Chehalis Basin Strategy Flood Retention Expandable (FRE)Presentation to Lewis County FCZD

October 25, 2018

Operational Goals of FRE

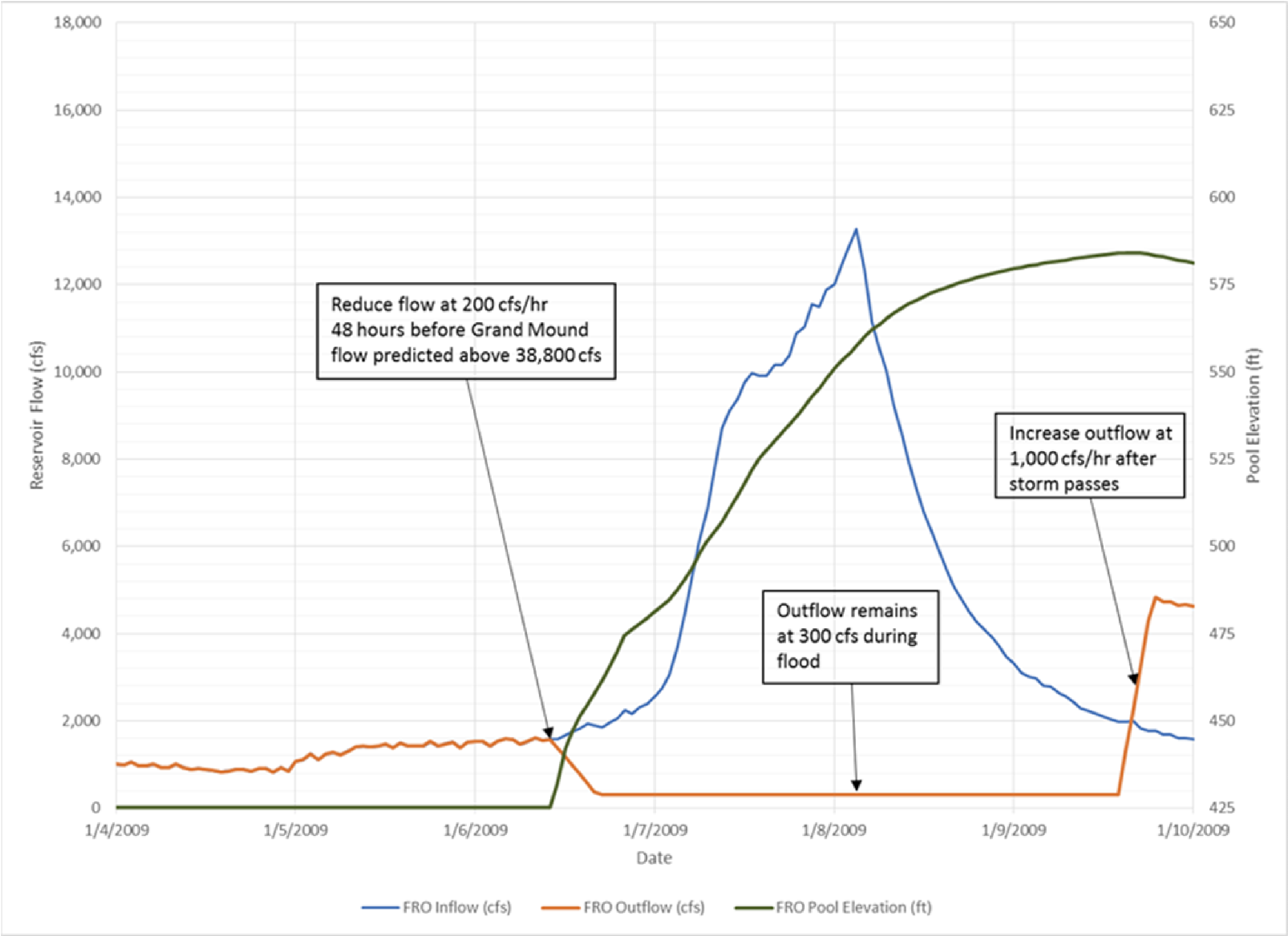
- Provide flood reduction in downstream areas
- Preserve geomorphic processes downstream
- Maintain slope stability in reservoir
- Keep rate of change in flows downstream within accepted limits
- Provide for debris management/removal in reservoir after floods

Proposed Operating Rules – Flood Retention Expandable (FRE)

- Available flood storage capacity = 65,000 acre-feet
- Operate the facility without impounding water except during a potentially damaging flood
- Begin storing when Grand Mound flows are predicted to be above the "Major Flood" (38,800 cfs) within 48 hours
- Reduce reservoir outflow at a rate of 200 cfs/hour until reaching 300 cfs
- Maintain reservoir pool for additional 2 weeks for debris management

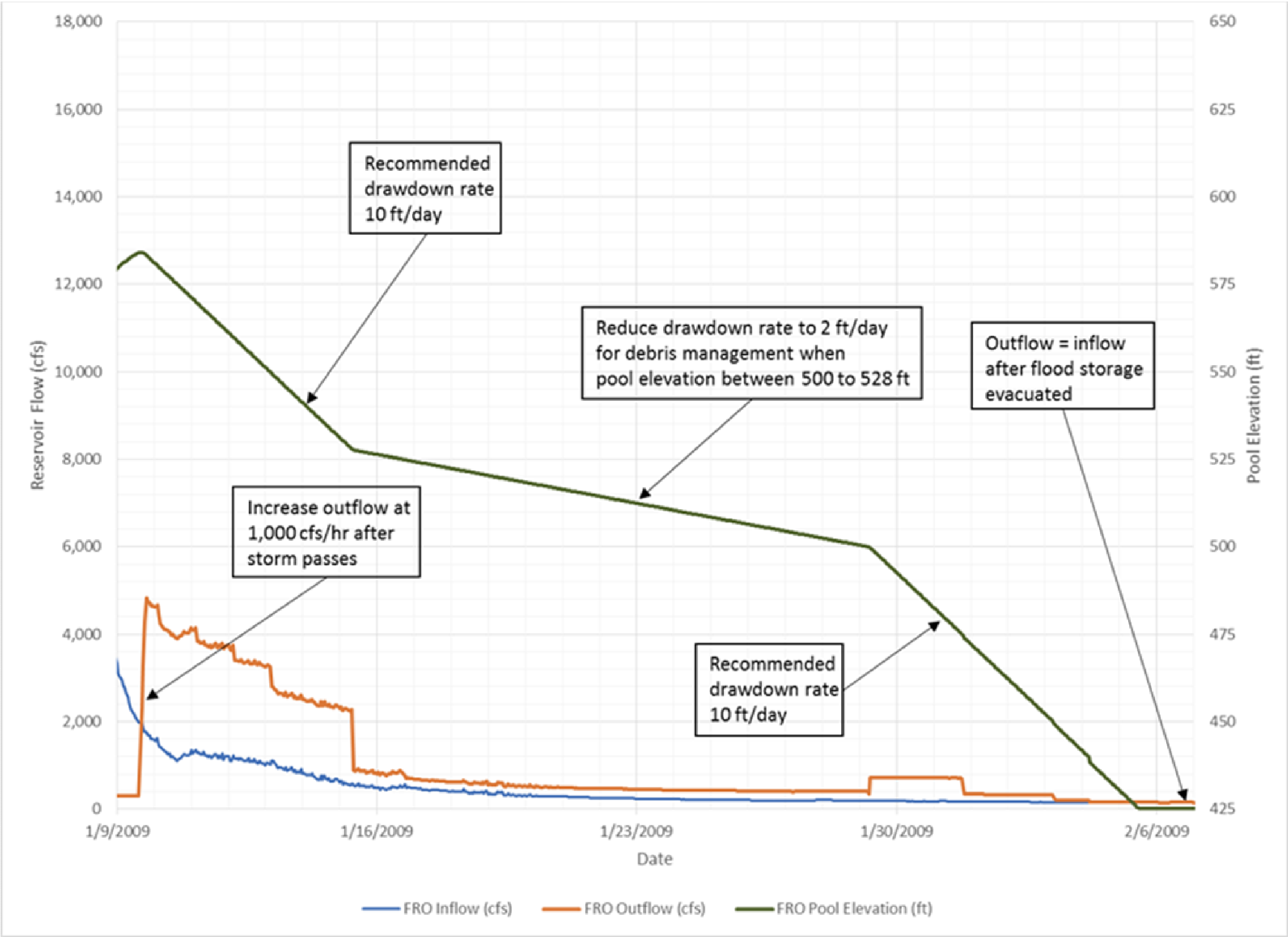
Example Inflow/Outflow Hydrograph for FRE

Before and during a flood



Example Inflow/Outflow Hydrograph for FRE

After a flood



Peak Flow Reduction During Floods

Reservoir in use during major flood (greater than 38,700 cubic feet per second [cfs] at Grand Mound), which is a 7-year flood (about 15 percent chance of occurrence in any year)

