



WSDOT

Scour Workshop

Module 3

WSDOT Scour Policies and Procedures

May 30th, 2023

Julie Heilman

State Hydraulic Engineer HQ Development Division WSDOT



Current Duties

- Hydraulics Section
- Hydrology Section
- Stormwater Section
- Fish Passage Section



Background and Experience

- 22 years at WSDOT
- Construction Management
- Transportation Engineer
- Hydraulics Engineer



Education

- B.S. Civil Engineering (WSU)



Personal Interests

- 2 teenagers
- 1 college kid
- Lots of House Projects
- Large extended family

Design Manual Updates

Chapter 800 – Hydraulic Design

The Situation Before the Update

- Chapter 800 – Hydraulic Design previously consisted of four pages
- The following was not well defined:
 - Roles and responsibilities of various team members (update in 800.01)
 - Importance and timing of coordination with other specialty groups (update in 800.02)
 - Hydraulic design process and required deliverables in scoping, pre-design, design and construction (update in 800.03)
 - Floodplain management and required deliverables (update in 800.04)
 - Water crossing design for fish passage (update in 800.05)

What triggered the change?

- Fish Passage Federal Injunction resulted in large increase in number of hydraulic design projects.
- Resilient infrastructure requires proper scour analysis and coordination with an interdisciplinary team throughout project delivery.
- Scour analysis is required for hydraulic design projects and can have a large impact on project cost.
- WSDOT manuals have historically been written for internal designers.
- Need to better define the WSDOT process.
- More projects are using other project delivery methods.
- Need to clearly define roles and responsibilities.

The Changes - Overview

Previous Version

800.01 General
800.02 References
800.03 Hydraulic
Considerations
800.04 Safety Considerations
800.05 Design Responsibility
800.06 Documentation

2022 Version

800.01 General
800.02 Coordination with Other Specialty
Groups
800.03 Hydraulic Design Process
800.04 Floodplain Management
800.05 Water Crossings
800.06 Safety Considerations
800.07 Documentation
800.08 References

Exhibit 800-1 Specialty Group Coordination: Pre-Design

Exhibit 800-2 Specialty Group Coordination: Contractor Supplied
Design

Exhibit 800-3 Specialty Group Coordination: Design

Exhibit 800-4 Hydraulic Design Process

Exhibit 800-5 Preliminary Hydraulic Design: Stream Design
Process

800.01 General

Below is a summary of roles and responsibilities:

- **PEO** – responsible for the preparation of correct and adequate stormwater and drainage design. The work may be performed by WSDOT or a private consultant engineer but is overseen by the PEO. The PEO is also responsible for initiating the application for required hydraulic-related permits.
- **Region Hydraulic Engineer (RHE)** - responsible to provide technical assistance to Scoping teams, Pre-Design teams, PEOs, WSDOT consultants, Maintenance, Developer Services and Local Programs. The roles and responsibilities of the RHE and HQ Hydraulics Section are outlined in the Hydraulics Manual.
- **WSDOT Headquarters (HQ) Hydraulics Section** – responsible for the preparation or oversight of all hydraulics Specialty reports as described in the Hydraulics Manual. While the PEO is responsible for preparation of reports, plans, specs, and estimate for all drainage facilities except bridges, assistance from the RHE and the HQ Hydraulics Section may be requested for any drainage facility design.

800.01 General – Cont'd

Below is a summary of roles and responsibilities:

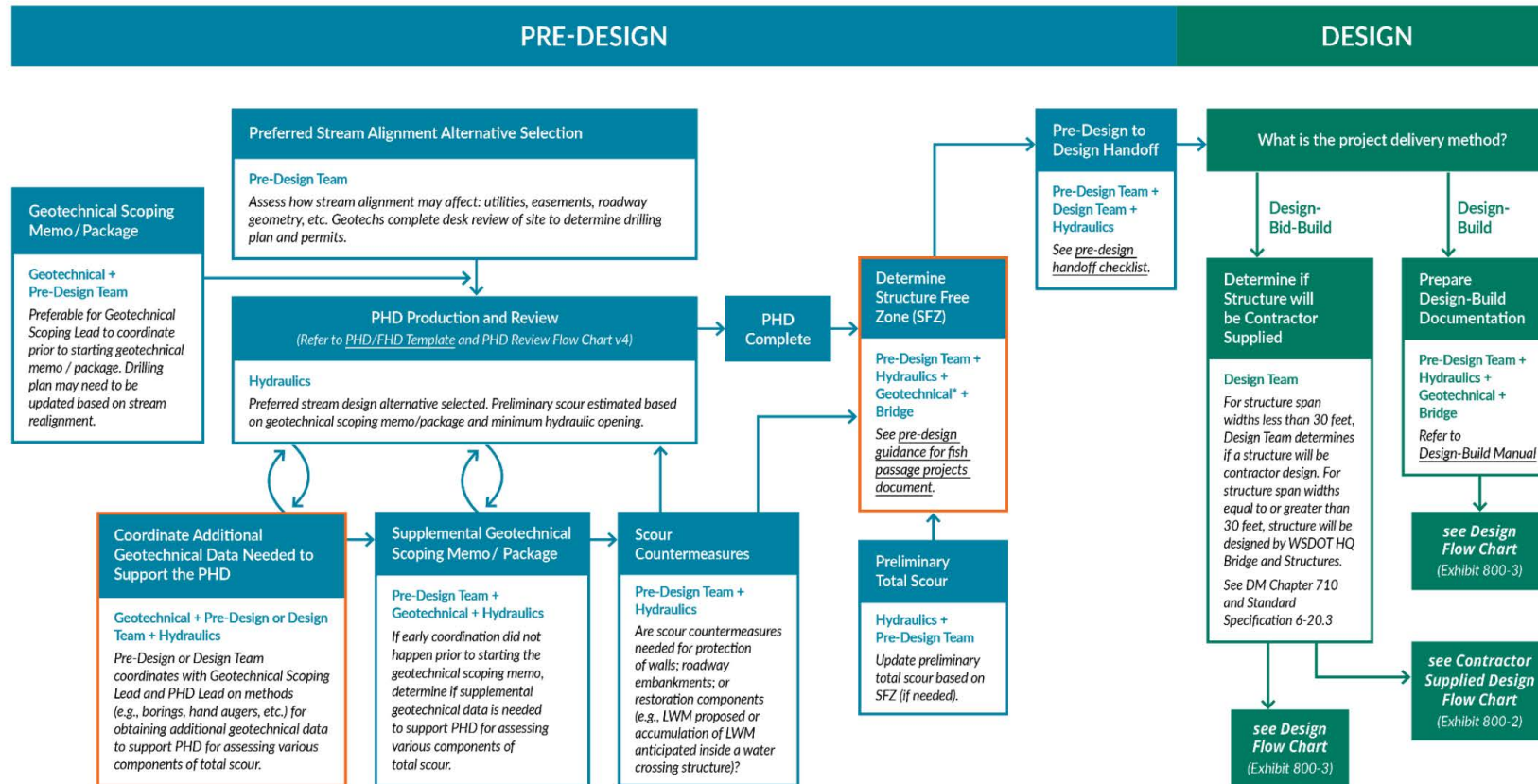
- **Geotechnical** – responsible for understanding the characteristics of the soil and rock materials that support or are adjacent to a transportation facility so that, when designed, constructed, and maintained, the facility will be adequate to safely carry the estimated traffic and to support hydraulic structures for stormwater and stream crossing designs, as set forth in the Geotechnical Design Manual.
- **Bridge** – responsible for delivering or coordinating bridge design calculation and plans per WSDOT Bridge Design Procedure and the Bridge Design Manual; review consultant and contractor designed structures; acts as the subject matter expert for structural issues; assure that the most cost-effective and appropriate structure type is selected for a particular bridge site.
- **Pre-Design Team** – consists of engineering, environmental, utilities, real estate, geotechnical, bridge and structures staff for coordination prior to beginning preliminary design. The [Pre-Design Guidance for Fish Passage Projects](#) document contains helpful links and provides guidance for pre-design.
- **Design Team** – the team of designers, checkers, engineers, and architects responsible for design and preparation of the contract documents for construction.

800.02 Coordination with Other Specialty Groups

- Pre-design team
- Design team
- Bridge
- Geotechnical
- Hydraulics
- WSDOT maintenance office
- WSDOT construction office

800.02 – Cont'd

SPECIALTY GROUP COORDINATION | PRE-DESIGN
EXHIBIT 800-1



General Notes

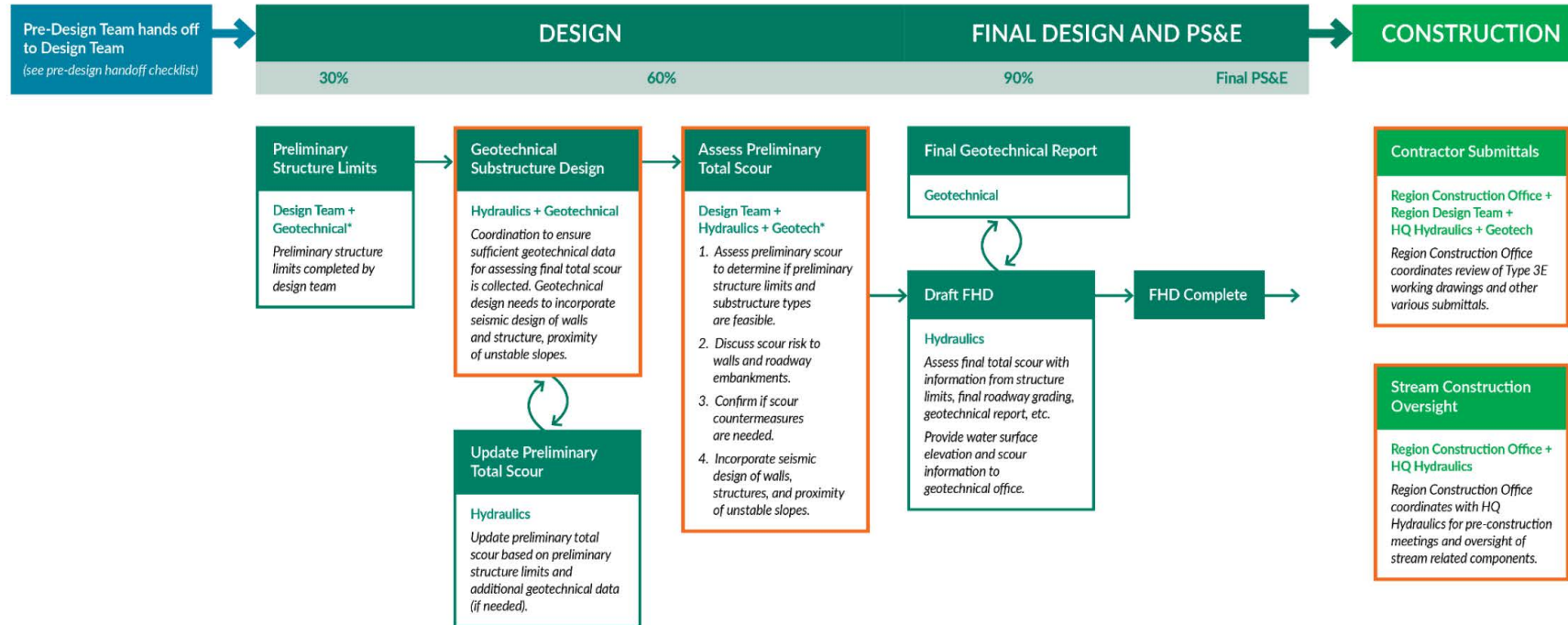
* Incorporate seismic design of walls, structures and proximity of unstable slopes.

Specialty Group Coordination

Contact HQ Hydraulics with questions.

800.02 – Cont'd

SPECIALTY GROUP COORDINATION | CONTRACTOR SUPPLIED DESIGN**
EXHIBIT 800-2



General Notes

* Incorporate seismic design of walls, structures and proximity of unstable slopes.

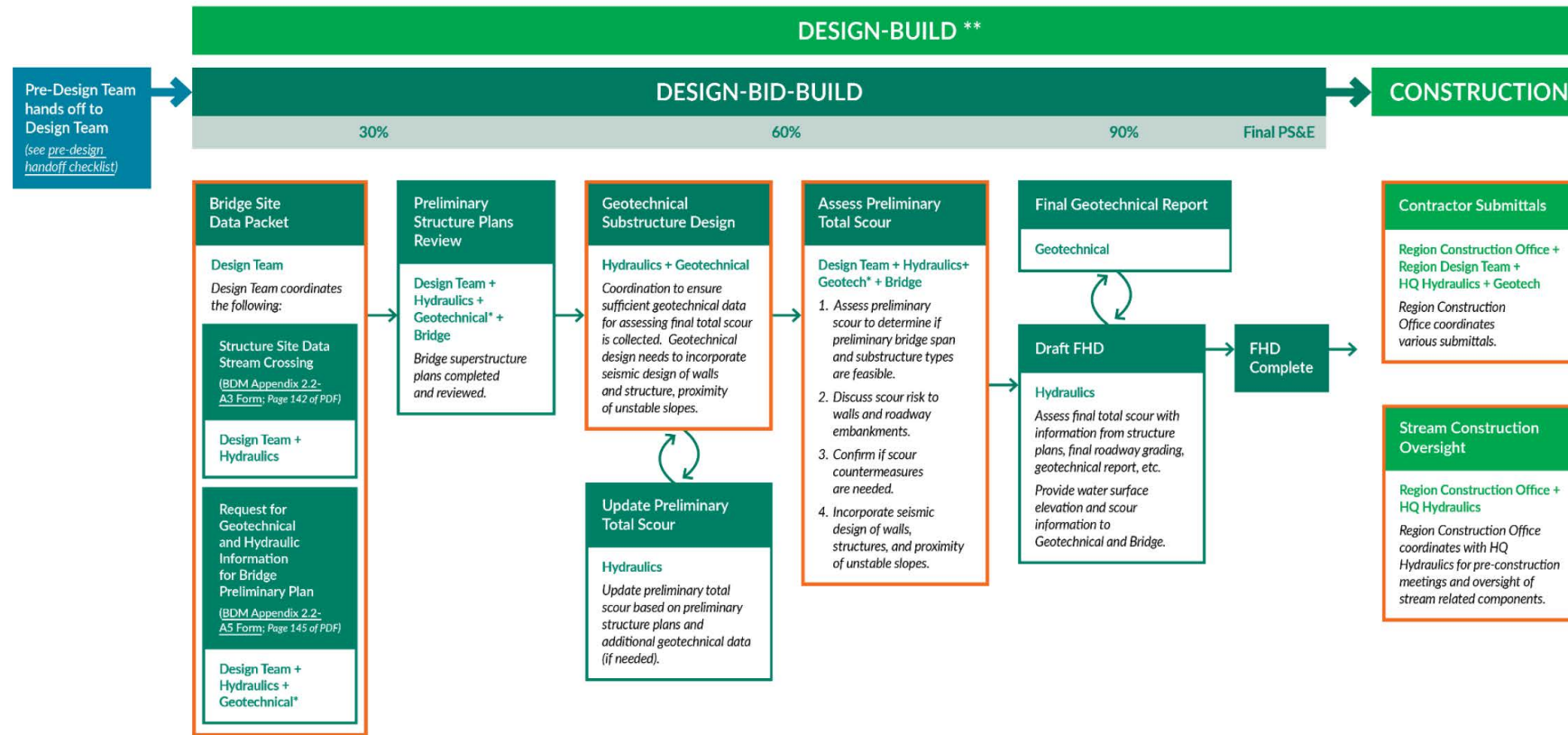
** See DM Chapter 710 and Standard Specification 6-20.3.

