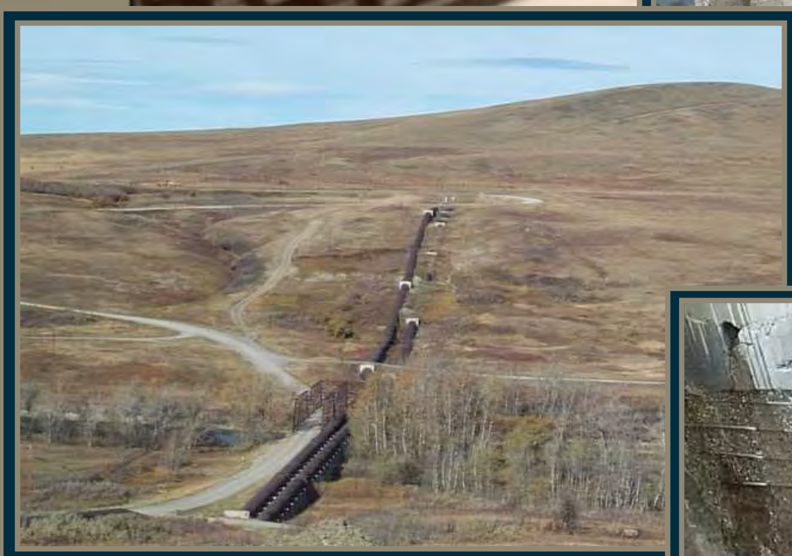
ST. MARY DIVERSION FACILITIES
DATA REVIEW, PRELIMINARY COST ESTIMATE AND PROPOSED REHABILITATION PLAN

February 11, 2005



"Lifeline of the Hi-line"

Montana DNRC

Conservation & Resource Development Division

Thomas, Dean & Hoskins, Inc.

TD&H

Engineering Consultants

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ACHP	–	Advisory Council on Historic Preservation
ACOE	–	Army Corps of Engineers
AF	–	acre feet – 43,560 cubic feet
AIRFA	–	American Indian Religious Freedom Act
ARPA	–	Archaeological Resources Protection Act
APE	–	area of potential effect
BA	–	biological assessment
BOR	–	U.S. Bureau of Reclamation
CFR	–	Code of Federal Regulations
cfs	–	Cubic feet per second
CIP	–	cast-in-place
CMP	–	corrugated metal pipe
DNRC	–	Department of Natural Resources
DR	–	discipline reports
EA	–	Environmental Assessment
EIS	–	environmental impact statement
EPA	–	Environmental Protection Agency
FONSI	–	finding of no significant impact
F&WCA	–	Fish and Wildlife Coordination Act
GIS	–	geographical information system
GPS	–	global positioning system
HAER	–	Historic American Engineering Record
HDPE	–	high-density polyethylene
H:V	–	horizontal to vertical
IJC	–	International Joint Commission
MEPA	–	Montana Environmental Policy Act
MFWP	–	Montana Fish, Wildlife & Parks

MOU	–	memorandum of understanding
MR&I	–	Municipal, Rural and Industrial
NAGPRA	–	Native American Graves Protection and Repatriation Act
NEPA	–	National Environmental Policy Act
NHPA	–	National Historic Preservation Act
NPS	–	National Park Service
NRCS	–	Natural Resource Conservation Service
NRIS	–	Natural Resource Information Service
NRPH	–	National Register of Historic Places
O&M	–	operations and maintenance
PA	–	Preferred Alternative (for context of this report, PA refers to the overall capacity that the St. Mary River Diversion Facilities will ultimately be rehabilitated)
PER	–	Preliminary engineering report
PVC	–	polyvinyl chloride
RCP	–	reinforced concrete pipe
RFP	–	request for proposals
ROW	–	right-of-way
SCADA	–	Supervisory control and data acquisition
SCS	–	Soil Conservation Service
SHPO	–	State Historic Preservation Office
St.	–	Saint
TD&H	–	Thomas, Dean & Hoskins, Inc.
T&E	–	threatened & endangered
TERO	–	Tribal Employment Rights Ordinance
THPO	–	Tribal Historic Preservation Office
TSEP	–	Treasure State Endowment Program
USFWS	–	United States Fish and Wildlife Service
USGS	–	United States Geological Survey

V. ACKNOWLEDGEMENTS

This report represents the combined efforts of many individuals and organizations through their input, cooperation and dedication to the overall goal of finding a workable solution towards the rehabilitation of the St. Mary Diversion Facilities. These parties include, but are not limited to, the State of Montana DNRC – Conservation and Resource Development Division, the Blackfeet Nation, the U.S. Bureau of Reclamation – Montana Area Office, and the members and supporters of the St. Mary Rehabilitation Working Group.

This report also represents the combined efforts of our consultant team including ECI – Denver, CO; UMA – Lethbridge, AB; Entranco – Helena, MT and Bellevue, WA; GCM – Butte, MT; Bioeconomics – Missoula, MT; and WestWater Consultants – Corvallis, MT. Although Thomas, Dean & Hoskins is ultimately responsible for the content of this report, it could not have been possible without everyone's technical expertise, experience and enthusiasm for this project.

Much of the background information contained in this report was obtained from many other sources. We have made attempts to credit the sources and ensure accuracy; however, some omissions may exist. For this, we apologize.

1.0 EXECUTIVE SUMMARY

The Milk River is the economic mainstay of North Central Montana from Havre to Glasgow. The majority of Milk River flows, utilized by irrigators, municipalities, and for recreational and wildlife benefits, is diverted from the St. Mary River basin near Glacier National Park into the North Fork of the Milk River via a 90-year old, 29-mile long facility. Separate components include a diversion dam, canal headgates, several inverted siphons, check and wasteway structures, five hydraulic drops, and approximately 29 miles of canal. The diversion facilities are owned and operated by the U.S. Bureau of Reclamation (BOR), and many portions are in danger of failure. Sudden failure would result in severe environmental damage to the Blackfeet Indian Reservation and the St. Mary River or the North Fork of the Milk River and an economic catastrophe for the economies of North Central Montana.

Besides an economic disaster to the irrigators and the State of Montana, a loss of diverted water to the Milk River Basin would also detrimentally impact the following:

- Municipalities that depend on the Milk River as a source of drinking water,
- Ft. Belknap Indian Nation Reserved Water Rights Compact, which is contingent on diverted water,
- State and Federal wildlife refuges and preserves,
- Recreational and fishing facilities along the Milk River and related storage reservoirs,
- Numerous endangered, threatened and proposed species including the Piping Plover (threatened) and Pallied Sturgeon (endangered), which benefit from supplemented Milk River flows, and
- Missouri River flows below the mouth of the Milk River, thereby increasing shortages.

