Streamside Tailings Operable Unit
Silver Bow Creek Remedial Action
Subarea 3, Durant Canyon

Lessons Learned in Design and Construction

Pierre LeMieux

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TECHNICAL SERVICES, INC.

Scope

1. Silver Bow Creek History
2. Characterization and Design Challenges
3. Piped Stream Diversions
4. Preparing and Flexible Contract
5. Stream & Embankment Design Approach
6. Floodplain Regrading Design Approach
7. Fish Barrier – (Briefly)
8. Lessons Learned
9. Before and After Photos

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Lead Agency

Department of Environmental Quality
Remediation Division
1225 Cedar Street
Helena, MT 59601

Design Engineers

Pioneer Technical Services
1101 S. Montana
Butte, MT 59701

Contractor

Helena Sand & Gravel
2209 Airport Road
Helena, MT 59601

Cooperating Agencies

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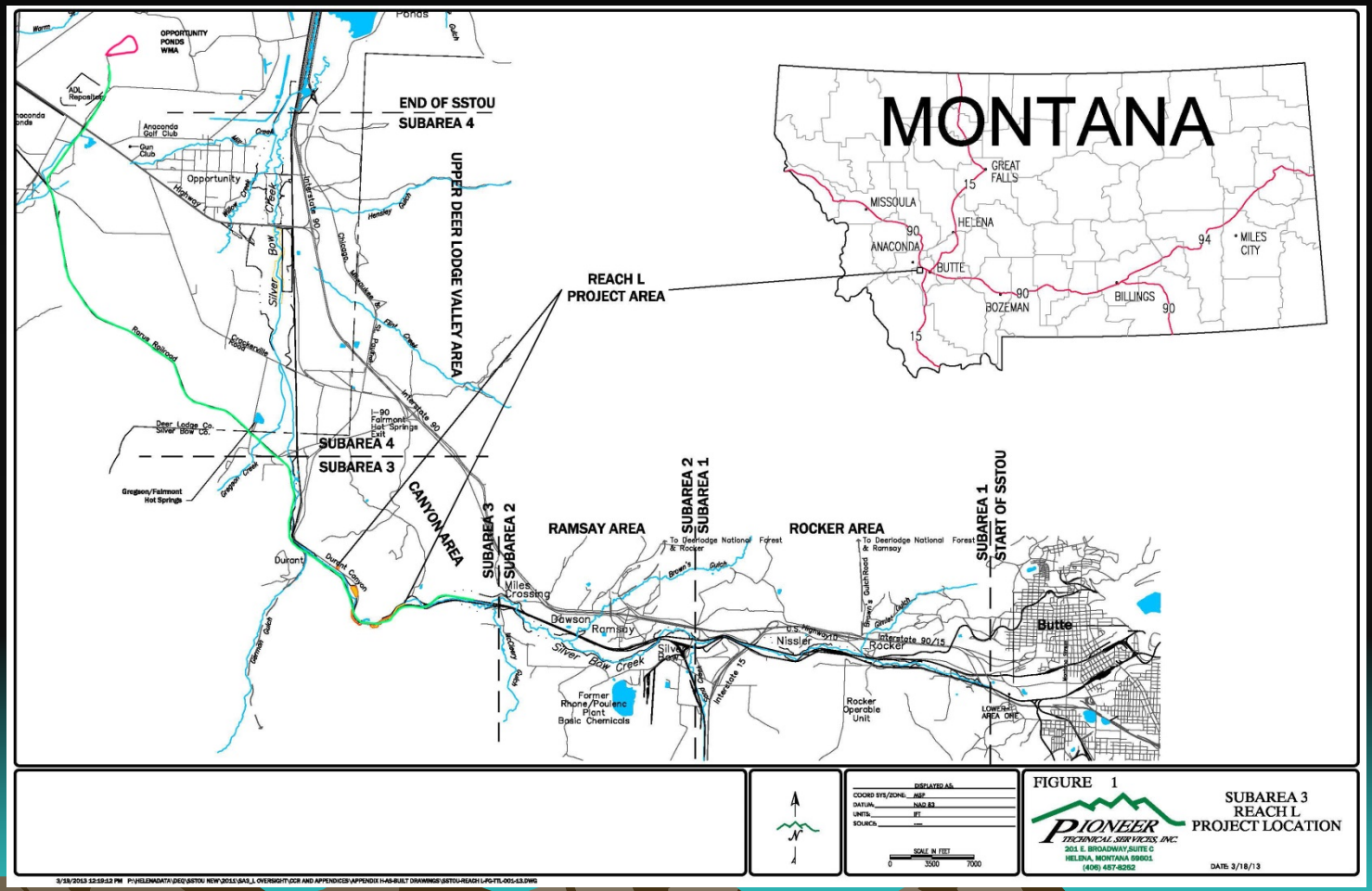
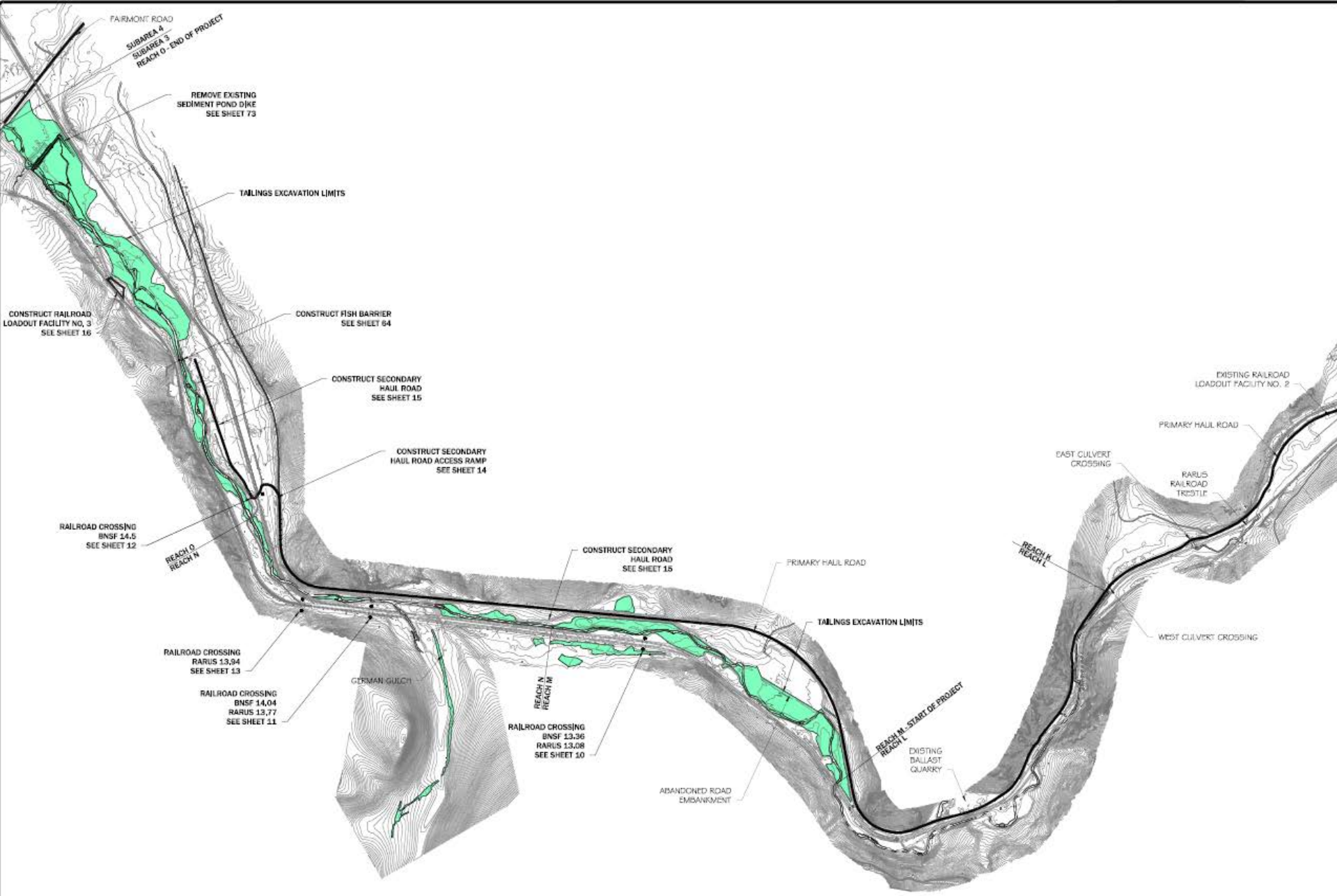
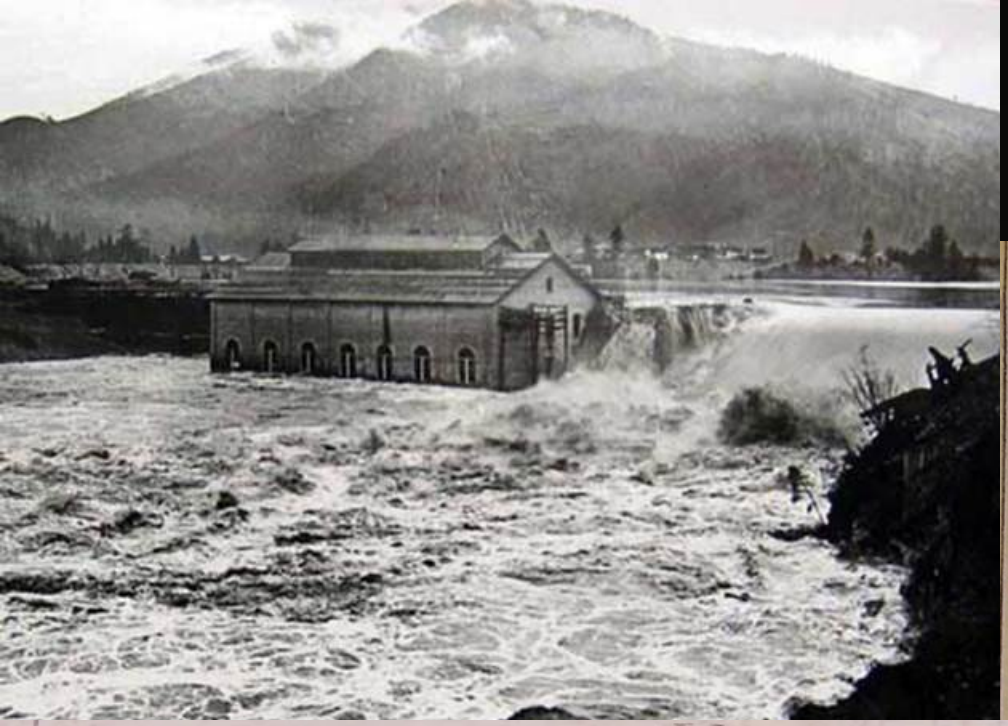
Site Location