Specialty Group Coordination

Contact HQ Hydraulics with questions.

800.02 – Cont'd

SPECIALTY GROUP COORDINATION | DESIGN
EXHIBIT 800-3



General Notes

- * Incorporate seismic design of walls, structures and proximity of unstable slopes.
- ** This process is not intended for all deliverables.

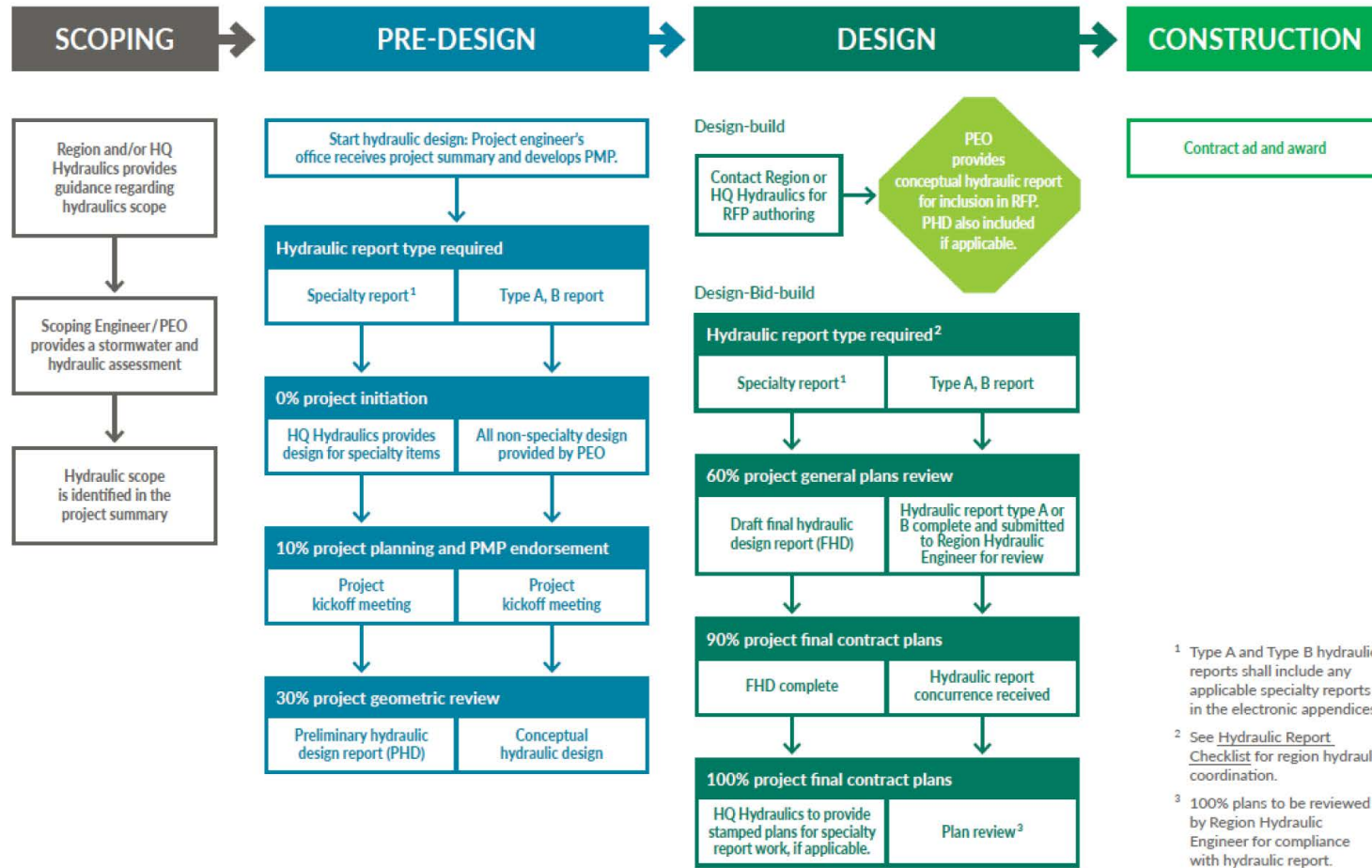
Specialty Group Coordination

Contact HQ Hydraulics with questions.

800.03 Hydraulic Design Process

HYDRAULIC DESIGN PROCESS

EXHIBIT 800-4



800.04 – Floodplain Management

Encroachment of a highway or highway facility into a floodplain might present significant problems and requires an investigation for further action. A thorough investigation includes the following:

- The effect of the design flood on the highway or highway facility and the required protective measures.
- The effect of the highway or highway facility on the upstream and downstream reaches of the stream and the adjacent property.
- Compliance with hydraulic-related environmental concerns and hydraulic aspects of permits from other governmental agencies per Chapter 225 of the Design Manual.
- Addressing requirements in Chapter 432 of the Environmental Manual.
- Compliance with floodplain requirements for non-water crossing projects per the Hydraulics Manual.

800.04 – Floodplain Management

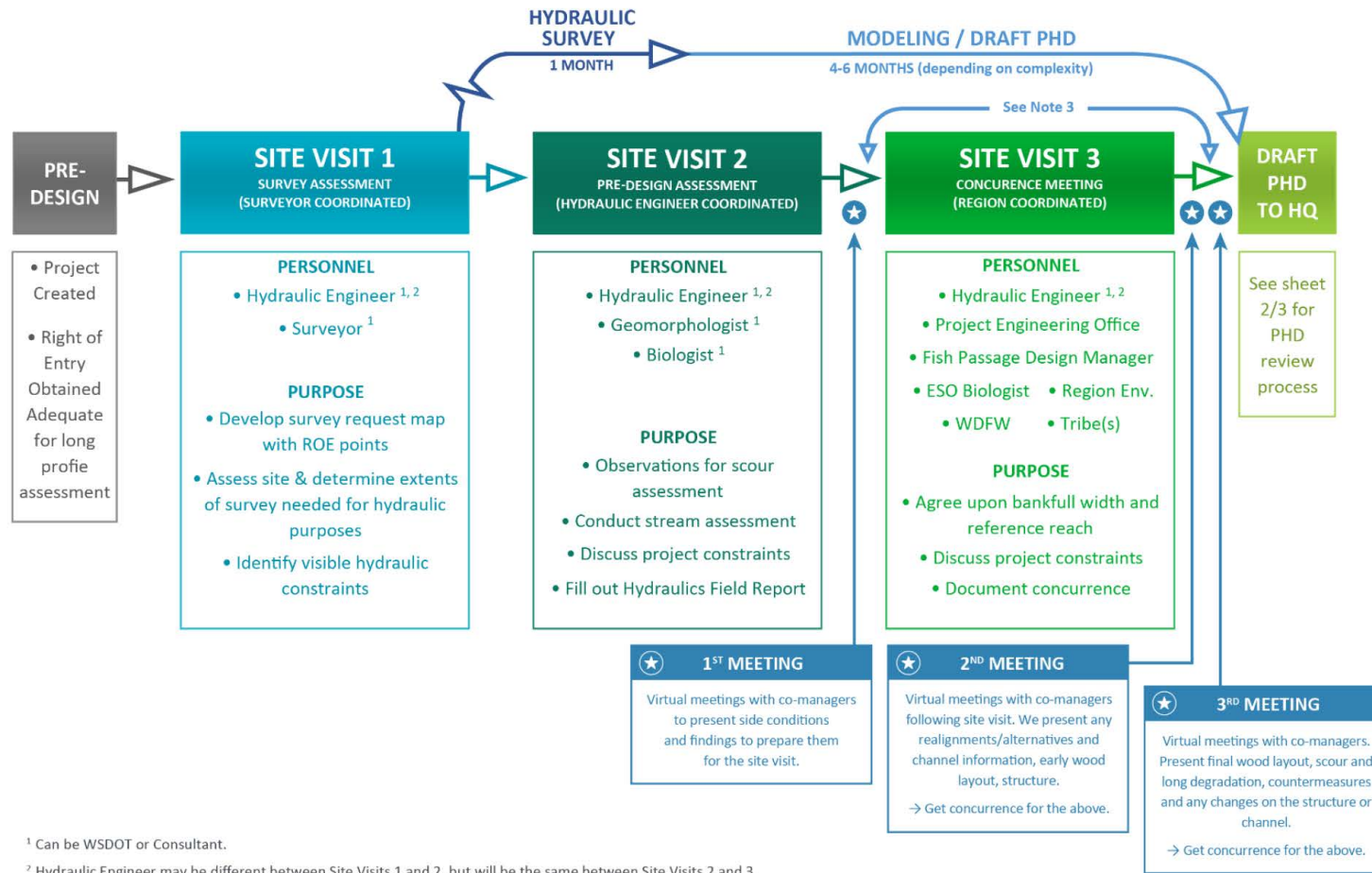
- A Flood Risk Assessment (FRA) is required for all riverine and coastal projects .
- WSDOT has developed a template for completing an FRA which serves as communication tool for identifying potential risks of meeting:
 1. FEMA,
 2. local jurisdiction, and
 3. public health and safety in the preliminary stages of design.
- The FRA helps to identify subsequent deliverables that may be needed for the permitting process.
- The FRA is further discussed in the Hydraulics Manual. Projects proposed within a Special Flood Hazard Area (SFHA) and other floodplain management additional requirements are found in Chapter 432 of the Environmental Manual.

800.05 Water Crossings

- Chapter 7 of the Hydraulics Manual covers the design requirements for water crossings on state highways.
- All fish-bearing water crossings within Washington State must meet the requirements of WAC's Hydraulic Code Rules and the requirements of the Hydraulics Manual.

800.05 Water Crossings – Cont'd

PRELIMINARY HYDRAULIC DESIGN (PHD) EXHIBIT 800-5
STREAM DESIGN PROCESS



¹ Can be WSDOT or Consultant.

² Hydraulic Engineer may be different between Site Visits 1 and 2, but will be the same between Site Visits 2 and 3.

³ For complex sites additional meetings, coordination, and site visits may be necessary to discuss design updates and other challenges.

