Elbow and School Section Coulees Ecosystem Restoration

Design, Construction and Monitoring

Montana AWRA Conference

October 11th, 2023

Presented By:
Robert Sain
Tanner Tompkins

Outline

- Project Location
- Ecosystem Restoration objectives
- Design Approach
- Permitting
- Construction
- Monitoring

Broken O Land and Livestock

Broken O Coulees, north-side, tributaries to Sun River lengths and objectives

	Length (miles)	Length within Broken O	Management Objectives	Comments
Elbow Coulee	11.6	8	Preserve, Enhance, Restore, Reconnect	fish passage barriers removed, irrigation water removed, Ag infrastucture conflicts reduced with 1,080 acres out of grazing rotation; possible regenerative style grazing in the future
COMPLETED IN 2021, tributary to School Section				
School Section Coulee	15	7	Preserve, Enhance, Restore, Reconnect	Irrigation Dam Removed, 2 miles completed, 400 acres to be removed from grazing rotation.
ON-GOING				
Big Coulee	21	18	Preserve, Enhance, Restore, Reconnect	To be determined
Duck Coulee	8.2	8.2	Preserve, Enhance, Restore	To be determined
Sun River	130	26	Preserve, Enhance, Restore as needed	To be determined

~20% of the Sun River—tail-water

Altered Watershed Hydrology

STREAMS (COULEE'S) BISECTED AND AUGMENTED BY CANALS

SUB-SURFACE IRRIGATION RETURN FLOW

DIRECT IRRIGATION WASTEWATER

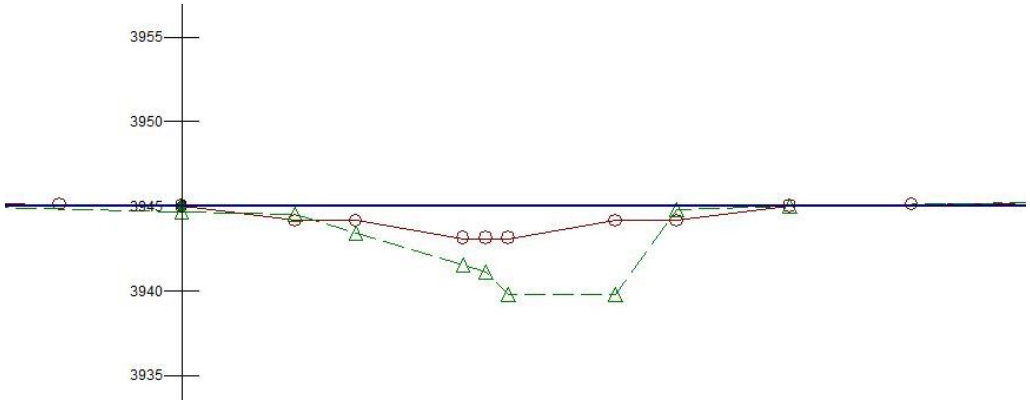
AGRICULTURE INFRASTRUCTURE ENCROACHMENT

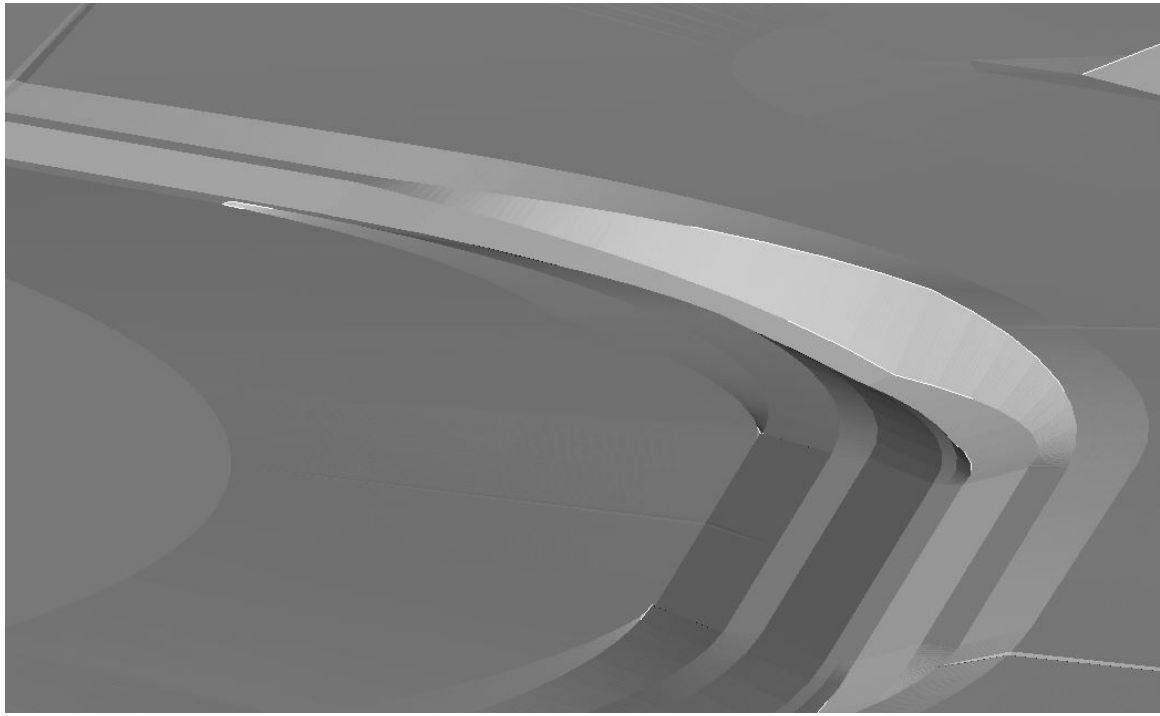
Pre-existing Conditions

Ecosystem Restoration Objectives

- Removing as many watershed stressors as possible
- Disconnecting canal water from streams
- Re-aligning channels under or around Ag infrastructure
- Enhancing degraded streambanks
- Enhancement in stream fish habitat and spawning riffles
- Implementing cattle exclusion fencing and protecting riparian areas
- Improving real estate aesthetics and fishing

Design Approach





Initial Assessment Streamflow

LOW FLOW ~ 6 CFS
BANKFUL FLOW ~ 23 CFS

Design Riffle Cross-Sections hydraulics check
Mannings vs R/D84

ELEV	DEPTH	AREA	WET PER	WIDTH	HYD RAD	MEAN D	SLOPE	ROUGH	R/D84	VELOCITY	U/U*	U^2/2g	DISCHARGE	SHEAR	POWER	POWER/W	FROUDE	TRANSPORT
(ft)	(ft)	(sq ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	[n] (ft^(1/6))		(fps)		(ft)	(cfs)	(psf)	(lb/s)	(lb/ft/s)		(lb/s)
3965.25	0.1	0.67	6.91	6.86	0.1	0.1	0.012	0.045	0.4	0.78	3.97	0.01	0.52	0.07	0.39	0.06	0.43	0
3965.35	0.2	1.37	7.33	7.22	0.19	0.19	0.012	0.045	0.76	1.2	4.41	0.02	1.64	0.14	1.23	0.17	0.48	0
3965.45	0.3	2.11	7.74	7.58	0.27	0.28	0.012	0.045	1.08	1.51	4.68	0.04	3.19	0.2	2.39	0.32	0.5	0
3965.55	0.4	2.89	8.15	7.95	0.35	0.36	0.012	0.045	1.4	1.8	4.89	0.05	5.19	0.26	3.89	0.49	0.53	0
3965.65	0.5	3.7	8.57	8.31	0.43	0.45	0.012	0.045	1.72	2.06	5.06	0.07	7.63	0.32	5.71	0.69	0.54	0
3965.75	0.6	4.55	8.98	8.67	0.51	0.52	0.012	0.045	2.04	2.31	5.2	0.08	10.51	0.38	7.87	0.91	0.56	0
3965.85	0.7	5.44	9.39	9.03	0.58	0.6	0.012	0.045	2.32	2.52	5.32	0.1	13.69	0.43	10.25	1.14	0.57	0.41
3965.95	0.8	6.36	9.8	9.39	0.65	0.68	0.012	0.045	2.6	2.72	5.42	0.11	17.27	0.49	12.93	1.38	0.58	0
3966.05	0.9	7.31	10.22	9.75	0.72	0.75	0.012	0.045	2.88	2.91	5.51	0.13	21.25	0.54	15.91	1.63	0.59	0
3966.15	1	8.31	10.63	10.11	0.78	0.82	0.012	0.045	3.12	3.07	5.59	0.15	25.48	0.58	19.08	1.89	0.6	0
3966.25	1.1	9.34	11.04	10.48	0.85	0.89	0.012	0.045	3.4	3.25	5.67	0.16	30.33	0.64	22.71	2.17	0.61	0
3966.35	1.2	10.4	11.46	10.84	0.91	0.96	0.012	0.045	3.64	3.4	5.73	0.18	35.34	0.68	26.46	2.44	0.61	2.77

