CHAPTER 4
DOCUMENTATION

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4.1 Introduction

This chapter provides hydraulic study documentation guidelines for bridges, culverts, stormwater drainage systems, stormwater water quality treatment facilities, and stormwater storage facilities. These guidelines are for designers within the agency and consultants designing either ODOT projects or local jurisdiction projects administered by ODOT. Additional documentation guidelines for other topics, such as channel and storage facilities, are in their respective chapters.

Proper documentation provides:

- essential information for planning and environmental studies, regulatory and permit documents, and design,
- data for operation and maintenance,
- justification for the expenditure of public funds and the selection of structure type,
- future reference for engineers and others if an improvement, change, or rehabilitation is needed,
- information for the development of defense in matters of litigation, and
- public information.

The documentation level is often proportional to the study importance and complexity. Documentation almost always consists of:

- the Preliminary Hydraulic Recommendations (hydraulic and/or stormwater),
- the Report(s) (hydraulics and/or stormwater),
- the supporting data, and
- the documentation storage file.

Hydraulic and stormwater studies and documentation are almost always done by a professional engineer registered in Oregon or people working under the direct supervision of the engineer. These requirements are discussed in Chapter 3. Consultants preparing recommendations and reports for ODOT should submit copies of the listed documentation to ODOT for review. The reviewer may request additional documentation in some instances. The review comments are to be considered and addressed before the report is finalized and distributed.

Many hydraulic and stormwater studies for federally funded non-ODOT projects are prepared by consultants and reviewed by ODOT. Typically an engineer outside of the agency will use the same procedures as an ODOT engineer to compile and calculate the data. There are no requirements that the engineer must use ODOT methods. The consulting engineer should be aware that the ODOT reviewer may check the values using ODOT design procedures, and if the values in the report are significantly different than values determined by ODOT methods, the reviewer may express concern. Following the guidelines in this chapter will simplify the review process.

4.2 Bridge and Large Culvert Study Documentation

Many aspects of a bridge or culvert design are based on the Preliminary Hydraulic Recommendations and the Hydraulics Report. As a result, if the structure is to perform as intended, this information must be complete and accurate. Following these guidelines will help to assure the documentation is complete. These guidelines apply to hydraulic recommendations and reports for:

- bridges,
- circular culverts with diameters more than or equal to 6 feet,
- pipe-arches with equivalent diameters more than or equal to 6 feet,
- box culverts with spans more than or equal to 6 feet,
- multiple barrel culverts with cumulative span widths more than or equal to 6 feet,
- open-bottom culverts of all sizes,
- culverts providing fish passage, and
- complex hydraulic structures such as cast-in-place energy dissipators, flumes, etc.

These guidelines go step-by-step through typical ODOT hydraulic study documentation with checklists of common items. These guidelines are for typical bridges or culverts on streams or rivers and they may not be applicable for structures at other locations. Some studies may address more or fewer items than those listed, as discussed in the specific chapters in this manual. Engineering judgment should be used when preparing documentation, and any variances from these guidelines should be discussed with the Geo-Environmental Engineering and Asset Management Unit prior to submitting materials for review.

4.2.1 Recommendations and Report Distribution

Hydraulic information is used by numerous members of the project team. The Preliminary Recommendations, the Hydraulic Report, and revisions and amendments to these documents, are distributed as follows.

- Ten copies to the project team leader for distribution among the project team.
- One copy to the Federal Highway Administration Division Bridge Engineer in Salem for projects on the National Highway System involving new construction and reconstruction of facilities when the total project cost exceeds one million dollars, or rehabilitation (3R) projects when total project costs exceed five million dollars. The Hydraulics Report and its revisions and amendments are sent to the FHWA. The Preliminary Hydraulic Recommendations are not submitted.
- One copy to the Geo-Environmental Section's Engineering and Asset Management Unit. Submit in Adobe Acrobat portable document format (pdf) by completing the project

report submittal form.

Project Report - Submittal Form 734-5056[A1]

- The original copy to the project files.

Items to Check

_____Does the distribution list include ten copies for the Project Team Leader?
_____Does the distribution list include the FHWA if the project is subject to federal review?
_____Is a copy sent to the Geo-Environmental Section and the Standards and Practices Unit and the original kept in the project file?

4.2.2 Preliminary Hydraulic Recommendations

The Preliminary Hydraulic Recommendations are a one or two page memorandum accompanied by one or more drawings. The recommendations are issued after the initial site visit and before the hydraulic survey request. This information gives the project team a preliminary idea of the hydraulic structure type, size, location, and special features or concerns. An example is in Appendix A.

4.2.3 Hydraulics Report

The Hydraulics Report provides detailed information for many tasks, such as structure design, roadway design, environmental documents, and permit applications. It is also of interest to maintenance personnel, and in the case of larger projects with federal funding, the FHWA. Excerpts of several Hydraulic Reports are included in the chapter text to provide guidance to the reader on specific situations. A complete report is in Appendix B.

4.2.3.1 Introduction

A typical introduction includes a brief description of the project scope stating the reason the structure is being built or replaced. ODOT bridge numbers are included where applicable. New bridge numbers are required for replacement bridges and larger culverts. Also included is a description of the reference datum for the elevations in the report, i.e. 1929 NGVD with the 1947 adjustment, assumed datum, 1988 NAVD, etc. Examples follow.

The existing bridge (Bridge # 12586A) is being replaced by a new widened structure on a different alignment (Bridge # 18463) during the reconstruction of the highway. The existing bridge is too narrow and in the wrong location to accommodate the widened roadway. All elevations in this report are based on the project datum, the 1929 National Geodetic Vertical Datum with the 1947 adjustment.

or

A culvert with two 48-inch span by 24-inch rise reinforced concrete box barrels was recommended in the original 22 December 1995 Hydraulics Report. These culvert barrels have projecting ends and open channels at the inlet and outlet. Recently, it was decided that a safety grate is needed at the inlet and the culvert will discharge into an enclosed storm drain system manhole. In addition, a wetland will be constructed immediately upstream from the culvert, and a special drop style inlet will be needed to keep water pooled in the wetland. This amended report provides the hydraulic information for this revised culvert.

Items to Check

_____Is the report scope defined?
_____Are the bridge numbers included?
_____Is the elevation datum described?

4.2.3.2 Regulatory Requirements and Permit Data

There are numerous regulations and requirements for hydraulic structures in addition to ODOT design standards. These topics are presented in the Regulatory Requirements and Permit Data section. The most common regulations and requirements are described below.

Floodplain Development Regulations - Cities and counties often require an engineer to certify the project meets their floodplain development regulations, as discussed in Chapters 2 and 3. The Hydraulic Data sheets or a suitable reference should list the water surface elevations and other data that show the proposed structure is in compliance. This data should be supported by narrative comments. Two examples follow.

Bear Creek has a floodway designated in the National Flood Insurance Program, and the bridge widening and roadway work on this project are designed to meet applicable floodway standards and regulations. Changes to the Bear Creek floodway caused by the proposed project are addressed in the Request for Conditional Letter of Map Revision submitted by ODOT to the City of Medford.

or

City of Beaverton regulatory standards require the extended culvert to have headwater elevations no higher than the existing culvert. As per agreement with the city, discharges listed in the hydraulic study for the nearby TRI-MET train bridges were used in this study. As shown in the Hydraulic Data tables, the extended culvert produces lower headwater elevations than the existing culvert. The increased hydraulic performance of the extended culvert is due to the beveled top edge on the upstream extension. The square top edge of the existing culvert is not as efficient as the beveled edge.

Fish Passage - Fish passage is a concern at all crossings of fish-bearing streams. Passage requirements are based on NMFS, Endangered Species Act and ODFW requirements, OAR Div. 412. Appropriate environmental permitting and authorizations should be listed as a reference, if needed. Specific design data and a description of fish passage features are required. An example is shown on the following page.

Riparian Habitat – Projects in riparian areas are subject to regulations pertaining to both construction procedures and the finished product. Several regulations are listed in the Data Collection chapter. Hydraulically related construction methods and design features required by these regulations should be mentioned in the Hydraulics Report. As an example, a culvert was designed to meet the FHWA "Federal Aid to Highways Programmatic" (FAHP). FAHP requires large woody debris to be included in the project design. The Hydraulics Report says wood will be included as described in the narrative at the bottom of the following page.

Other Environmental Regulations and Requirements - Other environmental concerns, regulations, or requirements can affect structure type, size, or location. Region permit or environmental specialists are good sources of information about these issues. The Biological Assessment, Environmental Impact Statement, or other documents should be listed as references, as needed. These requirements should be mentioned if they affect the waterway opening characteristics. Examples are wild and scenic river requirements, the need to provide animal passage along streambanks, etc.

Fish Passage Data Table Example

The extended culvert is designed to pass fish, as per 'Oregon Department of Fish and Wildlife Standards and Criteria for Stream-Road Crossings.' An extended culvert at this site needs fish weirs in order to pass fish. There would be insufficient flow depth in the barrel during the low design flow if weirs are not used. The Oregon Department of Fish and Wildlife requires data on fish passage and a description of fish passage features when they review the project plans. The fish passage information below applies to the culvert described in this Hydraulics Report.

Fish Passage Data

Design Species:	Cutthroat trout less than 20 inches long
Low Design Flow:	Less than 1 cubic foot per second
Minimum Depth at Low Design Flow:	9 inches
High Design Flow:	57 cubic feet per second
Average Velocity at High Design Flow:	3 feet per second
Maximum Jump Height:	6 inches
Jump Pool Length:	28 inches

Design features include.

1. The upstream edge of the upstream apron is below the elevation of the stream bottom and the water surface to maintain sufficient water depth at low flows. This requires a negative slope on the upstream apron, as shown in Figure 1.
2. Fish weirs are incorporated into the downstream apron to maintain sufficient water depth during low flows.
3. Two extra fish weirs are included to maintain fish passage if there is degradation of the channel bottom during the design life of the culvert. These weirs are too low to provide pools when the streambed is at its current elevation. These weirs will provide jump pools if the streambed degrades.
4. The bottom of the basin is 1.5 feet lower than the water surface elevation during the low design flow to provide fish passage through the stilling basin at the outlet.

The proposed culvert design will also incorporate large woody debris in the pond area created by beaver dams upstream from the culvert location. The quantity and exact location of the woody debris will be determined at a later date.

In-Water Work Period - Information on the in-water work period is useful for people designing and administering the project. It can be included in the report as follows.

The in-water work period for Hall Creek is July 1 through September 30 unless specified otherwise by ODFW.

Ordinary High Water - Water surface elevations during the ordinary high water event are often required for permit applications. Methods to determine this elevation are located in Chapter 6. This information is included in the Hydraulic Data sheet and mentioned in the report as follows.

To provide data for the Division of State Lands permit, the ordinary high water elevations based on a field survey are listed in Tables 2 and 3.

Navigational Clearance - Vertical and horizontal clearance can be an issue on navigable waterways, as discussed in Chapter 10. These requirements should be mentioned in the narrative if they affect the type, size, or location of the replacement structure. An example follows.

