Hydraulics Report

Cedar Mill Creek – CLOMR

November 2020, Draft

Prepared For:

Washington County Oregon

November 2020, Draft

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Version	Effective Date	Description of Revision	Prepared by	Reviewed by
1.0	03/16/2020	Community Review Draft	Daniel Child	Cedomir Jesic
2.0	11/06/2020	2nd FEMA Submittal Draft	Daniel Child	Cedomir Jesic

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Appendices

Tables

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Acronyms

1D	One Dimensional
2D	Two Dimensional
CLOMR	Conditional Letter of Map Revision
CMP	Corrugated Metal Pipe
DTM	Digital Terrain Model
FEMA	Federal Emergency Management Agency
FIS	Flood Insurance Study
HEC-RAS	Hydrologic Engineering Center River Analysis System
HU	Hydrologic Unit
LiDAR	Light Detection and Ranging
NAD83	North American Datum of 1983
NAVD88	North American Vertical Datum of 1988
NGVD29	National Geodetic Vertical Datum of 1929
NMFS	National Marine Fisheries Service
RC	Reinforced Concrete
SLOPES V	Standard Local Operating Procedure for Endangered Species version 5
USACE	United States Army Corps of Engineers
USGS	United States Geologic Survey

1 Introduction

1.1 Study Area

The Cedar Mill Creek Watershed is in Washington County, Oregon and is contained within United States Geologic Survey (USGS) Hydrologic Unit (HU) 170900100401 (Beaverton Creek). Highway 26 runs perpendicular to the creek through the northern half of the watershed. The watershed contains the sub-watershed for North Johnson Creek with both creeks running through the cities of Portland and Beaverton. The watershed terminates at the confluence of Cedar Mill Creek and Beaverton Creek at the Tualatin Hills Nature Park (See Figure 1-1).

This study was performed in response to several bridge and channel improvement projects proposed by Washington County along Cedar Mill Creek and its tributary North Johnson Creek. The study area is bounded between the south side of Highway 26 and the confluence of Cedar Mill Creek and Beaverton Creek, roughly 2 miles southwest of the highway.

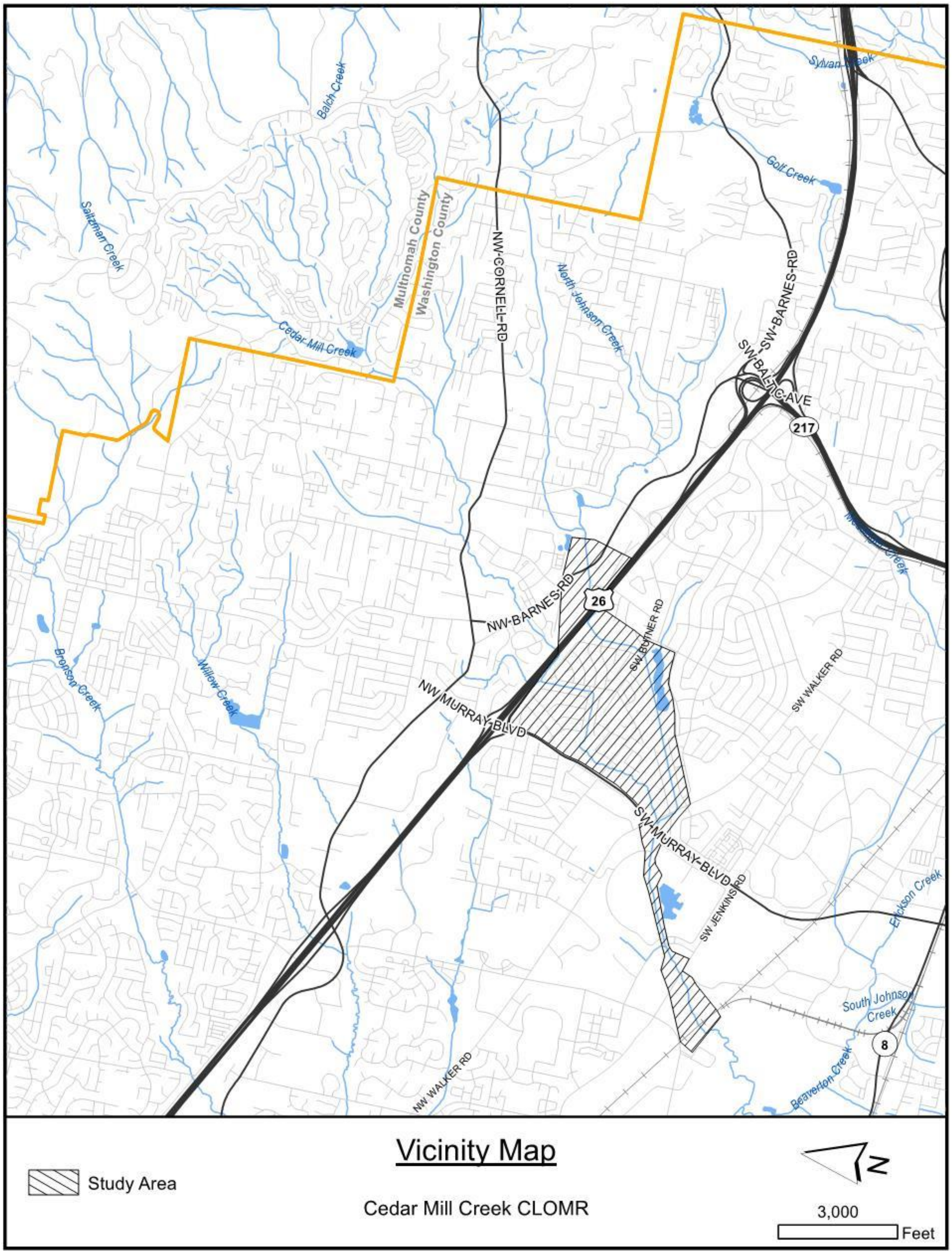


Figure 1-1 Vicinity Map

1.2 Purpose of Study

The purpose of this study is to capture the effect on the Flood Insurance Rate Map that three projects proposed by Washington County would have following their completion. The proposed projects are located along Cedar Mill Creek at SW Jenkins Rd, SW Murray Blvd and SW Walker Rd; and along North Johnson Creek at SW Far Vista Street, SW Walker Rd, and SW Butner Rd.

1.3 Type of Flooding

The entire study area is riverine without any tidal influences, with sources of flooding occurring from riverine flow. The downstream boundary of the watershed at Beaverton Creek is roughly 55 miles east of the Pacific Ocean and roughly 79 miles southeast of the mouth of the Columbia River.

1.4 Flooding History

Reports of flooding along Cedar Mill and North Johnson Creek are nearly annual in some locations as winter storms hit the watershed. The watershed is highly urbanized and responds quickly to short, high intensity storms which cause a quick, dramatic rise in water surface elevations in the channels. Issues are most present between Beaverton Creek and Barnes Road where the channel transitions from the steep hillslopes to lowland areas, and the creek flows overtop their banks consistently through this reach.

1.5 Endangered Species Act Compliance

The SW Murray Boulevard/SW Walker Road Intersection Improvement Project, the SW Jenkins Rd Improvement Project, and the SW Butner Rd culvert replacement project all require permit from the U.S. Army Corps of Engineers (USACE). Because federally listed anadramous fish are present within each project area, Section 7 consultation with the National Marine Fisheries Service (NMFS) is required to ensure that the proposed projects comply with the ESA before the USACE can issue the Section 404 Permit. To ensure compliance with the ESA, the proposed projects have been designed to include the relevant project design criteria of the Standard Local Operating Procedure for Endangered Species (SLOPES V) for Stormwater, Transportation, or Utilities programmatic biological opinion National Marine Fisheries Service (NMFS) No: NWR-2013-10411.

A summary of how the proposed SW Murray Boulevard/SW Walker Road Intersection Improvement Project incorporates each of the SLOPES V project design criteria is provided in Appendix C.

The culvert replacement for SW Butner Rd, and SW Jenkins Rd Improvement were found in compliance with SLOPES V by the NMFS and Nationwide 401 Water Quality Certification Approvals, and Oregon Department of State Lands (DSL) Removal/Fill Permits have been issued for the projects by the State of Oregon. A copy of the issued permit is included in Appendix C.

2 Methodology and Modeling

2.1 Methodology

Hydraulic modeling of the study area was conducted using the USACE Hydrologic Engineering Center River Analysis System (HEC-RAS) version 5.0.5. The models utilize a combined 1D and 2D geometry, and were developed to analyze the 10-, 4-, 2-, 1-, and 0.2-percent-annual-chance flood events for Cedar Mill and North Johnson Creek.

2.2 Topography

2.2.1 Datum and Survey

To be consistent with the effective model, survey data was collected using the North American Datum of 1983 (NAD83) with the Oregon State Plane North projected geographic coordinate system, and the vertical datum used by Washington County, Oregon which is the National Geodetic Vertical Datum of 1929 (NGVD29). Results of the modeling were converted to the North American Vertical Datum of 1988 (NAVD88) by adding 3.4 feet to the calculated elevations consistent with the published FIS for Washington County. Using VERTCON, actual vertical shifts between NGVD29 and NAVD88 through the study area range from 3.497 feet to 3.510 feet. Data used in modeling and collected using NAVD88 was converted to NGVD29 by subtracting 3.5 feet from the elevation value.

2.2.2 Cross-Sections

Cross-sections used in the models are taken from the effective model. Cross-sections were interpolated between effective cross-sections to provide stability for the unsteady state condition, and allow for better connection between the 1D and 2D portions of each model.

2.2.3 Digital Terrain Model

The Digital Terrain Model (DTM) used in the 2D analysis was constructed using a variety of sources including Aerial Light Detection and Ranging (LiDAR) as well as ground survey. LiDAR from two sources were used. The first is an aerial survey conducted by Washington County between the Beaverton Creek Wetlands and SW Walker Road which was referenced to horizontal and vertical control points placed by the County and referenced to the County's horizontal and vertical datum. The second is LiDAR collected in 2014 for the Portland Metro area which includes Washington, Multnomah, and Clackamas Counties and is referenced to the Oregon State Plane North projected coordinate system using the NAD83 horizontal datum and NAVD88 vertical datum. Ground survey for SW Murray Blvd, SW Walker Rd, and SW Jenkins Rd were conducted using Washington County horizontal and vertical datum. Ground survey for SW Butner Rd, and North Johnson Creek between SW Walker Road and Highway 26 was conducted using the Oregon State Plane North coordinate system with the NAD83 horizontal datum and NGVD29 vertical datum. Table 2-1 summarizes the sources of data, base datum, and shifts made to the final datum for the model which is the Oregon State Plan North coordinate system with a NAD83 horizontal datum and a NGVD29 vertical datum.

Table 2-1 DTM Data Sources

Source of Data	Ground / LiDAR	Date Collected	Horizontal Datum	Vertical Datum	Horizontal Shift	Vertical Shift
Washington County Aerial Survey	LiDAR	2014	Washington County	NGVD27	Georeferenced using aerial images	none
Portland Metro Aerial Survey	LiDAR	2014	NAD83 OR State Plane North	NAVD88	none	-3.5 feet
Walker Rd/Murray Blvd Survey	Ground	2014	Washington County	NGVD27	Georeferenced using aerial images	none
Jenkins Rd Survey	Ground	2016	Washington County	NGVD27	Georeferenced using aerial images	none
Butner Rd Survey	Ground	2018	NAD83 OR State Plane North	NGVD27	none	none
North Johnson Creek Survey - Phase I	Ground	2019	NAD83 OR State Plane North	NGVD27	none	none
North Johnson Creek Survey - Phase II	Ground	2020	NAD83 OR State Plane North	NGVD27	none	none

2.3 Boundary Conditions

The existing and proposed conditions models have two upstream boundary conditions for Cedar Mill Creek and North Johnson Creek, and a single downstream boundary condition at the end of Cedar Mill Creek downstream end of the TriMet Light Rail Bridge. The model also contains several points of lateral inflow corresponding to major discharge locations identified through hydrologic modeling.

2.3.1 Inflow Hydrographs

Inflow hydrographs were determined from the hydrologic modeling outlined in the Hydrology Report for the Cedar Mill Creek CLOMR. Friction slopes for these hydrographs were also determined from the hydrologic model. Table 2-2 identifies the hydrograph sources from the XPSWMM Hydrologic model for each model inflow location.

Table 2-2 Inflow Hydrograph Sources

Inflow ID	XPSWMM Hydrograph Source		Notes
	Link Hydrographs	*Sub-Basin Hydrographs*	
3015663	3015663	-	
3015009	-	CM8N1_2 and CM-003	
3012302	3012782, 3052260, 3040088, 3011750	-	Hydrographs from 3012782 and 3040088 are subtracted from the sum of hydrographs from 3052260 and 3011750 to calculate net inflow
CM-001	-	CM-001	
COMMONWEALTH	137639	NJ3S1_1 and NJ-003-D	
NJ-002	138004	NJ-002	
276120	137682	-	
NJ-001	138292 and 138356	NJ-001-A and NJ-001	
CMNJ-005	138355, 138647, 138633, 138528, and 226070	CMNJ-005	
CMNJ-004	187564, 187563 and 139444	CM3N1_4	
CMNJ-003	-	CM3_1 and CMNJ-003	
CMNJ-002	170021	CMNJ-002	
254971	254971	-	
NJ Inflow	3108465	NJ6_1	
138102	138102	-	
276088	276088	-	
NJ4_1	-	NJ4_1	
3106814	137096	NJ5_1, NJ5_1A and NJ-005-A	
3107360	136984	NJ5_2	
3104317	172631	-	

2.3.2 Initial Conditions

Initial conditions for the existing and proposed conditions models were determined using a restart file, in which a constant flow determined from the receding end of the 2-year 24-hour flow hydrographs for the corresponding inflow points was held for a period of 24 hours prior to creating the file. This condition was chosen to mimic the winter conditions of the area which generally have long periods of sustained rainfall prior to peak storm events, and in which a portion of offline floodplain storage and wetlands are already inundated to some degree.

