Site restoration:
Beyond barrier removal to restoring a diverse, functional hydrologic system

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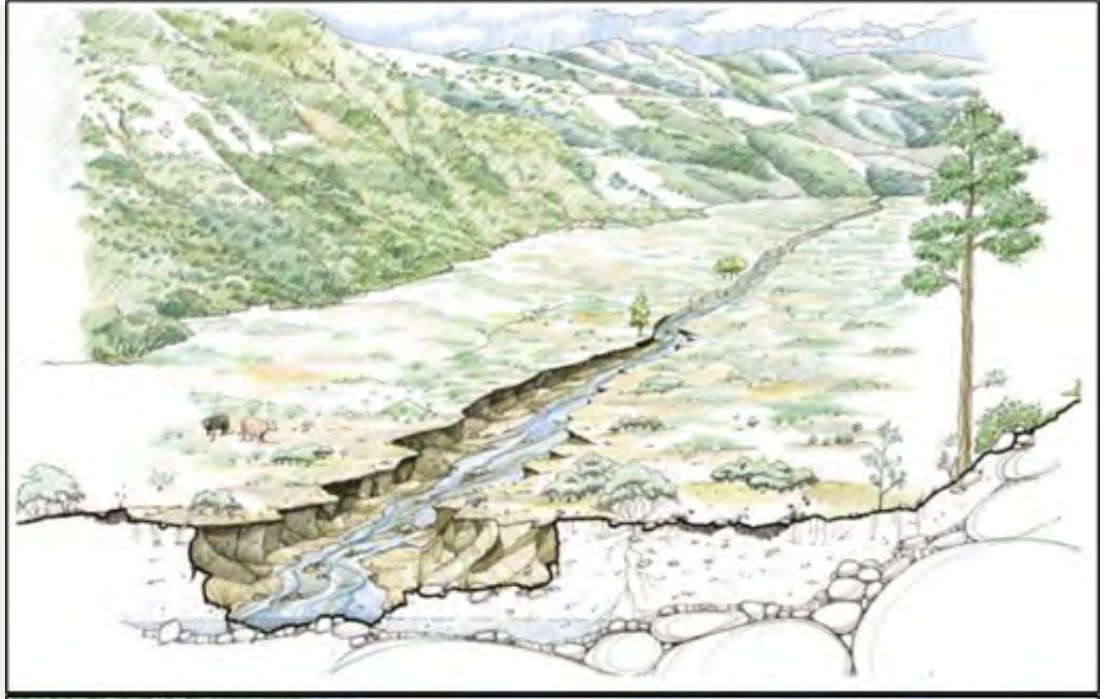
Allaire Diamond, Vermont Land Trust

Reconnecting Rivers Workshop, December 5, 2024



Degraded System

- Disconnected from floodplain
- Stream is straightened, incised
- High velocity = high erosion and flood damage
- Low water table and minimal groundwater
- No wetland margins

Functional System

- Floodplain connection
- Stream is sinuous
- Water flows slowly, minimal erosion
- Riparian wetlands
- Lush and diverse plant communities
- Groundwater connection

(American Rivers, 2020)

Idaho

Skidmore and Wheaton 2022

Three elements of site restoration, and why we care about them

1. **Valley-Stream Topography** – the hydrologic system we are restoring extends across the entire valley
2. **Instream Structure & Roughness** -- slow down water and stabilize bed
3. **Plants** – habitat, biodiversity, stabilize sediment

Valley-Stream Topography

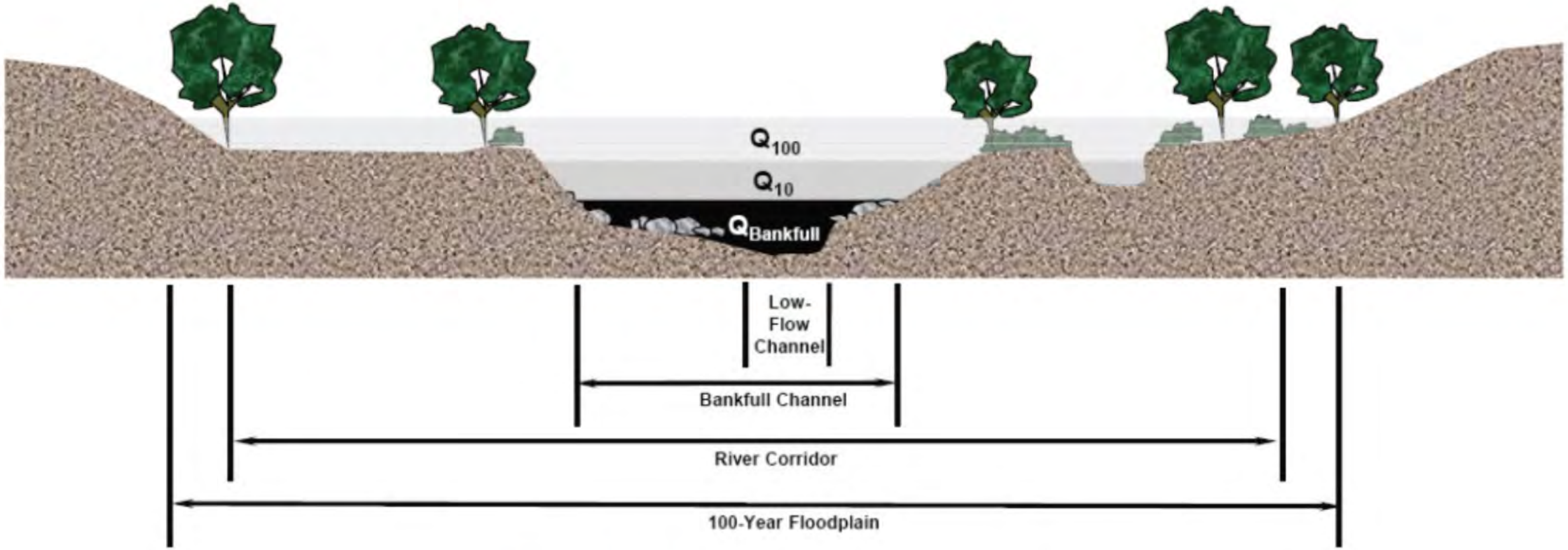


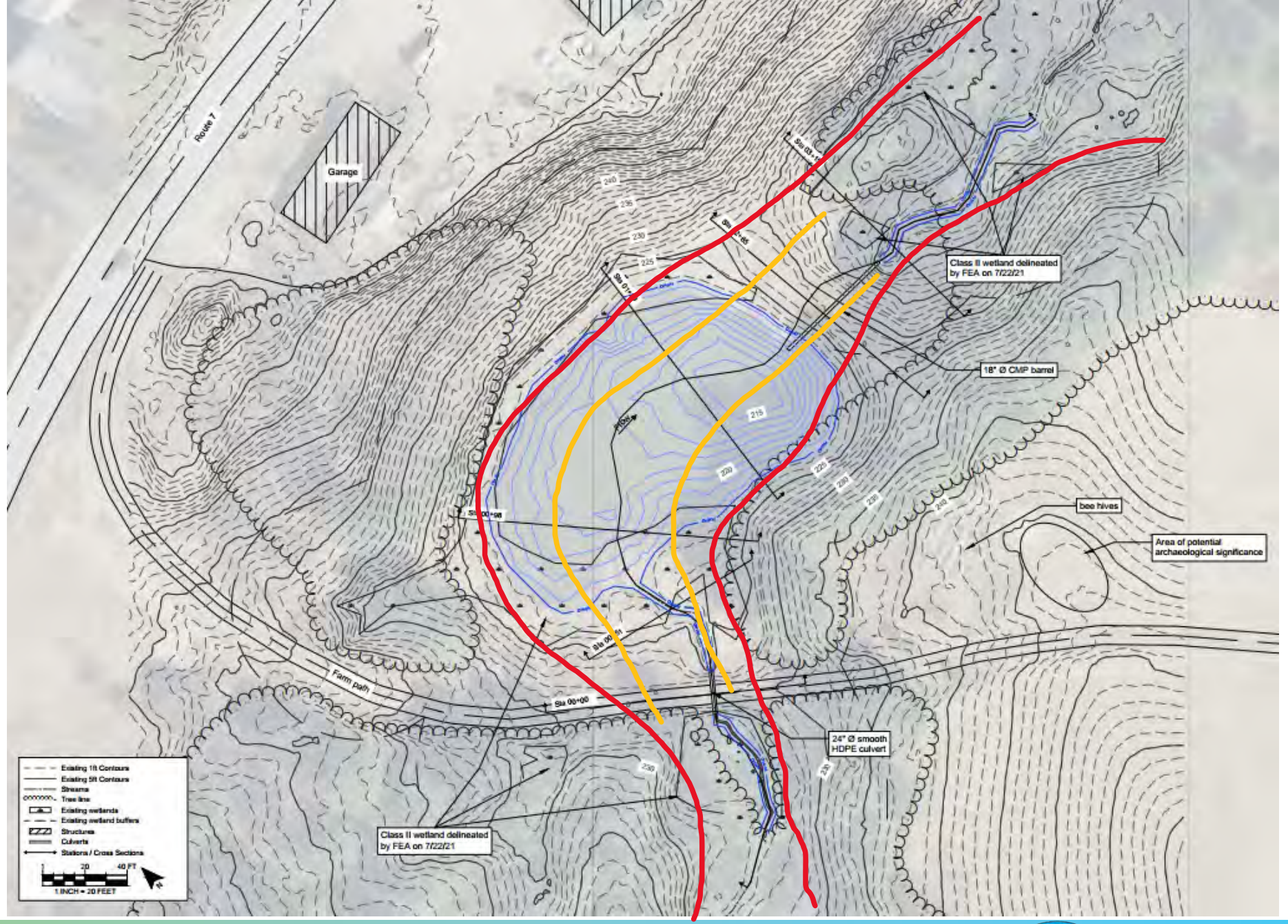
Figure 3.2: Cross section schematic. (Schiff et al., 2014)

