Chapter 1 Design Policy

1-1 Introduction

This *Hydraulics Manual* provides policy for designing hydraulic features related to Washington State Department of Transportation (WSDOT) roadways including hydrology, culverts, open-channel flow, drainage collection and conveyance systems, water crossings, and pipe materials. These hydraulic features maintain safe driving conditions and protect the roadway from surface and subsurface water. The chapters contained in the *Hydraulics Manual* are also based on the Federal Highway Administration's (FHWA's) *Hydraulic Engineering Circulars* (HECs) and the American Association of State Highway and Transportation Officials (AAS*HTO) Drainage Manual*.

The *Hydraulics Manual* makes frequent references to WSDOT's *Highway Runoff Manual*, which provides WSDOT's requirements for managing stormwater discharges to protect water quality, beneficial uses of the state's waters, and the aquatic environment in general. The intent is to use the two manuals in tandem for complete analysis and design of stormwater facilities for roadway and other transportation infrastructure projects. Projects should consult WSDOT's *Design Manual* for general hydraulic design guidance. Design-build projects should also consult the *Design Manual* and the *Design-Build Manual*.

In addition to the guidance in the *Hydraulics Manual*, the hydraulic designer shall use good engineering judgment and be mindful of WSDOT's legal and ethical obligations concerning hydraulic issues. Drainage facilities must be designed to convey water across, along, or away from the highway in the most economical, efficient, and safe manner possible without damaging the highway or adjacent properties and without causing permit violations. Furthermore, care must be taken so that highway construction does not interfere with or damage any of these facilities.

This chapter explains WSDOT policy regarding hydraulic design and hydraulic reports. In Section 1-2, the roles and responsibilities of the Project Engineer's Office (PEO), Region Hydraulics Engineer (RHE), and State Hydraulics Office are defined. WSDOT has specific documentation requirements for a hydraulic report, which are specified in Section 1-3. Each hydraulic feature is designed based on specific design frequencies and, in some cases, a specific design tool or software. A summary of the design frequency and design tools or software for most hydraulic features contained in the *Hydraulics Manual* is provided in Section 1-4. Section 1-5 describes the Complete Streets program and how it may affect some aspects of hydraulic design. Section 1-6 defines the process for reviewing and issuing concurrence of a hydraulic report.

1-2 Responsibility

The PEO is responsible for the preparation of correct and adequate drainage design. All drainage structure types, culverts, storm sewer, drainage, general pipe connections, and pipe locations must be verified and annotated by the PEO. Actual design work may be performed

by the PEO, by another WSDOT office, or by a private consulting firm with engineering staff who are licensed in Washington State; however, in all cases, it is the PEO's responsibility to complete the design work and verify that a hydraulic report is prepared as described in Section 1-3. In addition, the hydraulic report shall follow the review process outlined in Section 1-6. The PEO is also responsible for initiating the application for hydraulic-related permits required by various local, state, and federal agencies.

The *Hydraulics Manual* version may be "locked" for up to three years upon Design Approval for Design-Bid-Build projects. However, an approved Preliminary Hydraulics Design Report (PHD) and, when applicable, an approved Preliminary Hydraulics Report Type A or Type B are required (see Section 1-3 Hydraulic Reports for more information). Application of policy changes to "locked" projects will be evaluated on a case-by-case basis to determine potential project impacts. The State Hydraulic Engineer will make the final decision regarding whether updated policy will be implemented on locked projects. For Design-Build projects, the applicable manual version is locked when the Request for Proposals (RFP) is published.

While the PEO is responsible for preparation of hydraulic reports and plans, specifications, and estimates (PS&E) for all drainage facilities, assistance from the RHE and the State Hydraulics Office may be requested for any drainage facility design. The RHE and State Hydraulics Office offer technical assistance to PEOs and local programs for the items listed below:

1. Hydraulic design of drainage facilities (culverts, storm sewers, stormwater best management practices [BMPs], siphons, channel changes, etc.).
2. Hydraulic design of structures (culverts, headwalls, etc.).
3. Analysis of closed drainage basins and unusual or unique drainage conditions.
4. Upstream and downstream analysis to identify and evaluate potential impacts from the project on the hydraulic conveyance system near the project site. The analysis shall be divided into three sections:
    a) Review of resources
    b) Inspection of drainage conveyance systems in the site area
    c) Analysis of upstream effects
    d) Analysis of downstream effects

The roles and responsibilities of the RHE and State Hydraulics Office are outlined in Table 1-1. The State Hydraulics Office also takes primary responsibility for the following:

1. Design of habitat features and stream restoration elements.
2. Hydraulic analysis (one-dimensional [1D] and two-dimensional [2D]) and support for scour of water crossings.
3. Analysis of streambank erosion along roadways, river and stream lateral migration, the design of countermeasures for scour and stream instability, and environmental mitigation.

4. Floodplain studies, flood predictions, and special hydrological analysis (snowmelt estimates, storm frequency predictions, etc.).
5. Wind and wave analysis.
6. Technical support to local programs for hydraulic or bridge-related needs.
7. Providing the Washington State Attorney General's Office with technical assistance on hydraulic issues.
8. Updating information in the Hydraulics Manual periodically.
9. Providing technical information for the *Highway Runoff Manual* updates.
10. Maintaining WSDOT's Standard Plans; *Standard Specifications for Road, Bridge, and Municipal Construction* (Standard Specifications); and General Special Provisions (GSP) involving drainage-related items.
11. Designing water supply and sewage disposal systems for safety rest areas. The PEO is responsible for contacting individual fire districts to collect local standards and forward the information to the State Hydraulics Office.
12. Reviewing and concurring with Type A hydraulic reports, unless otherwise delegated to the RHE by the State Hydraulics Office.
13. Providing the regions with technical assistance on hydraulic issues that are the primary responsibility of the PEO.
14. Providing basic hydrology and hydraulics training material to the regions. Either the RHE or State Hydraulics Office personnel can perform the actual training. (See the State Hydraulics Office on the WSDOT Hydraulics Training web page for information on course availability.)