2.4 Structures

A total of six structures are proposed within the study area. The dimensions of the proposed structures and the existing structures being replaced are outlined in Table 2-3. Design sheets for each proposed structure is included in Appendix B.

Table 2-3 Proposed Structures

Reach	Street Crossing	Existing Structure		Proposed Structure	
		Structure Type	*Dimensions*	*Structure Type*	*Dimensions*
Cedar Mill	SW Jenkins Rd	Bridge	38ft span, 6ft rise	Bridge	47.7ft span, 6.2ft rise
Cedar Mill	SW Murray Blvd	Bridge	64ft span, 8ft rise	Bridge	71ft span, 8.8ft rise
Cedar Mill	SW Walker Rd	Culvert	18ft span, 7ft rise, 79ft length RC Box	Bridge	60ft span, 8.1ft rise
N Johnson	SW Far Vista Dr	Culvert	14ft span, 8.2ft rise, 125ft length RC Box	Culvert	20ft span, 8.2ft rise, 63ft length RC Box
N Johnson	SW Walker Rd	Culvert	14ft span, 8.2ft rise, 119ft length RC Box	Culvert	20ft span, 8.2ft rise, 192ft length RC Box
N Johnson	SW Butner Rd	Culvert	6ft diameter, 40ft length CMP	Culvert	9ft span, 5ft rise, 50.3ft length RC Box

2.4.2 <u>Rating Curves</u>

Within the 2D model, structures are either modeled as Culvert connections or as rating curves. Bridges, due to their complex and non-standard geometry, require the use of a rating curve to adequately model the impact of the bridge within the 2D model area. To calculate these rating curves for the bridges modeled in the Existing Condition, Proposed Condition, and Floodway models, a separate HEC-RAS 1D steady state model was developed using updated topography and hydrology. Water surface elevations for a range of flows from the updated hydrology calculations were calculated using this model and correlated to the flow rates to generate the rating curve used in the 2D model.

For bridges that experience weir flow during any of the analyzed flow regimes, flow through the bridge opening rather that the total flow through the bridge was used in the rating curve as the bridge weir flow is accounted for in the 2D model. Bridges that had no impact to the water surface elevations for flows up to and including the 500-year peak flow were excluded from the 2D model to reduce model uncertainty. Bridges at the following stations were excluded for this reason: 3004491, 3006570, 3007402, and 3008390.

2.4.3 <u>Removed Structures</u>

Bridges within the Effective study along North Johnson Creek at stations 3103028, 3104819, and 3104922 are not present in the Existing Conditions or Proposed Conditions models as those bridges are no longer present.

2.5 Ineffective and Storage Areas

Ineffective areas used in the 1D portion of the existing and proposed conditions models were maintained from the effective 1D model. Ineffective and storage areas of the 2D portion of the models were included within the mesh and explicitly accounted for.

2.6 Manning’s Roughness Values

Roughness values for the 1D portion of the existing and proposed conditions models were maintained from the effective 1D model. Manning’s Roughness coverage areas used for the 2D portion of the models were determined from aerial photographs and field inspection, generating areas of “typical” coverage types. The coverage types and their assigned Manning’s ‘n’ values are outlined in Table 2-4.

Table 2-4 Manning's 'n' Values

Cover Type	Manning's 'n' Value	Source		
Building	0.500	W.J. Syme, 2008		
Channel	0.035	HEC-RAS Hydraulic Reference Manual	Table 3-1	(A)(1)(b)
Forest	0.100	HEC-RAS Hydraulic Reference Manual	Table 3-1	(A)(2)(d)(3)
Grass	0.035	HEC-RAS Hydraulic Reference Manual	Table 3-1	(A)(2)(a)(2)
Open Water	0.070	HEC-RAS Hydraulic Reference Manual	Table 3-1	(A)(1)(g)
Parking Lot	0.016	HEC-RAS Hydraulic Reference Manual	Table 3-1	(B)(6)(b)
Roadway	0.013	HEC-RAS Hydraulic Reference Manual	Table 3-1	(B)(6)(a)
Shrub	0.070	HEC-RAS Hydraulic Reference Manual	Table 3-1	(A)(2)(c)(4)
Other Areas (2D Default)	0.030	HEC-RAS Hydraulic Reference Manual	Table 3-1	(A)(2)(a)(1)

Roughness coverages change between the existing and proposed conditions, accounting for proposed improvements and channelization. Figure 2-1 and Figure 2-2 illustrate the coverage areas for the existing and proposed conditions respectively.

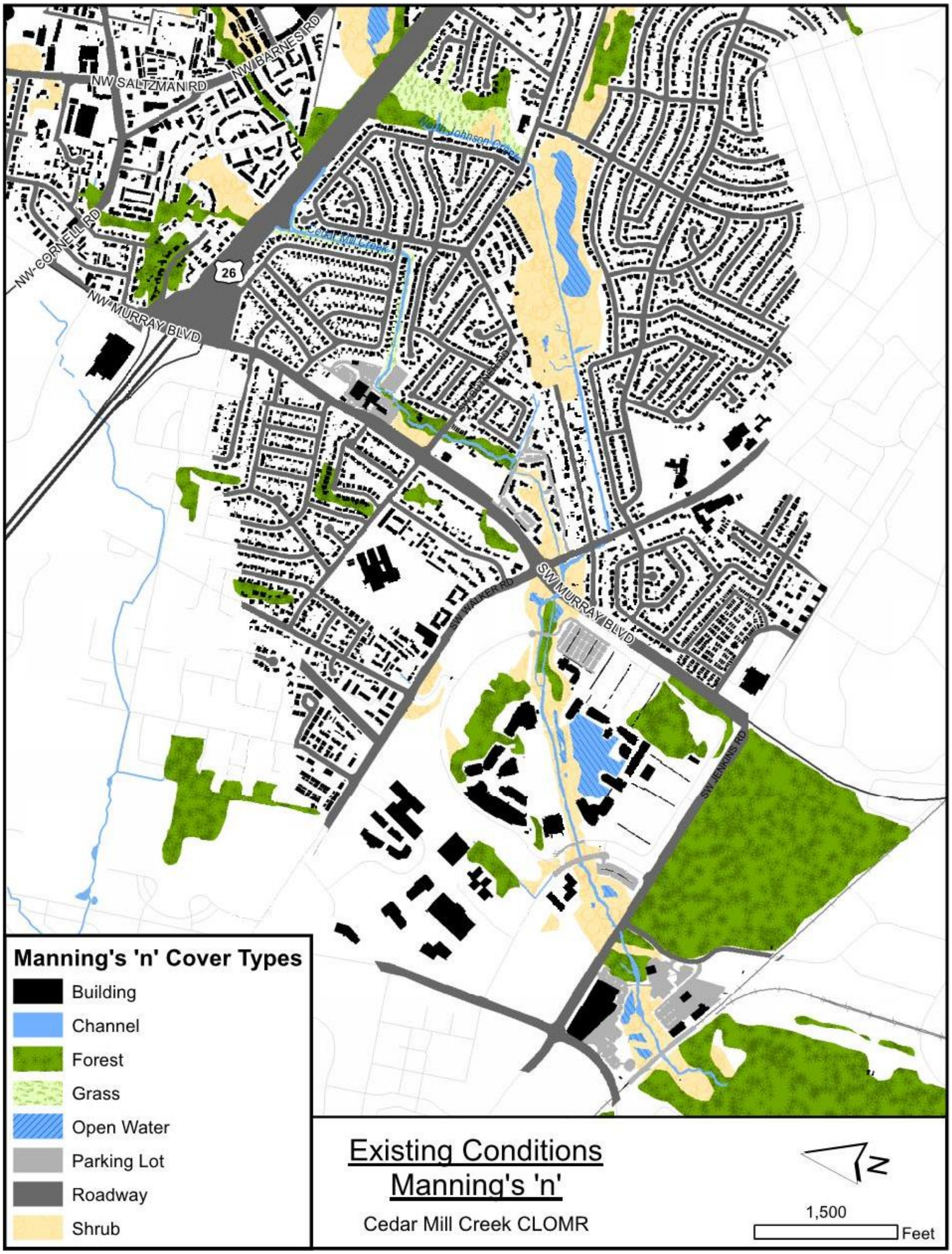


Figure 2-1 Existing Conditions Manning's 'n' Coverage

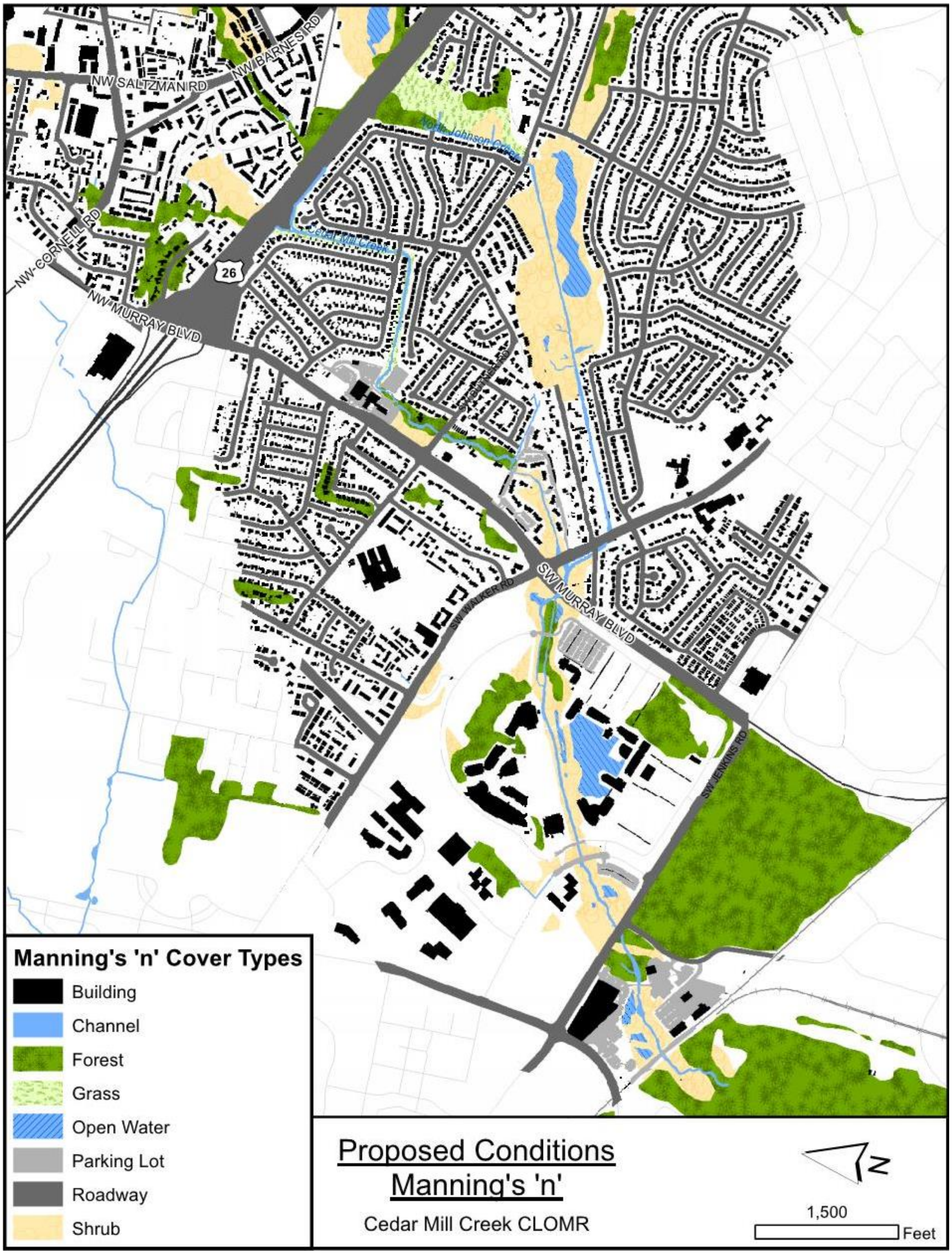


Figure 2-2 Proposed Conditions Manning's 'n' Coverage

2.7 Split and Diverted Flow

Split and diverted flow in the existing and proposed condition models was modeled explicitly through either connections to the 2D portion of the model through lateral structures, or within the 2D mesh itself. All flow within the study area either remains within localized storage or leaves the system at the downstream boundary. No flow is lost outside of the model boundaries.

2.8 Floodway Analysis

The floodway analysis was conducted using the hydraulic model using built-in user set encroachments for all 1D cross-sections, and by reducing the coverage of the 2D mesh to simulate encroachment in the 2D portion of the model. Encroachments for the 1D portion of the model were initially set to the width of the channel and adjusted by hand in order to bring the total rise in the base flood elevation to less than or equal to 1 foot. In the 2D portion of the model, the active mesh was reduced initially to the width of the channel and widened as needed. Areas of large floodplain storage were retained within the floodway in order to prevent dramatic increases in flow downstream and cause a rise greater than 1 foot without encroachment ever being considered.

3 Results

In general, results of the modeling show inundation consistent with reported flooding, with severity similarly consistent with reports from the Communities. Compared to the effective model, the new model better illustrates the overland flow paths north of SW Walker Rd and south of Highway 26. The area is highly complex in regards to flow patterns, and incorporates multiple points of connection to the adjacent waterways and numerous discrete flow paths that merge and diverge in non-dendritic drainage patterns that cannot be easily represented in a traditional 1D model. A conservative approach to delineation of the 100-year floodplain was taken for these areas to account for the rough definition of the topographic data and the variability of these flow paths.

