RECLAMATION

Managing Water in the West

Value Engineering

Final Report

St. Mary Diversion and Headworks Replacement and ESA Modifications

K8T-1510-GP10-008-00-0-1

Conducted in Cooperation with Bureau of Indian Affairs and Fish and Wildlife Service for Bureau of Reclamation, Great Plains Region

U.S. Department of Interior
Bureau of Reclamation
Technical Resources Office
Design, Estimating, and Construction (DEC)
Oversight and Value Program Office
Denver, Colorado

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Executive Summary

The Value Study Team met on March 28, 2011, for a five-day study of the St. Mary Diversion and Headworks Replacement and ESA Modifications. The estimated cost of the baseline design is approximately $22,000,000. The Value Study Team developed seven proposals, which are summarized (in random order) below. If all the savings proposals are accepted, their maximum savings potential is $13,295. Note that in calculating the maximum potential savings, the cost of the study ($60,000) was not deducted.

It is notable that the majority of the proposals are cost additives. Cost additive proposals should not be immediately discounted just because they do not reduce the overall cost of the project. The value that these proposals add to the project is described in the individual proposal detail provided in this report.

Independent Proposals: The following proposals are independent of all other proposals and could be accepted or rejected individually without affecting other proposals. Proposal Nos. 1, 2, and 3 could be combined for additional value. These proposals would provide enhanced constructability or cost savings for the baseline design.

Proposal No. 1. Automated Trash Removal. The estimated additional costs of this proposal is $560,000 before adding any study and/or implementation costs.

Proposal No. 2. Salvage Membrane. The estimated cost savings of this proposal is unknown before adding any study and/or implementation costs.

Proposal No. 3. Alternate Building Materials. The estimated additional cost of this proposal is $48,300 before adding any study and/or implementation costs.

Proposal No. 4. Combine Control Buildings. The estimated additional cost of this proposal is $64,300 before adding any study and/or implementation costs.

Proposal No. 5. PIT Tag Monitoring System. The estimated additional cost of this proposal is $435,000 before adding any study and/or implementation costs.

Proposal No. 6. Electric Barrier Installation. The estimated additional cost of this proposal is $660,000 before adding any study and/or implementation costs.

Proposal No. 7. Modified Fish Bypass Chute. The estimated cost savings of this proposal is $13,295 before deducting any study and/or implementation costs.

In addition to the proposals listed above, the Value Study Team identified eight items which should be considered during the final design process. These items are included in the "Design Considerations" table shown on page 32.

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Value Method Process

The Value Method is a decision-making process, originally developed in 1943 by Larry Miles, to creatively develop alternatives that satisfy essential functions at the highest value. It has many applications but is most often used as a management or problem-solving tool.

The study process follows a Job Plan that provides a reliable, structured approach to the conclusion. Initially, the Team examined the component features of the program, project or activity to define the critical functions (performed or desired), governing criteria and associated costs. Using creativity (brainstorming) techniques, the Team suggested alternative ideas and solutions to perform those functions, consistent with the identified criteria, at a lower cost or with an increase in long-term value. The ideas were evaluated, analyzed and prioritized, and the best ideas were developed to a level suitable for comparison decision making and adoption.

This report is the result of a “formal” Value Study by a Team comprised of people with the diversity, expertise, and independence needed to creatively scrutinize the issues. The Team members bring a depth of experience and understanding to the discipline they represent; and an open and independent enquiry of the issues under study, to creatively solve the problems at hand. The Team applied the Value Method to the issues and supporting information, and took a “fresh” look at the problems to create alternatives that fulfill the client’s needs at the greatest value.

Current Description

Background: The St. Mary's Diversion Works was constructed in 1915 on the St. Mary River, 0.75 miles downstream from Lower St. Mary Lake near Babb, Montana. The project consists of a 6-foot concrete weir and sluiceway with a length of 198-feet. The St. Mary Diversion Dam diverts water into the St. Mary Canal, located on the west side of the St. Mary River.

In November 1999, the U.S. Fish and Wildlife Service (FWS) listed the bull trout as a threatened species under the Endangered Species Act. The listing of bull trout prompted the U.S. Bureau of Reclamation (Reclamation) to evaluate methods that would prevent entrainment of fish into the canal, to move upstream past St. Mary Diversion Dam (Mefford, et al, 2003), and allow passage in the St. Mary River. Additionally, the infrastructure is aging and updates have been proposed. As a result, Reclamation is considering concepts for replacing the existing dam and canal headworks with a new dam and headworks. The new facility will include adequate screening and fish passage both at the dam and from the canal back to the river, while providing exclusion of invasive species.

The diversion dam, headworks, and canal are approaching 100-years old. Recent exams of the diversion dam and headworks revealed substantial freeze-thaw damage to exposed concrete surfaces. Concrete core samples taken from the diversion dam and headworks indicated very poor concrete exists where concrete has been exposed to ice and frequent freeze-thaw action. The baseline design includes replacement of the existing diversion and intake facility, a rock ramp fishway, one sluiceway, trash racks, and a vertical fish screen.