FAIRMONT ROAD
SUBAREA 4
SUBAREA 3
REACH O - END OF PROJECT
REMOVE EXISTING
SEDIMENT POND DIKE
SEE SHEET 73
TAILINGS EXCAVATION LIMITS
CONSTRUCT RAILROAD
LOADOUT FACILITY NO. 3
SEE SHEET 16
CONSTRUCT FISH BARRIER
SEE SHEET 64
CONSTRUCT SECONDARY
HAUL ROAD
SEE SHEET 15
CONSTRUCT SECONDARY
HAUL ROAD ACCESS RAMP
SEE SHEET 14
RAILROAD CROSSING
BNSF 14.5
SEE SHEET 12
REACH O
REACH N
CONSTRUCT SECONDARY
HAUL ROAD
SEE SHEET 15
PRIMARY HAUL ROAD
TAILINGS EXCAVATION LIMITS
RAILROAD CROSSING
RARUS 13,94
SEE SHEET 13
RAILROAD CROSSING
BNSF 14,04
RARUS 13,77
SEE SHEET 11
GERMAN GULCH
REACH N
REACH M
RAILROAD CROSSING
BNSF 13,36
RARUS 13,08
SEE SHEET 10
REACH M - START OF PROJECT
REACH L
EXISTING
BALLAST
QUARRY
ABANDONED ROAD
EMBANKMENT
REACH K
REACH L
EXISTING RAILROAD
LOADOUT FACILITY NO. 2
PRIMARY HAUL ROAD
EAST CULVERT
CROSSING
RARUS
RAILROAD
TRESTLE
WEST CULVERT CROSSING

History - Butte America

Historic Flood of 1908



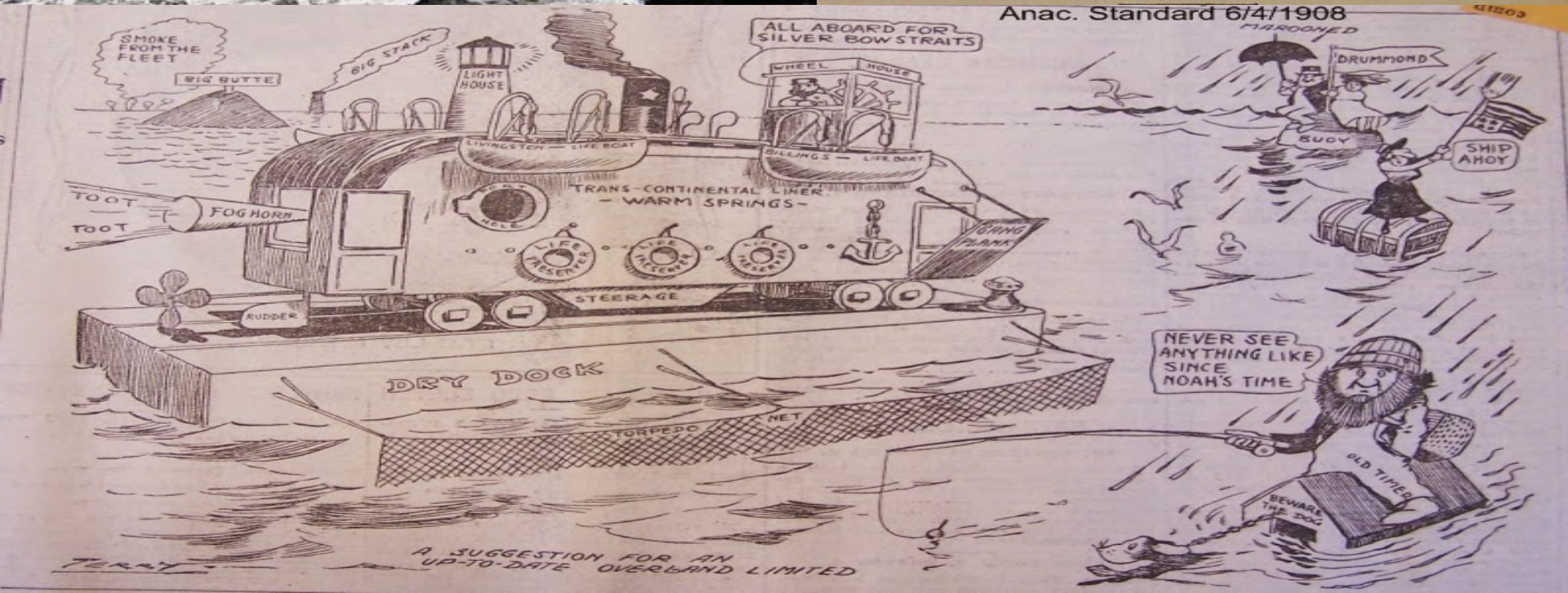
(Continued on Page Four)

Butte Miner 6/6/1908

PLAGUE OF DARKNESS REIGNS BETWEEN TWILIGHT AND DAWN

Butte Is Without Electric Light and Street Car Service Until Tangle of Wires Can Be Cleared. Fears Are Held That Flood Situation Has Not Yet Reached Climax— Mining Operations Are Greatly Curtailed.

Anac. Standard 6/4/1908



Project History

- In 1983, Silver Bow Creek/Butte Area was placed on EPA's National Priorities List.
- The 26-miles of stream side tailings along Silver Bow Creek was designated as the Stream Side Tailings Operable Unit (SSTOU)
- In 1995, a Record of Decision was issued for remedial action for SSTOU. The ROD requires tailings removal within the 100-year floodplain.
- In 1999, a settlement was reached between the State of Montana and ARCO. From the settlement amount, $80 million plus interest was set aside for DEQ and EPA to remediate Silver Bow Creek.

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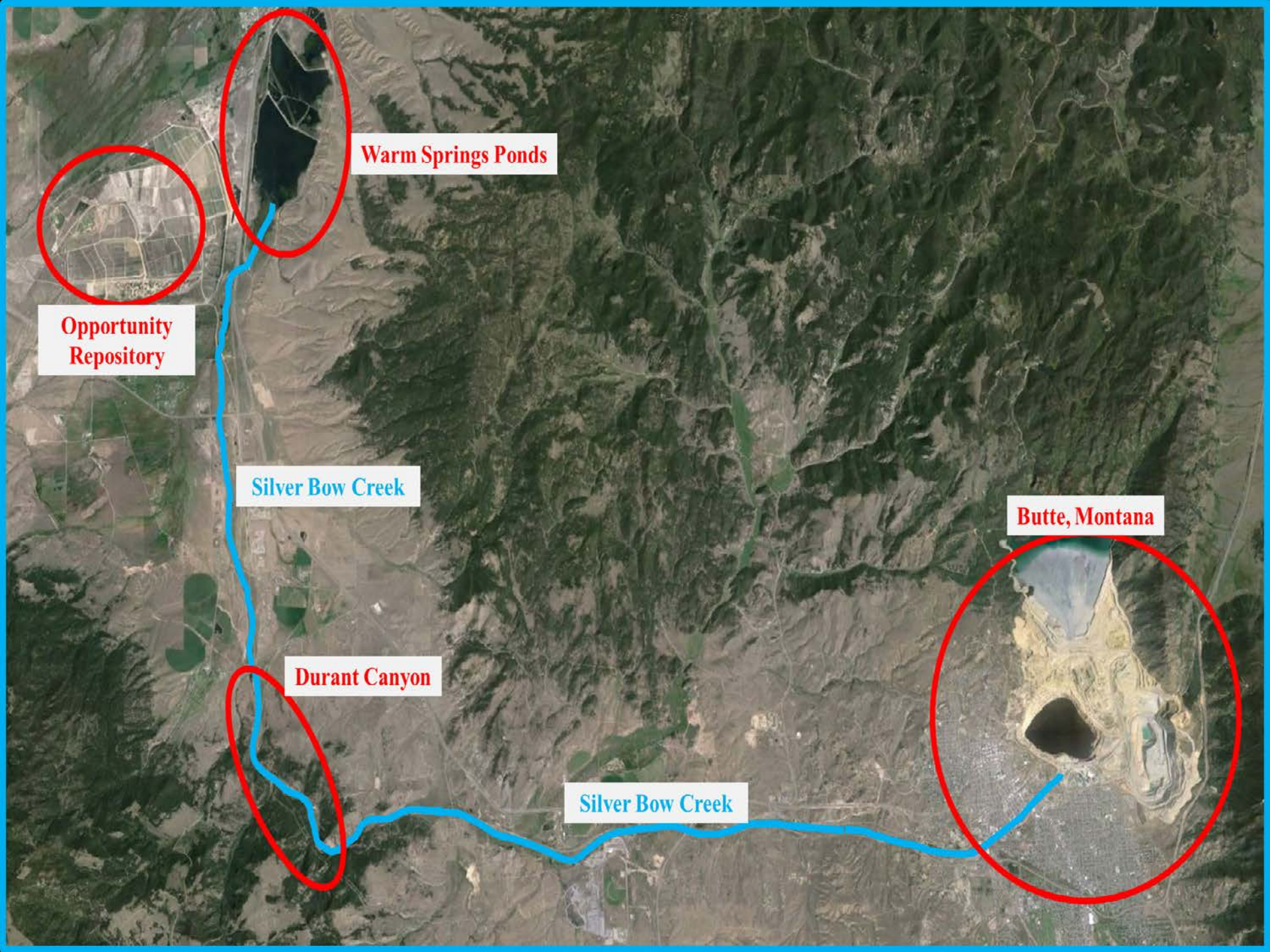
Warm Springs Ponds
Opportunity Repository
Silver Bow Creek
Butte, Montana
Durant Canyon
Silver Bow Creek


S4P7N-TP
064
10/9/08 1600


10/06/2008

BALANCE BETWEEN CHARACTERIZATION, DESIGN, AND FIELD MODIFICATIONS

- Limited access in the confines of the canyon limited the scale and scope of characterization efforts
- Design focus was to prepare a flexible contract to account for actual conditions encountered in the field

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WASTE EXCAVATION & VERIFICATION

- Lessons Learned
  - Would have been great to have better survey data, more (& better) characterization data, and more field time.
  - Be conservative in building design surfaces with at least 9” over-excavation built in.
  - Paying by rail car or truckload can be fairly accurate and is helpful in making sure removal goals are met without slowing down the process by waiting for surveys, paperwork, etc.
  - GPS-Controlled Equipment can be a time/money saver.