4 Effective Elevation Comparison

Table 4-1 and Table 4-2 illustrate the effective, existing, and proposed base flood elevations for the relevant cross-sections for Cedar Mill and North Johnson Creeks. Table 4-3 and Table 4-4 illustrate the difference in elevations between the three scenarios. Cross-sections for the overland flow areas have been omitted from the table due to the effective cross-sections not being drawn perpendicular to the direction of flow for these areas and therefore having varying results for base flood elevations and not adequately representing the impacts of the new study.

Table 4-1 Effective Elevation Comparison – Cedar Mill Creek (Base Elevations)

Reach	Cross-Section ID	Base Flood Elevation (NGVD29)			Base Flood Elevation (NAVD88)		
		Effective	*Existing*	*Proposed*	*Effective*	*Existing*	*Proposed*
Cedar Mill Creek	E	170.18	170.44	170.44	173.70	173.96	173.96
	F	177.58	174.95	175.08	181.10	178.47	178.60
	G	177.58	174.98	175.11	181.10	178.50	178.63
	H	177.58	175.01	175.14	181.10	178.53	178.66
	I	177.68	175.15	175.27	181.20	178.67	178.79
	J	178.58	176.75	176.10	182.10	180.27	179.62
	K	178.68	176.88	176.33	182.20	180.40	179.85
	L	179.18	177.95	177.10	182.70	181.47	180.62
	M	179.28	178.04	177.15	182.80	181.56	180.67
	N	179.48	178.31	177.69	183.00	181.83	181.21
	O	179.88	178.91	178.66	183.40	182.43	182.18
	P	179.98	179.07	178.87	183.50	182.59	182.39
	Q	180.48	179.48	179.39	184.00	183.00	182.91
	R	180.88	179.88	179.85	184.40	183.40	183.37
	S	180.98	180.37	180.38	184.50	183.89	183.90
	T	181.38	180.70	180.73	184.90	184.22	184.25
	U	181.38	180.84	180.88	184.90	184.36	184.40
	V	182.48	181.22	181.01	186.00	184.74	184.53
	W	185.28	182.93	181.10	188.80	186.45	184.62
	X	185.38	183.57	183.24	188.90	187.09	186.76
	Y	185.68	184.43	184.35	189.20	187.95	187.87
	Z	187.48	185.40	185.39	191.00	188.92	188.91
	AA	191.08	189.15	189.15	194.60	192.67	192.67
	AB	192.38	190.55	190.55	195.90	194.07	194.07
	AC	194.78	192.90	192.89	198.30	196.42	196.41
	AD	195.38	194.72	194.72	198.90	198.24	198.24
	AE	198.38	197.70	197.71	201.90	201.22	201.23
	AF	201.18	199.45	199.47	204.70	202.97	202.99
	AG	204.18	202.72	202.72	207.70	206.24	206.24
	AH	206.48	205.31	205.31	210.00	208.83	208.83
	AI	208.88	206.50	206.50	212.40	210.02	210.02
	AJ	209.48	206.98	206.98	213.00	210.50	210.50
	AK	210.28	207.98	207.98	213.80	211.50	211.50
	AL	211.88	209.96	209.96	215.40	213.48	213.48
	AM	212.48	212.27	212.30	216.00	215.79	215.82
	AN	214.68	214.35	214.36	218.20	217.87	217.88
	AO	217.38	217.43	217.43	220.90	220.95	220.95

Table 4-2 Effective Evaluation Comparison – North Johnson Creek (Base Elevations)

Reach	Cross-Section ID	Base Flood Elevation (NGVD29)			Base Flood Elevation (NAVD88)		
		Effective	*Existing*	*Proposed*	*Effective*	*Existing*	*Proposed*
North Johnson Creek	A	183.48	181.70	181.14	187.00	185.22	184.66
	B	183.98	182.20	181.43	187.50	185.72	184.95
	C	184.38	182.36	181.52	187.90	185.88	185.04
	D	184.68	182.58	181.74	188.20	186.10	185.26
	E	185.08	183.08	182.38	188.60	186.60	185.90
	F	185.88	183.66	183.29	189.40	187.18	186.81
	G	186.38	184.01	183.78	189.90	187.53	187.30
	H	186.58	184.20	183.99	190.10	187.72	187.51
	I	186.58	184.21	184.00	190.10	187.73	187.52
	J	186.58	184.36	184.24	190.10	187.88	187.76
	K	187.18	188.99	186.08	190.70	192.51	189.60
	L	192.78	189.79	187.70	196.30	193.31	191.22
	M	192.78	189.81	187.85	196.30	193.33	191.37
	N	192.88	189.95	188.36	196.40	193.47	191.88
	O	192.88	190.58	189.83	196.40	194.10	193.35
	P	194.48	194.85	194.85	198.00	198.37	198.37
	Q	198.18	196.15	196.15	201.70	199.67	199.67
	R	202.88	202.89	202.89	206.40	206.41	206.41
	S	203.58	202.89	202.89	207.10	206.41	206.41
	T	203.58	202.98	202.98	207.10	206.50	206.50
	U	204.68	204.44	204.44	208.20	207.96	207.96
	V	206.28	206.55	206.55	209.80	210.07	210.07

Table 4-3 Effective Evaluation Comparison – Cedar Mill Creek (Delta)

Reach	Cross-Section ID	Δ (feet)		
		Existing - Effective	*Proposed - Effective*	*Proposed - Existing*
Cedar Mill Creek	E	0.26	0.26	0.00
	F	-2.63	-2.50	0.13
	G	-2.60	-2.47	0.13
	H	-2.57	-2.44	0.13
	I	-2.53	-2.41	0.12
	J	-1.83	-2.48	-0.65
	K	-1.80	-2.35	-0.55
	L	-1.23	-2.08	-0.85
	M	-1.24	-2.13	-0.89
	N	-1.17	-1.79	-0.62
	O	-0.97	-1.22	-0.25
	P	-0.91	-1.11	-0.20
	Q	-1.00	-1.09	-0.09
	R	-1.00	-1.03	-0.03
	S	-0.61	-0.60	0.01
	T	-0.68	-0.65	0.03
	U	-0.54	-0.50	0.04
	V	-1.26	-1.47	-0.21
	W	-2.35	-4.18	-1.83
	X	-1.81	-2.14	-0.33
	Y	-1.25	-1.33	-0.08
	Z	-2.08	-2.09	-0.01
	AA	-1.93	-1.93	0.00
	AB	-1.83	-1.83	0.00
	AC	-1.88	-1.89	-0.01
	AD	-0.66	-0.66	0.00
	AE	-0.68	-0.67	0.01
	AF	-1.73	-1.71	0.02
	AG	-1.46	-1.46	0.00
	AH	-1.17	-1.17	0.00
	AI	-2.38	-2.38	0.00
	AJ	-2.50	-2.50	0.00
	AK	-2.30	-2.30	0.00
	AL	-1.92	-1.92	0.00
	AM	-0.21	-0.18	0.03
	AN	-0.33	-0.32	0.01
	AO	0.05	0.05	0.00

Table 4-4 Effective Evaluation Comparison – North Johnson Creek (Delta)

Reach	Cross-Section ID	Δ (feet)		
		Existing - Effective	*Proposed - Effective*	*Proposed - Existing*
North Johnson Creek	A	-1.78	-2.34	-0.56
	B	-1.78	-2.55	-0.77
	C	-2.02	-2.86	-0.84
	D	-2.10	-2.94	-0.84
	E	-2.00	-2.70	-0.70
	F	-2.22	-2.59	-0.37
	G	-2.37	-2.60	-0.23
	H	-2.38	-2.59	-0.21
	I	-2.37	-2.58	-0.21
	J	-2.22	-2.34	-0.12
	K	1.81	-1.10	-2.91
	L	-2.99	-5.08	-2.09
	M	-2.97	-4.93	-1.96
	N	-2.93	-4.52	-1.59
	O	-2.30	-3.05	-0.75
	P	0.37	0.37	0.00
	Q	-2.03	-2.03	0.00
	R	0.01	0.01	0.00
	S	-0.69	-0.69	0.00
	T	-0.60	-0.60	0.00
	U	-0.24	-0.24	0.00
	V	0.27	0.27	0.00

5 References

1. *Hydrology Report for Cedar Mill Creek* CLOMR (November 2019). Cardno. Portland, OR

2. Syme, W. J. (2008, September). *Flooding in Urban Areas - 2D Modelling Approaches for Buildings and Fences*. Engineers Australia, 9th National Conference on Hydraulics in Water Engineering. Darwin City, NT Australia.

APPENDIX

A

INPUT & OUTPUT

Appendix A
Input & Output

HEC-RAS Model

Project File

- CedarMillJohnson.prj

Plan Files

- CedarMillJohnson.p01, .p02 , .p03, .p04, .p05, .p06 , .p07, .p08, .p09, .p10, .p13, .p14, .p15, .p16, .p17, .p18

Geometry Files

- CedarMillJohnson.g01, .g02, .g03, .g04

Steady Flow Files

- CedarMillJohnson.f01, .f02

Unsteady Flow Files

- CedarMillJohnson.u01, .u03, .u05, .u06, .u07, .u08, .u09, .u11, .u12, .u13, .u14, .u15, .u16

Restart Files

- CedarMillJohnson.p01.22SEP2008 2400.rst
- CedarMillJohnson.p03.22SEP2008 2400.rst
- CedarMillJohnson.p07.22SEP2008 1200.rst

Terrain

- CedarMillJohnson_Existing.1182-SURFACE-EXISTING.tif
- CedarMillJohnson_Exsiting.hdf
- CedarMillJohnson_Existing.vrt
- CedarMillJohnson_Proposed.1182-SURFACE-PROPOSED.tif
- CedarMillJohnson_Proposed.hdf
- CedarMillJohnson_Proposed.vrt

Manning's 'n' Values

- CedarMillJohnson_Existing.hdf
- CedarMillJohnson_Existing.tif
- CedarMillJohnson_Proposed.hdf
- CedarMillJohnson_Existing.tif

APPENDIX B

STRUCTURE DESIGN PLANS

Appendix B
Structure Design Plans

SW Jenkins Road

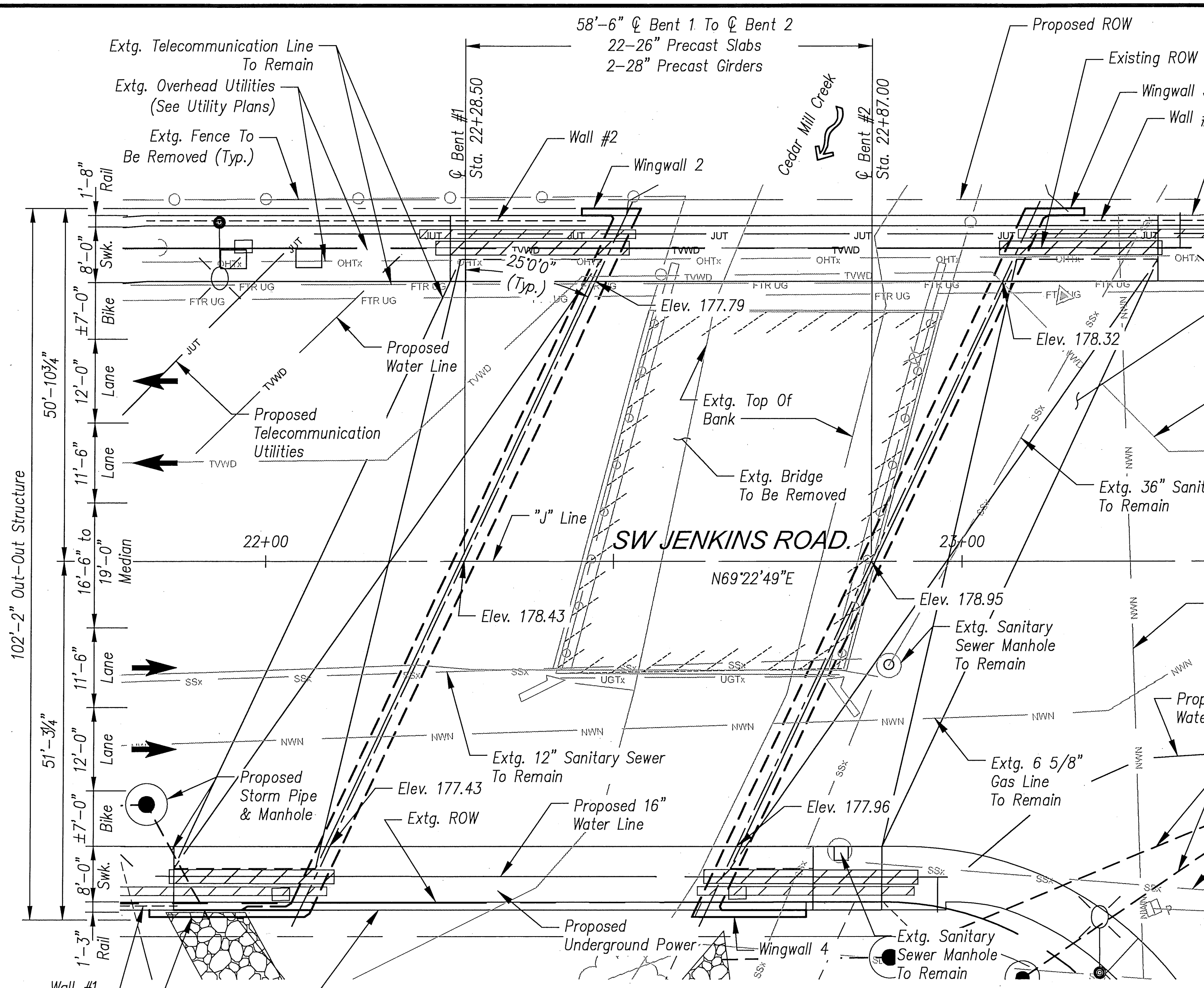
- S-1 – Jenkins Rd. Bridge over Cedar Mill Creek Plan & Elevation
- 2B-16 – CEDAR MILL CREEK CHANNEL GRADING PLAN