Figure 1 - General and Location Map

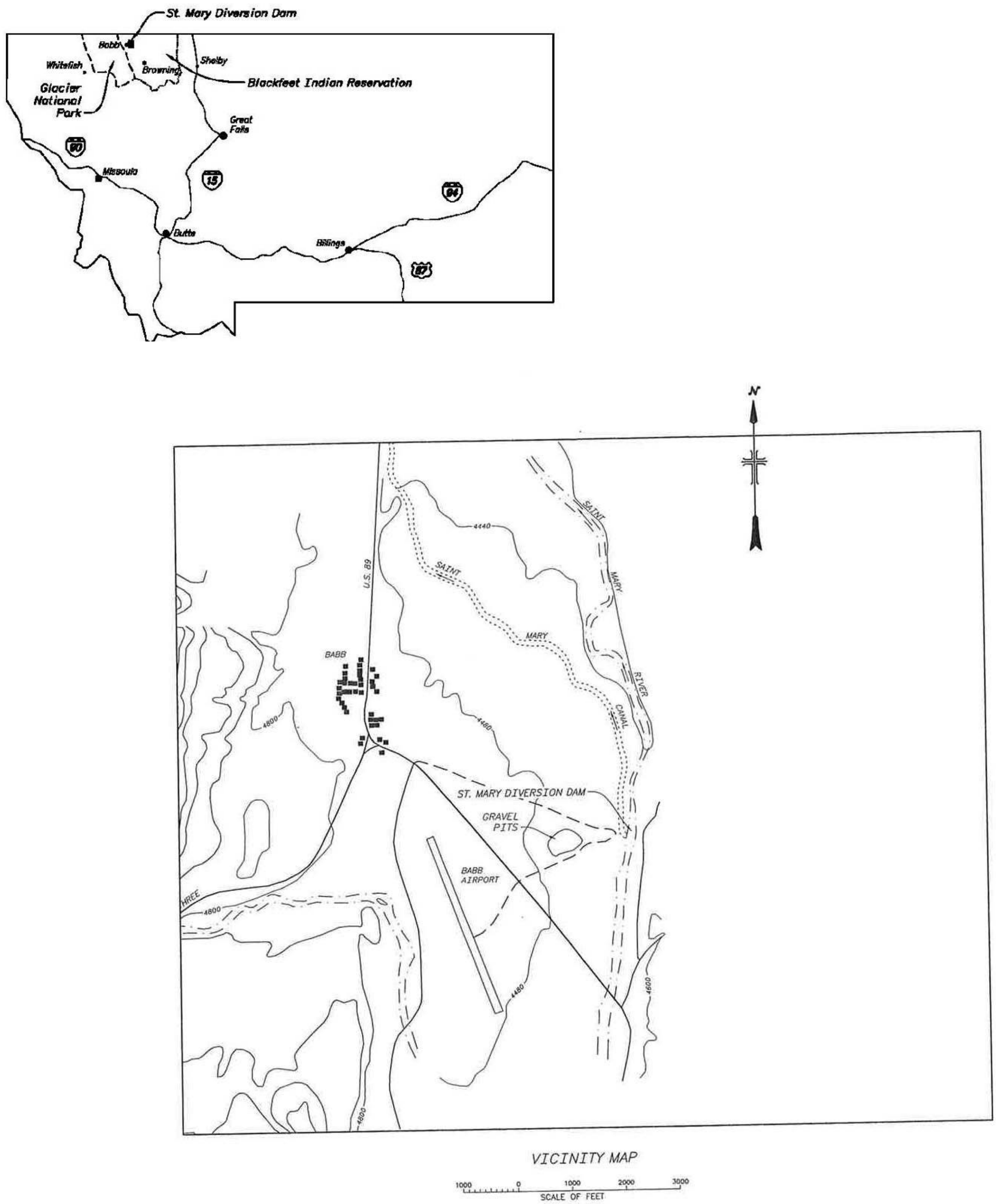


Figure 2 - Site Plan

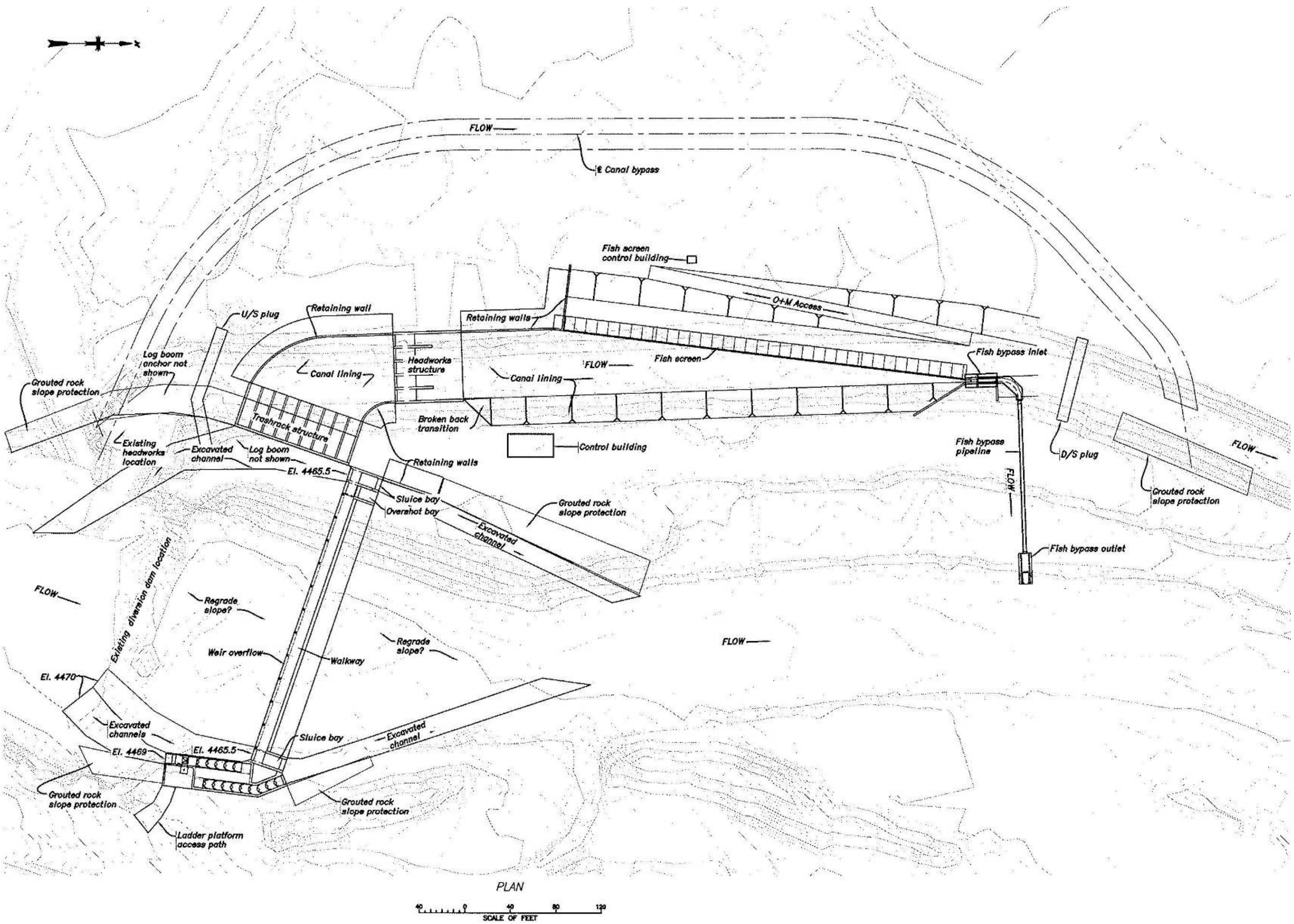
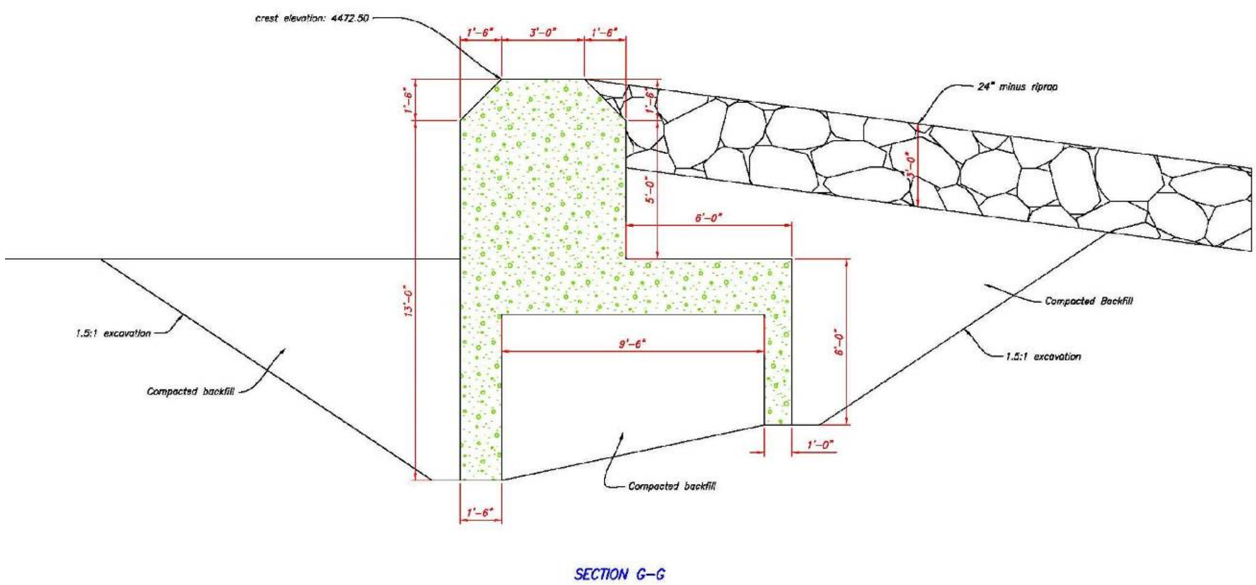


Figure 3 - Baseline Cross Section (Rock Ramp)



Owner, Users, and Stakeholders List Identification and Issues Determination	
Owner	**Owner Issues**
Bureau of Reclamation	Water Management, ESA Compliance, Maintenance, Tribal Trust, Worker and Public Safety, Cost
User	**User Issues**
Irrigators	Reliable Water Supply, Cost, Future O&M Costs, Economic Stability
Tribe	Fisheries, Wildlife, Water Rights, Environmental Impact, Impacts to Landowners, Impacts to Swiftcurrent Creek Restoration Projects, Cultural Impacts, Socioeconomic Impact, Invasive/Exotic Species, Water Based Recreation
Municipalities	Reliable Water Supply, Cost, Future O&M Costs, Economic Stability
General Public	Water Based recreation, Access, Fish and Wildlife, Aesthetics, Economics
Stakeholder	**Stakeholder Issues**
National Park Service	Water Based Recreation, Visitor and Maintenance Access, Natural Resource Impacts and Benefits, Aesthetics, Water Quality and Quantity, Physical Habitat and Connectivity, Ecosystem Impacts, Invasive/Exotic Species
General Public	Water Based Recreation, Access, Fish and Wildlife, Aesthetics, Economics
Montana Department of Natural Resources and Conservation	Reliable water supply for irrigators and communities, Functional St Mary canal system
US Fish & Wildlife Service	ESA Regulatory Responsibility, Critical Habitat, Natural Resource Impacts and Benefits, Water Quality and Quantity, Physical Habitat and Connectivity, Ecosystem Impacts, Invasive/Exotic Species
Canada	St Mary - Milk River allocations by International Treaty

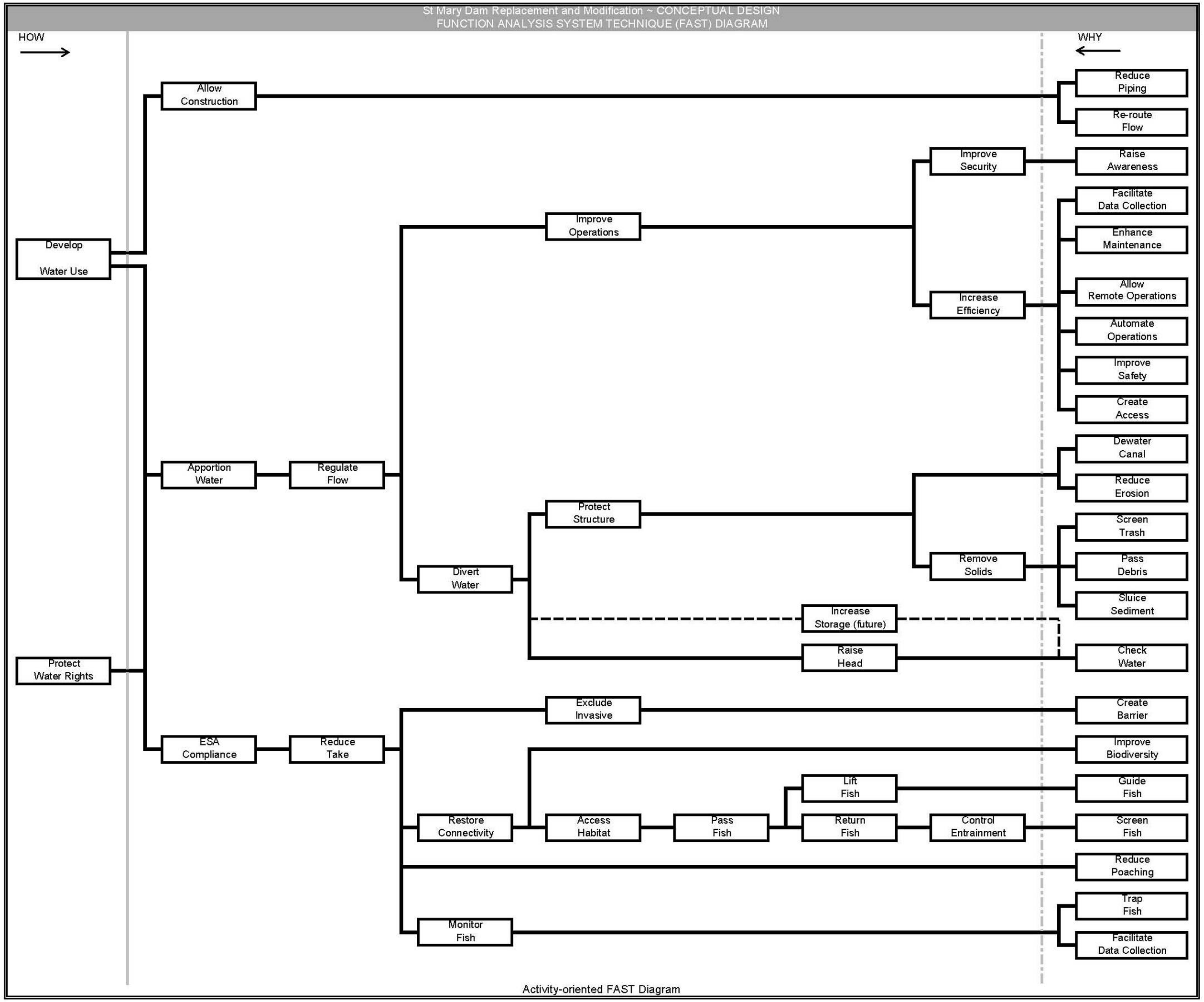
Function Analysis System Technique (FAST)

The Value Study Team used the function analysis process to generate a Function Analysis System Technique (FAST) diagram, designed to describe the present solution from a function point of view. The FAST diagram helped the Team identify those design features that support critical functions and those that satisfy noncritical objectives. The FAST diagram helped the Team focus on a common understanding of how project objectives are met by the present solution.