ELEV	DEPTH	AREA	WET PER	WIDTH	HYD RAD	MEAN D	SLOPE	ROUGH	R/D84	VELOCITY	U/U*	U^2/2g	DISCHARGE	SHEAR	POWER	POWER/W	FROUDE	TRANSPORT
(ft)	(ft)	(sq ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	[U/U*]		(fps)		(ft)	(cfs)	(psf)	(lb/s)	(lb/ft/s)		(lb/s)
3965.25	0.1	0.67	6.91	6.86	0.1	0.1	0.012	0	0.4	0.11	0.58	0	0.08	0.07	0.06	0.01	0.06	0
3965.35	0.2	1.37	7.33	7.22	0.19	0.19	0.012	0	0.76	0.58	2.16	0.01	0.8	0.14	0.6	0.08	0.24	0
3965.45	0.3	2.11	7.74	7.58	0.27	0.28	0.012	0	1.08	0.98	3.02	0.01	2.06	0.2	1.54	0.2	0.32	0
3965.55	0.4	2.89	8.15	7.95	0.35	0.36	0.012	0	1.4	1.34	3.66	0.03	3.89	0.26	2.91	0.37	0.39	0
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3965.85	0.7	5.44	9.39	9.03	0.58	0.6	0.012	0	2.32	2.32	4.9	0.08	12.62	0.43	9.45	1.05	0.53	0.41
3965.95	0.8	6.36	9.8	9.39	0.65	0.68	0.012	0	2.6	2.6	5.18	0.1	16.51	0.49	12.36	1.32	0.55	0
3966.05	0.9	7.31	10.22	9.75	0.72	0.75	0.012	0	2.88	2.86	5.43	0.13	20.94	0.54	15.68	1.61	0.58	0
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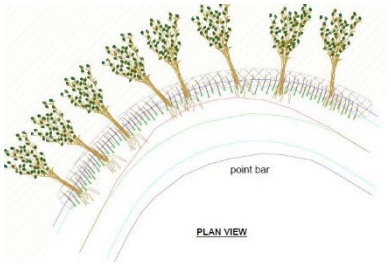
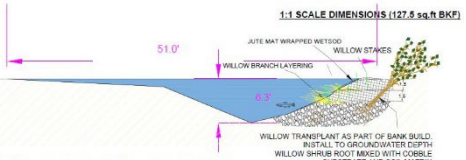
3966.25	1.1	9.34	11.04	10.48	0.85	0.89	0.012	0	3.4	3.35	5.84	0.17	31.25	0.64	23.4	2.23	0.62	0
3966.35	1.2	10.4	11.46	10.84	0.91	0.96	0.012	0	3.64	3.56	6.01	0.2	37.04	0.68	27.73	2.56	0.64	2.77

Design Riffle and Pool treatments

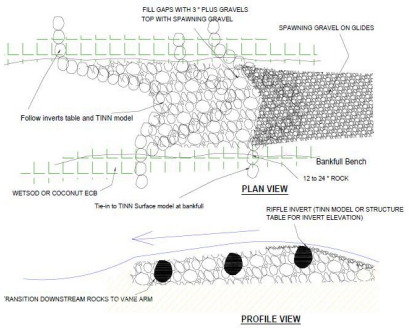


Notes:
1. Install 10 to 15' tall willow or alder trees (or large shrubs) with root mass embedded into the streambank sub-excavation area.
2. Mix gravel and cobble in and around willow root masses and for bank toe.
3. Wrap wetland sod with heavy Jute woven matting. Two sod lifts could be needed to reach bankfull bench.
4. Use stout stakes to hold matting and sod lifts in place.
5. Use 100% coconut blanket (ECB) along all disturbed areas including on point bars and along bankfull benches.
6. Willow branch layering to be placed between wrapped sod and the wood and soil matrix.
7. Seed under the top, tie-in, of soil wrap prior to stout staking.
8. Install willow stakes at 2 foot off sets below bankfull.
9. No need for a berm along the top of bank since willow vegetation should have a similar function.


Example of this treatment used along Elbow Coulee, phase 3

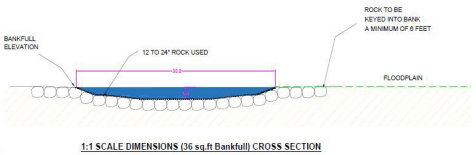


WETSOD LIFTS w/ WILLOW EYE-BROW BANK TREATMENT

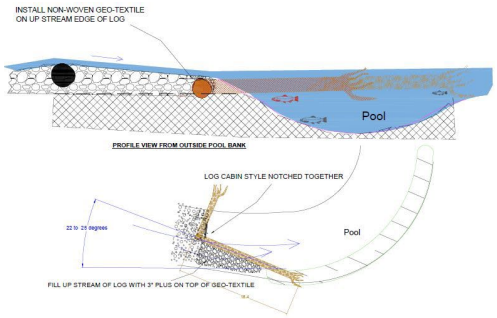


Notes:
1. Grade control riffle to consist of alternating rock vanes with 3" plus cobble and spawning gravel added within interstitial spaces.
2. Rock inverts located in the TINN model and with key thalwag and bankfull vane inverts located in the structures table.
3. Sub-excavate below riffle surface and fill with 3" plus ranch rock until point of refusal.
4. Tie vanes into bankfull at least 6' into the floodplain to prevent near term flanking, prior to vegetation establishment.
5. For streambank edges install either erosion control blanket (100% coconut) or use actual wetland sod leveled out to match TINN surface.


EXAMPLE PHOTO OF A GRADE CONTROL RIFFLE INSTALLED FOR SCHOOL SECTION, PHASE I



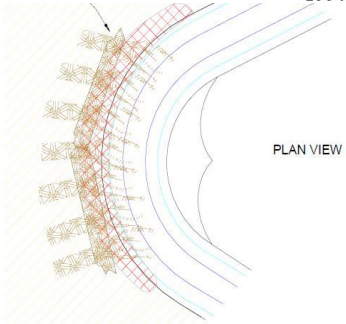
RIFFLE W/ ROCK GRADE CONTROL



LOG VANE (TYPICAL)

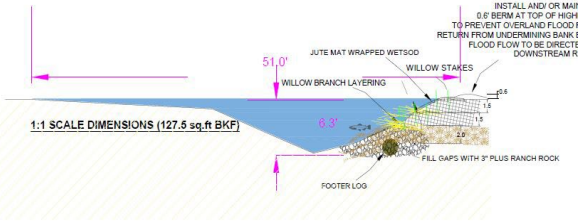

Example Log Vane used on Elbow Coulee, Phase 3

Notes:
1. Important for both the log vane arm and log elbow section to tie into bankfull and that the top of each log is buried under the bankfull bench.
2. Apex to start within the downstream portion of riffle prior to 'run'.
3. Vane arm may consist of one or two logs to make the distance. Two logs may help fill the voil and provide better fish habitat.
4. Fit log vane and elbow together at apex using cables, chain-saw notches or by over-lapping.
5. Fill space up stream and behind vane arm with a footer log and, or rock or sod prior to stapling geo-textile onto the vane arm.
6. Either use geo-textile over top of the log vane section.
7. Add 4" inch plus, ranch rock on top of geo-textile so as to create a smooth tie-into bankfull.




Example Photo of this treatment used up stream in School Section, Phase 1

Notes:
1. Important that the footer log and rootball are installed below the bottom of the deepest part of the pool (thalwag).
2. The footer log may have a rootwad or not
3. Rootwad and footer log to be locked together tight with spaces filled with 3" plus ranch rock.
4. Add some soil, prior to laying down branches/ willows
5. Branch layering to be placed under wrapped soil or wrapped sod.
6. Wrapped sod or soil requires heavy jute matt/ coir wrap
7. Seed under the top, tie-in, of soil wrap prior to stout staking.
8. Add 0.6 foot-tall, over-land, run-off berm on top of bank.
9. Install willow stakes at 2 foot off sets below bankfull.



Permitting

--Federal

404—USACE NWP 27 authorization

(self mitigating)

--State of Montana

401—DEQ Certification

318—FWP

SWPPP—DEQ—over an acre of land dist.