Walker/Murray Improvements

- SM-1 – MURRAY BLVD. BRIDGE PLAND & ELEVATION
- SW-1 – WALKER RD BRIDGE PLAN & ELEVATION
- S-4 – FAR VISTA DR CULVERT PLAN AND ELEVATION
- WALKER ROAD CULVERT PLAN & ELEVATION

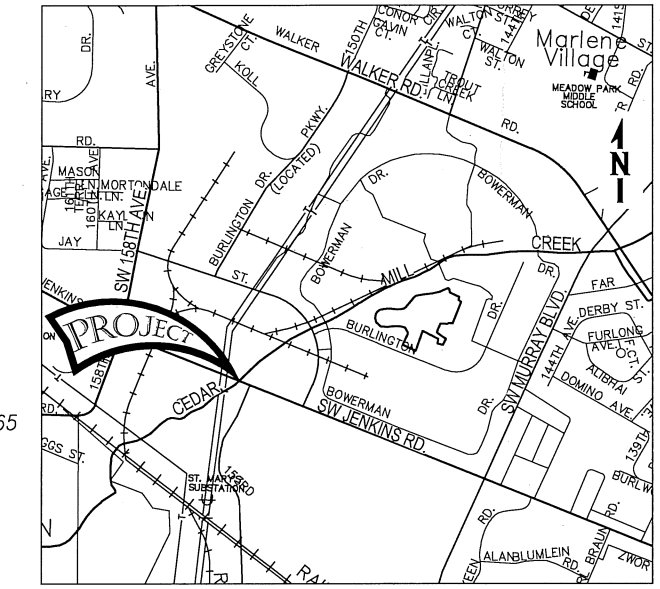
SW Butner Rd Culvert #1623 Replacement

- GE – CULVERT #1623 PLAN & PROFILE
- GE-2 – CULVERT #1623 DETAILS



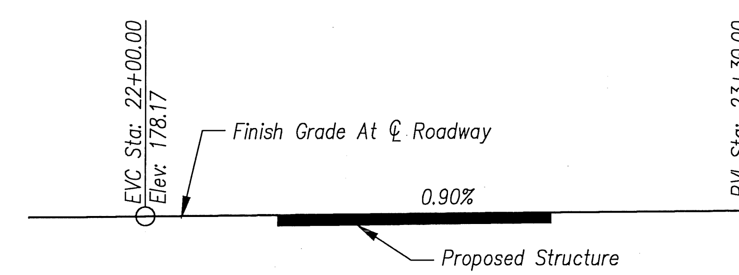
PLAN VIEW

SCALE: 1" = 20'



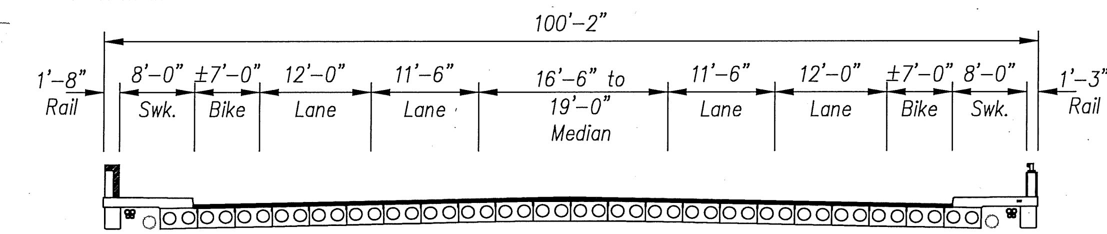
LOCATION MAP

SCALE: NTS



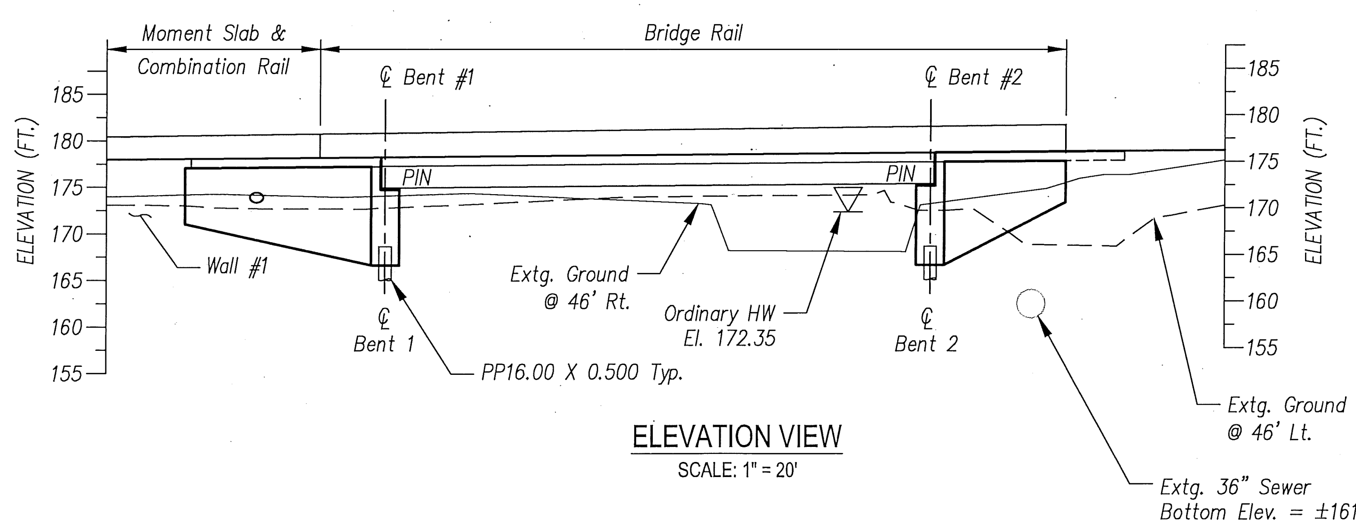
GRADELINE DIAGRAM

N.T.S.



TYPICAL SECTION

SCALE: 1" = 20'



ELEVATION VIEW

SCALE: 1" = 20'

Notes:

1. Elevations are shown based on National Geodetic Vertical Datum, 1929 (NAVD 29).
2. See Rdwy Plans for proposed grading on Cedar Mill Creek.
3. See Utility Sheets for proposed utility locations and existing utility relocation implementation.
4. Elevations provided are at the top of roadway.
5. Proposed riprap not shown for clarity, see sht S-5 for proposed limits and details.

REGISTERED PROFESSIONAL ENGINEER 88456PE OREGON NOV 12, 2013 ANDY BOWEN

EXPIRES: 12/31/2019

WASHINGTON COUNTY OREGON Department of Land Use & Transportation

WHPacific

PLOT STAMP: 03/13/19 3:00P MBINDAL
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NO. | REVISIONS

SW Jenkins Road
SW 158th Avenue - SW Murray Boulevard
WASHINGTON COUNTY

Jenkins Rd. Bridge over Cedar Mill Creek
PLAN & ELEVATION

PROJECT NUMBER 100240

SHEET NO. 1 OF 39

SHEET TITLE S-1

REGISTERED PROFESSIONAL ENGINEER
57790PE
OREGON
JUL 11, 2006
JASON T. TRUONG
EXPIRES: 06/30/2020

WASHINGTON COUNTY OREGON
Department of Land Use & Transportation

WHPacific

PLOT STAMP: 03/01/19 12:13P BWALKER
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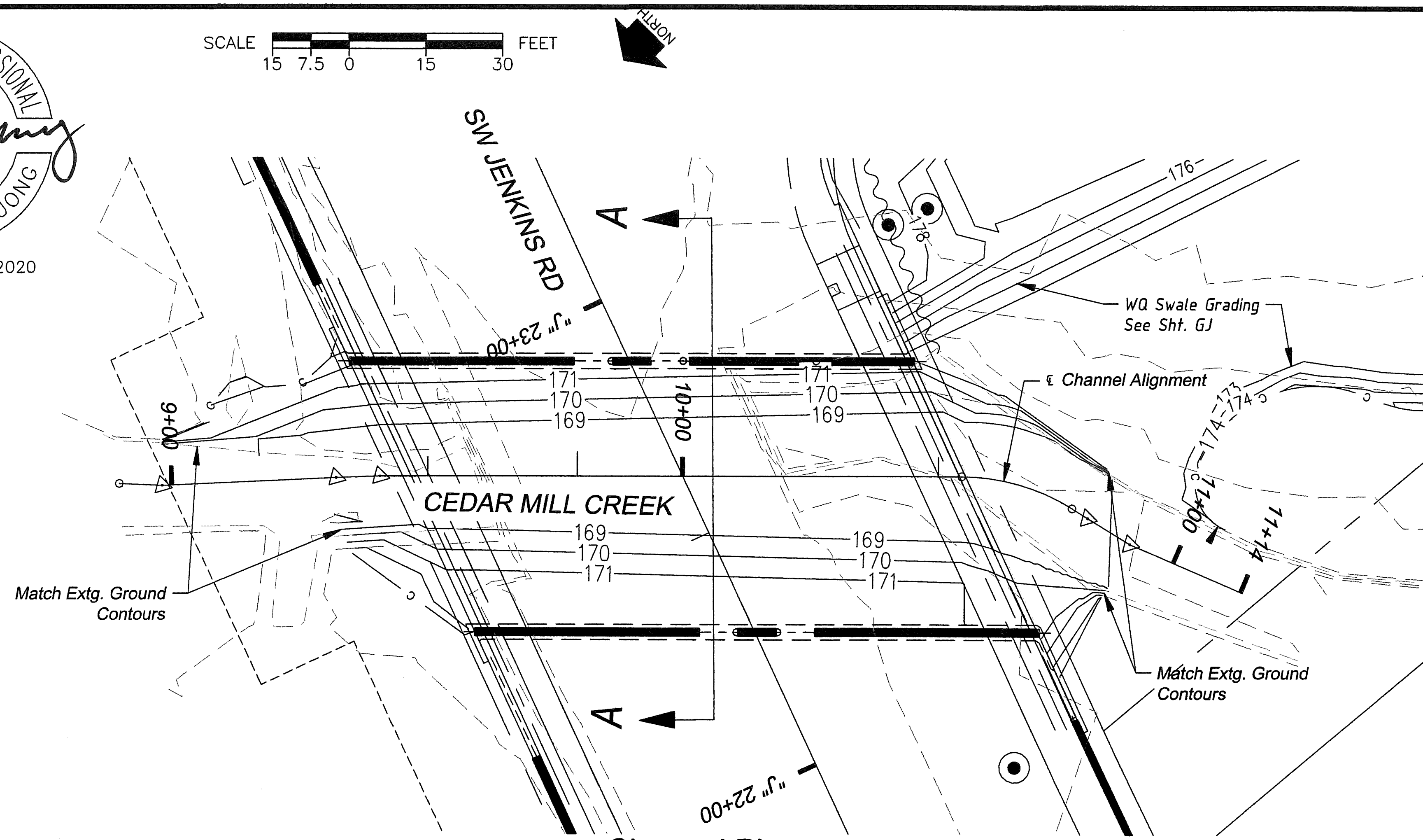
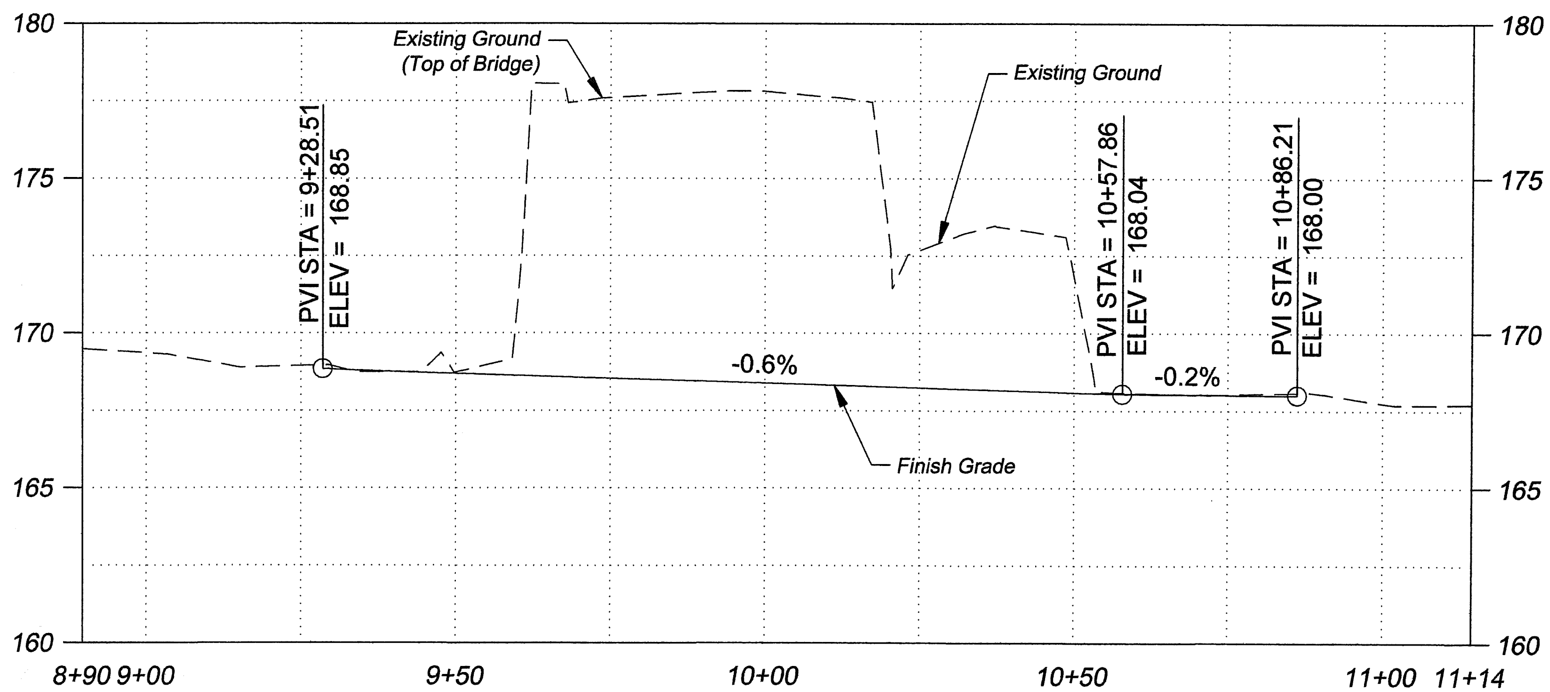
NO.	REVISIONS