Boats travel through this crossing. As a result, the Oregon State Marine Board has requested that passage clearance under the proposed crossing be maintained at the present level.

Other Regulations and Requirements - In some cases there are other regulations or requirements that affect the type, size, or location of a bridge or culvert. As an example, the irrigation districts or U. S. Bureau of Reclamation have hydraulic requirements or regulations about structures on their waterways. Region permit specialists are good sources of information about these issues. These requirements should be mentioned if they affect the waterway opening characteristics.

Items to Check

_____Is it mentioned if the structure is in a regulatory floodway or floodplain?
_____Is it mentioned if the design must satisfy applicable flood plain development ordinances?
_____Is it noted if FIS data was used to design the structure?
_____Are fish passage concerns mentioned if they affect the hydraulic design?
_____Are the needed fish passage data listed?
_____Are riparian habitat or other environmental regulations mentioned if they affect the hydraulic design?
_____Are design features mentioned if they are included to meet riparian area use regulations?

_____Is the in-water work period listed?
_____Are the ordinary high water elevations listed?
_____Is navigational clearance mentioned if it is required or if it affects the design?
_____Are other regulations governing the type, size, and location of the structure mentioned if they affect the hydraulic design?

4.2.3.3 Hydrology Information

The hydrology section lists the flood flows expected for various recurrence intervals. Hydrology methods are discussed in Chapter 7. The hydrology section should include, but is not limited to:

- the flooding source (i.e. runoff, high tides, etc.), the contributing drainage area at the site, and the time of year when floods usually occur,
- the method used to determine the hydrology, and
- the flood recurrence interval versus peak discharge relationship at the site. This data is usually listed in a table, and it includes the 2, 5, 10, 25, 50, 100, and 500-year flows,
- historical flood data, if available, and
- drainage maps with drainage boundaries and flow directions noted. This is needed for complex drainages where the boundaries are not obvious, such as urban areas.
- The fish passage high and low flow design discharges with accompanying narrative. Presentation of this data is discussed in Chapter 7. These discharges are also listed on the fish passage design data table presented in Subsection 4.2.3.2.

Items to Check

_____Is the drainage area listed?
_____Is the method of determining the hydrology noted?
_____Are 2-year, 5-year, 10-year, 25-year, 50-year, 100-year, and 500-year discharges listed?
_____If flows from an FIS report or gaging station are used and adjusted to the drainage area at the bridge site, is this mentioned along with a description of the adjustment method?
_____Are significant historic floods or flood damage mentioned?
_____Are maps included for complex drainages?
_____Are fish passage design discharges presented?

4.2.3.4 Ice and Debris

This section mentions whether or not ice or debris passage are a problem or concern with a structure. Some types of bridges that are adequate for conveying water may be poor choices for

conveying water containing debris or ice. In addition, a proposal to replace a bridge with a culvert on a stream carrying debris or ice deserves careful review. Debris and/or ice passage should be mentioned if it affects the type, size, or location of the proposed structure. It should also be noted if ice or debris passage has not been a problem.

Items to Check

_____Is debris passage adequately described if it is a problem?
_____Is ice passage described if it is a problem?
_____Is it noted that ice or debris passage is not a concern if this is the case?

4.2.3.5 Hydraulic Design

The report includes a section on hydraulic design. This section presents most of the hydraulic information used to design the structure, including a design narrative, hydraulic data sheets, and drawings.

4.2.3.6 Design Narrative

The design narrative describes the type, size, and location of the existing and proposed structures. Designers will use this information to verify the structure described in the report matches the vertical and horizontal alignment of the proposed roadway. This is very important because the proposed highway alignment may be changed several times during the design process. An example follows.

> The existing structure is a 63-foot long 3-span reinforced concrete deck with timber superstructure bridge supported by pile trestles. The hydraulic performance of the existing bridge is summarized in Table 1.
>
> The proposed structure is a 69-foot long single-span combination spillthrough/vertical abutment bridge. This report is based on an alignment with the centerline of the new road approximately 0.33 feet higher and 28.83 feet north of the centerline of the existing road. The hydraulic performance of the proposed bridge is summarized in Table 2 and the waterway opening is shown in Figure 1. The inside face of the west abutment is at Station 937+67.06 and the face of the east abutment is at Station 938+35.96.

The design narrative describes flood characteristics if this information is needed to clarify the information listed on the Hydraulic Data sheet. An example follows.

The existing bridge does not convey the entire flow of Oak Creek during large floods. Water overtops the creek banks upstream from the highway and bypasses the bridge during floods of a 17-year or greater recurrence interval. Most of this bypass flow overtops a low section of the roadway 850 feet west of the bridge. The remainder of the bypass flow crosses under the highway through two 30-inch diameter concrete pipes 1,050 feet west of the bridge. The bypass flow rejoins Oak Creek downstream from the bridge crossing.

The design narrative discusses special features and miscellaneous topics which affect the design. Drawings should be provided as needed. This information will be used to incorporate the features into the design. Special features and miscellaneous topics include, but are not limited to the following.

- Channel changes.
- Debris control structures.
- Streambank or embankment protection.
- Upstream settling basins.
- Recommended end treatments for culverts. Dimensioned drawings should be included for inlets not shown on standard plans, such as drop inlets, slope-tapered inlets, etc.
- Recommended barrel materials for culverts, in conformance to ODOT alternate materials policy, as discussed in Chapter 5. Occasionally, alternate materials cannot be specified because only certain types will work. If so, the narrative should mention why the alternate material cannot be used.
- Invert protection for culverts.

A narrative description of a special inlet follows.

The recommended style of safety grate is shown in Figure 2a. The longitudinal bars should be on the top face and the transverse bars should be on the bottom face, as shown in Figure 2b.

The design narrative provides construction and maintenance information to the designers, project management, and maintenance personnel. A typical or frequent maintenance should be described in detail. Examples follow.

Silt and gravel have accumulated in the streambed upstream from the existing culvert. The stream channel should be regraded to the profile shown in Figure 1. Upstream from the culvert the streambed should be relocated to match the inlet to the arch. Within the culvert there should be at least 8 feet of clearance between the channel bottom and the top of the culvert. The channel should be restored to resemble the natural channel.

or

During floods the proposed culvert will convey more water than the existing culverts and flow depths and velocities will increase at the outlet of the culvert and in the downstream canal. These greater flows may accelerate the erosion of the mudstone ledge and the embankment slope. As a result, the embankment slope near the outlet should be inspected periodically and revetment installed as needed.

The narrative should also mention if the existing structure blocks fish passage and the reasons. This information will aid in the preparation of environmental documents. As an example:

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

Any changes to the hydraulic characteristics of nearby structures caused by the proposed bridge or culvert should be mentioned in the narrative. An example follows.

The proposed fish passage culvert is much larger than the existing culvert. It eliminates the need to replace the overflow culvert at milepoint (M.P.) 40.18. This culvert can be removed or left in place and filled with grout.

Items to Check

_____Are the types, sizes, and locations provided for existing and proposed structures?
_____Are flood characteristics addressed if this information helps support the Hydraulic Data sheets?
_____Are channel changes, debris control structures, streambank, or embankment protection

described?
_____Are other special design features described?
_____Is frequent or atypical maintenance addressed?
_____Are culvert features described, such as end treatments, barrel materials, and invert protection?
_____Is fish passage through the existing culvert described?
_____Are any changes to hydraulic conditions at nearby structures described?

4.2.3.7 Hydraulic Data Sheets

All hydraulic reports should include Hydraulic Data sheets for the existing and proposed structures. Blank and completed sheets for a bridge and a culvert are shown in Figures 4-1 through 4-4. Figure rounding guidelines are listed in Subsection 4.2.3.12.

Many times the water surface elevation in an adjacent water body can affect the hydraulic characteristics of the river or stream that flows through the structure, as discussed in Chapter 10. Two data sheets are needed for the existing structure and each alternative replacement structure if the water surface elevations at the crossing are affected by water surface elevations in a downstream water body. Typically, one data sheet summarizes the hydraulic performance during the discharge-tailwater conditions that result in the greatest velocities through the structure, and the other sheet describes the discharge-tailwater combinations that cause the highest water surface elevations. A single data sheet can be used if the elevations during both conditions are clearly listed. This is done in the report included in the Appendix. A summary of the methods for calculating hydraulic data follows.

Discharges and Recurrence Intervals - The first and second rows are for discharges and recurrence intervals, respectively. Selection of these values is discussed in Chapter 9 for culverts and Chapter 10 for bridges.

The Design event discharge is listed in the first column. As discussed in Chapter 3, 25 and 50-year flows are the most common design discharges. In most cases, the design flows are used to determine the minimum recommended waterway areas and bottom of beam elevations for bridges, and the recommended barrel sizes for culverts.

The Base Flood discharge is listed in the second column **and it is always the 100-year flow**. In regulatory floodplains and floodways it can control the minimum recommended waterway areas and bottom of beam elevations of bridges and the minimum recommended barrel sizes for culverts. It is also used in scour analyses.

BRIDGE

PROJECT: **COMPILED BY:**

DATE:

TABLE _:	HYDRAULIC DATA			
	DESIGN EVENT	BASE FLOOD	ROADWAY OVERTOPPING FLOOD	ORDINARY HIGH WATER
Discharge (cubic feet per second)				
Recurrence Interval (years)		100		-
Approach Section H.W. Elevation w/Natural Channel[1] (feet)				-
Approach Section H.W. Elevation w/ Bridge[1] (feet)				
Backwater (feet)				-
H.W. Elev. at Upstream Face of Bridge[2] (feet)				
H.W. Elev. At Downstream Face of Bridge[3] (feet)				
Waterway Area at Downstream Face of Bridge[4] (square feet)				-
Average Velocity at Downstream Face of Bridge (feet per second)				-

[1] Approach section is one waterway opening width upstream from upstream face of bridge.

[2] Located at upstream face of bridge along the embankment.

[3] Located at downstream face of bridge opening.

[4] Area normal to channel centerline. Projected area of piers has been subtracted.