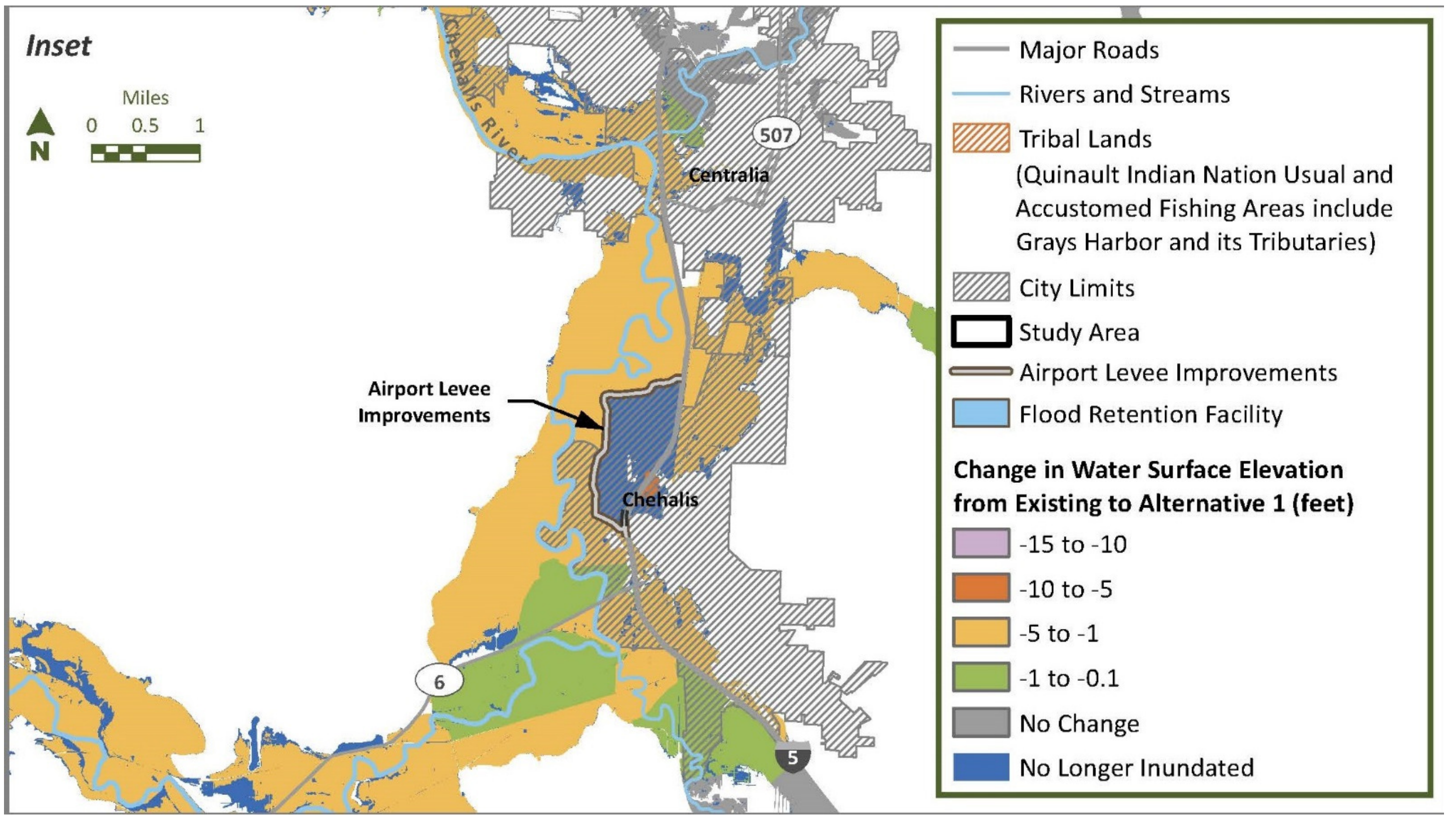
FLOOD	EXISTING PEAK FLOW (CFS)	PEAK FLOW WITH FLOOD RETENTION (CFS)	DIFFERENCE IN PEAK FLOW (%)
100-year	70,600	58,400	-17.3%
10-year	43,800	37,500	-14.4%
1996	72,100	61,200	-8.5%
2007	71,100	52,100	-26.7%
2009	57,300	48,600	-15.2%

Peak Elevation Reduction

Water Surface Elevation Reduction in the Chehalis River (100-year flood)

LOCATION	EXISTING PEAK ELEVATION (FEET)	PEAK ELEVATION WITH FLOOD RETENTION (FEET)	DIFFERENCE IN PEAK ELEVATION (FEET)
Near Doty	319.2	308.1	-11.1
Downstream of South Fork	222.2	217.1	-5.1
Along Airport Levee	180.5	179.0	-1.5
Behind Airport Levee	180.3	173.3	-7.0
Mellen Street	177.7	176.0	-1.7
Galvin Road	168.2	166.5	-1.7
Grand Mound	147.5	146.6	-0.9
Near Rochester	124.4	123.4	-1.0
Montesano	18.6	17.9	-0.7

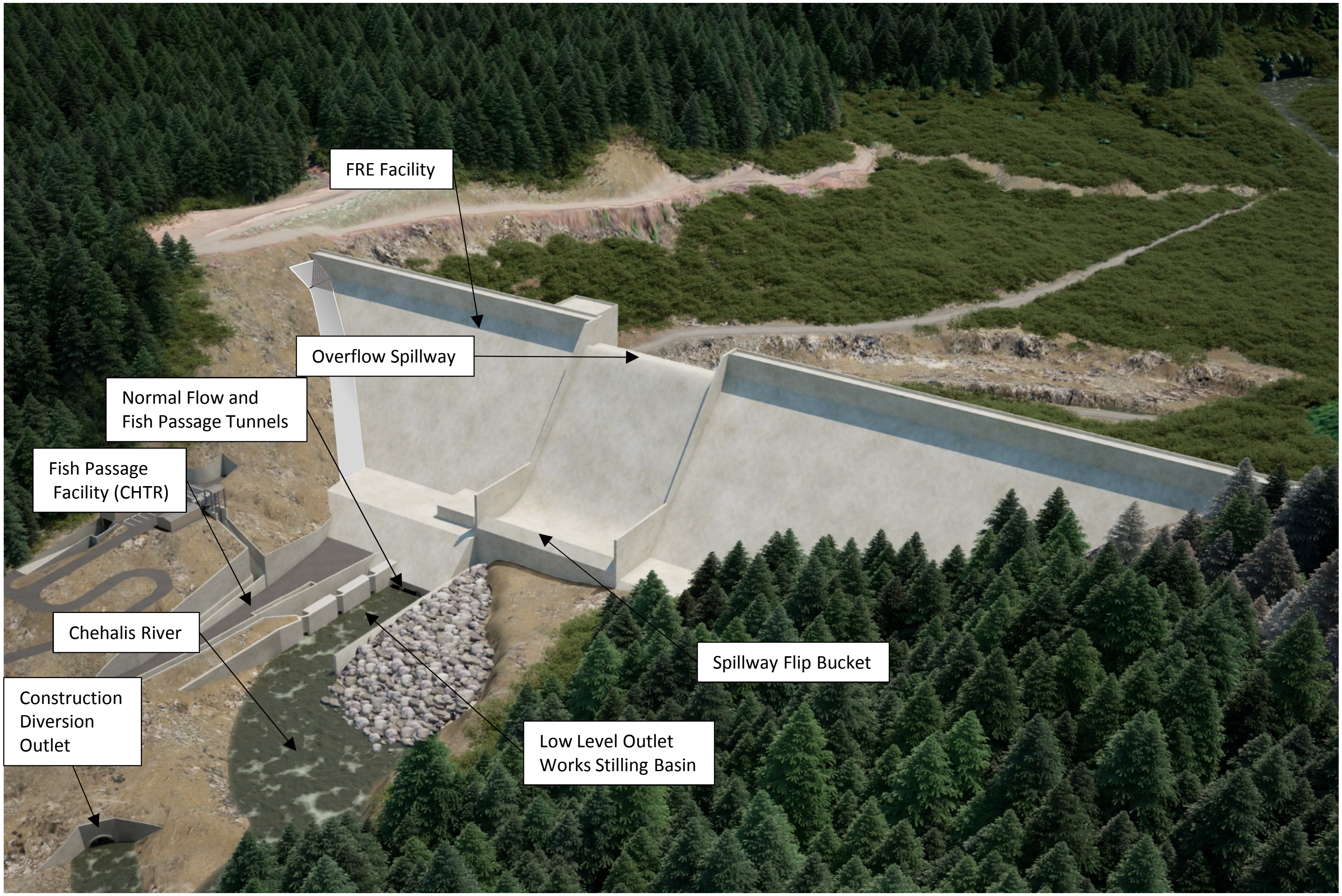
Flood Reduction – Upper Chehalis Basin (100-year Flood)