SW Jenkins Road
SW 158th Avenue - SW Murray Boulevard
WASHINGTON COUNTY

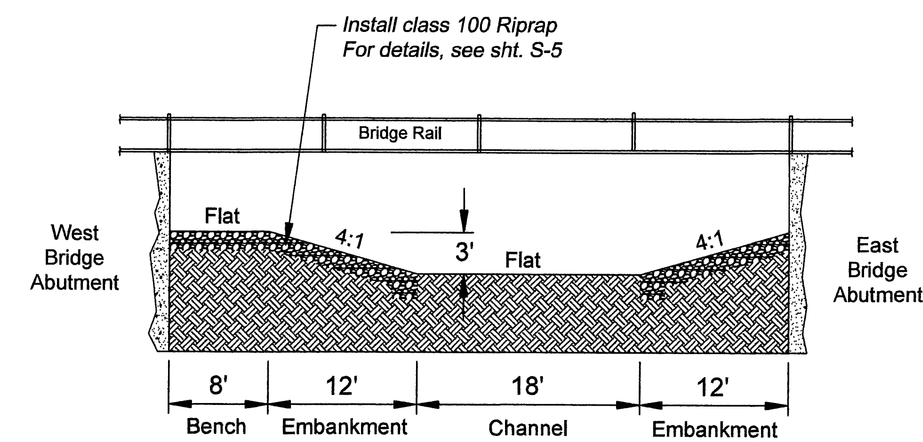
CEDAR MILL CREEK
CHANNEL GRADING PLAN



Channel Plan

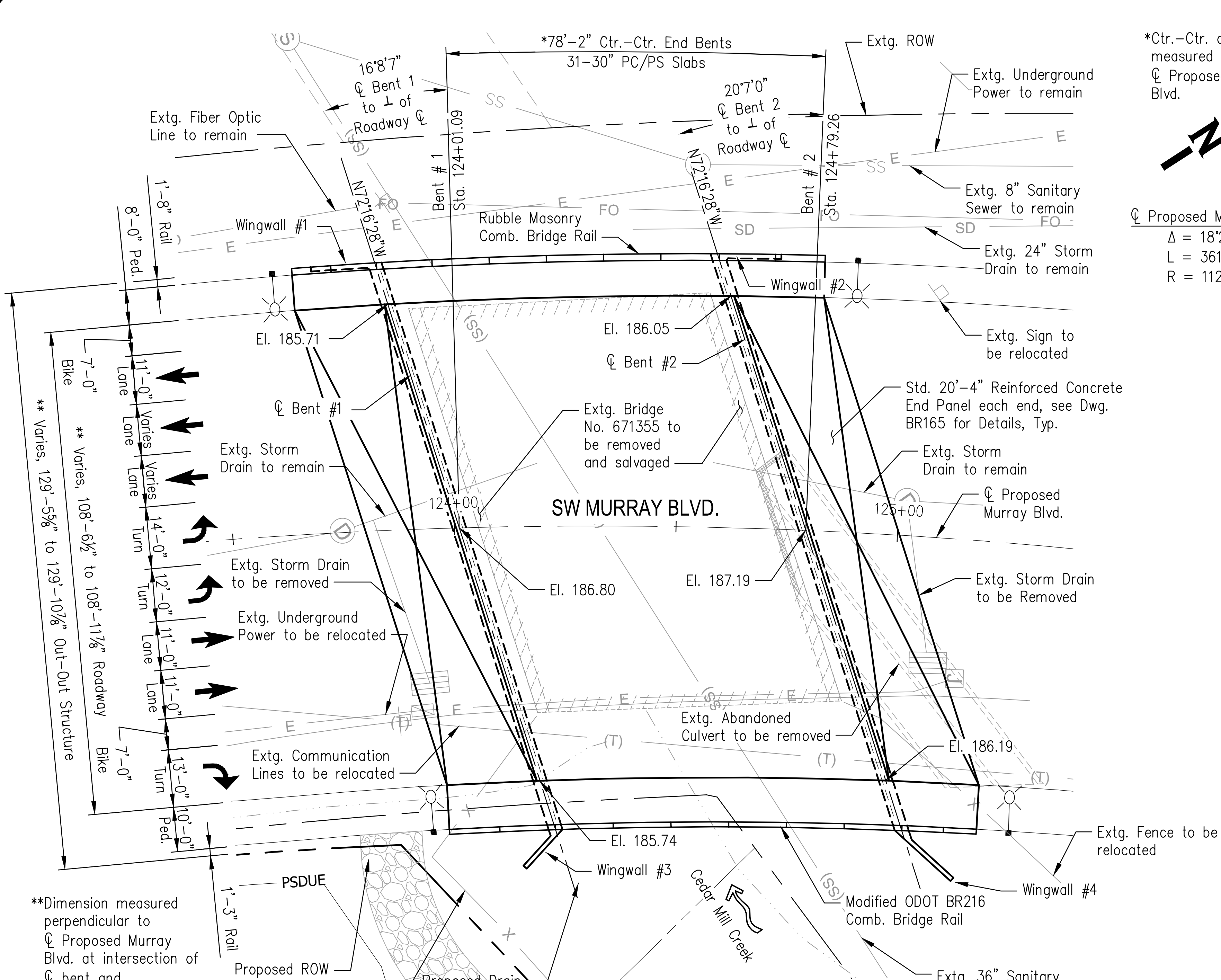


℄ Channel Profile



Channel Section A-A

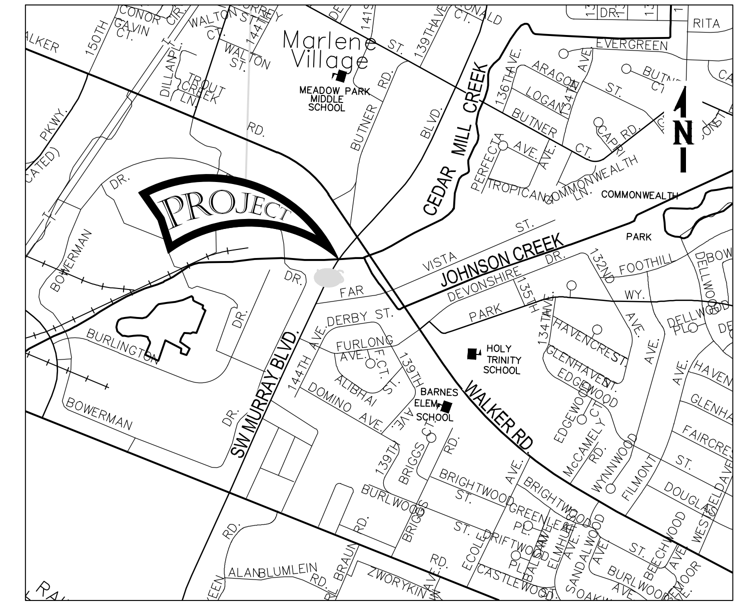
PROJECT NUMBER
100240
SHEET NO.
---- OF
SHEET TITLE
2B-16



PLAN
SCALE: 1" = 30'

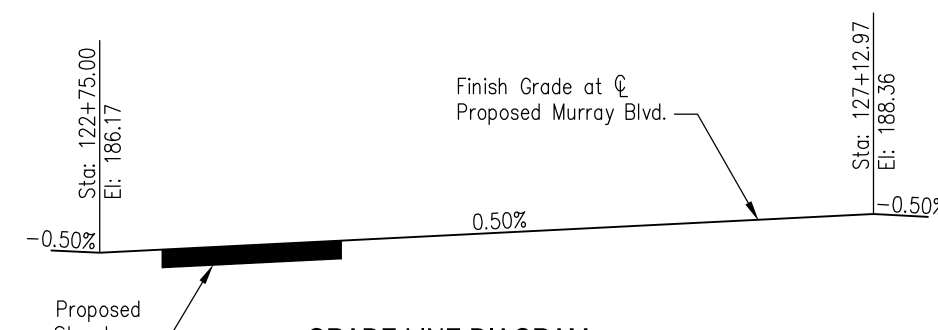
*Ctr.–Ctr. distance measured along ℄ Proposed Murray Blvd.

℄ Proposed Murray Blvd.
Δ = 18°26'00"
L = 361.94'
R = 1125.00'

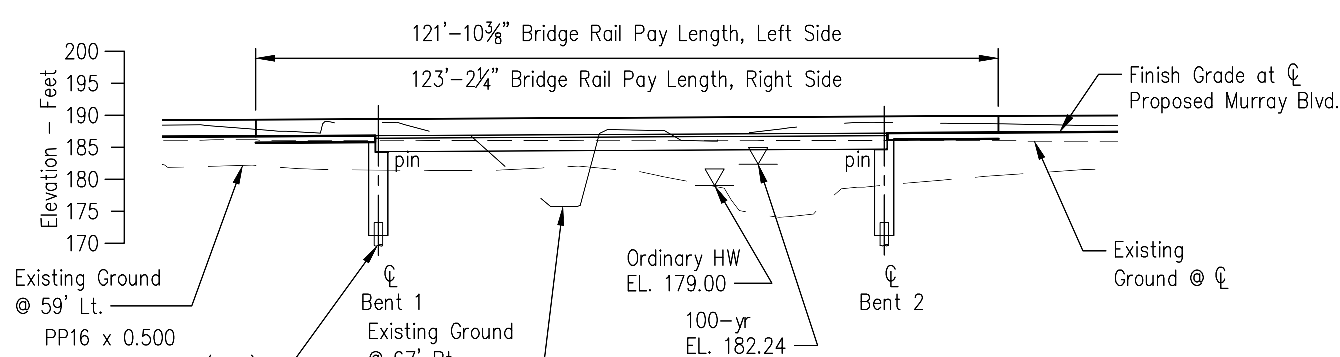


SEC. 33 T1S, R1W, WM.

LOCATION MAP
SCALE: NTS



GRADE LINE DIAGRAM
SCALE: NTS



ELEVATION
SCALE: 1" = 30'

Notes:
1. Elevations are shown based on National Geodetic Verical Datum, 1929 (NAVD 29).
2. See Rdwy Plans for proposed grading on Cedar Mill Creek.
3. Elevations provided are at the top of roadway.

PRELIMINARY FOR INFORMATION ONLY

NOT FOR CONSTRUCTION

SCALE WARNING: IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE.