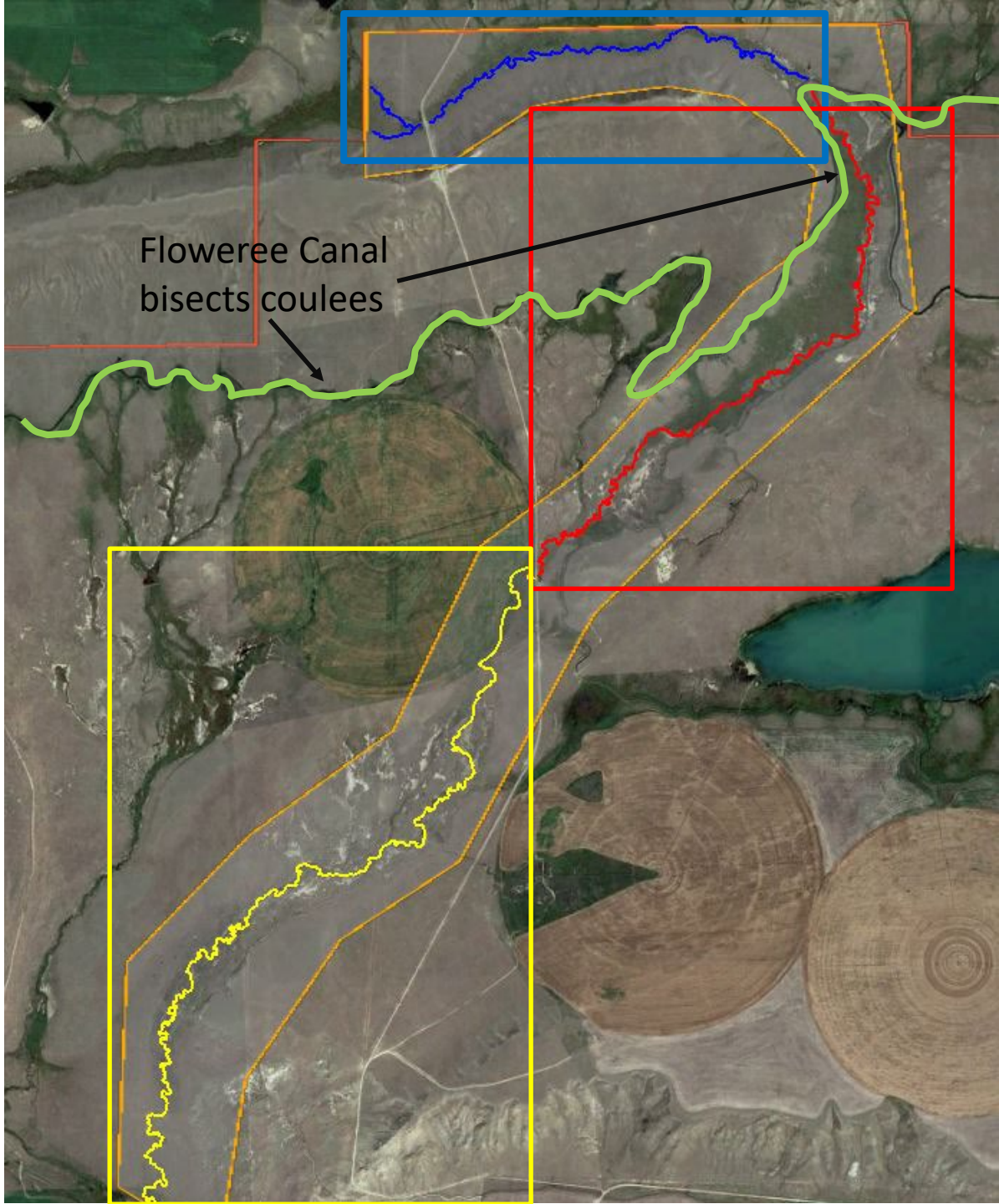
--County

310—Teton County

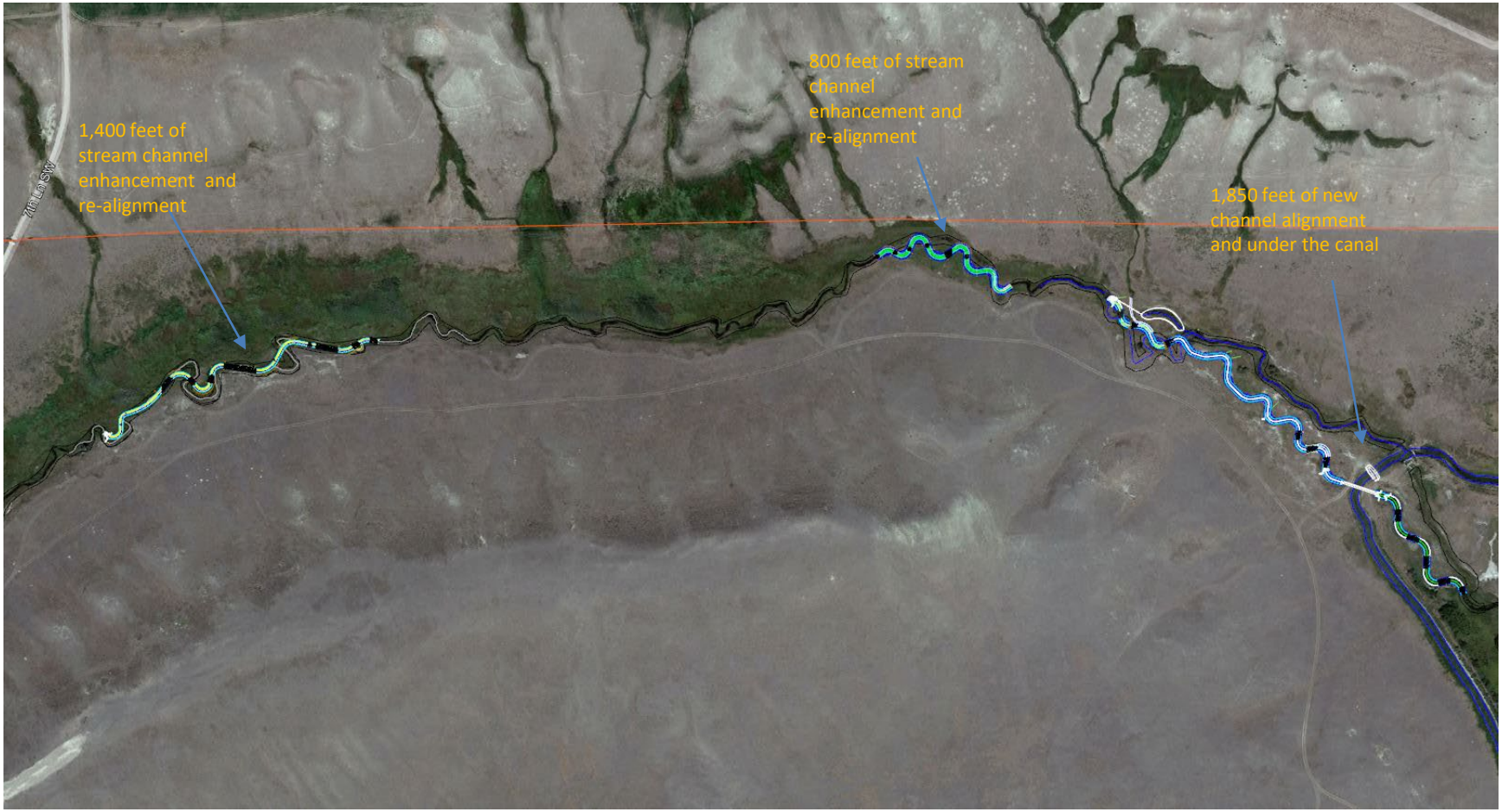
Elbow Coulee
Three Phased approach

- Restoration/ re-alignment: ~2 miles
- Stream was re-routed under a canal for fish passage
- Irrigation water re-routed of channel
- Fish passable culvert installed
- Preservation/ self-heal: ~6 miles
- 1,080 Acres excluded from grazing