Button Dam Removal
Colchester, VT

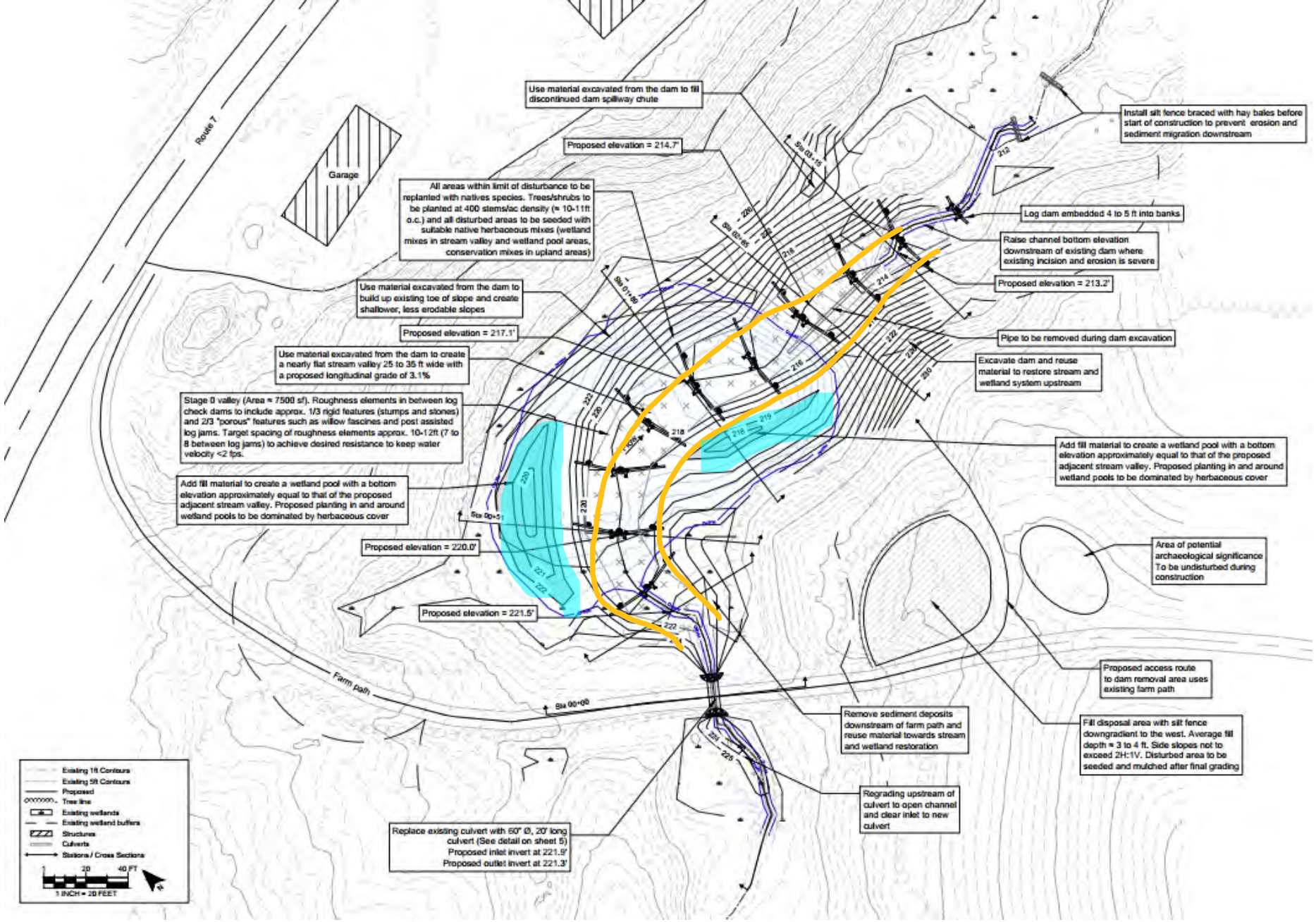
Eugene Button

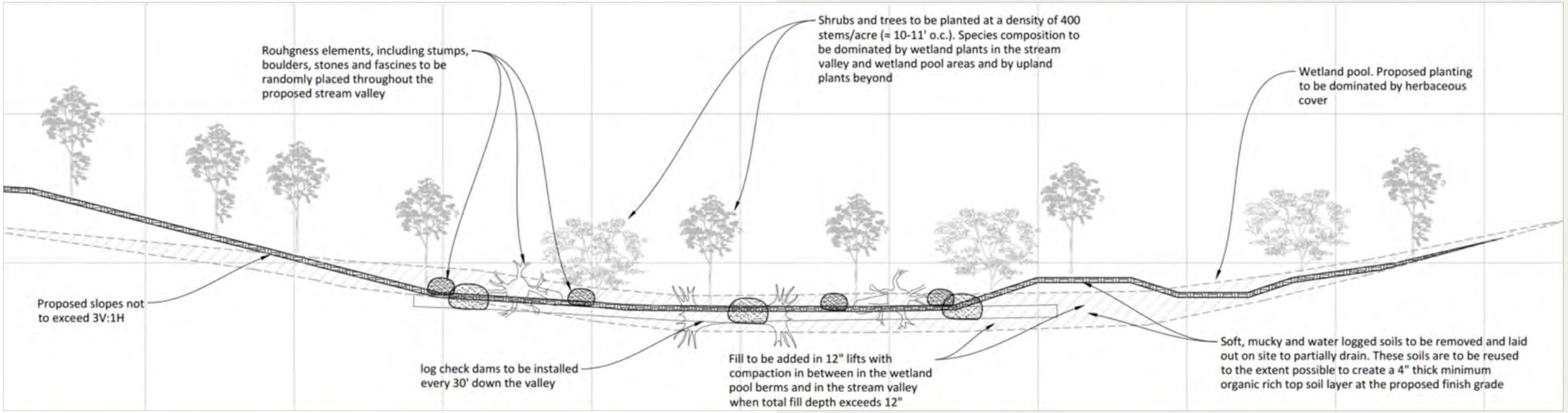
Design - 2021-22

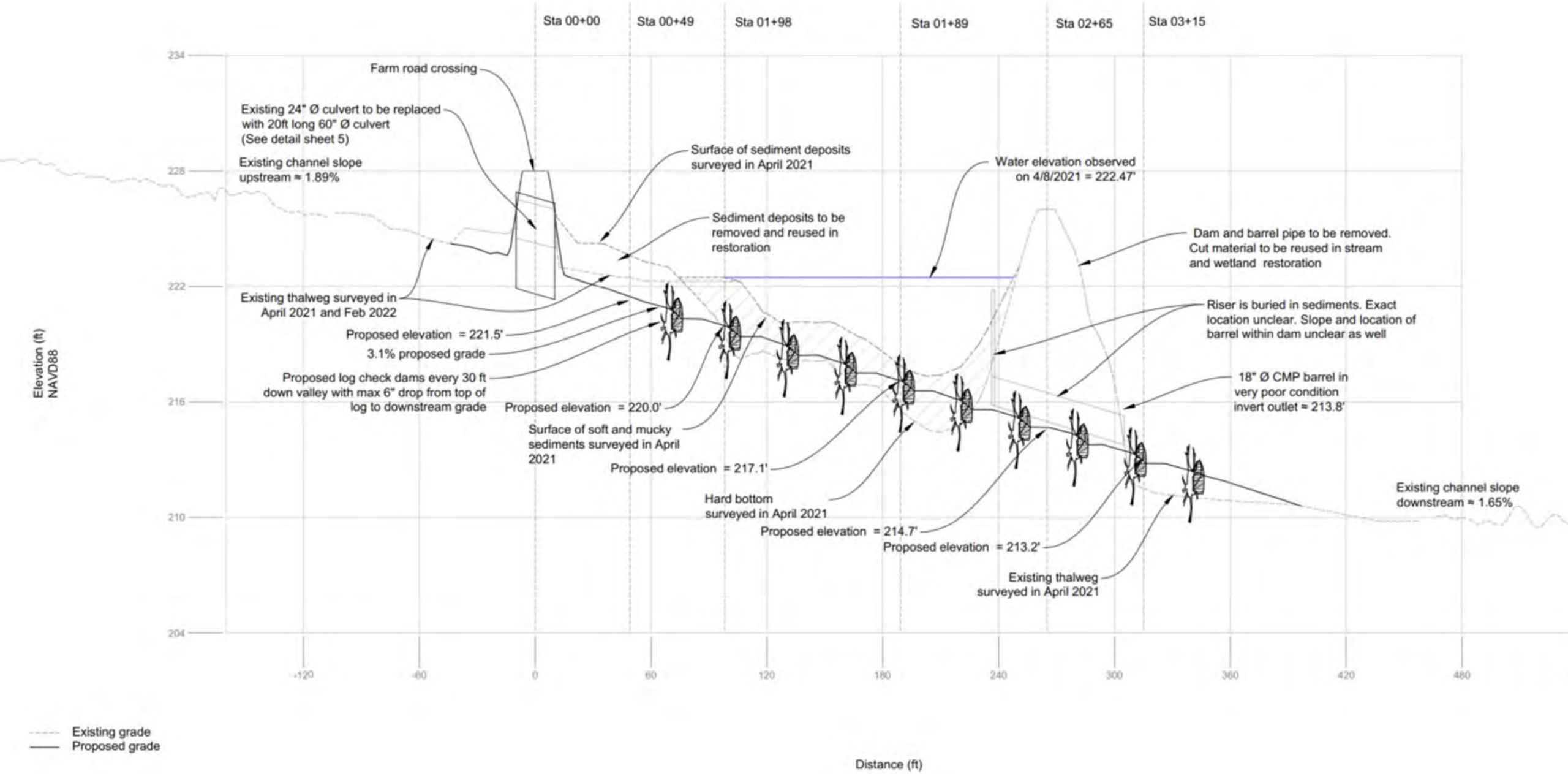
Removal - 2022




Analog Channel
• 3% Valley slope upstream
• Multi-thread channel
• Wood provides vertical stability
• Ledge outcroppings common


Use material excavated from the dam to fill discontinued dam spillway chute
Install silt fence braced with hay bales before start of construction to prevent erosion and sediment migration downstream
Proposed elevation = 214.7'
All areas within limit of disturbance to be replanted with natives species. Trees/shrubs to be planted at 400 stems/ac density (≈ 10-11ft o.c.) and all disturbed areas to be seeded with suitable native herbaceous mixes (wetland mixes in stream valley and wetland pool areas, conservation mixes in upland areas)
Log dam embedded 4 to 5 ft into banks
Raise channel bottom elevation downstream of existing dam where existing incision and erosion is severe
Use material excavated from the dam to build up existing toe of slope and create shallower, less erodable slopes
Proposed elevation = 213.2'
Proposed elevation = 217.1'
Pipe to be removed during dam excavation
Use material excavated from the dam to create a nearly flat stream valley 25 to 35 ft wide with a proposed longitudinal grade of 3.1%
Excavate dam and reuse material to restore stream and wetland system upstream
Stage 0 valley (Area ≈ 7500 sf). Roughness elements in between log check dams to include approx. 1/3 rigid features (stumps and stones) and 2/3 "porous" features such as willow fascines and post assisted log jams. Target spacing of roughness elements approx. 10-12ft (7 to 8 between log jams) to achieve desired resistance to keep water velocity <2 fps.
Add fill material to create a wetland pool with a bottom elevation approximately equal to that of the proposed adjacent stream valley. Proposed planting in and around wetland pools to be dominated by herbaceous cover