FRE Design

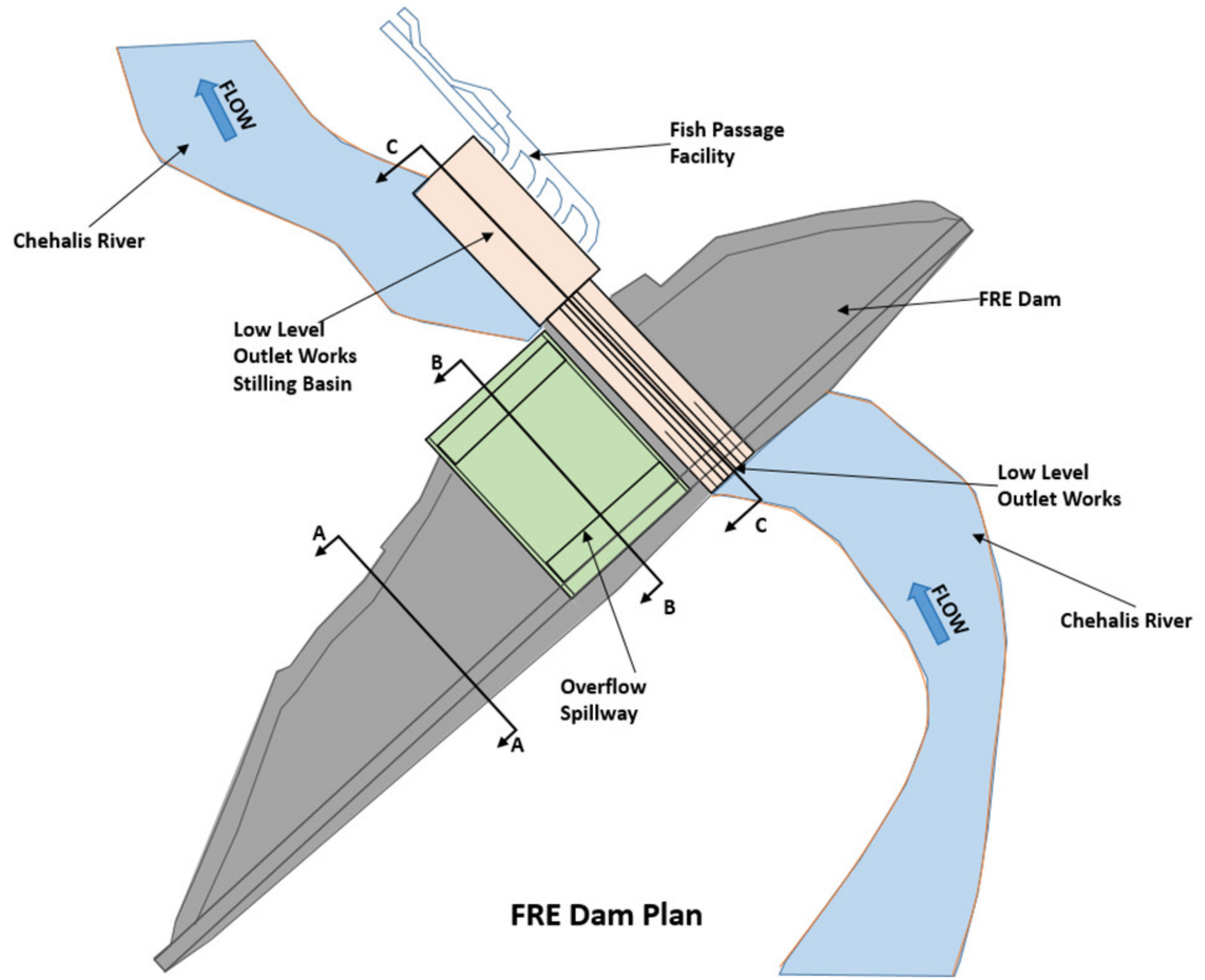
- Reservoir normally dry, temporary inundation during major floods (up to 32 days)
- Flood storage = 65,000 acre-feet
- Max storage depth in reservoir (at dam) = 227 feet
- Inundation area at max storage = 863 acres
- Length of reservoir at full pool = 6.8 miles
- Fish passage through 5 large tunnels in dam except when reservoir is in use then a CHTR (trap and haul facility) will be used

FRE Dam



FRE Facility
Overflow Spillway
Normal Flow and
Fish Passage Tunnels
Fish Passage
Facility (CHTR)
Chehalis River
Construction
Diversion
Outlet
Spillway Flip Bucket
Low Level Outlet
Works Stilling Basin

FRE Design



FRE Dam Plan

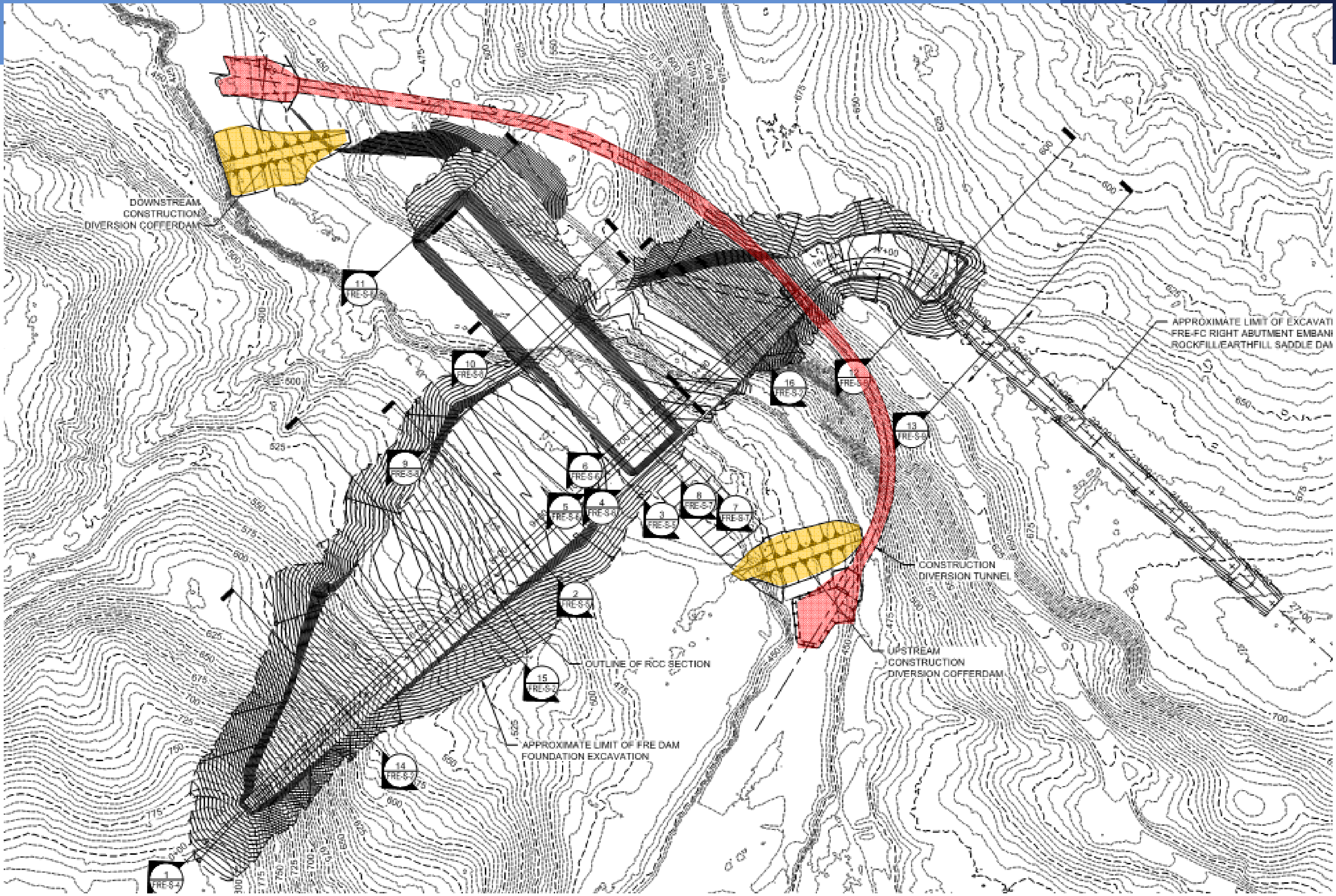
FRE Design

- FRE Dam would allow for future expansion
- FRE volume (65,000 acre-feet) but with a larger foundation to allow the dam to be raised to store 130,000 acre-feet (FRE-FC).
- Gates and outlets would also be designed to work under greater pressure if dam raised in the future
- Additional storage volume could be used to hold larger floods expected under climate change or to provide instream flow and reduce temperatures in the Chehalis River in the future.

