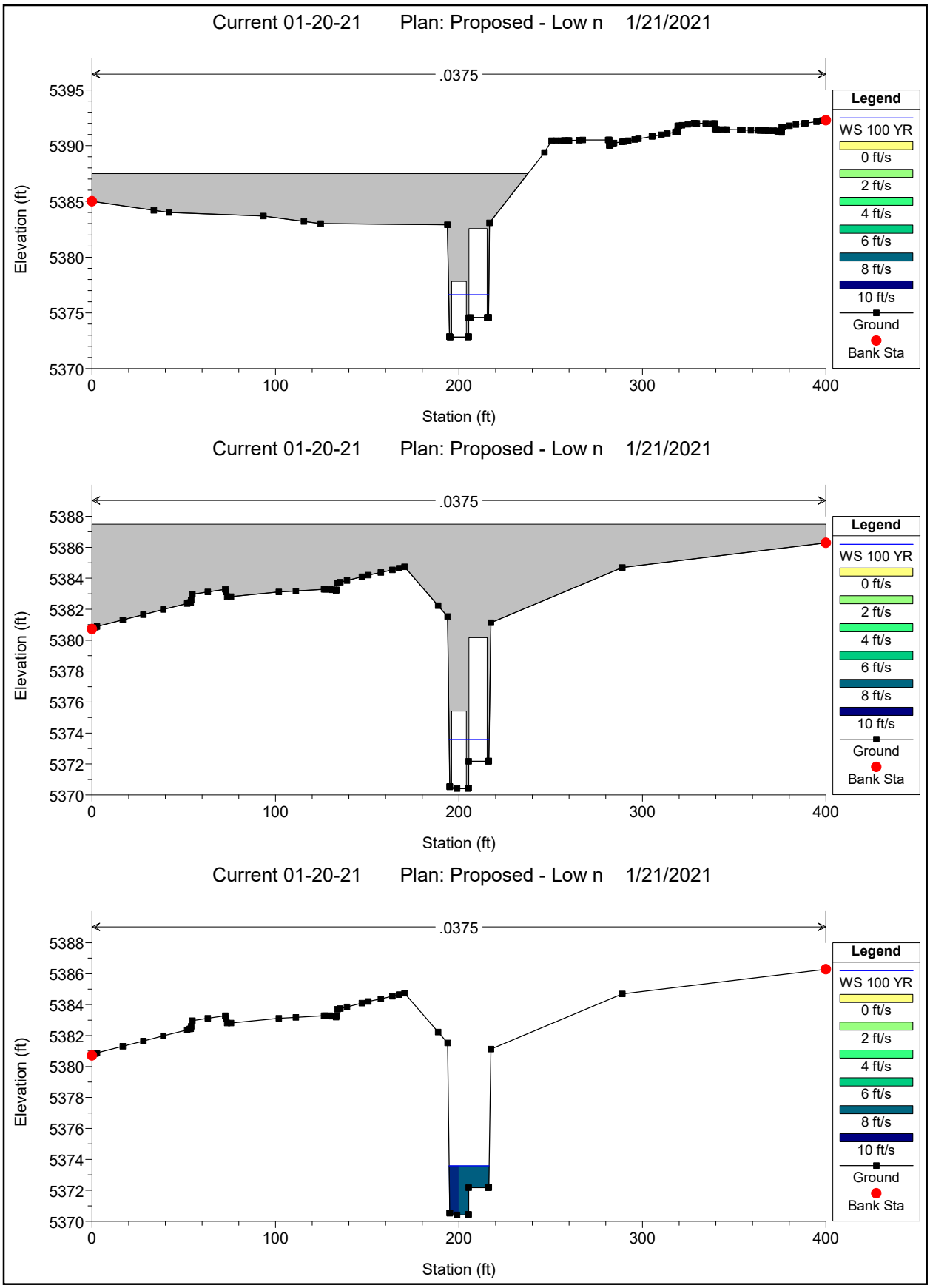
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Elevation (ft)
Station (ft)
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10 ft/s
Ground
Bank Sta
Current 01-20-21 Plan: Proposed - Low n 1/21/2021
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Elevation (ft)
Station (ft)
Legend
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Ground
Bank Sta
Current 01-20-21 Plan: Proposed - Low n 1/21/2021
.0375
Elevation (ft)
Station (ft)
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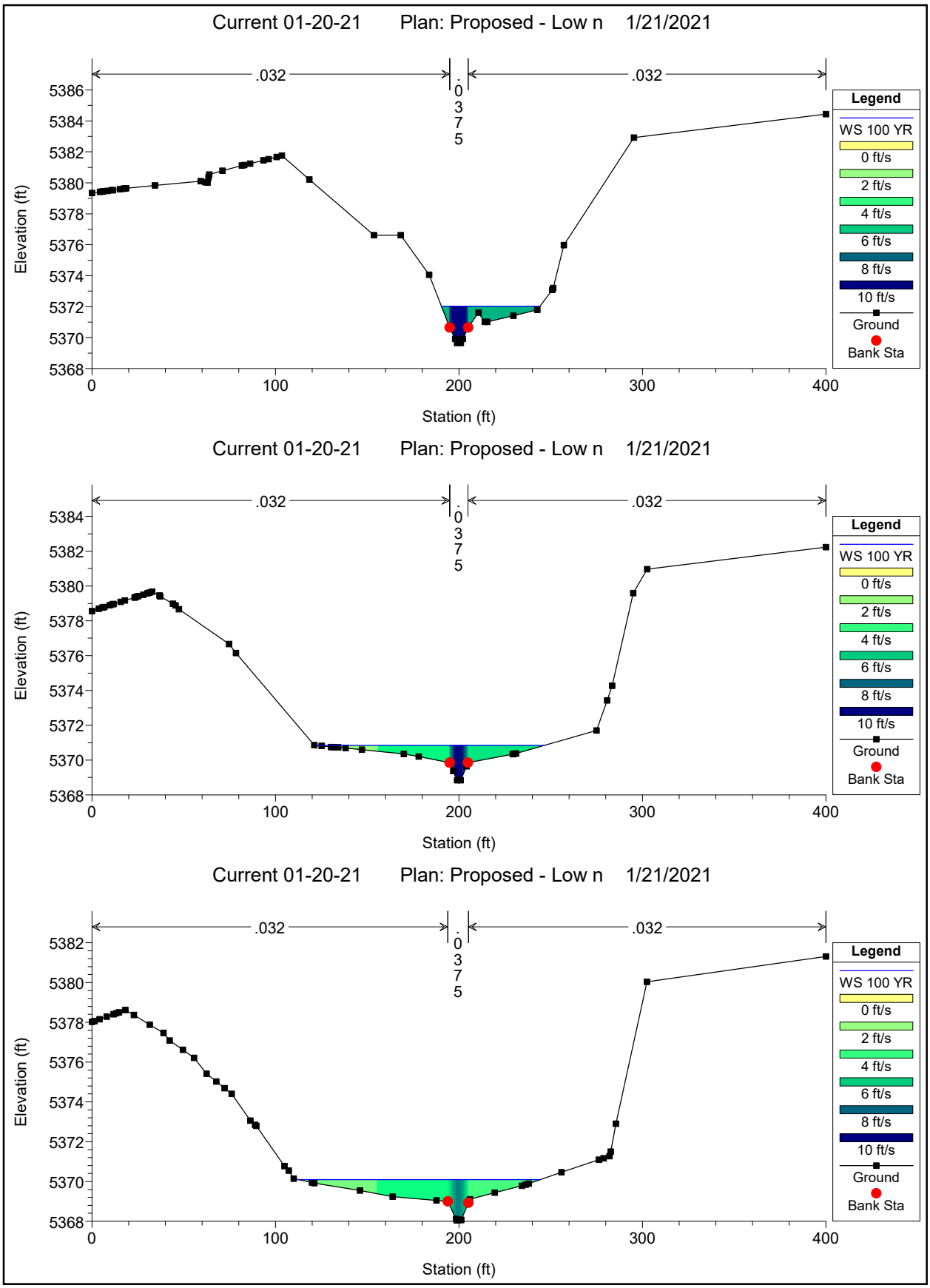
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Elevation (ft)