Volume Measurement and Payment

- All tailings volume measured and paid by the train cars
- Limited time and budget associated with post-excavation surveys
- Easy to make field calls for additional removals without accounting for every cubic yard via survey or truck counts

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DEERE

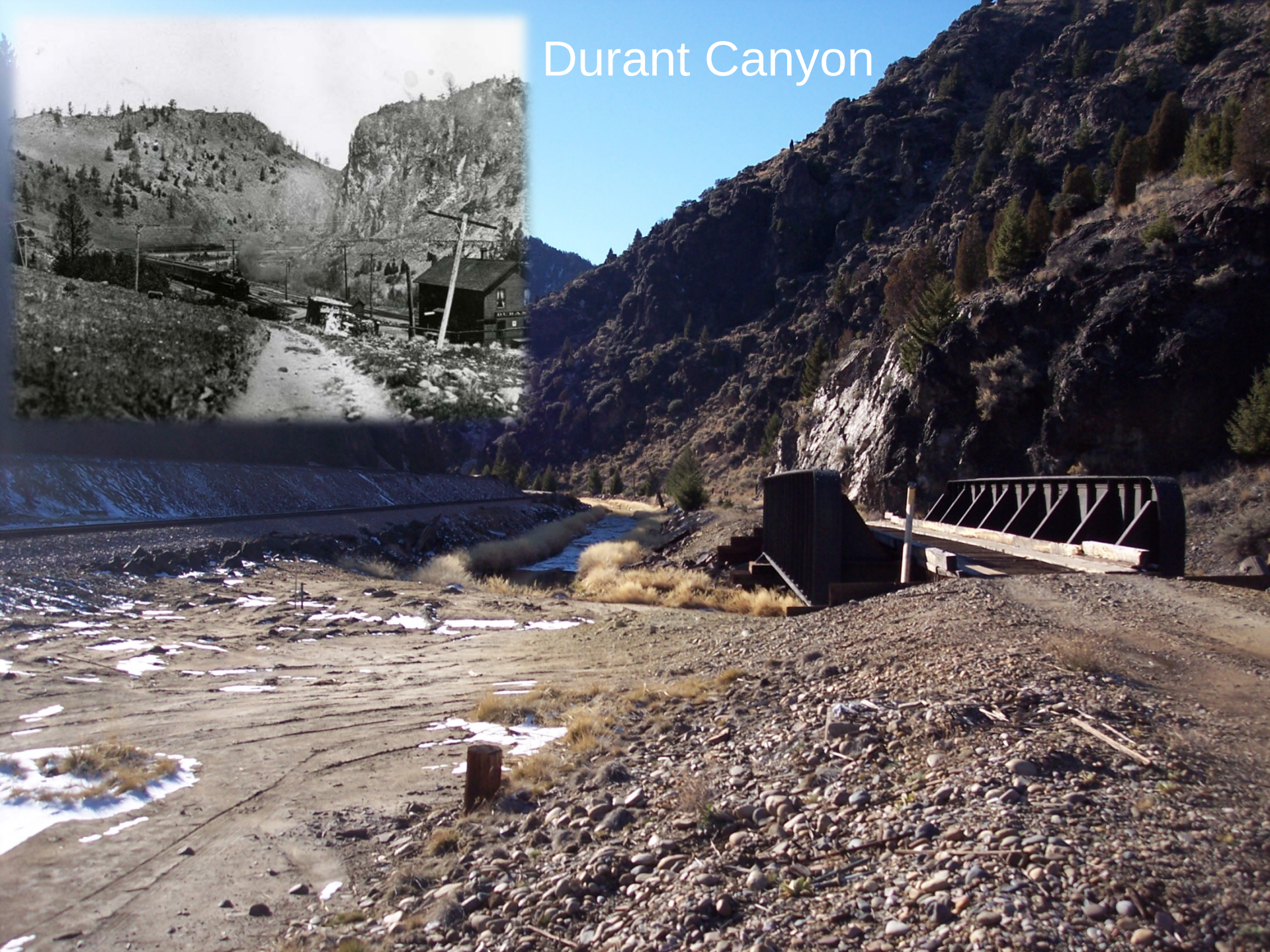
CONTRACTING & CONSTRUCTION MANAGEMENT – LESSONS LEARNED

- Dealing with “Low-Bid” Environment.
- Better to design for worst case and then back off in the field.
- Write your bid items to account for Murphy’s Law – try to predict shortcuts.
- Be flexible where possible but keep the “No” Card on hand. It’s always easier to start with No and work your way to Yes.

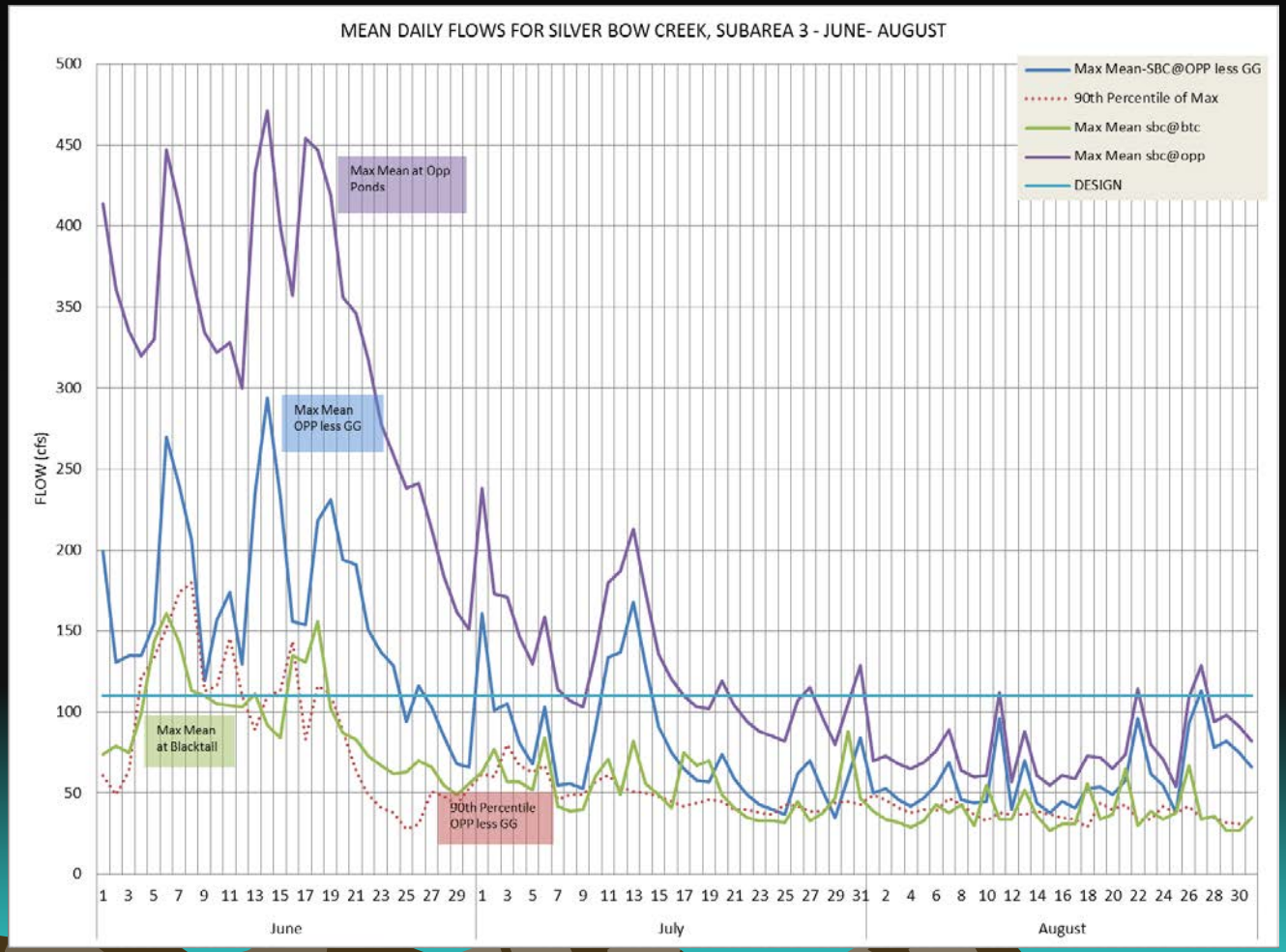
CONTRACTING & CONSTRUCTION MANAGEMENT

- Define a minimum depth and measure in square yards and/or acres where possible.
- Better to design and pay for diversions than expect the Contractor to do it.
- This goes for any engineering-related item – design up front then consider Contractor alternate ideas if necessary.

Durant Canyon



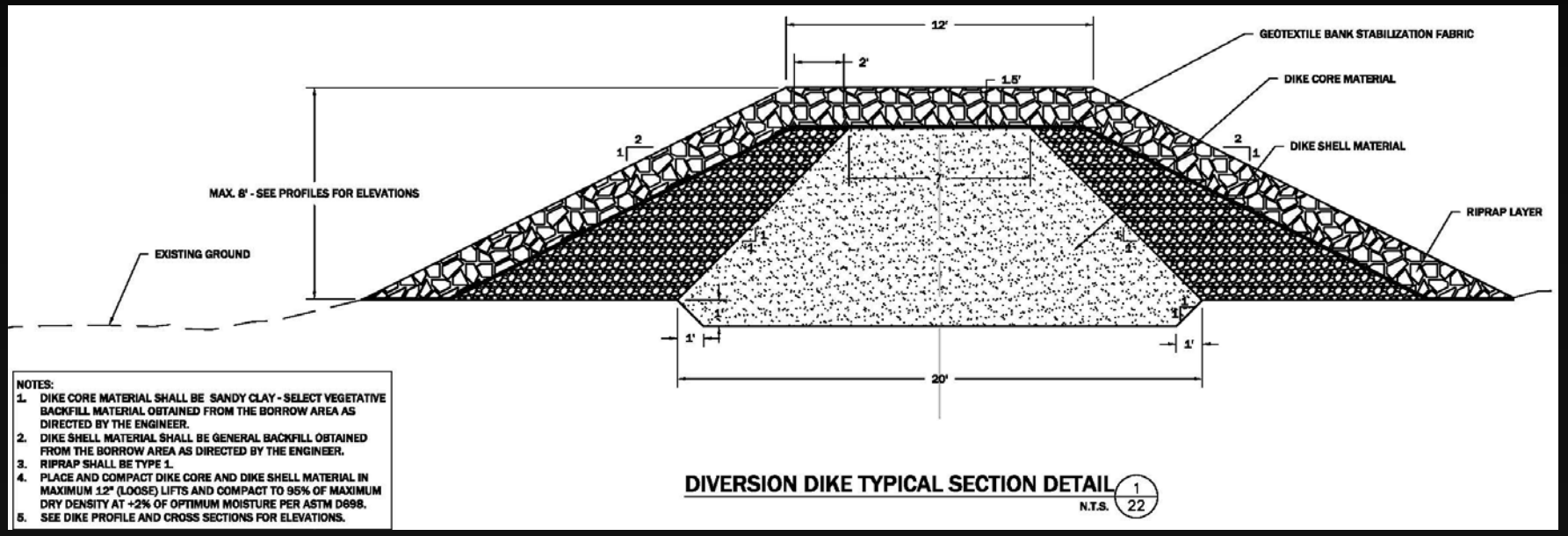
STREAM DIVERSION DESIGN

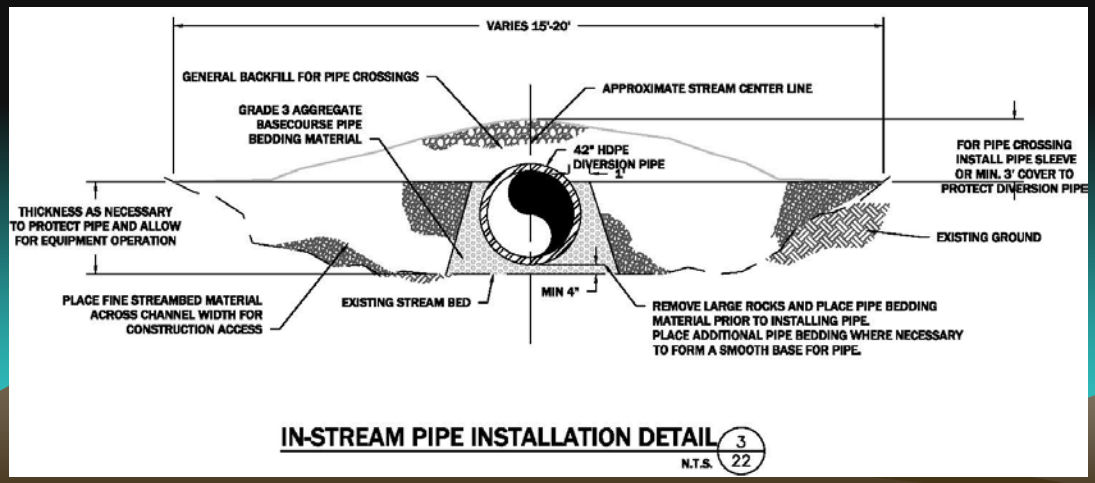


DIVERSION PIPE PROCUREMENT

PIONEER
TECHNICAL SERVICES, INC.