800.06 Safety Considerations

**No
Changes**

800.07 Documentation

**No
Changes**

800.08 References

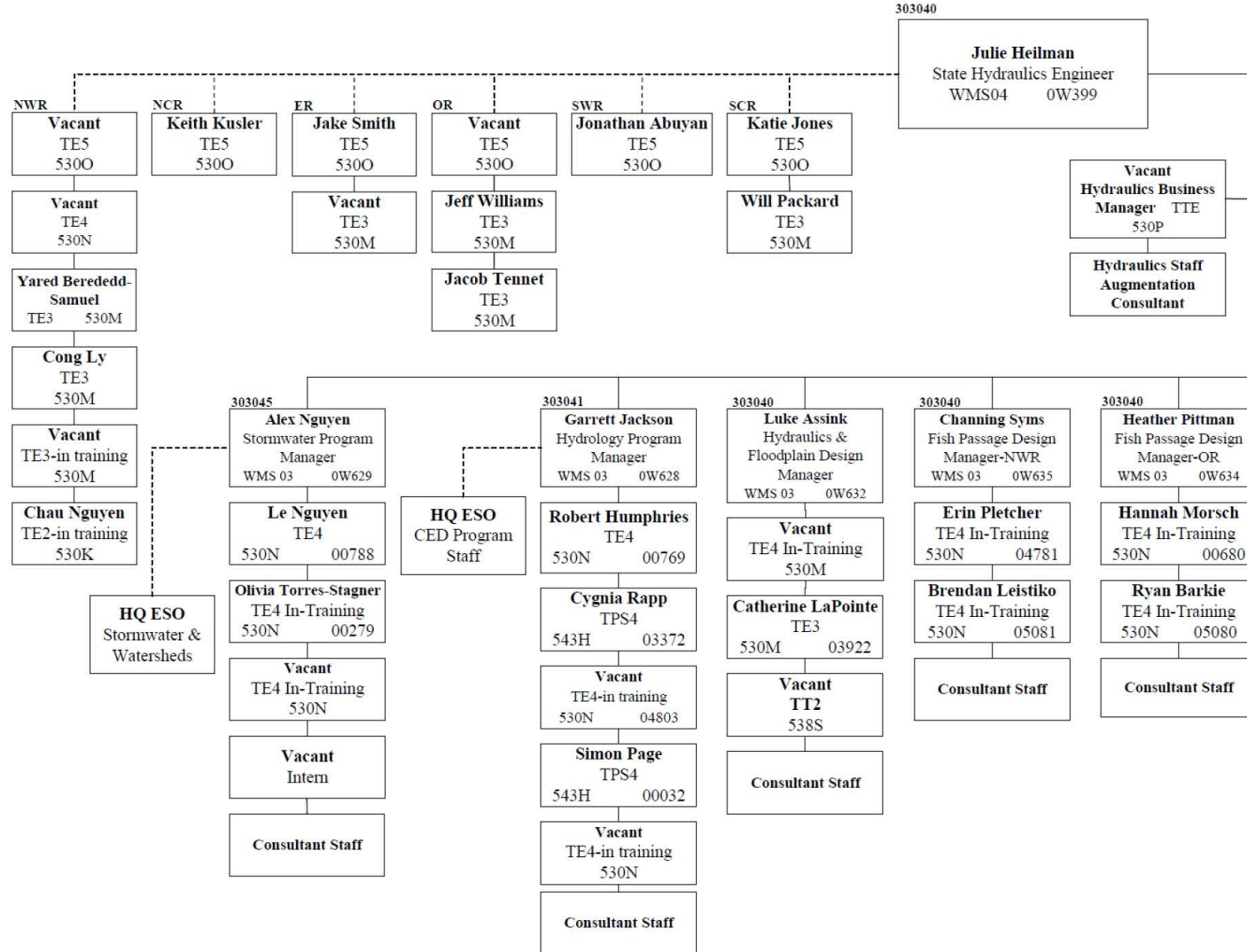
- ***Bridge Design Manual***, M 23-50.20, WSDOT
- ***Design-Build Manual***, M 3126.08, WSDOT
- ***Environmental Manual***, M 31-11.25, WSDOT
- ***Geotechnical Design Manual***, M 46-03.16, WSDOT
- **Highway Runoff Manual**, M 31-16, WSDOT
- **Hydraulics Manual**, M 23-03, WSDOT
- ***Plans Preparation Manual***, M 22-31.08, WSDOT
- ***Standard Plans for Road, Bridge, and Municipal Construction*** (Standard Plans), M 21-01, WSDOT
- ***Standard Specifications for Road, Bridge, and Municipal Construction*** (Standard Specifications), (Amendments and General Special Provisions), M 41-10, WSDOT
- **Utilities Manual**, M 22-87, WSDOT

Hydraulics Office Org Chart

MULTIMODAL DEVELOPMENT & DELIVERY

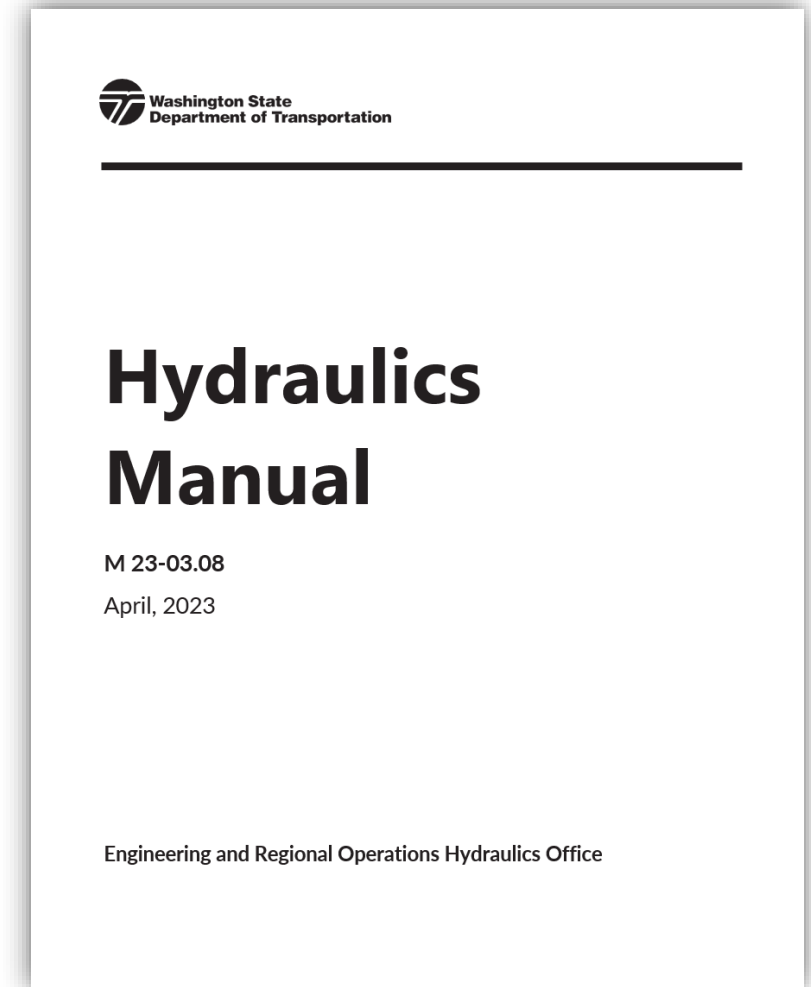
DEVELOPMENT DIVISION

Hydraulics Section



Hydraulics Manual Updates

- Hydraulics Manual updated (April 2023)
- H_HD Template continually updated
- WSDOT scour certification



Hydraulics Manual Updates

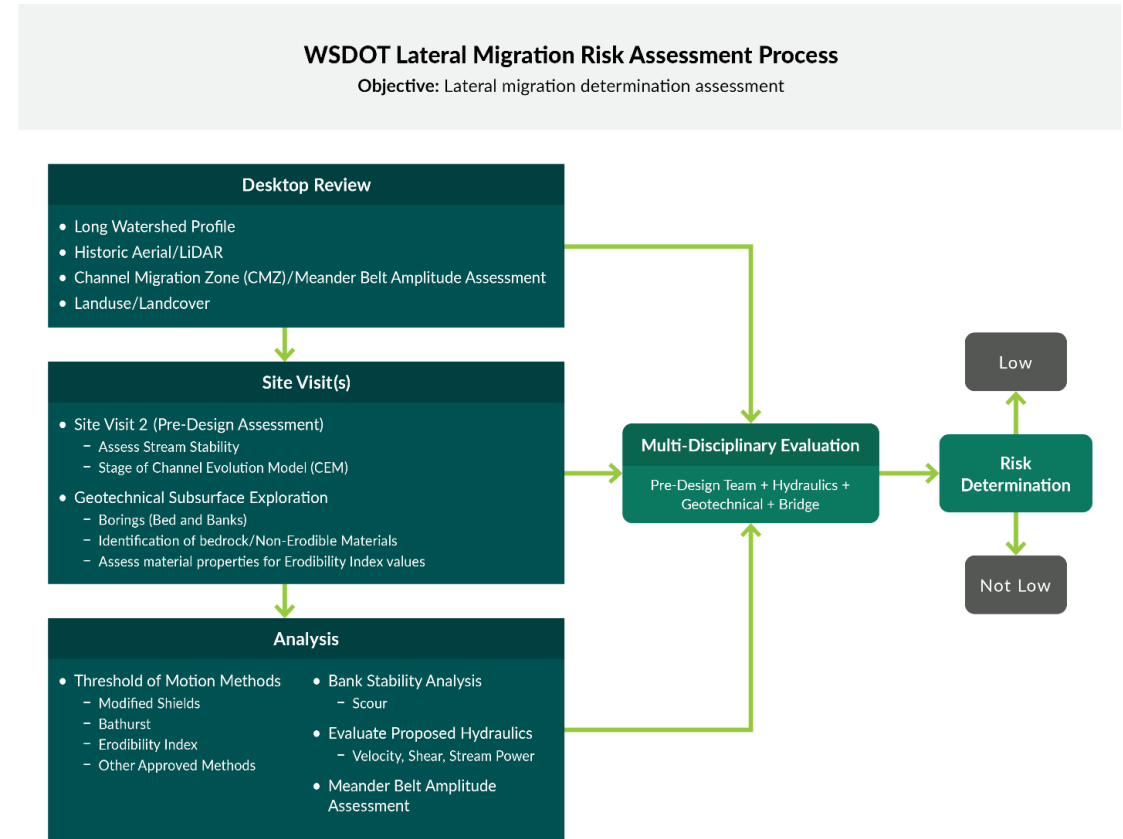
- Updates to WSDOT Hydraulics Manual – Chapter 7
- New sections are **bolded linetype**
- Revised sections are regular linetype

Section	Edit Summary
7-2.5.2 Lateral Migration	Explains procedures for assessing lateral migration potential for a stream.
7-2.6 Flood Risk Assessment	Describes the purpose of the Flood Risk Assessments and what type of analysis is required based on FEMA Special Flood Hazard Areas (SFHAs).
7-4.4.1 Floodplain Utilization Ratio	Updated section to explain that the Floodplain Utilization Ratio (FUR) should be calculated by dividing the flood-prone width by the bankfull width (BFW) at each cross section.
7-4.8 Total Scour	Identifies the minimum depth of scour to be considered for bridges and three-sided structures
7-4.9 Lateral Migration for Water Crossing Structures	Explains how lateral migration should be considered when calculating total scour and foundation design for the structure.
7-4.10 Channel Complexity	Provides new meander bar design guidance; coarse bands complexity feature guidance removed
7-8.1 Streambed Camera Monitoring	Describes streambed camera monitoring efforts from July 2021 to present
7-9 Performance Management	Identifies performance management process for repairs or modifications that are deemed necessary to maintain fish passage

Hydraulics Manual Updates

Section 7-2.5.2 – Lateral Migration

- Risk considered “not low” unless a detailed risk assessment is conducted and results in a determination that risk to the structure is “low”
- Preliminary flowchart created for determining lateral migration risk (will be updated in future HM iterations)
- Multi-disciplinary evaluation (pre-design team; hydraulics; geotechnical)
 - Early coordination is key
- Meander belt assessment now required for all crossings



Hydraulics Manual Updates

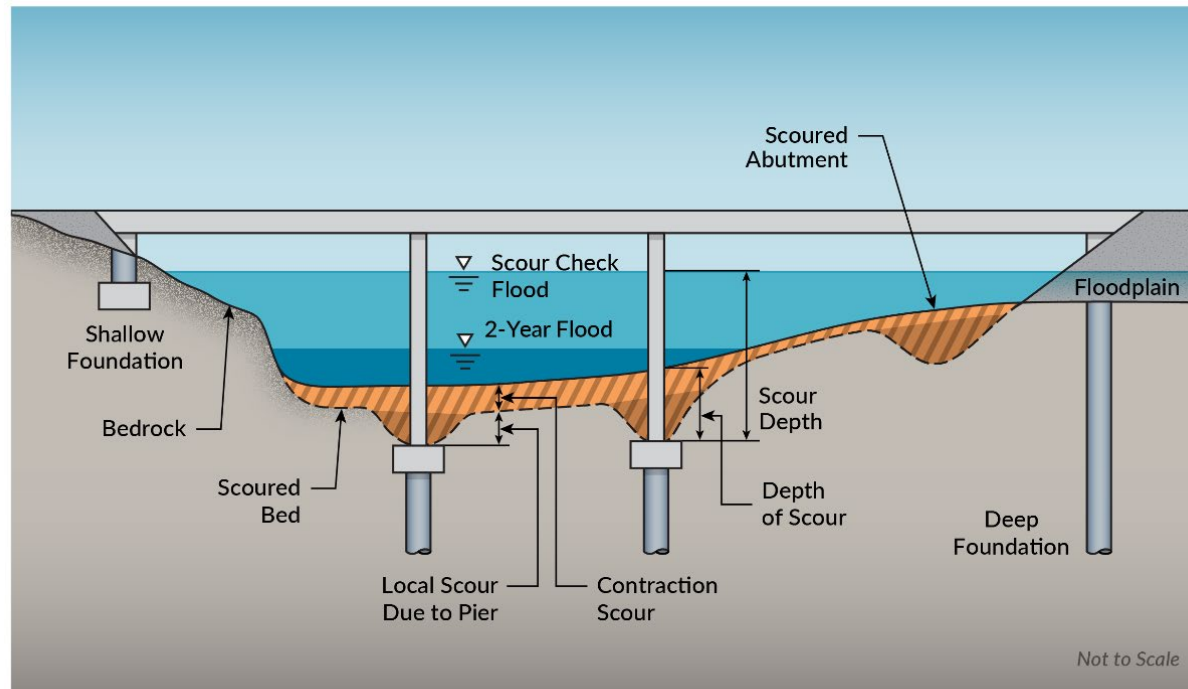
Section 7-4.8 – Total Scour

- Total scour shall be assessed following methodologies in HEC-18 for all flows up to the scour design flood and scour check flood events that results in worst-case total scour for each event
- A minimum of 3 feet of total scour is required for all bridges and three-sided structures
- Potential for lateral migration must also be assessed to evaluate total scour

Hydraulics Manual Updates

Section 7-4.9 – Lateral Migration for Water Crossing Structures

- If non-erodible soils are present such that **no lateral migration** is expected to occur, LTD and contraction scour is a uniform offset from the existing channel section