Station (ft)
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6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 01-20-21 Plan: Proposed - Low n 1/21/2021
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Elevation (ft)
Station (ft)
Legend
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8 ft/s
10 ft/s
Ground
Bank Sta
Current 01-20-21 Plan: Proposed - Low n 1/21/2021
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.0375
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Elevation (ft)
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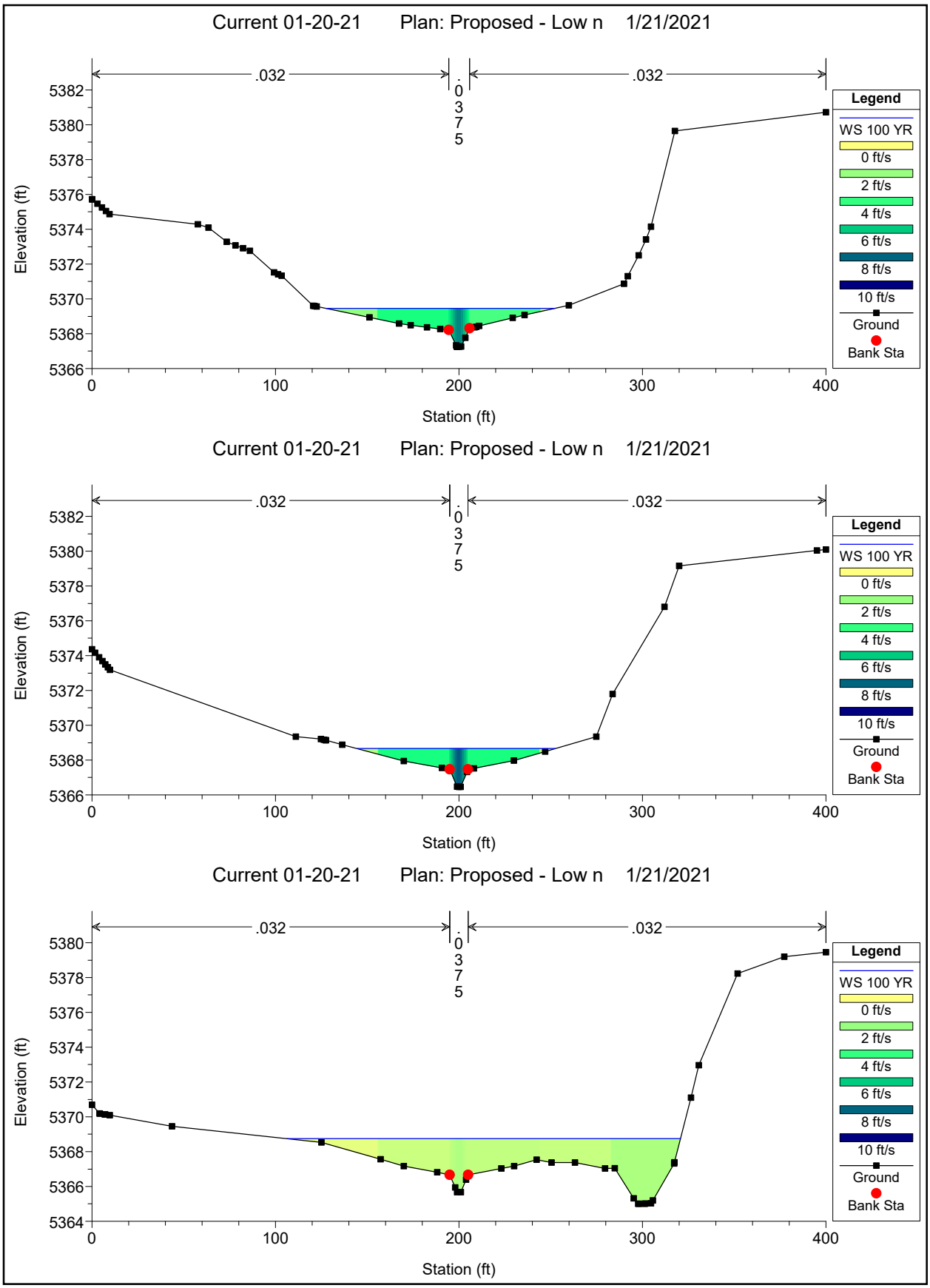