Continued degradation of the diversion and conveyance system has resulted in a diminished capacity. Originally designed to deliver 850 cfs of water during the irrigation season, current capacity is on the order of 670 cfs. Deterioration of the facilities and lack of modernization further impacts operating efficiency and diversion opportunity. Annual water shortages in the Milk River Basin have been well documented. The BOR and the Montana DNRC both agree that rehabilitation of the St. Mary Facilities back to its original capacity or greater would significantly reduce these shortages.

The diversion facilities lie entirely within the boundaries of the Blackfeet Nation, and as such, they are an important stakeholder. For the last 90 years, environmental issues and concerns, both Tribal and Federal, have arisen regarding the operation of the facilities. For example, the diversion dam precludes passage of bull trout (a threatened species) during operation, and bull trout, as well as other fish species, are permanently lost into the conveyance canal each season. Also, the canal prism and elevated siphons impact elk migration. Improvements are warranted to mitigate these environmental shortcomings, as well as many others.

Since its conception, the Milk River Project, including the St. Mary Diversion Facilities, was authorized by the Federal Government as a single-use irrigation project. As such, the Milk River Project irrigators are obligated by Federal Law to pay nearly 100% of the costs to operate and maintain the facilities through annual assessments on their irrigated lands. Within the last 15 years, maintenance costs, just to maintain a minimum level of service and to avert failure of the system, have escalated commensurate with the accelerating deterioration of the aging facilities. These costs have exceeded the irrigators' maintenance payments and their ability to pay.

The BOR's "North Central Montana Regional Feasibility Report" (BOR, 2004) screened numerous alternatives to reduce water shortages in the Milk River Basin and concluded that the rehabilitation of the St. Mary Diversion Facilities was the most viable option and the only one that would produce positive economic benefits. The following report summarizes the existing studies and background information available on the Facilities, summarizes our site inspections with respect to existing conditions and deficiencies, and presents a Rehabilitation Plan or "roadmap" towards the ultimate goal of overall rehabilitation of the St. Mary Diversion Facilities. This report represents the first step in an iterative process extending through the final phase of construction. The Blackfeet Nation will be an involved party throughout the entire process. The remaining steps are as follows:

- Perform related studies pertaining to slope instability at the St. Mary River Siphon, Basin Hydrology, Economics and Hydropower Feasibility.

- Conduct environmental studies and prepare NEPA compliance documents.
- Evaluate and select the optimum rehabilitated capacity of the Diversion Facilities (referred to in this report as the “Preferred Alternative”).
- Conduct feasibility studies of the major structures comprising the overall facilities.
- Prepare designs and construction documents.
- Construct the recommended rehabilitation improvements.

Due to the preliminary nature of the project, detailed cost estimates are beyond the scope of this report. However, this report does establish a project budget based on a review of existing BOR data. Depending on the rehabilitated canal capacity, (Preferred Alternative), current estimates (updated and revised by TD&H) to rehabilitate the Diversion Facilities range from $120,000,000 to $127,000,000 and assume a 2007 construction start date. The current overall project costs are summarized on Tables 1.1 and 1.2 for rehabilitated capacities of 850 cfs and 1000 cfs, respectively. These cost estimates reflect the BOR’s initial or “appraisal-level” efforts for the construction costs developed in 2002 and 2003. It is not the intent of this report to criticize or endorse the BOR”s previous work and reports or pass judgment on the BOR’s design approach or methodologies. In order to identify the Preferred Alternative, it is necessary to summarize existing conditions and deficiencies and review preexisting information and studies. We have provided additional information when prudent so that future decisions can be made effectively. In addition, we believe there are additional alternatives that should be further evaluated during the Feasibility Study phases that would help to reduce the overall construction and design costs, as well as future O&M costs.

Rehabilitation costs will continue to increase, simply from inflation, by ± $3,000,000 per year. Constant and fruitful progress must be made toward this goal to avoid system failure and avert environmental and economic catastrophes.

TABLE 1.1 OVERALL ESTIAMTED PROJECT COSTS – 850 cfs

Line Items	Diversion Dam and Headgates	Kennedy Creek Siphon	Kennedy Creek and Wasteway	St. Mary River Siphon	Hall Coulee Siphon	Hydraulic Drops No. 1 – No. 5	Canal Prism Rehab.	TOTALS
Approx. Construction Costs	$6,608,700	$504,300	$849,300	$4,512,300	$2,176,500	$2,351,600	$32,466,900	$49,469,600
Inflation Costs (1)	$1,052,600(2)	$63,300	$106,600	$566,300	$273,200	$295,200	$4,074,900	$6,432,100
Subtotal	$7,661,300	$567,600	$955,900	$5,078,600	$2,449,700	$2,646,800	$36,541,800	$55,901,700
Unlisted Items (10%)	$1,149,200(3)	$56,800	$95,600	$507,900	$244,900	$264,700	$3,654,200	$5,973,300
Subtotal	$8,810,500	$624,400	$1,051,500	$5,586,500	$2,694,600	$2,911,500	$40,196,000	$61,875,000
Contingencies (25%)	$2,202,600	$156,100	$262,900	$1,396,600	$673,700	$727,800	$10,048,500	$15,468,200
Subtotal	$11,013,100	$780,500	$1,314,400	$6,983,100	$3,368,300	$3,639,300	$50,244,500	$77,343,200
Non-Contract Costs (37%)	$4,074,900	$288,700	$486,400	$2,583,700	$1,246,300	$1,346,600	$18,590,500	$28,617,100
Subtotal	$15,088,000	$1,069,200	$1,800,800	$9,566,800	$4,614,600	$4,985,900	$68,835,000	$105,960,300
TD&H Recommended Items	$100,000 (4)	$0	$50,000 (4)	$0	$0	$0	$7,816,000 (5)	$7,966,000
Subtotal	$15,188,000	$1,069,200	$1,850,800	$9,566,800	$4,614,600	$4,985,900	$76,651,000	$113,926,300
Tribal Fees (5%)	$759,400	$53,500	$92,500	$478,400	$230,700	$249,300	$3,832,500	$5,696,300
Total Costs per Structure	$15,947,400	$1,222,700	$1,943,300	$10,045,200	$4,845,300	$5,235,200	$80,483,500	$119,622,600

Notes: 1. Inflation costs are based on 3% growth rate over 4 years (12.55%), except where noted.
2. Inflation costs are based on 3% growth rate over 5 years (15.93%).
3. 15% used to calculate unlisted items.
4. SCADA
5. SCADA and considerations for canal realignment, relocation, armoring and two-bank construction.