PROJECT NUMBER 100238

WASHINGTON COUNTY OREGON
Department of Land Use & Transportation

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	BY	DATE
DRWN	TAC	6/13/16
DSGN	RJC	6/13/16
CHKD	ARB	6/13/16

WALKER/MURRAY IMPROVEMENTS
WALKER ROAD & MURRAY BLVD INTERSECTION
CITY OF BEAVERTON / WASHINGTON COUNTY

MURRAY BLVD. BRIDGE PLAN & ELEVATION

SHEET NO.
OF
SHEET TITLE
SM-1

Plot Stamp: 4/4/2019 5:31:01 PM - Mukul Bindal
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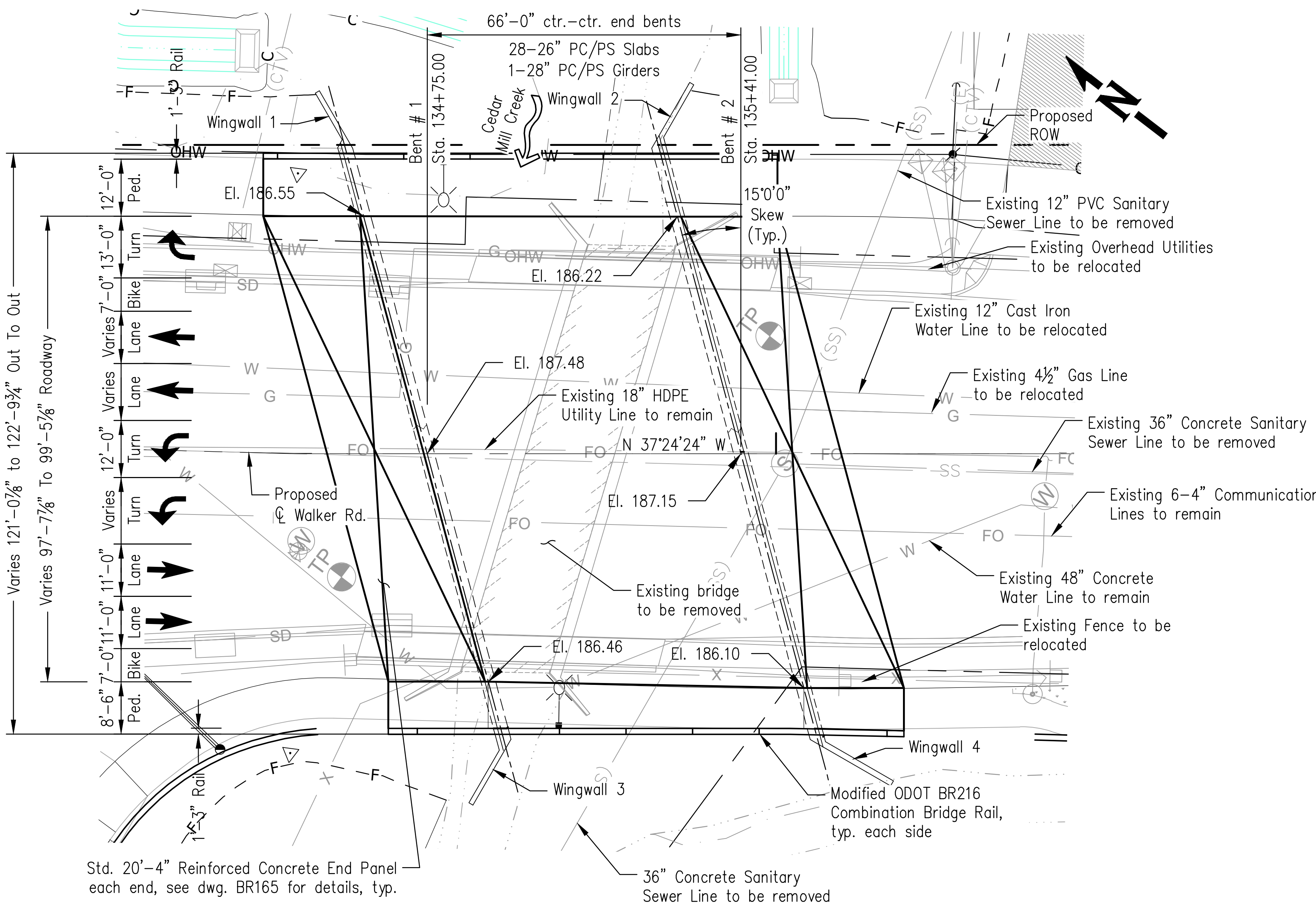
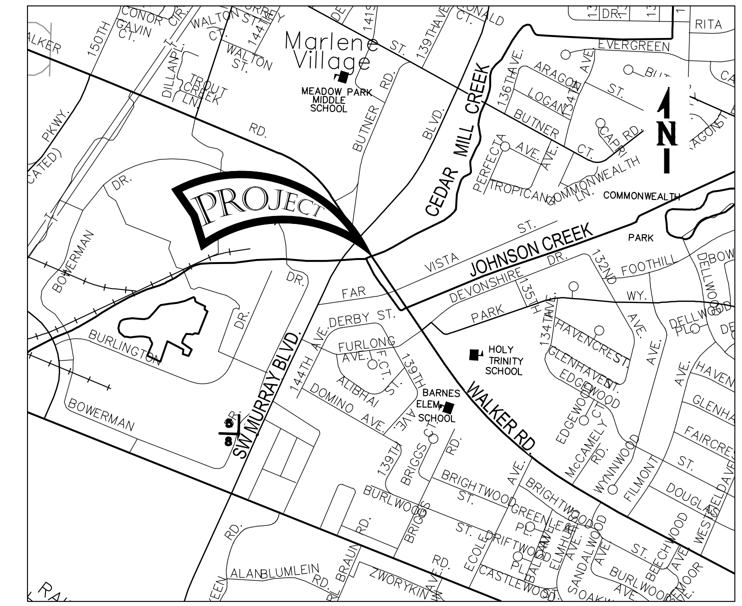
PRELIMINARY FOR INFORMATION ONLY

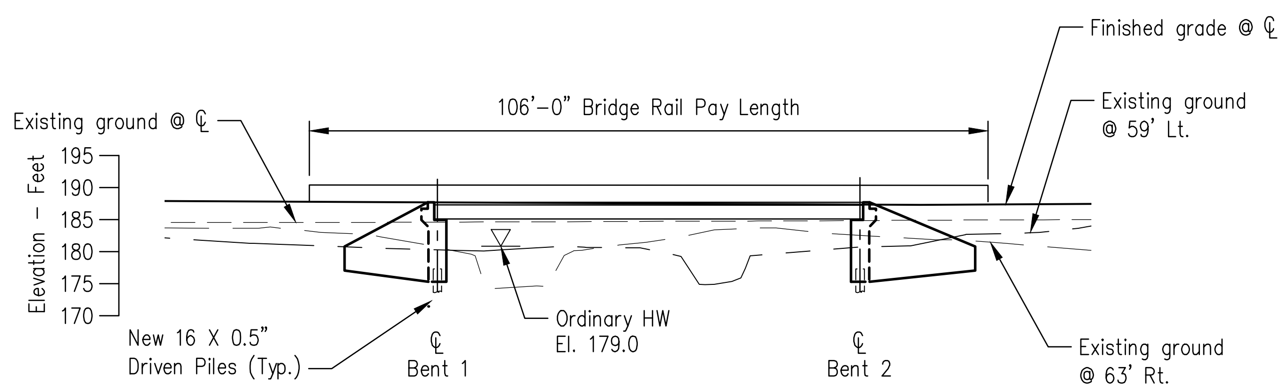


PLAN VIEW
SCALE: 1" = 30'



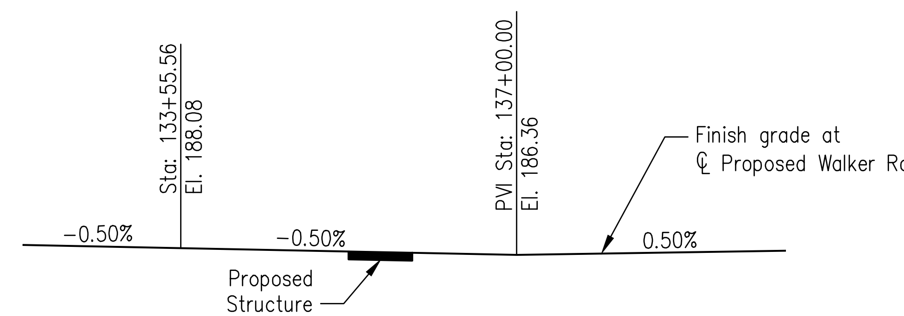
SEC. 33 T1S, R1W, WM.

LOCATION MAP
SCALE: NTS



ELEVATION VIEW
SCALE: 1" = 30'

NOTE:
See Sheet X-XX for new channel grading and creek alignment.



GRADELINE DIAGRAM
SCALE: NTS

SCALE WARNING:
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE.

NOT FOR CONSTRUCTION

PROJECT NUMBER
100238

WASHINGTON COUNTY OREGON
Department of Land Use & Transportation
WHPacific

NO.	REVISIONS

	BY	DATE
DRWN	MGF	4/4/19
DSGN	RJC	4/4/19
CHKD	ARB	4/4/19

WALKER/MURRAY IMPROVEMENTS
WALKER ROAD & MURRAY BLVD INTERSECTION
CITY OF BEAVERTON / WASHINGTON COUNTY

WALKER RD BRIDGE
PLAN & ELEVATION

SHEET NO.
OF
SHEET TITLE
SW-1

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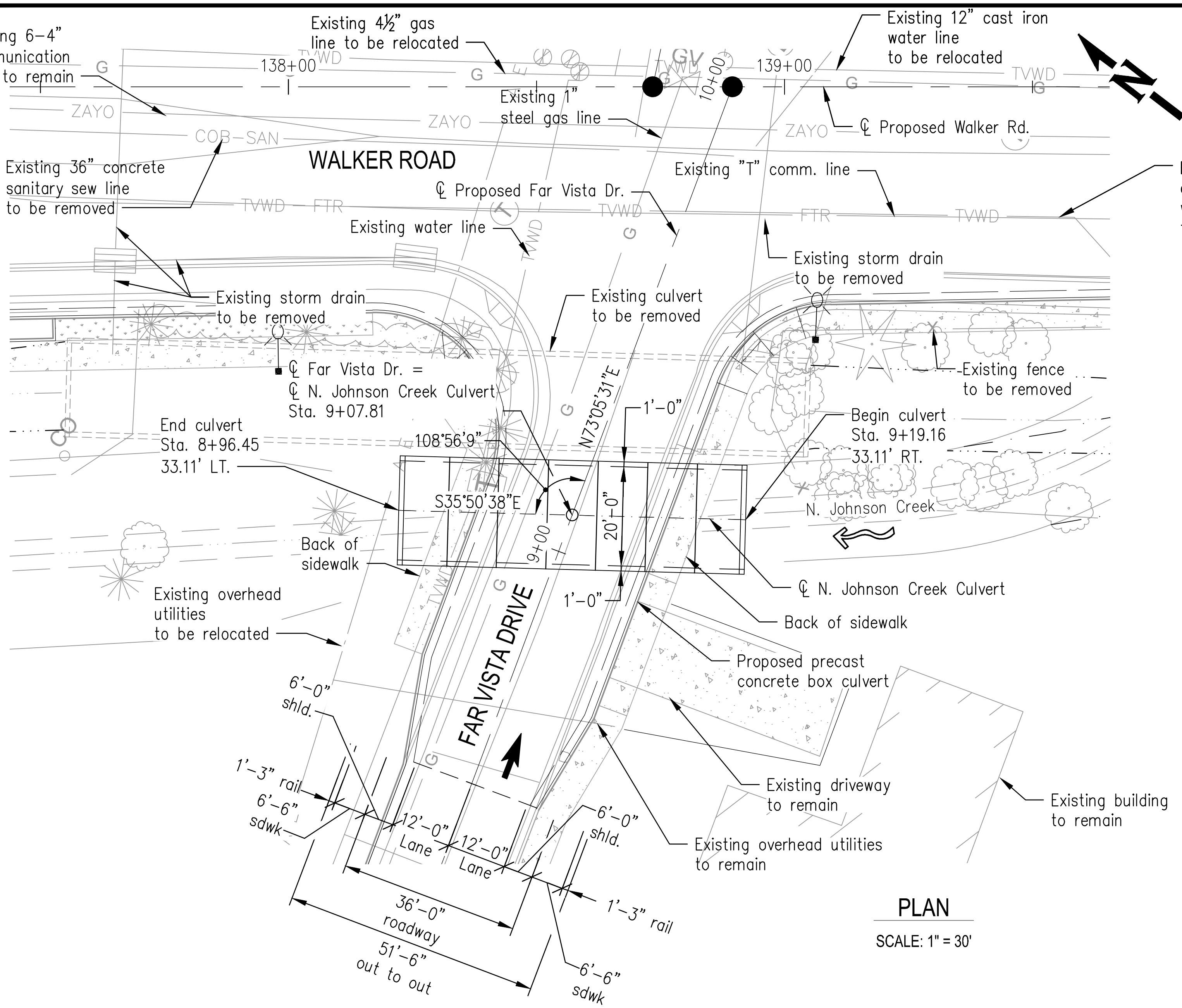
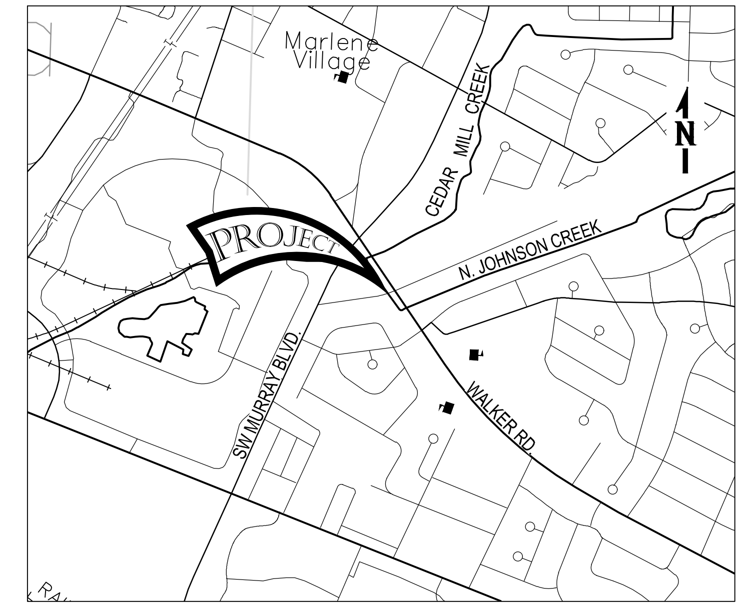
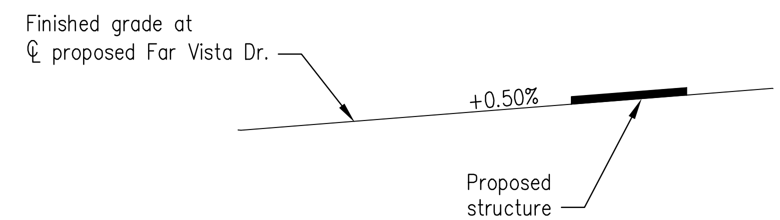


PLAN
SCALE: 1" = 30'

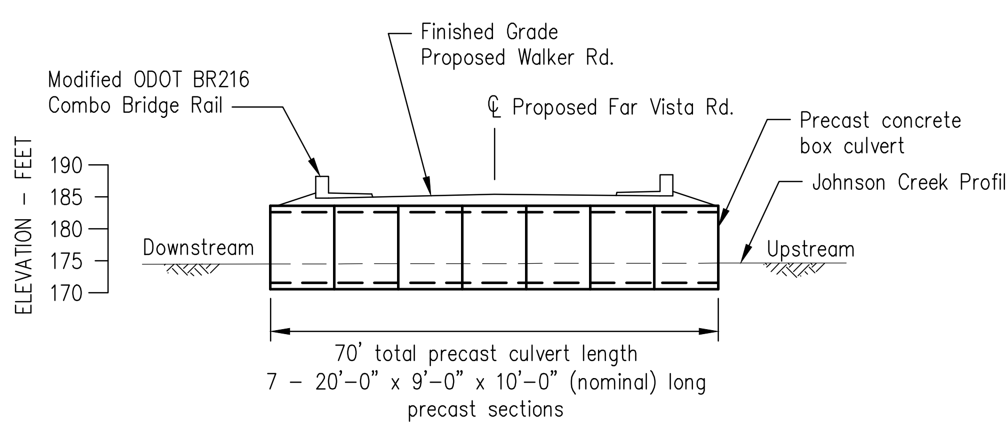


SEC. 33 T1S, R1W, WM.

