

APPENDIX B

HYDRAULICS REPORT EXAMPLE

Hydraulics Report

For District 4 Drainage & Operations Repairs In Support Of:

Dry Creek Culvert Replacement

Pacific Highway West 1W (OR091), MP 88.20

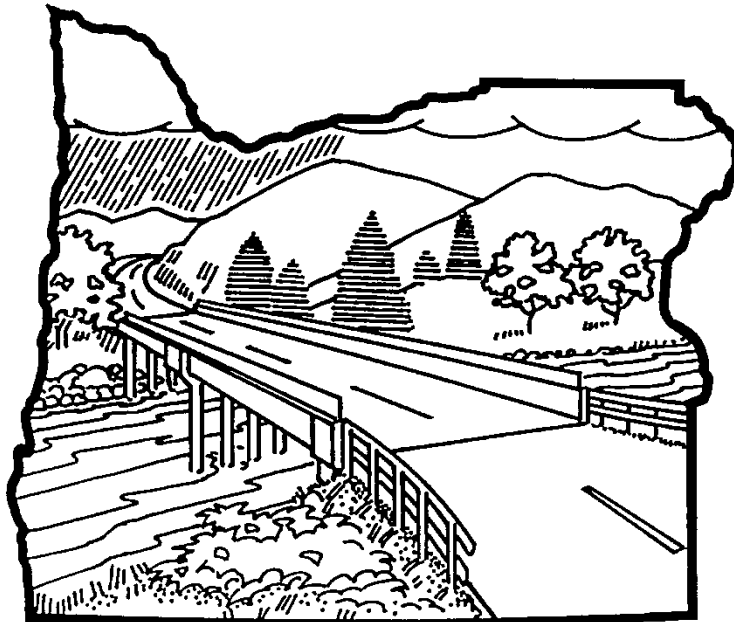
BENTON COUNTY

Published xxxxx xx, 20XX

Bid xxxx, 20XX

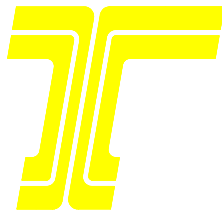
EA PE001234-567

Key # 12345



Prepared By: **XXXX**
Hydraulic Designer

Reviewed By: **XXXX**
Hydraulic Engineer



(Seal Affixed Here)

Oregon Department of Transportation

Table of Contents

HYDRAULICS REPORT SYNOPSIS	5
Introduction	6
Regulatory Requirements and Data for Permits	6
Floodplain Development Regulations	6
Aquatic Species Passage and Riparian Habitat.....	6
Fish Passage Data	7
Ordinary High Water	7
Other Regulations and Requirements	7
Hydrology Information.....	7
Ice and Debris.....	8
Hydraulic Design.....	8
Existing Culvert.....	8
Proposed Culvert	8
Revetment Design.....	9
Temporary Water Management.....	9
Scour.....	10
Detour Structure	10
Table 1, Peak Flow Data.....	8
Table 2, Estimated Discharges for Temporary Water Management.....	10
Table 3, Hydraulic Data, Existing Culverts.....	11
Table 4, Hydraulic Data, Proposed Culverts	12

HYDRAULICS REPORT SYNOPSIS
DRY CREEK CULVERT REPLACEMENT, BRIDGE #19590
Benton County

PROJECT TYPE

- | | |
|--|---|
| ☒ Bridge
☐ Replacement
☐ Modernization
☐ Water Quality | ☒ Culvert
☒ Fish Passage
☐ Widening
☐ Water Quantity |
|--|---|

HYDROLOGY

- | | |
|---|---|
| ☐ Stream Gage Data
☐ FEMA - FIS
☐ Parol Evidence
☐ SCS TR-20 | ☒ U.S.G.S. Regression Equa.
☐ Historical Floods
☐ Rational Formula
☐ King County Method |
|---|---|