Add fill material to create a wetland pool with a bottom elevation approximately equal to that of the proposed adjacent stream valley. Proposed planting in and around wetland pools to be dominated by herbaceous cover
Proposed elevation = 220.0'
Area of potential archaeological significance To be undisturbed during construction
Proposed elevation = 221.5'
Proposed access route to dam removal area uses existing farm path
Remove sediment deposits downstream of farm path and reuse material towards stream and wetland restoration
Fill disposal area with silt fence downgradient to the west. Average fill depth ≈ 3 to 4 ft. Side slopes not to exceed 2H:1V. Disturbed area to be seeded and mulched after final grading
Regrading upstream of culvert to open channel and clear inlet to new culvert
Replace existing culvert with 60" Ø, 20' long culvert (See detail on sheet 5)
Proposed inlet invert at 221.9'
Proposed outlet invert at 221.3'
Garage
Route 7
Farm Path
Existing 1ft Contours
Existing 5ft Contours
Proposed
Tree line
Existing wetlands
Existing wetland buffers
Structures
Culverts
Stations / Cross Sections
0
20
40 FT
1 INCH = 20 FEET


Roughness elements, including stumps, boulders, stones and fascines to be randomly placed throughout the proposed stream valley
Shrubs and trees to be planted at a density of 400 stems/acre (≈ 10-11' o.c.). Species composition to be dominated by wetland plants in the stream valley and wetland pool areas and by upland plants beyond
Wetland pool. Proposed planting to be dominated by herbaceous cover
Proposed slopes not to exceed 3V:1H
log check dams to be installed every 30' down the valley
Fill to be added in 12" lifts with compaction in between in the wetland pool berms and in the stream valley when total fill depth exceeds 12"
Soft, mucky and water logged soils to be removed and laid out on site to partially drain. These soils are to be reused to the extent possible to create a 4" thick minimum organic rich top soil layer at the proposed finish grade