TABLE 1.2 OVERALL ESTIAMTED PROJECT COSTS – 1000 cfs

Line Items	Diversion Dam and Headgates	Kennedy Creek Siphon	Kennedy Creek and Wasteway	St. Mary River Siphon	Hall Coulee Siphon	Hydraulic Drops No. 1 – No. 5	Canal Prism Rehab.	TOTALS
Approx. Construction Costs	$6,956,500	$663,600	$913,000	$6,104,800	$2,229,600	$2,431,300	$33,368,500	$52,667,300
Inflation Costs (1)	$1,108,000(2)	$83,200	$114,600	$766,200	$279,800	$305,200	$4,188,000	$6,845,000
Subtotal	$8,064,500	$746,800	$1,027,600	$6,871,000	$2,509,400	$2,736,500	$37,556,500	$59,512,300
Unlisted Items (10%)	$1,209,700(3)	$74,700	$102,800	$687,200	$251,000	$273,600	$3,755,700	$6,354,700
Subtotal	$9,274,200	$821,500	$1,130,400	$7,558,200	$2,760,400	$3,010,100	$41,312,200	$65,867,000
Contingencies (25%)	$2,318,600	$205,400	$282,600	$1,889,500	$690,100	$752,600	$10,328,100	$16,466,900
Subtotal	$11,592,800	$1,026,900	$1,413,000	$9,447,700	$3,450,500	$3,762,700	$51,640,300	$82,333,900
Non-Contract Costs (37%)	$4,289,300	$380,000	$522,800	$3,495,600	$1,276,600	$1,392,200	$19,106,800	$30,463,300
Subtotal	$15,882,100	$1,406,900	$1,935,800	$12,943,300	$4,727,100	$5,154,900	$70,747,100	$112,797,200
TD&H Recommended Items	$100,000 (4)	$0	$50,000 (4)	$0	$0	$0	$8,038,600 (5)	$8,188,600
Subtotal	$15,982,100	$1,406,900	$1,985,800	$12,943,300	$4,727,100	$5,154,900	$78,785,700	$120,985,800
Tribal Fees (5%)	$779,100	$70,300	$99,300	$647,200	$236,400	$257,700	$3,939,300	$6,049,300
Total Costs per Structure	$16,781,200	$1,477,200	$2,085,100	$13,590,500	$4,963,500	$5,412,600	$82,725,000	$127,035,100

Notes: 1. Inflation costs are based on 3% growth rate over 4 years (12.55%), except where noted.
2. Inflation costs are based on 3% growth rate over 5 years (15.93%).
3. 15% used to calculate unlisted items.
4. SCADA
5. SCADA and considerations for canal realignment, relocation, armoring and two-bank construction.

2.0 PURPOSE OF STUDY

2.1 PRIMARY OBJECTIVE

The overall St. Mary Diversion Facility is a large and integrated system comprised of many individual hydraulic structures. Each component is equally important and critical to the diversion, conveyance, and supply of water from the St. Mary River to the Milk River Basin. This diverted water is essential to the economy of North Central Montana from Havre to Glasgow, as well as the remainder of the state. However, the St. Mary Diversion Facilities, of which many of the hydraulic components are nearly 90 years old, are in dire need of immediate rehabilitation to avert failure and avoid economic and environmental catastrophes.

This report focuses on the infrastructure replacement and rehabilitation of the St. Mary Diversion Facilities. Additional analyses of environmental impacts of operation and storage in Fresno are necessary to develop a comprehensive approach. The primary objective of this report is to summarize existing studies and background information available on the facilities, summarize the findings of an independent site inspection with respect to existing conditions and deficiencies, and present a preliminary Rehabilitation Plan for achieving the overall goals of selecting a Preferred Alternative, rehabilitating the diversion facilities and restoring the project as a reliable source of water to North Central Montana.

2.2 SCOPE OF WORK

The State of Montana Department of Natural Resources (DNRC), acting as facilitator on behalf of the St. Mary Rehabilitation Working Group, issued a Request for Proposals (RFP) to develop a "roadmap" or plan towards the primary objective of overall Facility rehabilitation. The scope of work for this first phase includes the three following tasks:

1) Review all available engineering, geotechnical and environmental information prepared by the U.S. Department of Interior for the St. Mary Facilities;

2) Conduct site inspections of the St. Mary Facilities to identify deficiencies and design concepts for replacement and/or rehabilitation of the St. Mary Facilities;
3) Develop a report recommending priority areas of study necessary to identify the preferred alternative, environmental compliance and cultural resource requirements for replacement and/or rehabilitation of the St. Mary Facilities.

For this first phase of work, DNRC established a study area extending from the diversion dam on the St. Mary River to the last hydraulic drop where diverted water joins the North Fork of the Milk River. This report does not specifically address existing conditions and deficiencies upstream of the diversion dam including Lower St. Mary Lake, Swiftcurrent and Boulder Creeks and Sherburne Dam and Reservoir or facilities downstream of the last hydraulic drop such as Fresno Dam and Reservoir. These concerns are outside of the project limits for this study and either are currently being assessed under different studies or will be investigated and evaluated in the future.

3.0 PROJECT BACKGROUND

3.1 PROJECT SETTING AND DESCRIPTION

The St. Mary Diversion Facilities are located entirely within the boundaries of the Blackfeet Nation in Glacier County, Montana. The Project is situated east of Glacier National Park and south of the Canadian Border. Figure 3.1 shows the location of the Diversion Facilities and the location of several hydraulic components comprising the Project.

The Diversion Facilities consist of, in part, the following key components:

- Sherburne Lake/Dam - Sherburne Lake collects and stores spring and summer runoff from the mountains draining into Swiftcurrent Creek. The dam is used to regulate releases from the reservoir to supplement the demand for diverted water throughout the irrigation season.

- Swiftcurrent Creek Dike - This is a manmade earthen dike below Sherburne Dam, which controls and directs creek flows and reservoir releases into Lower St. Mary Lake. Prior to the Project, Swiftcurrent Creek flowed across an actively forming alluvial fan, and the creek channel was prone to periodic migration following severe flood events.

- St. Mary Diversion Dam - Located on the St. Mary River approximately 0.75 miles downstream (north) of Lower St. Mary Lake, the diversion dam diverts water into the St. Mary Canal. The diversion season typically begins in early to mid March and ends late September to early October. Earlier shutdowns are initiated when large-scale maintenance and repairs are required.

- Canal Prism – The canal, approximately 29 miles long including siphons and drops, is a one-bank, unlined, contour canal of earthen construction. Originally, the prism consisted of a 26-foot bottom trapezoidal section with 2:1 (H:V) fill slopes and 1½:1 cut slopes. The invert slope is 0.0001 ft/ft or 0.53 ft per mile.