Component	Active Verb	Measurable Noun
Structural	Develop	Water use
Structural	Protect	Water Rights
Sitework	Allow	Construction
Headworks Structure	Apportion	Water
Structural	ESA	Compliance
Structural	Regulate	Flow
Structural	Reduce	Take
Structural	Divert	Water
Fish Ladder	Restore	Connectivity
Mechanical – Headworks Structure	Monitor	Flow
Overshot Gates	Improve	Operations
Mechanical – Trashrack Structure	Protect	Structure
Fish Screen	Exclude	Invasives
Fish Ladder	Access	Habitat
Fish Ladder	Pass	Fish
Crest Overshot Gates	Increase	Storage (future)
Fish Ladder	Lift	Fish
Bypass Pipe	Return	Fish
Control Building	Improve	Security
Structural	Increase	Efficiency
Mechanical – Trashrack Structure	Remove	Solids
Fish Screen	Control	Entrainment
Sitework	Reduce	Piping
Sitework	Re-route	Flow
Structural	Raise	Awareness
Structural	Facilitate	Data collection (civil)
Control Building	Enhance	Maintenance
Control Building	Allow	Remote operations
Control Building	Automate	Operations
Structural	Improve	Safety
Sitework	Create	Access
Cofferdam, dewatering, unwatering	Dewater	Canal
Sitework	Reduce	Erosion
Mechanical – Trashrack Structure	Screen	Trash
Overshot Gates	Pass	Debris

Mechanical – Headworks Structure	Sluice	Sediment
Structural	Check	Water
Structural	Create	Barrier
Fish Ladder	Improve	Biodiversity
Fish Ladder	Guide	Fish
Fish Screen	Screen	Fish
Fish Ladder	Reduce	Poaching
Fish Screen	Trap	Fish
Fish Ladder	Facilitate	Data collection (bio)

Figure 4 - St. Mary Dam Replacement and Modification – FAST Diagram



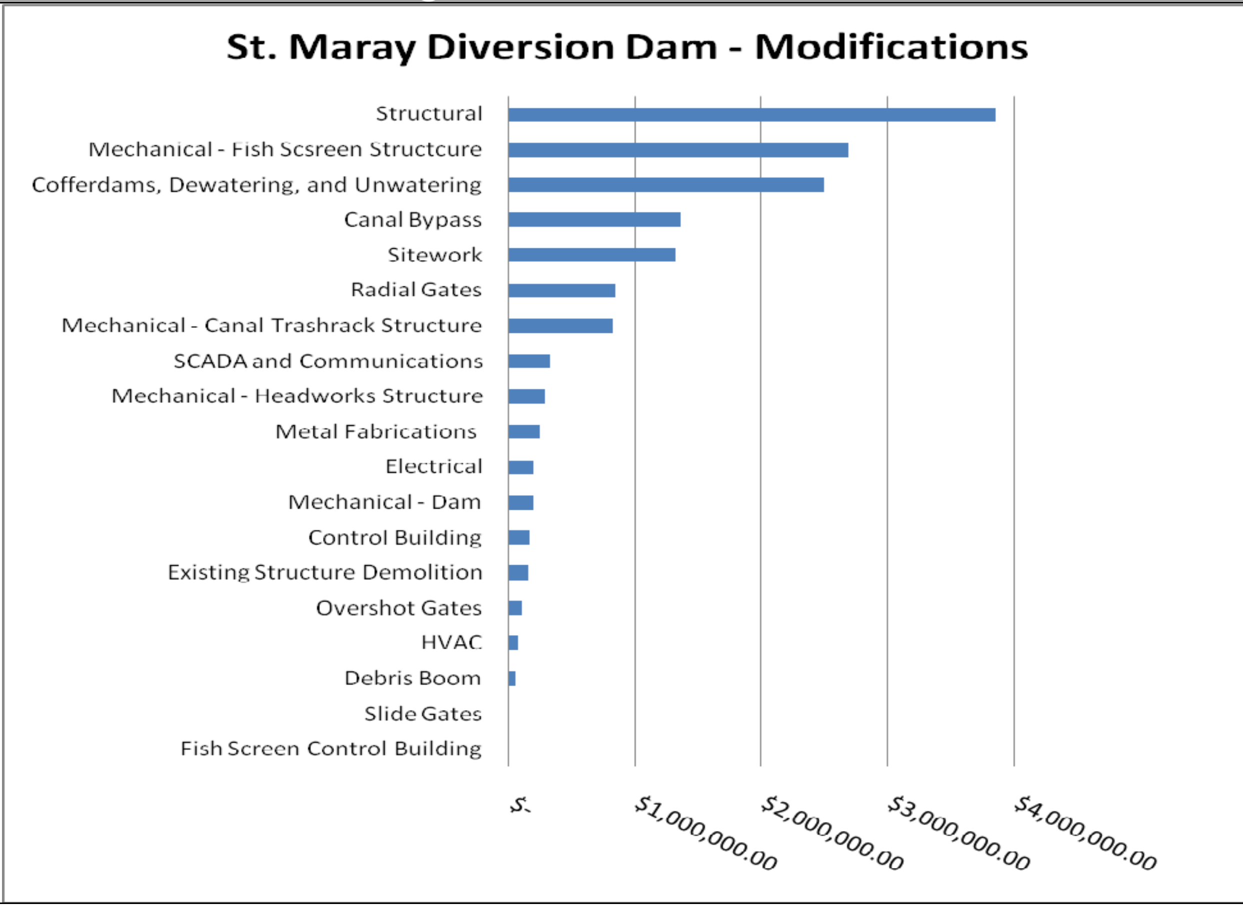
Cost Model and Estimate Information

The Value Study Team cost model is based on the conceptual design estimates provided by the Design Team for the preferred project design. The cost model was developed by the Value Study Team and was used to focus on features with the greatest potential for savings and to highlight areas of value mismatch. Unit prices were reviewed by the Cost Estimator and Value Study Team members to ensure reliability and applicability.

Cost Savings and the original design concept estimates are of the same general level of development, although these costs may vary as final designs are pursued.

Note: The cost estimates prepared for this study have been developed for the sole purpose of comparing costs of proposals to the functional equivalent in the baseline design. The value study schedule dictates the time and resources allowed for preparation of cost estimates for each proposal alternative. Therefore, these cost estimates are not recommended to be used for budgeting or construction purposes. At the time of final specification, the Design Team will more accurately quantify any savings/avoidances resulting from acceptance of proposals. This information will be reported in the accountability report. If as a result of the Value Study a cost estimate is required for appropriations, we recommend that a new total baseline cost estimate be completed.

Figure 5 - Cost Model



Proposal No. 1: – Automated Trash Removal

Description

Proposal No. 1.   Automated Trash Removal

Proposal Description: Use automated trash removal rake at the trash rack at the river turnout

Critical Items to Consider: Operators at DNRC's Toston power plant use a trash rake manufactured in Austria by Kuenz (www.kuenz.com translate to English. See Figure 6). It greatly eases the handling of Missouri River debris at the dam and plant intake. Use of a specially designed rake would eliminate the potential for damage to occur to the rack if an excavator with just a bucket and thumb is used to remove trash.

Ways to Implement: Make trash rack steeper, minimize structural footprint for trash rack, and add automated trash rake to remove trash.

Changes from the Baseline Design: Add automated trash removal to assumptions for the structure

Advantages	Disadvantages
• Automated removal of trash. • Prevents additional damage vs excavator usage. • Improves safety for trash removal. • Improves reliability for canal flow. • Dedicated equipment for trash removal. • Makes labor/equipment resources available for other service needs.	• Requires access. • Required trash pile removal. • Additional equipment O&M.

Potential Risks

Electrical / Mechanical failure removes the ability to remove trash from the rack. Hydraulic leak may not be immediately detected and posses an additional risk to the stream.

Cost Item	Nonrecurring Costs
Original Baseline Design	$ 0
Value Concept	$ 560,000
Additional Costs	$ 560,000

Figure 6 - Automated Trash Rake

Proposal No. 2: Salvage Membrane

Description

Proposal Description: Salvage membrane in temporary bypass channel to contractor

Critical Items to Consider: Unless we use Visqueen in a geotextile sandwich, the impervious liner for what should be only a temporary bypass channel will be quite expensive. Depending on the contractor, we may see some savings in that bid item if the contractor is allowed to salvage the liner for reuse or sale. Assumptions and questions:

- Assume the impervious membrane is between two layers of geotextile
- Assume since it will be temporary that it does not need to have rock/pit run/whatever cover (Ignore freeze/thaw issue)
- Assume minimum 3 year service lifespan
- Needs to be robust to environmental factors and damage.

Ways to Implement: Make changes to Contract to require salvage value from the Contractor for the geotextile in the temporary bypass channel.

Changes from the Baseline Design: Additional detail in the contract to alert the contractor of salvage expectations.

Advantages	Disadvantages
• Reduces landfill waste. • Product Recycling.	• Potential for salvage is unknown.

Proposal No. 3: Alternate Building Materials

Description

Proposal Description: Construct control building using precast concrete panels in lieu of current design. For example, see Figure 7.

Critical Items to Consider: Specify high "R" value materials for use in the contract due to climate. Addition of sky light will provide energy efficient lighting for structure.

Ways to Implement: Specify alternate material in contract.

Changes from the Baseline Design: New design material for construction.

Advantages	Disadvantages
• More vandal resistant • More durable • Precast is stronger due to controlled environment when formed • Less maintenance. • Energy.	• None identified.

Potential Risks

None Identified.

Cost Item	Nonrecurring Costs
Original Baseline Design	$175,700
Value Concept	$224,000
Additional Costs	$48,300

Figure 7 - Supplier for Precast Concrete

http://www.missoulaconcrete.com/

Proposal No. 4: Combine Control Building/Storage Area

Description

Proposal Description: This proposal is to combine the two Control Buildings into one building located where the Fish Screen control building currently sits (see Figure 8). We would also add an area to store some equipment (see Figure 7).

Critical Items to Consider: Distance of Electrical runs.

Ways to Implement: Design buildings to combine all functions required.

Changes from the Baseline Design: One building instead of two (or more). See Figure 9.

Advantages	Disadvantages
• Only have to secure one building. • Easier access to control building. • Provides some on-site secure storage for equipment. • Less area to secure with fencing. • Smaller over all site footprint.	• Increases electrical run to control gates.

Potential Risks

Consolidation may increase vandalism .

Cost Item	Nonrecurring Costs
Original Baseline Design	$175,700
Value Concept	$240,000
Additional Costs	$ 64,300

Figure 8 - Alternative Building Layout

New Building would be 16 x 46.