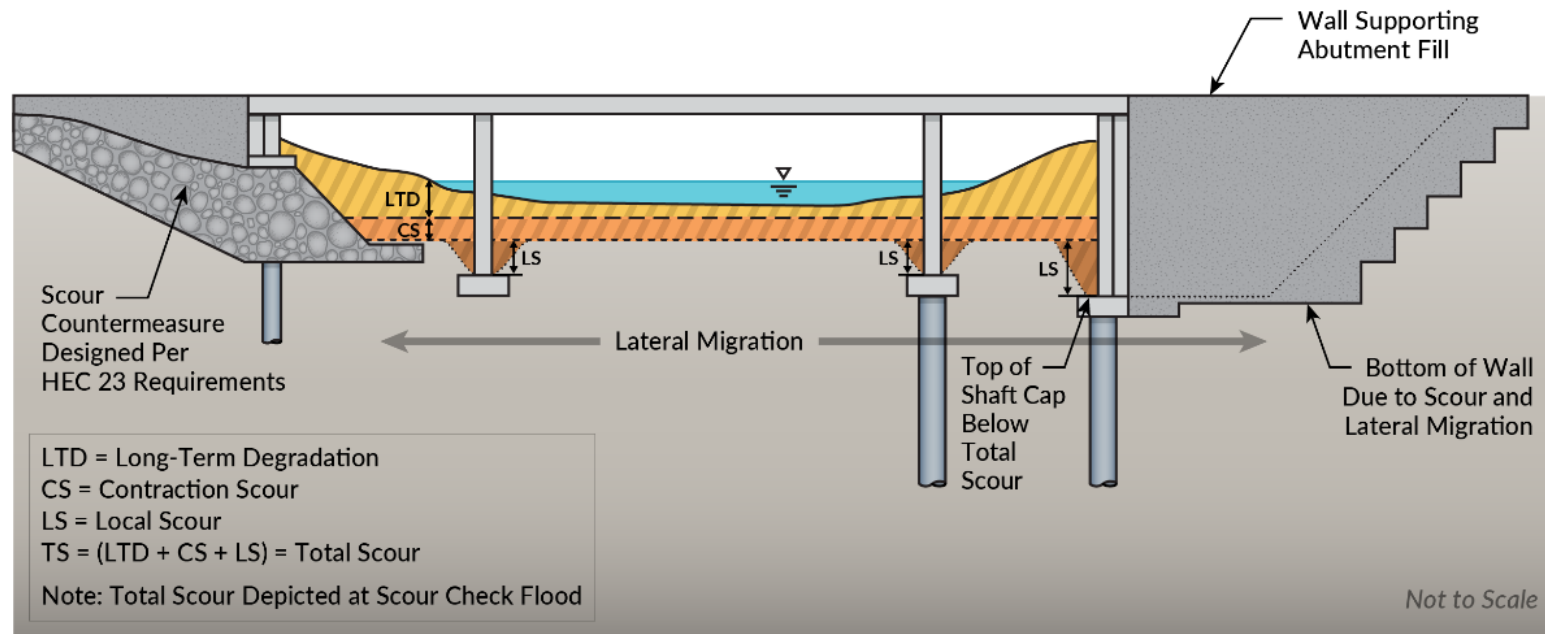
Bedrock identified; low potential for erosion; shallow bridge foundation acceptable

No bedrock identified; deep bridge foundation required; abutment scour not applied to channel thalweg elevation due to no potential for lateral migration

Hydraulics Manual Updates

Section 7-4.9 – Lateral Migration for Water Crossing Structures

- If lateral migration may occur, the thalweg is the starting elevation for determining total scour for all components within the extents of potential lateral migration



Scour countermeasures designed and constructed meeting HEC-23 requirements – use of an apron below LTD and contraction scour at scour check flood to mitigate abutment scour

No scour countermeasures designed or constructed; total scour utilized for designing bridge foundations

Bridge and Structures Office Updates

Amy Leland

State Bridge Design Engineer

HQ Bridge Design Office

WSDOT



Current Duties

- Bridge Design



Background and Experience

- 24 years at WSDOT
- Seismic and Substructure Specialist
- Bridge Engineer



Education

- M.S.E. (Structures) at UW
- B.S. in Mathematics and Applied Physics at PLU



Personal Interests

- 2 teenagers and 1 20-year-old
- Hiking, skiing, traveling and puzzles

BDM – Scour without Lateral Migration

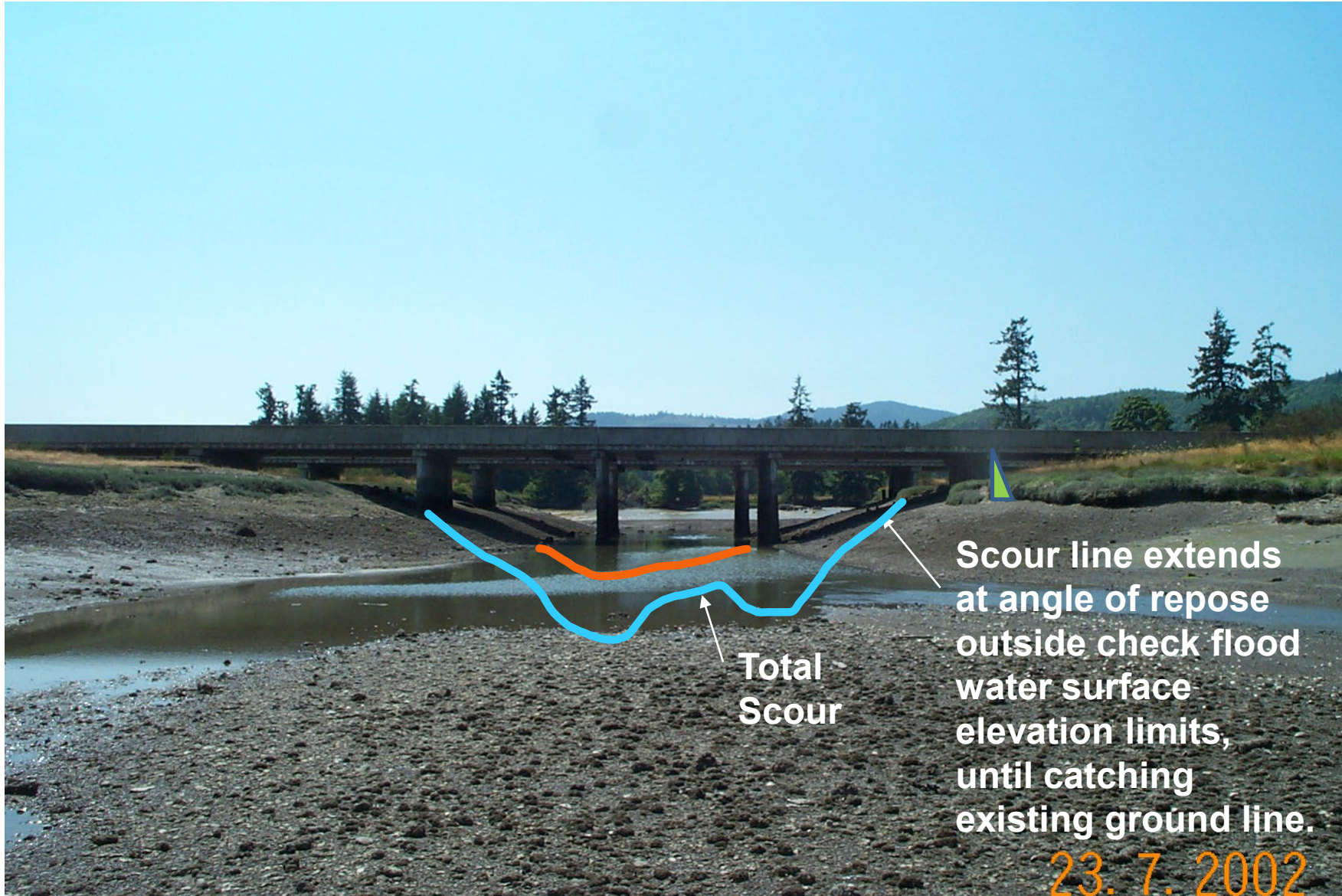


Image Source: WSDOT

Fig 7.1.7-1 – Scour w/o Lateral Migration

SCOUR WITHOUT LATERAL MIGRATION

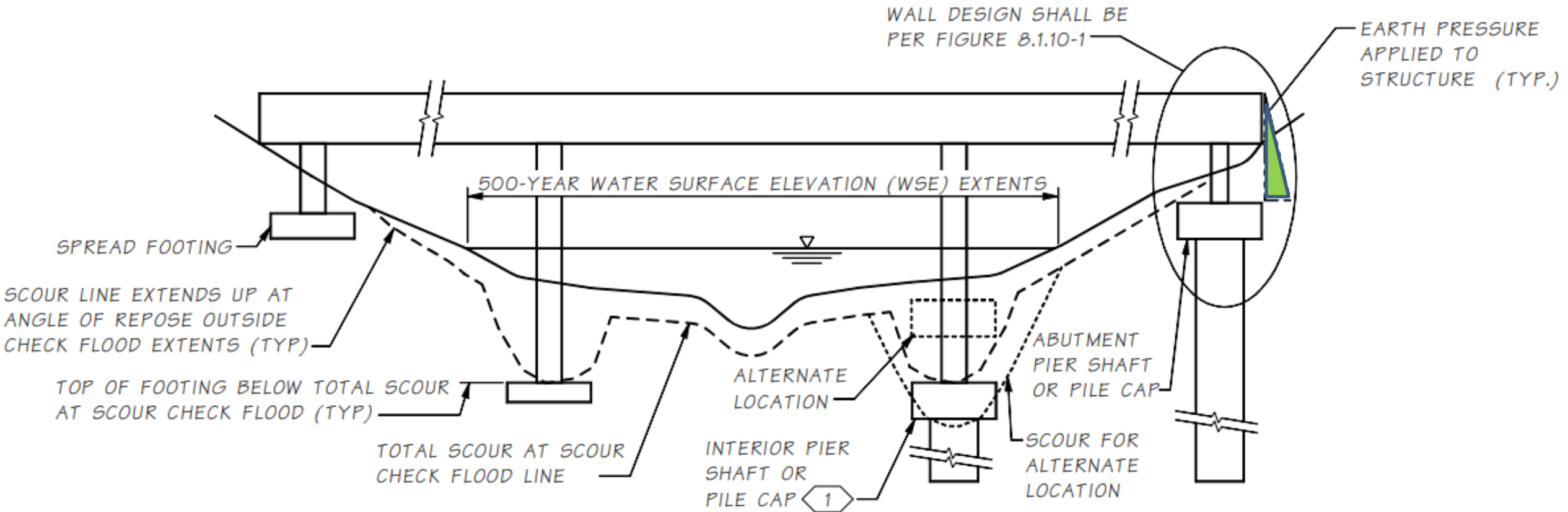
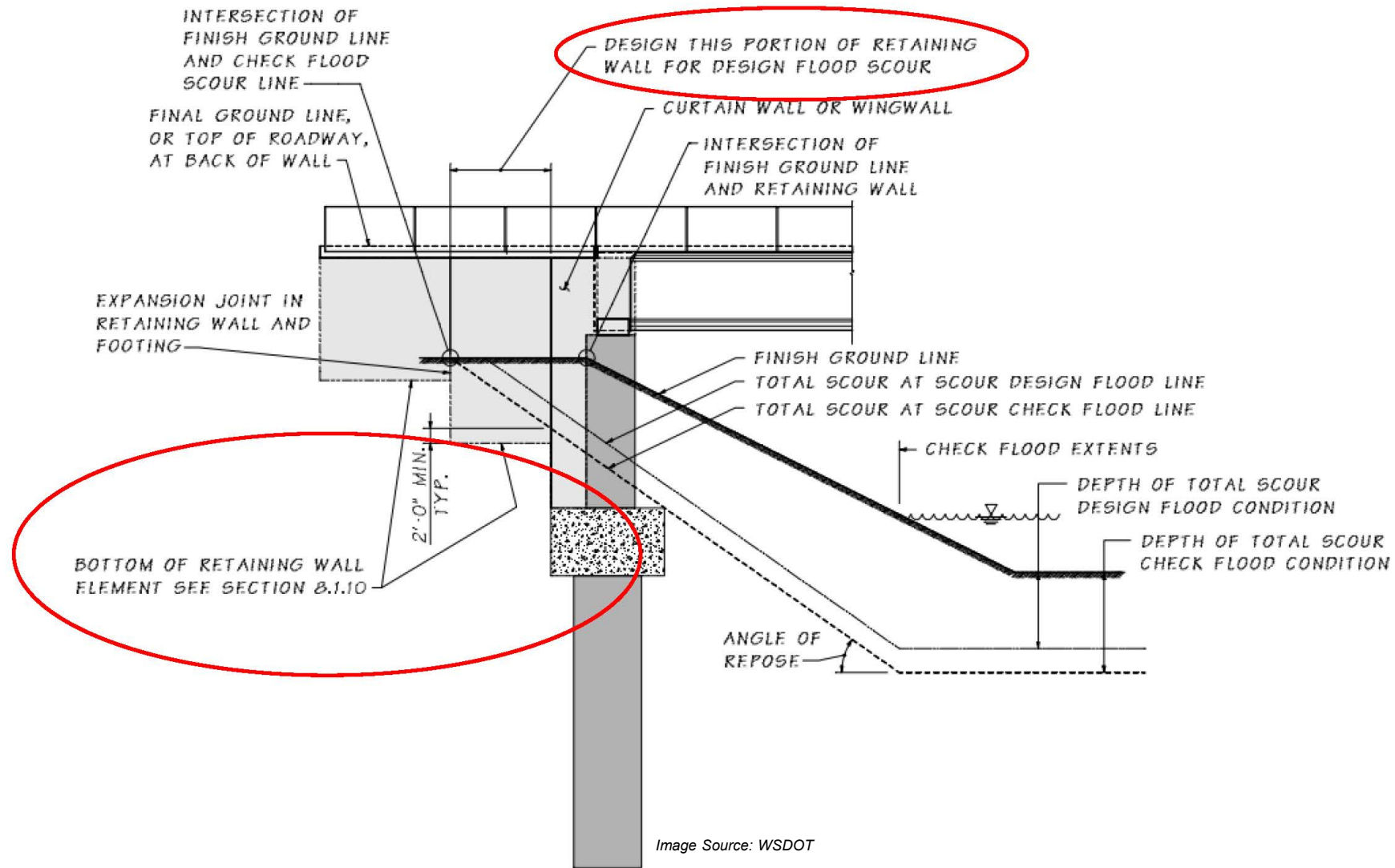