1-3 Hydraulic Reports

The hydraulic report is intended to serve as a complete documented record containing the engineering justification for all drainage-, water crossing–, floodplain-, conveyance-, and stormwater-related installations and modifications that occur as a result of the project. A hydraulic report facilitates design review and assists in PS&E preparation. The hydraulic report shall be well written in the appropriate WSDOT template, and be defensible in a court of law. This section contains specific guidance for developing, submitting, and archiving a hydraulic report.

A *Highway Runoff Manual* certificate number is required for the stormwater designer who designs a new stormwater BMP on WSDOT right-of-way (ROW) or modifies an existing stormwater BMP on WSDOT ROW, or where a stormwater BMP is designed or modified and will be turned back to WSDOT ownership. The *Highway Runoff Manual* certificate number is given to those who have successfully passed the *Highway Runoff Manual* training course and is required on the title page of any hydraulic report created for WSDOT. See training information on the WSDOT Hydraulics Training web page.

A *Fish Passage and Stream Restoration Design* (FPSRD) certificate number is required for all authors and co-authors of any portion of a fish passage and stream restoration design

specialty report. See Table 1-1 for a list of specialty reports and other requirements. An FPSRD certificate number is given to those who have viewed all the training modules and successfully passed the comprehensive exam. Additional information, training resources, and the point of contact for this training can be found on the WSDOT Hydraulics Training web page. As WSDOT updates the FPSRD training modules a re-certification number is also required. Any updates to this training will be posted on the WSDOT Hydraulics Training web page.

A scour analysis is required for all WSDOT projects or WSDOT-managed infrastructure associated with scour or that have a potential to be impacted by scour, such as water crossings, walls, roadway embankments, and other WSDOT infrastructure. A *WSDOT Scour Certification Record* number is required for all Stream Team members (defined in Chapter 7-1) that are conducting scour calculations, lateral migration, scour analysis, and reviews as part of or supporting specialty reports. See Table 1-1 for a list of specialty reports and other requirements. A *Scour Certification Record* certificate number is given to those who have viewed all the WSDOT Scour Training Workshops and FHWA Bridge Scour Workshop Recordings; completed National Highway Institute (NHI) Course 135046, *Stream Stability and Scour at Highway Bridges, and* NHI Course 135048, *Countermeasures Design for Bridge Scour and Stream Instability*; and successfully passed the comprehensive exam. Additional information, training resources, and the point of contact for this training can be found on the WSDOT Hydraulics Training web page. As WSDOT updates the Scour Training modules a re-certification number is also required. Any updates to this training will be posted on the WSDOT Hydraulics Training web page.

The following training courses are required to obtain a scour certification:

- FHWA Bridge Scour Workshop Recordings
- NHI Course 135046, *Stream Stability and Scour at Highway Bridges*
- NHI Course 135048, *Countermeasures Design for Bridge Scour and Stream Instability*
- WSDOT 2023 Scour training

SRH-2D hydraulic modeling training is required for all WSDOT projects or WSDOT-managed infrastructure that requires hydraulic modeling as part of the hydraulic design process. Hydraulic modelers are required to obtain a training certificate from NHI for attending Course 135095, *Two-Dimensional Hydraulic Modeling of Rivers at Highway Encroachments*. Other equivalent SRH-2D hydraulic modeling training requires approval by the State Hydraulics Office.

1-3.1 *Hydraulic Report Types*

There are three types of hydraulic reports: specialty report, Type A, and Type B. Table 1-1 provides guidance for selecting the report type; however, consult the RHE for final selection.

Table 1-1 Hydraulic Report Documentation

Report Type	Description[b]	Concurrence[c]		PE Stamp
		RHE	State Hydraulics Office	
Stormwater and hydraulic assessment[a]	All projects shall complete a stormwater and hydraulics assessment to determine what type of stormwater and hydraulic design, documentation, and level of effort are needed for the project. Some questions for the PEO to answer as part of the stormwater and hydraulic assessment include: • Does the project have existing stormwater and hydraulic deficiencies within the project limits? If so, assess and discuss the risk of the project not addressing these deficiencies. • Do the project's impacts or modifications make existing stormwater and hydraulic conditions worse? • Do the project's impacts or modifications create new stormwater and hydraulic issues that need to be addressed? • Are there any stormwater retrofit opportunities within the project limits?			
Specialty report[d,l]	Projects with any of the following components: • Culverts or buried structures greater than 48 inches in diameter or span • Bridge drainage • Fish passage[e] • Bank protection • Woody material (WM)[e] • River structures (e.g., barbs, engineered log jams [ELJs], levees)[e] • Channel realignment/modifications or restoration[e] • Any fills in floodplain or floodway • Pump stations • Hydraulic connectivity zones • Siphons • Bridges • Scour analysis (e.g., bridges, walls, roadway embankments, other WSDOT infrastructure)[f]		✓	✓[g]

Report Type	Description[b]	Concurrence[c]		PE Stamp
		RHE	State Hydraulics Office	
A[d,l]	Projects with any of the following components: • Water quality treatment facility • Flow control facility • Storm sewer systems that discharge into a stormwater treatment or flow control facility • Create, modify, or remove any existing or new BMP (full or partial treatment BMP) • Fish passage stormwater treatment assessment for full or partial treatment[h] • Region facilities projects[i]		✓[i,j]	✓
B[c,d,k]	Projects without Type A components and with any of the following components: • Stormwater and non-fish passage culverts up to 48 inches in diameter[d] • Storm sewer systems that do not discharge into a stormwater treatment or flow control facility • Paving/safety restoration and preservation projects	✓		✓

Notes:

PE = Professional Engineer.
RHE = Region Hydraulics Engineer.

a. A stormwater and hydraulic assessment typically occurs just after project kickoff during design (project development). In some cases, a stormwater and hydraulic assessment may be as early as the predesign phase of a project.
b. Projects listed are examples. Projects not listed may still require a specialty report based on direction from the RHE.
c. In no case may the PEO provide concurrence on its own design.
d. State Hydraulic Office and the RHE shall be involved in developing the scope, budget, schedule, and/or the Request for Proposal for projects.
e. Fish passage projects shall be designed by a Stream Team, approved by the State Hydraulics Office, and consist of a stream design engineer, geomorphologist, and biologist, who shall all co-author the specialty report and have received their FPSRD certifications.
f. Scour certification is required for stream design engineers, Geomorphologists, or any other team members conducting and reviewing scour calculations and analysis.
g. The PE stamp shall be either by the State Hydraulics Office or by a licensed engineer in Washington State and approved by the State Hydraulics Office.
h. All fish passage projects shall complete a stormwater and hydraulic assessment for the feasibility of full or partial stormwater treatment BMPs. See *Highway Runoff Manual* for more information.
i. Facilities designed by the RHE will have concurrence from the State Hydraulics Office.
j. The State Hydraulics Office may delegate final review authority and concurrence for all Type A hydraulic reports to a person designated by the assistant regional administrator for development in each region.
k. A Hydraulic Report Concurrence memo is required by the RHE to the PEO to document that all comments have been addressed.
l. A Hydraulic Report Concurrence memo is required by the State Hydraulic Office to document that all comments have been addressed.