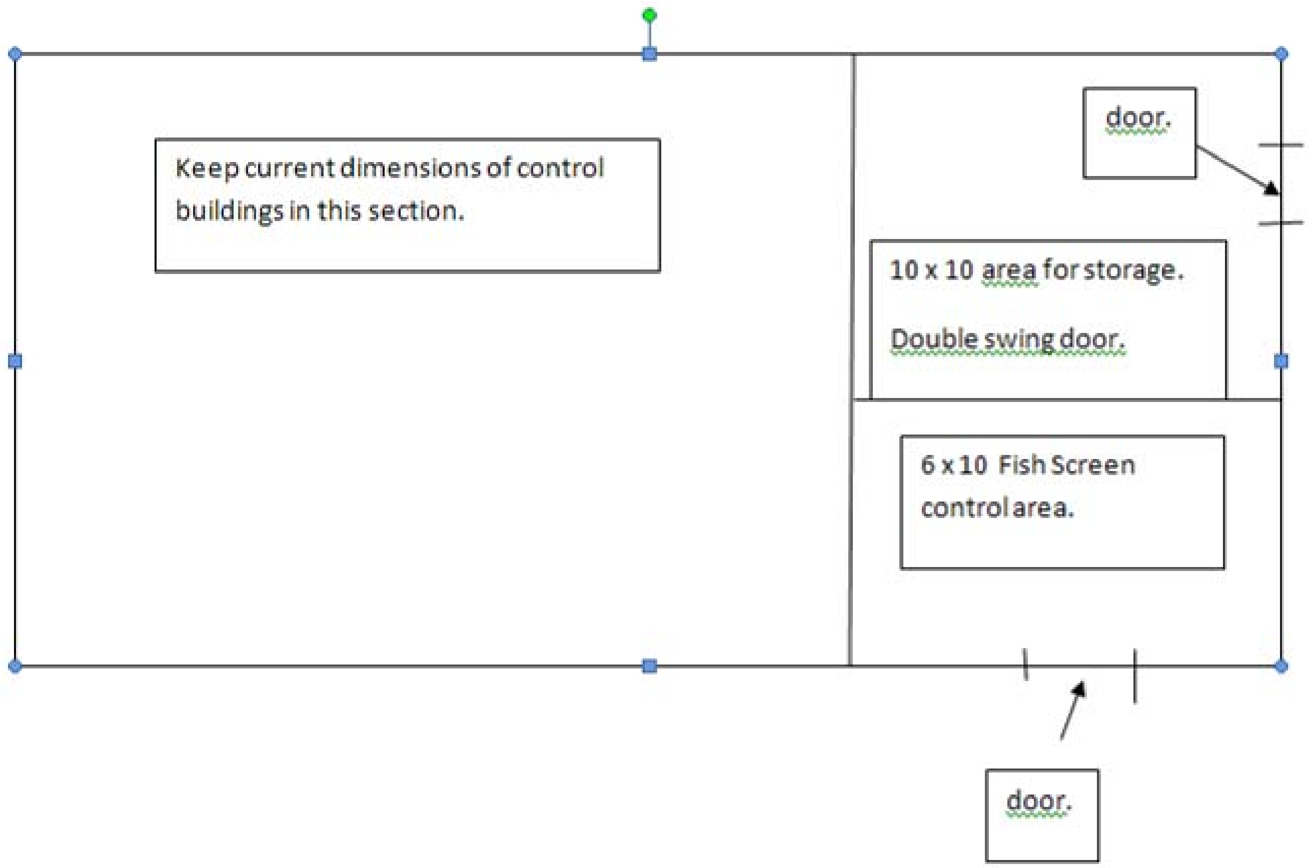
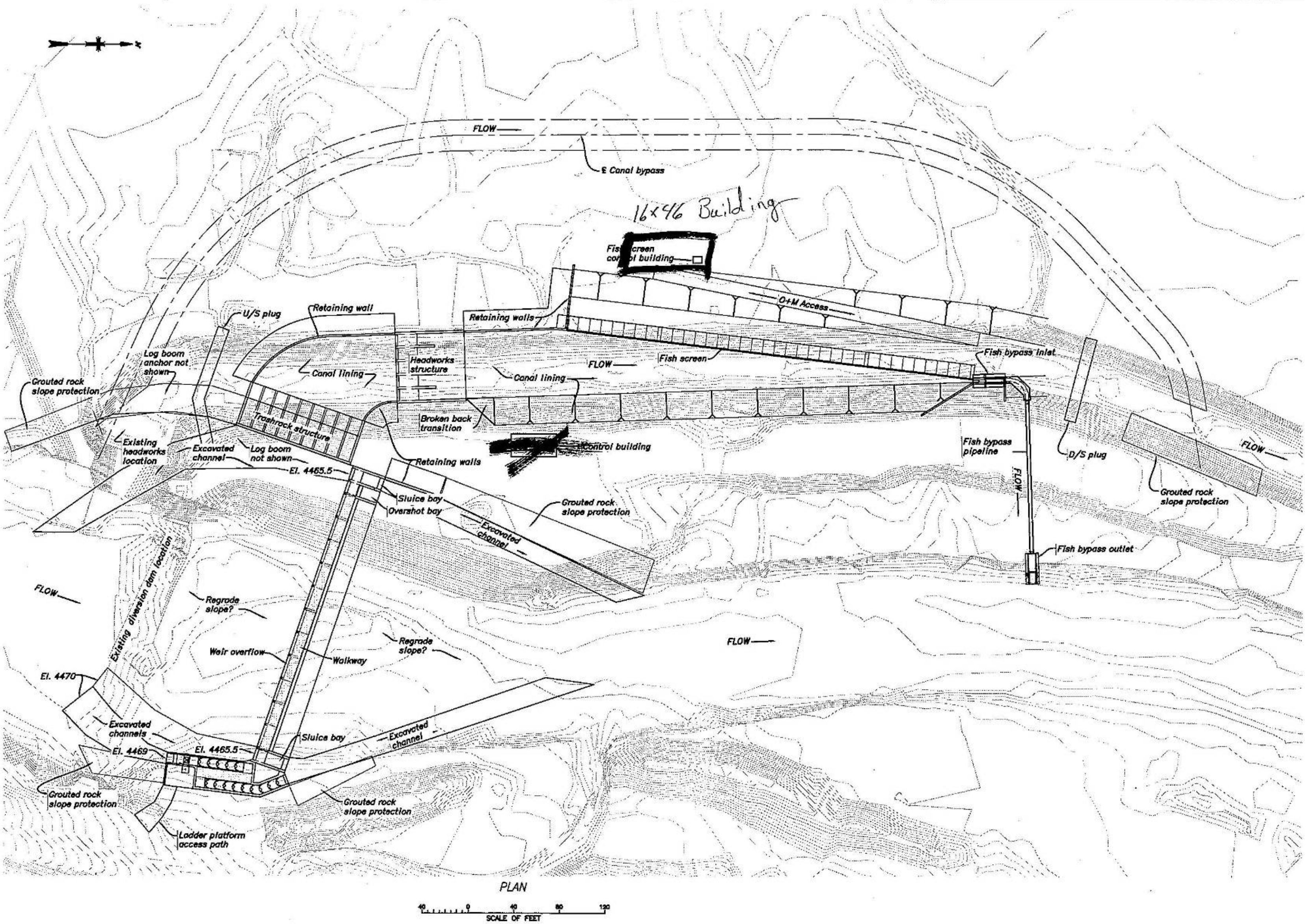


Figure 9. - Revised Site Layout



Proposal No. 5. PIT Tag Monitoring System

Proposal Description: Use of PIT-Tag Monitoring System to monitor fish (up and downstream) passage at the St. Mary Diversion

Critical Items to Consider:

- This system would be additive to the proposed designs of the St. Mary Diversion and facilities.
- A PIT-Tag monitoring system is required to monitor efficacy of fish passage at the St. Mary Diversion.
- Tagging operations are conducted annually in the St. Mary drainage and a number of tagged Bull Trout already exist in the drainage. This system allows ability to monitor these previously tagged fish and take full advantage of this previous tagging investment.
- Pass-by Antennae (flat-plate) would be used on the dam crest and in the sluiceways.
- Pass-Through Antennas would be used in the fish ladder and fish bypass outlet.
- PIT-Tag Antennas in the sluiceways would only be used during sluicing operations.
- PIT-Tag Antennas in the fish bypass outlet would only be used while canal intake is in operation.
- PIT-Tag Antennas in the fish ladder would only be used while the fish ladder is in operation.
- PIT-Tag Antennas on dam crest would only be used while spilling water over dam crest.
- Paired PIT-Tag Antennas would be used to determine direction of fish movement.
- Would need conduits to run power and antenna/transceiver cables.
- Distance from antennas to transceivers may limit efficiency of PIT-Tag detection.

During the development of this proposal, it was discovered that the technology does not exist yet to cover the crest of the dam (figure 10, location 6) at the expected flows. Provided cost, therefore, does not cover this system for the dam crest. Contactor stated that the technology to cover the crest is only a year or two into the future.

Ways to Implement: Contractor based installation; proprietary techniques; custom build. Would require a Memorandum of Understanding regarding data collection and cost of operation. Could be permanent or temporary.

Changes from the Baseline Design: This system represents a Development - based requirement for fish passage monitoring. See Figure 11.

Advantages	Disadvantages
• Automation. • Shown to be effective in several case-studies. • Effective at determining fish passage. • Successfully used at multiple hydro-barriers in the U.S. to monitor fish passage. • Passive fish monitoring.	• May require some O&M. • Ability to monitor may be limited by very high water and frequency interference from some structure. • Would need space to house tag readers. • Larger footprint (conduit) for fish monitoring.