Image Source: WSDOT

Fig 8.1.10-1 – Scour w/o Lateral Migration



Hydraulics Manual Figure

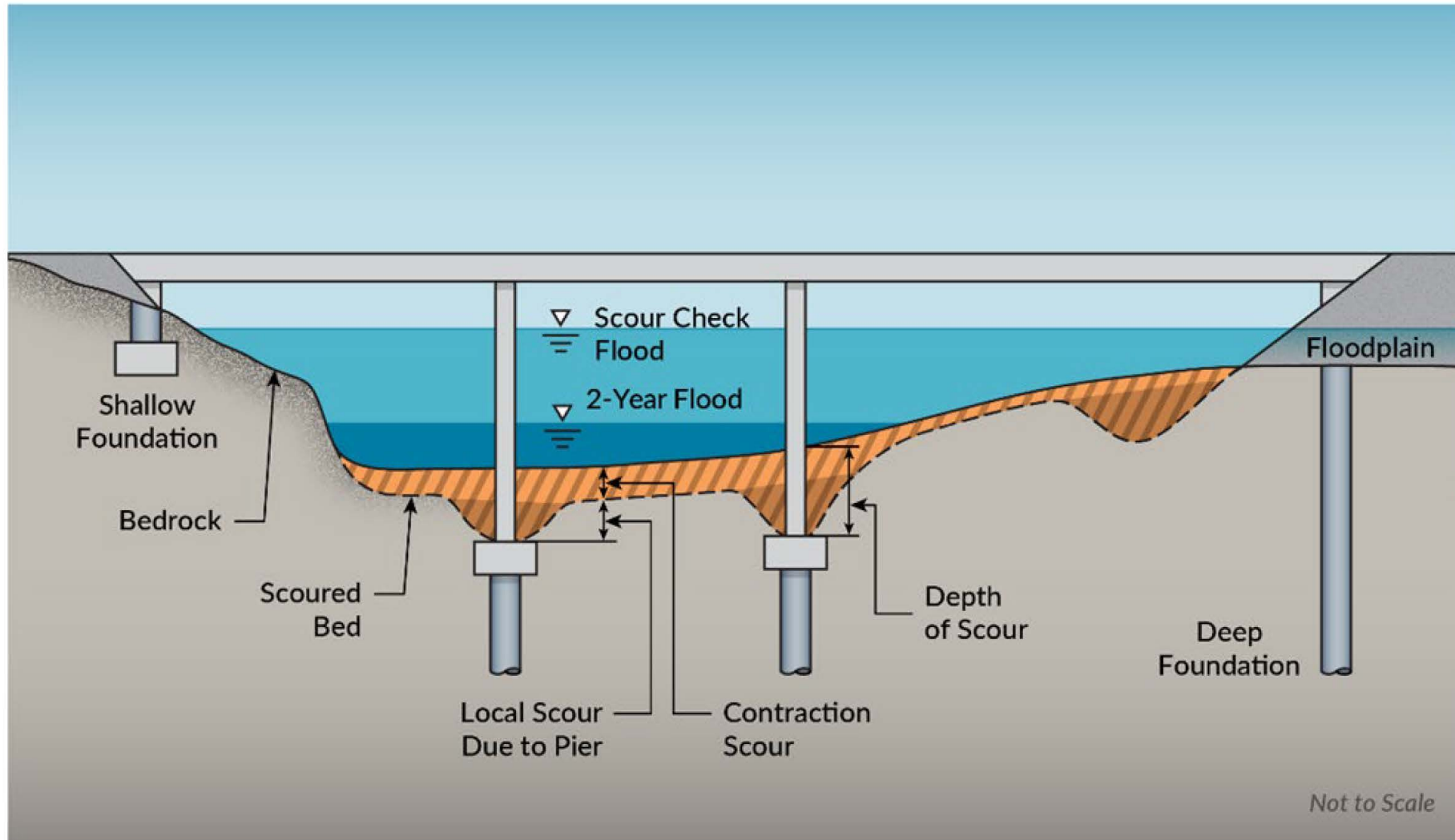


Image Source: WSDOT

BDM – Scour with Lateral Migration

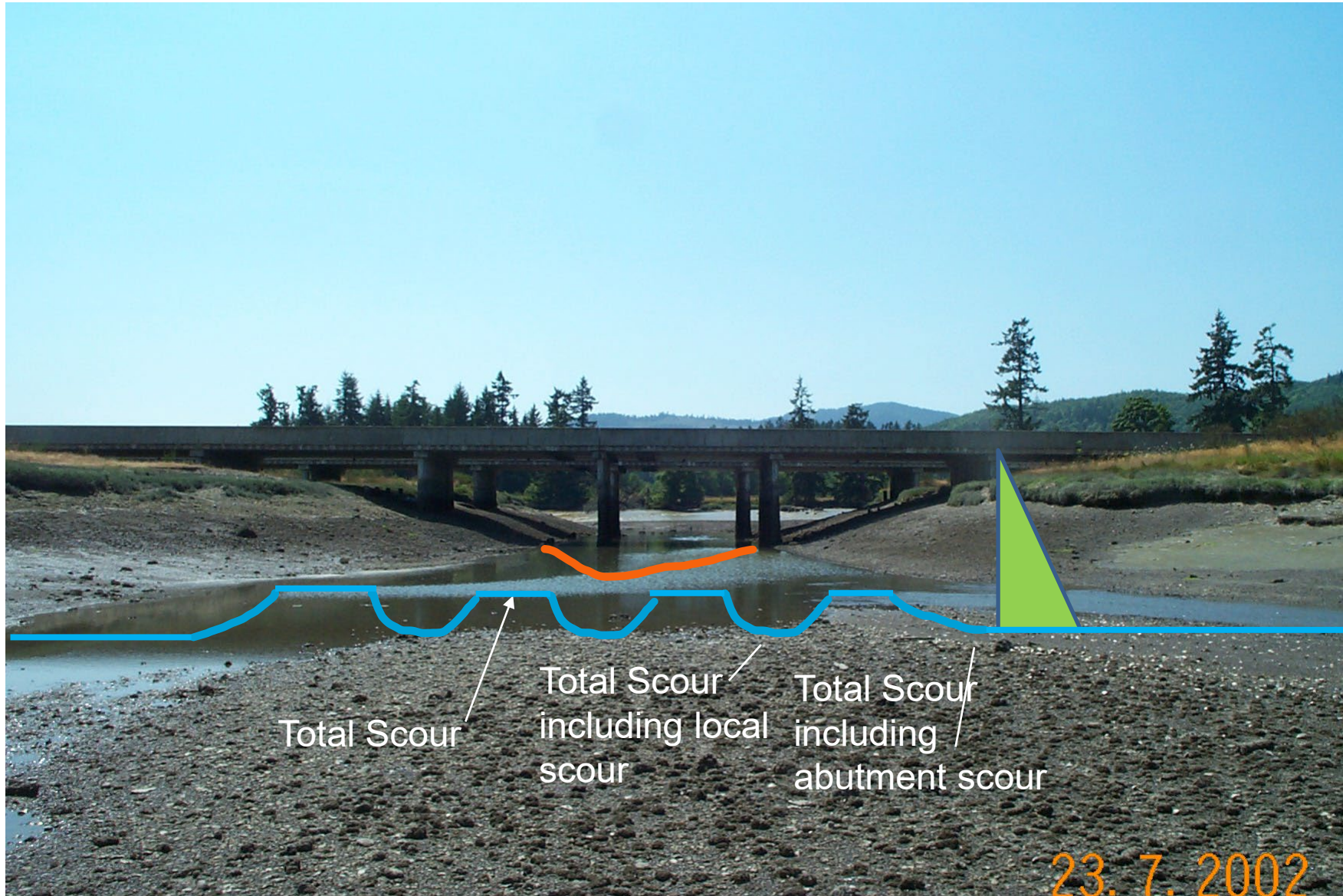


Image Source: WSDOT

Fig 7.1.7-1 – Scour with Lateral Migration

SCOUR WITH LATERAL MIGRATION

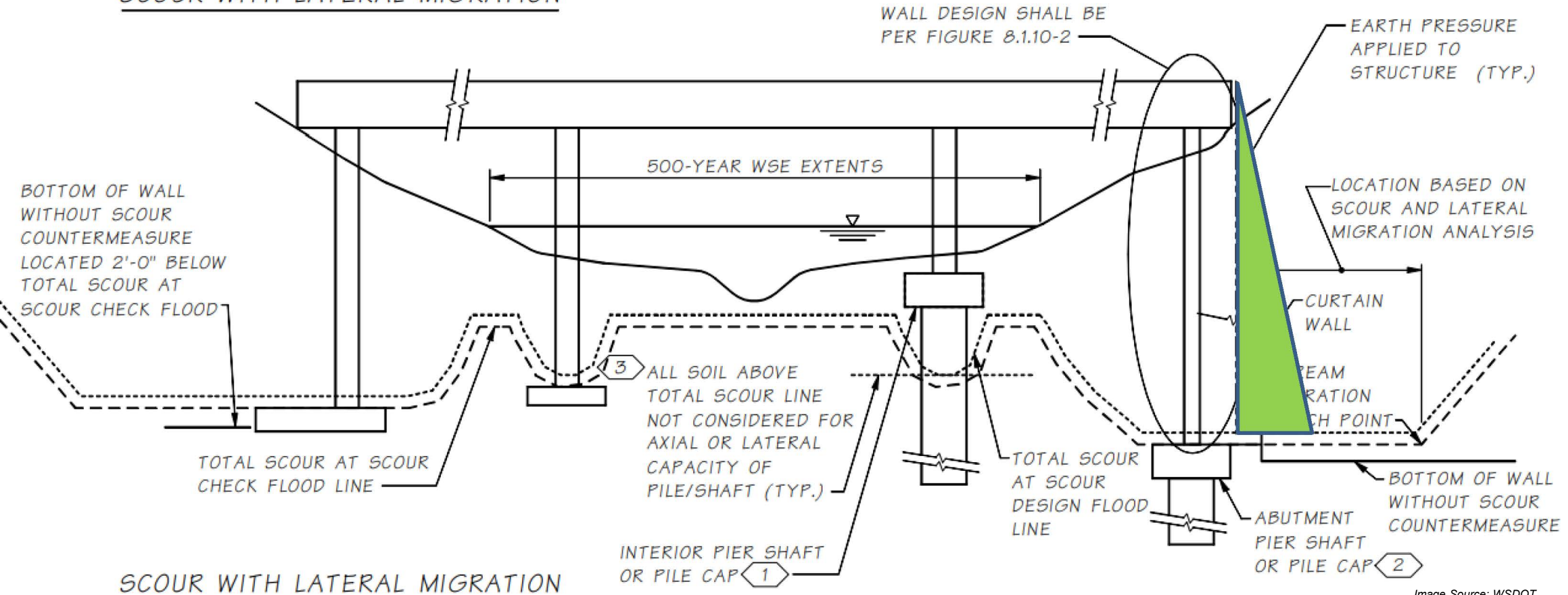


Image Source: WSDOT

Fig 8.1.10-2 – Scour with Lateral Migration

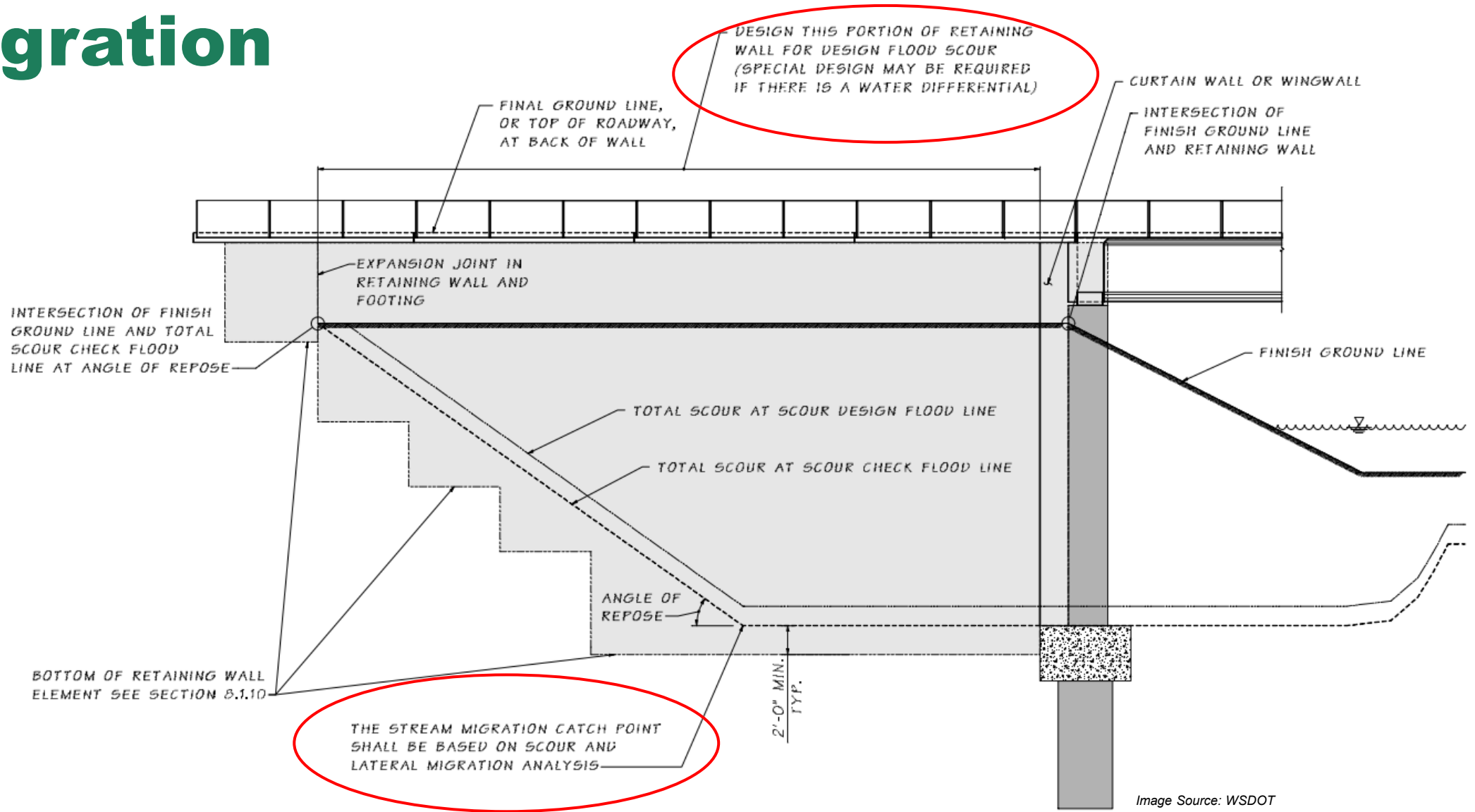


Image Source: WSDOT

Hydraulics Manual Figure

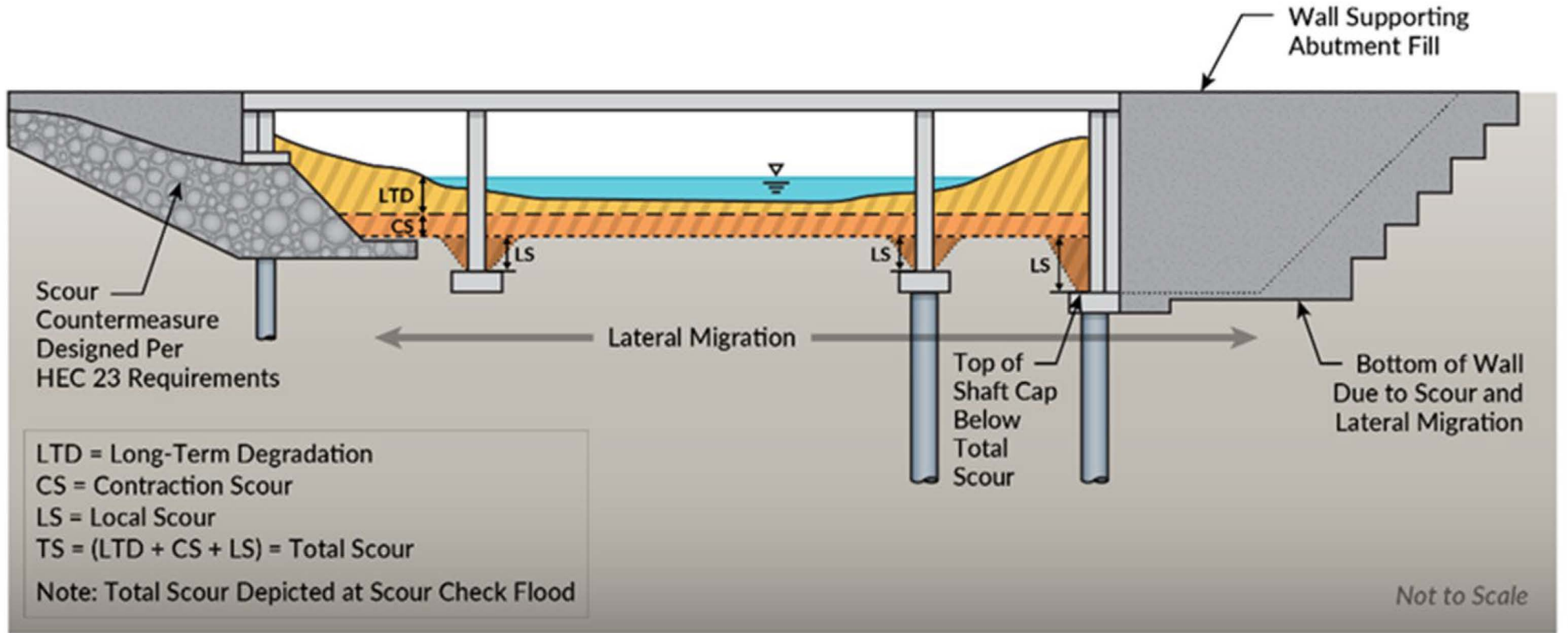


Image Source: WSDOT

BDM – Scour with Lateral Migration and Countermeasure

Hydraulic EOR recommendation