St. Mary Diversion Facilities

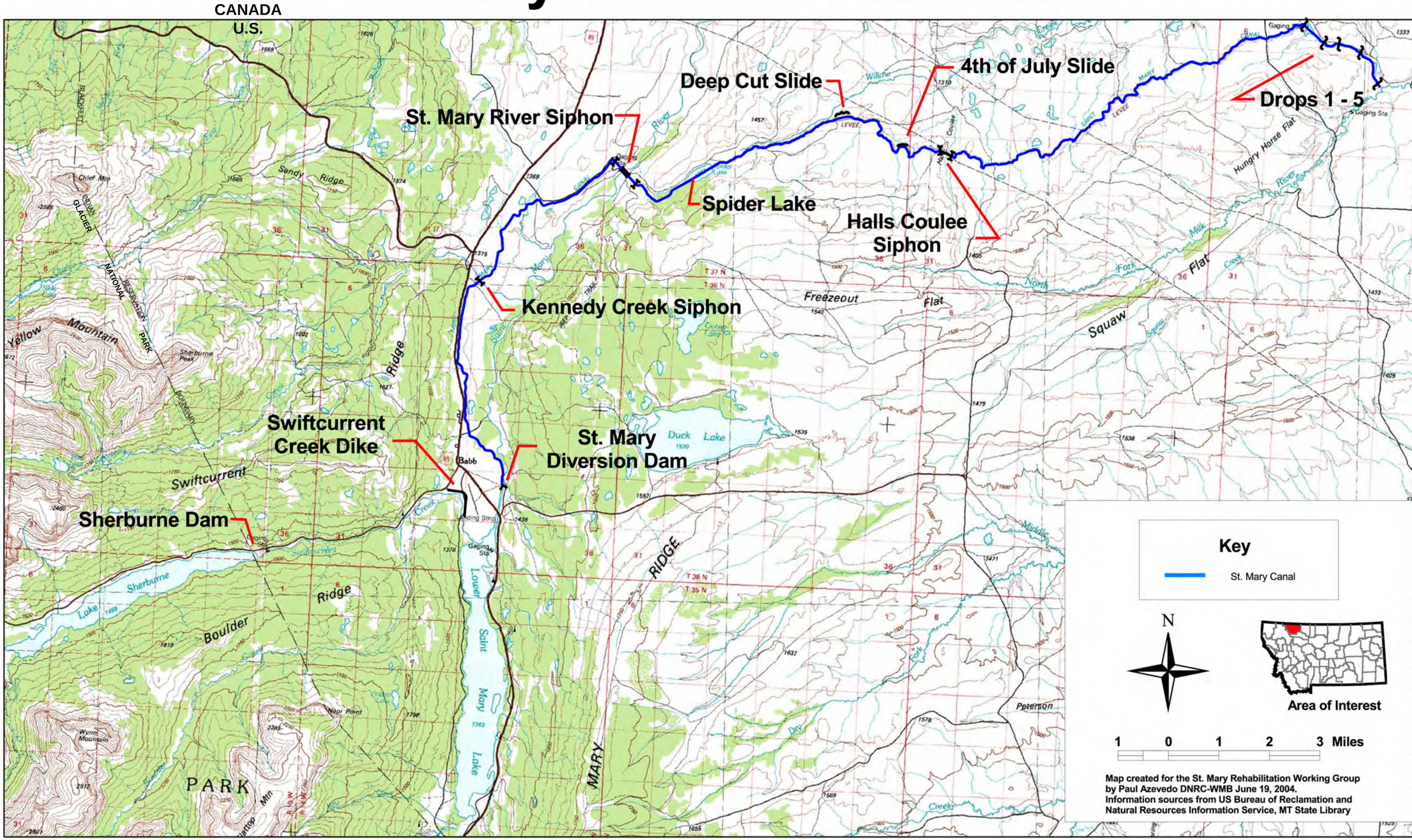


Figure 3.1

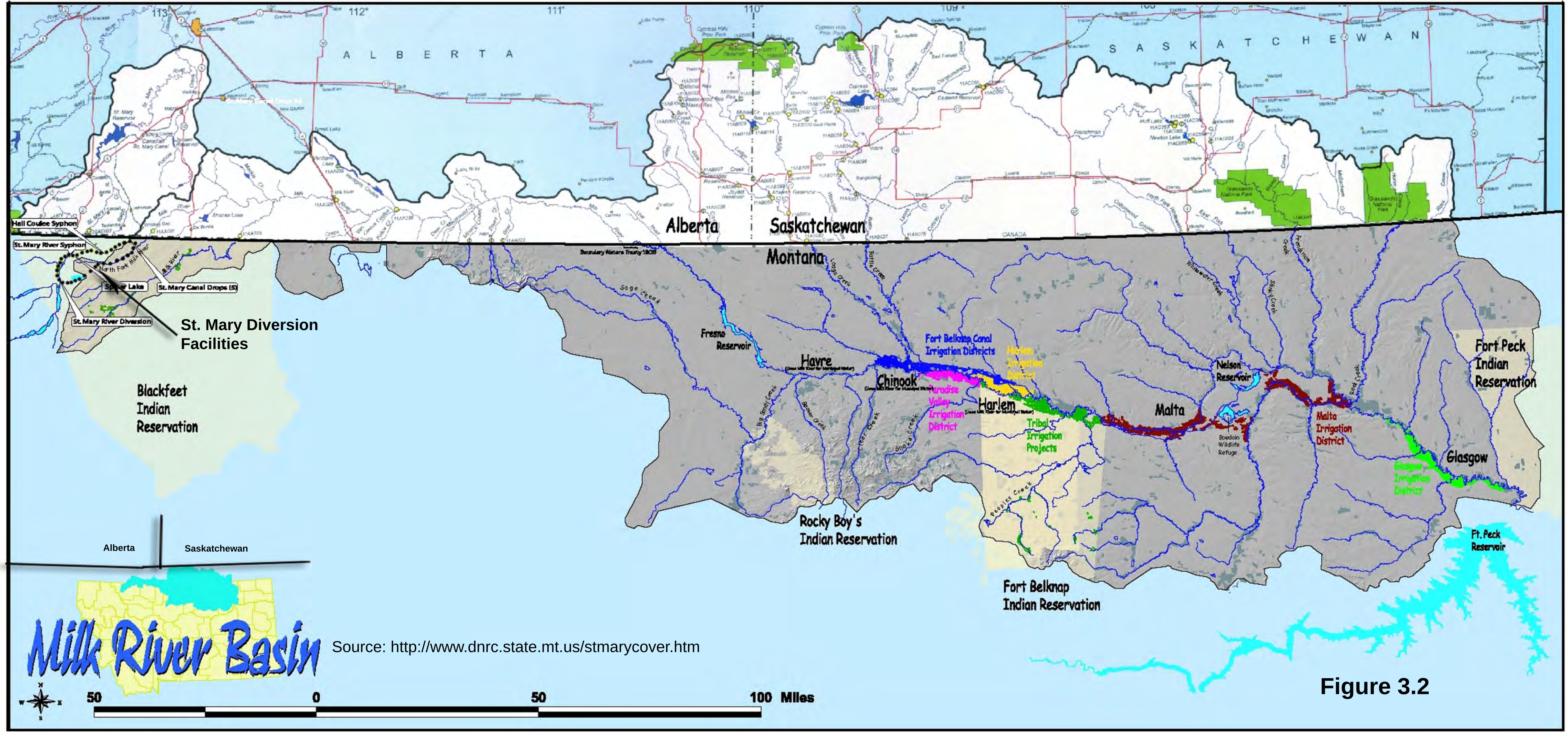
- Kennedy Creek Siphon - Kennedy Creek, similar to Swiftcurrent Creek, flows atop an active alluvial fan. The St. Mary Canal passes under Kennedy Creek through a reinforced concrete, inverted siphon. Manmade dikes upstream of the siphon crossing control Kennedy Creek's propensity for channel migration.