REMARKS:

Manning's "n" bridge opening
Manning's "n" main channel
Manning's "n" overbanks

Figure 4-1 Blank Bridge Data Sheet

BRIDGE

PROJECT: Oak Creek Bridge # 18463
Pacific Hwy - Lebanon (RR Tracks) Section
Corvallis - Lebanon Highway, M.P. 12.48
Linn County Key # 06420

COMPILED BY: _____

DATE: 6 October 1997

TABLE 2: Proposed Bridge	HYDRAULIC DATA			
	DESIGN EVENT	BASE FLOOD	ROADWAY OVERTOPPING FLOOD	ORDINARY HIGH WATER
Discharge (cfs)	1,850	2,390[6]	2,060[5]	-
Recurrence Interval (yrs)	50	100	80	
Approach Section H.W. Elevation w/Natural Channel[1] (ft)	277.0	277.5	277.2	-
Approach Section H.W. Elevation w/ Bridge[1] (ft)	277.8	278.4	278.0	274.7
Backwater (ft)	0.6	0.9	0.8	-
H.W. Elev. at Upstream Face of Bridge[2] (ft)	277.7	278.3	277.9	274.6
H.W. Elev. At Downstream Face of Bridge[3] (ft)	276.5	276.9	276.7	274.4
Waterway Area at Downstream Face of Bridge[4] (ft^2)	290 (331)	290 (331)	290 (331)	--
Average Velocity at Downstream Face of Bridge (ft/s)	6.4	7.0	6.4	-

[1] Approach section is one waterway opening width upstream from upstream face of bridge.
[2] Located at upstream face of bridge along the embankment.
[3] Located at downstream face of bridge opening.
[4] Area normal to channel centerline. Area in parentheses is parallel to roadway centerline.
[5] 1,870 cfs flows under the bridge and 190 cfs flows through culverts west of the bridge.
[6] 2,030 cfs flows under bridge, 170 cfs flows over road to west of bridge, and 190 cfs flows through culverts to the west of the bridge.

REMARKS:

The spillthrough structure is a 70-foot long single-span bridge with combination spillthrough/vertical abutments. The structure is skewed 29 degrees. Three 36-inch diameter culverts are located under the roadway to the west of the bridge.

Manning's "n" bridge opening = 0.04
Manning's "n" main channel = 0.04
Manning's "n" overbanks = 0.04

Figure 4-2 Example Bridge Data Sheet

CULVERT

PROJECT: **COMPILED BY:**

DATE:

TABLE _:	HYDRAULIC DATA			
	DESIGN EVENT	BASE FLOOD	500-YEAR FLOOD	ORDINARY HIGH WATER
Discharge (cubic feet per second)				-
Recurrence Interval (years)		100	500	
Highwater Elevation of Natural Channel, at Culvert Inlet (feet)				-
Headwater Elevation at Culvert Inlet (feet)				
Backwater Depth at Culvert Inlet (feet)				-
Tailwater Elevation at Culvert Outlet (feet)				
Average Velocity at Culvert Outlet (feet per second)				-

REMARKS:

K_e =

Upstream invert elevation =
Downstream invert elevation =

Figure 4-3 Blank Culvert Data Sheet

CULVERT

PROJECT: Little Oak Creek Culvert Bridge 18496
Pacific Highway - Lebanon (RR Tracks) Section
Corvallis - Lebanon Highway, M.P. 15.40
Linn County

COMPILED BY: _____

DATE: 13 November 1997

TABLE 2 Proposed Culvert	HYDRAULIC DATA			
	DESIGN EVENT	BASE FLOOD	500-YEAR FLOOD	ORDINARY HIGH WATER
Discharge (cfs)	220	260	350	-
Recurrence Interval (yrs)	50	100	500	-
Highwater Elevation of Natural Channel, at Culvert Inlet (ft)	313.2	313.3	313.5	-
Headwater Elevation at Culvert Inlet (ft)	314.4	314.8	316.1	312.4
Backwater Depth at Culvert Inlet (ft)	1.2	1.5	2.6	-
Tailwater Elevation at Culvert Outlet (ft)	312.5	312.6	312.8	311.7
Average Velocity at Culvert Outlet (ft/s)	8.9	9.4	10.4	-

REMARKS:

The proposed culvert is a 10-foot span by 6-foot rise by 84-foot long reinforced concrete box culvert with a beveled inlet, wingwalls, aprons, and cutoff walls. The culvert invert is buried 2 feet below the channel bottom. The culvert centerline crosses road centerline at Station 812+08.0 with a 16 degree right hand forward skew.

K_e = 0.2

Upstream and downstream invert elevations = 308.4 ft

Figure 4-4 Example Culvert Data Sheet

The 500-year or Roadway Overtopping Flood discharges are listed in the third column. An exception is when the roadway overtopping flood is the design event, in which case the third column is left blank. This large flow is often called the "check discharge" as described in Chapter 10. This discharge is used for the revetment design and the scour depth calculations. Roadway overtopping flood data, if listed, should be valid for the specific structure summarized on the data sheet. It is quite common for existing and replacement structures to have two different roadway overtopping discharges. If flow occurs over road or through an overflow structure, these discharges and the discharge through the bridge opening are listed in the "Remarks" on the data sheet, as shown in Figure 4-2.

The Ordinary High Water elevations at the upstream and downstream faces of the proposed structure are listed in the last column. These elevations are determined by hydraulic analyses for sites where hydraulic modeling has been performed. The elevations are determined by field observations and surveys in the absence of hydraulic modeling. These elevations are used in environmental documents and permits.

Hydraulic Data Sheets for Bridges - The third through fifth rows summarize backwater data. These depths and elevations are determined by methods in Chapter 10. The backwater depths listed in the fifth row equal the elevations in the fourth row minus the elevations in the third row.

The sixth and seventh rows list water surface elevations at the upstream and downstream faces of the bridge. The elevation at the upstream face is the water surface along the embankment. It is the surface elevation at the approach section (with bridge in-place) minus the friction loss between the approach section and the bridge. The elevation at the downstream face is the water surface as it passes under the downstream edge of the bridge deck.

The eighth row lists the flow areas at the downstream face of the bridge opening. The areas are normal to the channel centerline regardless of the angle of intersection between the stream and road centerlines. The flow area excludes the projected areas of piers, if piers are present.

The ninth row lists the average flow velocities at the downstream face of the bridge opening. The average velocities are the discharges in the first row divided by the areas in the eighth row unless there is roadway overtopping or flow through an overflow structure. The velocities are based on discharges through the bridge opening, only, if overtopping or overflow occurs. Make sure that $Q = V/A$. Note any overtopping or overflow amounts under comments.

The bridge length, type, number of spans, and skew angle are listed in the "Remarks" section of the data sheet.

Hydraulic Data Sheets for Culverts - The first and second rows summarize the hydrology. The third through fifth rows list water surface elevation data determined by methods in Chapter 9. The surface elevations in the natural channel without the road or culvert in-place are listed in the third row. These elevations are in the natural channel at the location of the proposed culvert inlet. They are "highwater" elevations. The surface elevations at the inlet with the culvert in-place are listed in the fourth row. They are "headwater" elevations. The backwater depths in the fifth row are equal to the headwater elevations in the fourth row minus the highwater elevations in the third row.

The sixth row lists the tailwater elevations at the culvert outlet.

The seventh row lists the average outlet velocities. Flows through the culvert, only, are used in the calculations. Unless there is roadway overtopping flow, the average velocities are the discharges in the first row divided by the flow areas at the outlet. The actual flow area at the outlet should be used in the calculations if the outlet is partially full.

The inlet and outlet invert elevations, the culvert length and skew angle, the inlet loss coefficient, K_e, and the inlet configuration (projecting, mitered, beveled, slope tapered, or side tapered) are listed in the "Remarks" section of the data sheet.

ODOT policy is to recommend alternate culvert barrel materials if they can be used, as discussed in Chapter 5. Often the alternatives have different hydraulic characteristics. The hydraulic performance of each alternative is listed on a separate data sheets if this is the case.

Items to Check

(Data sheets for bridges and culverts.)

_____Are Hydraulic Data sheets included?
_____Can fluctuating water surface elevations in a downstream water body affect hydraulic characteristics at the structure? If so, are Hydraulic Data sheets included which reflect the range of tailwater elevations at the structure?
_____Are appropriate discharges and recurrence intervals listed on the data sheets?
_____Does the roadway overtopping flow and recurrence interval apply to the structure described on each data sheet?
_____Are ordinary high water elevations listed for all proposed structures?
_____Are the roadway overtopping flows listed if overtopping occurs more frequently than every 500 years?
_____Are flows over the road excluded from the flows used to calculate the average velocities?
_____Is the information on the data sheet consistent with the data shown on the drawings and the narrative discussion?

Items to Check
(Data sheets for bridges.)

_____Is it noted if the information is for the existing or proposed structure?
_____Are the backwater depths calculated at the right locations?
_____Are water surface elevations at the bridge opening calculated at the correct locations?
_____Are the waterway areas normal to the channel centerline?
_____Are the structure type, length, skew angle, etc noted in the "Remarks"?

Items to Check
(Data sheets for culverts.)

_____Are the outlet velocities based on actual flow areas?
_____Are invert elevations, culvert length, skew angle, inlet loss coefficient, and inlet configuration listed?
_____Are data sheets included for alternate materials if the hydraulic characteristics of the alternatives differ?

4.2.3.8 Drawings

A hydraulic report includes drawings of the proposed bridges and/or culverts. At a minimum, these drawings show the bridge waterway opening cross-section or the elevation view of the culvert. Headwalls, wingwalls, retaining walls, and the revetment protecting these structures are also shown, along with any special features. Often additional drawings are needed. This could include a drawing of a change in channel alignment for a bridge. For a culvert, this may be a drawing of a special inlet or special details required for fish passage.

Bridge Waterway Opening Drawings – A typical waterway opening drawing is shown in Plate 4-1. The drawing should show the following.

- The recommended waterway opening and the existing groundline at the opening, including stationing and elevations.
- The recurrence interval and elevation of the design flood.
- The water surface elevation at the downstream face of the bridge during design flood.
- The width of the waterway at the downstream face of the bridge. The width is the distance parallel to the roadway centerline from edge of water to edge of water during the design event.
- The area below the design event water surface elevation normal to the channel centerline. This area is the same as the design event waterway area in the Hydraulic Data table.
- The area below the design event water surface elevation parallel to the roadway centerline if the crossing is skewed (a crossing where the roadway and waterway centerlines are perpendicular has a skew angle of 0 degrees).

- The skew angle in degrees.
- A note verifying the projected pier area has been subtracted from the waterway opening area shown, if the bridge has piers.
- The width and elevation of the channel bottom if a trapezoidal waterway opening is recommended.
- The minimum recommended bottom of beam elevation. The bottom of beam elevations at both abutments should be noted if the bridge is on a grade.
- The abutment type, including the end slopes if spillthrough abutments are recommended.
- The revetment protection, including details.
- The potential scour elevations (or evidence solid rock is present, i.e. Geotechnical Report).
- The datum for the elevations.

Culvert Elevation View Drawings - A typical culvert elevation view drawing is shown in Plate 4-2. The following should be shown.

- The longitudinal section of the culvert along the barrel centerline including the existing and proposed groundlines and channel bottoms. Elevations and distances right and left of the roadway centerline should be shown on the drawing axes.
- The profile of the channel bottom near the culvert.
- The recurrence interval, headwater elevation, and tailwater elevation of the design flood.
- The barrel length, invert elevations, and slope.
- The degree of skew of the crossing. (A crossing where the roadway and culvert centerlines are perpendicular has a skew angle of 0 degrees.)
- The barrel size, number of barrels, and type.
- The inlet configuration (mitered, projecting, beveled, etc.),
- The minimum elevations of revetment on the embankments around the culvert ends.
- Revetment on or in the channel bottom upstream or downstream from the proposed culvert.
- The burial depth if the culvert invert is buried below the channel bottom.
- The burial depth if revetment is buried below the channel bottom.
- The datum for the elevations.