STREAM DIVERSION DETAILS





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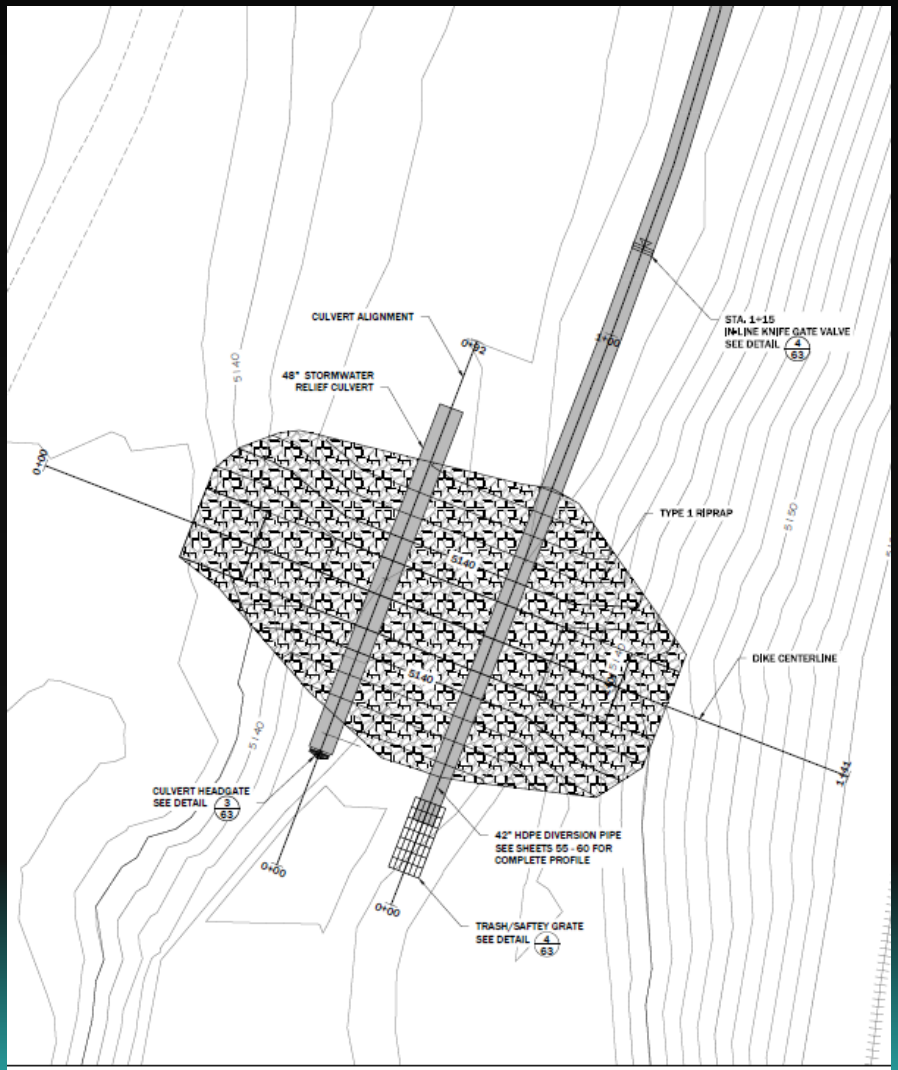
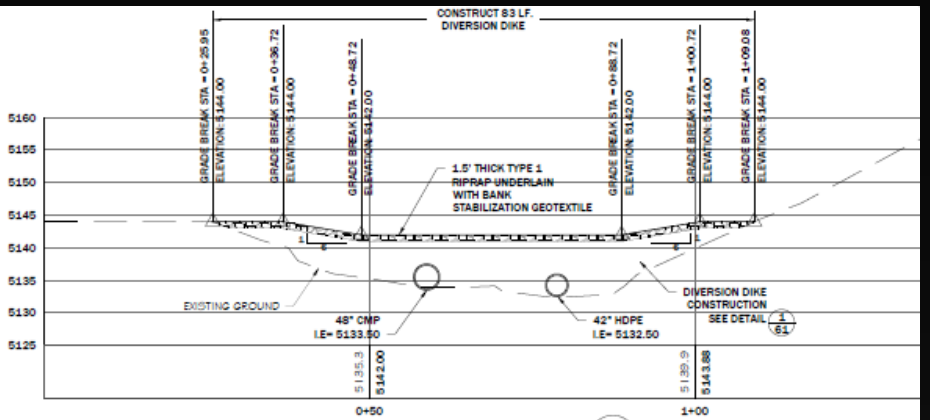
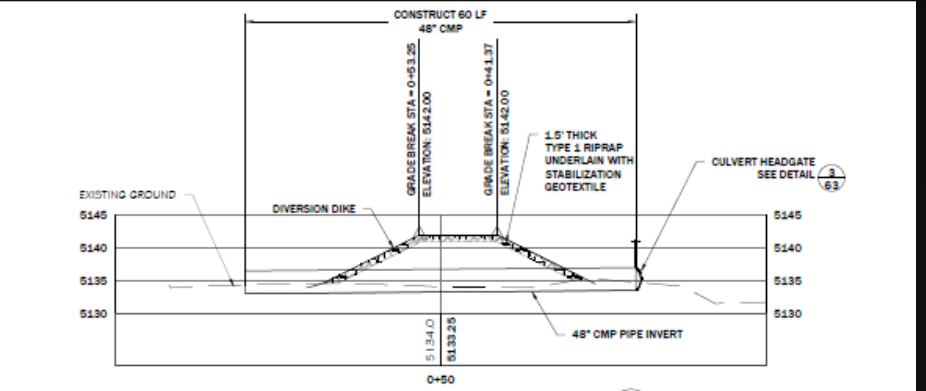
Diversion Details



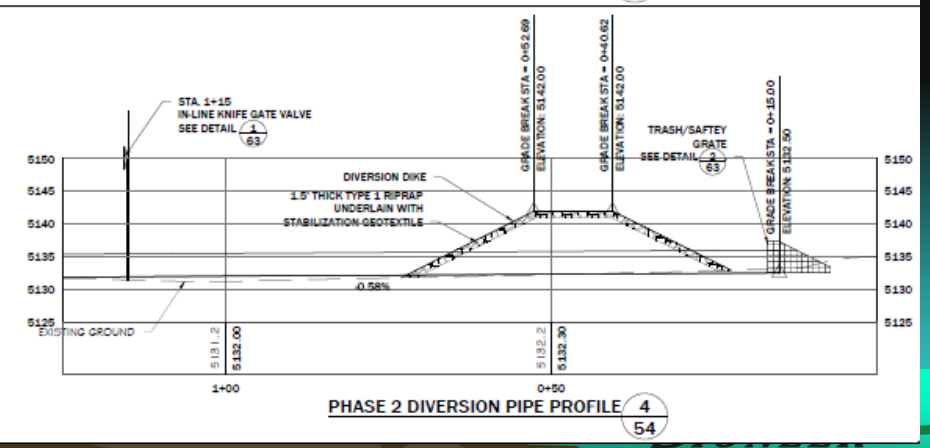
PHASE 2 DIVERSION DIKE PLAN 1/54



PHASE 2 DIVERSION DIKE PROFILE 2/54



PHASE 2 STORMWATER RELIEF CULVERT 3/54



PHASE 2 DIVERSION PIPE PROFILE 4/54

Typical Diversion Dike Installation Sequence

Setting Stormwater Relief Culvert

Setting HDPE Diversion Pipe

Compacting around Culverts

Compacted Earthen Core

Riprap Shell

Typical Diversion Dike

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Piped Stream Diversion – Install Pipe @ Centerline of Existing Channel

- Gabion Mattresses on one slope and earthen fill/e-mat opposite slope

Piped-Diversion Installation

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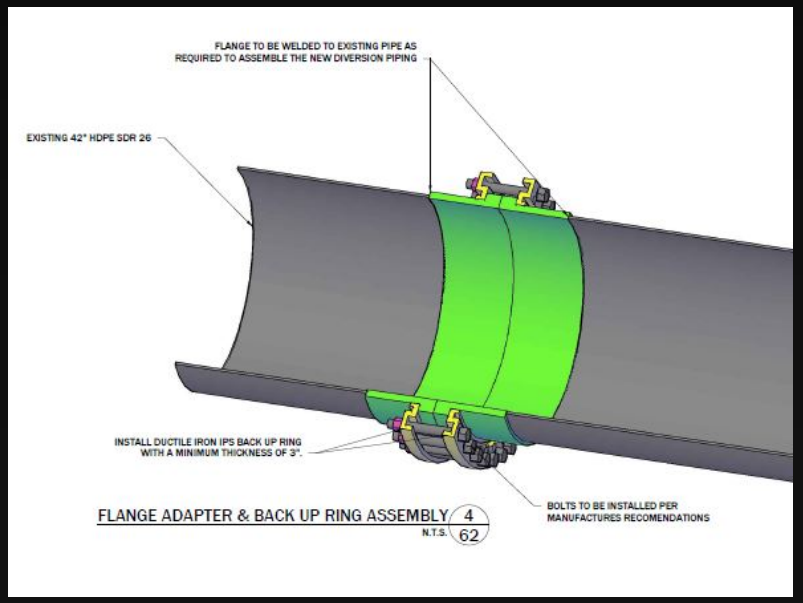
TECHNICAL SERVICES, INC.

Lesson Learned on Contractor Substitutions

Required pipe joint = flange with back-up ring assembly.