HYDRAULIC MODEL

- | | |
|--|--|
| ☒ HEC-RAS 4.0
☐ HydroCAD | ☐ Culvert Master
☐ StormCAD |
|--|--|

CONCERNS

- | Yes | No | Concern |
|-------------------------------------|-------------------------------------|---|
| ☐ | ☒ | Ice has been a problem. |
| ☐ | ☒ | Debris has been a problem |
| ☐ | ☒ | Erosion has been a problem |
| ☐ | ☒ | Scour has been a problem. |
| ☐ | ☒ | Channel aggradation/degradation has been a problem. |
| ☐ | ☒ | Roadway overtopping has occurred. |
| ☒ | ☐ | Fish passage required. |
| ☐ | ☒ | Threatened and Endangered species on this project. |
| ☒ | ☐ | Flood plain development regulations. |
| ☐ | ☒ | “No rise” in 100 year floodplain regulation. |
| ☐ | ☒ | Navigational clearance is required |

Introduction

Currently, there are two 4 ft. diameter concrete culverts approximately 98 ft. long with headwalls on both the upstream and downstream ends. Several years ago, part of the east (downstream) slope of the highway failed and blocked off the outlet of the south culvert. Maintenance crews constructed a repair by attaching a CMP extension to the north culvert, constructing a stone embankment and using salvaged concrete bridge rail as a retaining wall. The repair constructed by the maintenance crew is only a temporary solution and the slope on the east side of the highway is unstable and inadequately supports the guardrail and the roadway.

The existing single, smooth barrel culvert is hydraulically inadequate and it blocks upstream fish passage. Due to the small diameter of the existing culvert, the velocity in the culvert can be too high for fish passage during almost all high flow events. Additionally, during lower flow events, there is a small jump between the culvert outlet and the scour pool at the outlet.

Since the existing structure is a pair of culverts each less than 6 feet in diameter, there is no existing bridge number. The ODOT bridge number for the new structure is 19590.

All elevations in this report are based on the project datum, the NGVD 1929.

On Hwy 99W at Airport Road, the 2000 ADT is 6300. The DHV is 0.15 times the ADT; therefore the DHV is 945. Since the DHV is greater than 100, therefore the storm design recurrence interval is 50 years (ODOT Hydraulics Manual).

Regulatory Requirements and Data for Permits

Floodplain Development Regulations

The culvert is in Zone A, “Area of Special Flood Hazard” as designated by the Flood Insurance Rate Maps produced by the Federal Emergency Management Agency (FEMA). The culvert is subject to Benton County floodplain restrictions.

The county floodplain development regulations require that adequate protection (either rock armoring or vegetative cover) be provided to fill slopes exposed to the 100-year flood depending on the velocity of the flood waters. The proposed design will meet these requirements.

Benton Country development codes require that the structure in the floodplain shall not increase the water surface elevation of the base flood more than 1 foot at any point. The proposed culvert design meets these criteria, as is evident upon examination of the base flood headwater elevations calculated for the existing and proposed culverts (see Table 1 and Table 2).

Aquatic Species Passage and Riparian Habitat

The culvert is designed to pass fish as per a request from the Oregon Department of Fish and Wildlife (ODFW). It meets the standards in the ODFW “Standards and Criteria for Stream Road Crossings” dated September 16, 1996. The ODFW requires data on fish passage and a description of fish passage design features when they review the project plans. The fish passage information below applies to the culvert described in this Hydraulic Report.

Fish Passage Data

Width of Active Channel: 12 ft.

Width of Culvert: 12ft. diameter circular steel pipe

Design Features Include:

1. The proposed culvert will span the active stream channel and incorporate streambed simulation.
2. The steel pipe will be placed on a 1.34% slope.
3. The steel pipe will be filled 4 ft deep with bed material. This will allow a natural channel bottom to form in the culvert barrel.
4. There will be a series of sediment retention baffles in the pipe. See Figure 2.

See Figures 1, 2, and 3 for details of the proposed culvert.