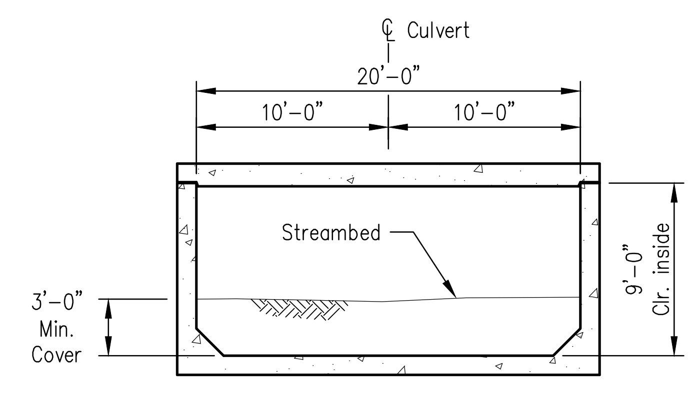
LOCATION MAP
SCALE: NTS



GRADE LINE DIAGRAM
SCALE: NTS



ELEVATION
SCALE: 1" = 30'



TYPICAL SECTION
SCALE: 1" = 10'

PRELIMINARY FOR INFORMATION ONLY

Scale Warning:
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PROJECT NUMBER
100238

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Department of Land Use & Transportation

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NO.	REVISIONS

	BY	DATE
DRWN	NSR	6/1/16
DSGN	RJC	6/1/16
CHKD	NM	6/1/16

WALKER/MURRAY IMPROVEMENTS
WALKER ROAD & MURRAY BLVD INTERSECTION
CITY OF BEAVERTON / WASHINGTON COUNTY

FAR VISTA DR CULVERT
PLAN AND ELEVATION

SHEET NO.
OF
SHEET TITLE
S-4

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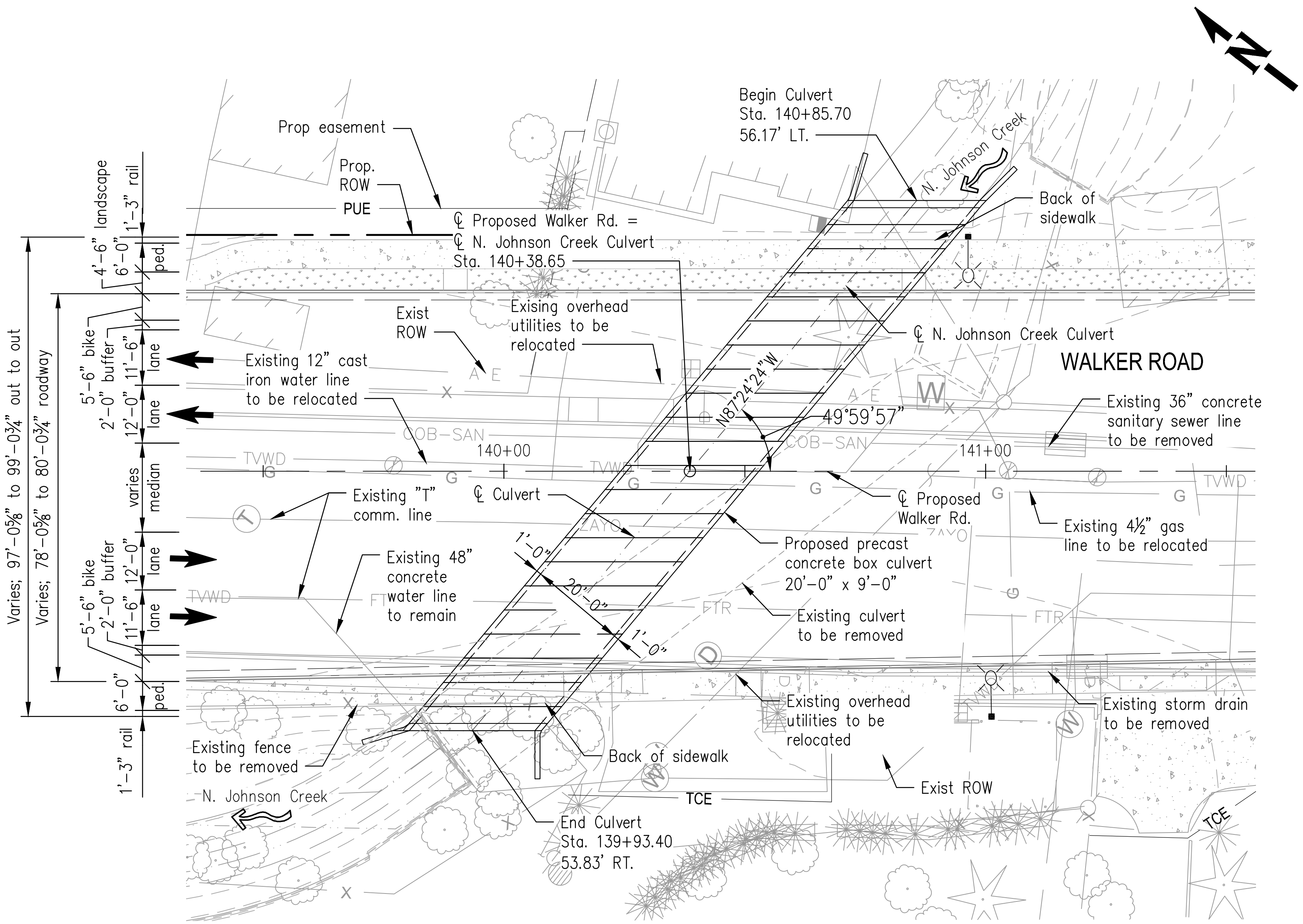
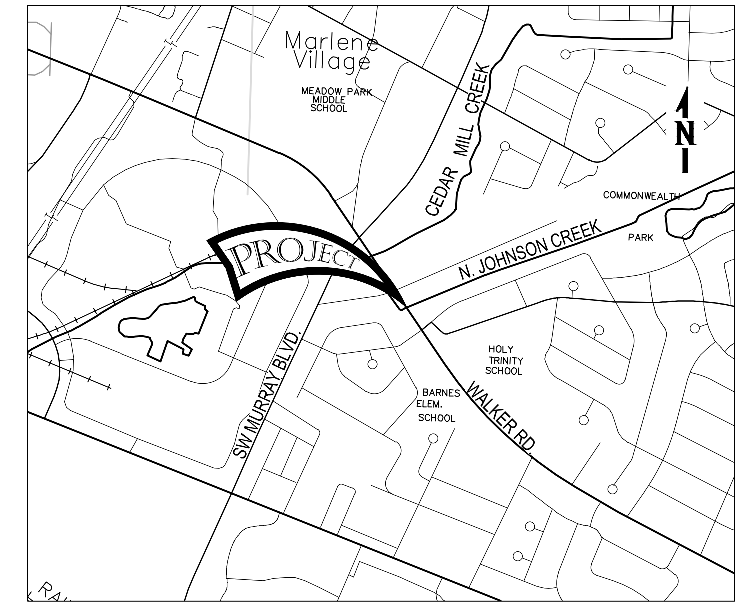
PRELIMINARY FOR INFORMATION ONLY

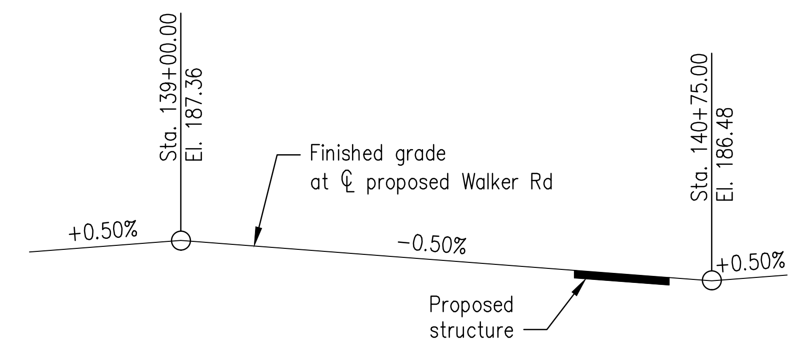


PLAN
SCALE: 1" = 30'

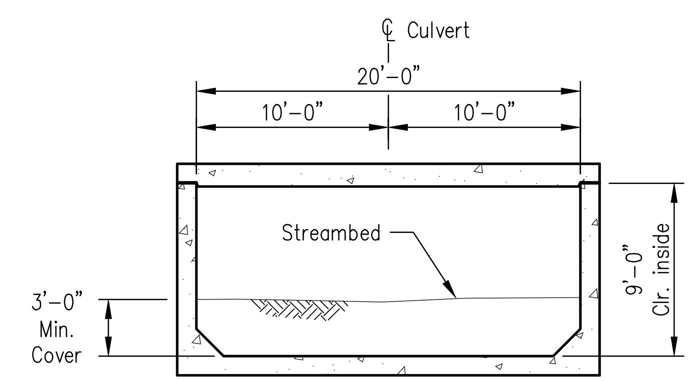


SEC. 33 T1S, R1W, WM.

LOCATION MAP
SCALE: NTS



GRADE LINE DIAGRAM
SCALE: NTS



TYPICAL SECTION
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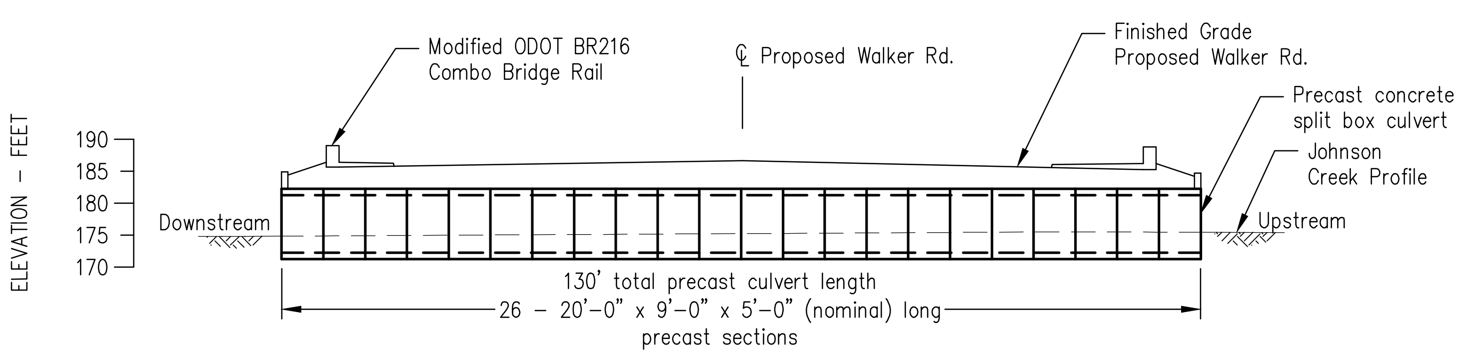

ELEVATION
SCALE: 1" = 30'

Scale Warning:
If this bar does not measure 1" then drawing is not to scale.