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Phase 2 – Diversion Alignment

- Sediment Pond Dike
- Open Channel Diversion
- Tie-in Dike (install at end of 2014 Construction Season)
- Fish Barrier Location
- Diversion Pipe (in trench or on slope)
- Diversion Pipe (in existing channel)
- Phase 2 Diversion Dike


KOMATSU


KOMATSU
PC 270 LC
KOMATSU

Pipe in Trench / Pipe on Slope

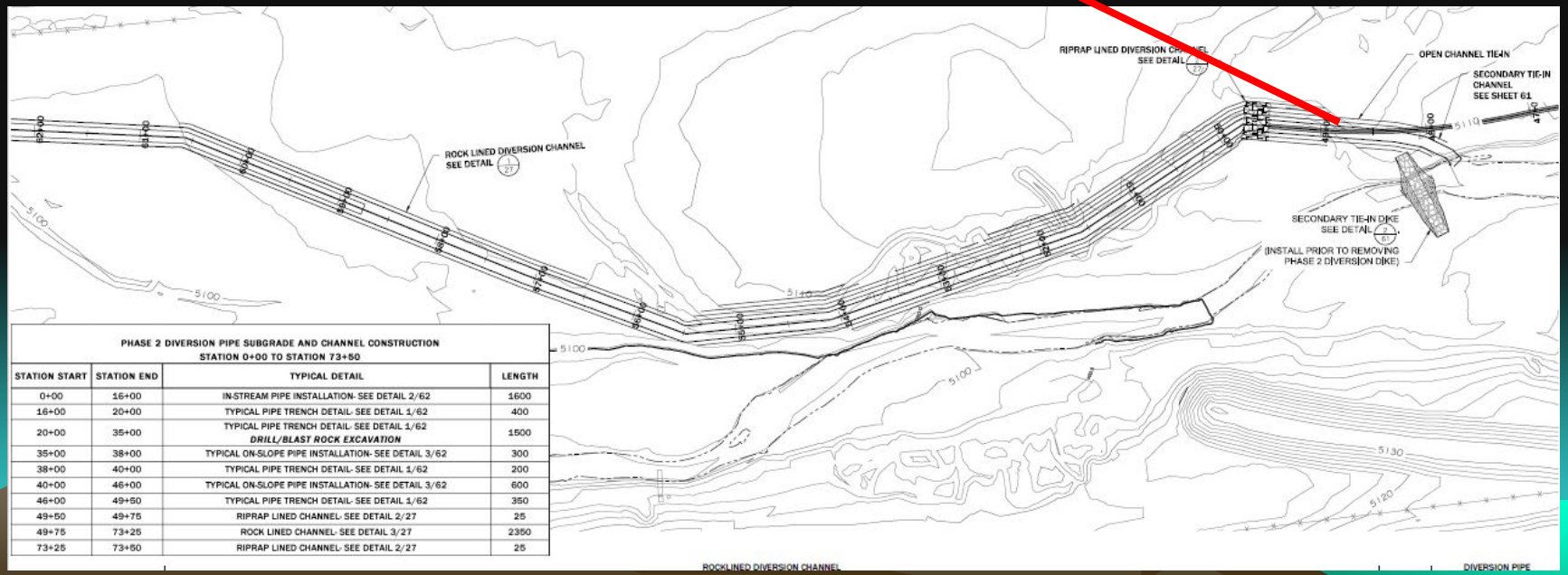
Drill and Blast Required

Typical Pipe Trench

Open Channel Diversion Area

Approximate Location for transition to open-channel diversion

Floodplain opened-up and allowed for Transition to open-channel



PHASE 2 DIVERSION PIPE SUBGRADE AND CHANNEL CONSTRUCTION
STATION 0+00 TO STATION 73+50

STATION START	STATION END	TYPICAL DETAIL	LENGTH
0+00	16+00	IN-STREAM PIPE INSTALLATION- SEE DETAIL 2/62	1600
16+00	20+00	TYPICAL PIPE TRENCH DETAIL- SEE DETAIL 1/62	400
20+00	35+00	TYPICAL PIPE TRENCH DETAIL- SEE DETAIL 1/62 ***DRILL/BLAST ROCK EXCAVATION***	1500
35+00	38+00	TYPICAL ON-SLOPE PIPE INSTALLATION- SEE DETAIL 3/62	300
38+00	40+00	TYPICAL PIPE TRENCH DETAIL- SEE DETAIL 1/62	200
40+00	46+00	TYPICAL ON-SLOPE PIPE INSTALLATION- SEE DETAIL 3/62	600
46+00	49+50	TYPICAL PIPE TRENCH DETAIL- SEE DETAIL 1/62	350
49+50	49+75	RIPRAP LINED CHANNEL- SEE DETAIL 2/27	25
49+75	73+25	ROCK LINED CHANNEL- SEE DETAIL 3/27	2350
73+25	73+50	RIPRAP LINED CHANNEL- SEE DETAIL 2/27	25

Design Lesson – Remember to Account for Ice in Capacity Calculations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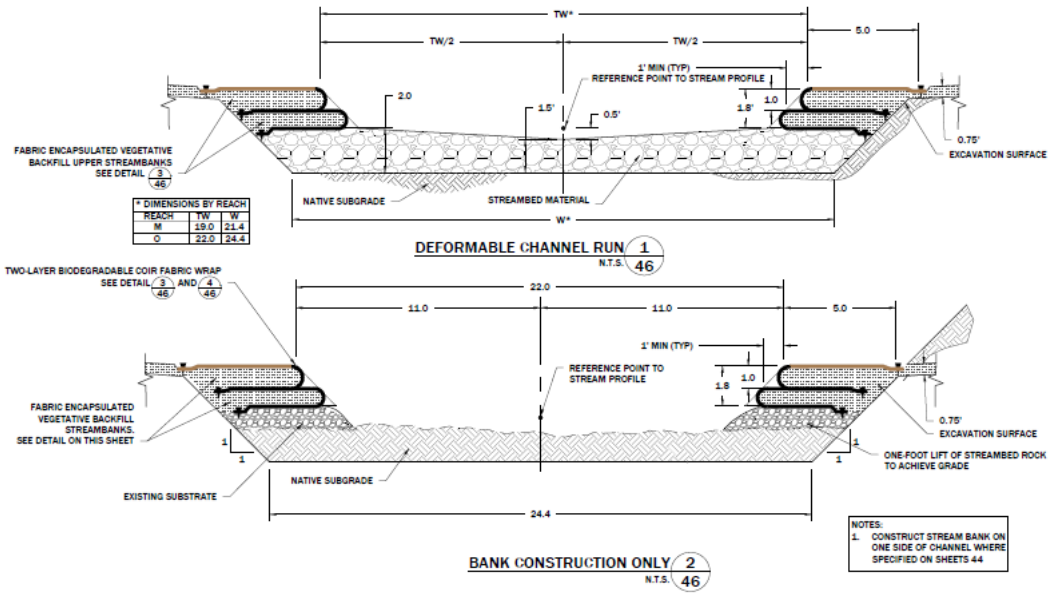
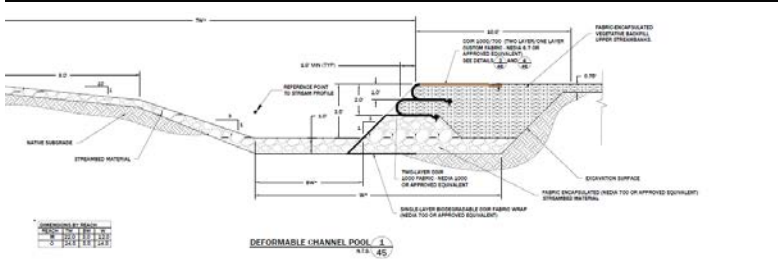
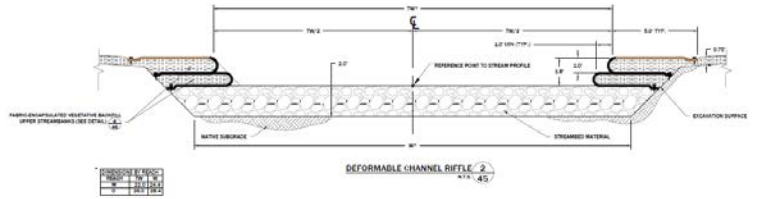
STREAM CONSTRUCTION

- Lessons Learned:
  - Have multiple tools/treatments to apply to changing conditions in the field.
  - Preserve existing streambed where possible.
  - For Streambed rock and other aggregates, try to simplify and limit gradations to something that considers local availability, cost to import, crushing, etc., in addition to design requirements.





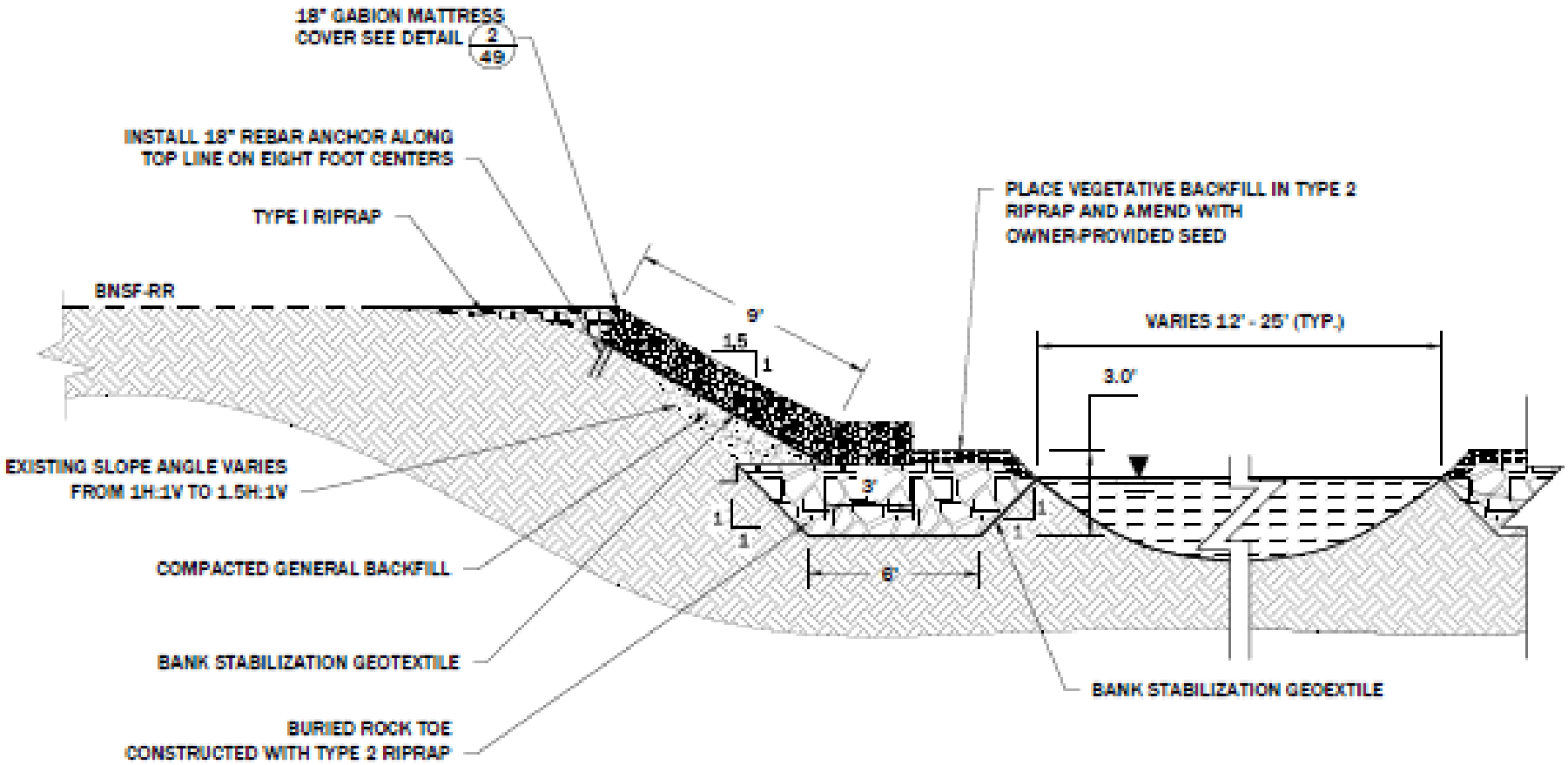


Stream Channel Measurement & Payment

18	DEFORMABLE CHANNEL CONSTRUCTION				
18a	Deformable Channel Pool	2,810	LF	$ 85.00	$ 238,850.00
18b	Deformable Channel Riffle	1,345	LF	$ 125.00	$ 168,125.00
18c	Deformable Channel Run	2,167	LF	$ 125.00	$ 270,875.00
18d	Deformable Channel - Construct Banks Only	4,353	LF	$ 70.00	$ 304,710.00
18e	Deformable Channel - Construct One-Bank Only	1,850	LF	$ 60.00	$ 111,000.00