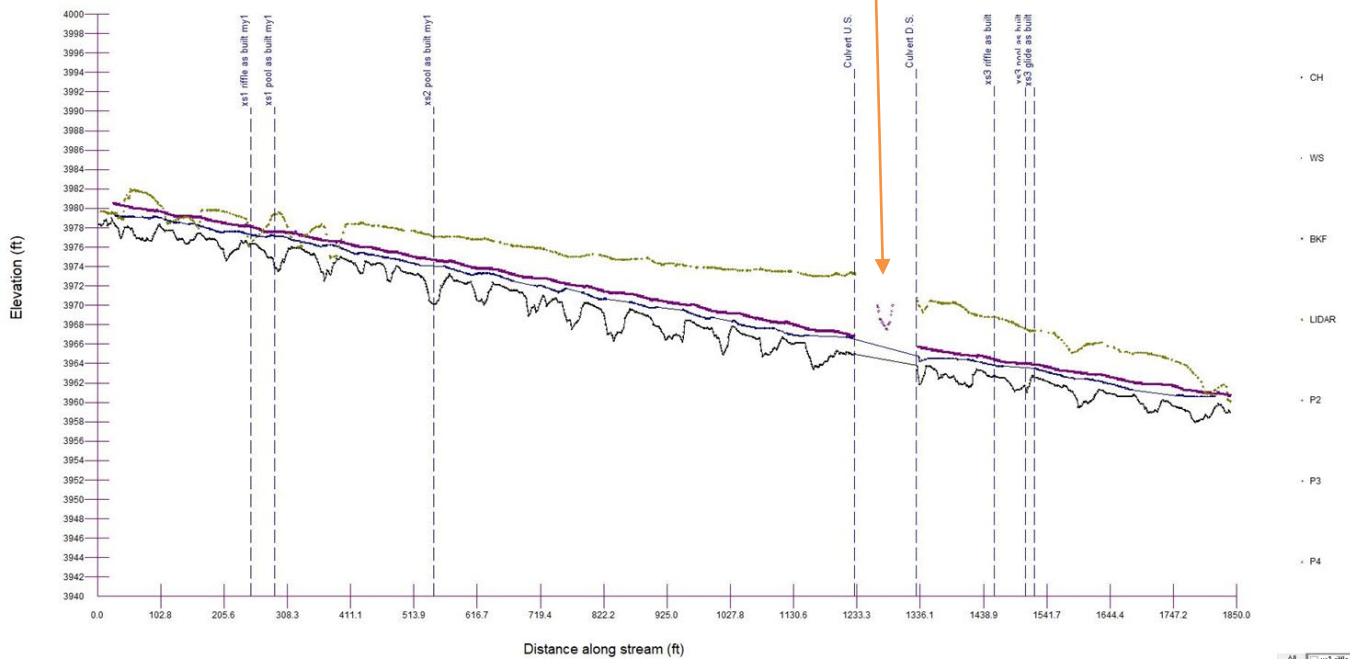
Elbow Coulee Phases		
Broken O	Length (miles)	Completed
PHASE 1	1.6	2017
PHASE 2	2.4	2019
PHASE 3	4	2020
Total (miles)	8	