PROJECT NUMBER
100238

WASHINGTON COUNTY OREGON
Department of Land Use & Transportation

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NO.	REVISIONS

	BY	DATE
DRWN	NSR	6/1/16
DSGN	RJC	6/1/16
CHKD	NM	6/1/16

WALKER/MURRAY IMPROVEMENTS
WALKER ROAD & MURRAY BLVD INTERSECTION
CITY OF BEAVERTON / WASHINGTON COUNTY

WALKER ROAD CULVERT
PLAN & ELEVATION

SHEET NO.
OF
SHEET TITLE

Plot Stamp: 3/15/2020 3:13:02 PM - Travis Sater
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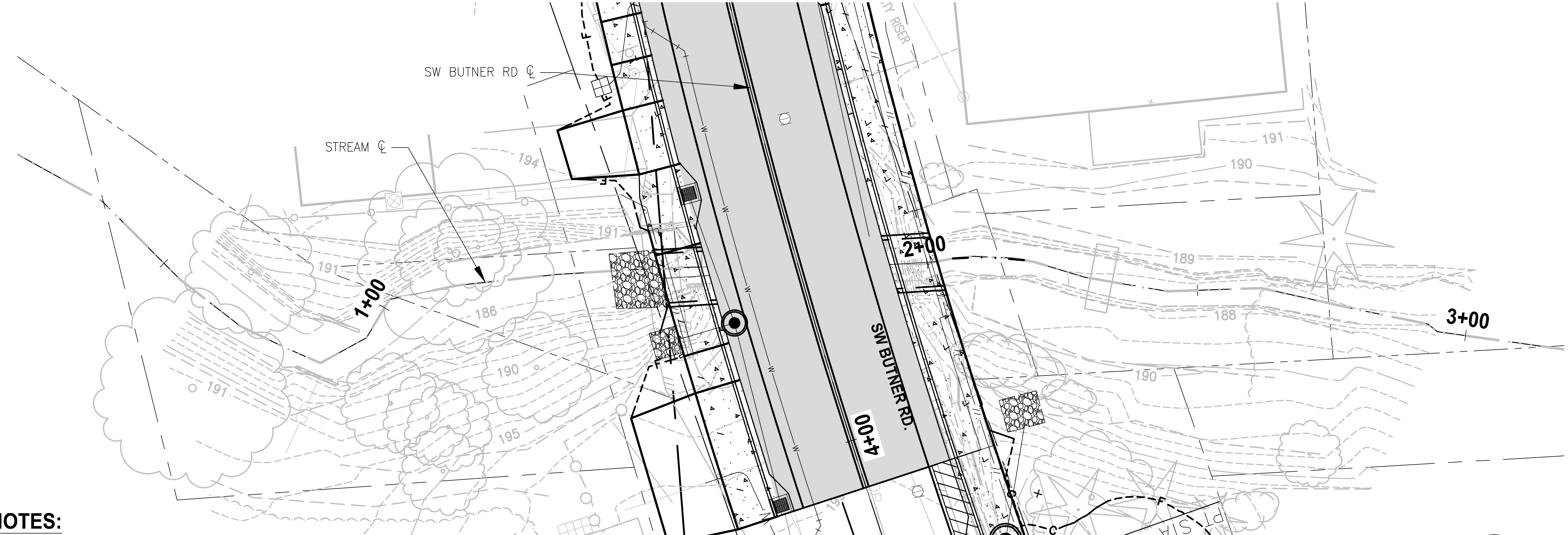
CULVERT #1623 PLAN & PROFILE

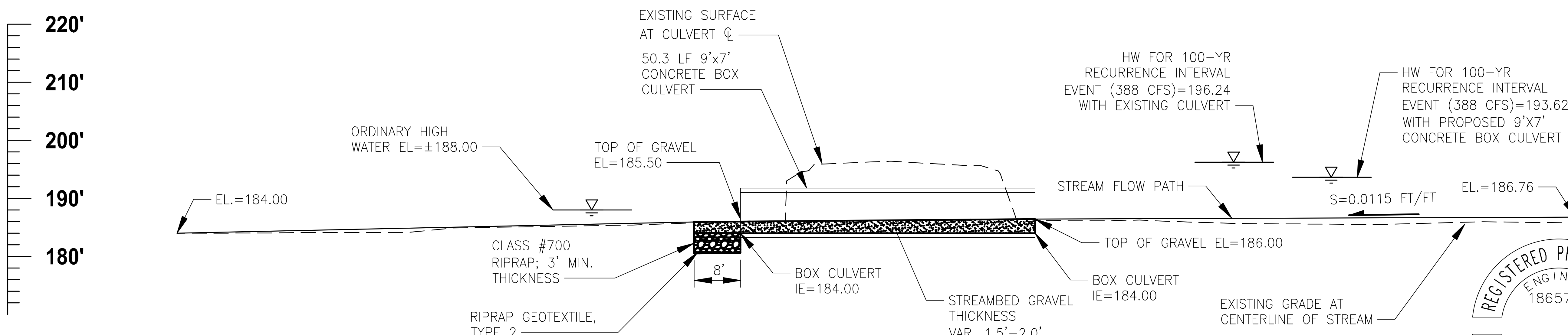


NOTES:

1. ACTIVE CHANNEL WIDTH ±8 FEET AT CULVERT OUTLET.
2. RESTORE DISTURBED CHANNEL CROSS SECTION, TO GRADING EXTENTS, TO MATCH UNDISTURBED SECTION.
3. REGRADE STREAM AS DIRECTED BY ENGINEER TO TRANSITION STREAMBED TO CULVERT.
4. PLACE ALL GRANULAR STRUCTURAL BACKFILL MATERIAL WITHIN PIPE ZONE IN LIFTS NOT TO EXCEED 6".

CULVERT PLAN
1"=20'

SCALE IN FEET
0 20 40



CULVERT PROFILE
1"=20'

REGISTERED PROFESSIONAL ENGINEER
18657PE
OREGON
JULY 16, 1996
JEFFREY L. COOP
EXPIRES: DEC. 31, 2019

95% REVIEW

Department of Land Use & Transportation
WASHINGTON COUNTY OREGON

Parametrix
ENGINEERING . PLANNING . ENVIRONMENTAL SCIENCES
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PLOT STAMP: 10/22/19 7:36A HANSEHAL
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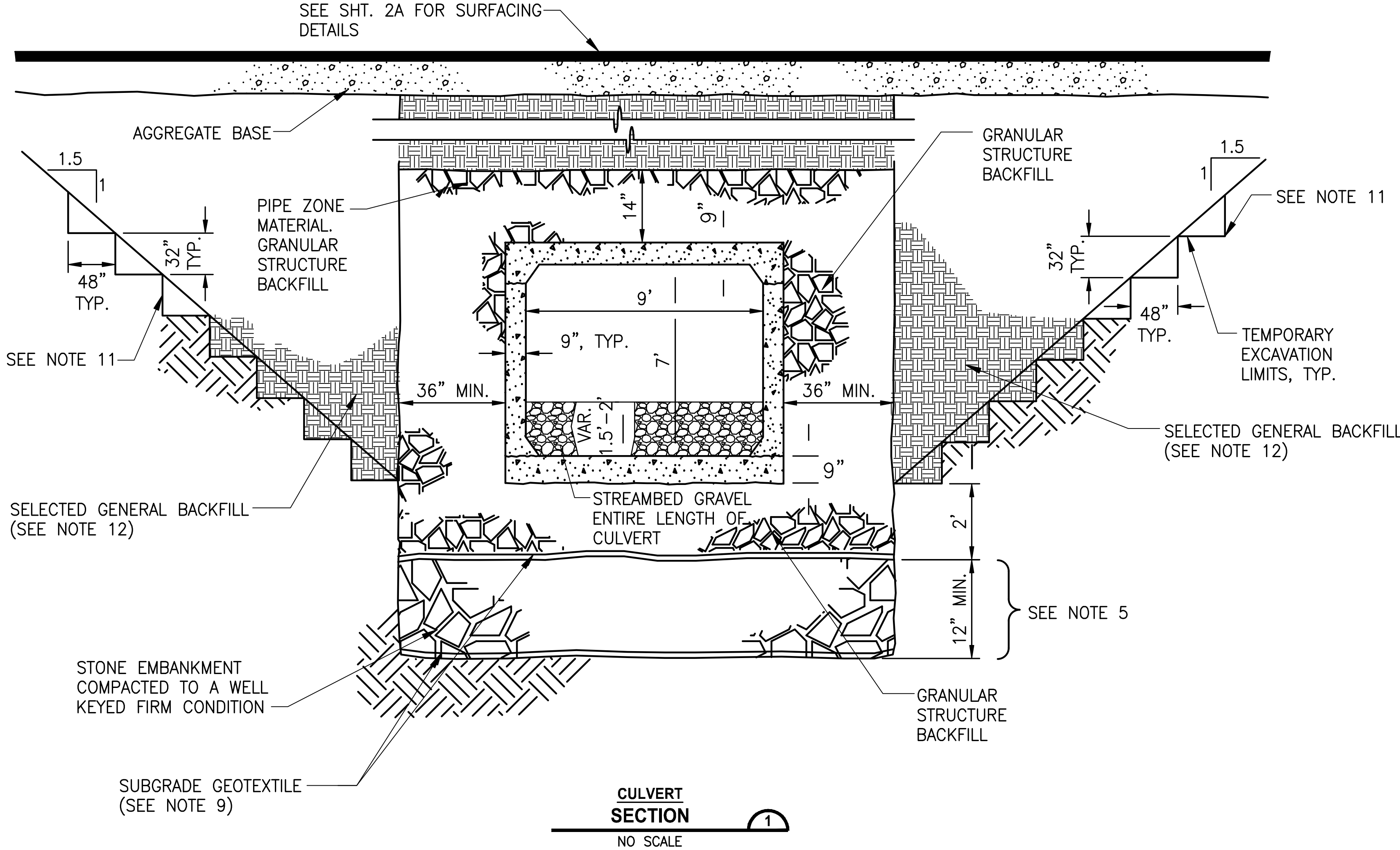
NO.	REVISIONS

SW BUTNER RD CULVERT #1623 REPLACEMENT
SW BUTNER RD
WASHINGTON COUNTY

CULVERT #1623 PLAN & PROFILE

PROJECT NUMBER
100306
SHEET NO.
34 OF 39
SHEET TITLE
GE

CULVERT #1623 DETAILS



CULVERT SECTION (1)
NO SCALE

NOTES:

1. RESTORE DISTURBED CHANNEL CROSS SECTION TO MATCH UNDISTURBED SECTION.
2. REGRADE STREAM WITHIN ROW AS DIRECTED TO TRANSITION STREAMBED TO CULVERT.
3. FILL WITHIN PIPE ZONE SHALL BE PLACED IN 6" LIFTS AND COMPACTED WITH HAND-OPERATED EQUIPMENT.
4. CULVERT SHALL BE REINFORCED CONCRETE BOX CULVERT CONFORMING TO ASTM C1433. REINFORCEMENT SHALL BE BASED ON DESIGN EARTH COVER SHOWN ON THE PROFILE AND ASTM C1433 TABLE 1.
5. PRIOR TO PLACEMENT OF ANY FILL MATERIAL, OVER-EXCAVATE AND BACKFILL, WITH SELECT STONE BACKFILL, ANY SOFT SUBGRADE AREAS AS DETERMINED BY THE ENGINEER.
6. SEE THE CONCRETE PIPE AND BOX CULVERT INSTALLATION MANUAL BY THE AMERICAN CONCRETE PIPE ASSOCIATION FOR INSTALLATION REQUIREMENTS.
7. TRENCH SIDE SLOPE REQUIREMENTS SUBJECT TO ADJUSTMENT BY ENGINEER BASED ON FIELD CONDITIONS.
8. PIPE ZONE MATERIAL SHALL MEET REQUIREMENTS OF OREGON STANDARD SPECIFICATIONS FOR CONSTRUCTION SECTION 00405.13.
9. SUBGRADE GEOTEXTILE SHALL MEET REQUIREMENTS OF OREGON STANDARD SPECIFICATIONS FOR CONSTRUCTION SECTION 02320, TABLE 02320-4.
10. TRENCH BACKFILL SHALL BE CLASS A,B,C, OR D BACKFILL MEETING THE REQUIREMENTS OF THE OREGON STANDARD SPECIFICATIONS FOR CONSTRUCTION SECTION 00405.14.
11. PLACE AND COMPACT NEW EMBANKMENT IN HORIZONTAL LAYERS.
12. SELECTED GENERAL BACKFILL MATERIAL SHALL MEET REQUIREMENTS OF OREGON STANDARD SPECIFICATIONS FOR CONSTRUCTION SECTION 00330.13.

REGISTERED PROFESSIONAL ENGINEER 18657PE OREGON JULY 16, 1996 JEFFREY L. COOP
EXPIRES: DEC. 31, 2019

95% REVIEW

Department of Land Use & Transportation
WASHINGTON COUNTY OREGON
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ENGINEERING . PLANNING . ENVIRONMENTAL SCIENCES
700 NE MULTNOMAH, SUITE 1000 | PORTLAND, OR 97232
P 503.233.2400
WWW.PARAMETRIX.COM
PLOT STAMP: 10/22/19 7:36A HANSEHAL
LAYOUT: GE-2 CULVERT #1623 DETAILS
PATH: ...\99SVCS\CADD\DWG\ 2568-012-C-DT00.DWG
NO. REVISIONS
SW BUTNER RD CULVERT #1623 REPLACEMENT
SW BUTNER RD
WASHINGTON COUNTY
CULVERT #1623 DETAILS
PROJECT NUMBER 100306
SHEET NO. 35 OF 39
SHEET TITLE GE-2

APPENDIX C

ESA COMPLIANCE DOCUMENTS

Appendix C
ESA Compliance Documents

- Nationwide 401 Water Quality Certification Approval for SW Butner Road Culvert Replacement
- Oregon Department of State Lands Removal/Fill Permit for SW Butner Road Culvert Replacement
- *ESA Compliance for CLOMR, SW Murray Boulevard/SW Walker Road Intersection Improvement Project, Washington County, Oregon.* WHPacific (2020).
- Oregon Department of State Lands Removal/Fill Permit for SW Jenkins Road Improvement

About Cardno

Cardno is an ASX-200 professional infrastructure and environmental services company, with expertise in the development and improvement of physical and social infrastructure for communities around the world. Cardno's team includes leading professionals who plan, design, manage, and deliver sustainable projects and community programs. Cardno is an international company listed on the Australian Securities Exchange [ASX:CDD].

Cardno Zero Harm

At Cardno, our primary concern is to develop and maintain safe and healthy conditions for anyone involved at our project worksites. We require full compliance with our Health and Safety Policy Manual and established work procedures and expect the same protocol from our subcontractors. We are committed to achieving our Zero Harm goal by continually improving our safety systems, education, and vigilance at the workplace and in the field. Safety is a Cardno core value and through strong leadership and active employee participation, we seek to implement and reinforce these leading actions on every job, every day.

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