1-3.2 *Preparing Hydraulic Documentation*

The overall hydraulic design process is part of scoping, predesign, design, and construction. To allow the most efficient hydraulic report review and assessment, PEOs shall follow the hydraulic review process outlined in Section 1-6.

1-3.2.1 Type A and Type B Hydraulic Report Content and Outline

The hydraulic report outline identifies the required subject matter that the Type A (and sometimes Type B) hydraulic report shall contain. PEOs shall provide a well-organized hydraulic report such that an engineer with no prior knowledge of the project could read and fully understand the hydraulic/hydrologic design decisions made for the design of the project. The hydraulic report shall contain enough information to allow reproduction of the design in its entirety, but at the same time the hydraulic report shall be concise and avoid duplicate information that could create confusion. Because the software used for analysis will change over time, all assumptions and input parameters shall be clearly documented to allow the analysis to be reproduced in other software in the future, if needed.

The hydraulic report outline has been developed as a starting point. Use of the outline is mandatory; organizing hydraulic reports in the outline format may expedite the review process. Because some regions have modified the outline to meet specific regional needs or requirements, PEOs shall contact their RHE to determine the correct outline before starting a hydraulic report. Once the relevant outline is selected, PEOs shall read through the outline, determine which sections are applicable to the project. For those sections of the outline that are not applicable, the PEO shall keep the section headers but just list not applicable or "N/A" for the content of those sections. This will help ensure all hydraulic reports are consistent in their sections and numbering. Either the RHE or the State Hydraulics Office can be contacted for assistance in preparing a hydraulic report and for current updates to the hydraulic report outline.

The detailed documentation of a Type B hydraulic report can vary greatly depending on the details of the project scope. Work with the RHE to determine the appropriate level of detail needed to document the hydraulic design decisions in a Type B hydraulic report.

The hydraulic report author shall not copy sections of the *Hydraulics Manual* or *Highway Runoff Manual* into the hydraulic report because it would add redundant information to the report. Instead, authors shall reference the relevant section and manual version in the hydraulic report narrative.

1-3.2.2 Specialty Report Content and Outline

Specialty reports shall consist of a preliminary hydraulic design (PHD) report and a final hydraulic design (FHD) report. The PHD report is created during the initial stages of project design, prior to the final design and construction phase. This report provides a preliminary analysis of the hydraulic considerations that will influence the design moving forward. The FHD report is the basis for the project's FHD approval and is used throughout the construction phase to ensure that hydraulic components function as intended and support the overall safety and functionality of the transportation infrastructure.

Both reports are critical in ensuring that WSDOT projects meet necessary hydrological requirements and WSDOT design policies. Report templates can be found on the WSDOT Hydraulics and Hydrology webpage (Hydraulics & hydrology | WSDOT).

1-3.2.3 Stormwater and Hydraulic Assessment Content

A stormwater and hydraulic assessment is required to be completed for every project. The purpose of the assessment is to identify if there is any drainage-, water crossing–, conveyance-, and stormwater-related work on the project so the level of effort and required hydraulic documentation can be discussed and planned for. The PEO shall conduct the assessment right after project kickoff and it may take the form of a general meeting between the PEO and the RHE or State Hydraulics Office. When the level of effort and required hydraulic documentation discussed during the assessment is determined to be very minor (e.g., a paver project), the assessment documentation could simply be the meeting notes or follow-up email between the PEO and RHE or State Hydraulics Office stating that there is no drainage-, water crossing–, conveyance-, or stormwater-related work on the project. If the amount and type of work changes on the project, the PEO shall update the RHE to re-evaluate the level of effort and required hydraulic documentation for the project based on the new information. If the level of effort and required hydraulic documentation discussed during the stormwater and hydraulic assessment appears to be significant, it is recommended that the PEO schedule regular check-in meetings with the RHE or State Hydraulics Office as the design progresses. See the hydraulic report checklist. The stormwater and hydraulic assessment deliverable would be the meeting notes.

One important outcome from the stormwater and hydraulic assessment is a discussion on the feasibility of dispersion and infiltration on the site to aid in the design of low-impact development (LID) BMPs. To determine the feasibility of LID BMPs, the PEO may need geotechnical information about site soils, infiltration rates, and seasonal high groundwater table elevations where potential stormwater BMP locations are along the project. After the stormwater and hydraulic assessment and if the project may be required to construct or place stormwater BMPs, it is strongly recommended that the PEO issue a geotechnical soils investigation memorandum as early as possible. The PEO shall discuss these issues with the Region Materials Engineer (RME) or HQ Geotechnical Office in preparation of a geotechnical investigation memorandum. Issuing the geotechnical investigation memorandum early in the project development process will give enough time for the geotechnical investigation work to be completed so that the stormwater designs can be completed on time.

For WSDOT fish barrier removal projects, the PEO shall discuss potential stormwater treatment areas along the project during the stormwater and hydraulic assessment to identify if there may be any areas that could be used for stormwater retrofit. For more information, see the Stormwater Retrofit Assessment for Fish Barrier Projects document on the WSDOT Hydraulics & hydrology website under the Tools, templates & links tab. For other WSDOT projects that are not fish barrier removal projects, PEOs are strongly encouraged to follow the same process for identifying stormwater treatment areas along the project and to identify potential stormwater retrofit areas during the stormwater and hydraulic assessment.