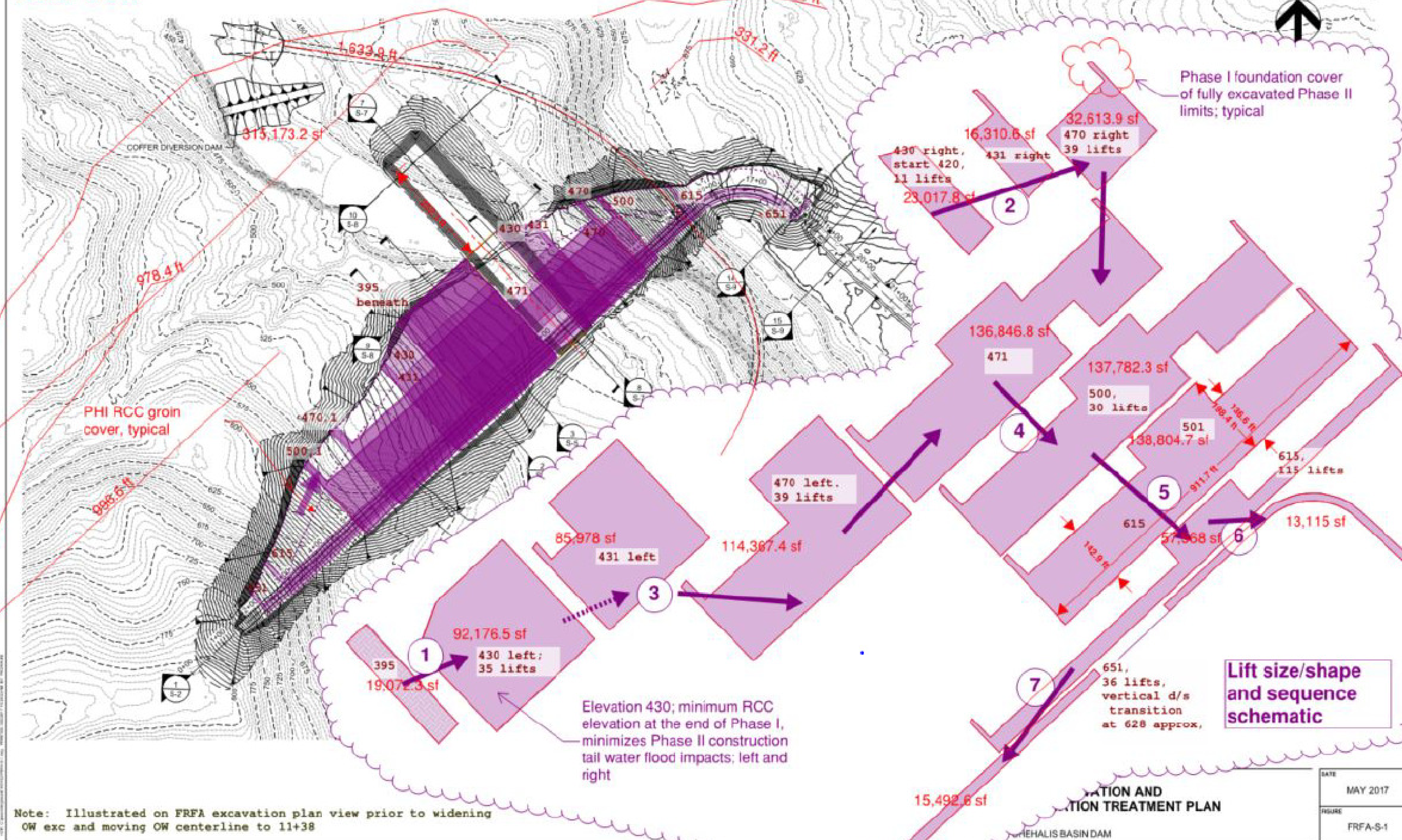
FRE Construction - Diversion Tunnel & Cofferdams

- Right abutment diversion tunnel
- Upstream and downstream cofferdams
- Exit location downstream of new CHTR facility
- Tunnel design information needs for next design phase
  - Rock type and appropriate tunnel support
  - Tunnel headers
  - Energy dissipation at discharge end

Coffer Dams and Diversion Tunnel



Phase I - Illustration of Phase I RCC Progression
Plan View



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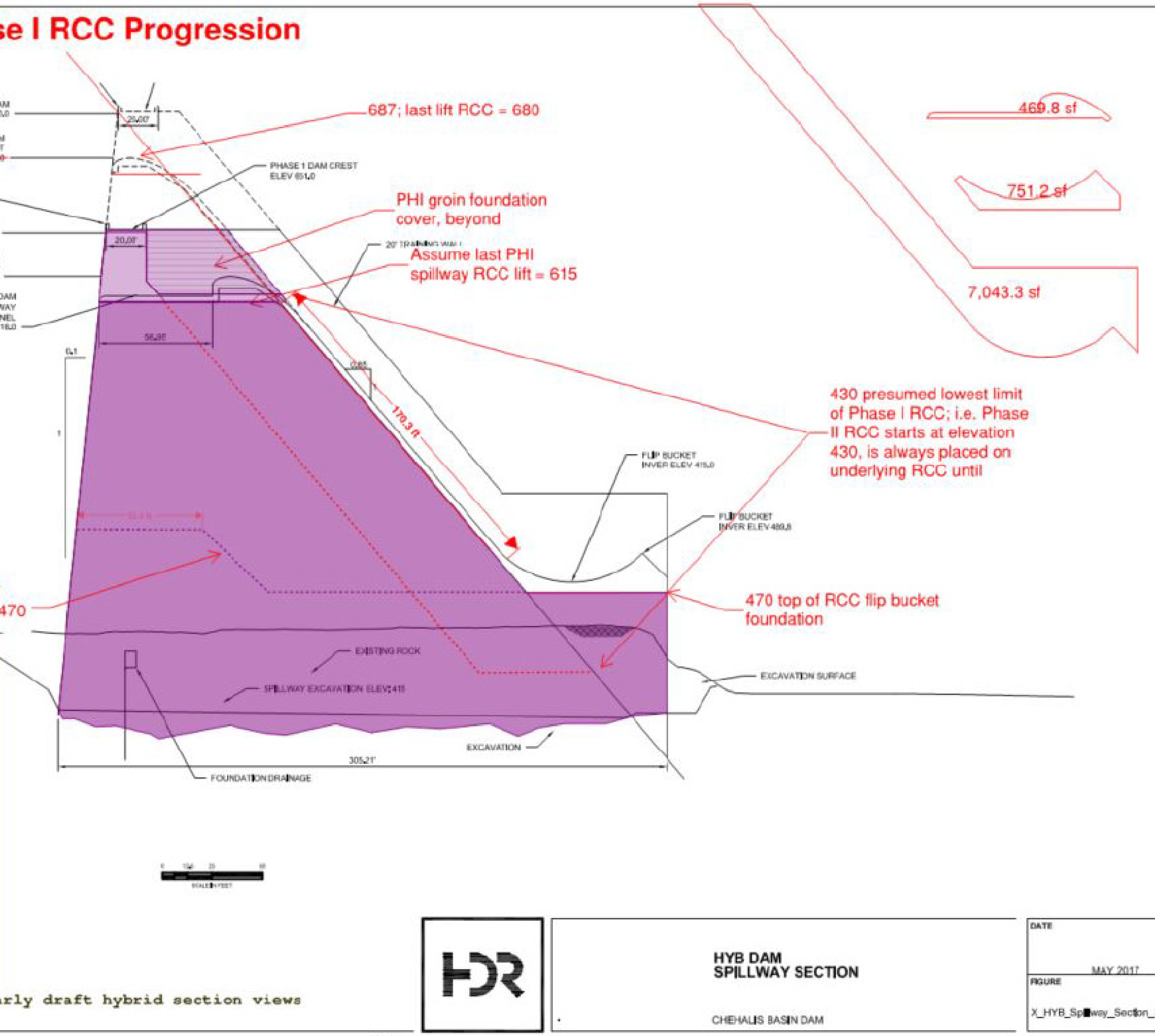
Phase I - Illustration of Phase I RCC Progression
Section *View*



PHI Concrete Structure Quantities
1) Outlet encasement: 7400sf x 300' = 82kcy; 70,000cy (ref H S-6-7 QTO; with potential to optimize); use 60,000cy as "likely" case
2) Flip: 751sf x 210' = 5,800cy
3) PHI sloped face = 210' x 3' x 170' = 4,000cy
4) PHI approach, and ogee to sloped face = 210' x 470sf = 3,650cy
5) Crest: (20'x1' +(3.5' +3.5')x1') x (18+10-2+20 - 200') = 1,400cy
6) Stilling basin: 120% x (95' x 40' - 85' x 36') x 250' = 8,200cy; 8600cy ref H S-6,7; plus add 2' leveling = 1600cy
7) Intake and trashrack: 100% x (95' x 40' - 85' x 38') x 260' = 5,500cy. See H S-06-07, use 5800cy.
8) Spillway training walls: 7043sf x 2' x 2each = 1,050cy
9) Other - not otherwise identified: 4,000cy
Total all structures (without Fish Passage) = 105,900cy: use as max; 95,900cy as likely; and 80,000 cy as low range.
adjusting in item 1).