The instream work period for Dry Creek is July 1 to October 15 unless otherwise specified by the ODFW.

Ordinary High Water

The ordinary high water elevation is listed in the tables, and is based on a visual field inspection.

Other Regulations and Requirements

The culvert is an outfall for the airport/industrial area drainage basin per the South Corvallis Drainage Master Plan (KCM, 1998). The culvert has been checked to verify it will perform adequately during the published design discharge for the airport area basin. This is shown in Table 2.

Dry Creek is not recognized as a navigable waterway by the Division of State Lands pursuant to ORS 274, therefore, navigational clearance is not required.

Hydrology Information

The drainage basin of Dry Creek is a relatively small area (4.15 sq. mi.) that includes the Corvallis Airport and the farmland surrounding the airport. The basin has flat topography and is located entirely on the floor of the Willamette Valley. Dry Creek empties into the Booneville Slough, which once was a main channel of the Willamette River, but is now a backwater area for the Willamette River.

The Dry Creek drainage basin lies partially inside the Corvallis Urban Growth Boundary. For calculation purposes, build-out conditions were assumed inside the UGB, which is zoned light industrial, intensive industrial, and Public-Institutional (airport). While approximately 57% of the basin is farmland, and will likely continue to remain so since it lies outside of the UGB, the major source of flooding will be runoff from impervious surfaces located in the industrial zones and the airport. To determine the flows during certain storm events, the NRCS TR-55 method was used. The following table summarizes the flows.

Method	2-year event (cfs)	5-year event (cfs)	10-year event (cfs)	25-year event (cfs)	50-year event (cfs)	100-year event (cfs)	500-year event (cfs)
NRCS TR-55	500	616	664	885	976	1025	1250*
South Corvallis Drainage Master Plan prepared by KCM, Inc.	N/A	N/A	N/A	N/A	865	901	

Table 1, Peak Flow Data

*By extrapolation from data.

The South Corvallis Drainage Master Plan drew the Dry Creek watershed boundaries at the Urban Growth Boundary (UGB), even though areas outside of the UGB drain into the watershed. Consequently, the watershed area in the South Corvallis Drainage Master Plan is approximately 1000 acres smaller than the watershed determined by consulting a USGS quad map. Because of this discrepancy, the flow amounts for Dry Creek from the South Corvallis Drainage Master Plan were not considered when determining the flow of the 50-year event. The South Corvallis Drainage Master Plan was consulted for general information about land use in the Dry Creek watershed.

Ice and Debris

The drainage basin for Dry Creek is located entirely on the Willamette Valley floor, therefore, ice and snow debris will be an unlikely occurrence. The current primary land use in the drainage basin is agriculture and public-institutional (airport). The future land use in the basin will include agriculture, public-institutional, light industrial and intensive industrial. Large debris, such as trees, is not anticipated given the current and future land use in the basin.

Hydraulic Design

Existing Culvert

The existing culverts are 4 ft. diameter, approximately 98 ft. long. The south culvert is blocked at the outlet. The culverts are being replaced because they are hydraulically inadequate and block upstream fish passage. The hydraulic performance of the existing culverts is summarized in Table 1.

Proposed Culvert

The proposed culvert is a 12 ft. diameter steel pipe, approximately 117 ft. long, installed by using trenchless installation techniques. The hydraulic performance of the proposed culvert is summarized in Table 2, and the culvert is shown in Figure 1. The pipe will be installed at a 1.34% slope, which is the overall slope of the stream channel.

The proposed culvert shall have a 30 degree right hand forward skew to the centerline of the highway. Placing the proposed culvert at the skew angle will eliminate the current scour

problem in the stream banks that occurs at the outlet of the existing culverts. See the “Scour” section of this report.

The proposed culvert will also have headwalls and retaining walls for protection at scour critical areas. For approximately 2 pipe diameters (24 feet) upstream and downstream of the culvert openings, the retaining walls shall be constructed of a structurally sound material, not necessarily concrete. For example, Hilfiker welded wire walls are an acceptable alternative to concrete walls at this site. Beyond the two pipe diameter distance, the retaining walls can be more biotechnical in nature, for example, Geocell walls with plantings. See Figure 1.