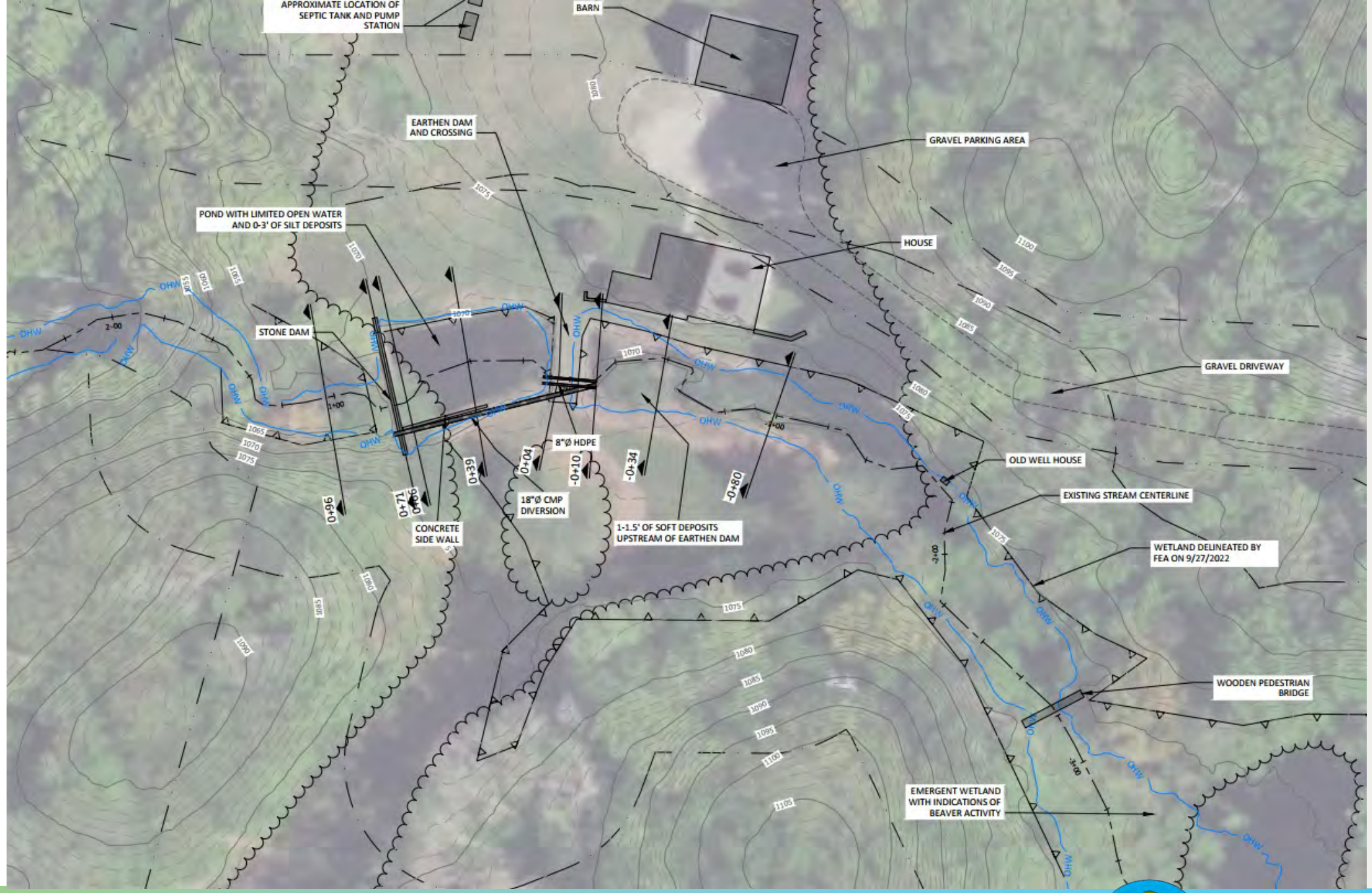

Sta 00+00
Sta 00+49
Sta 01+98
Sta 01+89
Sta 02+65
Sta 03+15
234
228
222
216
210
204
Elevation (ft)
NAVD88
-120
-60
0
60
120
180
240
300
360
420
480
Distance (ft)
Farm road crossing
Existing 24" Ø culvert to be replaced with 20ft long 60" Ø culvert (See detail sheet 5)
Existing channel slope upstream ≈ 1.89%
Surface of sediment deposits surveyed in April 2021
Water elevation observed on 4/8/2021 = 222.47'
Sediment deposits to be removed and reused in restoration
Dam and barrel pipe to be removed. Cut material to be reused in stream and wetland restoration
Existing thalweg surveyed in April 2021 and Feb 2022
Proposed elevation = 221.5'
3.1% proposed grade
Proposed log check dams every 30 ft down valley with max 6" drop from top of log to downstream grade
Riser is buried in sediments. Exact location unclear. Slope and location of barrel within dam unclear as well
18" Ø CMP barrel in very poor condition invert outlet ≈ 213.8'
Proposed elevation = 220.0'
Surface of soft and mucky sediments surveyed in April 2021
Proposed elevation = 217.1'
Hard bottom surveyed in April 2021
Existing channel slope downstream ≈ 1.65%
Proposed elevation = 214.7'
Proposed elevation = 213.2'
Existing thalweg surveyed in April 2021
Existing grade
Proposed grade