- St. Mary River Siphon - The diverted water crosses the St. Mary River from one side of the valley to the other through two 90-inch diameter, mild steel, inverted pipe siphons. The siphons, approximately 3,205 feet in length, cross the river atop a bridge which also serves as a Glacier County road bridge. The siphon diameter reduces to 84 inches atop the bridge. The bridge is proposed to be replaced by Glacier County using Treasure State Endowment Program (TSEP) funds.

- Halls Coulee Siphon - Another pair of inverted siphons, 1,405 feet long, conveys the diverted water across a topographical low region, Halls Coulee. Although smaller, 78 inches in diameter, the siphons are of similar construction as the St. Mary River Siphons.

- Hydraulic Drops 1 to 5 - Five separate concrete chutes and plunge pools convey the diverted water into the North Fork of the Milk River. These structures are necessary to dissipate the hydraulic energy associated with an elevation drop of 218 feet from the St. Mary - Milk River divide to the North Fork of the Milk River below.

- Milk River - The natural channel of the Milk River is used to convey diverted water to Fresno Reservoir and eventually to the direct and indirect beneficiaries of the Milk River Irrigation Project. The Milk River enters Canada and flows approximately 216 miles before re-entering the U.S. 50 miles northwest of Havre. Figure 3.2 shows the relationship of the St. Mary Diversion Facilities to the downstream portion of the Milk River Basin where the diverted water is utilized.



Source: http://www.dnrc.state.mt.us/stmarycover.htm

Figure 3.2

3.2 PROJECT HISTORY

3.2.1 Project Origin.

As early as the 1880's, homesteaders began constructing small individual irrigation projects in the Milk River Basin near Chinook and Harlem. Limited natural flows of the Milk River precluded further irrigation development. Studies were initiated in the 1890's to locate potential sources of supplemental water for the Milk River Basin. The preferred alternative consisted of diverting water from the St. Mary River near present day Babb and conveying it eastward into the North Fork of the Milk River.

The St. Mary River represents a constant and reliable source of water, which is derived from high mountain streams headwatered on the east slope of the Rocky Mountains in the northeast corner of Glacier National Park. The St. Mary River runs north into Canada, connecting with the Saskatchewan River system and eventually emptying into the Hudson Bay. Stream flows in the St. Mary River are fairly consistent from year to year. Information on flows is available from 1902 to the present (U.S. Geological Survey, 2004). During that period, maximum flow of the river at the U.S.-Canada Boundary (USGS Station 05020500) was estimated to be 40,000 cubic feet per second (cfs) on June 5, 1908. The lowest annual seven-day minimum flow was 27 cfs ending November 26, 1936. The mean annual natural flow of the river, including diverted water, is on the order of 925 cfs or 670,000 acre-feet (AF).

Conversely, the headwaters of the Milk River originate in upland hills and plateaus east of the St. Mary River drainage. Natural Milk River water is derived from the melting of limited snow pack and seasonal precipitation events. Stream flows in the Milk River are more erratic year to year as compared to flows in the St. Mary River (U.S. Geological Survey, 2004). Information on flow near the mouth of the Milk River is available from 1939 - present. During that period, maximum flow at the Nashua, Montana (USGS Station 06174500) near where the river joins the Missouri River was 45,300 cfs, recorded on April 18, 1952. The lowest annual seven-day minimum flow was 0 cfs ending July 17, 1984. The average March - October flow at the Eastern Crossing (USGS Station 06135000) at the U.S.-Canadian border, upstream of Fresno Reservoir is 500 cfs or 243,000 AF.

It is important to note that the flow measurements after 1916 in the St. Mary River downstream of the diversion dam and in the Milk River downstream of Drop No. 5 do not represent natural unencumbered flows but rather the overall effect of the water diversion project. It is reported that in dry years, over 90 to 95 percent of the water in the Milk River Basin is diverted from the St. Mary River. During average years, the diverted St. Mary water represents approximately 70 percent of the Milk River flow from May through September. Also, it is reported the natural flow of the Milk River would run dry in the late summer 7 out of 10 years without the diverted water. The following Figure 3.3 represents the relationship of the Milk River headwaters relative to the St. Mary River.

3.2.2 Construction

The United States Reclamation Service (later the Bureau of Reclamation) was established on June 17, 1902 by Congress to provide construction and maintenance of irrigation works for the storage, diversion, and development of waters for the reclamation of arid and semiarid lands in the 17 western states. A hundred years earlier, Central Montana was referred to by Lewis and Clark after their two-year expedition (1802 through 1804) as the “Great American Desert”.

The initial plans for the Milk River Project were prepared by the Reclamation Service and submitted for approval by the Secretary of the Interior on July 8, 1902, only a few weeks following the formation of the Reclamation Service. This submission relied on information developed during ongoing work with the U.S. Geological Survey (USGS). The initial approval authorized the allotment of funds for additional surveys and administrative costs. On March 14, 1903, the Secretary of the Interior authorized construction of Reclamation’s first five projects, including the Milk River Project. On March 25, 1905, $1,000,000 was allocated for construction of storage works on the St. Mary River and facilities to divert water from the St. Mary River to the head of the Milk River (Simonds, 1999).