Items to Check
(Bridges and Culverts)

_____Are drawings included for all proposed alternative structures with differing dimensions or hydraulic characteristics?
_____Is all applicable information included on the drawing(s)?
_____Is the data on the drawing consistent with the data on the Hydraulic Data Sheet and in the narrative discussion?
_____Are additional drawings included that show special features?

4.2.3.9 Scour

This section describes possible long term changes in channel bottom elevation due to either aggradation or degradation, possible shifts in channel alignment due to lateral instability, clear-water or live-bed contraction scour, and pier scour, as discussed in Chapter 10. In addition, any past problems with aggradation, degradation, lateral stability, or scour are discussed. Also, this section presents the methods and assumptions used to determine the potential scour elevations shown on the waterway drawings.

ODOT bridges are rated for susceptibility to scour using "National Bridge Inventory System Item 113 – Scour Critical Bridges," as discussed in Chapter 10. If the modified existing structure or proposed structure will have a scour rating of 6 or lower, this should be mentioned in the report with reasons for the low rating.

Items to Check

_____Are past problems with scour described?
_____Is channel aggradation/degradation addressed?
_____Is lateral stability of the channel addressed?
_____Are the types of scour that compose the total scour mentioned?
_____Based on available information, will the proposed modified or new structure have an adequate rating for susceptibility to scour?

4.2.3.10 Revetment Design

This section recommends revetment protection in the vicinity of the structure, as discussed in Chapter 10 for bridges, Chapters 9 and 11 for culverts and storm drain outfalls.

Revetment Around Bridges - The riprap protection for a bridge is discussed in the narrative and it is shown on the waterway opening drawings and additional drawings if needed. A typical recommendation for riprap protection around a spillthrough abutment follows. Design discharges for end fills (embankments) are the 50-year event. Larger flows are used as check discharges, as discussed in Chapter 3. Riprap recommendations for vertical abutments, piers, and other applications use modified versions of the following language.

The abutment and embankment protection for the proposed bridge is designed to withstand the 50-year* event. Recommended protection of the 1V : 2H abutment end slopes are a 3.0 foot thick blanket of Class 700 loose riprap with riprap backing, as shown in Figure 1. The riprap should conform to Section 00390.00 of the ODOT 2008 Oregon Standard Specifications for Construction. The riprap backing should be Type 2 riprap geotextile conforming to Section 00390.10 of the Standard Specifications. A granular filter blanket is not recommended.

* by letter from Deputy Director

The riprap should wrap around the bridge abutments and protect the fresh embankment slopes below elevation 1,362.9 feet. 4.0 foot deep toe trenches should be provided. The toe trench is not needed for slopes away from the stream channel. The revetment should extend longitudinally along each embankment face a distance sufficient to protect the end panels from undermining.

Riprap or other protection that is considered to be temporary should be addressed in the report. The expected protection life and the consequences of its failure should be mentioned. Any required periodic maintenance should be described.

Revetment Design for Culverts - Recommended revetment around culvert inlets and outlets is discussed in the narrative and shown on the culvert drawing. A typical ODOT recommendation for revetment around a culvert follows. Revetment recommendations for other types of culverts use modified versions of the following language.

Erosion protection consists of a 1.5 foot thick blanket of Class 100 loose riprap around the inlet and outlet up to elevation 76.4 feet. The riprap should conform to Section 00390.00 of the ODOT 2002 Oregon Standard Specifications for Construction. A filter blanket is not needed. The riprap should extend along the embankment at least 10 feet from the outside edge of the wingwalls. The toe trench around the outlet cutoff wall should be backfilled with Class 50 riprap after the wall is constructed, as shown in Figure 1.

Items to Check
(Bridges and Culverts)

_____If needed, are riprap backing specifications mentioned?
_____Does the revetment design narrative or drawing note the type or class of revetment, blanket thickness, toe trench dimensions, and minimum elevation of revetment protection?
_____Is wave action a concern and is it addressed?

_____Are narrative and drawings included to describe special or unique revetment design features?

Items to Check
(Bridges)

_____Does the narrative or drawing indicate the extent of revetment protection needed on the abutment end slopes, embankment side slopes, and piers?
_____If revetment or other protection is temporary, is expected life, failure consequences, and maintenance discussed?

Items to Check
(Culverts)

_____ Is the revetment protection shown or described for the culvert ends, such as revetment around cutoff walls, collars, wingwalls, etc?
_____ Are the vertical and horizontal limits of the revetment on the embankments shown on the drawings or mentioned in the narrative?

4.2.3.11 Temporary Water Management

The report should have recommendations for temporary water management (TWM). This data includes, but is not limited to:

- a brief description of the TWM facilities,
- a brief discussion about fish passage through the TWM facilities, noting any limitations such as passage blockage,
- the in-water work period,
- recommended period of the year for the TWM facilities, and
- a TWM discharge table, as shown in the table at the end of this subsection. The methods to calculate these discharges are described in Chapter 7.

Items to Check

Additional TWM data is needed if a detour roadway is used, such as the flow area of the detour structure and minimum elevation of the detour roadway. The report should also contain a brief statement about the detour location. Other information about the detour may include a discussion of maintenance needs such as monitoring for debris or scour. Detour structures in floodways are also subject to Federal Emergency Management Agency standards and these hydraulic requirements should be mentioned. Detours are sometimes subject to fish passage and navigational clearance requirements just like permanent structures, and these requirements should also be discussed.

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) 5 Percent Exceedance Discharge (Average daily discharge expected to be exceeded 2 days each month.)
2) 25 Percent Exceedance Discharge (Average daily discharge expected to be exceeded 8 days each month.)
3) 50 Percent Exceedance Discharge (Average daily discharge expected to be exceeded 16 days each month.)

- In-Water work period extends from 1 July through 15 October.
- Temporary water management shown on plans recommended for 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.

Items to Check

_____ Are the TWM facilities briefly described?
_____ Is fish passage through the facilities described and any limitations noted?
_____Are TWM discharges listed with seasonal limitations?
_____Are minimum waterway opening areas and minimum elevations listed for detour roadway bridges or culverts?
_____If applicable, are other detour structure issues addressed such as maintenance needs, fish passage, and navigational clearance?

4.2.3.12 Rounding-off Guidelines

Guidelines for rounding-off hydraulic data are listed in this subsection.

- Elevations of structural members such as bridge decks or footings: round to the nearest hundredth of a foot.
- Channel and bridge opening widths: round to the nearest foot for structures over 100 feet wide. Round to nearest tenth of a foot for smaller openings.
- Cross-section areas: round to nearest square foot.
- Drainage areas: round to nearest three significant figures.
- Velocities: round to nearest tenth of a foot per second.
- Discharges:
  - round to two significant figures for discharges less than 1000 cubic feet per second,
  - round to three significant figures when discharges are greater than 1000 cubic feet per second, and
  - round to four significant figures when discharges are greater than 10,000 cubic feet per second.
- Pipe and pipe-arch sizes: use sizes listed in Oregon Standard Drawings RD380, RD382, RD384, and RD386.
- Box culvert sizes: use sizes listed in ODOT Standard Drawings BR820, BR825, BR830, BR835, BR840, or BR841.

4.3 Bridge and Large Culvert Study Supporting Data

These guidelines apply to supporting data for hydraulic studies of the facilities listed in Section 4.2. The supporting data in many aspects is as important as the project report. It provides:

- information needed for review prior to approving the report for distribution,
- documentation to justify and support the report recommendations, and
- useful information for maintenance of the proposed facility, the designs of modifications to the facility, and the hydraulic designs of nearby or subsequent facilities, and
- supporting data for resolution of drainage complaints and lawsuits.

These guidelines are for a typical bridge or culvert and they are not applicable for all situations. Engineering judgment should be used when deciding whether or not to retain data. Factors to consider are the availability of the data from other sources, the ease of recreating the data if it is needed, the importance of the data to the study, and the utility of the information.

In general, all data and calculations should be retained that support the data in the Hydraulic

Data Sheets and the details shown on the drawings. Data is retained for the existing structure and the design alternative that is built. Notes and calculations are discarded for alternative structures that are not built. Recommendations for specific topics follow.

Regulatory Requirements and Permits Supporting Data - The following should be retained in the project file:

- copies of correspondence, certification letters, applications, and other materials related to the compliance with floodplain regulations, and
- copies of FEMA floodway boundary revision requests.

The critical correspondence and forms are retained. Generic information is not kept, such as the instructions on how to fill out the forms, copies of regulations, etc.

The following material is referenced in the main project file. It is stored separately in the Geo-Environmental Section's Engineering and Asset Management Unit with similar material from other locations and projects:

- the original HEC-2 or HEC-RAS river modeling input data supplied by FEMA, and
- FEMA maps and flood studies.

Hydrology Supporting Data - The following should be retained in the project file:

- copies of flood parol evidence such as a witness statement and supporting material, and
- hydrologic calculations (including input and output printouts if computer solutions are used).

The following material is referenced in the main project file. It is stored separately in the Geo-Environmental Section's Engineering and Asset Management Unit with similar material from other locations and projects:

- flood photographs and highwater mark survey information, and
- USGS quadrangle maps showing the drainage area.

Hydraulic Design, Scour Calculations, and Revetment Design Supporting Data - The following should be retained in the project file:

- notes and calculations detailing the assumptions used to determine the downstream water surface elevations if variable elevations can occur (see Chapter 10),
- notes and calculations detailing the overtopping flow assumptions used in the analysis of the existing and proposed structures,
- notes and calculations for the hydraulic design, scour calculations, and revetment design

including printouts of the input and output files if a computer solution is used, and
- documentation of past scour problems if the material is not stored in another file, such as the bridge maintenance file.

Detour Design Supporting Data - The detour structure design data is retained until the detour is removed and any disputes related to the detour are settled.

Other Supporting Data - The following should be retained in the project file:

- the original signed and stamped copy of the Hydraulics Report,
- the bridge vicinity map (typically this map shows the locations of the existing and proposed structures, channel profile location, and cross-section locations),
- notes from the hydraulic survey, such as stream cross-sections, profiles, and other hydraulic topographic data,
- photographs,
- as-constructed plans that show the waterway opening and pile tip or footing elevations, and
- critical correspondence and other information that should be filed and retained.

Paper copies of the previously listed location information can be quite bulky and difficult to file. It is recommended that digital terrain models, other electronic survey data, and hydraulic computer models be copied onto a CD and stored in the project file instead of paper copies.

4.4 Small Culvert Design Documentation and Supporting Data

Documentation and supporting data retention guidelines for small culvert hydraulic studies are in this section. These culverts are usually designed by the roadway designer. Small culverts are:

- circular culverts with diameters less than or equal to 4 feet,
- pipe-arches with equivalent diameters less than or equal to 4 feet, and
- box culverts with spans less than or equal to 4 feet.