Simpson Dam
Dorset, VT

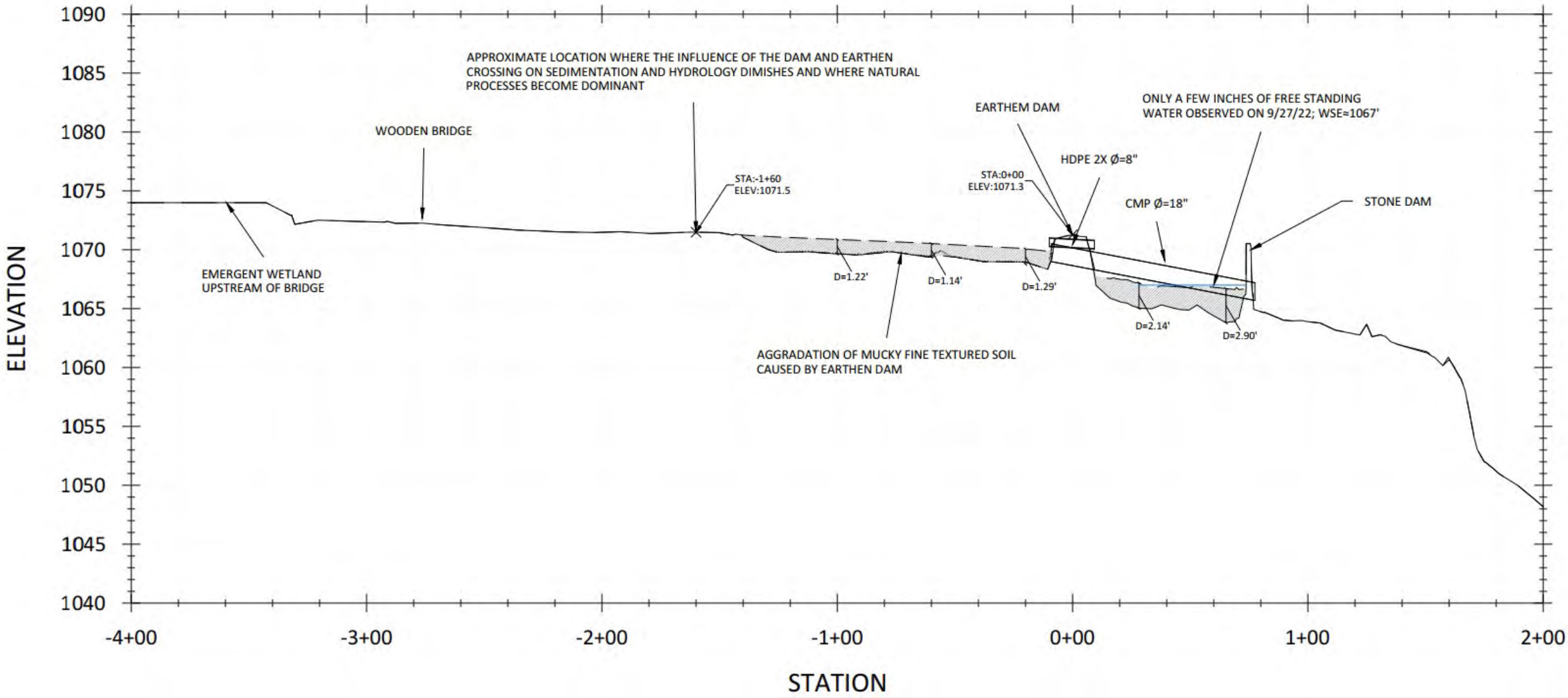
Valerie & Jeff Simpson

Design - 2022-23

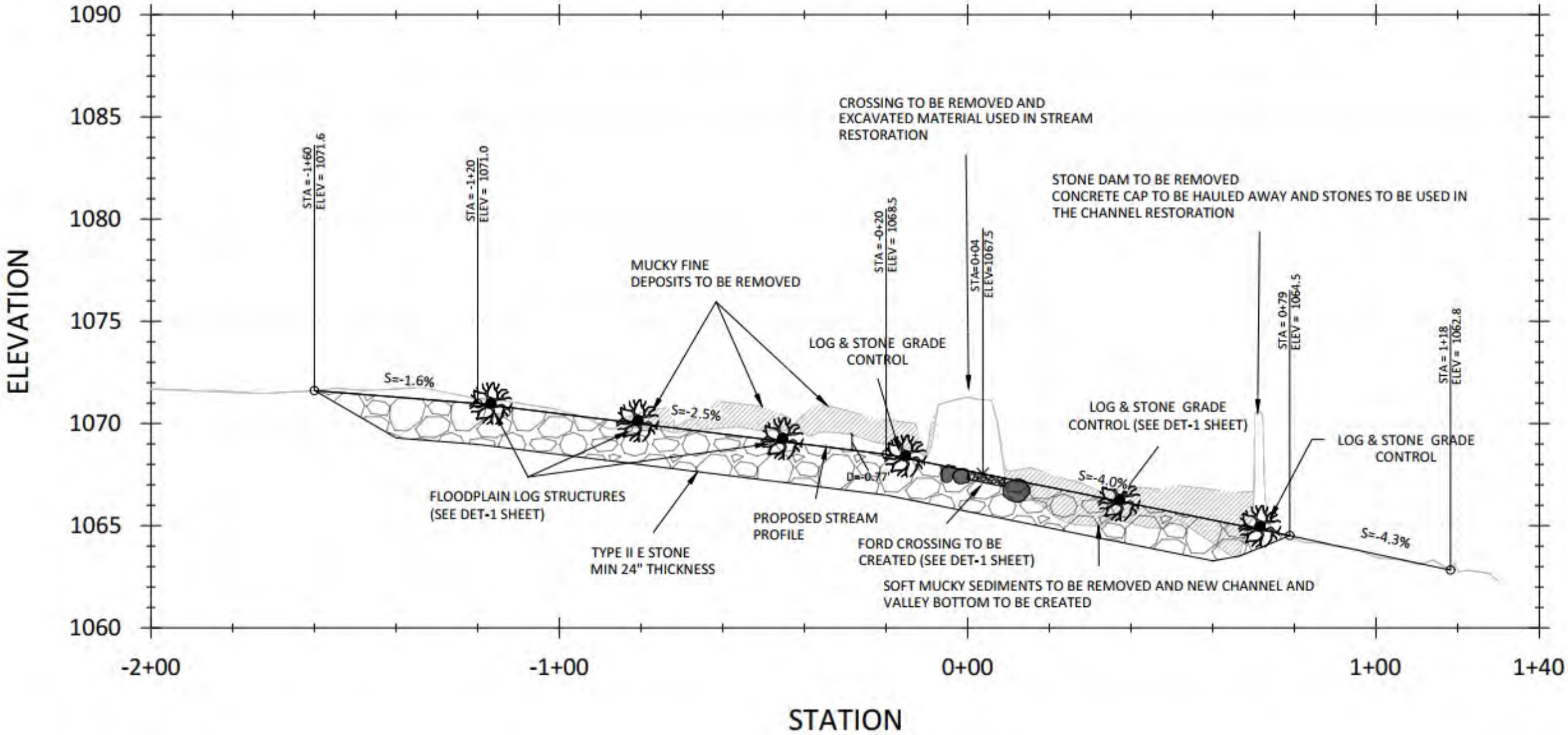
Removal - 2024

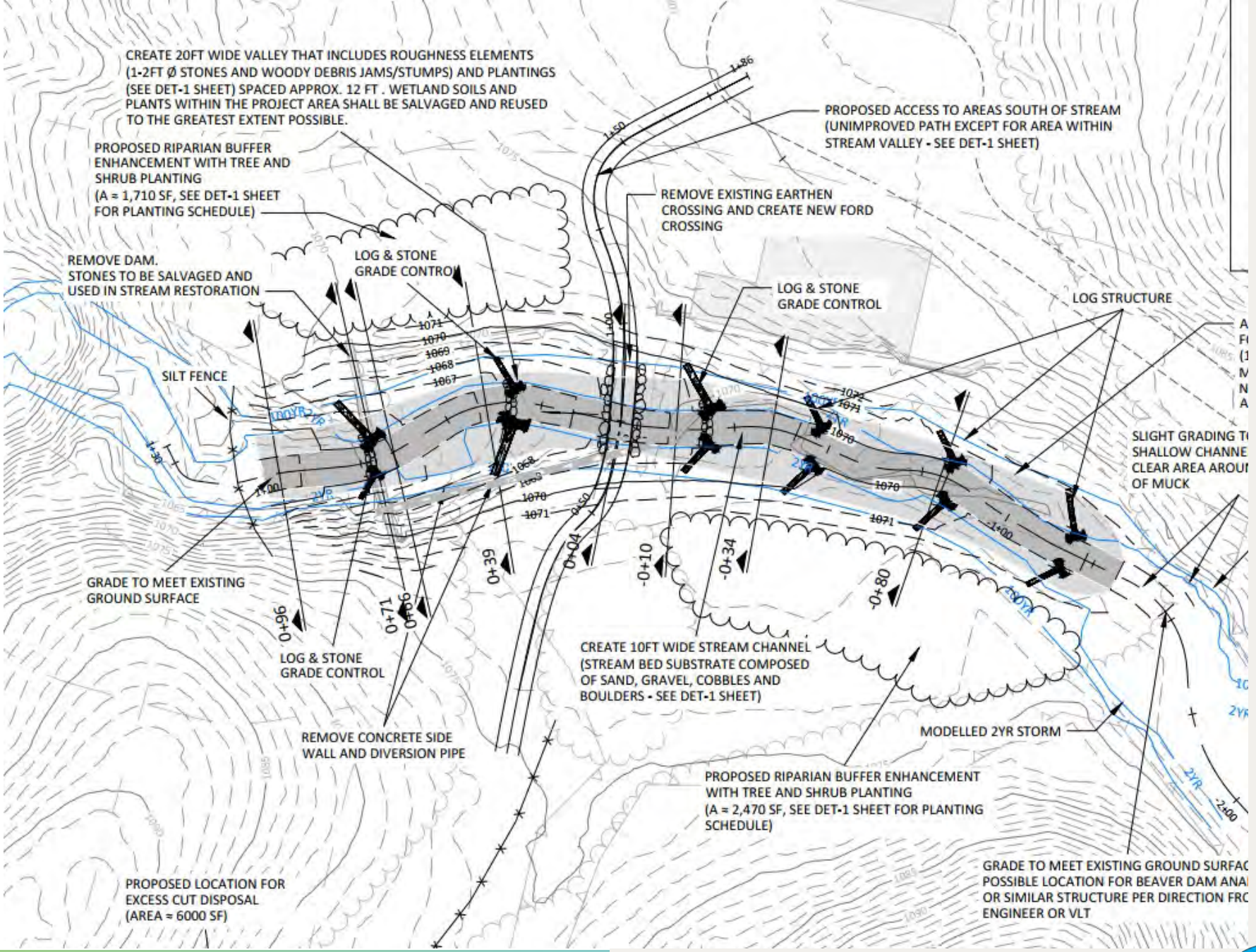


EXISTING STREAM PROFILE

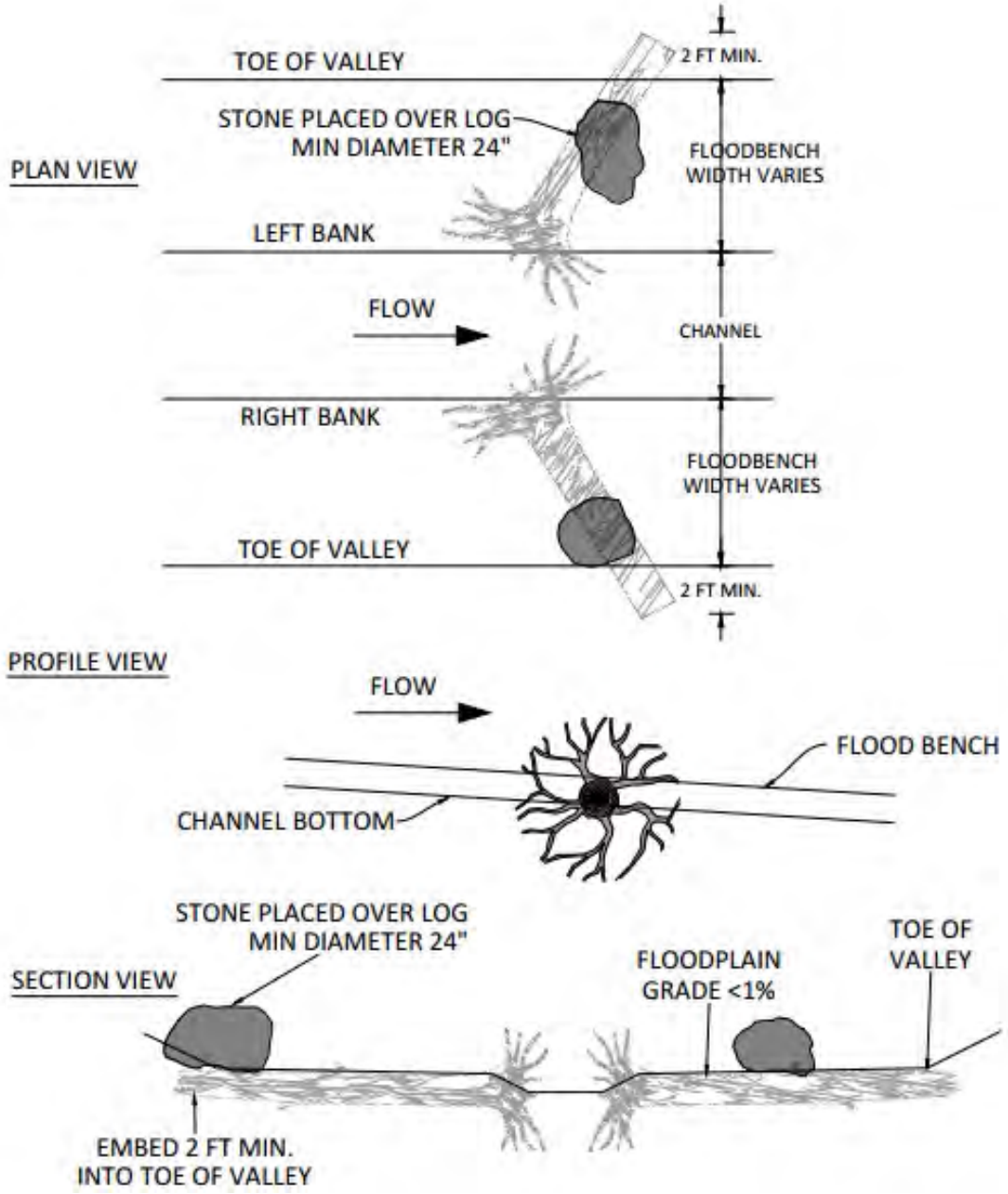


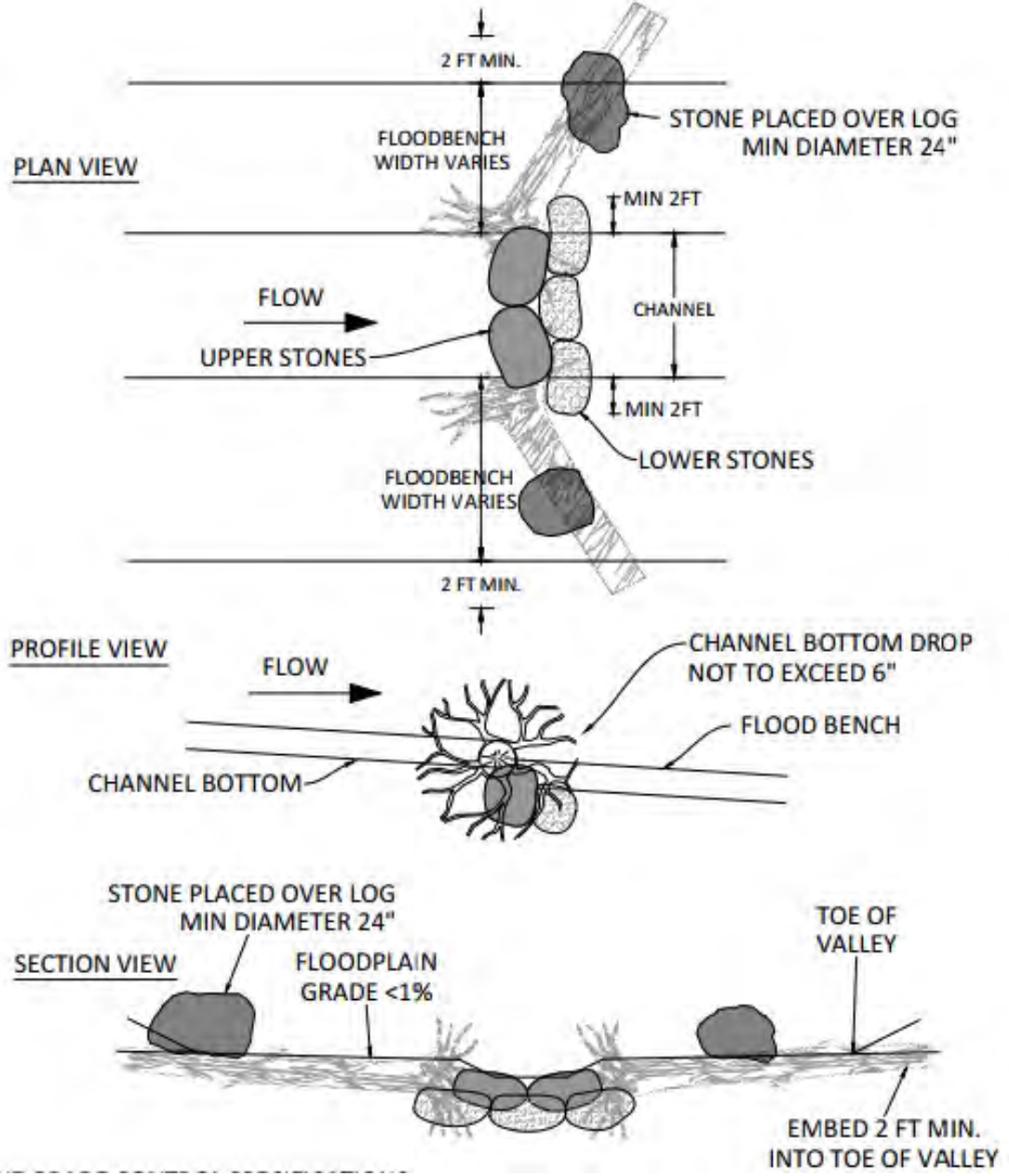
PROPOSED STREAM PROFILE

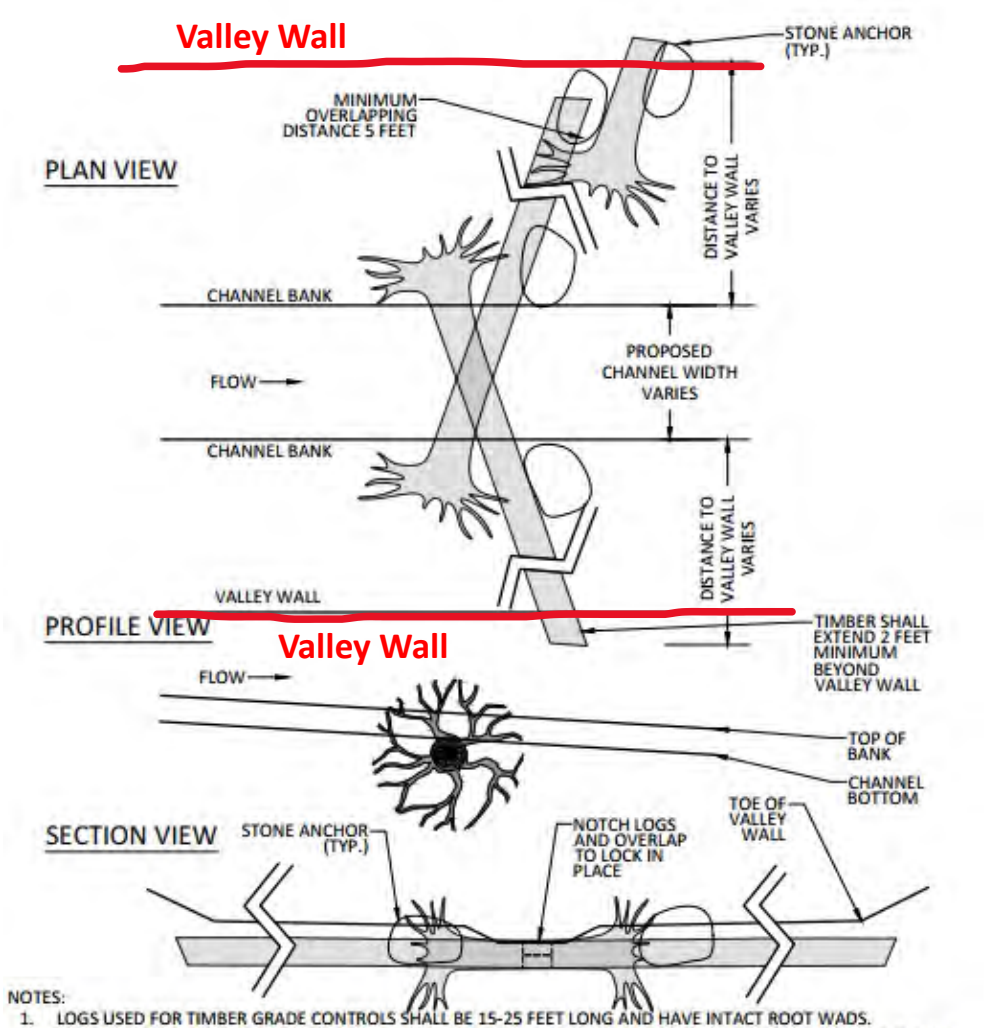



CREATE 20FT WIDE VALLEY THAT INCLUDES ROUGHNESS ELEMENTS (1-2FT Ø STONES AND WOODY DEBRIS JAMS/STUMPS) AND PLANTINGS (SEE DET-1 SHEET) SPACED APPROX. 12 FT . WETLAND SOILS AND PLANTS WITHIN THE PROJECT AREA SHALL BE SALVAGED AND REUSED TO THE GREATEST EXTENT POSSIBLE.
PROPOSED ACCESS TO AREAS SOUTH OF STREAM (UNIMPROVED PATH EXCEPT FOR AREA WITHIN STREAM VALLEY - SEE DET-1 SHEET)
PROPOSED RIPARIAN BUFFER ENHANCEMENT WITH TREE AND SHRUB PLANTING (A = 1,710 SF, SEE DET-1 SHEET FOR PLANTING SCHEDULE)
REMOVE EXISTING EARTHEN CROSSING AND CREATE NEW FORD CROSSING
REMOVE DAM. STONES TO BE SALVAGED AND USED IN STREAM RESTORATION
LOG & STONE GRADE CONTROL
LOG & STONE GRADE CONTROL
LOG STRUCTURE
SILT FENCE
SLIGHT GRADING T SHALLOW CHANNE CLEAR AREA AROU OF MUCK