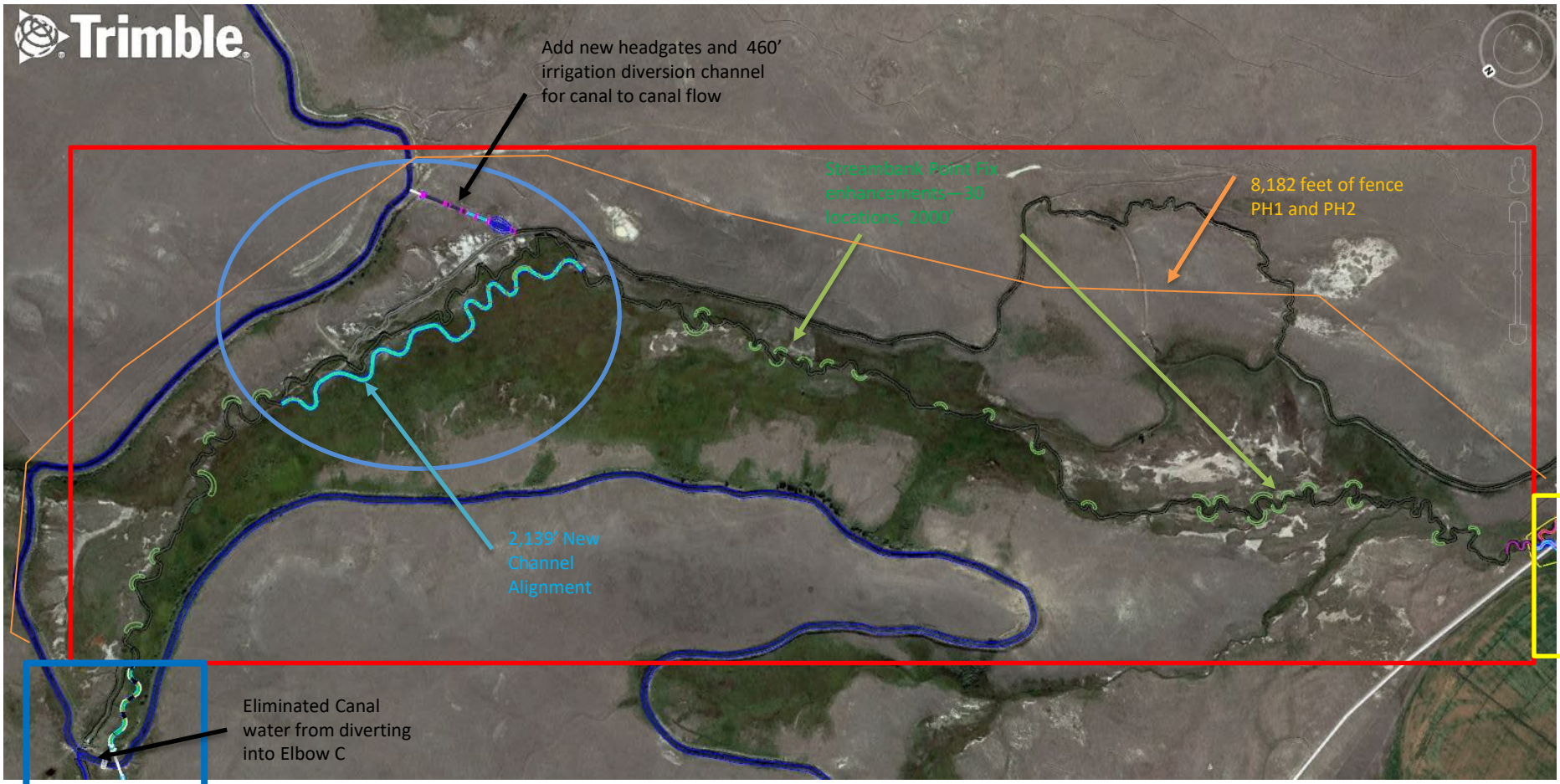
Elbow Phase I, 3 reaches



Elbow Coulee STA 61+00 As Built Longpro

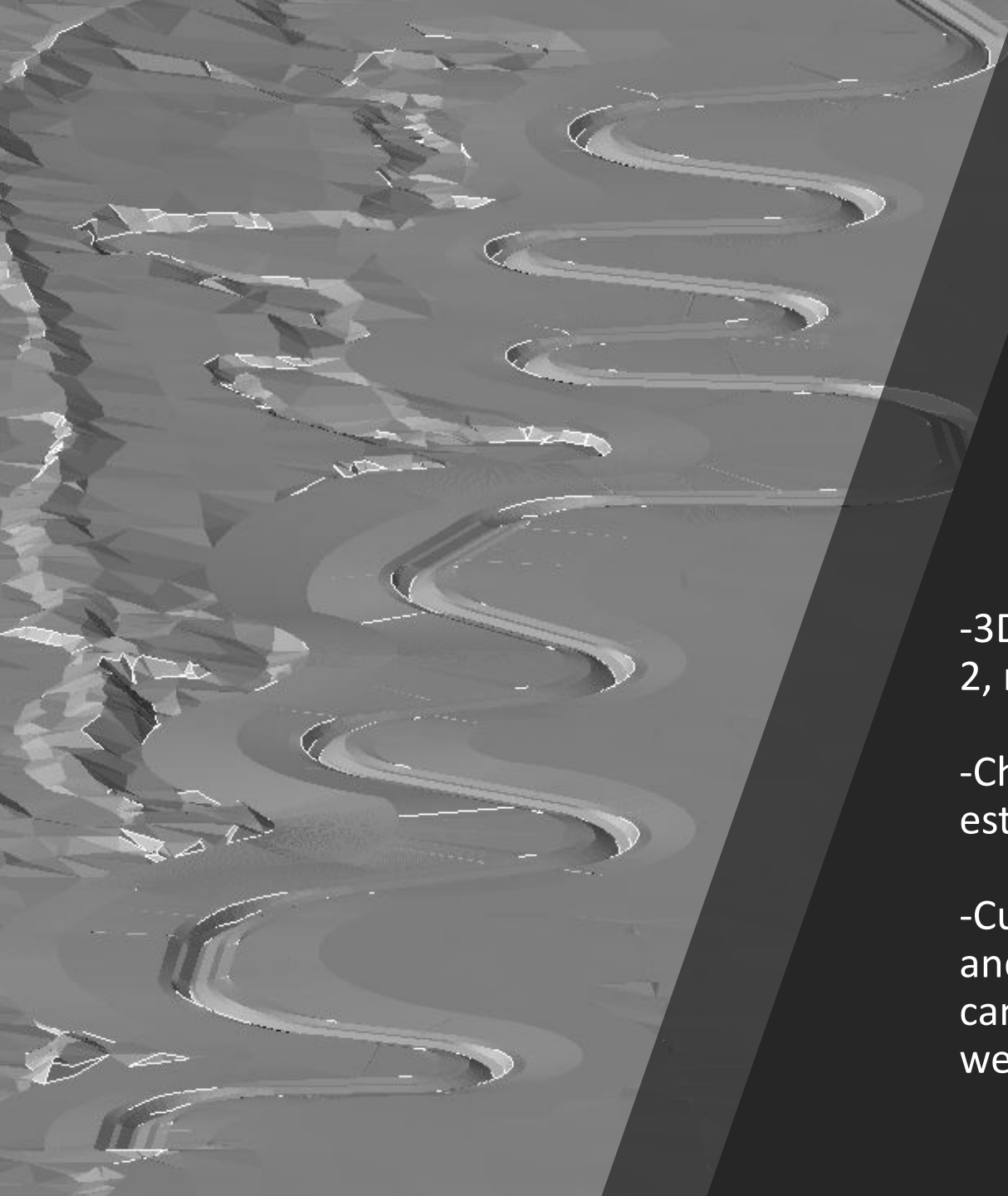


Elbow Phase 2



Pre-existing Conditions Change to phase 2

- ½ mile downstream of canal crossing
- Irrigation split backwater
- Over-widened channel
- Highly eroded streambanks
- Lacking fish habitat



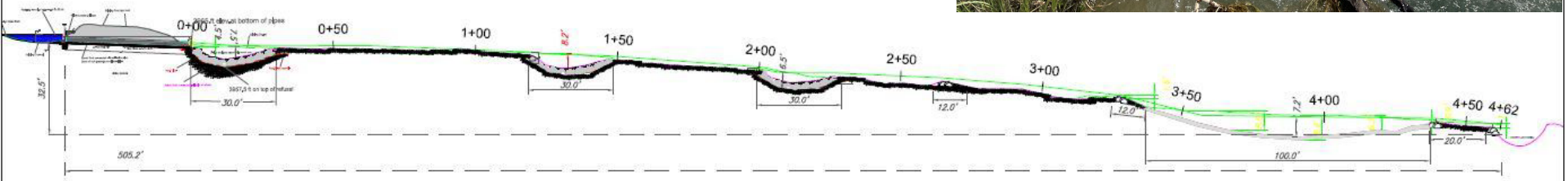
-3D VIEW TINN Elbow Phase 2, new-alignment

-Channel was cut through established wetland

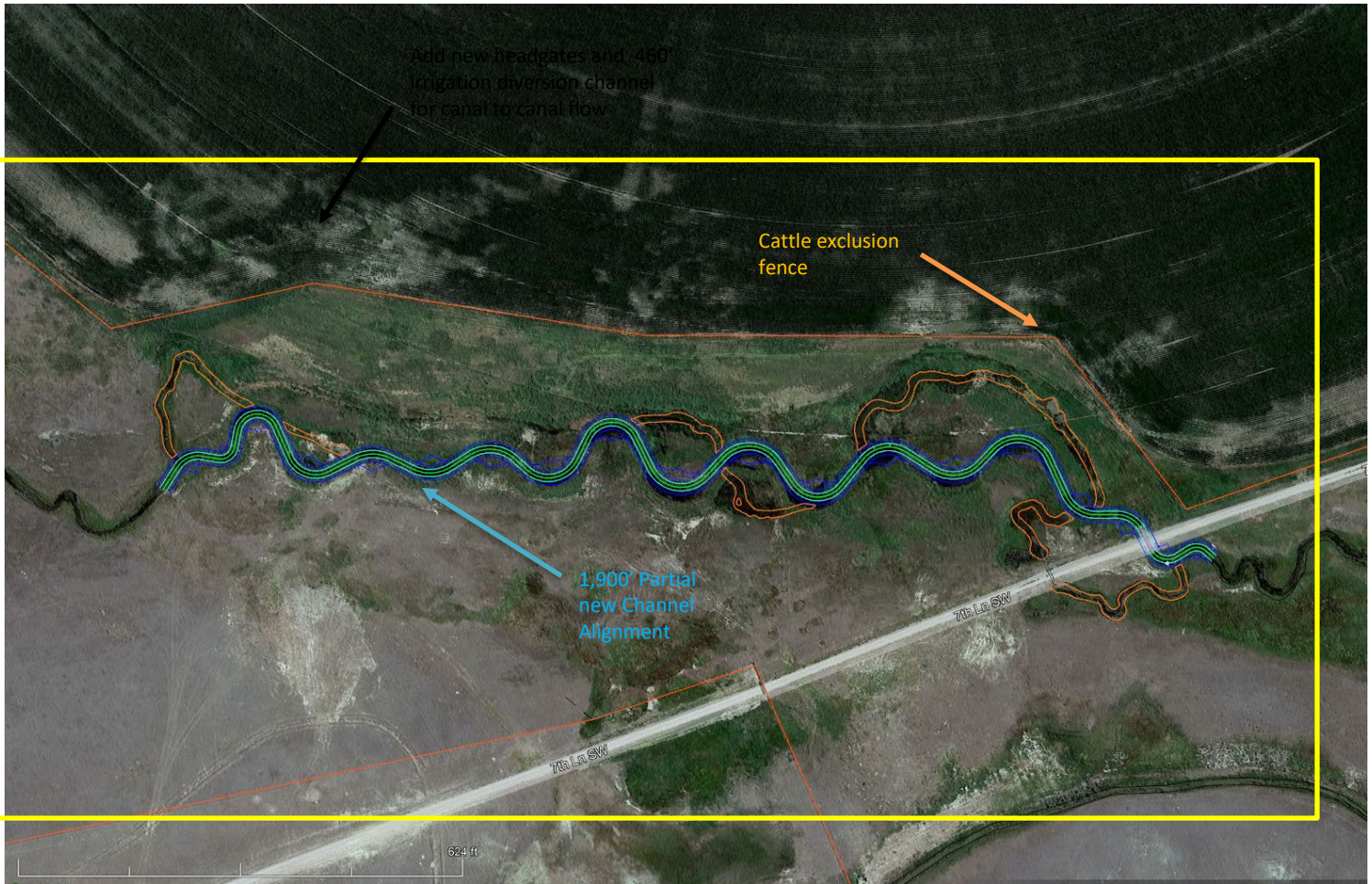
-Cut material used to plug and convert old channel and canal lateral to emergent wetlands.