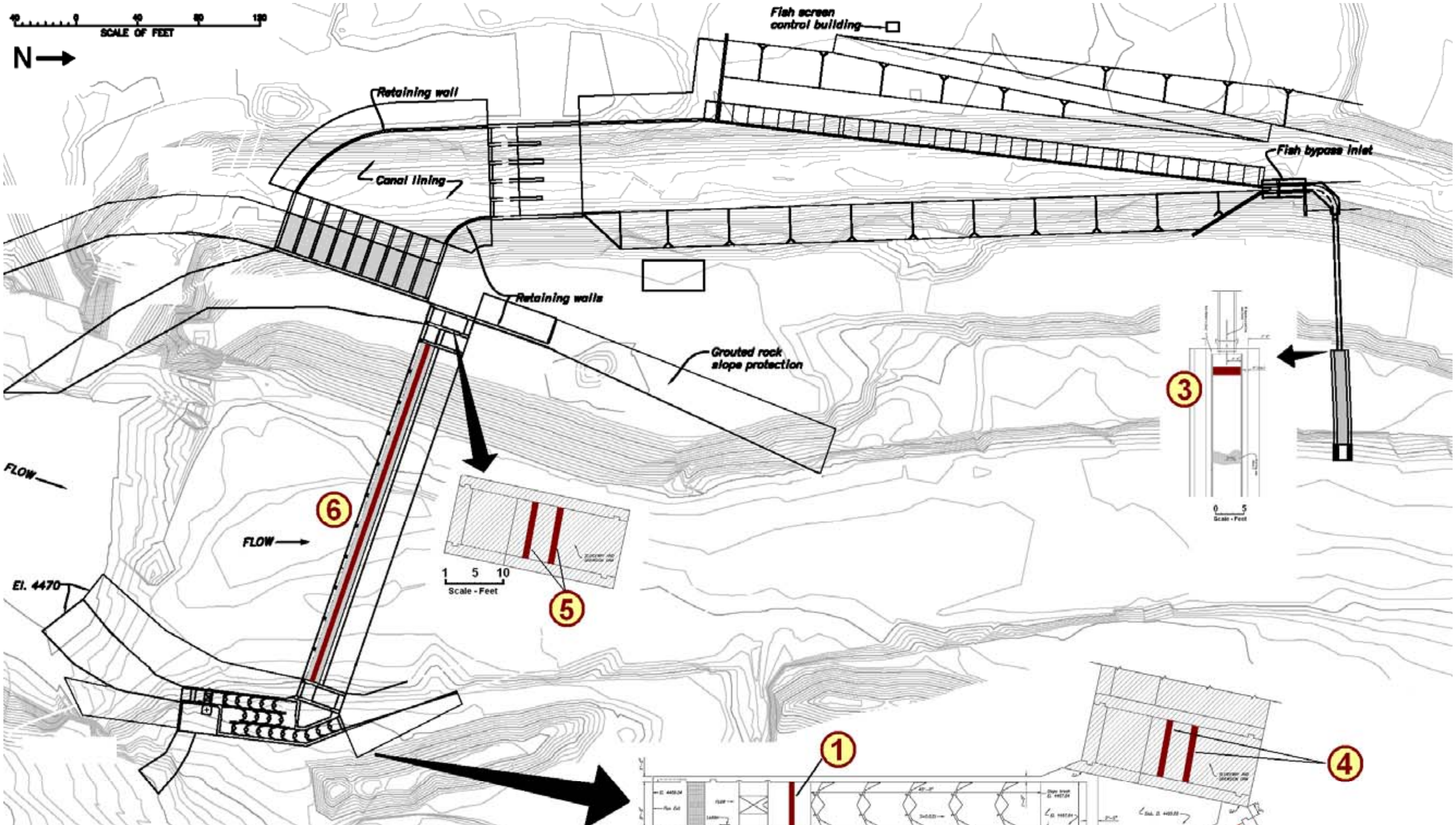
Potential Risks	
None Identified	
Cost Item	**Nonrecurring Costs**
Original Baseline Design	$0
Value Concept	$435,000
Additional Costs	$435,000

Figure 10 - PIT Tag Antenna

Pass-By Antenna

Pass-By Antenna

Figure 11 - Revised Site Layout



(#) - PIT Tag Antennae Locations

1 - Single Antenna - Fish Ladder (Upstream End)
2 - Paired Antennae - Fish Ladder (Downstream End)
3 - Single Antennae - Fish Screen Bypass Return Chute
4 - Paired Antennae - Sluiceway Channel (West)
5 - Paired Antennae - Sluiceway Channel (East)
6 - Dam Crest

Proposal No. 6: Electric Barrier Installation

Description

Proposal Description: Use of Electrical current to prevent upstream passage of non-native species at the St. Mary Diversion. See Figures 12 and 13.

Critical Items to Consider:

- Barrier only functional at prevention of upstream migration at this site
- Barrier likely embedded in concrete apron below diversion dam
- Requires '50 amp' service drop. Probably needs generator back-up
- Likely used year-round
- Automated but needs to be tuned. Not robust to changes in salinity or large increases in water-depth
- This is a behavioral barrier, not a physical barrier
- O&M requirements (for example, cathodic loss)
- Represents shock hazard to recreationalists

Ways to Implement:

- Contractor based installation. Proprietary techniques
- Likely need to coordinate with General Contractor during removal and reinstallation of apron
- Permanent vs. Temporary?
- Requires de-watering
- Good fit for concrete

Changes from the Baseline Design: This represents an additional level or a standalone option to block upstream passage or to guide fish to the ladder

Advantages	Disadvantages
• Automation. • Shown to be effective in several case-studies. • Effective at blocking large fish. • Can be used to span entire diversion dam. • Improve utilization of ladder.	• Behavioral barriers are never 100 percent effective • Maintenance if cathodic loss occurs • Engineering for Rock Ramp design problematic. • Not robust to changes in salinity or increasing water depth. • Arcing might cause fire hazard.

Potential Risks

Electrocution risk, Life span of Barrier, Additional cathodic loss to other exposed steel structure, possible interference with gate automation.

Cost Item	Nonrecurring Costs
Original Baseline Design	$0
Value Concept	$660,000
Additional Costs	$660,000

Figure 12 - Site Layout for Electrical Barriers

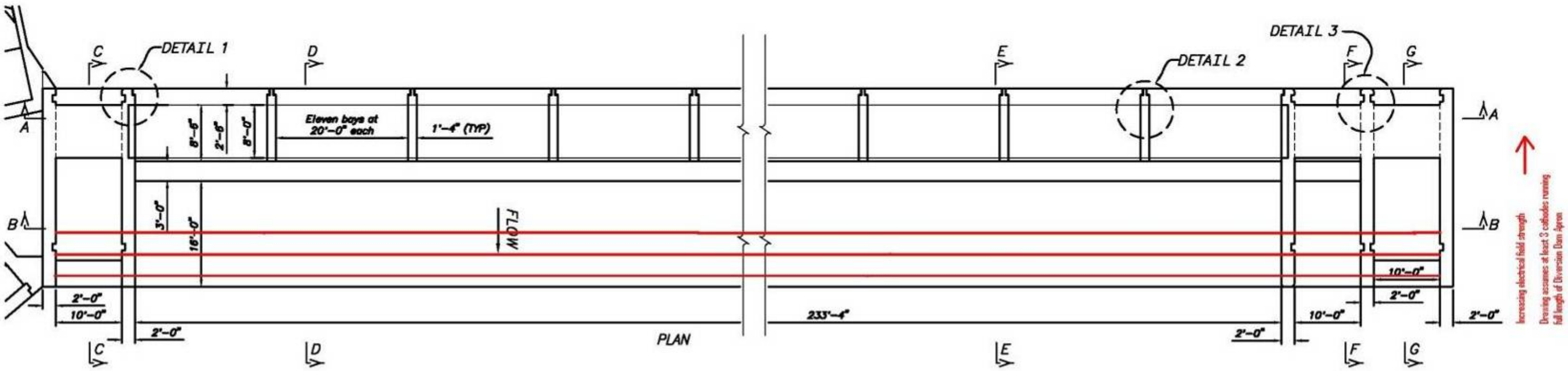


Figure 13 - Electrical Barrier Installation

Proposal No. 7. Modified Fish Bypass Chute

Proposal Description: Replaces the downstream section of the bypass pipe with a modified concrete channel to accommodate fish sampling gear

Critical Items to Consider:

- This would replace the proposed designs of the St. Mary Diversion fish bypass pipe and outlet.
- This addition replaces the lower 34 feet of the bypass pipe by extending the downstream chamber 34 feet west towards the canal, resulting in 50 feet of open top concrete channel (chute).
- This modification is being done to facilitate fish sampling associated with fish screening and bypass operations while avoiding over-river safety issues and sampling difficulties.
- Sampling devices are "flow-through" and would not impact bypass outlet flow.
- Fish sampling gear attachment points would utilize either temporary or permanent concrete anchors.

Ways to Implement: Sampling devices could be installed at time of construction or after

Changes from the Baseline Design: Additional chute length to accommodate fish monitoring and ease pipe cleanout.

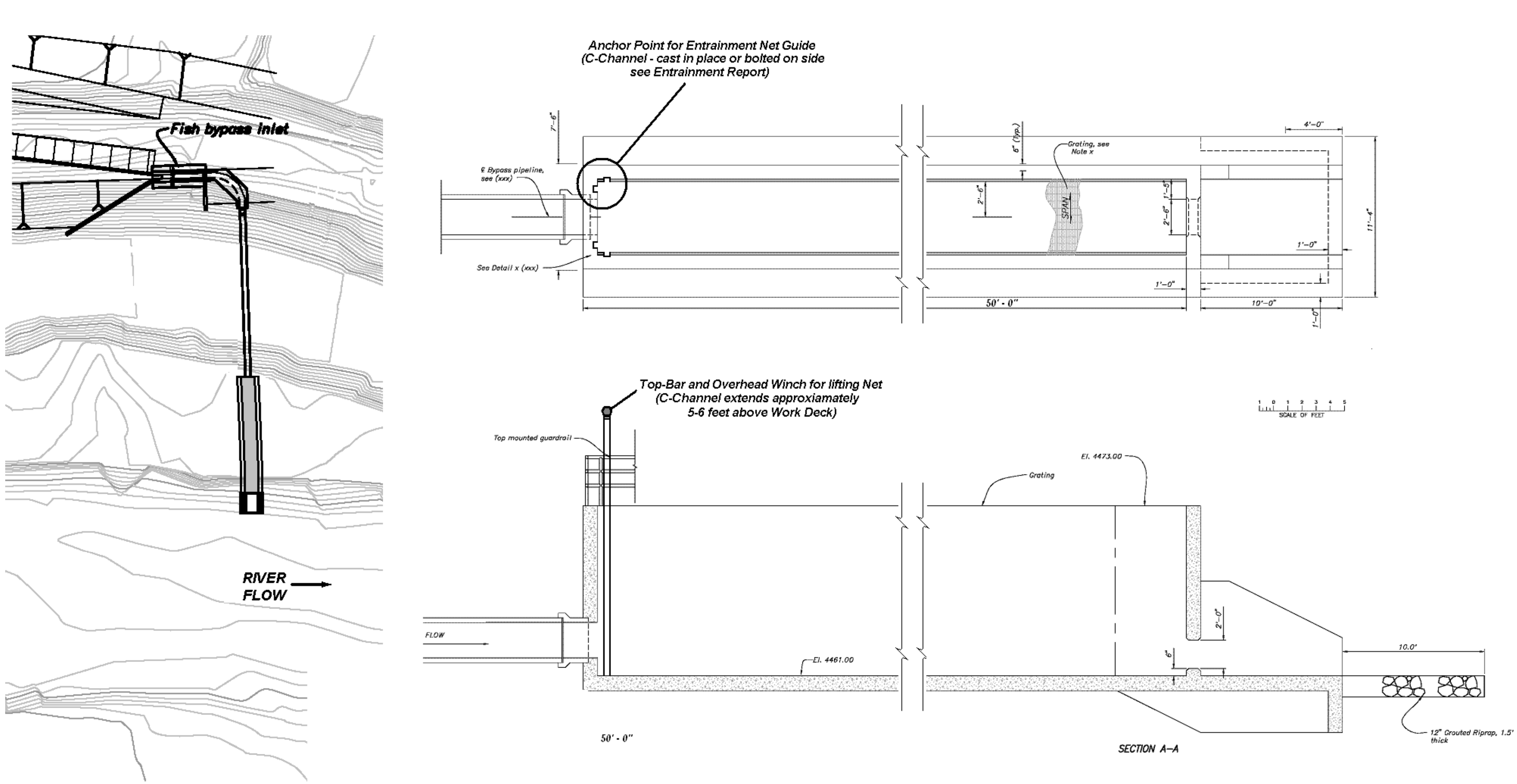
Advantages	Disadvantages
• Provides a safe and sizeable working area. • Removes sampling gear from river. • Could improve bypass maintenance. • Provides two new biological sampling methodologies (PIT-Tag monitoring, entrainment netting). • Shorter length of pipe for removing plugs.	• May require some O&M. • Increased concrete "footprint" and potential spalling. • Might affect downstream hydrology. • Additional earthwork to avoid erosion into chamber.