Revetment Design

At the inlet and outlet of the proposed culvert, there will be a headwall and retaining walls to restrain adjacent side slopes as previously discussed. See Figure 3 for details on the wall protection.

Temporary Water Management

During the in-water construction period of July 1 to October 15, flows in Dry Creek will be bypassed around the work area. The conceptual plan for temporary water management (TWM) is to construct one or more temporary dams across the creek upstream from the work area. One or more pumps with fish screens will pump creek flows into a bypass pipe or hose that is run

through the existing culvert to an area in the existing channel downstream from the construction area. There, the water will be released back to Dry Creek. A temporary dam will be constructed if needed, on the downstream side of the construction area. The dam will prevent fish from entering the construction site. As a contingency plan for temporary water management, gravity flow via the existing culvert will remain an option during construction. Fish passage will be blocked throughout the construction period.

DRY CREEK AT HWY 99W

ESTIMATED DISCHARGES FOR TEMPORARY WATER MANAGEMENT

	AVERAGE DAILY DISCHARGE IN CUBIC FEET PER SECOND (GALLONS PER MINUTE)		
NOTE	1	2	3
JULY	3.1 (1,400)	2.0 (900)	1.4 (630)
AUGUST	2.0 (900)	1.1 (490)	0.77 (350)
SEPTEMBER	2.5 (1,100)	1.3 (580)	0.68 (310)
OCTOBER	11.0 (5,000)	3.3 (1,500)	1.4 (630)

- 1) Average Exceedance Discharge (Average daily discharge expected to be exceeded 2 days each month.)
- 2) Average Exceedance Discharge (Average daily discharge expected to be exceeded 8 days each month.)
- 3) Average Exceedance Discharge (Average daily discharge expected to be exceeded 16 days each month)

In-Water work period extends from 1 July through 15 October

Listed discharges are surface water from the upstream watershed. The estimated discharges are based on nearby gaged basins. Discharges in the subject watershed may differ.

Table 2, Estimated Discharges for Temporary Water Management

Scour

There is an existing scour problem at the stream bank downstream of the existing culverts. Due to the alignment of the existing culverts, during high flow events the water exits the existing open culvert and hits the bank nearly perpendicularly. This has caused a large scour hole. Placing the proposed culvert at a 30 degree skew angle will eliminate further scour at the scour hole. In addition, downstream scour from the proposed culvert will be further reduced downstream because it does not constrict the flow like the existing culvert does.

The proposed culvert will accommodate long-term profile changes, such as the future degradation of the channel bed.

Detour Structure

Because the culvert is being replaced using trenchless construction methods, the highway is anticipated to remain open to traffic during construction and will eliminate the need for a detour structure. Hwy 99W is also the designated detour route for heavy haul trucks until three bridges on I-5 near Eugene are replaced.

Project: District 4 Drainage & OPS Repairs
 Dry Creek Culvert
 Pacific Highway West 1W (OR 091) at M.P. 88.20
 Benton County
 Key No. 12366

Compiled By: _____ (name) _____
 Date: 03/04/03

Existing Culverts	HYDRAULIC DATA			
	DESIGN EVENT	BASE FLOOD	MAXIMUM PROBABLE FLOOD	ORDINARY HIGH WATER
Discharge (cfs)	976 ¹	1025 ²	1250 ³	
Recurrence (yrs) Interval	50	100	500	Annual
Highwater Elevation (feet) Of Natural Channel At Culvert Invert	217.9 (228.1)	218.2 (229.4)	218.8 (232.6)	
Headwater Elevation (feet) At Culvert Inlet	237.7 (237.9)	237.7 (238.0)	238.0 (238.3)	215.5
Backwater Depth (feet) At Culvert Inlet	19.8 (9.8)	19.5 (8.6)	19.2 (5.7)	
Tailwater Elevation (feet) At Culvert Outlet	217.4 (228.1)	217.6 (229.3)	218.3 (232.6)	213.8
Average Velocity (ft/s) At Culvert Outlet	24.3 (17.3)	24.9 (16.3)	24.3 (13.1)	