Report documentation for culverts with diameters or equivalent diameters of 6 feet or larger, culverts designed to pass fish, or open-bottom culverts are outlined in Section 4.2. Report documentation guidelines for culverts with diameters larger than 4 feet, but less than 6 feet, are presented in Section 4.5.

Documentation is described for a typical small culvert. In some cases additional documentation may be warranted. An example would be a small culvert located in a floodway. In this instance, documentation would be needed to demonstrate the replacement culvert would comply with

applicable flood management ordinances. As a general rule, small culvert documentation should include:

- verification that design objectives and standards have been met,
- data needed to incorporate the culverts into the roadway design,
- data about the capacity of the culverts if discharge changes are anticipated during the project design life (such as runoff from anticipated development),
- information on special maintenance needs and anticipated modifications such as extensions, and
- any changes to hydraulic conditions at nearby, upstream, or downstream drainage facilities due to the culvert replacement.

Documentation for small culverts may include many items, such as design sheets, maps, calculations, narrative, tables, and drawings. The following is needed for a typical design.

- Design sheets described in Chapter 9 for the following discharges described in Chapter 3:
  - design events,
  - check floods (cross-culverts, only), and
  - base floods (culverts subject to floodplain management ordinances).
  - Drainage maps showing runoff patterns and drainage area boundaries.
  - Calculations and assumptions for headwater and tailwater elevations, outlet scour protection, fill heights, barrel material life, and invert protection design.
  - Recommended barrel materials in conformance with ODOT alternate materials policy, as discussed in Chapter 5. Occasionally, alternate materials cannot be specified because only one type of barrel material is suitable. If so, it should be documented in the narrative why alternate materials cannot be used.
  - Recommended end treatments as discussed in Chapter 9.
  - Descriptions of special design considerations such as upstream settling basins, etc.
  - Descriptions of maintenance needs if they will be atypical or unusually frequent.
  - If needed, recommended invert protection as discussed in Chapter 5.
  - If needed, details of channel changes, ditches, etc.
  - If needed, outlet erosion protection as discussed in Chapter 11.
  - If needed, details of debris control structures as discussed in Chapter 9.
  - If needed, details of streambank protection as discussed in Chapter 15.
  - Important correspondence.

Items to Check

_____Are culvert design sheets included?
_____Are drainage maps included?
_____Are design assumptions and calculations included?
_____Are recommended barrel materials and end treatments listed?

_____Are special design considerations mentioned and described, such as settling basins, atypical or frequent maintenance, invert protection, channel changes, outlet erosion protection, debris control structures, etc?
_____Is important correspondence included?
_____Are changes to hydraulic characteristics at nearby structures noted?

4.5 Medium Culvert Design Documentation and Supporting Data

Medium culverts have diameters or equivalent diameters greater than 4 feet, but less than 6 feet. These culverts are designed by a professional engineer registered in Oregon or people under the direct supervision of the engineer, as discussed in Chapter 3.

Medium culverts where fish passage is not required, and with no special design features, can use the level of documentation appropriate for small culverts. Medium culverts requiring fish passage or having special design features need the level of documentation required for large culverts. Examples of special features are:

- roughening rings inside the culvert barrel,
- cast-in-place reinforced concrete drop, side tapered, or slope-tapered inlets, or
- cast-in-place reinforced concrete energy dissipators.

Medium culverts in critical locations may also justify a "large culvert" design study. An example is a culvert to be jacked or rammed through a deep fill under a wide highway. This culvert would be a very expensive installation, and a more comprehensive "large culvert" study is justified.

4.6 Stormwater Design Documentation

These documentation guidelines are for all projects that include stormwater designs. They are primarily intended for facilities conveying, treating or storing runoff from ODOT property.

Projects that include ODOT right-of-way improvements along with other improvements (private development, local agency, or other) will need to comply with ODOT and/or the local or governmental agency with jurisdiction for stormwater treatment. These projects will need to also comply with all requirements for detention of runoff from sources draining onto ODOT property or into ODOT drainage systems. The report writing guidelines for these systems are included in Appendix C.

4.6.1 Water Resources Impact Assessment

The Water Resources Impact Assessment is a document stating whether or not water quality treatment is needed. If the determination is that treatment is required, then the document states what level (engineered facility or BMP only) of treatment is needed. The water resources impact assessment is a short report developed early in the design process by environmental personnel.

The need for peak flow control is also determined early in the design process. It is sometimes stated in the water resources assessment when it is required by environmental regulations. Peak flow control requirements are often determined by the hydraulics engineer when local regulations or liability considerations are identified.

The documentation for water quality treatment and peak flow control requirements are retained as a reference for subsequent recommendations and reports.

4.6.2 Preliminary Stormwater Recommendations

This is a formal document that outlines the scope of the project, the basic storm water conveyance system layout, pipe outfall locations, treatment and/or storage requirements, and the recommended treatment and/or storage concepts. These recommendations do not contain facility designs. It is a tool to assist in the selection of the types and locations of the facilities to be designed and is an important tool to assist other personnel (environmental, right-of-way, hazardous materials experts, etc). These recommendations are prepared after the receipt of the Water Resources Impact Assessment and a determination of the need for storage, and before the preliminary engineering and facility designs. Preliminary facility design commences after the team approves the design concepts in the recommendations.

The preliminary stormwater recommendations should be prepared by, or under the direct supervision of a registered professional engineer and the report should be sealed by the engineer, as discussed in Chapter 3. Copies of the recommendations should be provided to the project development team for review and comment. Typically, this includes the project team leader, the environmental representative, the roadway and/or bridge designers, right-of-way agent, hazardous materials specialist, and if involved, the local agency representative. The review comments are to be considered and addressed, and the recommendations revised as needed. The revised recommendations should be approved by all team members before the start of facility design.

The contents of typical preliminary stormwater recommendations are presented in the remainder of this subsection. Specific guidance for storage and water quality designs is included in Chapters 12 and 14, respectively.

Introduction and Title - The preliminary recommendations starts with a title that lists the project name, highway name and number, beginning and ending milepoints, county, and date of the report. The introduction mentions the people who prepared the recommendations, the purpose of the report, a brief description of the project, and a summary of treatment/storage concepts and recommendations on their use. An example follows.

PRELIMINARY STORMWATER RECOMMENDATIONS
Oregon Coast Hwy. @ Cannon Beach N. Entrance Section
Oregon Coast Highway (OR # 6), M.P. 27.96 to 28.68
Clatsop County
3 June 2001

1.0 INTRODUCTION

This recommendations were prepared by _____P.E. with special thanks to _____ for preparing a significant amount of the technical information.

1.1 PURPOSE

The purpose of these recommendations are to outline potential solutions for improving the quality of storm water runoff from the facilities located within the Cannon Beach North Entrance project. It also outlines possible solutions for detaining the additional runoff from the added impervious surface.

1.2 JOB DESCRIPTION

The primary purpose of the project is to reconstruct the intersection at the north entrance to Cannon Beach from the Oregon Coast Highway. A southbound on and off-ramps will be constructed as well as a northbound on-ramp. The northbound on-ramp will pass underneath a new structure to be built on the realigned Oregon Coast Highway.

1.3 SUMMARY

The following information has been summarized for quick reference. Assumptions and design criteria used to develop these recommendations are described in more detail in subsequent sections.

WATER QUALITY MITIGATION LOCATIONS

Total = 2

Location #	Station	Description
1	1496+06 to 1499+34	NB On-ramp O'xing
2	1509+19 to 1515+75	Ecola Creek

		Location Number 1		2	
Mitigation Alternatives		Recommended	Acceptable	Recommended	Acceptable
A	Extended Detention Dry Pond[1]	Yes	Yes	No	Yes
B	Bioretention Pond	No	No	No	No
C	Constructed Wetland	No	No	No	No
D	Infiltration Trench / Dry Well[2]	No	No	No	No
E	Infiltration / Retention Basin[2]	No	No	No	No
F	Bioslope	No	No	No	No
G	Biofiltration Swale	No	Yes	Yes	Yes
H	Filter Strip	No	No	No	Yes
I	Porous Pavement	No	No	No	No
J	Proprietary Structure	No	Yes	No	Yes

STORAGE MITIGATION LOCATIONS

Total = 1

Location#	Station	Description
1	1496+06 to 1499+34	NB On-ramp O'xing

		Location Number 1		2	
Mitigation Alternatives		Recommended	Acceptable	Recommended	Acceptable
I	Dry Pond[1]	Yes	Yes	N.A.	N.A.
II	Vault[3]	No	Yes	N.A.	N.A.
III	Tank[3]	No	Yes	N.A.	N.A.

[1]A single dry pond could satisfy both treatment and storage requirements at Location 1.
[2]Mitigation Alternatives D and E could eliminate the need for storage at Location 1.
[3]A vault or a tank would be built at Location 1 in addition to the selected treatment facility.

Existing and Proposed Conditions Narrative – The introduction is followed by a narrative that describes the proposed changes to the existing conditions. The pollutant removal and storage targets should also be mentioned. An example follows.

2.0 EXISTING AND PROPOSED CONDITIONS

2.1 GEOGRAPHY

The project runs at a steady 6 percent slope from north to south down to Ecola Creek. It appears that the entire project is within the same drainage basin. Approximately 4.3 acres of new impervious surface will be constructed on this project.

- Location 1 is the northbound on-ramp overcrossing which is the approximate middle of the project. Approximately 2.5 acres of new impervious area will be constructed from the beginning of the project to here. Storage in the form of detention will be required at this location.
- Location 2 is Ecola Creek which is at the end of the project. Approximately 1.85 acres of new impervious area will be constructed from Location 1 to here. Detention is not required at this location.

2.2 TARGET POLLUTANT REMOVAL

There are no specific constituents identified by regulations for storm water on this project. Total suspended solids (TSS) will be targeted because it is the most common and measurable constituent. A XX-percent TSS removal rate from the new impervious surface area will be the goal.

2.3 TARGET DETENTION RELEASE RATE

The runoff at Location 1 enters an ODOT cross-culvert that has limited capacity for increased peak discharge. This culvert is not within the limits of this project. As a result, at Location 1 for the 50-year runoff event, the post-construction release rate from detention should not exceed the pre-construction runoff rate of 2.45 cubic feet per second.

Proposed Mitigation Alternatives - The third section in the Preliminary Stormwater Recommendations is a brief generic discussion of all proposed mitigation alternatives. Topics addressed are location, removal efficiency, storage capacity, constructibility, maintenance, and cost. BMP and storage alternatives from Chapters 14 and 12, respectively, are evaluated and listed.

Example recommendations follow. Three different mitigation alternatives were discussed in the example; extended detention dry ponds, biofiltration swales, filter strips, proprietary treatment structures, vaults, and tanks. These alternatives were listed as either recommended or acceptable in the preceding summary table. The discussion of one alternative, the extended detention dry pond, is included in the following text.

3.0 PROPOSED MITIGATION ALTERNATIVES

A total of four different water quality BMP's and three storage facilities are described in the following sections. Six BMP's are not included due to their high costs or other factors making them less desirable. Additional information is available on these BMP's if requested.