1-3.2.4 Deviations from the *Hydraulics Manual*

Deviations from the requirements in the *Hydraulics Manual* must clearly state why a deviation is necessary and document all the steps used in the analysis in a hydraulic deviation. Deviations from this manual require approval prior to submitting a hydraulic report for review. Requests for a deviation shall go through the RHE to the State Hydraulics Office. A Hydraulics Manual Deviation template is available on the WSDOT Hydraulics & hydrology website under the Tools, templates & links tab.

1-3.2.5 Design Tools and Software

The design tools and programs described in the *Hydraulics Manual* and in the *Highway Runoff Manual* shall be used whenever possible. To determine if software and/or a design tool is required, PEOs shall review Section 1-4 or check the expanded list on the State Hydraulics Office website. If a PEO wishes to use a design tool or software other than those required, it must request concurrence during the 10 percent milestone timeline for the hydraulic design report through the RHE.

1-3.2.6 Contract or Scope of Work for Hydraulic Support

Contact the RHE and/or State Hydraulics Office to review the contract or scope prior to hiring a consultant.

1-3.3 *Hydraulic Report Deliverables, Submittals, and Archiving*

It is important to understand the various stormwater and hydraulic deliverables produced for a given project. It is equally important to understand to whom to submit deliverables and when. Hydraulic reports have their own WSDOT document retention schedule so understanding the process for archiving these records is also discussed in this section.

1-3.3.1 Hydraulic Report Deliverables for Design-Bid-Build Projects

Following Table 1-1, at a minimum, the PEO shall develop a stormwater and hydraulic assessment for each project and coordinate with RHE. In the scenario where there is a lot of stream work but little road work (like a fish barrier correction project), the PEO would need a stormwater and hydraulic assessment, a Type B hydraulic report, and a specialty report. For more complicated roadway improvement projects, the PEO would need a stormwater and hydraulic assessment, a Type A hydraulic report, and possibly a specialty report. The PEO shall work with the RHE or State Hydraulics Office to determine what type of hydraulic documentation is needed for the design-bid-build project during the stormwater and hydraulic assessment.

1-3.3.1.1 Hydraulic Report Submittal Process for Design-Bid-Build Projects

1-3.3.1.1.1 Specialty Report Submittals

The PEO shall coordinate with the State Hydraulics Office for the PHD and FHD report referenced in Section 1-3.2.2.

1-3.3.1.1.2 Type A and Type B Hydraulic Report Submittals

The hydraulic report submittal process will vary based on the hydraulic report type. For a Type B hydraulic report for a design-bid-build project, because the drainage-, conveyance-, and stormwater-related work on the project is very limited, the PEO can work with the RHE or State Hydraulics Office to determine a submittal timeline for the Type B hydraulic report. For a Type A hydraulic report for a design-bid-build project, the submittal process is a little more defined. Below is a description of each Type A hydraulic report submittal and the approximate timing of each submittal:

a) **Preliminary Type A report:** This submittal shall occur during the project development phase after the stormwater and hydraulic assessment.

   a. Recommend this submittal after *Highway Runoff Manual* minimum requirements and Endangered Species Act (ESA) programmatic consultation stormwater requirements (if applicable) have been determined, draft threshold discharge area (TDA) delineations are complete, discharge locations have been identified, existing drainage issues within the project limits have been identified, existing stormwater drainage system has been mapped within the project limits, stormwater retrofitting requirements have been determined (if applicable), potential stormwater (*Highway Runoff Manual*) and hydraulic (*Hydraulics Manual*) deviations have been identified, and cursory review of possible stormwater connection utility discharge permits has been conducted.

   b. Generally, this may occur around 30 percent project design.

   c. The design PEO submits the Preliminary Hydraulic report Type A for review and comments to the RHE or State Hydraulics Office per Table 1-1.

b) **Intermediate Type A Hydraulic report:** This submittal typically occurs when all of the engineering design work has been completed.

   a. Recommend this submittal when the stormwater and hydraulic design is complete; the final stormwater BMP type, size, and locations have been designed; the conveyance design is complete; the upstream and downstream analysis is complete; any stormwater (*Highway Runoff Manual*) and hydraulic (*Hydraulics Manual*) deviations have been approved; and draft BMP maintenance plans have been created.

   b. The design PEO submits the intermediate Type A hydraulic report for review, comments, and concurrence to the RHE or State Hydraulics Office per Table 1-1.

   c. This generally occurs around 90 percent project design.

   d. If there are drainage-related addendums (changes) during the PS&E phase of the project, the PEO shall contact the engineer of record who stamped the intermediate Type A hydraulic report to evaluate those addendums to determine if they affect the stormwater and hydraulic design and if those changes require an update to the intermediate Type A hydraulic report. Any

changes need to be incorporated into the intermediate Type A hydraulic report and the hydraulic report needs to be restamped.

e. The design PEO submits the revised intermediate Type A hydraulic report (because of addendums) for review, comments, and concurrence to the RHE or State Hydraulics Office per Table 1-1.

c) **Drainage-related change orders:** These submittals shall occur after the start of the construction phase of the project but before substantial completion.

a. Recommend this submittal when drainage-related change orders occur during the construction phase of the project.

i. For any drainage-related change orders that may affect the stormwater and hydraulics design, the construction office needs to contact the engineer of record who stamped the intermediate Type A hydraulic report so that those drainage-related change orders can be evaluated to determine if they affect any other parts of the stormwater and hydraulic design and if any redesign is required. If contacting the original engineer of record is not possible, the construction office needs to contact the RHE or State Hydraulics Office to determine if any changes need to be made to the stormwater and hydraulic design and intermediate Type A hydraulic report because of the drainage-related change order(s). Any drainage-related changes need to be worked into the overall stormwater and hydraulic design and the final Type A hydraulic report. In some cases where drainage-related change orders require significant changes, many things may need to be updated including TDA delineations, *Highway Runoff Manual* minimum requirements, the stormwater design documentation spreadsheet, the conveyance design, and any stormwater and hydraulic deviations previously approved. The engineer of record overseeing these new changes would need to stamp the final Type A hydraulic report to cover any changes as a result of the drainage-related change orders.