Table 3, Hydraulic Data, Existing Culverts

The existing culverts are 98 feet long by 4 foot diameter concrete pipe with headwalls on both the upstream and downstream sides. Culvert data assumes that both barrels are operating as designed. Currently, one barrel (the south barrel) is plugged.

Elevations and flow velocities not in parenthesis represent peak flows in Dry Creek with low water elevations in the Booneville Channel (a backwater of the Willamette River). Data in parenthesis represent peak flows in both Dry Creek and coincident highwater elevations in the Booneville Channel. For example, a 100-year discharge occurs in Dry Creek at the same time a 100-year flood elevation occurs in the Booneville Channel.

¹ 607 cfs flows through culvert and 369 cfs flows over the highway.

(434 cfs flows through the culvert and 542 cfs flows over the highway.)

² 625 cfs flows through the culvert and 400 cfs flows over the highway.

(409 cfs flows through the culvert and 616 cfs flows over the highway.)

³ 611 cfs flows through the culvert and 638 cfs flows over the highway.

(328 cfs flows through the culvert and 922 cfs flows over the highway.)

Project: District 4 Drainage & OPS Repairs
 Dry Creek Culvert # 19590
 Pacific Highway West 1W (OR 091) at M.P. 88.20
 Benton County

Compiled By: _(name)_
 Date: 03/31/03

Proposed Culvert	DESIGN EVENT	BASE FLOOD	MAXIMUM PROBABLE FLOOD	SOUTH CORVALLIS DRAINAGE MASTER PLAN
Discharge (cfs)	976	1025	1250 ¹	865
Recurrence (yrs) Interval	50	100	500	50
Highwater Elevation (feet) Of Natural Channel At Culvert Invert	217.9 (228.1)	218.2 (229.4)	218.8 (232.6)	217.5
Headwater Elevation (feet) At Culvert Inlet	218.8 (233.2)	219.4 (234.6)	222.5 (236.9)	217.4
Backwater Depth (feet) At Culvert Inlet	0.9 (5.1)	1.2 (5.2)	3.7 (4.3)	0.1
Tailwater Elevation (feet) At Culvert Outlet	213.9 (228.1)	214.1 (229.3)	214.6 (232.6)	213.6
Average Velocity (ft/s) At Culvert Outlet	12.2 (12.2)	12.8 (12.8)	15.6 (11.8)	10.8

Table 4, Hydraulic Data, Proposed Culverts

Notes:

Elevations and flow velocities not in parenthesis represent peak flows in Dry Creek with low water elevations in the Booneville Channel (a backwater of the Willamette River). Data in parenthesis represent peak flows in both Dry Creek and coincident highwater elevations in the Booneville Channel. For example, a 100-year discharge occurs in Dry Creek at the same time a 100-year flood elevation occurs in the Booneville Channel.

The proposed culvert is a 12 ft. diameter steel pipe, approximately 117 ft. long. The stream bed in the culvert shall be approximately 4 feet above the invert of the pipe, resulting in a cross sectional flow area of 80 ft². The proposed culvert will have a headwall and retaining wall on both the inlet and outlet sides.

Inlet

Pipe elevation – 204.41 ft.
 Channel elevation – 208.4 ft.
 Inlet coefficient – $K_e = 0.50$

Outlet

Pipe elevation – 203.09 ft.
 Channel elevation – 207.1 ft.

The proposed culvert has a 30-degree right hand forward skew and will cross the centerline at station B 21+414.

¹ 1250 cfs flows through the culvert and zero cfs flows over the highway.
 (947 cfs flows through the culvert and 303 cfs flows over the highway.)