Potential Risks

None identified.

Cost Item	Nonrecurring Costs
Original Baseline Design	$23,487
Value Concept	$10,192
Savings	$13,295

Figure 14 - Modified Bypass Chute Layout



Design Considerations

1) Provide cost impacts of overshot gates (Obermyers) on the concrete structure option for direct comparison to rock ramp option

2) Provide cost impacts of designing for 100-year flood in lieu of 800-year flood

3) Baseline screen vs. inverted ‘V’ or ‘W’ screens – advantages and disadvantages

4) Slide gate at return pipe outlet chamber. May need a slide gate for optimum control of water trying to travel up return pipe while headworks is dewatered.

5) Project operators prefer slide gates over radial gates. What are the advantages of the radial gates?

6) Consider entire flow requirements. Is there enough water during low flows to supply water to the canal, fish ladder, AND fish return flows?

7) Leave access to return pipe outlet. May want to design an access to the return pipe outlet or specify that the Contractor will leave construction access.

8) Change design assumptions to bolted fish screens. VE Team found no advantage to having the ability to remove the screens during operation. We advise assuming the bolted screens will be used instead of the slide-in screens.

Design Options

The below listed Design Options are listed in increasing cost order as understood by the Value Team. These options are listed here to put into perspective new options considered during the Value Study. Design Option 1 and 5 are those options that were presented by the Design Team as the options at 30 percent Design. Design Option 6 has been determined, by the Value Team, to lack sufficient value to be considered any further. Options 2, 3, and 4 seem to be valid options that were beyond the ability of the Value Team to develop. However, this listing provided considerable value to the Value Team; therefore, it is provided here for the Design Teams further use, consideration and/or development.

Description
Design Option 1: Rock Ramp Option (Baseline Proposal, 30 Percent Design Option) <u>Proposal Description:</u> Grouted Rock face with concrete core with a crest elevation (El) of 4472.5 that will check water elevation for water user diversion and pass fish over crest of dam when adequate flow is provided. <u>Critical Items to Consider:</u> No opportunity to monitor fish and obtain feedback for effectiveness of structure to address ESA concerns.
Description
Design Option 2: Concrete Crest Dam (with Fish Ladder) <u>Proposal Description:</u> Concrete Crest Dam with a crest elevation of 4472.5 that will check water elevation for water use diversion and pass fish through a formal fish ladder in order to monitor effectiveness to address ESA concerns <u>Critical Items to Consider:</u> Would required future modifications to provide for additional storage in Lower St. Mary Lake instead of making allowances for the opportunity now.
Description
Design Option 3. Concrete Crest Dam (with Fish Ladder) and 3-feet Additional Elevation <u>Proposal Description:</u> Construct Concrete Crest Dam with a crest elevation of 4475.5 that will check water elevation for water use diversion, pass fish through a formal fish ladder, and capture additional water for storage. <u>Critical Items to Consider:</u> Increased surface elevation on Lower St. Mary Lake. Potential flooding of homes around Lower St. Mary Lake.

Description
Design Option 4. Relocate Headworks and Fish Screen to Kennedy Creek Siphon Proposal Description: Make no improvements to headworks at St. Mary Diversion. St. Mary Diversion Structure would be replaced at a later date to ensure water diversions into canal. Make new structures at the Kennedy Creek Wasteway to remove trash, control flows, and remove fish (see addendum for additional information). Critical Items to Consider: Separating headworks structures from diversion and fish ladder (all fee land) would be good location for new Camp 9. Could, conceivably, be cost neutral.

Description
Design Option 5. Concrete Crest Dam (with option to build overshot gates in the future, 30 Percent Design Option) Proposal Description: Build Concrete Crest Dam (with formal fish ladder) to elevation 4472.5 with over built crest to allow for future possible overshot gates to raise crest to elevation 4475.5. Critical Items to Consider: None identified

Description
Design Option 6. Concrete Apron with 10-foot Overshot gates Proposal Description: Build concrete apron and use 10-foot overshot gates to adjust dam crest anywhere between apron level and elevation 4475.5 Critical Items to Consider: Most expensive option with no additional value realized. Eliminated by VE Team

Disposition of Ideas

During the Creative Phase of the Value Engineering Study, the team is encouraged to offer any and all ideas on how to solve the problem. Criticism is strictly prohibited to provide an environment in which everyone can feel comfortable in offering thoughts and ideas without feeling evaluated on their professional capabilities by the ideas they offer. Also, it has been demonstrated that one persons "stupid" idea can often be the spark for someone else's "brilliant" idea. No ideas are evaluated during this phase of the study. Therefore, a few of the ideas presented are humorous and wild. A full listing of the ideas is presented to demonstrate the openness of the environment in which the ideas were offered.

Value Study Elements Considered as Potential Proposals and Their Disposition	
Idea	**Disposition**
1) Two screen by-pass	No discernible additional value available
2) Eliminate future capability of the Obermeyer Gates	Considered and listed as Design Option 2
3) Design for 100-yr flood instead of the 800-yr flood	Referred to the Design Team for further consideration as Design Consideration 2
4) Redesign the return intake to accommodate fish tendencies	Eliminated in favor of other ideas
5) Add regulating gate on return pipe	No discernible additional value available
6) Add stop logs in return chamber	No discernible additional value available
7) Add a redundant return pipe	Eliminated as unnecessary and in favor of other available options, Developed as Proposal 7.
8) Daylight at river for the return pipe needs to have a deep grouted pool	Undeveloped in favor of other options
9) 'V' or 'W' screen design	Undeveloped in favor of other options
10) Need a slide gate facing the river at the outlet chamber for the return pipe	Referred to the Design Team for further consideration as Design Consideration 4
11) "Suck and Truck" the fish around the obstruction	No discernible additional value available
12) Add an automated rake to remove the trash from the trash rack	Developed as Proposal 1.
13) Add traveling trash screen to remove the trash	Eliminated in favor of other ideas
14) Use side velocity to move trash down stream	Considered part of the baseline design
15) Turn headworks so that it faces downstream allowing trash to flow past	No discernible additional value available
16) Put the intake in the lake to minimize trash at the intake	No discernible additional value available
17) Dredge river bed so that the existing intake is in the lake	No discernible additional value available
18) Add infiltration gallery	Adds undesired additional O&M requirements

Value Study Elements Considered as Potential Proposals and Their Disposition	
Idea	**Disposition**
19) Add screen OG inlet	No discernible additional value noted
20) Add drum screens	No discernible additional value noted
21) Put an intake at canal siphon and pump up to canal elevation	Considered to be cost prohibitive
22) Build Babb dam	Considered to be cost prohibitive
23) Re-allocate water from Peck or Tiber	Considered to be politically prohibitive
24) Collect trash and create a market for an end product (pressed logs)	Not developed by Value Team in favor of other proposals. Referred to the Design Team
25) Create a physical elevator for fish (fish lock)	Not developed in favor of other ideas
26) Radio tag all fish to monitor	Developed as Proposal No. 5
27) Install viewing window in fish ladder	Not developed in favor of other ideas
28) Set up video cameras to monitor fish	Not developed in favor of other ideas
29) Auto monitor fish with laser trigger	Not developed in favor of other ideas
30) GPS tag fish to monitor	Not developed in favor of other ideas
31) Scanners everywhere on the structure with pit tags on fish to monitor	Developed as Proposal No. 5
32) Bring habitat to fish (create habitat where the fish are downstream)	Considered to be cost prohibitive
33) Pipe water from other source to St. Mary to facilitate new habitat	Considered to be cost and politically prohibitive
34) Add hatchery	Considered to be cost prohibitive
35) Annex Alberta to eliminate water right issues	Considered to be politically prohibitive
36) Install oxygen barriers	Not developed in favor of other ideas
37) Install electrical barriers	Developed as Proposal No. 6
38) Install sonar barriers	Not developed in favor of other ideas
39) Install strobe light barriers	Not developed in favor of other ideas
40) A combination of all the above barriers	Not developed
41) Return fish to Kennedy creek	Not developed, Referred to the Design Team for further consideration and/or design.
42) Screen fish at river	Considered to be cost prohibitive
43) Pay bounty on walleye	Not developed by the Value Team, referred to the MTAO for further development
44) Add tagged lottery fish to enhance bounty on walleye	Not developed by the Value Team, referred to the MTAO for further development