Deep Foundation Only
Increased SC Rock Class
Maintenance Access Required

Missing anything from list

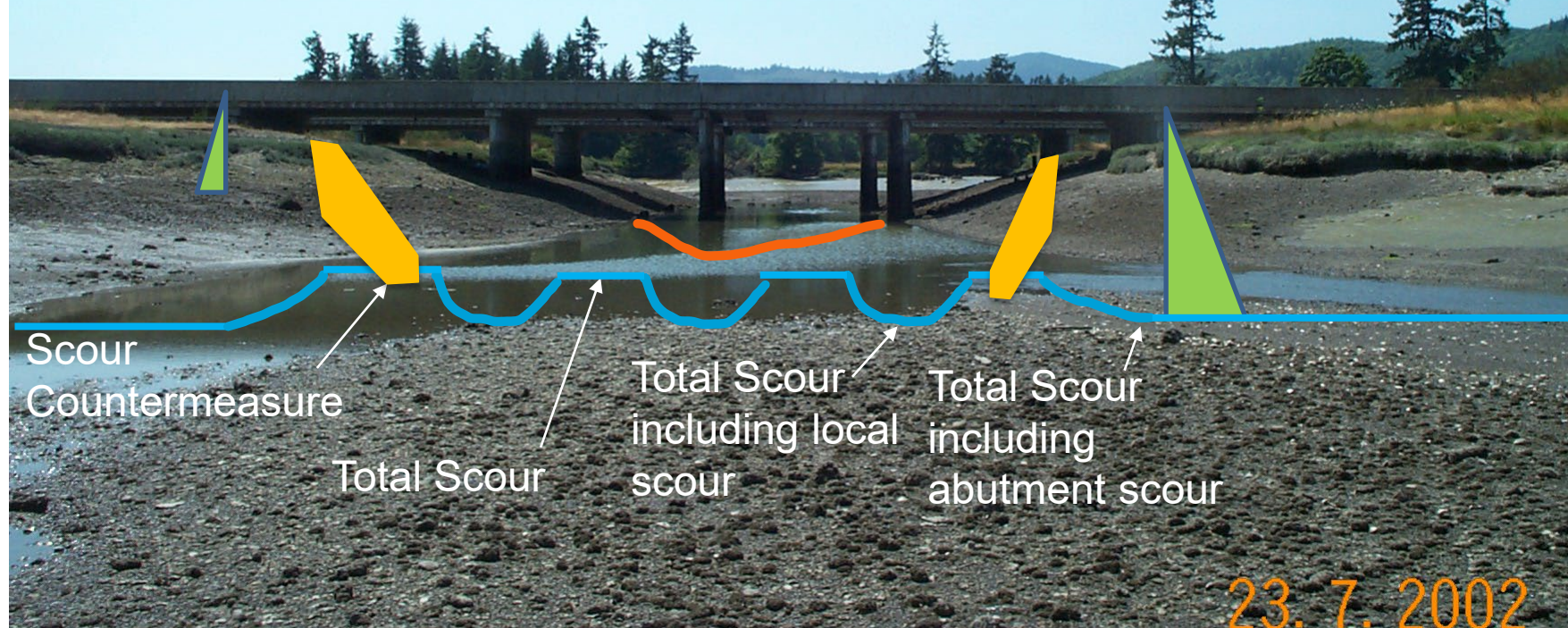
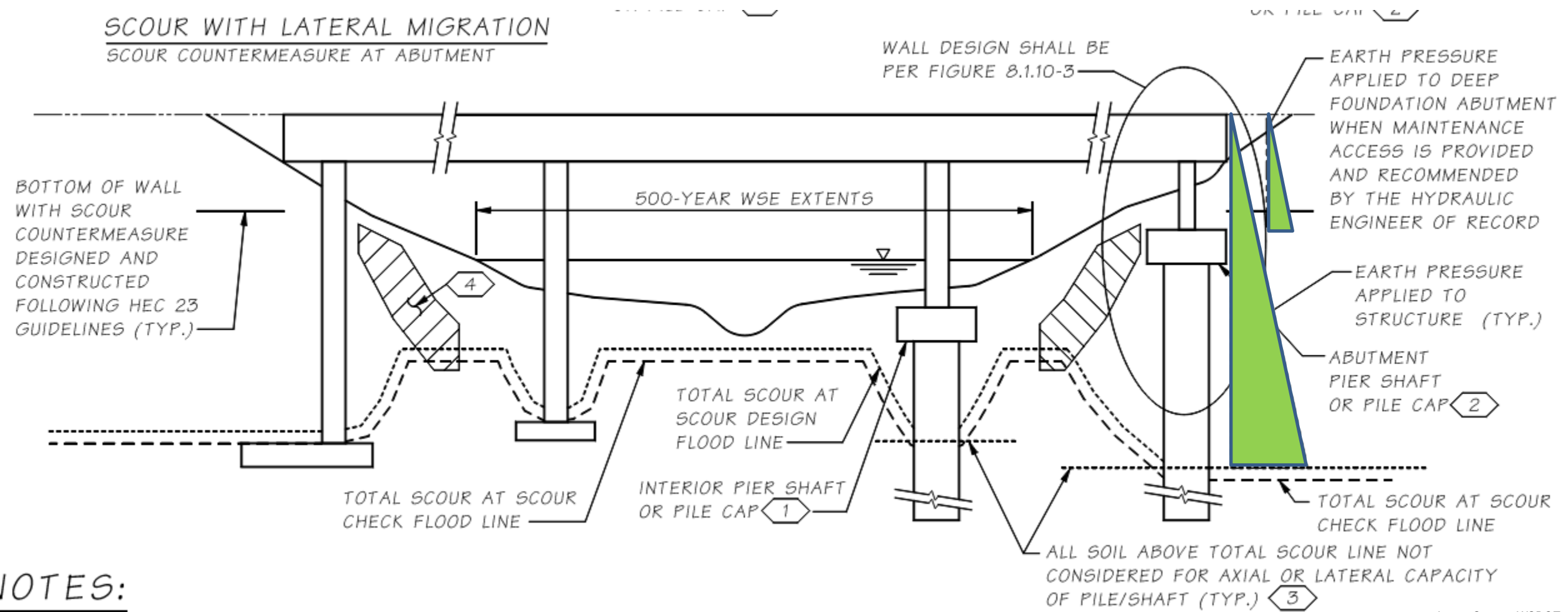


Image Source: WSDOT

Fig 7.1.7-1 – Scour with Lateral Migration and Countermeasure

SCOUR WITH LATERAL MIGRATION
SCOUR COUNTERMEASURE AT ABUTMENT



NOTES:

Image Source: WSDOT

Fig 8.1.10-3 – Scour with Lateral Migration and Scour Countermeasures

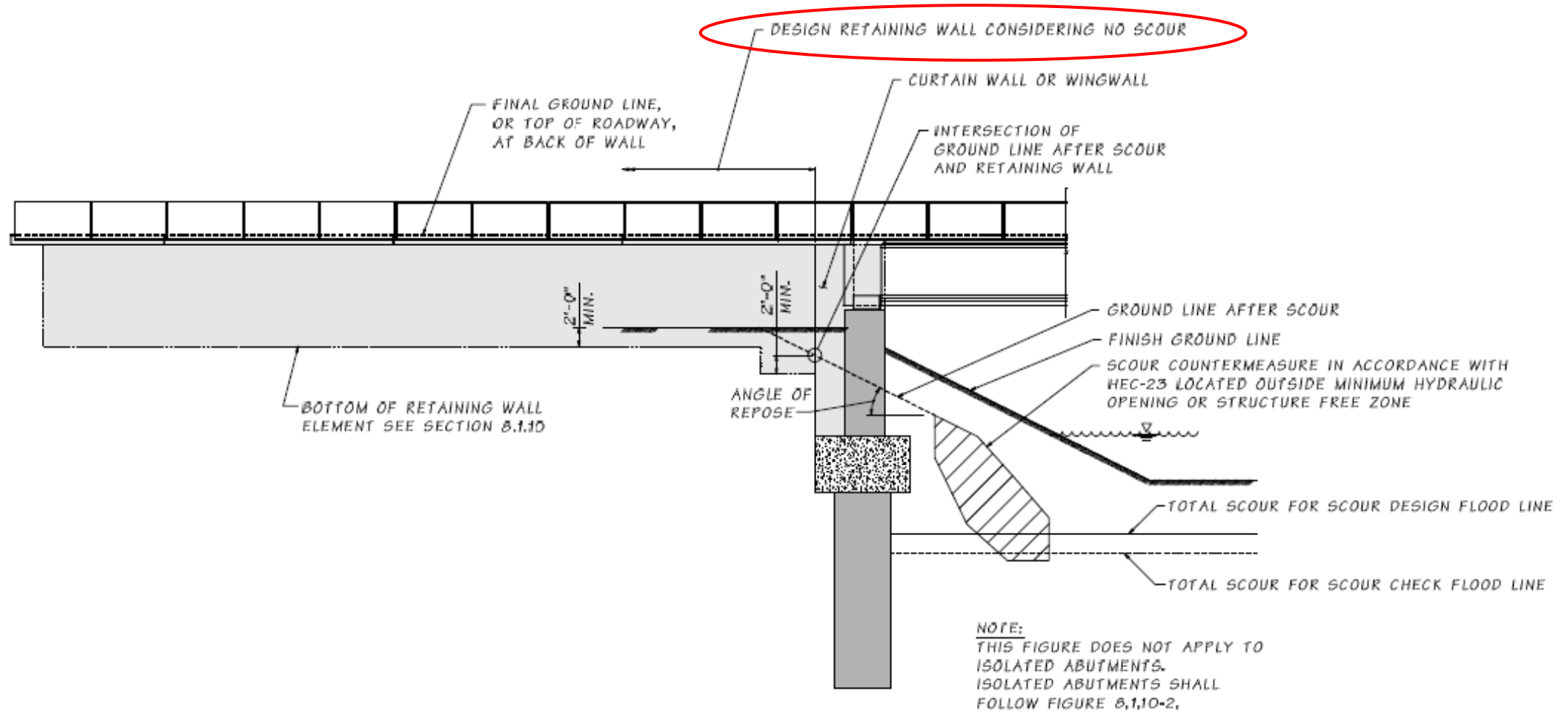


Figure 8.1.10-3 Scour with Lateral Migration and Scour Countermeasures

Image Source: WSDOT

Latest Modifications

Foundation Design Allows Countermeasure to Retain Soil
Deep Foundation Only
Maintenance Access Required