DEERE

Embankment Treatment Measurement & Payment

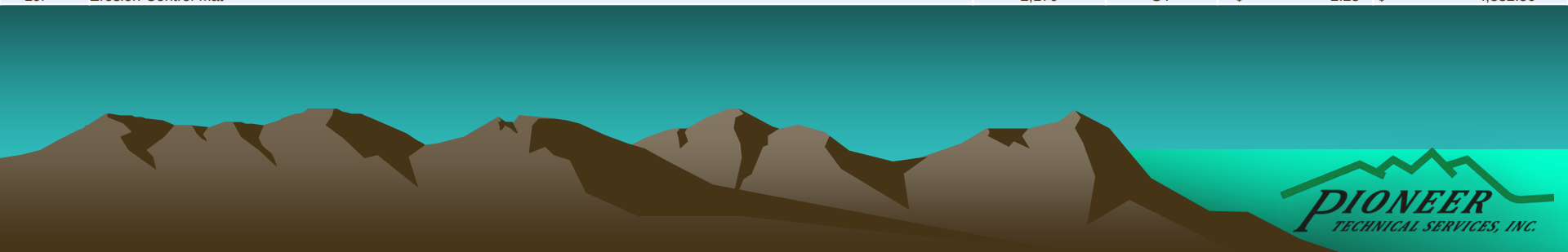


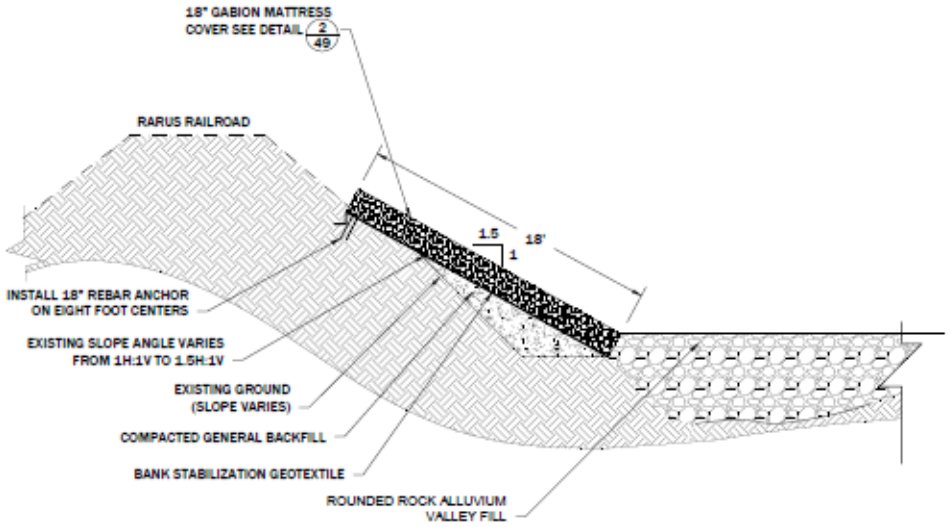
REVEGETATED TYPE 2 RIPRAP TOE WITH GABIONS ON SLOPE (TYP.) 1/49

N.T.S.

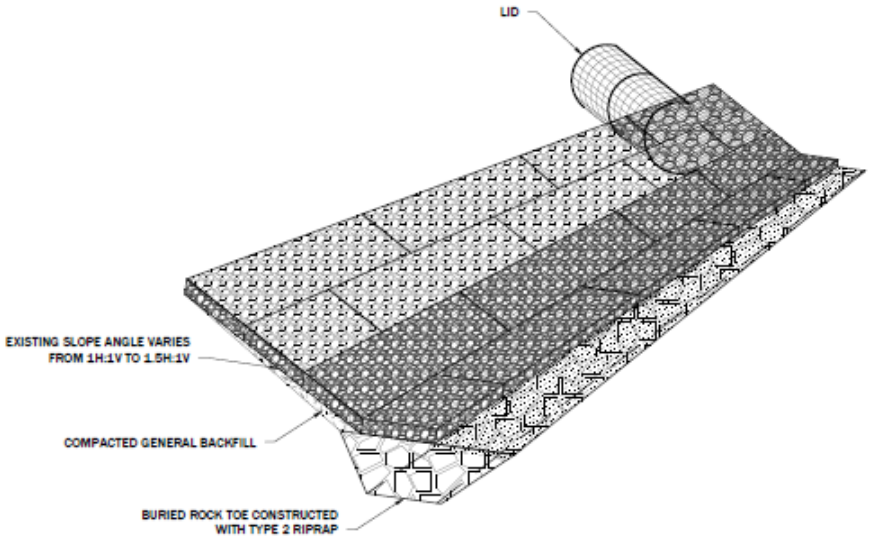
Pay on the "Plan" Area

19	RAILROAD EMBANKMENT TREATMENT				
19a	Type 1 Riprap	1,800	SY	$ 19.00	$ 34,200.00
19b	Type 2 Riprap	8,600	SY	$ 42.00	$ 361,200.00
19c	Revegetated Type 2 Riprap Toe	5,400	SY	$ 55.00	$ 297,000.00
19d	Bank Stabilization Geotextile	6,200	SY	$ 2.00	$ 12,400.00
19e	Install Owner-Provided 18-Inch Gabion Mattress with Fill	2,000	SY	$ 42.00	$ 84,000.00
19f	Procure and Install 18-Inch Gabion Mattresses with Fill	1,105	SY	$ 60.00	$ 66,300.00
19g	Compacted General Backfill	5,000	SY	$ 12.00	$ 60,000.00
19h	Railroad Embankment Rock Cover	5,500	SY	$ 5.00	$ 27,500.00
19i	Erosion Control Mat	2,170	SY	$ 2.25	$ 4,882.50

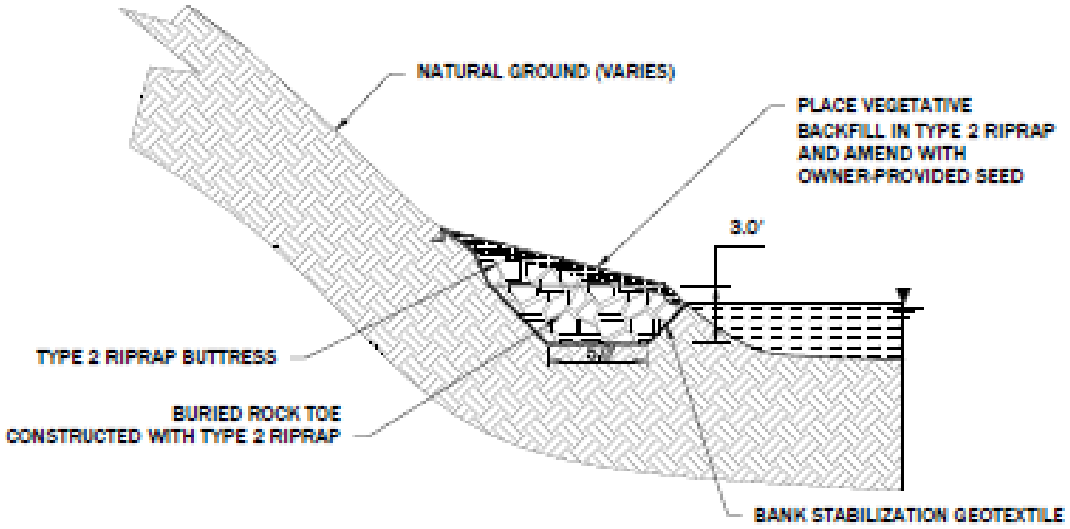




VALLEY ROCK FILL WITH GABIONS ON SLOPE (TYP.) 4/50
N.T.S.



GABION MATTRESSES ISOMETRIC VIEW (TYP.) 2/49
N.T.S.



REVEGETATED TYPE 2 RIPRAP TOE 3/50
N.T.S.

Additional Examples

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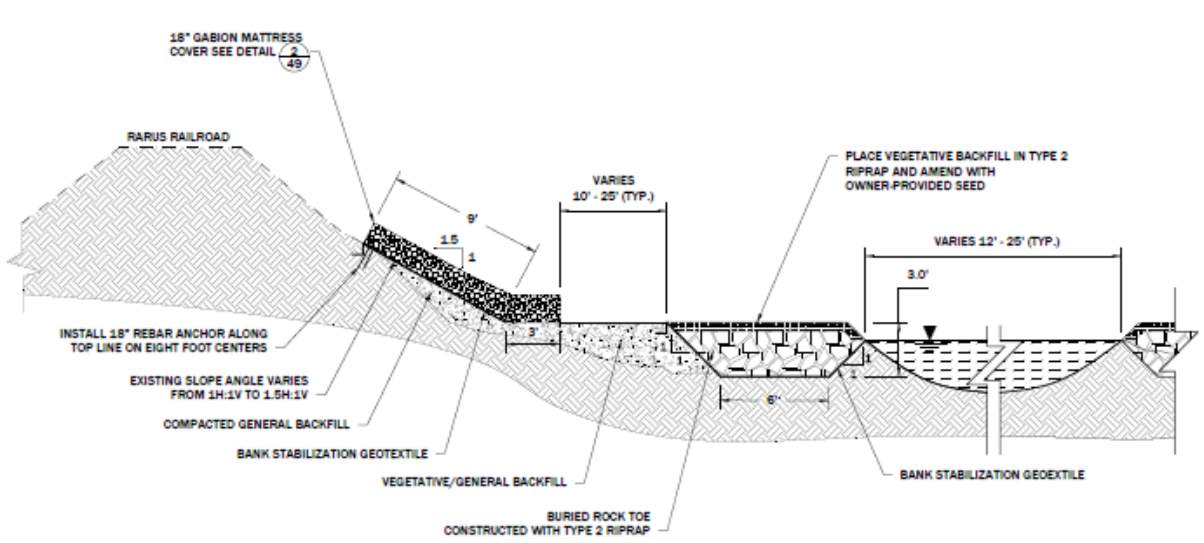
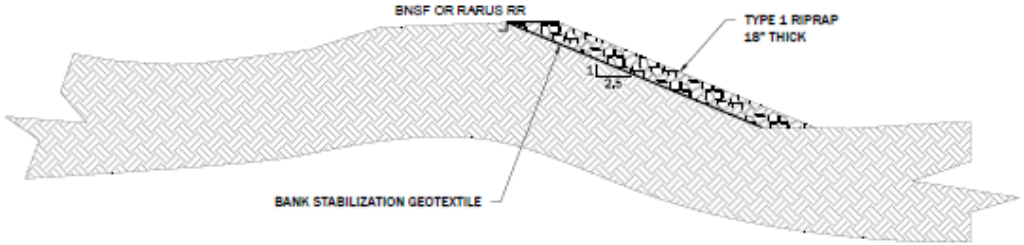
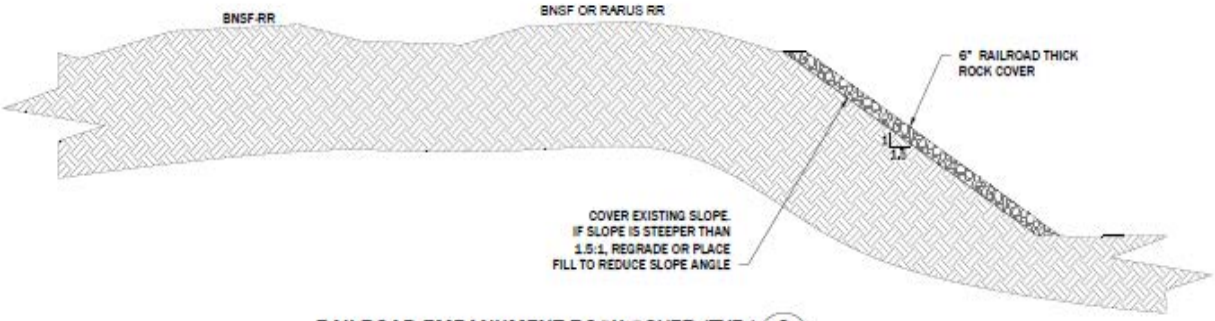