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Elevation (ft)
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4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 01-20-21 Plan: Proposed - Low n 1/21/2021
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.0375
.032
Elevation (ft)
Station (ft)
Legend
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8 ft/s
10 ft/s
Ground
Bank Sta
Current 01-20-21 Plan: Proposed - Low n 1/21/2021
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Elevation (ft)
Station (ft)
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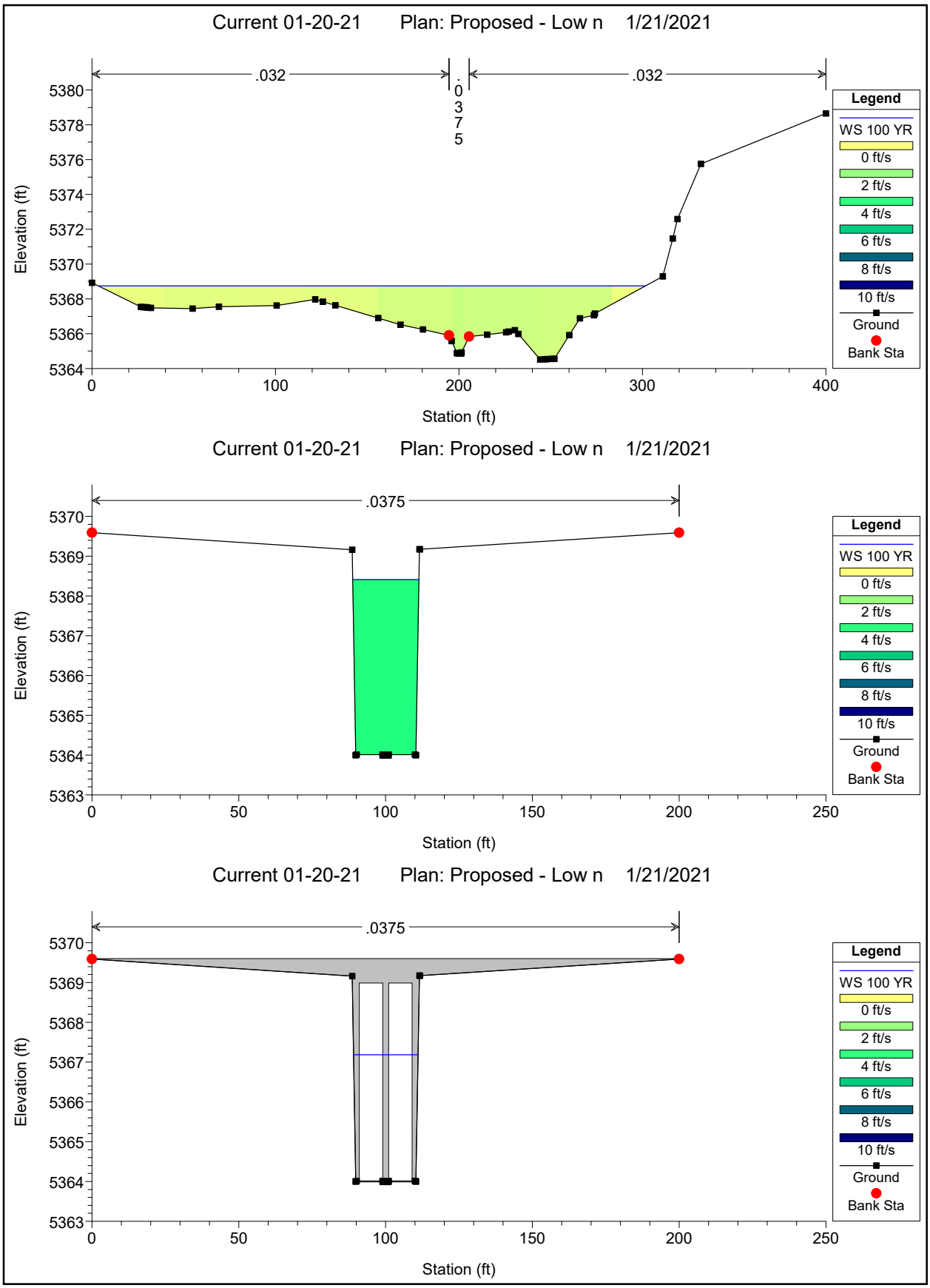