b. The construction PEO submits the drainage-related change orders for review and comments to the RHE or State Hydraulics Office per Table 1-1.

c. If the drainage-related change orders, after consulting with the engineer of record and the RHE or State Hydraulics Office, do not require a change or there are no drainage-related change orders to the intermediate Type A hydraulic report, then the intermediate Type A hydraulic report can be renamed as the final Type A hydraulic report.

d) **Final Type A Hydraulic report:** This submittal shall occur after construction of the project has reached substantial completion.

a. Recommend this submittal after all drainage-related change order submittals (if any) have been approved and constructed, drainage-related change order submittal changes have been incorporated into the final Type A hydraulic

report and all relevant sections of the final Type A hydraulic report have been updated, and as-built verification of stormwater and hydraulic features has occurred.

b. The construction PEO submits the final Type A hydraulic report for review, comments, and concurrence to the RHE or State Hydraulics Office per Table 1-1.

c. This generally occurs during the construction phase of the project but after substantial completion.

d. BMP maintenance plans shall be finalized along with the final Type A hydraulic report.

PEOs shall ensure that any electronic submittal is complete and is searchable. The PEO can use the hydraulic report checklist to help identify and schedule critical submittal dates.

1-3.3.2 Hydraulic Report Deliverables for Design-Build Projects

Projects using a design-build delivery method have a different hydraulic report submittal process from that described for the design-bid-build delivery method (see Section 1-3.3.1).

The PEO shall coordinate with the RHE or the State Hydraulics Office to determine the expected deliverable for the design-build project and coordinate on the completion of the RFP Technical Requirements 2.14 Stormwater and Technical Requirements 2.30 Water Crossings.

The design PEO typically creates a conceptual Type A or Type B hydraulic report and completes the RFP Technical Requirements 2.14 Stormwater, in preparation for the procurement phase of the design-build process. Once the design-builder is selected and awarded the contract, the design-builder becomes the engineer of record and completes the stormwater and hydraulic design and Type A or Type B hydraulic report for the project. The PEO shall coordinate with the State Hydraulics Office for the PHD and FHD report deliverables to complete RFP Section 2.30

A conceptual Type A or Type B hydraulic report describes the conceptual stormwater and hydraulic designs for the project that are used for various purposes. The conceptual hydraulic report is used to show one possible pathway for the design-builder to reach compliance with the hydraulic design requirements for the project. More information regarding the conceptual hydraulic report and other details can be found in the *Design-Build Manual*.

The design PEO must work with the RHE or State Hydraulics Office to develop the conceptual Type A or Type B hydraulic report and to complete RFP Section 2.14 for the project. The PEO shall coordinate with the State Hydraulics Office for the PHD and FHD report deliverables to complete RFP Section 2.30.

1-3.3.2.1 Hydraulic Report Submittal Process for Design-Build Projects

All submittals shall be in electronic format. All pages of all submittals shall be in searchable Portable Document Format (PDF). In addition to the searchable PDF document, submittals that include hidden information not visible in PDF format (such as calculations in the cells of a spreadsheet or drawing) shall be submitted in their original format (e.g., Word, Excel, InRoads) to facilitate WSDOT's full review and understanding of the basis and assumptions for calculations and other output

a) **Conceptual Type A or Type B hydraulic report:** This submittal shall occur during the project development phase after the stormwater and hydraulic assessment but before finalizing the RFP.

   a. Recommend this submittal after *Highway Runoff Manual* minimum requirements and ESA programmatic consultation requirements (if applicable) have been determined, draft TDA delineations are complete, existing drainage issues have been identified, the existing stormwater drainage system has been identified, discharge locations have been identified, stormwater retrofitting requirements have been determined (if applicable), potential stormwater (*Highway Runoff Manual*) and hydraulic (*Hydraulics Manual*) deviations have been identified and received approval, and cursory review of possible stormwater connection utility discharge permits has been conducted.

   b. The design PEO submits the conceptual Type A or Type B hydraulic design report for review and comments to the RHE or State Hydraulics Office per Table 1-1.

b) **Design-builder's Preliminary Type A or Type B hydraulic report:** This submittal shall occur after the project has been awarded to a design-builder but before the first intermediate drainage design package.

   a. This submittal shall provide draft designs and preliminary responses for the following issues:

      i. Meet *Highway Runoff Manual* minimum requirements and ESA programmatic consultation stormwater requirements (if applicable)

      ii. Provide draft TDA delineations

      iii. Determine existing discharge locations within the project limits

      iv. Determine existing drainage issues within the project limits

      v. Map the existing stormwater drainage system within the project limits

      vi. Determine stormwater retrofitting requirements (if applicable)

      vii. Identified potential stormwater (*Highway Runoff Manual*) and hydraulic (*Hydraulics Manual*) deviations

      viii. Identified possible stormwater connection utility discharge permits

ix. Any additional requirements per the RFP

b. The design-builder submits the Type A or B preliminary hydraulic report for review and comment to the WSDOT engineer (who sends it to the RHE or State Hydraulics Office per Table 1-1).

c) **Design-builder's intermediate drainage design packages:** These submittals shall occur after the design-builder's preliminary Type A or Type B hydraulic report but before the design-builder's Type A or B intermediate hydraulic report.

a. The design-builder submits the intermediate drainage design packages for review and comment to the WSDOT engineer (who sends it to the RHE or State Hydraulics Office per Table 1-1).

b. The first intermediate drainage design package shall describe the specifics of the changes from the Preliminary Type A or Type B Hydraulic Report to the proposed design.

c. All subsequent intermediate drainage design packages shall describe the specifics of the changes from the previous intermediate drainage design package(s) that covers the same drainage design being revised or updated.

d. All intermediate drainage design packages shall be easily readable as stand-alone documents, show why the revisions were made and how they impact the final overall stormwater and drainage design, include revised drawings and exhibits, supporting assumptions and calculations, and revised summaries and tables.

d) **Design-builder's Type A or Type B intermediate hydraulic report:** This submittal shall occur after the last design-builder's intermediate drainage design package but before the design-builder's Type A or B final hydraulic report.