GRADE TO MEET EXISTING GROUND SURFACE
LOG & STONE GRADE CONTROL
CREATE 10FT WIDE STREAM CHANNEL (STREAM BED SUBSTRATE COMPOSED OF SAND, GRAVEL, COBBLES AND BOULDERS - SEE DET-1 SHEET)
REMOVE CONCRETE SIDE WALL AND DIVERSION PIPE
MODELLED 2YR STORM
PROPOSED RIPARIAN BUFFER ENHANCEMENT WITH TREE AND SHRUB PLANTING (A = 2,470 SF, SEE DET-1 SHEET FOR PLANTING SCHEDULE)
PROPOSED LOCATION FOR EXCESS CUT DISPOSAL (AREA = 6000 SF)
GRADE TO MEET EXISTING GROUND SURFAC POSSIBLE LOCATION FOR BEAVER DAM ANA OR SIMILAR STRUCTURE PER DIRECTION FRO ENGINEER OR VLT
0+96
0+71
0+39
0+04
-0+10
-0+34
0+80
1+00
1+50
2+00
100YR
2YR

Instream Structure & Roughness


PLAN VIEW
TOE OF VALLEY
2 FT MIN.
STONE PLACED OVER LOG
MIN DIAMETER 24"
FLOODBENCH
WIDTH VARIES
LEFT BANK
FLOW
CHANNEL
RIGHT BANK
FLOODBENCH
WIDTH VARIES
TOE OF VALLEY
2 FT MIN.
PROFILE VIEW
FLOW
FLOOD BENCH
CHANNEL BOTTOM
SECTION VIEW
STONE PLACED OVER LOG
MIN DIAMETER 24"
FLOODPLAIN
GRADE <1%
TOE OF
VALLEY
EMBED 2 FT MIN.
INTO TOE OF VALLEY


PLAN VIEW
2 FT MIN.
STONE PLACED OVER LOG
MIN DIAMETER 24"
FLOODBENCH
WIDTH VARIES
MIN 2FT
FLOW
CHANNEL
UPPER STONES
MIN 2FT