2018 aerial/ 2023 photo

REMOVAL OF IRRIGATION WATER, NEW SPILLWAY

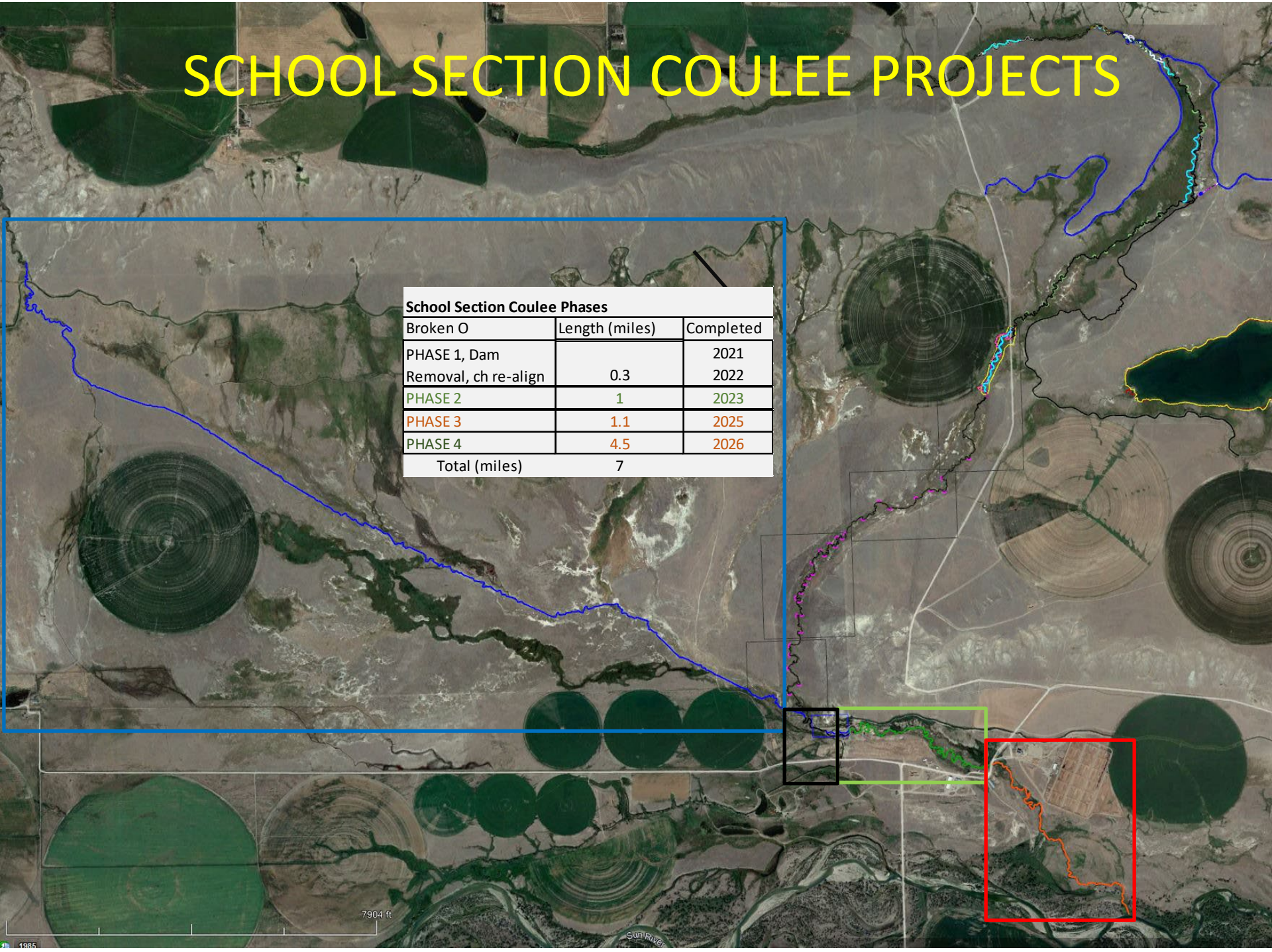


Elbow Phase 3



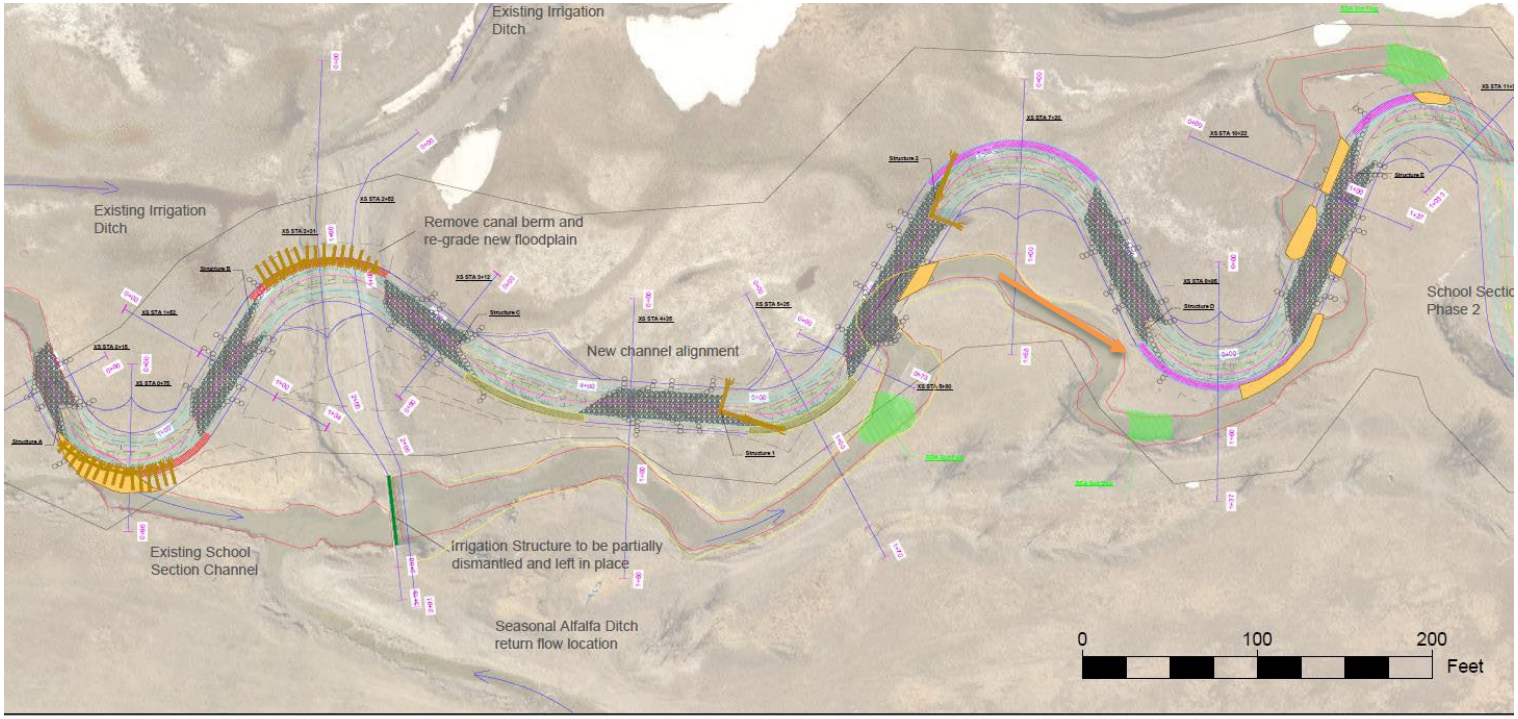

ELBOW COULEE PHASE 3
COMPLETED IN 2021

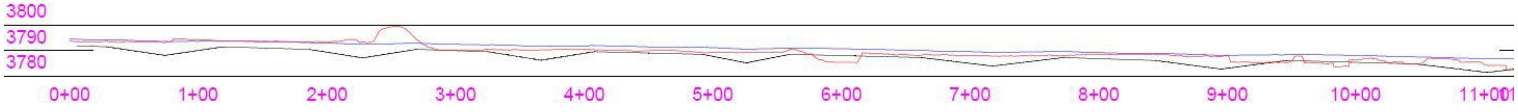
SCHOOL SECTION COULEE PROJECTS



School Section Coulee Phases		
Broken O	Length (miles)	Completed
PHASE 1, Dam Removal, ch re-align	0.3	2021 2022
PHASE 2	1	2023
PHASE 3	1.1	2025
PHASE 4	4.5	2026
Total (miles)	7	