Basinal Relationships of the St. Mary Diversion Facilities

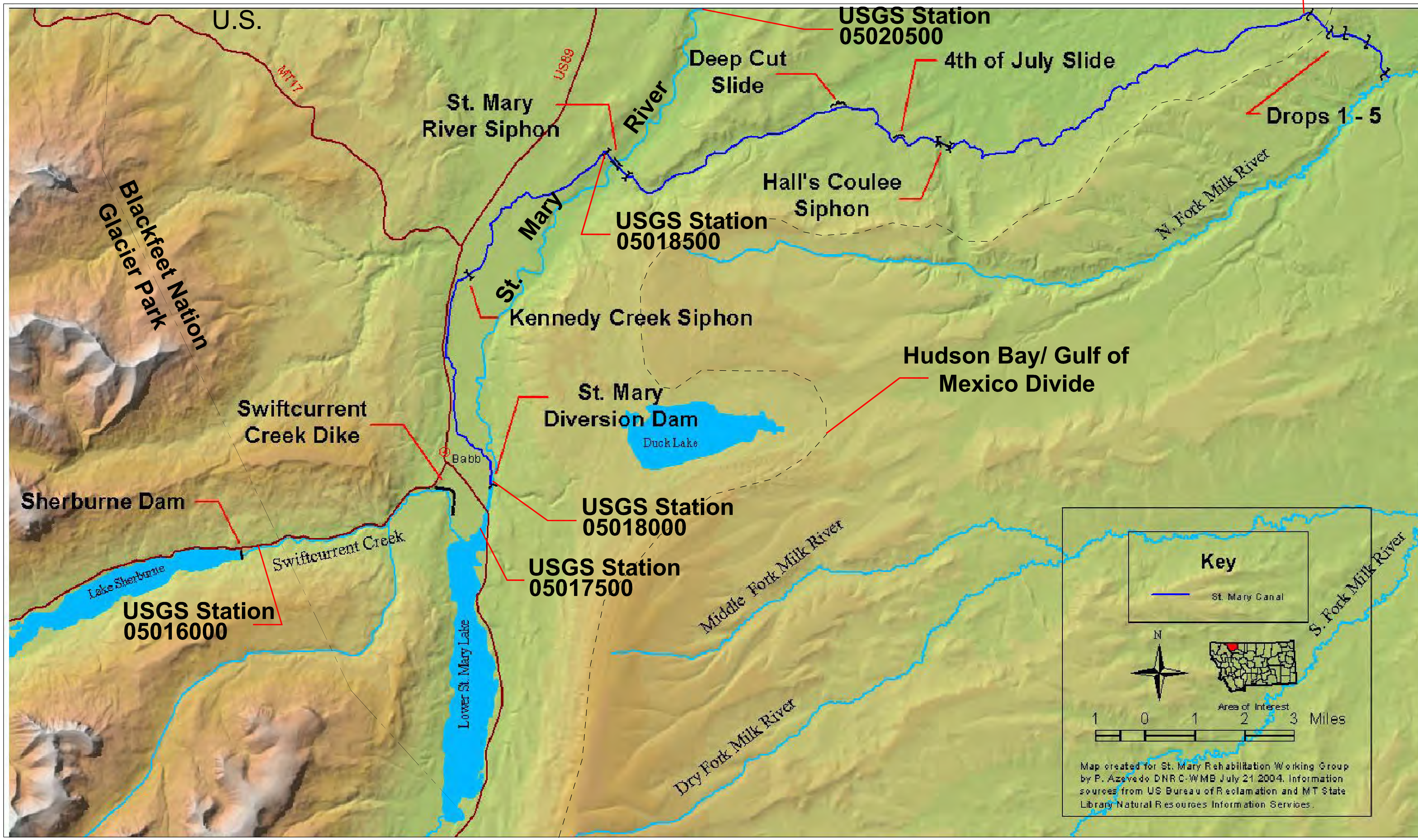


Figure 3.3

The original plan as envisioned by Reclamation Service engineers in the early 1900's called for storage of water from the St. Mary River behind a dam constructed at the mouth of St. Mary Lake. From the lake, the water would be diverted into a 30-mile long canal which would convey the water to the North Fork of the Milk River. The diverted water would flow into Canada via the Milk River and travel about 216 miles before re-entering the United States. Upon re-entering the United States, the water would be stored in a reservoir to be constructed near Havre, Montana, until needed downstream.

Construction of the features of the St. Mary Diversion River Project began in 1907 and would not be fully completed until 1925. During the first three years of construction of the diversion facilities, work progressed sporadically with operations moving forward for only part of each year. Construction of the canal was delayed for several years as engineers determined the best route for the canal. Work by government forces resumed in mid-1912. By the end of July 1914, over 40% of the excavations for the canal had been completed.

By the end of 1915, the diversion dam, canal, structures, hydraulic drops, one barrel of the St. Mary River crossing and one barrel of the Halls Coulee crossing had been completed. Water diversion and conveyance began in July 1916. The canal and structures were constructed with an initial capacity of 850 cubic feet per second (cfs), which required both siphon barrels to be in-place at each location. A single barrel limited the total capacity of the canal until the second barrel at each siphon location was installed. Installation of the second pipe of the St. Mary River and Hall's Coulee Siphons was carried out during 1925.

Construction of Lake Sherburne Dam, upstream of Lower St. Mary Lake on Swiftcurrent Creek, the primary storage feature of the project, began in late June 1914. Under the original plan of development, Lower St. Mary Lake was to be used for storage, but investigation at the St. Mary dam site revealed poor soil and foundation conditions that would have required significant expenditures to mitigate. Lake Sherburne Dam and Lake Sherburne were operated for the storage and release of project water for the first time in 1919, storing, then releasing 28,800 AF of water for project lands (Simonds, 1999).

As part of the original concept, reclamation engineers had planned for construction of an additional storage reservoir on the Milk River below the US-Canadian border. Presidential approval for construction of a dam on the Milk River was received in August 1935, and on February 20, 1936, the Secretary of the Interior approved construction of Fresno Dam. Work on the dam began in late March 1937. Fresno Dam was dedicated on November 7, 1939, three years and eight months after authorization.

3.2.3 Boundary Waters Treaty

When the Reclamation Service announced plans to divert water from the St. Mary River to the Milk River, the Canadian government protested, stating that the diversion would interfere with existing Canadian appropriations along the St. Mary River. The United States ignored the protests, contending that the diversion would have no effect on Canadian interests. Canada's response came in July 1904, when it was announced that the Canadian government had granted permission to two applicants to divert the waters of the Milk River back to the St. Mary River in Canada (Simonds, 1999). This was known as the "Spite Ditch" of which several miles were constructed.