Value Study Elements Considered as Potential Proposals and Their Disposition	
Idea	**Disposition**
45) Pulsed release out of return pipe to return fish	Not developed in favor of other ideas
46) Use ground water to supply water for irrigation instead of canal	Considered to be cost prohibitive
47) Use ground water to supplement water in canal	Considered to be cost prohibitive
48) Cloud seeding	Considered to be cost prohibitive
49) Siphon (suction) water into canal	Not developed in favor of other ideas
50) Install bulkheads across crest of dam to establish needed elevation	Not developed in favor of other ideas
51) Remove all flow into canal and return unused flow	Unacceptable to fish and wildlife and considered potentially politically sensitive
52) Pump water around structure	Considered to be cost prohibitive
53) Additional wasteway directly downstream of structure to facilitate quick dewatering	No discernible additional value available
54) Keep construction bypass and gate it for emergency dewatering of headworks	No discernible additional value available
55) Use Visqueen instead of PVC for liner in bypass channel	Developed as Proposal 2
56) Use bentonite slurry for canal lining to control seepage from bypass	Not developed in favor of other ideas
57) Leave on Contractor to provide and salvage seepage control	Developed as Proposal 2
58) Keep and gate bypass for future use	Not developed in favor of other ideas
59) Move control housing to fish screen control location	Developed as Proposal 4
60) Use slide gates at headworks for control	Referred to the Design Team for further consideration and development
61) Obtain Right-of-way and develop access to opposite side of river	Referred to the MTAO for further development
62) Combine all controls into one building	Developed as Proposal 4
63) Need to add storage into buildings for bio-equipment	Developed as Proposal 4
64) Additional building for bio-equipment storage	Not developed in favor of other ideas
65) Foot bridge to opposite side of river needs to remain	Not developed in favor of other ideas
66) Can we maintain the minimum flow in the canal, fish ladder, and return pipe	Referred to the Design Team for further consideration as Design Consideration 6
67) Install river gauge immediately downstream of headworks	Not developed, referred to the Design team for further consideration
68) Failure or warning when fish screen is plugged	Further investigation indicated this would be a part of the baseline design

Value Study Elements Considered as Potential Proposals and Their Disposition	
Idea	**Disposition**
69) Move Camp 9 to headworks	Not developed in favor of other ideas
70) All weather access road to diversion dam	Referred to MTAO for further development
71) Install interpretive kiosk	Referred to MTAO for further development
72) Dual slot for fish screen	Not developed in favor of other ideas
73) Leave access to return pipe outlet	Referred to the Design Team for further consideration as Design Consideration 7
74) Canopy over jib-boom area	Not developed in favor of other ideas
75) Fish working deck at fish bypass outlet and at fish ladder	Not developed in favor of other ideas
76) Power outlets about fish bypass and fish ladder	Not developed in favor of other ideas
77) Pump to create pressurized hose to clean fish screens and bio-equipment	Not developed in favor of other ideas
78) Handling system for fish screens	Further investigation indicated that this would be in the baseline design to the extent necessary
79) Coating and corrosion control on supper structure of fish screen	Further investigation indicated that this would be in the baseline design
80) Heated fish screen slots to allow timely installation of fish screen installation	Not developed in favor of other ideas
81) Pins for holding screens up during winter	Further investigation indicated this would be in the baseline design to the extent necessary
82) Larger building to allow for screen storage during the winter	Not developed in favor of other ideas
83) Wyoming snow fence and/or wind break	Considered unlikely to provide intended value for the location
84) Put fish screens at Kennedy Creek outlet	Developed as Design Option 4. (see appendix for more details)
85) Build dam with 3-feet additional crest elevation	Developed as Design Option 3, no additional development completed.

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Appendix

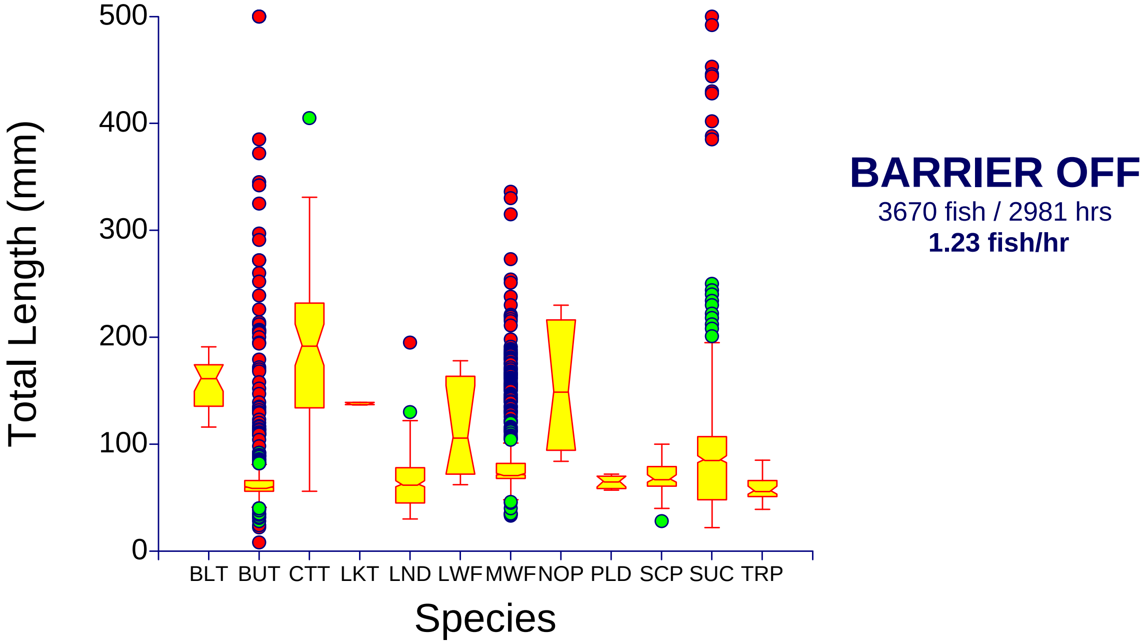
Electric Barrier Case Study

Electric Barrier was evaluated at St. Mary once before:

2003 – 2005
Used as a deterrent to downstream entrainment
Not effective at preventing entrainment

Fig. A- Installation of Electric Barrier on de-watered St. Mary Diversion headworks.

Fig. B- Final installation and subsequent water-up.



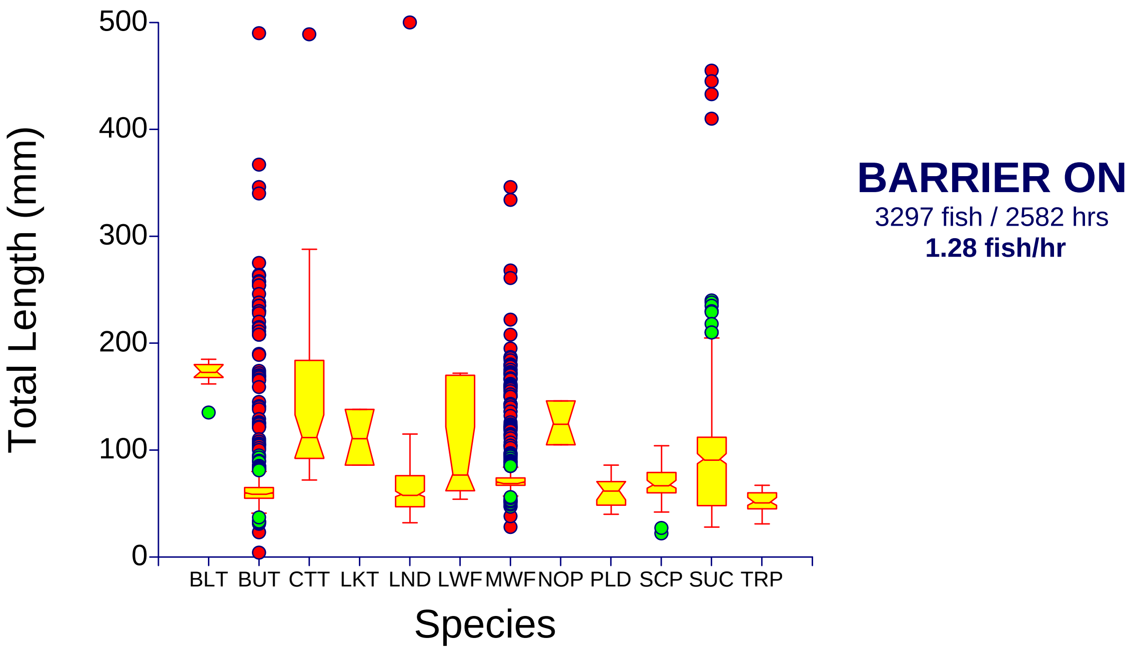


Figure C - Results from electric barrier evaluation at the St. Mary Diversion. Box plots showing lengths of all fish captured during barrier testing with the barrier turned “OFF” and turned “ON.” Entrainment rates are calculated as number of fish entrained per hours of netting. The testing was performed in 2003-2005 during the course of the general entrainment investigation presented in this report. St. Mary Diversion, St. Mary River drainage, Montana.

So what is different?
Barriers have been shown effective in other systems at preventing upstream migration.
Fish encounter gradually increasing voltages until they experience tetany then are carried back downstream by current.
Current designs can be incorporated into new apron associated with the fish ladder design.
Barrier could act as an effective guidance tool to move fish-to-fish ladder.

Installation Examples:

Figure D - Concrete apron pour to accommodate cathode field
*Photo from Smith-Root,Inc.

Figure E- Existing Barrier.
Photo from Smith-Root, Inc.

Product Description from Fish Guidance Systems, LTD….

One of the most important features of this fish barrier design is the graduated electric field. As fish advance into a graduated field, they feel an increasingly unpleasant sensation. When the sensation is too intense, fish are unable to advance further and cannot keep their body orientated with the water flow. They turn perpendicular to the field, and are either swept clear by water flow or swim in the opposite direction from the increasing electric field.

How Is The Graduated Field Produced?
The Graduated Field barrier uses from two to six pulse generators to provide ascending levels of field intensity. The pulsators (pulse generators) have their outputs connected to an array of evenly spaced electrodes placed across a stream bottom. Each pulsator can be adjusted to provide an increasing voltage between successive electrode pairs. This creates a gradually increasing electric field along the array. The pulsators are simultaneously triggered to cause the electric field lines to become additive and oriented with stream flow. Longer fish receive more head-to-tail voltage and are affected at an earlier stage, while smaller fish can penetrate the barrier further before being overcome or repelled.

Flush-Mounted Electrodes
Flush bottom-mounted electrode arrays do not alter normal water flow or catch debris. The electrodes are fixed into an insulating medium placed on the stream bottom. The insulating medium ensures that the electric current will flow through the water and not through the stream bottom. For most permanent installations, the insulating medium is a special concrete mix called InsulcreteTM. Site-specific designs include cast-in-place decks, pre-cast flat panels, and pre-cast culverts. Plastic culverts are now also available. These provide the required insulation and allow flush-mounting of circular electrodes. For site-evaluation we have portable canvas arrays that provide a temporary barrier system.

PIT Tag Antenna Case Study

NOTE: Photos and descriptions were taken from www.biomark.com. Additional case studies and applications can be found at this website.