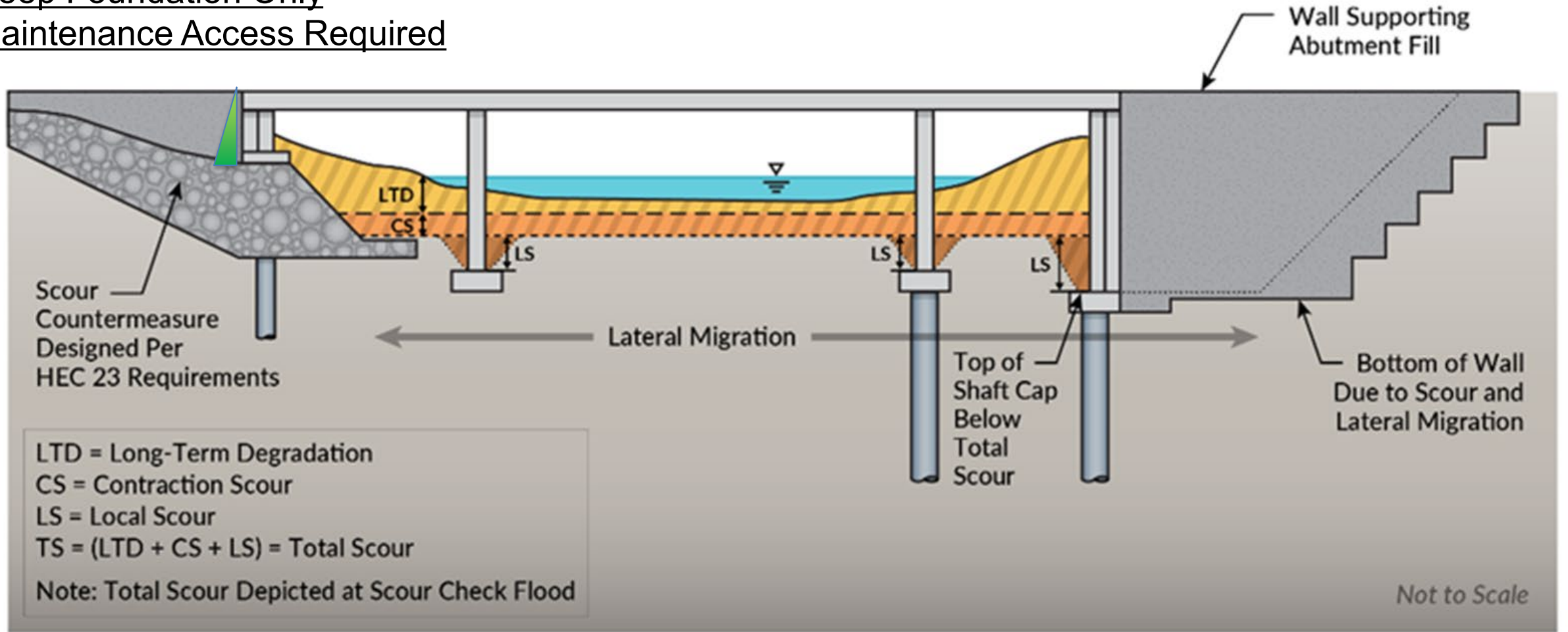


Image Source: WSDOT

BDM – Two Structures

No scour for bridge, and wall is designed for scour and is outside the structure free zone.



Image Source: WSDOT

BDM – Scour without Lateral Migration

Length of wall determined by performing an assessment to ensure the stability of the wall and structure element through the range of anticipated scour and lateral migration. Bottom of wall element or fascia 2 ft below total scour.

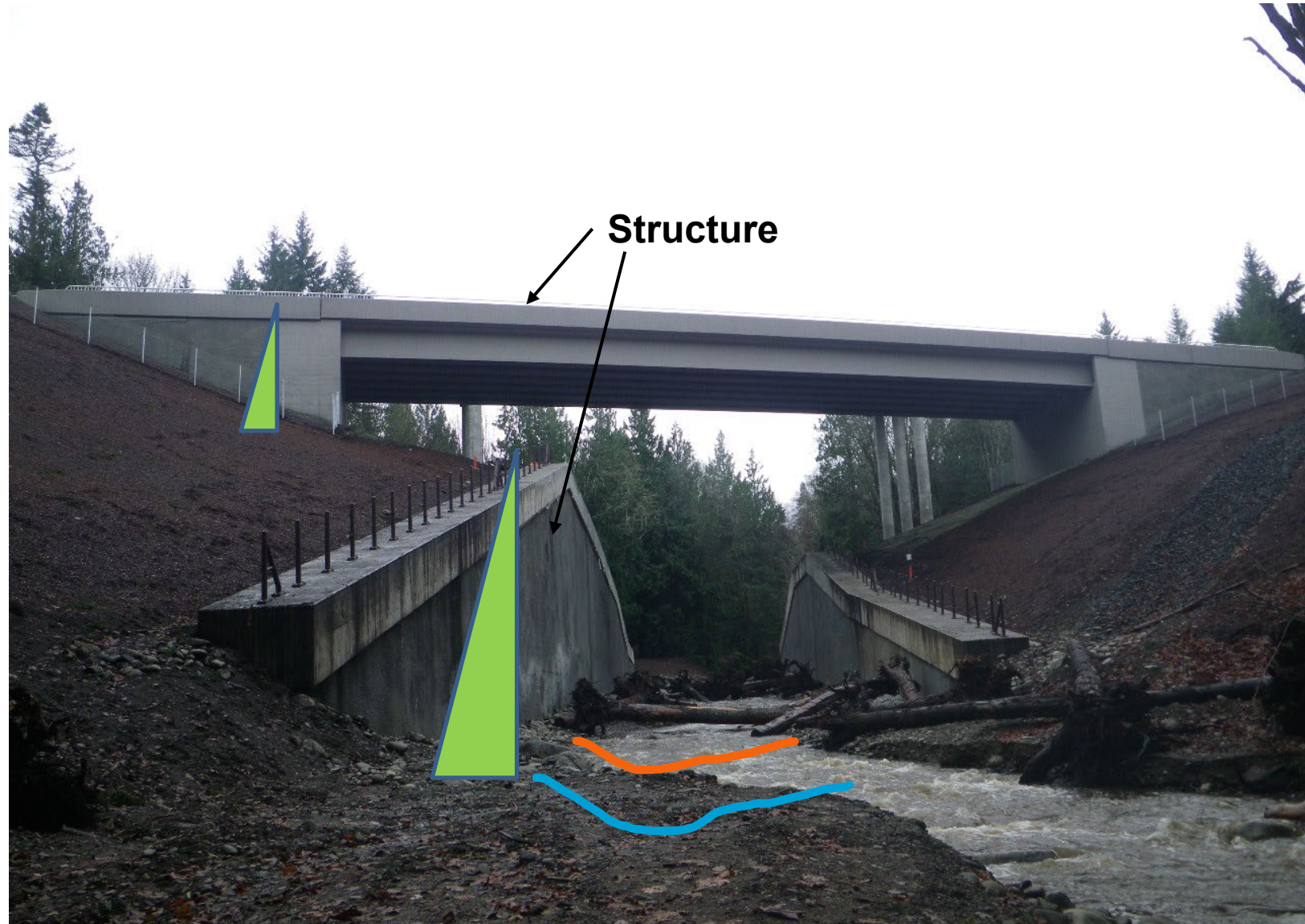


Image Source: WSDOT

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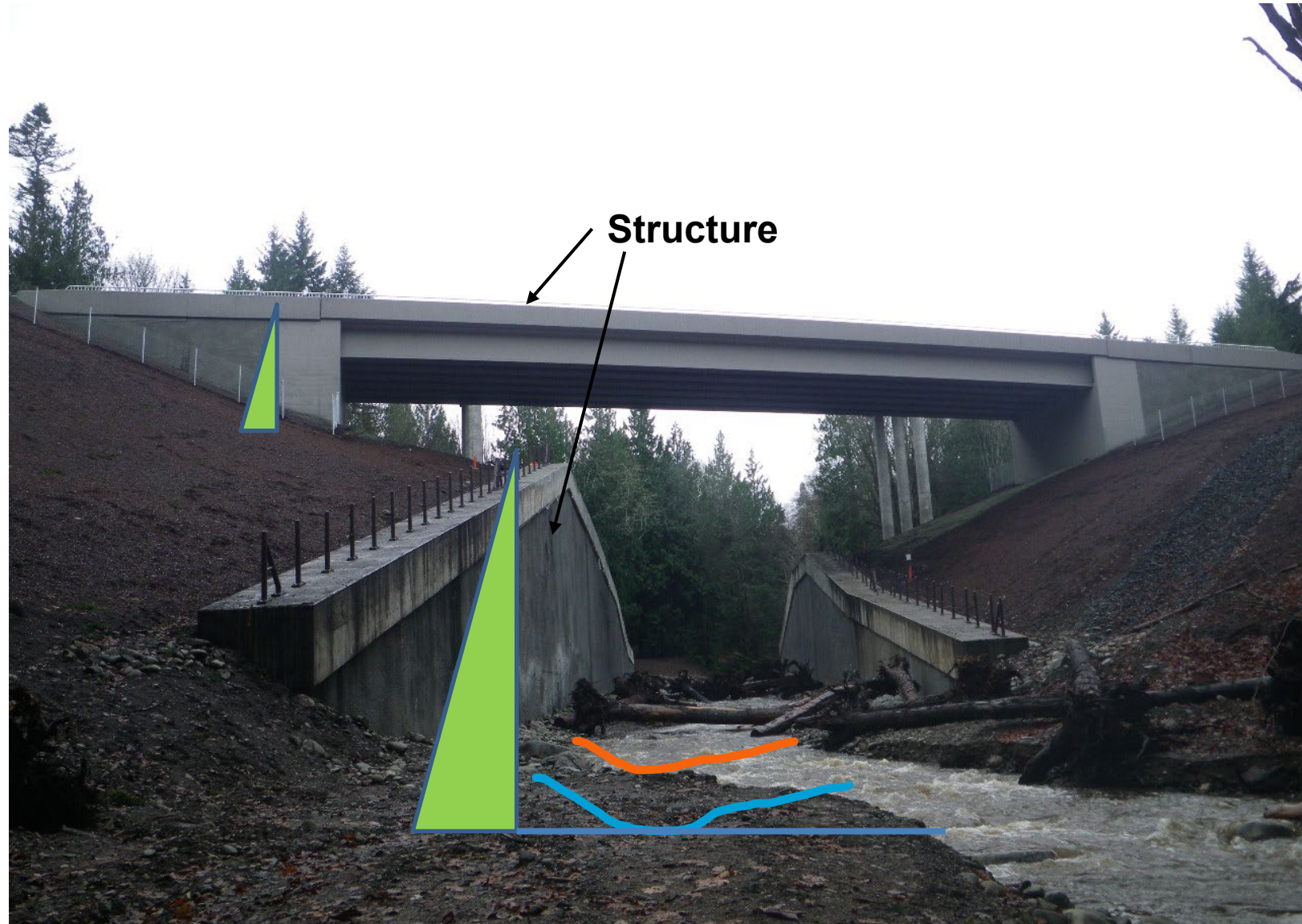
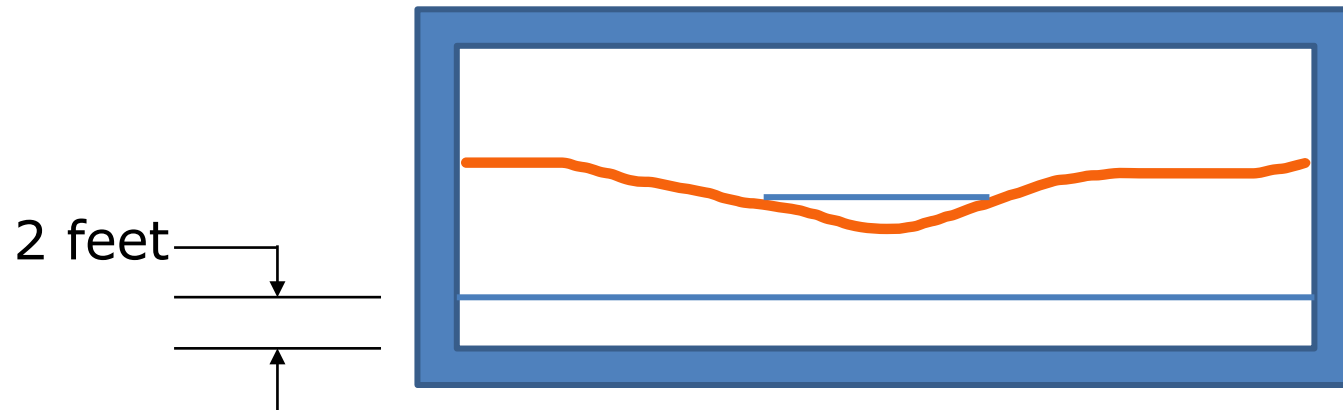


Image Source: WSDOT

BDM 7.1.7E – Scour for Buried Structures

- Three sided – follow guidance for bridges
- Four sided – top of bottom slab located a minimum of 2 ft below total scour at the scour design flood



- Wall lengths shall be determined by performing an assessment to ensure the stability of the wall and structure element through the range of anticipated scour and lateral migration.

Tsunami Scour

- BDM 3.16.8

Bridges Subjected to Tsunami Effects

The **AASHTO Guide Specifications for Bridges Subject to Tsunami Effects** are intended for the design and construction of **conventional bridges** to resist the effects of tsunami waves.