a. This submittal shall incorporate all of the intermediate drainage design packages into one coherent and complete stormwater and hydraulics design. The Type A or B intermediate hydraulic report shows how the project addressed and is compliant with the mandatory standards and the RFP.

b. The design-builder submits the Type A or B intermediate hydraulic report for review and comments to the WSDOT engineer (who sends it to the RHE or State Hydraulics Office per Table 1-1).

e) **Design-builder's Type A or Type B final hydraulic report:** This submittal shall occur after all construction is complete on the project and after the as-built verification of stormwater and hydraulic features walk-through.

a. This submittal shall incorporate any changes that occurred after the Type A or Type B intermediate hydraulic report and generate one coherent and complete stormwater and hydraulics design. The Type A or B final hydraulic report shows how the project addressed and is compliant with the mandatory standards and the RFP.

b. The design-builder submits the Type A or B final hydraulic report for review and comments to the WSDOT engineer (who sends it to the RHE or State Hydraulics Office per Table 1-1). The RHE or State Hydraulics Office shall issue a hydraulic report concurrence memo once all comments for the final hydraulic report have been resolved.

c. BMP maintenance plans shall be finalized along with the Type A final hydraulic report.

f) Specialty Reports: The specialty report(s) shall describe the approach taken and the order of the calculations, including sections on the methodologies used (appropriateness and accuracy requirements), design decisions made, and resultant summaries. The calculations shall include electronic copies of the input and output from the supporting computer programs, spreadsheets, hand calculations, exhibits, and sketches.

PEOs and the design-builder shall ensure that any electronic submittal is complete and is searchable. The PEO can use the hydraulic report checklist to help identify and schedule critical submittal dates.

1-3.3.3 Final Copies and Archiving

Upon receiving concurrence of a Type A or B hydraulic report, PEOs shall submit a searchable electronic copy of the Type A or B hydraulic report, which shall also include the concurrence letter, to the offices noted below. Electronic copies shall include the entire contents of the Type A or B hydraulic report (including the appendices files) in a PDF file. Each final Specialty Report shall include all narratives, calculations, drawings, and figures that are incorporated into searchable electronic files.

1. For design-bid-build projects, send one PDF of the Type A or B intermediate hydraulic report to the Construction Office for reference during construction.
2. For design-bid-build projects, along with the concurrence letter, the PEO shall upload the Type A or Type B intermediate hydraulic report to the Enterprise Content Management (ECM) application along with the Design Decision Package (DDP) for archiving.
3. For design-bid-build projects, if any stormwater or hydraulic related change orders occur during the project's construction that affect a hydraulic feature's intended function, the Type A or Type B hydraulic report shall be revised to incorporate the changes. After a review of the revised hydraulic report following Table 1-1 and receiving a new concurrence letter, the revised hydraulic report and concurrence letter shall be combined into one final hydraulic report document (PDF) and uploaded to the EMC by the construction office or RHE before the construction project closeout. If no stormwater or hydraulic related change orders occurred during the construction phase of the project, the construction office or RHE can make a note of this in the ECM and can rename the Type A or B intermediate hydraulic report to the final Type A or Type B hydraulic report.

4. For design-bid-build projects, the PEO shall upload Specialty Report(s) to the ECM application along with the DDP. The PEO shall also send one PDF to the Bridge Preservation Office.
5. For design-build projects, the Type A or B final hydraulic report and Specialty Reports shall be uploaded to the ECM application by the construction project office.

1-3.4 *Developers and Utility Agreements*

Developers, state and local agencies, utilities, and others designing stormwater facilities within the WSDOT ROW shall assume the same responsibility as the PEO and prepare hydraulic reports in compliance with the policy outlined in Chapter 1. Developers, state and local agencies, utilities, and others discharging stormwater to the WSDOT ROW may need a permit. For more information on requirements and permits for discharging to the WSDOT ROW and/or building on the WSDOT ROW, consult the *Design Manual*, Utilities Manual, and Local Agency Guidelines manual.

1-3.5 *Upstream and Downstream Analysis*

Conducting an upstream and downstream analysis as part of a Type A or B or specialty report identifies, evaluates, and documents the impacts and risks, if any, that a project will have on the drainage conveyance system, properties, and sensitive areas. All projects that propose to discharge stormwater from WSDOT ROW and meet the requirements below are required to provide an analysis as part of the hydraulic report; see the hydraulic report outline for more information. For projects that require a flood risk assessment see additional guidance in Chapter 7.

- Projects that add 5,000 square feet or more of new, impervious surface area.
- Projects where known drainage or erosion problems indicate there may be impacts on either the upstream or downstream conveyance system, properties, or sensitive areas.
- Projects that add less than 5,000 square feet of new impervious surface and where the project is within 300 feet of a stream.
- Projects that add less than 5,000 square feet of new impervious surface and the project's stormwater discharges into a stream within 0.25 miles upstream or downstream of the project limits.
- Projects that alter existing hydrology or drainage.

1-3.5.1 Upstream and Downstream Analysis for Type A and B Reports

At a minimum, the analysis must include the area of the project site to a point 0.25 miles downstream of the site and upstream to a point where any backwater conditions cease. The results of the analysis must be documented in the project hydraulic report. Potential impacts to be assessed in the report also include but are not limited to changes in flow, rates, storm duration, water surface elevations (WSELs), bank erosion, channel erosion, and nutrient loading from the project site. The analysis is divided into three steps that follow sequentially:

1. Review of resources
2. Inspection of drainage conveyance systems in the site area
3. Analysis of upstream and downstream effects

1-3.5.2 Review of Resources

The PEO reviews available resources to assess the existing conditions of the stormwater drainage systems in the project vicinity. Resource data commonly include aerial photographs, area maps, floodplain maps, wetland inventories, stream surveys, habitat surveys, engineering reports concerning the entire drainage basin, the *Climate Impacts Vulnerability Assessment* statewide map, GIS and light detecting and ranging (LiDAR) information, and any previously completed upstream or downstream analyses. All of this information shall encompass an area 0.25 miles downstream of the project site's discharge point from WSDOT's ROW and upstream to a point where any backwater conditions cease.