...arly draft hybrid section views

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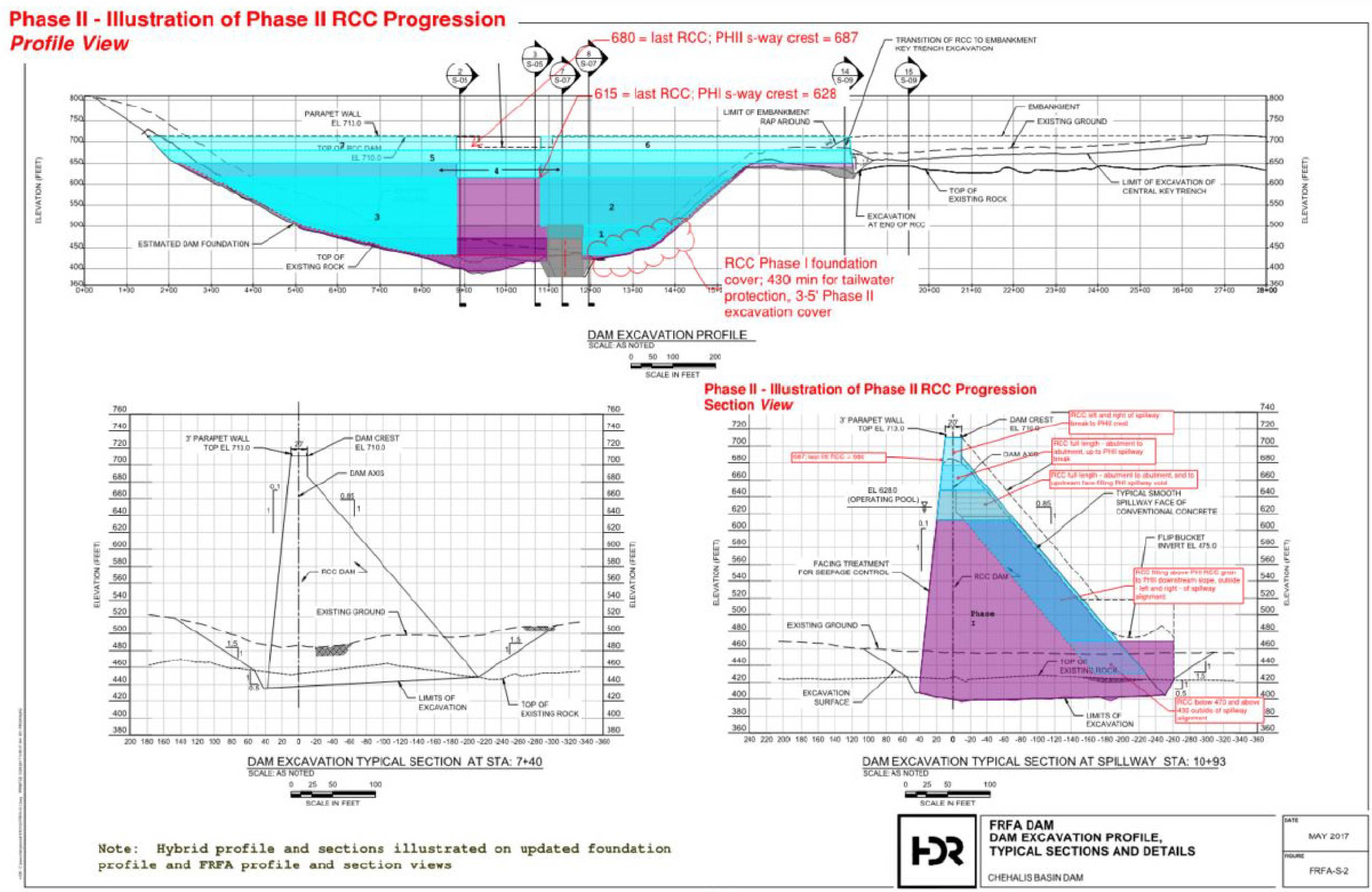
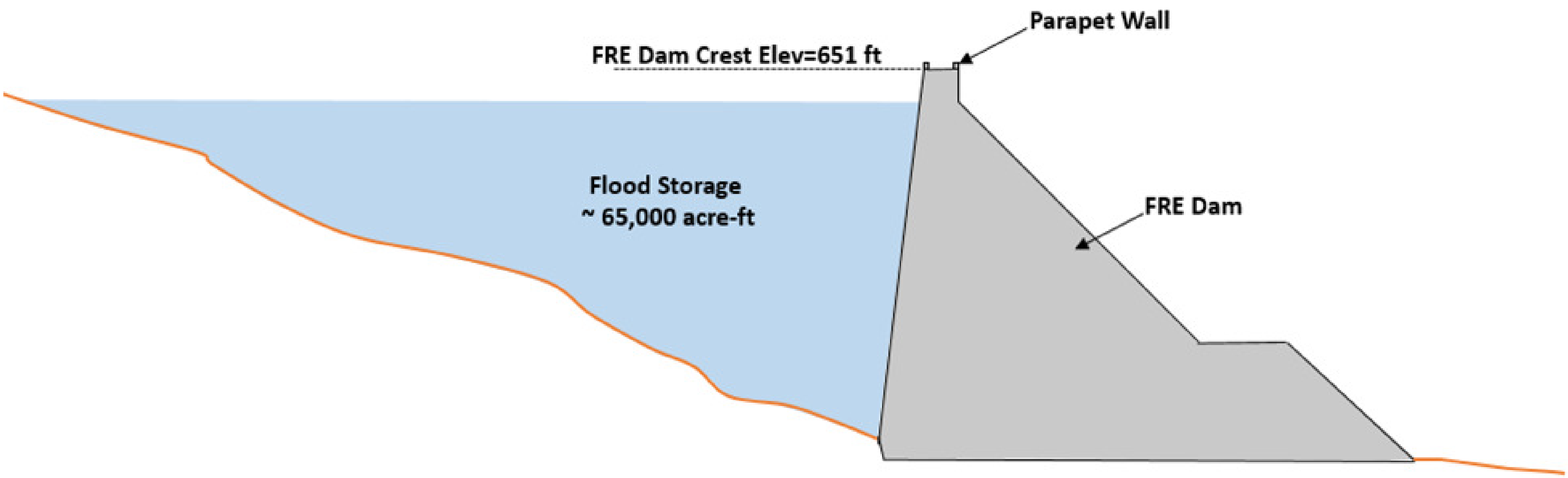

Phase II - Illustration of Phase II RCC Progression
Profile View
680 = last RCC; PHII s-way crest = 687
615 = last RCC; PHI s-way crest = 628
TRANSITION OF RCC TO EMBANKMENT KEY TRENCH EXCAVATION
PARAPET WALL EL 713.0
TOP OF RCC DAM EL 710.0
LIMIT OF EMBANKMENT RAP AROUND
EMBANKMENT
EXISTING GROUND
LIMIT OF EXCAVATION OF CENTRAL KEY TRENCH
TOP OF EXISTING ROCK
EXCAVATION AT END OF RCC
ESTIMATED DAM FOUNDATION
TOP OF EXISTING ROCK
RCC Phase I foundation cover; 430 min for tailwater protection, 3-5' Phase II excavation cover
ELEVATION (FEET)
DAM EXCAVATION PROFILE
SCALE: AS NOTED
SCALE IN FEET
Phase II - Illustration of Phase II RCC Progression
Section View
3' PARAPET WALL TOP EL 713.0
DAM CREST EL 710.0
DAM AXIS
EL 628.0 (OPERATING POOL)
TYPICAL SMOOTH SPILLWAY FACE OF CONVENTIONAL CONCRETE
FLIP BUCKET INVERT EL 475.0
FACING TREATMENT FOR SEEPAGE CONTROL
RCC DAM
Phase I
EXISTING GROUND
TOP OF EXISTING ROCK
EXCAVATION SURFACE
LIMITS OF EXCAVATION
DAM EXCAVATION TYPICAL SECTION AT STA: 7+40
SCALE: AS NOTED
SCALE IN FEET
LIMITS OF EXCAVATION
TOP OF EXISTING ROCK
DAM EXCAVATION TYPICAL SECTION AT SPILLWAY STA: 10+93
SCALE: AS NOTED
SCALE IN FEET
Note: Hybrid profile and sections illustrated on updated foundation profile and FRFA profile and section views
FRFA DAM
DAM EXCAVATION PROFILE, TYPICAL SECTIONS AND DETAILS
CHEHALIS BASIN DAM
DATE MAY 2017
FIGURE FRFA-S-2