The key to the success of the Milk River Project was the successful negotiation of a treaty with the Dominion of Canada that would ensure the unrestricted passage of the combined waters of the St. Mary and Milk Rivers through Canadian territory. Although not the only dispute among the two nations over waters shared by both, the St. Mary/Milk River dispute was one of the driving forces behind the negotiation and ratification of the 1909 Boundary Waters Treaty signed on January 11, 1909.

The 1909 Treaty mandated the creation of an International Joint Commission (IJC) to implement the principles of the 1909 Treaty. The Commission consists of 6 individuals, 3 representing each country. The IJC Order of 1921 provides for the measurement and apportionment of the waters of the St. Mary and Milk Rivers and their tributaries in the U.S. and Canada. These duties are performed by the USGS and the Water Survey Division of Environment Canada. The provisions of Article VI of the 1909 Treaty are as follows:

1) Agreement that the St. Mary and Milk Rivers and their tributaries are to be treated as one stream for purposes of irrigation and power,

2) And the waters thereof shall be apportioned equally between the two countries, but in making such apportionments, more than half may be taken from one river and less than half from the other country so as to afford a more beneficial use to each.

3) During the irrigation season, between the 1st of April and the 31st of October, inclusive, annually, the U.S. is entitled to a prior appropriation of 500 cfs of the waters of the Milk River or so much of such amount as constitutes three-fourths of its natural flow, and Canada is entitled to a prior appropriation of 500 cfs of the flow of the St. Mary River, or so much of such amount as constitutes three-fourths of its natural flow.

4) The channel of the Milk River in Canada may be used at the convenience of the U.S. for the conveyance, while passing through Canada, of waters diverted from the St. Mary River.

Disagreement exists between the U.S. and Canada on whether the IJC Order of 1921 properly implements the intent of the 1909 Treaty. Recently, the IJC announced its plans to establish an Administrative Measure Task Force to examine whether the existing administrative procedures can be improved to ensure more beneficial use of apportioned waters to each respective county. An interim report is expected March 28, 2005 with the final report due June 30, 2005.

3.2.4 Operation and Maintenance

The St. Mary Diversion Facilities are owned by the U.S. Federal Government and are operated and maintained by the Bureau of Reclamation (BOR). The BOR maintains a 2-person full-time crew to operate and maintain the diversion facilities. Since its conception, the St. Mary Diversion Facilities, as part of the overall Milk River Project, was authorized as a single-use irrigation project. As such, over the last 85 years, nearly 100% of the costs to operate and maintain the diversion facilities has been borne by irrigators within the Project through an annual assessment on their irrigated lands. The average annual O&M cost from 1998 to 2003 was $420,000, of which the Milk River Project irrigators were responsible for 98%, or $411,600, per year. In addition, the irrigators have been responsible for reimbursing the BOR for the initial construction costs of the diversion facilities, as well as O&M costs for Fresno Dam and other irrigation structures within their respective irrigation districts.

Within the last 10 to 15 years, maintenance costs have escalated commensurate with the accelerating deterioration of the aging facilities. Since 1999, the State of Montana DNRC has awarded over $400,000 in grants, and irrigators have contributed another $200,000 for crucial repairs to maintain operation of the diversion facilities. However, increasing costs of maintaining the system have exceeded the irrigators' maintenance payments.

3.3 PROJECT BENEFICIARIES

The diverted water of the St. Mary Diversion Facilities is the "life blood" of the Milk River Basin in north central Montana. Presently, over 140,000 acres (see Table 3.1) and more than 660 farms rely on the supplemented Milk River flows for agricultural production. This production accounts for approximately 8% of the cattle/calves, irrigated alfalfa, and irrigated hay produced in Montana. Irrigated agriculture is the economic mainstay of the Milk River Basin in Montana, and this was the identified purpose for the construction of the St. Mary Facilities and the Milk River Project.

Table 3.1 - Annual Average Irrigated Acres
In Milk River Basin (BOR, 2004)

Users	Average Acres
Milk River Project Irrigation Districts	98,777
Other BOR Contracts	11,529
Ft. Belknap Irrigation Project	5,000-6,000
Private Irrigation (Non-Contract)	25,000
Total Annual Average	>140,000

Note: Non-contract irrigators do not contribute financially to the Project.

Today, many additional beneficiaries are recognized and are equally dependent on the diverted flows. The Milk River provides municipal water to approximately 14,000 people in Havre, Chinook and Harlem. The BOR-contracted amount for these three communities is up to 4,000 acre-feet (AF) per year. In addition the Hill County Water District, a rural water system, has BOR contract water rights, and therefore, is dependent on diverted water.

Several State and Federal wildlife refuges and preserves are located in the Milk River Basin and benefit from diverted water. Bowdoin National Wildlife Refuge, 7 miles east of Malta, is a 15,550-acre refuge that provides food and habitat for an estimated 100,000 waterfowl each spring and fall. Bowdoin receives on average 3,500 AF per year of Project water. This is far less than the 14,000 to 16,000 AF per year reported to the BOR (BOR, 2004) and estimated by the refuge personnel to meet their objectives.

Fresno and Nelson Reservoirs were created as storage components as part of the Milk River Project. However, these reservoirs support tremendous tourism and public year-round recreational benefits including boating, camping and fishing.

Numerous endangered, threatened and proposed species including the Piping Plover (threatened) and Pallied Sturgeon (endangered) benefit from supplemented Milk River flows.