The background information is used to review and establish the existing conditions of the stormwater drainage system. This baseline information is used to determine whether the project will improve upon existing conditions, have no impact, or degrade existing conditions if no mitigating measures are implemented. The RHE and HQ Environmental Services Office staff will be able to provide most of this information. Other resource information sources include the Washington State Department of Ecology (Ecology), the Washington Department of Fish and Wildlife (WDFW), and local agencies.

1-3.5.3 Inspection of Stormwater Drainage System

The PEO must inspect the stormwater drainage system and identify any existing problems that might relate to stormwater runoff. The PEO will physically inspect (if possible) the stormwater drainage system at the project site and downstream from the WSDOT ROW for a distance of at least 0.25 mile and upstream to a point where any backwater conditions cease. The inspection shall include any problems or areas of concern that were noted during the resource review process or in conversations with local residents and the WSDOT Maintenance Office. The PEO shall also identify existing or potential conveyance capacity problems in the stormwater drainage system, existing or potential areas where flooding may occur, existing or potential areas of extensive channel destruction or erosion, and existing or potential areas of significant destruction of aquatic habitat (runoff treatment or flow control) that can be related to stormwater runoff. If areas of potential and existing impacts related to project site runoff are established, actions must be taken to minimize impacts to upstream and downstream resources.

1-3.5.4 Analysis of Upstream and Downstream Effects

This final step analyzes information gathered in the first two steps of the analysis. It is necessary to determine if the project will create any stormwater drainage system problems downstream or make any existing problems worse. The PEO must analyze upstream and downstream effects to determine corrective or preventive actions that may be necessary. If the project is within a medium- or high-vulnerability location according to the *Climate Impacts Vulnerability Assessment* statewide map, the PEO must run extreme storm events (e.g., the 100-year flood event) and evaluate the impacts and stability of the stormwater drainage system. The PEO will perform a risk assessment based on the extreme storm

events showing impacts to the stormwater drainage system and to downstream properties and sensitive areas.

PEOs will consult the *Highway Runoff Manual* for further guidance on the design flow rate for runoff treatment and flow control BMP design. In some cases, analysis of effects may indicate that no corrective or preventive actions are necessary. If corrective or preventive actions are necessary, the following options must be considered:

- Design the flow control facilities to provide a greater level of runoff control than stipulated in the minimum requirements in Chapter 3 of the *Highway Runoff Manual*.
- Take a protective action separate from meeting Minimum Requirements 5 and 6 in the *Highway Runoff Manual* for runoff treatment and flow control. In some situations, a project will have negative impacts even when the HRM Minimum Requirements are met. Below are two examples:
    - Roadway runoff in a project's TDA was sheet-flowing to the roadway side slopes in the pre-developed condition but is now being collected and conveyed to a new stormwater detention pond in the post-developed condition. The detention pond's emergency overflow consists of a weir built into the side of the detention pond. The detention pond's primary overflow is the top of the tee standpipe riser structure. The overflow structure discharges south to an existing conveyance system. The emergency overflow structure (pond weir), when activated during less frequent events, discharges to the east and does not flow to the existing conveyance system where the overflow structure discharges. In this scenario, even though the detention pond will provide flow control for more frequent storm events (up to the 25-year for eastern Washington or 50-year for western Washington), the larger, less frequent flood events (100-year) may not have flow control. These scenarios need to be analyzed as part of the downstream analysis. Because the stormwater is now collected and conveyed to two separate discharge locations, there may be more flow at those discharge locations than in the pre-developed condition. If a situation is encountered where downstream impacts will result from the project, the corrective action must be applied to the project based on a practicability analysis.
    - If a project is flow control exempt, the stormwater drainage system downstream of the project site shall be inspected to ensure adequate capacity. The PEO shall also analyze and document any changes to the downstream stormwater drainage system, properties, and sensitive areas. If there are any negative impacts, the PEO shall perform a risk analysis showing what would happen if no actions were taken to minimize the negative impacts.

1-3.6 *Existing Stormwater Drainage System*

During the stormwater and hydraulic assessment, the existing stormwater drainage system shall be discussed to identify any needed repairs or replacements. If possible, it is strongly recommended that the PEO physically inspect the entire existing stormwater

drainage system within the project limits, especially if changing how much flow goes to it. There may be condition ratings for some of these existing stormwater features in Highway Activities Tracking System (HATS) or the Stormwater Features Inventory Database (SFID) that may aid in determining the physical inspection requirements. Contact the State Hydraulics Office for culvert Level 1 and Level 2 inspection requirements and guidelines. See the 2020 AASHTO Culvert and Storm Drain System Inspection Guide for guidance on inspecting storm sewer, catch basins, manholes, inlets, grates, and ditches.

1-4 Storm Frequency Policy and Design Tools and Software

WSDOT policy regarding design storm frequency for hydraulic structures has been established so the PEO does not have to perform a risk analysis for each structure on each project. The design storm frequency is referred to in terms of mean recurrence interval (MRI) of precipitation. A more detailed discussion of MRI can be found in Chapter 2. New hydraulic structures shall also consider increased environmental degradation for final design size by evaluating higher storm events. Consult the RHE and the State Hydraulics Office early for discussion and concurrence.

For design of hydraulic features, the PEO shall review Section 1-3.2.5 for required design tools and software. The PEO shall work with the RHE to verify that the required design tools and software are used for design of hydraulic features.

If the PEO wants to use a design tool or hydraulic software that has not been approved by the State Hydraulics Office, the PEO shall provide a side-by-side comparison analysis showing the differences between the approved design tool or approved software and the proposed design tool or proposed software. The analysis shall be submitted to the RHE for review and approval. The approval of using an alternative design tool or alternative software shall be obtained before the intermediate hydraulic report can be submitted. Contact the RHE for additional guidance.

Table 1-2 presents a design reference chart and approved software.