Non-overflow Section of Dam

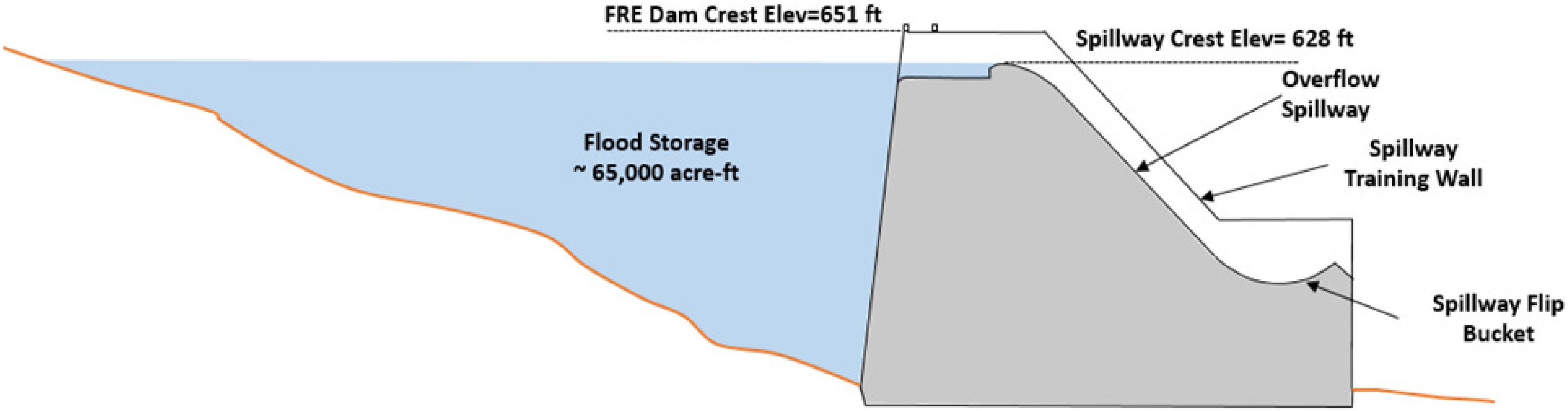


Section A-A
FRE Dam Non-Overflow Section

Spillway

- Ogee crest with shallow approach section
- 200 foot crest length at elevation 628 ft (msl)
- No spillway control gates
- Spillway chute constructed to final dimensions and footprint
- Flip bucket constructed to final dimensions

Spillway

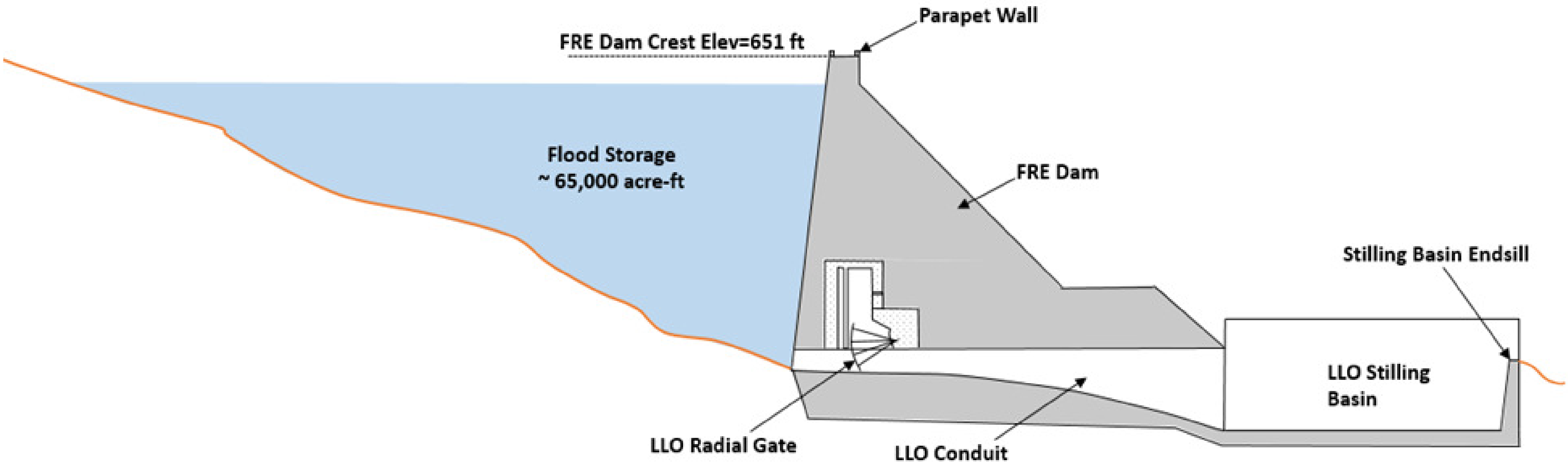


Section B-B
FRE Dam Overflow Spillway

Outlet Conduits and Water Quality Outlets

- Dam outlets
  - 5 Outlet conduits (1-12’Wx20’H, and 4-10’Wx16’H)
  - Radial control gates
  - Downstream stilling basin 240 ft long

Outlet Conduits and Water Quality Outlets

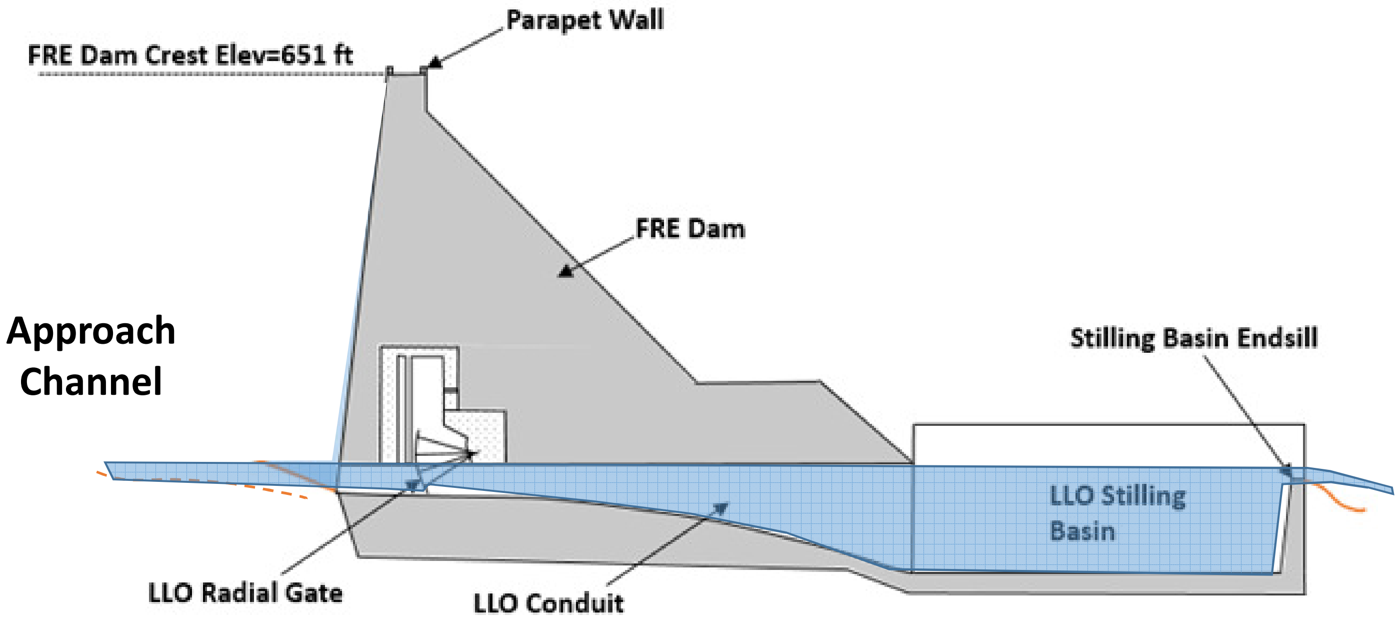


Section C-C
FRE Dam Low Level Outlet Works (LLO)

Fish Passage Design Considerations

- Upstream and Downstream Passage (no flood operations)
  - Outlet conduits
  - Target - Residents, juveniles, adults, and lamprey
- Upstream passage (when flood operations occur)
  - CHTR (Trap and transport)
  - Target - Residents, juveniles, adults, and lamprey