LOWER STONES
FLOODBENCH
WIDTH VARIES
2 FT MIN.
PROFILE VIEW
FLOW
CHANNEL BOTTOM DROP
NOT TO EXCEED 6"
FLOOD BENCH
CHANNEL BOTTOM
SECTION VIEW
STONE PLACED OVER LOG
MIN DIAMETER 24"
FLOODPLAIN
GRADE <1%
TOE OF
VALLEY
EMBED 2 FT MIN.
INTO TOE OF VALLEY



NOTES:

1. LOGS USED FOR TIMBER GRADE CONTROLS SHALL BE 15-25 FEET LONG AND HAVE INTACT ROOT WADS.
2. TIMBER GRADE CONTROLS TO EXTEND A MINIMUM OF 2 FEET BEYOND THE TOE OF THE VALLEY. USE ADDITIONAL OVERLAPPING LOGS AS NEEDED.
3. LOGS SHALL BE NOTCHED TOGETHER BELOW THE CHANNEL
4. TOP OF LOGS SHALL BE NO MORE THAN 2" ABOVE PROPOSED STREAM BOTTOM. LOGS SHALL BE BURIED IN FLOODPLAIN A MINIMUM OF 6", AND MAINTAIN A CONSTANT ELEVATION ACROSS VALLEY (SEE SHEET PRO-1)
5. STONES SHALL BE USED TO ANCHOR THE TIMBER GRADE CONTROL STRUCTURES. STONE SHALL BE A MINIMUM DIAMETER OF 24 INCHES AND LENGTH OF 36 INCHES. STONE SHALL BE BURIED BELOW THE FLOODPLAIN ELEVATION 2/3 OF THE STONE HEIGHT AND SHALL BEAR WEIGHT ON THE DOWNSTREAM SIDE OF THE LOG TO FURTHER SUPPORT AGAINST EROSIVE FORCES.
6. CARE SHALL BE TAKEN TO FULLY BACKFILL AND COMPACT SOIL AROUND LOGS AND STONES TO AVOID EROSION.