Bank Sta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Elevation (ft)
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2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 01-20-21 Plan: Proposed - Low n 1/21/2021
.0375
Elevation (ft)
Station (ft)
Legend
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0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 01-20-21 Plan: Proposed - Low n 1/21/2021
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Elevation (ft)
Station (ft)
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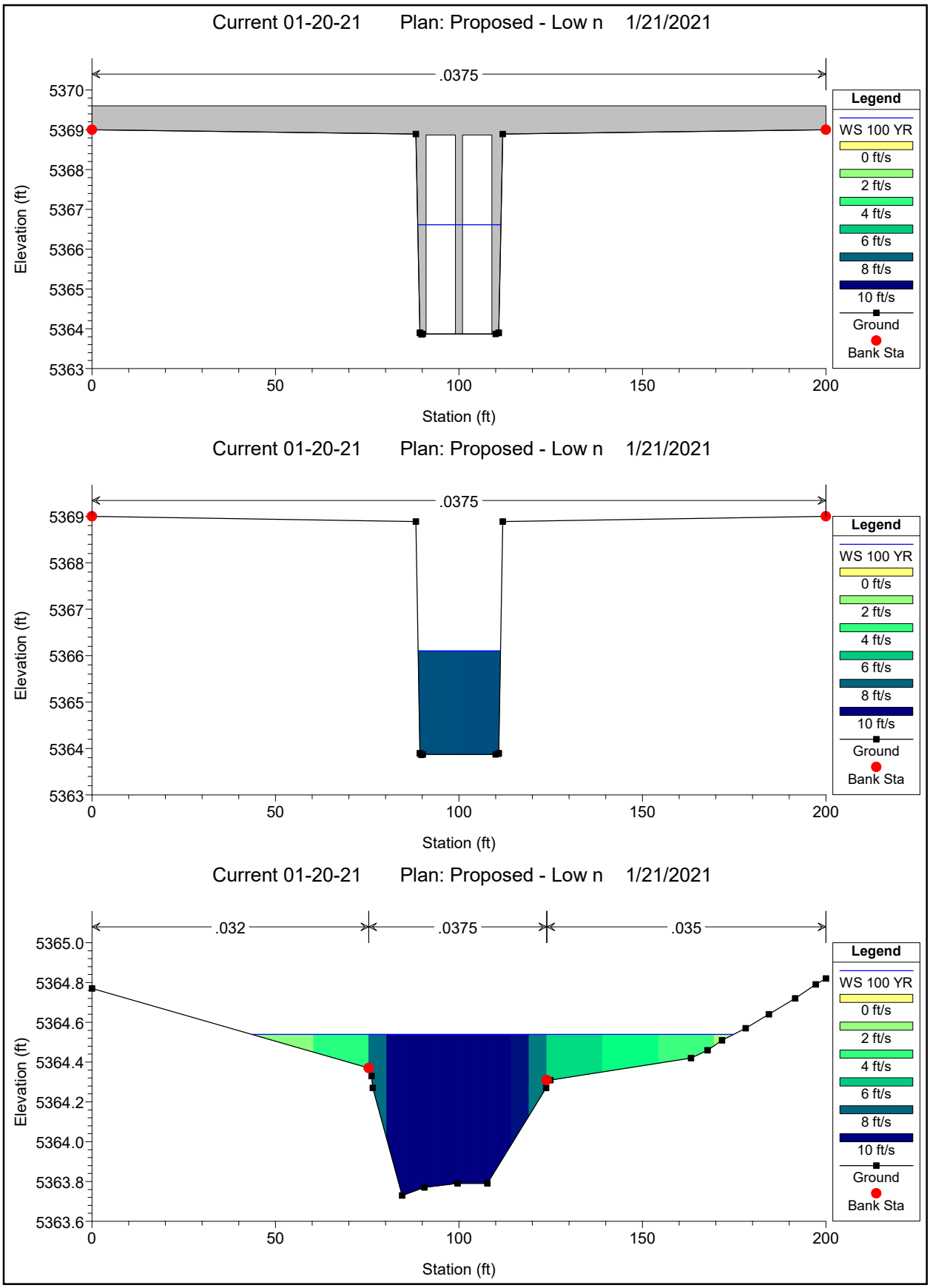
Ground
Bank Sta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Elevation (ft)
Station (ft)
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Ground
Bank Sta
Current 01-20-21 Plan: Proposed - Low n 1/21/2021
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Elevation (ft)
Station (ft)
Legend
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2 ft/s
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8 ft/s
10 ft/s
Ground
Bank Sta
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.0375
.035
Elevation (ft)
Station (ft)
Legend
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8 ft/s
10 ft/s
Ground
Bank Sta