Fish Passage During Normal Operation via Conduits



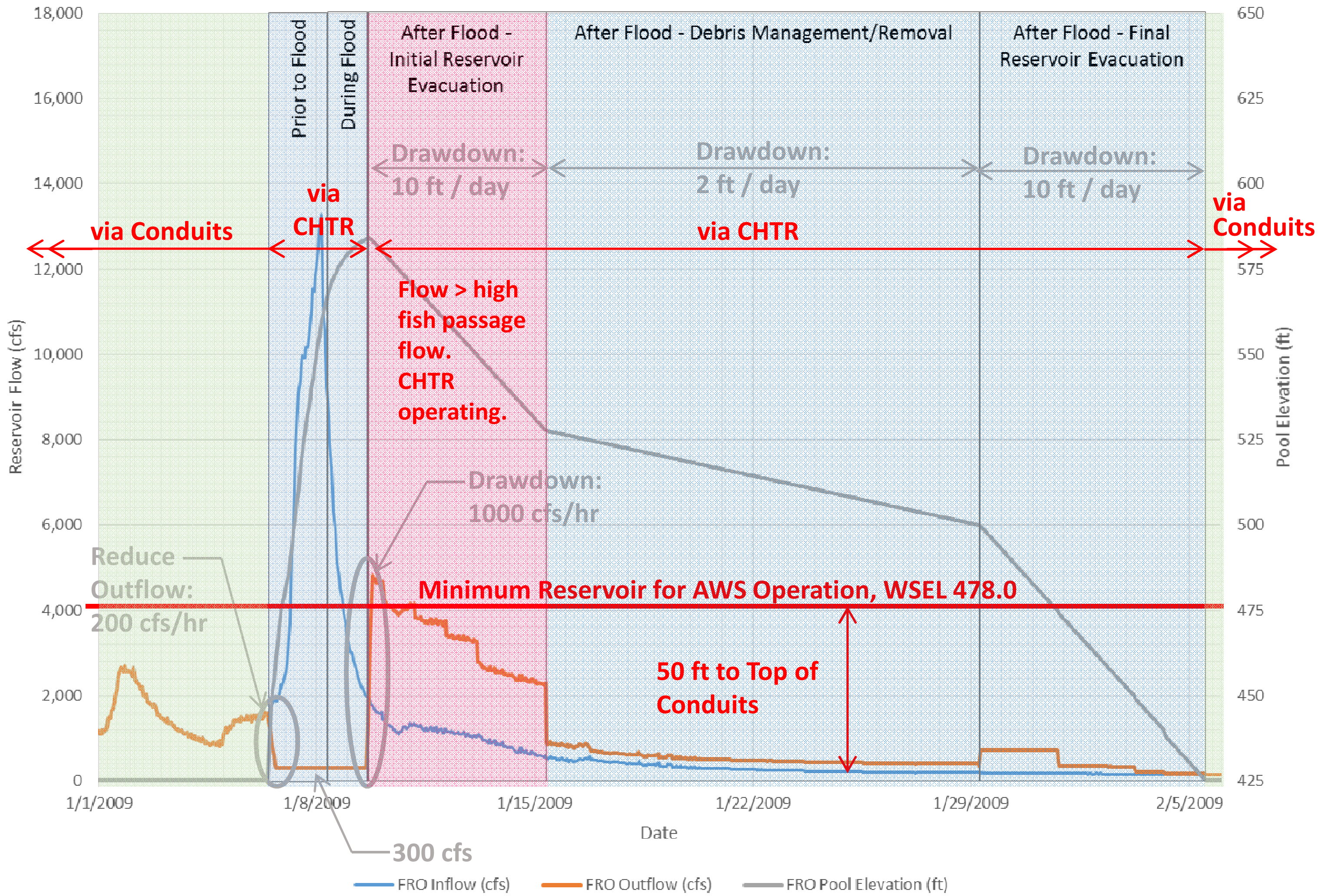
Section C-C
FRE Dam Low Level Outlet Works (LLO)

Fish Passage During Normal Operations via Conduits

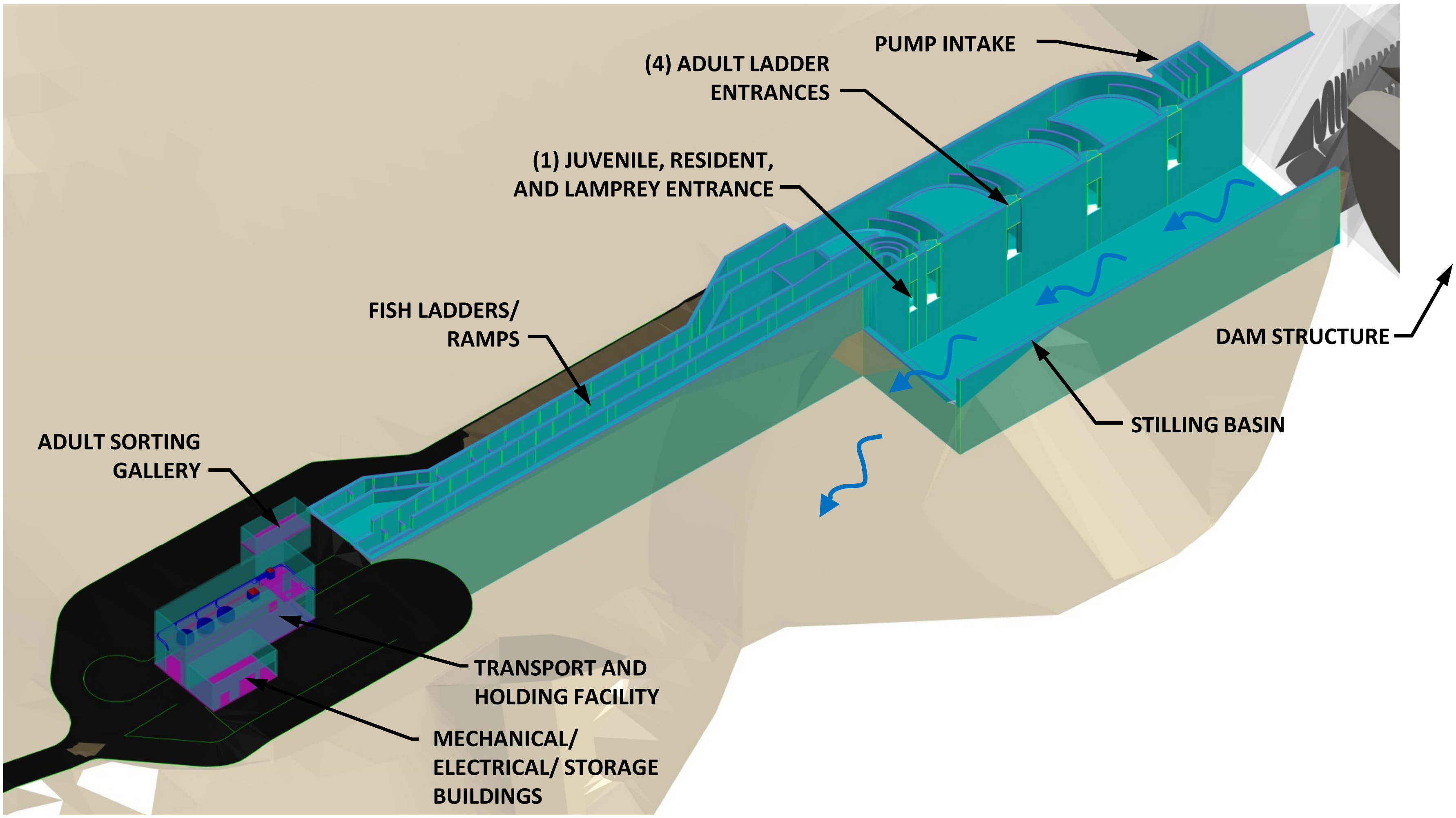
- Conduits provide both upstream and downstream fish passage
- Up to 5 conduits required
- Mimic natural flow and sediment regime of Chehalis River through project reach
- Target flow velocity ~ 2 fps or less to accommodate weaker swimming fish when possible