MITIGATION ALTERNATIVES

	Mitigation Alternatives	Included	Excluded
3.1	Extended Detention Dry Pond (for treatment and storage)	*	
	Bioretention Pond (treatment)		*
	Constructed Wetland (treatment)		*
	Infiltration Trench / Dry Well (treatment and storage)		*
	Infiltration / Retention Basin (treatment and storage)		*
	Bioslope (treatment)		*
3.2	Biofiltration Swale (treatment)	*	
3.3	Filter Strip (treatment)	*	
	Porous Pavement (treatment)		*
3.4	Proprietary Structure (treatment)	*	
3.5	Vaults or Tanks (storage)	*	

3.1 EXTENDED DETENTION DRY POND

Extended dry detention pond basins are depressions that treat and provide temporary storage (also called detention) of a portion of the stormwater runoff following a storm event. The extended detention time of the stormwater in the basin provides an opportunity for pollutants carried by the runoff to settle out. A 24- to 48-hour retention period is needed after each rainfall event. Water quality design volume is in addition to detention storage volume.

3.1.1 LOCATION

A dry pond could be placed at the outfall of the storm drain system at each location. The pond at Location 1 would be designed to provide both treatment and detention. The pond at Location 2 would be designed to provide treatment, only. The ponds can be placed "in-line" or "off-line."

3.1.2 CONSTITUENT REMOVAL EFFICIENCY

80% to 90% TSS Removal

3.1.3 DETENTION RELEASE RATE

Less than or equal to the pre-construction runoff rate of 2.45 cubic feet per second during the 50-year runoff event.

3.1.4 CONSTRUCTABILITY

A pond would need to be excavated large enough to hold the water quality storm (1/3 of the 2-yr/24-hour storm) and to detain the excess runoff from the 50-year storm. An access road would have to be provided as well as access to the bottom of the pond. The size of the pond is not affected by whether it is placed "in-line" or "off-line."

3.1.5 MAINTENANCE

Typical maintenance is expected to be:

- mowing to keep weeds under control,
- debris removal from control device, and
- sediment removal (every 1 or 2 years).

3.1.6 COST

Low to medium cost. Work included in construction will include, but not be limited to:

- excavation,
- seeding,
- outlet control structures (an orifice-standpipe-inlet at Location 1 and two Type "D" inlets at Location 2),
- scour protection near outlet ends of pipes discharging into ponds,
- scour protection near outlet ends of pipes discharging from ponds,
- scour protection (riprap) on auxiliary outlet spillways, and
- landscaping and planting trees around pond perimeters for shading.

Other Issues – The fourth section discusses mitigation issues that are not addressed in the previous section on alternatives. The following discussion is from the example recommendations.

4.0 OTHER ISSUES

Curbs vs Ditches – In the current design, the entire project area drains into roadside ditches and cross-culverts. All of this runoff would enter the treatment facility, and the water contains both runoff from pervious surfaces off of the roadway as well as impervious roadway surfaces. This is substantially more water than the mitigation alternative is required to treat. Treatment is needed for runoff from the new impervious surface area, only.

Note: The impervious surface area runoff can be collected from both existing and new impervious surfaces if the total impervious surface area to be treated is equivalent to the calculated new impervious surface area.

The proposed typical sections show no curbs. Curbed sections with inlets can be used to convey roadway runoff that requires treatment to the water quality facilities, and ditches can convey runoff from other areas that do not require treatment to the outfall. As a result, the use of curbs and inlets may substantially reduce the inflow of water into the treatment facilities, and smaller and less costly facilities may be adequate.

Recommendations – This section has preliminary recommendations about the proposed alternatives. Many aspects are addressed, such as dependability, ease of construction, ease of maintenance, cost, and appearance. An example follows.

5.0 RECOMMENDATIONS

The following table in addition to technical references were used to develop the recommended solutions for water quality mitigation and storage on this project:

	Mitigation Alternative	Dependability	Construction	Maintenance	Cost	Appearance
A&I	Extended Dry Detention Pond	High	Med	Med	Low-Med	Fair
G	Biofiltration Swale	High	Med	Low-Med	Low	Good
H	Filter Strip	Med	Easy	Low-Med	Low	Good
J	Proprietary Structure	High	Easy	Med	High	None

An Extended Dry Detention Pond as described in Subsection 3.1 is the recommended alternative at Location 1, and a Biofiltration Swale (Subsection 3.2) is the recommended alternative at Location 2.

Items to Check

_____Is the project and its purpose adequately described in the Introduction, Purpose, and Job Description sections?
_____Is a schematic concept design plan that clearly shows locations of each facility included?"
_____Are pipe outfall locations identified?
_____Are all of the mitigation alternatives that were considered summarized and categorized as "Recommended", "Not Recommended", "Acceptable" or "Not Acceptable?"
_____Are the existing and proposed conditions described, including target pollutant removal rates and storage system requirements?
_____Are the viable alternatives described with their proposed locations and estimates of their pollutant removal efficiency or storage adequacy?
_____Are constructability, maintenance, cost, appearance and other issues addressed?

_____Are recommendations included that address dependability, construction, maintenance, cost, and appearance?

4.6.3 Standard Stormwater Design Documentation

These documentation guidelines are for standard stormwater designs. Standard stormwater designs include roadway inlets, small storm drains and small channels or ditches. This information is part of the drainage design provided to the roadway designer who incorporates the drainage features into the roadway design. It also may be part of the work done by the roadway designer if the drainage and roadway designs are done concurrently.

Documentation for the typical standard stormwater design is included in this section. In some cases additional documentation should be submitted. An example would be documentation for a city in a cost-sharing agreement with ODOT, when it must be shown that the drainage system performs adequately during the "full buildout" discharge. As a general rule, the documentation for a stormwater design should provide all information needed to:

- review the drainage design and verify that design objectives and standards have been met,
- incorporate the drainage design into the roadway design,
- provide data about the capacity of the drainage system (this is used to evaluate future requests to discharge additional flow into the system), and
- aid in the maintenance of the facility, the design of modifications to the system, and the hydraulic design of nearby or subsequent facilities.

The standard stormwater design documentation should be prepared by, or under the direct supervision of, a registered professional engineer as discussed in Chapter 3. The package of materials should be bound together with a cover letter sealed by the engineer.

Documentation for stormwater systems includes many items, such as design sheets, maps, calculations, narrative, tables, and drawings. The following documentation is needed for a typical design.

- ODOT "Storm Sewer Design sheets (reference Chapter 13) for all storm drains shown on the map(s). The top of manhole and downstream invert elevations are listed on the design sheets. The elevations of other critical components should also be provided, such as gutters, ditch bottoms, upstream pipe inverts, manhole bottoms, etc. This data can be provided by profiles, tables, sketches, etc. Computer output can be provided in lieu of design sheets.
- A drainage system map(s). A small system can often be shown by a single map. A large system may require several maps. These maps show the location and type of the following features.

  - The existing utilities and structures which could be in conflict with the proposed storm drain.
  - The direction of overland flow into the drainage system,
  - The boundaries of drainage areas which contribute runoff to the system, including drainage areas for tributary drain systems. The divisions between different types of land use should be shown on the map (pavement, cultivated fields, etc.) along with the assigned runoff coefficients.
  - The surface contours at least within the drainage limits.
  - Streams, lakes, and other watercourses, past highwater and existing water surface elevations at the outfalls of the storm drains.
  - The estimated limits of flooding that would occur
  - The elevations of drainage divides, sags, and low points.
  - Drainage features such as:
    - gutters and ditches,
    - inlets,
    - pipes, including sizes (use standard sizes) and discharges,
    - manholes,
    - culverts such as driveway, road approach, and cross,
    - drain outfalls to existing streams, lakes, or other watercourses, and
    - additional features such as water quality facilities, detention facilities, energy dissipators, etc.
- Calculations and assumptions for hydrology including time-of-concentration, discharge elevations and velocities, tailwater elevations at outfall, barrel material life, and fill heights.
- Location of significant utilities which may require relocation or may dictate the final design configuration.
- Sketches showing junction structures (manholes, inlet boxes, etc) are of sufficient size to accommodate planned pipe connections.
- Tables, sketches, or narrative as needed to describe special features, allowable or recommended alternate materials, and invert protection.
- Important correspondence.

Items to Check

_____Are storm drain design sheets included?
_____Is additional elevation data provided?
_____Are drainage maps included which show all features?
_____Are design calculations and assumptions included?
_____Are recommended barrel materials and end treatments listed?
_____Are detention facilities required and/or included?
_____Are stormwater treatment facilities required and/or included?
_____Are junction structures sized appropriately?

_____Are special design considerations mentioned and described, such as settling basins, atypical or frequent maintenance, invert protection, channel changes, outlet erosion protection, debris control structures, energy dissipators, etc?
_____ Is important correspondence included?

4.6.4 Stormwater Design Report

These documentation guidelines are intended for stormwater designs that include significant facilities and large or critical projects. The documentation for these projects is greater than the standard stormwater design documentation. Significant facilities include, but are not limited to, any of the following:

- storm drain systems with pipes larger than 24 inches in diameter,
- stormwater quality facilities, and
- stormwater control facilities (detention, retention, split-flow structures, etc.)

This is the final report that describes in detail the facilities approved by the project development team after their review of the Preliminary Stormwater Recommendations. This report provides facility design information such as the type, size, location, critical dimensions, and features. It is usually completed after the advance plans and concurrently with the preparation of the project final plans.

The stormwater report should be prepared by, or under the direct supervision of, a registered professional engineer, and it should be sealed by the engineer, as discussed in Chapter 3. Copies of the stormwater report should be provided to the project development team. Usually this includes the project team leader, the environmental representative, the roadway and/or bridge designers, and if involved, the local agency representative. Also submit a copy in Adobe Acrobat portable document format (pdf) to Geo-Environmental's Senior Hydraulics Engineer by completing the project report submittal form located at the following website:

http://www.oregon.gov/ODOT/HWY/GEOENVIRONMENTAL/hyd_data_resources.shtml

The facility design(s) incorporated in the final plans should comply with the information in the stormwater report unless approval for any change has been obtained from the engineer who sealed the report. The contents of a typical stormwater design report are presented in the remainder of this subsection.

STORMWATER DESIGN REPORT
for
XXXXXXXXXXXXXXXXXX
BRIDGE (PORTLAND) SECTION

MT. HOOD HIGHWAY (OR #26), M.P. 0.31 to 1.02
CITY OF PORTLAND, MULTNOMAH COUNTY, OREGON

Key # 00000

Contents

- ☒ Inlets
- ☒ Storm Drains
- ☒ Detention
- ☐ Small Culverts
- ☒ Water Quality
- ☐ Small Channels
- ☐ Energy Dissipaters
- ☐ Pipe Rehabilitation

OCTOBER 1999

DFI No. D00001
DFI No. D00002
DFI No. D00003

Prepared by _____

(Seal affixed here)

Cover Sheet and index- The report cover sheet includes the title, the project name, the highway name and number, the beginning and ending milepoints, the county, and the unique drainage facility identification number (DFI) for every facility proposed on a project. This information should match with the data provided on the title sheet for the plans. The cover sheet also carries the seal of the engineer of record. An example follows.