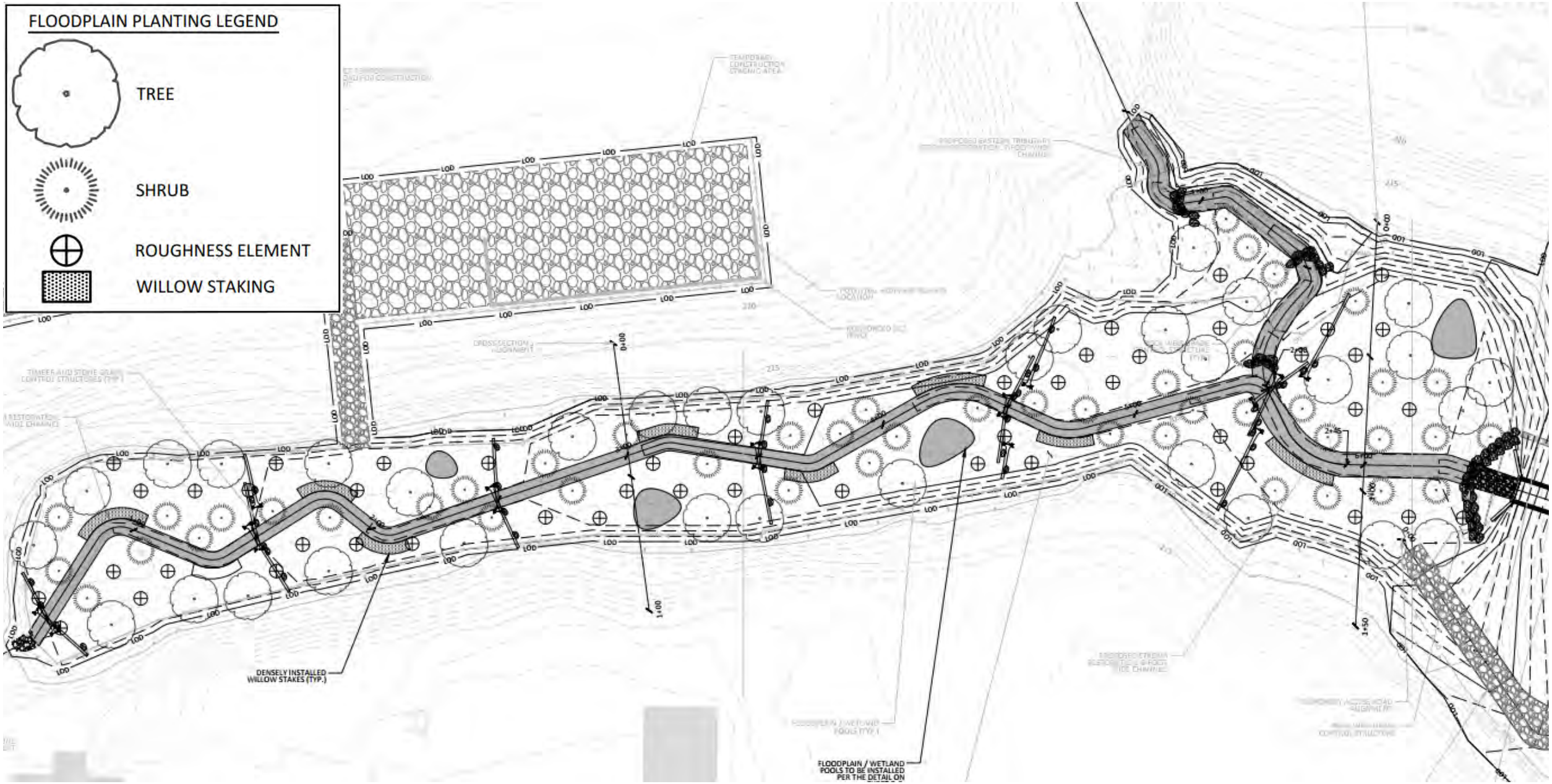
TIMBER GRADE CONTROL

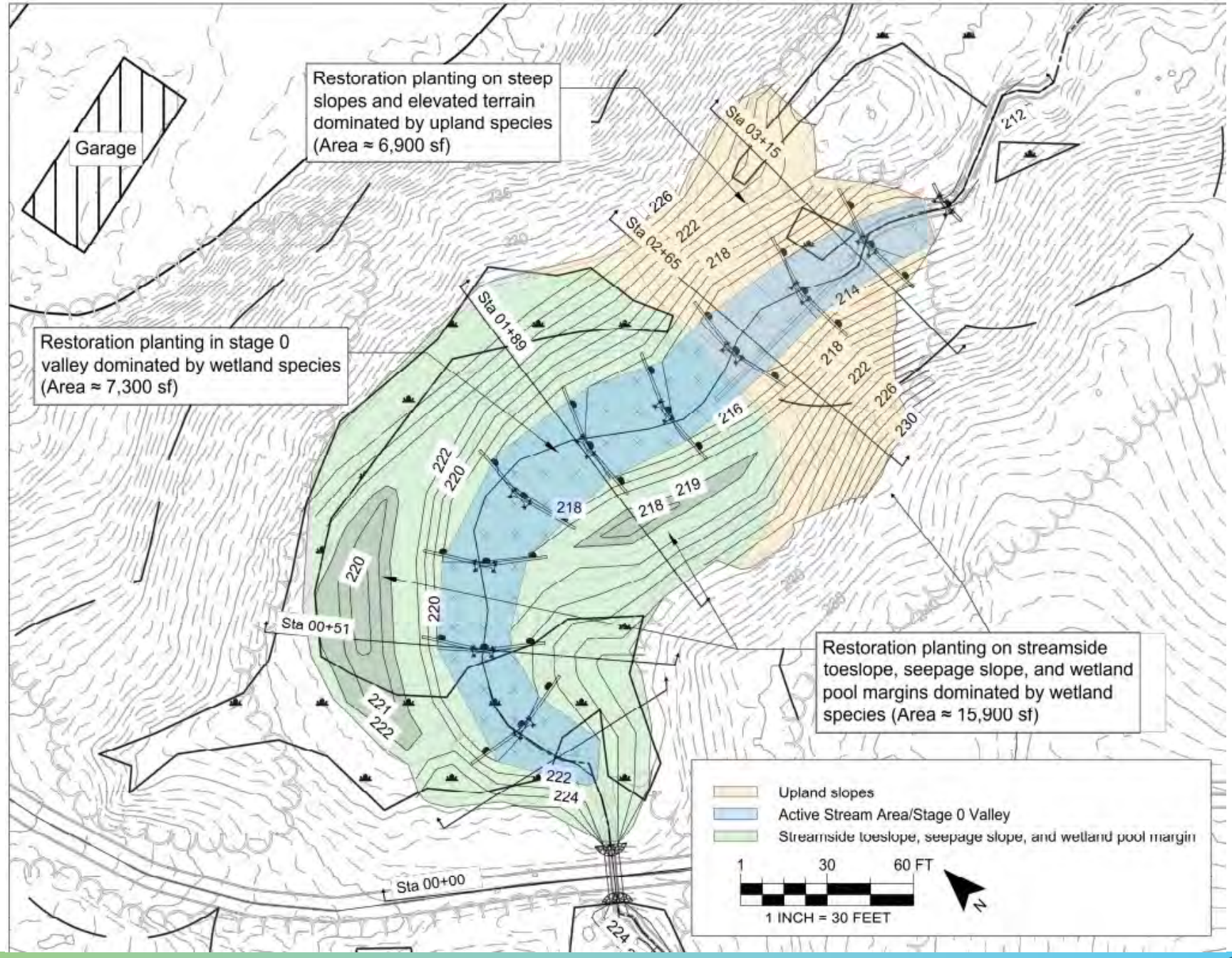
N.T.S


DEERE

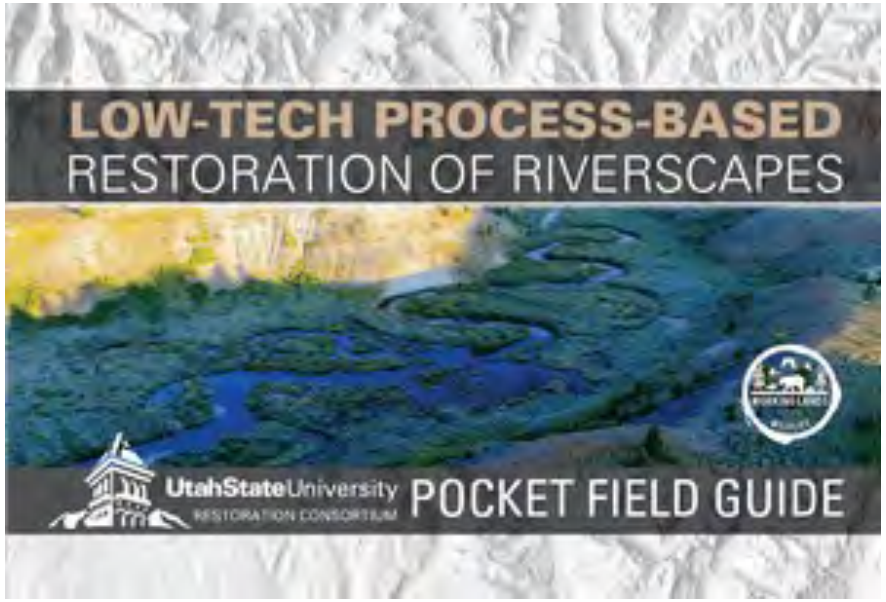

DEERE
135G


DEERE


FLOODPLAIN PLANTING LEGEND
TREE
SHRUB
ROUGHNESS ELEMENT
WILLOW STAKING
DENSELY INSTALLED WILLOW STAKES (TYP.)
FLOODPLAIN / WETLAND POOLS TO BE INSTALLED PER THE DETAIL ON


Garage
Restoration planting on steep slopes and elevated terrain dominated by upland species (Area ≈ 6,900 sf)
Restoration planting in stage 0 valley dominated by wetland species (Area ≈ 7,300 sf)
Restoration planting on streamside toeslope, seepage slope, and wetland pool margins dominated by wetland species (Area ≈ 15,900 sf)
Sta 03+15
Sta 02+65
Sta 01+89
Sta 00+51
Sta 00+00
212
214
216
218
219
220
221
222
224
226
230
Upland slopes
Active Stream Area/Stage 0 Valley
Streamside toeslope, seepage slope, and wetland pool margin
1
30
60 FT
1 INCH = 30 FEET
N


VOLVO
VOLVO



Skidmore and Wheaton 2022

Plants


Seeding – Wetland Mix
and Conservation Mix


Ben Legler


DEERE

Button – One Year Later


Simpson – Two Months Later