Table 1-2 Design Reference

Type of Structure	MRI (Years)	Chapter Reference	Hydrologic Method	Approved Software	Additional Notes
Curb and gutter on longitudinal slope (no inlet)	10	5	Rational	WSDOT Inlet Spacing Spreadsheet	
Curb opening or scupper on longitudinal slope	10	5	Rational	WSDOT Curb - Barrier Scupper Inlet Spreadsheet	
Curb opening or scupper in a sag condition	50	5	Rational	FHWA Hydraulic Toolbox	
Inlet against a curb on longitudinal slope	10	5	Rational	WSDOT Inlet Spacing Spreadsheet	If stormwater from this run of curb goes to a downstream stormwater BMP AND this run of curb is not going to a sag, inlet spacing shall be designed so that no bypass flow is allowed for the design storm event (MRI) of the downstream BMP or 10 year, whichever is greater.
Inlet against a curb on vertical curve sag/closed contour location	50	5	Rational	WSDOT Sag Design Spreadsheet	If stormwater from this sag goes to a downstream stormwater BMP, sag shall be designed so that no bypass flow is allowed for the design storm event (MRI) of the downstream BMP or 50 year, whichever is greater.
Inlet in a median or ditch that is in a sag location	50	5	Rational	Hydraulic Toolbox	See HM 5-5 for more details.
Storm sewer: Capacity check	25	6	SBUH/SCS or Rational	StormShed3G	If stormwater from this storm sewer goes to a downstream stormwater BMP, storm sewer shall be designed for the design storm event (MRI) of the downstream BMP or 25 year, whichever is greater. When doing a capacity check on an existing storm sewer system, the designer should use the same hydrologic method used to design the existing storm sewer system. If the existing storm sewer design cannot be determined, the designer shall use the Rational Method.
Storm sewer: Hydraulic Grade Line check	25	6	SBUH/SCS or Rational	StormShed3G	If stormwater from this storm sewer goes to a downstream stormwater BMP, storm sewer HGL shall be designed for the design storm event (MRI) of the downstream BMP or 25 year, whichever is greater. See HM 6-2.5 for more details.
Ditch	10	5	SBUH/SCS or Rational	StormShed3G or Hydraulic Toolbox	If stormwater from this ditch goes to a downstream stormwater BMP, ditch shall be designed for the design storm event (MRI) of the downstream BMP or 10 year, whichever is greater.
Gore area drainage	10	5	Rational	Hydraulic Toolbox	If stormwater from this gore area goes to a downstream stormwater BMP, gore area drainage shall be designed for the design storm event (MRI) of the downstream BMP or 10 year, whichever is greater.
Non-fish passage culverts: Design for HW/D ratio	25	3	Published flow records Flood reports (flood insurance study) USGS regression Rational SBUH/SCS	StormShed3G, HY-8, HEC-RAS, or SRH-2D	Coordinate with the RHE to determine the appropriate software to use and potential reports required. If using SRH-2D, please complete the SRH-2D Model Audit Checklist found on the WSDOT Hydraulics and Hydrology website on the Tools, templates, & links tab.
Non-fish passage culverts: Check for high flow damage	100	3	Published flow records Flood reports (flood insurance study) USGS regression Rational SBUH/SCS	StormShed3G, HY-8, HEC-RAS, or SRH-2D	Coordinate with the RHE to determine the appropriate software to use and potential reports required. If using SRH-2D, please complete the SRH-2D Model Audit Checklist found on the WSDOT Hydraulics and Hydrology website on the Tools, templates, & links tab.

Type of Structure	MRI (Years)	Chapter Reference	Hydrologic Method	Approved Software	Additional Notes
Temporary diversions	See Additional Notes	3	Published flow records Flood reports (flood insurance study) USGS regression Rational SBUH/SCS Continuous Simulation	StormShed3G, MGSFlood, HY-8, HEC-RAS, or SRH-2D	Coordinate with the RHE to determine the appropriate software to use and potential reports required. If using SRH-2D, please complete the SRH-2D Model Audit Checklist found on the WSDOT Hydraulics and Hydrology website on the Tools, templates, & links tab.
Water crossings	See Additional Notes	7	Published flow records Flood reports (flood insurance study) USGS regression	SRH-2D	Complete the SRH-2D Model Audit Checklist found on the WSDOT Hydraulics and Hydrology website on the Tools, templates, & links tab.
Stormwater BMP	See the *Highway Runoff Manual*				

Notes:
BMP = best management practice
HEC-RAS = Hydrologic Engineering Center's River Analysis System
HW/D = headwater to diameter ratio
MRI = mean recurrence interval
SBUH/SCS = Santa Barbara Urban Hydrograph/Soil Conservation Service
SRH-2D = Sedimentation and River Hydraulics – 2D Model
USGS = United States Geological Survey
WSDOT = Washington State Department of Transportation

1-5 Complete Streets

WSDOT projects involving Complete Streets are designed and operated to promote use and mobility for all users, including pedestrians, bicyclists, or transit riders. The program prioritizes comfortable, equitable network connectivity for all roadway users through close coordination with local partners and stakeholders. See the WSDOT *Design Manual* for additional information including the screening process to determine a project's need for the program.

Complete Streets or other active transportation design projects may cause changes to drainage structures or other hydraulic features beyond their basic requirements outlined in this manual; see Sections 5-4, 6-1 and 7-6.1 for additional information.

1-6 Hydraulic Design Schedule

Establishing a design schedule that includes the hydraulic components is critical to ensuring that the project's overall design and implementation proceed smoothly and efficiently. Hydraulic elements, such as drainage systems, culverts, stormwater management, and flood risk mitigation, can have significant impacts on various other aspects of a project, including environmental considerations, structural design, and compliance with regulations. By incorporating hydraulic design milestones early in the schedule, project teams can proactively assess how these components interact with and influence other design elements, identify potential conflicts, and make necessary adjustments to avoid delays or cost overruns. This integrated approach helps to ensure that the project is completed on time, meets regulatory requirements, and achieves its performance goals without unforeseen challenges arising from hydraulic issues.

1-6.1 *Milestones and Scheduling*

There are three primary types of hydraulic reports (see Section 1-3):

- Type A
- Type B
- Specialty

Schedule templates for these different types of hydraulic reports can be found online under Tools, Templates and Links on the WSDOT Hydraulics & hydrology website. Refer to *Design Manual* Section 800.03 and Exhibits 800-1 through 800-5 for an overview of the hydraulic design process. For additional guidance on schedule development please contact your RHE or the State Hydraulics Office.