Note: See Chapter 17 for details on obtaining and assigning a DFI.

1. **Overview**, including the following.

    a. **Project description**, including the overall project scope, including the need for the project.

    b. **Purpose of the study**, including a brief description of the facility design objectives, including the source of the objectives (i.e. environmental regulations, local drainage requirements such as drainage master plans, liability concerns, etc). This topic will be discussed in more detail in the body of the report. This discussion also includes the following.

        i. **Statement** that the design objectives have been met.

        ii. **Explanation** about why any design objectives have not been met, if this is the case.

    c. **Key issues** affecting project scope, need, or design.

    d. **Summary of the results**, as would be desired by a casual reader of the report, including abbreviated tables of pipe sizes and other facilities for quick reference.

2. **Background**, including information about the existing conditions and factors influencing the design. It includes the following.

    a. **Watershed characteristics**, both pre-construction, post-construction, and at the level of buildout expected at the end of the facility design life. Topics to be discussed are drainage area sizes, land uses, and other characteristics affecting drainage.

    b. **Project area** characteristics, with emphasis on the drainage systems.

        i. **Pre-construction** conditions, including the following.

            - **Description** of the existing drainage facilities.

- **Description** of existing drainage problems. This is especially important if a purpose of the project is to rectify an existing drainage deficiency.

- **Condition** of the existing system. This is especially important if a purpose of the project is to replace or upgrade a deteriorated drainage facility.

ii. Post-construction conditions, including a description of the proposed facilities.

c. The outfall, including the following.

i. Description of the outfall, including condition.

ii. Discharges expected at the outfall in the pre-construction, post-construction, and buildout at end of design life land use conditions.

iii. Discussion of the ability of the outfall to satisfactorily convey the three previously listed discharges.

d. Utilities, including the following.

i. Summary of the utility location information available and used in the design. Mention the limitations of the utility location data. Mention if utilities are present, there may be conflicts, and the utility locations are not known.

ii. Description of any utilities that affected the design, their effects, and how the effects were addressed in the design.

e. Investigations, including the following.

i. Research/previous studies used in the design should also be referenced. Examples are the hydraulic study for a previous design or a local Drainage Master Plan.

ii. Site reconnaissance used to collect design data should be mentioned. An example is the location survey or a video inspection of the existing facilities.

3. Design, including detailed design information. The reader is also referenced to the supporting design information listed in Subsection 4.6.3 of this chapter. This information must be included in the Design section of the report.

a. Design criteria, mentioning all criteria used in the design. References are made to published material available externally, and also to correspondence and other material retained in the supporting data file.

b. Analysis methods used in the design, including the following.

i. Hydrology, including method used, with assumptions.

ii. Hydraulics, including method used, with assumptions.

c. Narrative and calculations used in the design. The descriptive narrative and calculations for simple projects can be included in this report. Otherwise, a summary of the design calculations is appropriate for this section, and references are made to detailed information in the supporting data. Include a separate subsection for each facility or system.

4. Maintenance is addressed in this section, if any special activities will be required, or unusually frequent maintenance is expected. An example is a special manhole containing a proprietary filtering system. This system, along with its maintenance requirements, would be mentioned in the report. Detailed information will be included in an "Operation & Maintenance Manual" (see Subsection 4.6.6).

Items to Check

_____Is a cover sheet included with all appropriate information and the engineer's seal?
_____Is an overview included?
_____Is a background included?
_____Is design information such as a narrative and calculations included or referenced for each facility or system?
_____Is extraordinary maintenance described, including special activities or the need for unusually frequent service.

4.6.5 Stormwater Design Supporting Data

Typical stormwater design data is listed in Subsection 4.6.3 of this chapter. Specific projects may require more or less than the listed data. In general, data is retained that:

- shows the performance of the existing system, it is analyzed,
- shows the performance of the proposed system shown on the project plans,
- provides information for future maintenance,
- provides information of value if there is future litigation, or
- provides information useful for future designs and drainage planning.

Essential data includes, but is not limited to, drainage area maps and summaries of the hydrology and design data.

Data is not retained in the files that is:

- readily available in published references, such as textbooks,
- data pertaining to alternatives that are not built, and
- information used in project development that does not directly support the finished product, such as preliminary recommendations.

4.6.6 Stormwater Operation & Maintenance Manual

The Stormwater Operation & Maintenance Manual provides information about facility maintenance and operation. A unique manual must be prepared for every ODOT stormwater treatment and storage facility (low impact development approaches, swales, filter strips, bioretention basins, bioslopes, extended detention dry ponds, proprietary structures, storage dry ponds, tanks, and vaults) and copies of this manual are to be distributed to the personnel who maintain the facility, and the original document is retained in the project files. Also submit a copy of the manual in Adobe Acrobat portable document format (pdf) and in Microsoft Word format, and the operational plan Microstation file to Geo-Environmental's Senior Hydraulics Engineer by completing the project report submittal form located at the following website:

Note: A unique Operation and Maintenance Manual is not required for a pollution control manhole. Always note the location of these manholes on every treatment or storage facility operational plan.

http://www.oregon.gov/ODOT/HWY/GEOENVIRONMENTAL/hyd_data_resources.shtml

An inventory of prepared manuals can be viewed at the following website:

Operation & Maintenance Manuals Website

Two Microsoft Word template documents have been created for detention and water quality facilities. Use these templates to prepare a final Operation and Maintenance Manual. These templates are located in Appendix D. These Microsoft Word documents are "filename.dot" files and have to be saved as a "filename.doc" file. The following steps outline how to create a ".doc" file:

Step 1: Open the appropriate template located in Appendix D. The template for detention facilities is named "OM_Template_DetentionFacility". The template for water quality facilities is named "OM_Template_WaterQualityFacility"

Step 2: Select the "Save" command. Change the file type to "word document (*.doc)" in the field box titled "Save as type".

Step 3: Modify the file name using the drainage facility identification number. For example, the file name for facility #345 would be "OM_DFI_D00345".

Step 4: Select the "Save" button. You now can use the saved document to prepare the final Operation and Maintenance Manual.

The remaining section describes the contents of a typical manual. It proceeds through the manual from beginning to end.

Cover Sheet - The report cover sheet includes the title, drainage facility identification number, and facility type. The cover sheet also provides a spot for ODOT Maintenance Districts to add a photo of the constructed facility when applicable. An example follows.

1. Identification. This is the first section of the manual. It includes the following.

a. Drainage Facility Identification Number (DFI), listing the unique DFI number of the specific facility. For example, "D00040". See Chapter 17 for details on obtaining and assigning a DFI.

b. Facility Type. The type of facility. The following is a list of facility types that have been approved for use within ODOT right-of-way, and utilized by ODOT Maintenance. Proprietary facilities or facilities that have been internally designed must be named as either "Proprietary" or "Special" facilities. (i.e. Proprietary Water Quality Catch Basin)

- Detention Pond
- Detention Pond/Water Quality Biofiltration Swale Combo
- Detention Tank/Pipe
- Detention Vault
- Dispersion Trench
- Water Quality Biofiltration Swale
- Water Quality Bioretention Pond
- Water Quality Bioslope/Media Filter Strip
- Water Quality Catch Basin
- Water Quality Extended Detention Dry Pond
- Water Quality Filter Strip
- Water Quality Infiltration Pond
- Water Quality Manhole
- Water Quality Porous Pavement
- Water Quality Sediment Basin
- Water Quality Treatment/HazMat Containment Facility
- Water Quality Vault

c. Construction Drawings. The V-file number for the project is listed. As an example: "35V-103."

d. Location, listing the facility location by district, highway number, milepoint, and other information needed to locate facility. For example: "District 2A, Hwy 1, MP 289.83 to MP 289.50 – on west side of highway just north of I-5 at Nyberg Road off-ramp. Access via I-5."

2. Facility Contact Information. This section provides a general summary of contacts for operational clarification, maintenance clarification, and repair or restoration assistance. This section requires no or little modification.

OPERATION & MAINTENANCE MANUAL

DFI No. D00001

Facility Type: Detention Pond

FACILITY PHOTO

(AS-CONSTRUCTED)

Prepared: (month, year)

INDEX

3. **Construction.** This section lists the engineer of record, the year the project was finished and the name of the contractor. For example: "Engineer of Record: ODOT designer – Region 2 Hydraulics, Alvin Shoblom, (503) 986-3365, Construction was completed in the year 2000. The contractor was Moby Construction Company."

4. **Storm Drain System and Facility Overview.** This section tells how the system works, and it makes reference to detailed material in the remainder of the report and the appendices. Technical discussions and terminology are avoided. This section is written specifically for the personnel responsible for maintaining the system. Include:

   - Brief summary of location of facility
   - Type of facility and treatment function (such as detention pond or water quality biofiltration swale)
   - Overview of conveyance system such as location and features (catch basins, pretreatment structures, and piping)
   - Description of facility inlet and outlet
   - Description of facility access for equipment and maintenance
   - Note if heavy equipment is allowed with no limitation, allowed with limitation, or not allowed into above ground facilities

- Note any special facility features such as amended soils, porous pavers, liners, or underdrains

An example description and formatting preference is provided in Chapter 4, Appendix D.

5. **Facility Haz Mat Spill Feature**. This section tells what facility features are provided or could be modified to assist with capturing or containing hazardous materials. For example, and pond or swale can be used to store a volume of liquid by blocking the outlet pipe located at the outlet of the pond or swale. An example is provided in Chapter 4, Appendix D.

6. **Auxiliary Outlet (High Flow Bypass).** This section describes the overflow system and it tells maintenance personnel about items of concern. Note if the auxiliary outlet feature is designed into the facility or explain the location, type, and function of the auxiliary outlet when not designed into the facility. An example description and formatting preference is provided in Chapter 4, Appendix D.

7. **Maintenance Requirements**. This section addresses the required maintenance activities and when they should be done. References are made to other documents or sections of the manual as needed.

   Include the following summary in every manual. Mark Table 1 in every manual. Then mark the appropriate maintenance table according to facility type. Review the marked maintenance table provided in ODOT's Maintenance Guide. Select the special maintenance box when necessary and detail any additional maintenance requirements.

   Or

   Mark the box next to "Appendix C" when the facility is a proprietary structure. Obtain a copy of the Manufacturer's operation and maintenance manual and include in Appendix C. The Manufacturer's manual must include detailed maintenance instructions and drawings.

7. Maintenance Requirements
Routine maintenance table for non-proprietary stormwater treatment and storage/detention facilities have been incorporated into ODOT's Maintenance Guide. These tables summarize the maintenance requirements for ponds, swales, filter strips, bioslopes, and detention tanks and vaults. Special maintenance requirements in addition to the routine requirements are noted below when applicable. The ODOT Maintenance Guide can be viewed at the following website: http://www.oregon.gov/ODOT/HWY/OOM/MGuide.shtml

Maintenance requirements for proprietary structures, such as underground water quality manholes and/or vaults with filter media are noted in Appendix C when applicable.