Fish Passage During Flood Operations via CHTR Facility

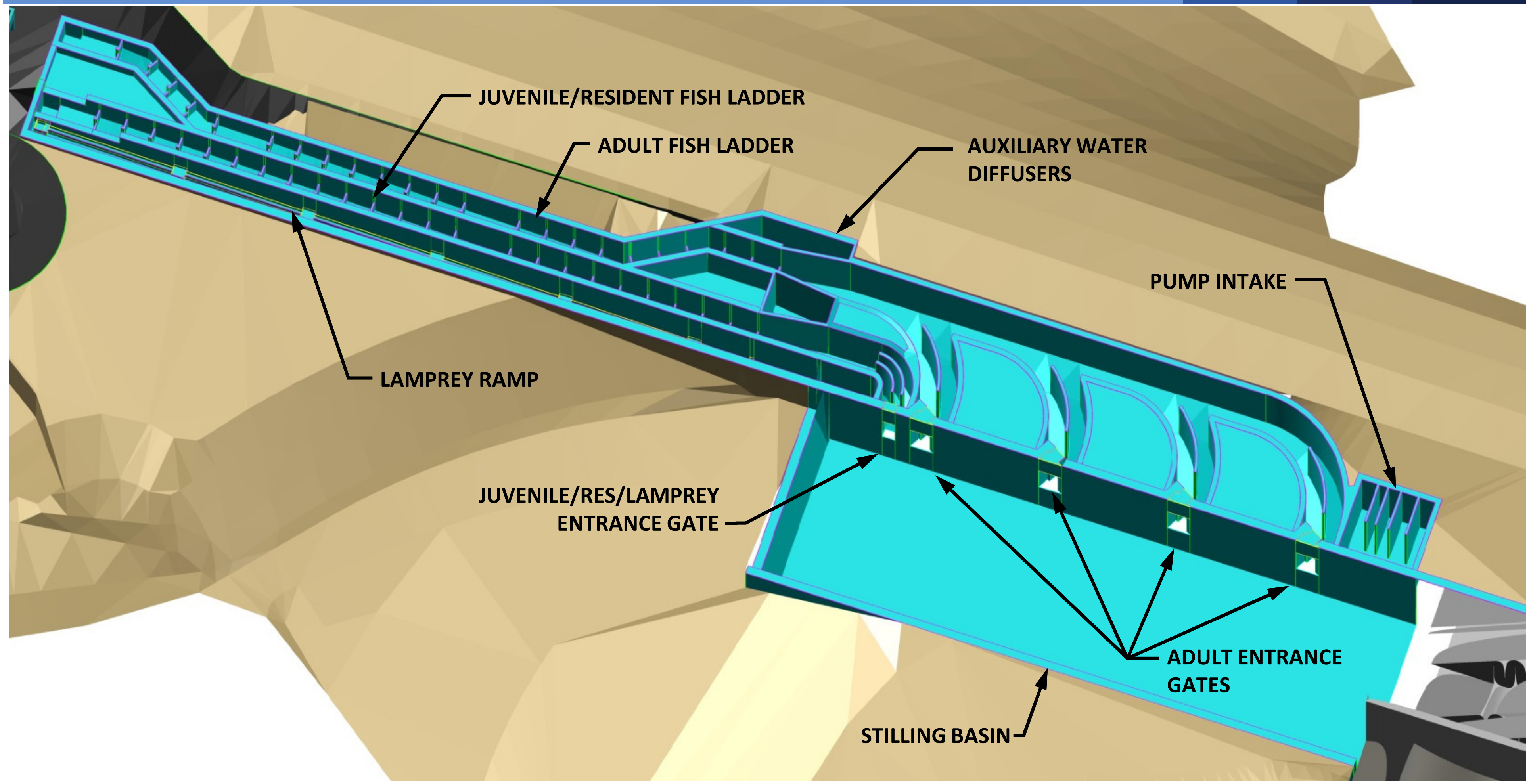
Example January 2009 flow event



Fish Passage During Flood Operations via CHTR Facility



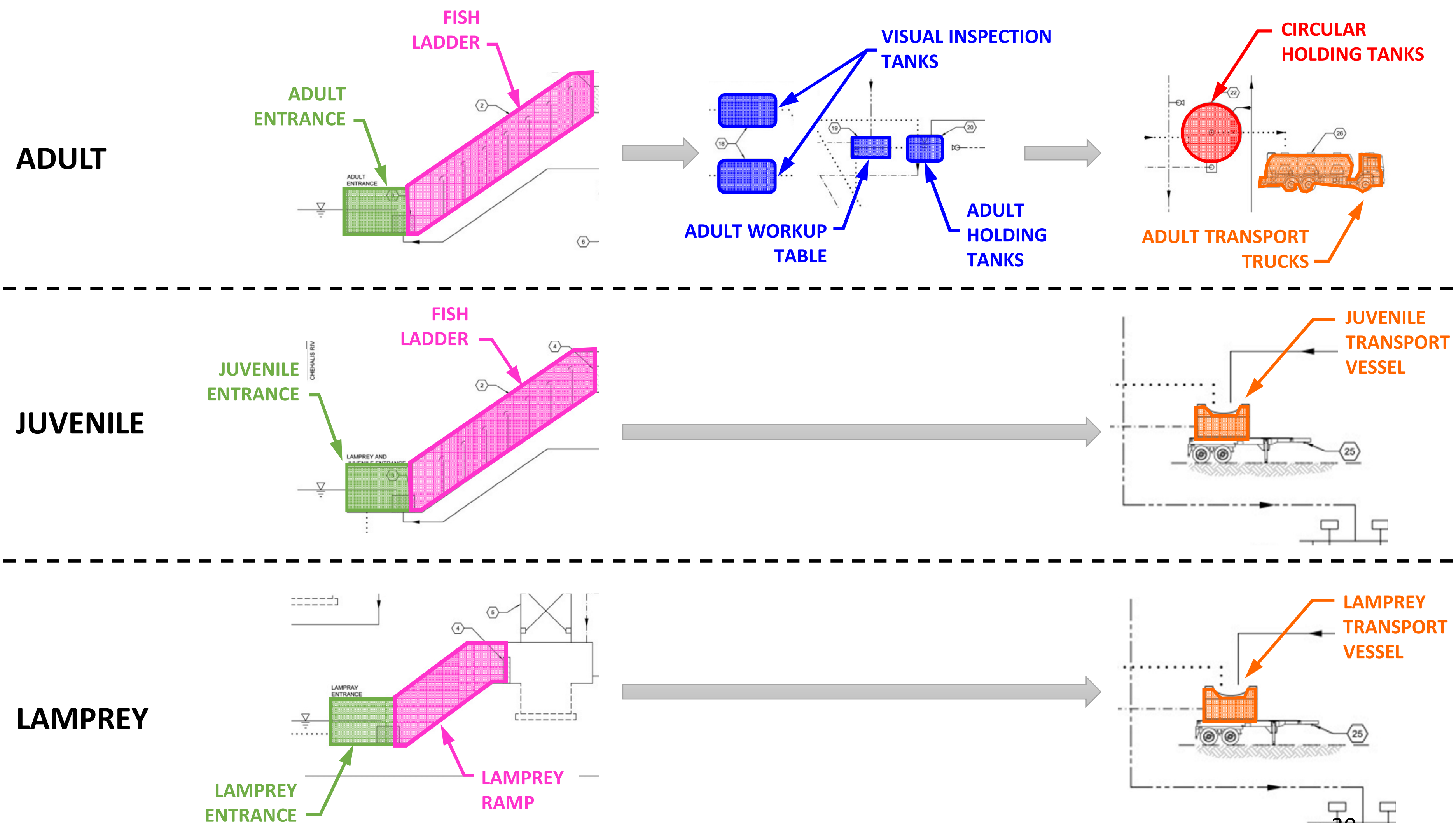
CHTR Facility Concept Design Isometric View



CHTR Facility Concept Design - Key Considerations

- Provide separate pathways for Adult, Juvenile/Resident, and Lamprey species targeted for passage
  - (1) Low velocity/Low hydraulic head entrance
  - (4) Adult fish ladder entrances
  - Three pathways: Adult Ladder, Juvenile/Resident Ladder, Lamprey Ramp
- Accommodate all resident species to the extent possible
  - To be evaluated based upon swimming capability of different resident species

CHTR Facility Concept Design - Three Pathways to Accommodate Expanded List of Species



Fish Passage During Construction

- Three options considered
  - Bypass tunnel
  - Construct elements of the CHTR first
  - Temporary Trap and Transport

Fish Passage During Construction

Option 1 - Bypass tunnel

- Designed to be hydraulically efficient
  - High velocity throughout range of fish passage flows
  - Smaller cross-sectional area
  - Low roughness
- Modifications to accommodate upstream fish passage would be too costly and would inhibit ability to convey flood flows around construction site
- Likely acceptable pathway for downstream passage of juveniles and post-spawn adults during construction

Fish Passage During Construction

Option 2 – Construct CHTR First

- Foundation excavation limits of dam interfere with construction of CHTR on right bank
- Construction phasing conflicts with stilling basin and ladder entrance – would require temporary fish passage measures regardless

Fish Passage During Construction

Option 3 – Temporary Trap and Transport

- Likely the most pragmatic and cost effective strategy to be used throughout construction
- Elements can be located downstream of the proposed project providing better isolation of the construction area
- Designed to allow safe passage of downstream migrants
- Targets adult life stages – Limited anticipated success collecting upstream migrating juveniles if they occur during the construction period.

Questions/Comments