School Section Phase 1

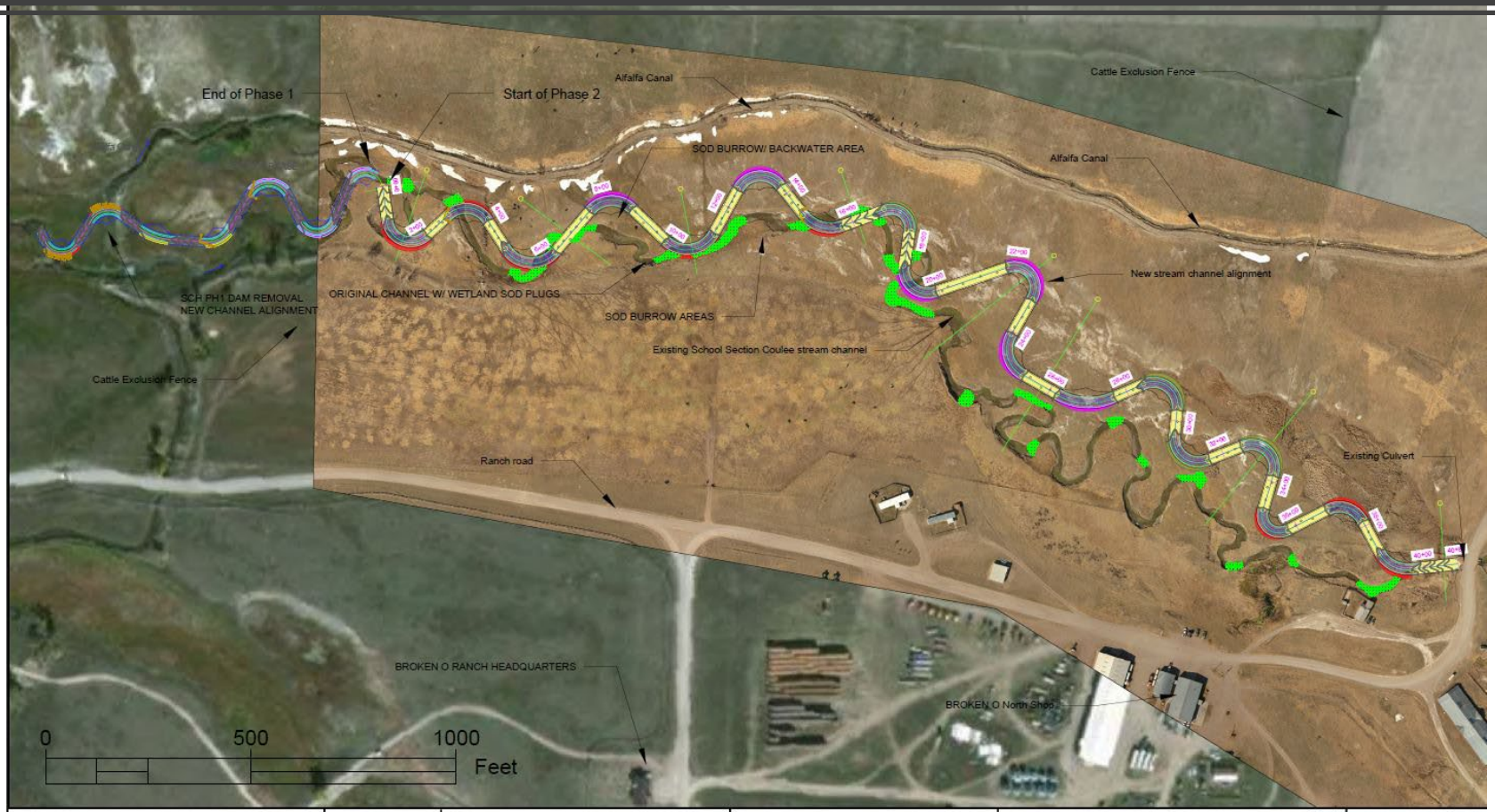




BROKEN RANCH	DESIGNED FLS DRAWN FLS CHECKED DATE 06/05/2018	PLAN AND PROFILE VIEW 2 to 1 vertical exaggerated, PROFILE VIEW	NEW CHANNEL ALIGNMENT, DAM REMOVAL; SCHOOL SECTION COULEE, PHASE 1	TETON COUNTY, MONTANA STA 0+00 through 11+00	

SCHOOL SECTION IRRIGATION DAM REMOVAL LOCATION, LOOKING DOWNSTREAM AND UPSTREAM, 2022

School Section Phase 2




SCHOOL SECTION PHASE 2
TO BE COMPLETED IN 2023

Construction and Monitoring

- GPS Enabled Excavators
- On-Site Materials
- Drone Monitoring
- Fisheries Monitoring


KOBELCO


2015
Elbow Coulee Phase 1 NAIP
2021
0
375
750
Feet

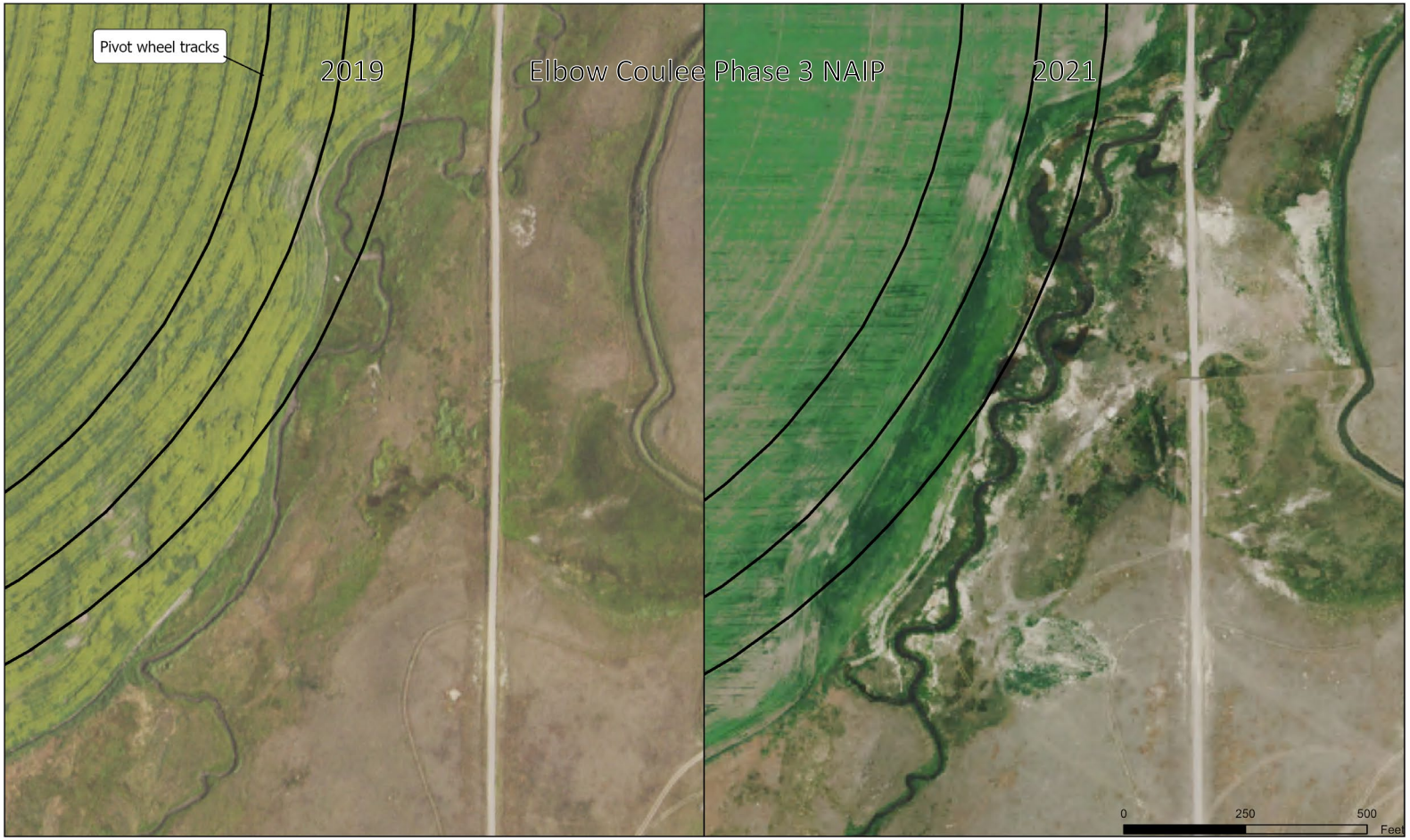
UAS May 2018

UAS June 2019


2017
Elbow Coulee Phase 2 UAS
2019
0
262.5
525
Feet

UAS May 2018

UAS July 2020


Pivot wheel tracks
2019
Elbow Coulee Phase 3 NAIP
2021
0
250
500
Feet

UAS May 2020

UAS July 2021


2020
School Section Coulee Phase 1 UAS
2022
0
187.5
375
Feet

UAS June 2018

UAS July 2023


• Irrigation Dam on School Section Coulee
• Fish passage barrier
• Removed/re-routed October 2021

SCHOOL SECTION ALFALFA DITCH IRRIGATION DAM BEFORE AND AFTER

Fisheries Monitoring

Passive Integrated Transponder (PIT) Tag Antenna Array – April 2021

Fisheries Monitoring

PIT Tag Install/Fish Data Processing

Brown Trout, 490 mm (19 inches)
Tag # - 3DD.003E04CE6D
Tagged 4/28/2021
Tagged in Elbow Phase 1
Station 56+00

Upper Elbow Coulee
Site 4

Passed on 4/29/2021
moving downstream

Passed on 6/14/2021
moving upstream

Tagged on 4/28/2021

Floweree Canal
Diversion Structure
Stream routed under canal
May 2017

Elbow Coulee

School Section Coulee

Lower Elbow Coulee
Site 1

Passed on 5/1/2021
moving downstream

Passed on 6/13/2021
moving upstream

Upper School Section
Site 2

Alfalfa Canal
Diversion Structure
Removed October 2021

Passed on 5/5/2021
moving downstream

Passed on 6/12/2021
moving upstream

Lower School Section
Site 3

Date: 10/8/2023
Background: 2019 NAIP Imagery
Projection: NAD83 Montana State Plane 2500