The following stormwater facility maintenance table (See ODOT Maintenance Guide) should be used to maintain the facility outlined in this Operation and Maintenance Manual or follow the Maintenance requirements outlined in Appendix C when proprietary structure is selected below:

☒ Table 1 (general maintenance)
☐ Table 2 (stormwater ponds)
☐ Table 3 (water quality biofiltration swales)
☐ Table 4 (water quality filter strips)
☐ Table 5 (water quality bioslopes)
☐ Table 6 (detention vaults)
☐ Table 7 (detention tanks/pipes)
☐ Appendix C (proprietary structure or special designs)

☐ Special Maintenance requirements:

An example is provided in Chapter 4, Appendix D**.**

8. Waste Material Handling. This section discusses handling and disposal of waste material. Contacts are listed along with phone numbers. Include the following summary with every manual. Obtain and adjust the contact number for the Region Hazmat Coordinator according to the appropriate region.

8. Waste Material Handling

Material removed from the facility is defined as waste by DEQ. Refer to the roadwaste section of the ODOT Maintenance Yard Environmental Management System (EMS) Policy and Procedures Manual for disposal options: http://egov.oregon.gov/ODOT/HWY/OOM/EMS.shtml

Contact any of the following for more detailed information about management of waste materials found on site:

ODOT Clean Water Unit	(503) 986-3008
ODOT Statewide Hazmat Coordinator	(503) 229-5129
ODOT Region Hazmat Coordinator	(xxx) xxx-xxxx
ODEQ Northwest Region Office	(503) 229-5263

An example is provided in Chapter 4, Appendix D.

Operation & Maintenance Manual Appendices:

Appendices are included to organize supporting information as outlined below.

A cover sheet is included at the front of the appendices. The cover sheet lists the material that is included in each Appendix. An example of appendix cover sheets is provided in Chapter 4, Appendix D.

Appendix A:

An operation plan, profile and details are required in all O&M Manuals. An Example of an operation plan is provided in Figure 4-5 and several Operation Drawings are shown in Chapter 4, Appendix D. This plan summarizes the facility operation features and details needed to assist personnel who maintain the facility. **Copies of construction plans will not be accepted as a facility's operational plan to be used in O&M Manuals**.

Include the operational plan and profile in Appendix A of the Operation Manual. The operational plan includes:

- Legend
- Title block with the following details:
  - Drainage facility identification number
  - District number
  - Highway number
  - Facility type
  - Highway name
  - Beginning and ending milepoints
  - county

Include a plan view with the following information:

- North Arrow
- Edge of pavement lines
- Adjacent sidewalk lines
- Nearby cross streets, ramps, etc.
- Maintenenance access
- Adjacent traffic features such as barriers, sign, etc.
- Upstream and downstream drainage system (piping, ditches, etc.)
- Upstream and downstream drainage structures (manholes, catch basins, etc.)
- Pond or swale footprint lines:
  - Top of facility line
  - Bottom of facility line

- Pond or swale features:
  - Inlet pipe(s)
  - Inlet structure (flow splitter)
  - Inlet riprap
  - Inlet flow spreader
  - Inlet ditch/channel
  - Forebay
  - Outlet structure(s) (manhole, catch basins)
  - Outlet pipe(s)
  - Outlet riprap
  - Outfall (ditch/channel,pipe, streambank)
- Underground vault, tank or manhole footprint lines:
  - Alignment and footprint of facility
- Underground vault, tank, or manhole features:
  - Inlet pipe(s)
  - Inlet structure (flow splitter)
  - Outlet pipes
  - Outlet riprap
  - Outfall (ditch/channel, pipe, streambank)
- Label the following plan view features:
  - Facility – within box label include:
    - Type of facility
    - Drainage facility identification number
    - Beginning and ending milepoint
  - Bubble label:
    - Facility inlet
    - Facility outlet
    - Inlet/outlet riprap
    - Flow spreaders
    - Flow splitter manholes
    - Flow control manholes
    - Outfall
  - Length of facility (in feet)
  - Travel lanes (e.g. northbound lanes, southbound lanes)
  - Highway number and name
  - Cross streets
  - Tributary creek, ditches, wetland areas
  - Upstream and downstream pipe sizes
  - Off ramps and on ramps
  - Nearby treatment or storage facilities:
    - Type of facility
    - Drainage facility identification number

- Cross-section locations
- Pavement drainage patterns
- Drainage pipe flow direction arrows
- Facility flow direction arrows

Include pond and swale profiles with the following information:

- Existing ground lines (top and bottom of facility)
- Existing ground hatch
- Inlet piping
- Inlet structure
- Inlet riprap
- Flow spreaders
- Outlet structure
- Outlet riprap
- Outfall (ditch/channel, pipe, streambank)
- Label the profile with the following information:
  - Facility – within box label include:
    - Type of facility
    - Drainage facility identification number
  - Pipe sizes
  - Length of facility (in feet)
  - Flow direction
  - Bubble label
    - Facility inlet
    - Facility outlet
    - Inlet/outlet riprap
    - Flow spreaders
    - Flow splitter manhole
    - Flow control manhole
    - Outfall

Include pond and swale cross-section with the following information:

- Existing ground lines (top and bottom of facility)
- Show location and orientation of porous pavers and underdrain when applicable
- Label the cross-section with the following information:
  - Top of facility
  - Bottom of facility
  - Width of facility
  - Porous pavers
  - Underdrain piping

Include detention pipe or vault or manhole structure schematic/profile with the following information:

- Facility footprint lines (length and height)
- Inlet piping
- Inlet structures (manholes, catch basins)
- Outlet piping
- Outlet structures (manholes, catch basins)
- Outlet riprap
- Outfall (ditch/channel, piping, streambank)
- Label:
  - Within the box label include:
    - Type of facility
    - Drainage facility identification number
  - Pipe sizes
  - Length of facility (in feet)
  - Flow direction
  - Bubble label
    - Facility inlet
    - Facility outlet
    - Flow splitter manhole
    - Flow control manhole
    - Outfall
    - Outlet riprap

Include **plan view and cross-section details** of the facility's flow splitter structure and/or flow control structure with the following information:

- Inlet piping
- Outlet piping
- Diversion features (weirs)
- Flow control features (orifices)
- Orifice screening
- Label structure components:
  - Flow control weir
  - Flow control orifice(s)
  - Flow control orifice(s) screening
  - Riser pipe
  - Riser pipe overflow outlet
  - Pipe sizes

- Flow direction through structure (water quality flow direction, high flow/bypass flow direction)

Appendix B:

Include plans and details in Appendix B. Copies of the pertinent project construction plans from the ODOT V-Files are included for reference. The as-constructed versions of the plans are preferred if available. At least include:

- The cover/title sheet
- Water quality/detention plan sheets and/or sometimes designs on included on the roadway plans
- Other details

An example of applicable plan sheets is shown in Chapter 4, Appendix D.

Appendix C:

Include Proprietary or Special design structure maintenance instructions, drawings, and plans in Appendix C.

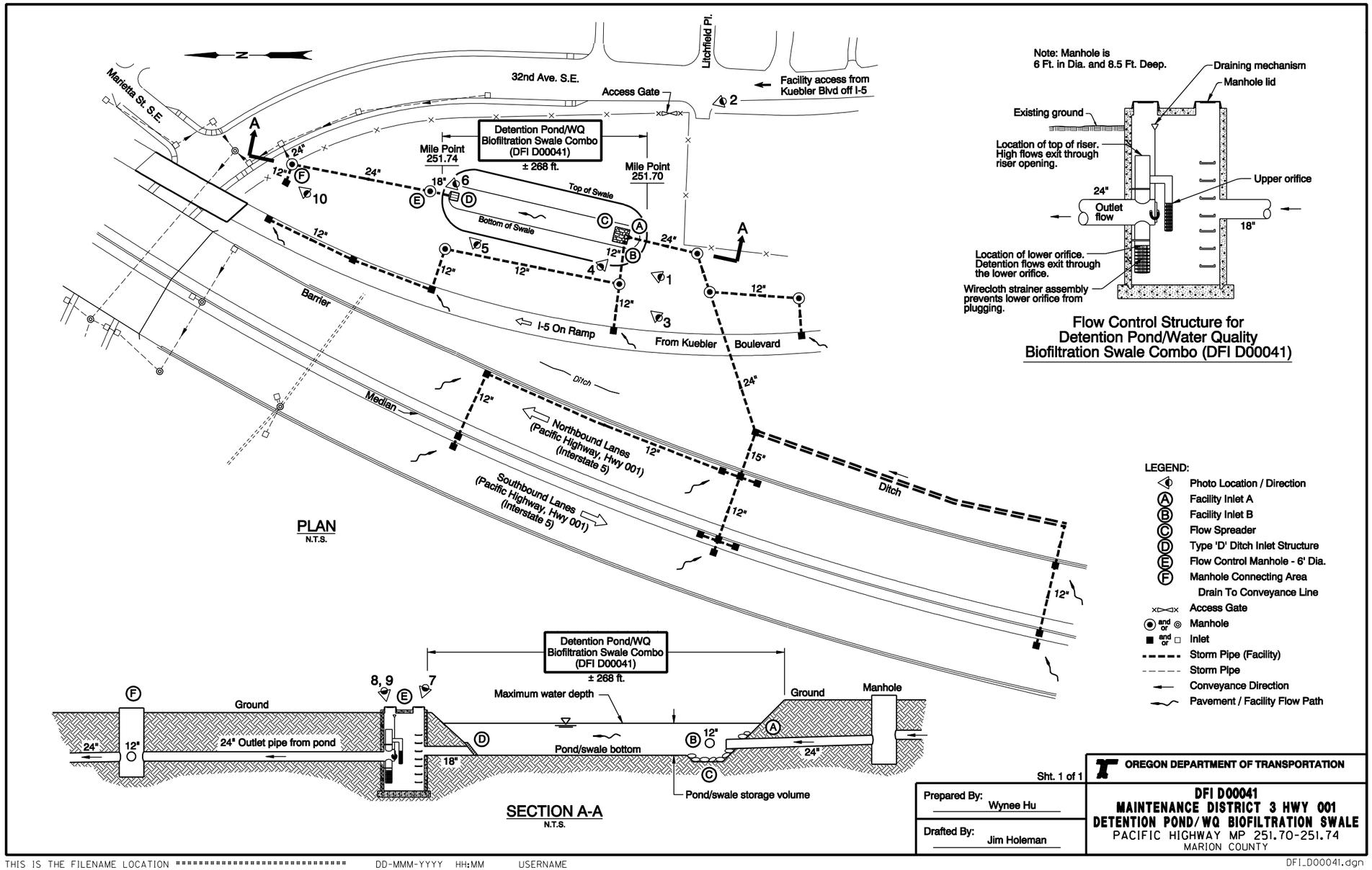

Figure 4-5 Example O&M Operational Plan