REVEVETATED TYPE 2 RIPRAP TOE OFFSET TO GABIONS ON SLOPE (TYP.) 5/50
N.T.S.



RAILROAD EMBANKMENT RIPRAP COVER (TYP.) 1/50
N.T.S.



RAILROAD EMBANKMENT ROCK COVER (TYP.) 2/50
N.T.S.

Puzzle Pieces

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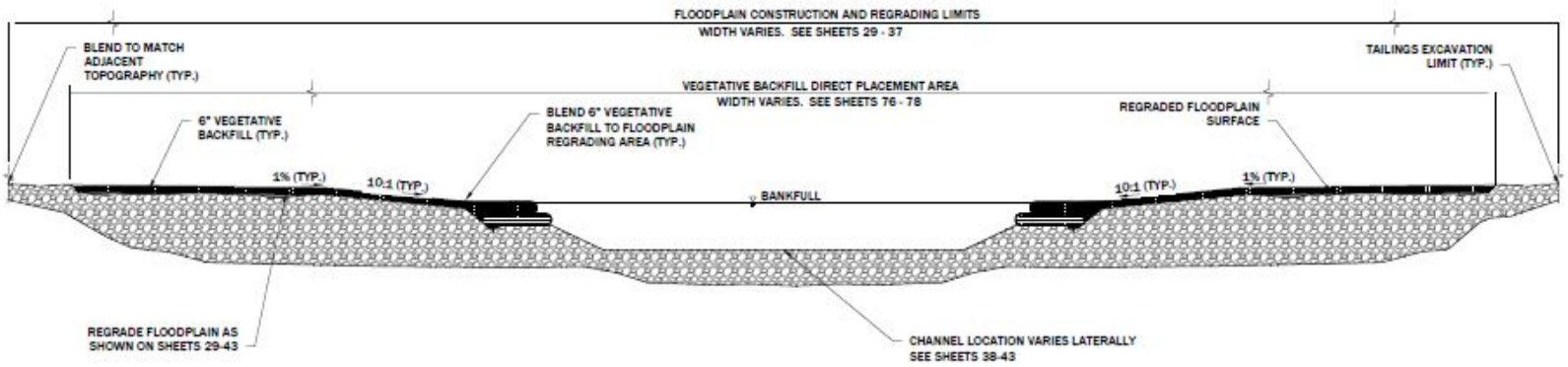
Lesson Learned – Floodplain Regrading



FLOODPLAIN CROSS-SECTION (TYPICAL) 1/28

N.T.S.

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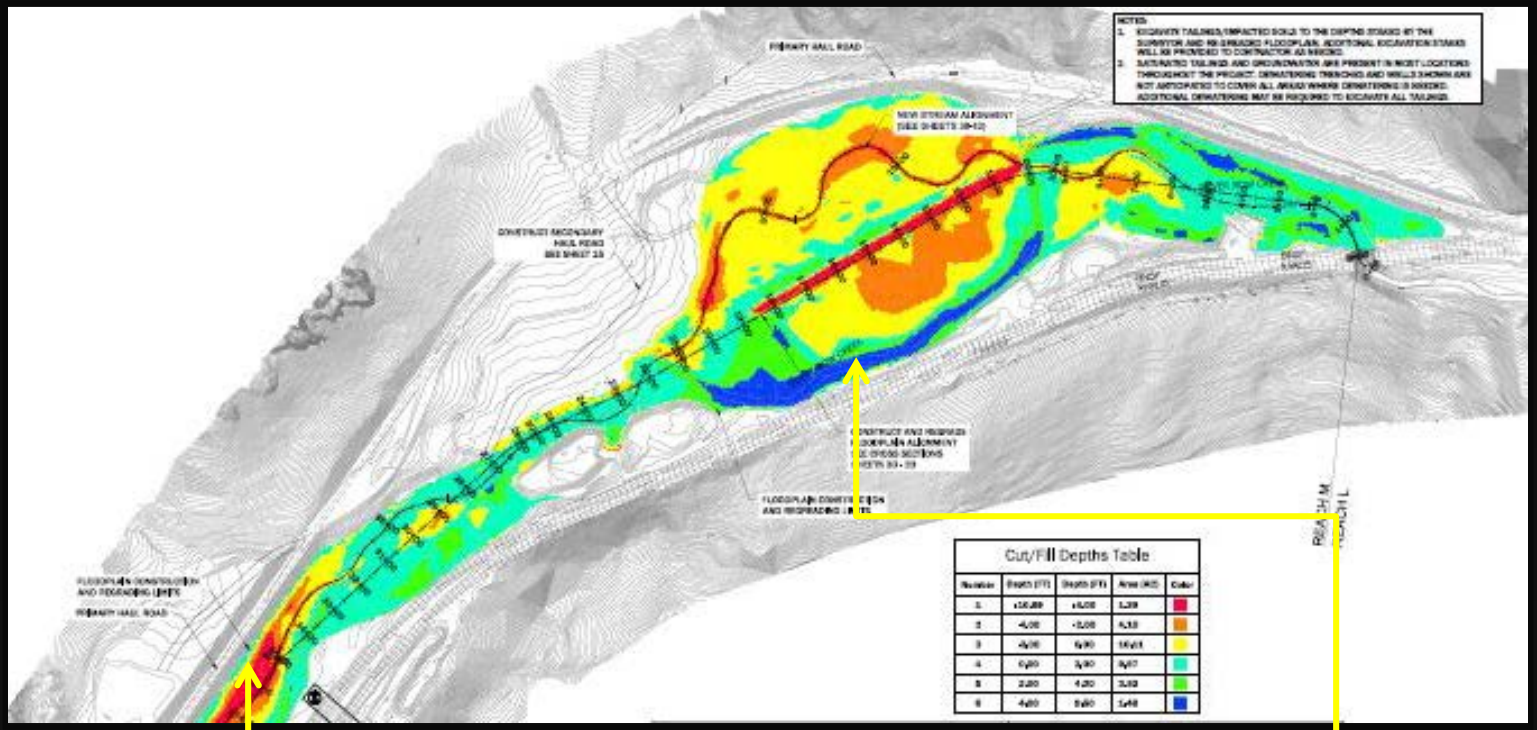
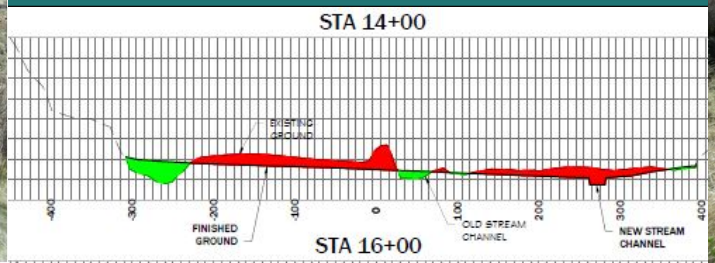
Reach M Tailings Area

Floodplain Construction and Regrading (design approach)



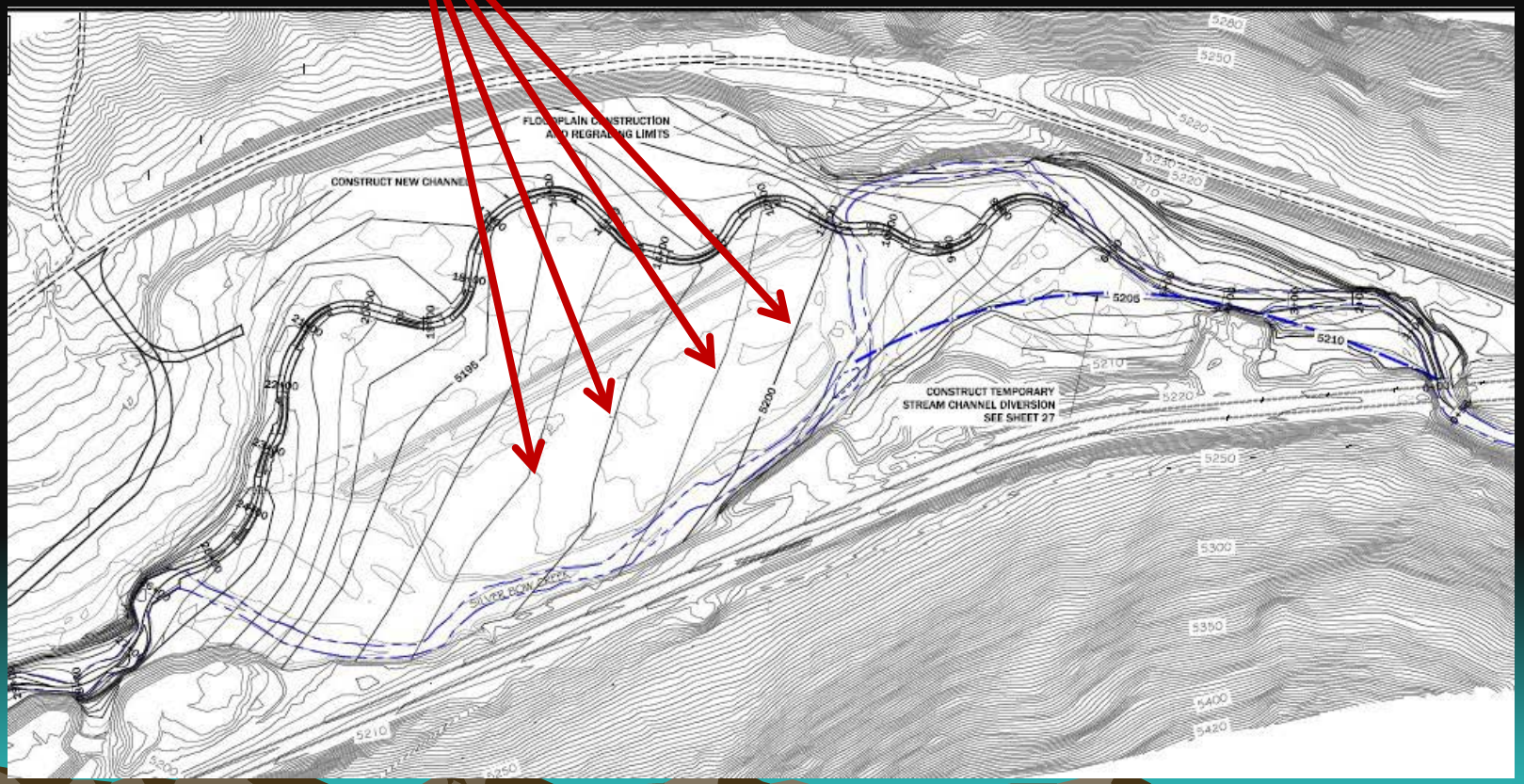
TYPICAL CUT ZONE



TYPICAL FILL ZONE

Floodplain Construction

- Note final contours and the objective to build topography



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Floodplain Construction & Regrading
With GPS Operations
8/24/2013