Antennas

Biomark offers pass-by and pass-through PIT-tag antenna designs. Pass-by antennas detect PIT-tagged animals as they pass over the antenna; whereas, pass-through antennas detect tags as they pass-through the antenna opening. Antennas are constructed of durable, weather resistant thermoplastic. The antennas are connected to the FS1001M reader by a control or exciter cable; one cable per antenna. To maximize performance, the exciter cable is typically 100 ft or less in length. Each antenna is thoroughly tested as part of the fabrication process.

Pass-by Antennas

Pass-by antennas are designed to facilitate installation without requiring attachment to an existing structure. The antennas are secured within a shallow trench in the river substrate, resulting in the antenna surface being level with the river bottom. This approach minimizes the potential for antennas to be dislodged by high flow, debris, and/or ice. Biomark currently offers pass-by antennas in 20, 10, and 6 ft lengths. Nominal detection distances, vertically above the antenna, are 15, 20, and 24 in, respectively.

Pass Through Antennas

Pass-through antennas are designed to detect PIT-tagged animals as they move through a defined area such as a fishway or den entrance. Pass-through antennas are secured in an upright orientation and can be placed in existing guide slots, mounted to the entrance/exit of an opening, or be free-standing in the case of small stream applications. Common opening sizes for Biomark pass-through antennas are 10' x 4' and 5 ' x 5'. Custom sized antennas can be designed for specific applications. PIT-tagged animals can be detected on either side of the antennas as well as throughout the antenna opening. For example, the nominal detection range of the 5 ft x 5 ft antenna can extend up to 24 in from each side of the antenna.

Vendor:

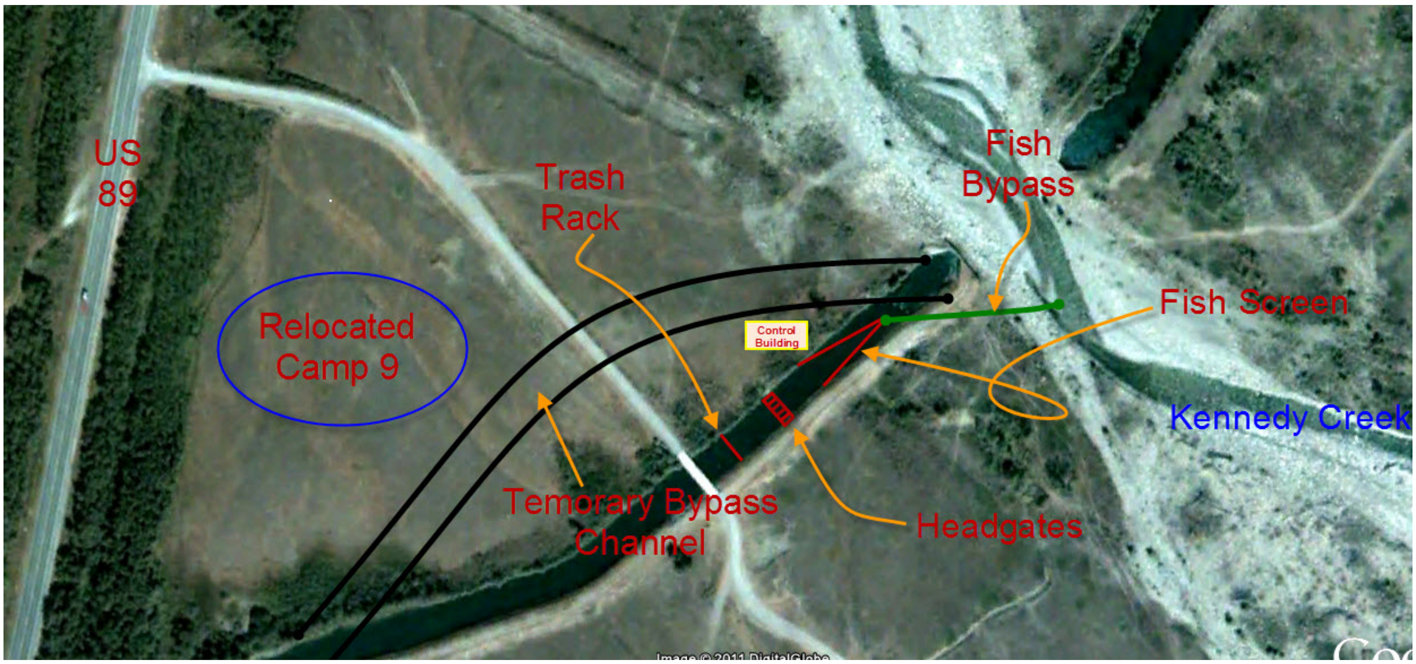
Biomark
SPECIALISTS IN ELECTRONIC IDENTIFICATION

703 South Americana Blvd
Suite 150
Boise, Idaho 83702

Dir 208.275.0011
Fax 208.275.0031

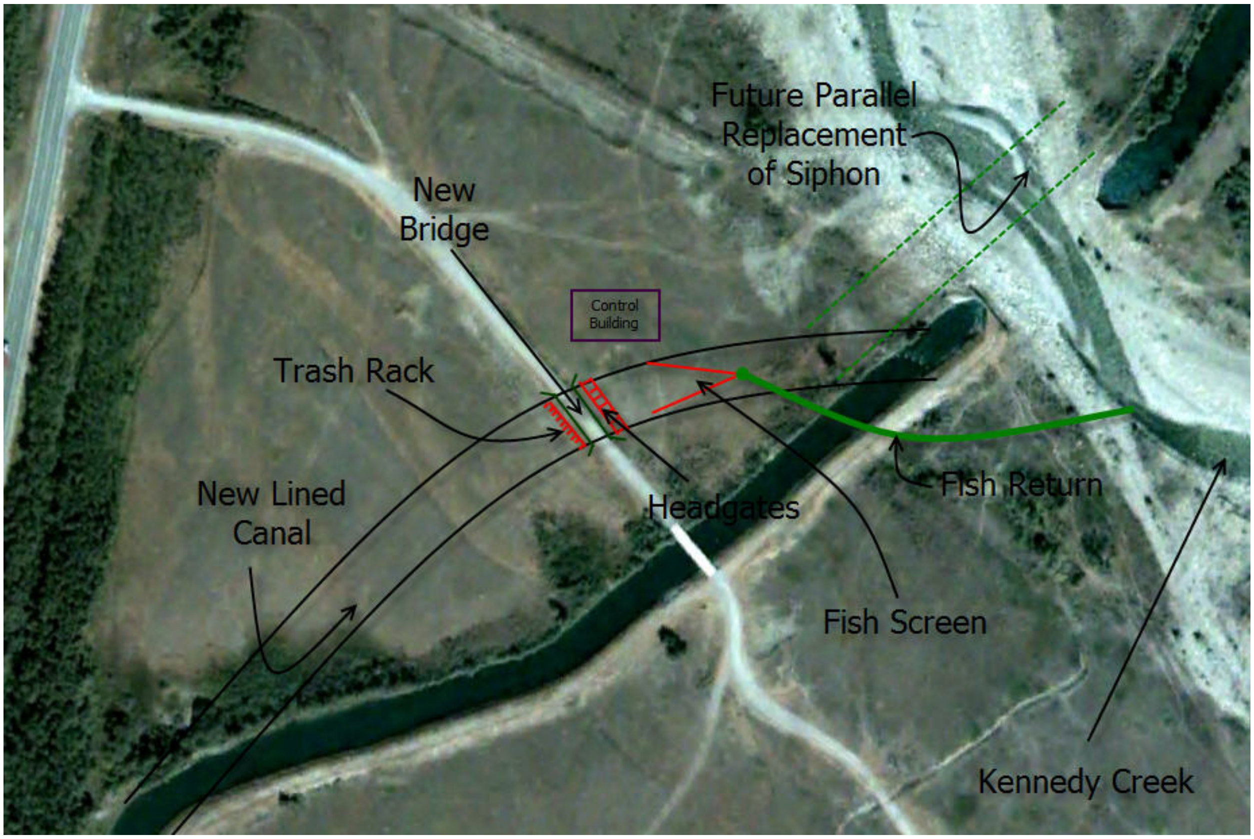
Headworks at Kennedy Creek Concept Development

- Move headworks and fish screen to Kennedy Creek—Option "B" to base concept
  - Given the current uncertainty with Lower St. Mary Lake sediment issues, Swift Current Creek dike issues, and the potential to store compact water in Lower St. Mary Lake, it seems prudent to at least investigate the possibility of moving the trash rack, headgates, and fish screen down the canal to Kennedy Creek. Such a relocation of these project components would give Reclamation a better chance of addressing ESA issues in the near future. The existing diversion dam would be left in place with the possibility of a "temporary" fish passage. During ESA consultation Reclamation would commit to constructing a new diversion dam and permanent fish passage with the concurrence of the Blackfeet Tribe. Waiting to build a new diversion dam allows the potential raise of the crest elevation to be designed into that part of the final ESA compliance from the inception.



1. Options are to put new structures in **lined** existing canal and build temporary bypass during construction or to construct new structures in a new section of lined canal.
   a. It is a good idea to line all canal approaches and exits at siphon structures
2. Though not costed out, the assumption is that structural costs would be similar to base concept.
3. The opportunity to incorporate a "full" wasteway function at this location should be considered:
   a. Wasteway acts as safety valve to protect system.
   b. Replace the problematic existing wasteway downstream of the Kennedy Creek siphon.
   c. Upsize fish bypass, or
   d. Configure wasteway to act as redundant fish bypass
      i. Redundant bypass has been recommended to be added to baseline design.
4. Treating this as "Option B" keeps baseline design viable if all issues can be dealt with prior to final design of facilities to comply with ESA at the existing diversion dam and headworks.
5. It is assumed that the winter flow in the river will be maintained below the existing 1-foot sill allowing the stretch of canal from the river to Kennedy Creek to dewater over the river.
6. The potential relocation of Camp 9 to Kennedy Creek is depicted in the above dwg because this would be a good location should such a move become a reality.
7. The major deviation from the baseline design is the location.

❖ The original version of this proposal (shown above) put the structures in the existing canal. Further thinking has come up with some arguments to pursue the option to put those structures in a new section of canal.



1. Eventual rehab of the entire system may include a new siphon at Kennedy Creek. A new canal section with headworks allows for parallel construction of a new siphon.

2. Putting the trash rack upstream of a bridge and the headgates downstream of the same bridge makes sense regardless of the canal location.

3. Building a new HS-20 bridge allows for that design to accommodate trash rack raking and headgate O & M. This has to potential to actually save some money with this concept.

4. NOTE: To retain the advantage of the new canal alignment being proactive in regards to the potential, future replacement of the siphon, the fish return probably needs to be routed under the existing canal.

5. Again, this location would seem to be a good one for relocated Camp 9 facilities.