- Tsunami Guide Specs 8.1

8.1.1—Expected Scour

The tsunami-induced scour, y_{s_t} (ft), shall be taken as:

$$y_{s_t} = R_t y_{s_{corr}} \quad (8.1.1-1)$$

- Wave direction, velocity and depth from DNR

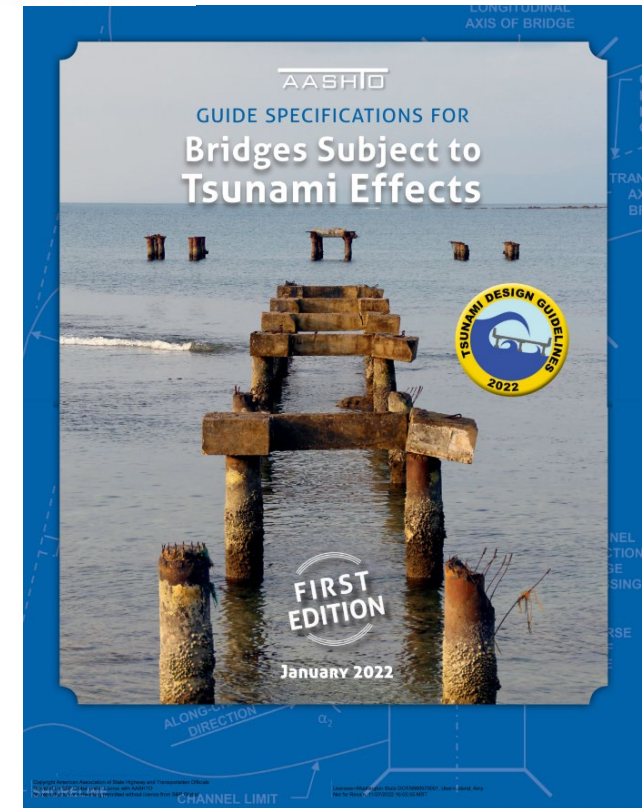


Image Source: WSDOT

Geotechnical Office Updates

Andrew Fiske

State Geotechnical Engineer

HQ Construction Division, State Geotechnical Office
WSDOT



Current Duties

- Foundations Section
- Engineering Geology Section
- Geotechnical Design and Project Development Section



Background and Experience

- 17 years at the State Geotechnical Office
- Construction Management
- Transportation Design
- Private Sector Consultant



Education

- B.S. Civil and Environmental Engineering (UMaine)
- 99% of an M.S. Geotechnical Engineering (UMaine)



Personal Interests

- Two teens (One of them in College)
- Trail running
- Ski-to-Sea

The Geotechnical Office and You



- We are here to help from the earliest stages through construction



- Questions during your analysis



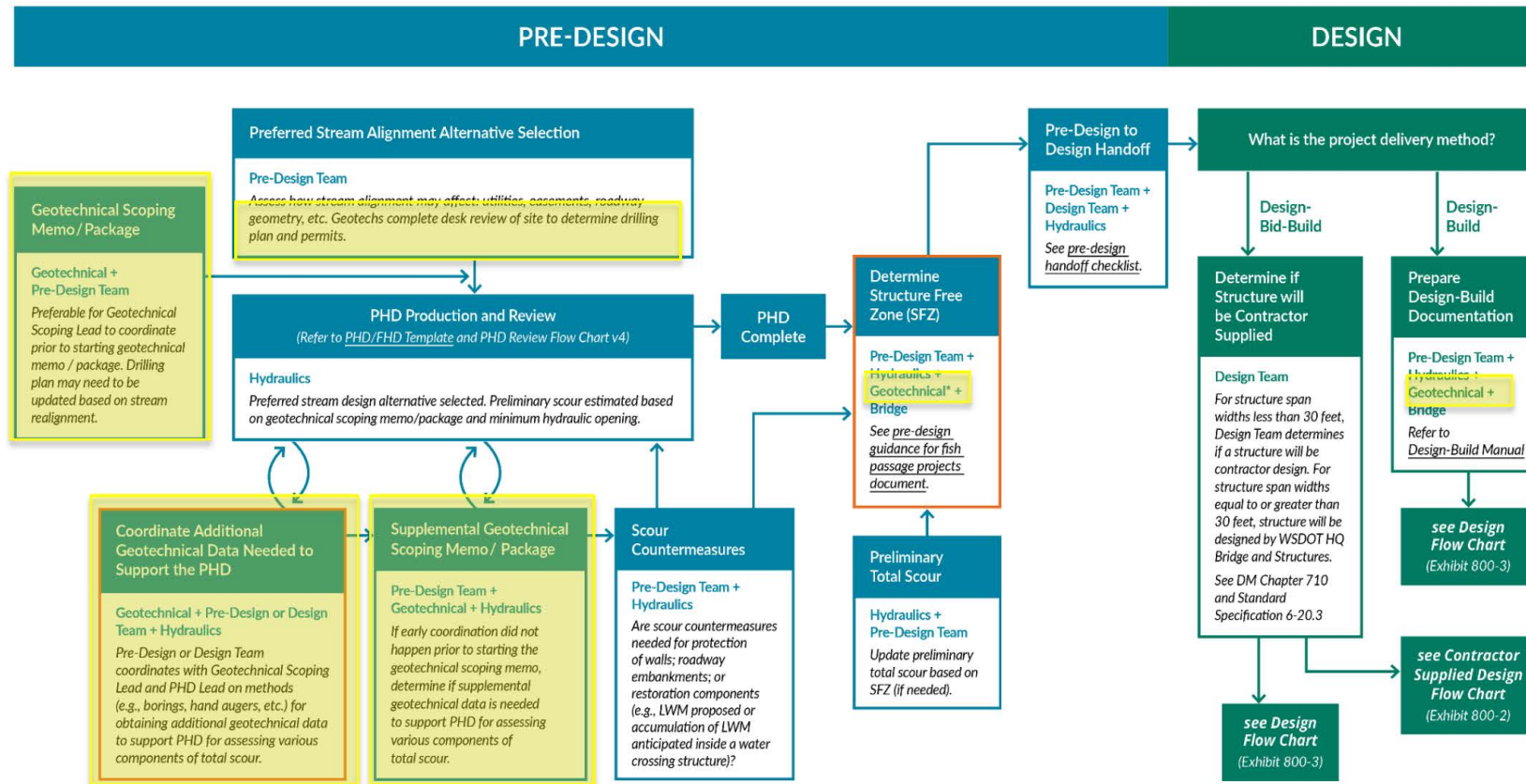
- Geotechnical Scoping Memo, source of subsurface information early on in the project



- Brainstorming

800.02 – Cont'd

SPECIALTY GROUP COORDINATION | PRE-DESIGN
EXHIBIT 800-1



General Notes

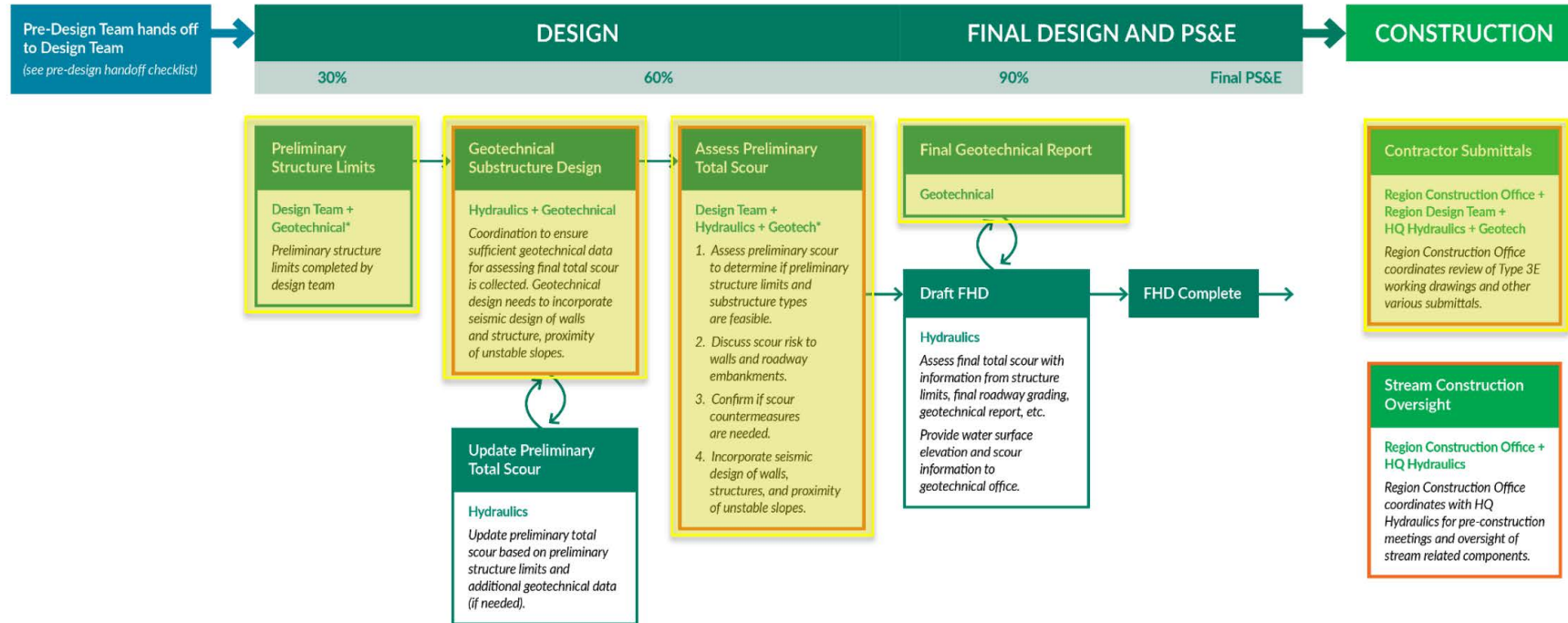
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Specialty Group Coordination

Contact HQ Hydraulics with questions.

800.02 – Cont'd

SPECIALTY GROUP COORDINATION | CONTRACTOR SUPPLIED DESIGN**
EXHIBIT 800-2



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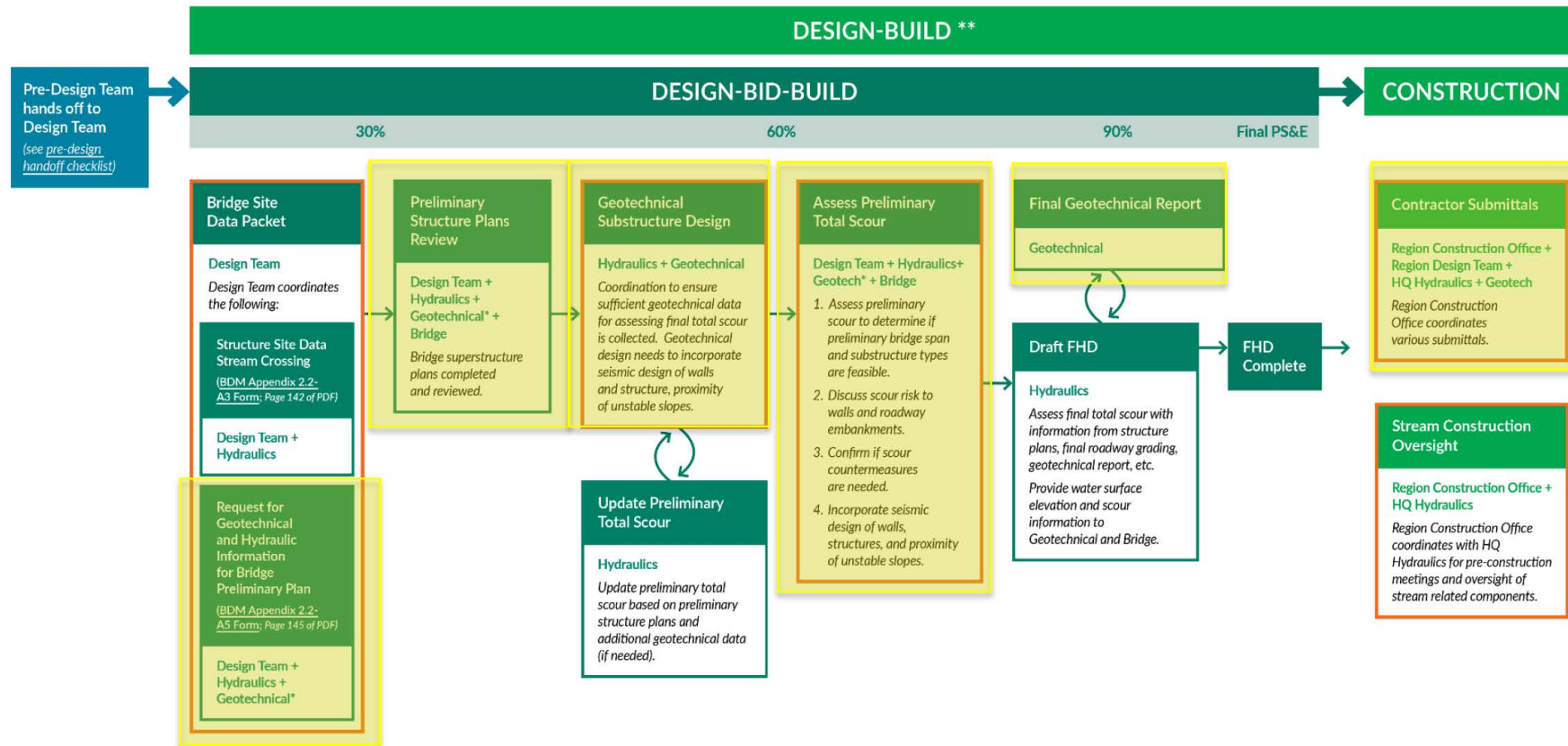
** See DM Chapter 710 and Standard Specification 6-20.3.

Specialty Group Coordination

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