Fish Barrier Installation

- 55’ Wide X 22’ High
- Isolate Native Cutthroat Trout
- Maintain Sediment Transport
- Rock Fill volume – 11,000 CY

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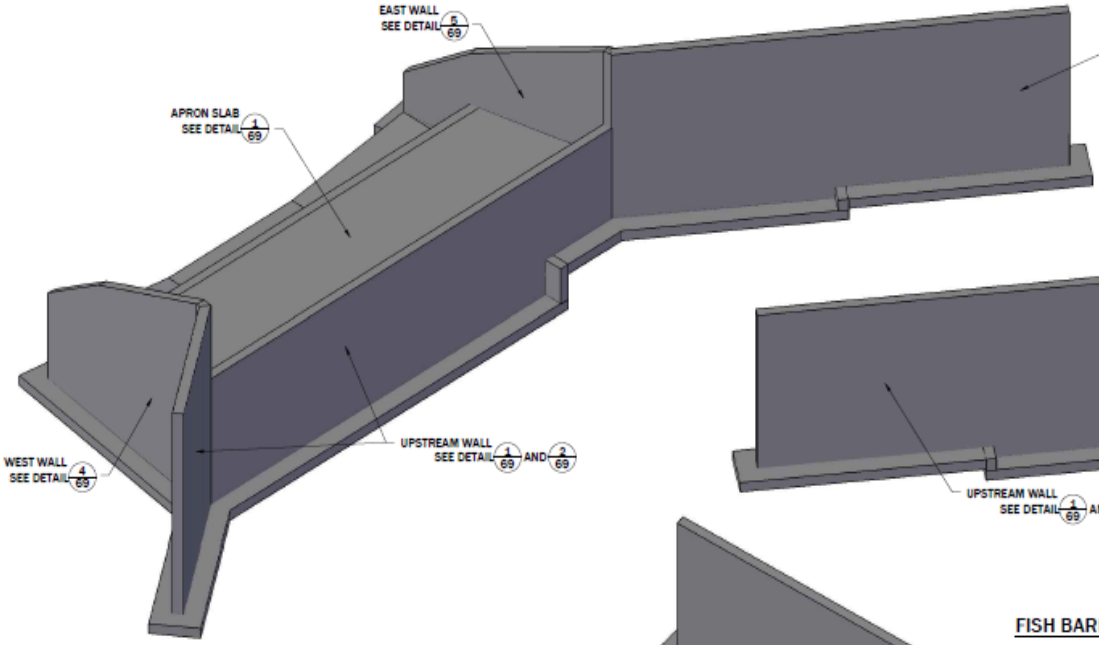
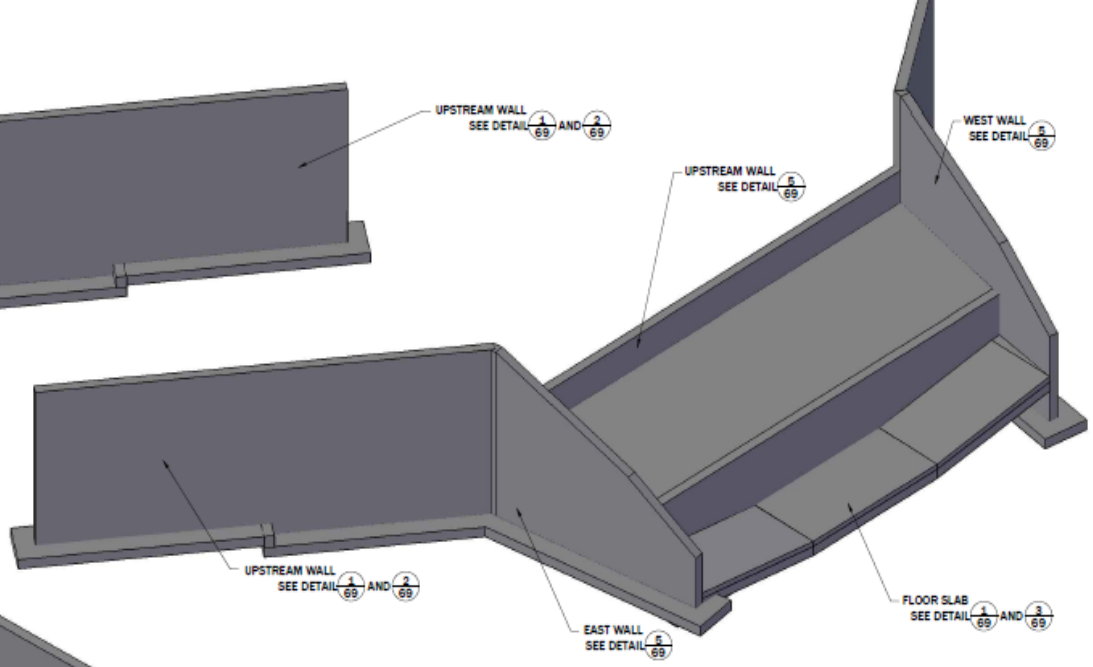
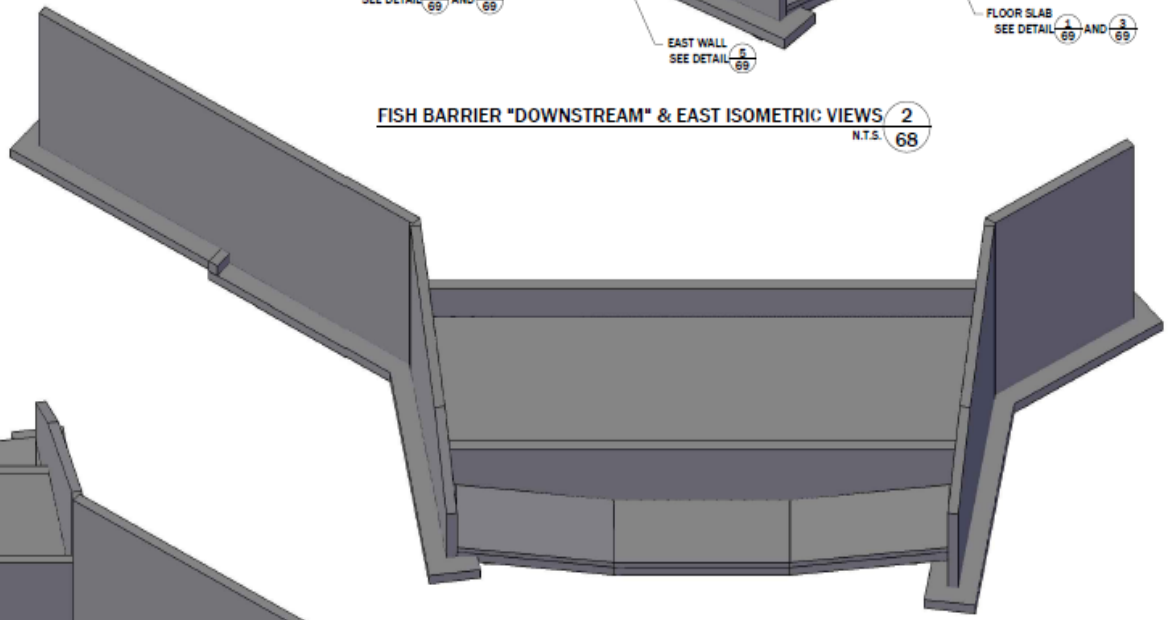


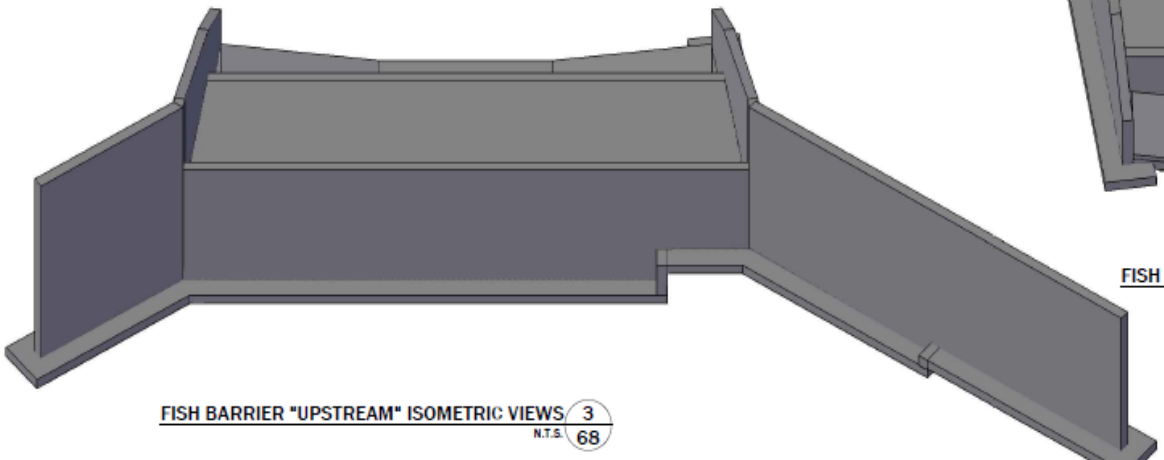
FISH BARRIER "UPSTREAM" & WEST ISOMETRIC VIEWS 1/68
N.T.S.



FISH BARRIER "DOWNSTREAM" & EAST ISOMETRIC VIEWS 2/68
N.T.S.



FISH BARRIER "DOWNSTREAM" ISOMETRIC VIEWS 4/68
N.T.S.



FISH BARRIER "UPSTREAM" ISOMETRIC VIEWS 3/68
N.T.S.

PIONEER
TECHNICAL SERVICES, INC.


Before, During, & After
















CONCLUSIONS

- TEAMWORK AMONGST ALL PARTIES IS THE KEY TO SUCCESS
- YouTube – Pioneer Technical Services

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