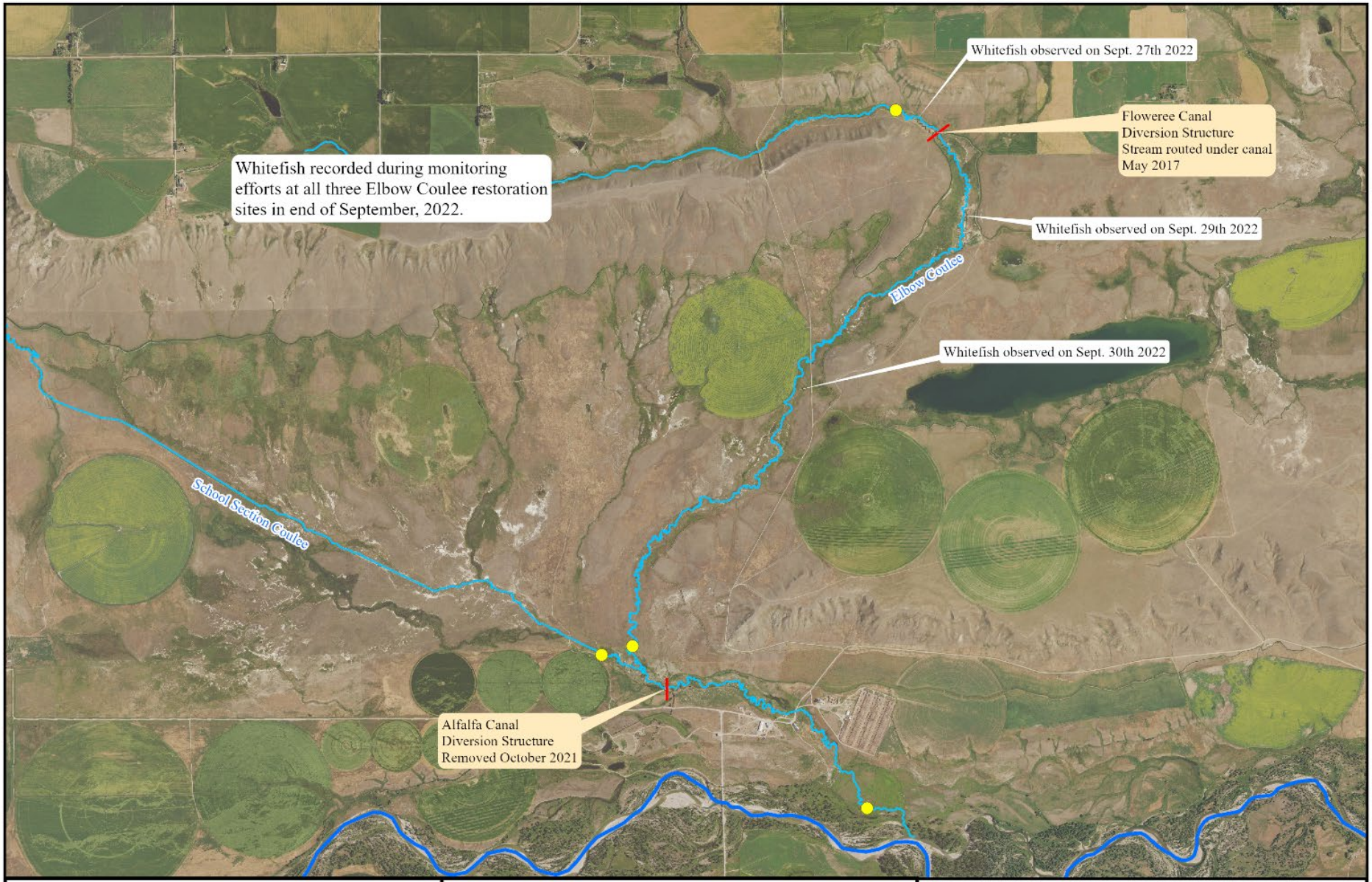
0 0.5 1
Miles

Broken O Ranch

Fish Tracking Telemetry Sites
Brown Trout CE6D Movement

Telemetry Sites - Installed April 2021
Streams
Sun River

N



Date: 10/8/2023
Background: 2019 NAIP Imagery
Projection: NAD83 Montana State Plane 2500

0 0.55 1.1
Miles

Broken O Ranch

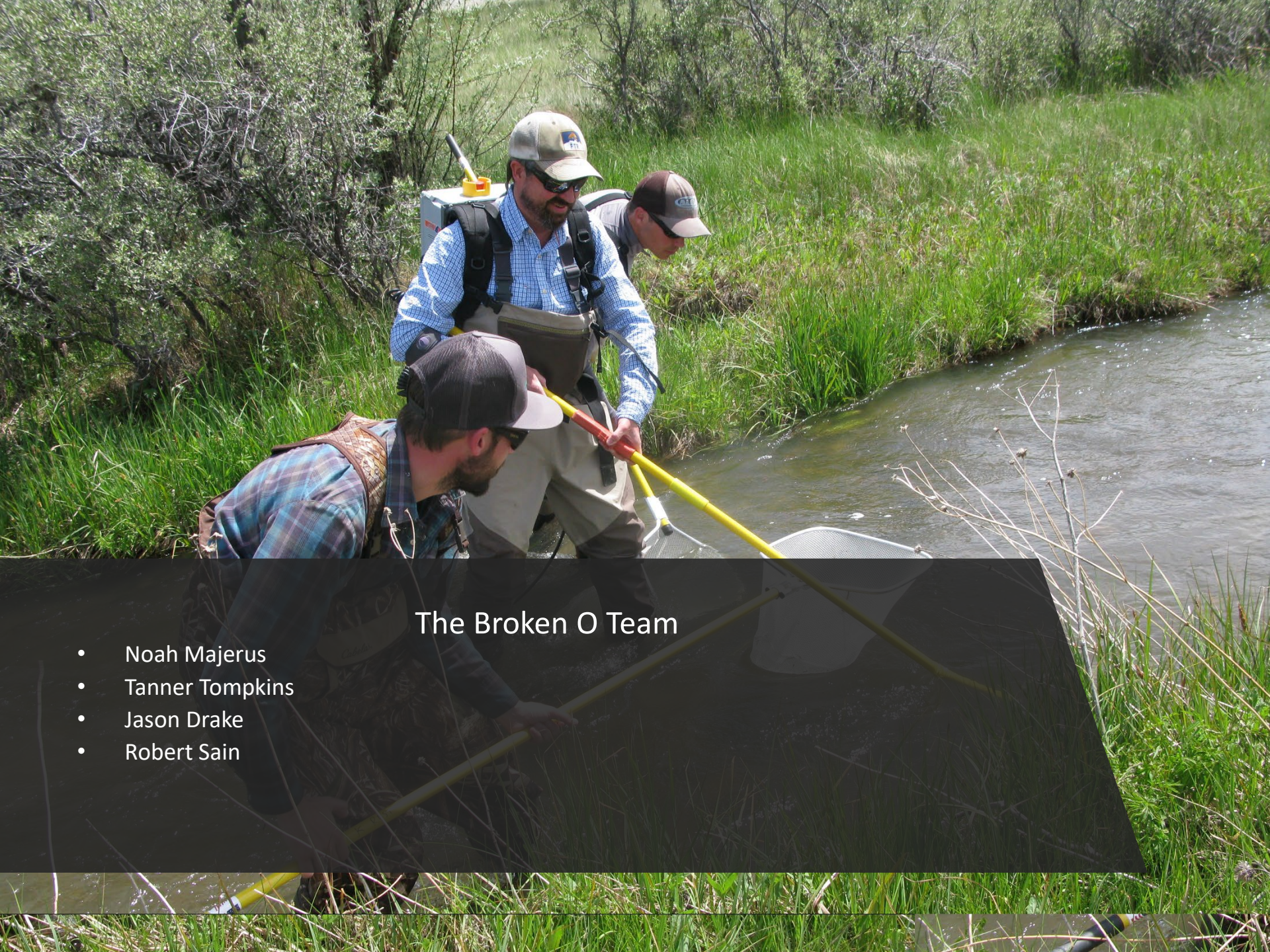
Whitefish Movement Post Dam Removal

Telemetry Sites - Installed April 2021
Streams
Sun River

N

Conclusions

- Eliminate as many watershed stressors as possible prior to restoration.
- Work closely with the ranch operational management to ensure the projects benefit ranch operations
- Design with fish habitat in mind
- Monitor and adaptively manage



The Broken O Team

- Noah Majerus
- Tanner Tompkins
- Jason Drake
- Robert Sain

Questions

- Accepting applications for 2024