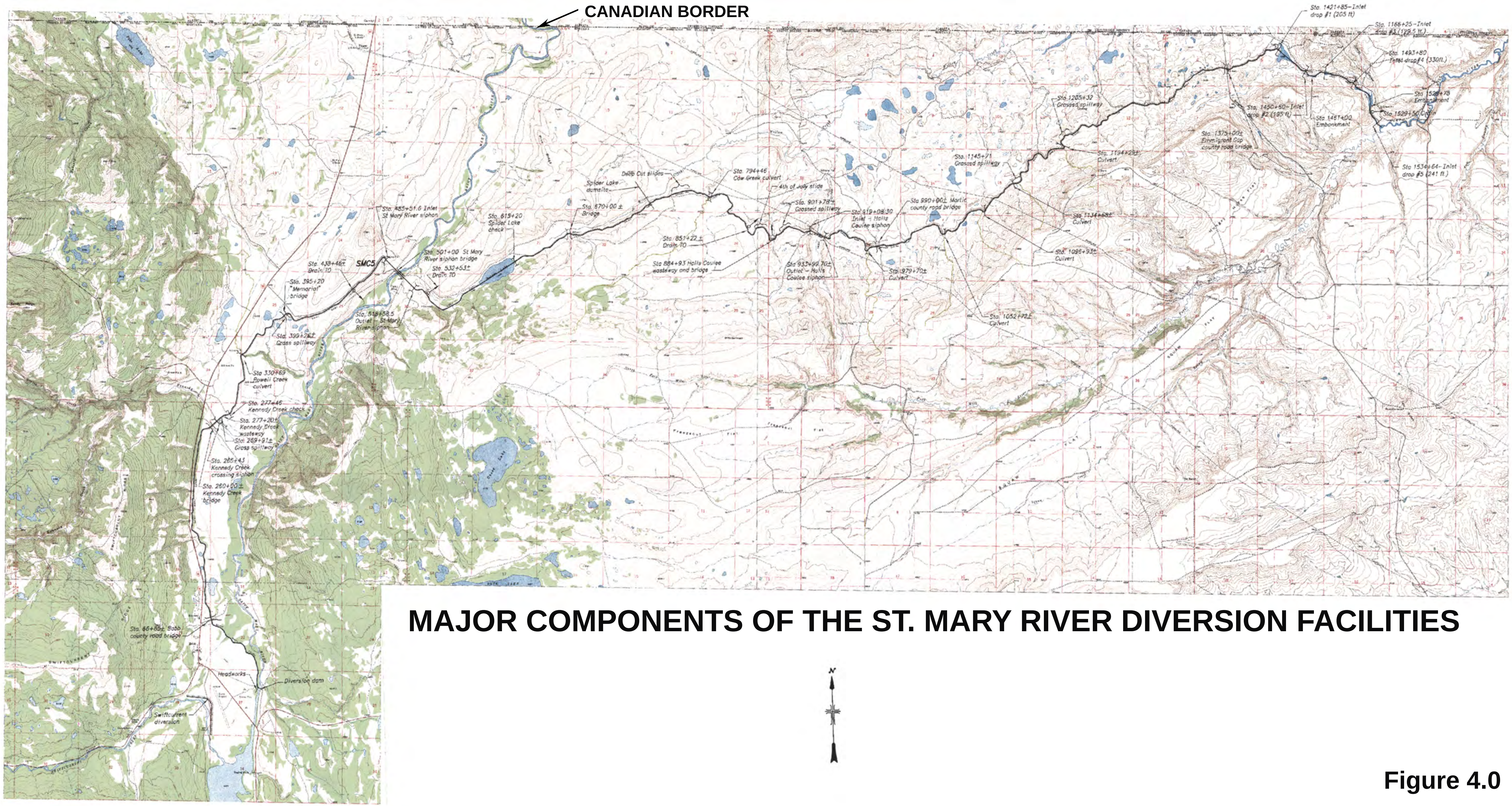
The Fort Belknap Reserved Water Rights Compact is predicated on the continued viability of St. Mary Facilities to divert water to the Milk River Basin. The Blackfeet Nation Reserved Water Rights Compact is currently unsettled. The Diversion Facilities afford potential benefits to the negotiation of that Compact.

4.0 OVERVIEW OF INDIVIDUAL FACILITY COMPONENTS

In this section of the report, a summary of the existing conditions and deficiencies, as reported by others and as observed directly be members of the TD&H team, has been provided on each of the major hydraulic structures, as well as the conveyance canal. Portions of some structures could not be fully assessed due to standing water, i.e. the Kennedy Creek Siphon and the plunge pool of each hydraulic drop. In such cases, reliance was made on previous inspections conducted by others under optimum conditions. The locations of these structures are shown on Figure 4.0.

In addition, a review has been made of the BOR's repair or replacement alternatives and estimated construction costs for each structure. Generally at this stage, the BOR's efforts to date reflect only "appraisal level" designs and cost estimates for budgetary purposes. More accurate designs and cost estimates would generally be developed during Feasibly Studies and Preliminary Engineering Reports as unknowns are resolved and a recommended alternative is selected. We have provided input to additional alternatives we believe have merit and that should be considered in the subsequent studies. Some of these alternatives were not considered by the BOR, while others were considered but dismissed. These alternatives may represent an initial cost savings during construction and throughout the life of the structure as O&M costs. Our opinions are based on recent projects and past experiences with similar structures. A full evaluation and cost comparison, however, cannot be made at this time.

Review of the BOR's construction and project costs for each structure were cursory in nature and limited to obvious omissions, questionable quantities or unit prices and math errors, which may impact realistic funding appropriations. Due to the preliminary nature of the BOR's work to date and the Project itself, it is not possible to prepare independent comparative cost estimates.



MAJOR COMPONENTS OF THE ST. MARY RIVER DIVERSION FACILITIES

Figure 4.0

The BOR's approach to cost estimating at the appraisal-level is to determine the estimated construction costs including mobilization and to increase them by 10 to 15% for unlisted items. This subtotal is increased by 25% for contingencies and increased again by 37% for non-contract costs. The final estimate is between 1.88 to 1.97 times the original construction costs. For this type of project, private consultants typically use a 20% construction contingency and 20% for design fees and studies. The BOR's Cost Estimating Handbook (BOR, 1989) defines unlisted items, contingencies, and non-contract items as follows:

- Unlisted Items – Percentage allowance for additional items of work which will appear in the final design required for a fully finished feature.
- Contingencies – Percentage allowance to cover minor differences between actual and estimated quantities, unforeseeable difficulties at the site, possible minor changes in the plans, and other uncertainties.
- Non-contract Costs – Non-contract activities are usually based on a percentage of the construction cost. Non-contract costs include: planning, investigations, designs and specifications, contract administration, water rights, environmental permits, and rights-of-ways.

In our opinion, comparisons between repair costs and the costs to replace a given structure should be made cautiously. Actual repair costs can often exceed estimated replacement costs due to unforeseen conditions not fully realized until exposed during construction. Additional contingencies must be planned ahead to account for these potential unknowns. When replacement and repair costs are comparable, it is typically prudent to plan and budget for replacement.

It is not the intent of this report to criticize or endorse the BOR's previous work and reports or pass judgment on the BOR's design approach or methodologies. This report focuses on the infrastructure replacement and rehabilitation of the St. Mary Diversion Facilities necessary to restore the project as a reliable source of water to North Central Montana. To achieve this, it is necessary to summarize existing conditions and deficiencies and review preexisting information and studies. We have provided additional information when prudent so that future decisions can be made effectively.

4.1 DIVERSION DAM

4.1.1 Structure Overview.

The St. Mary Diversion Dam was constructed in 1915 and is a concrete buttress weir with a hydraulic and structural height of 6 feet. It is located approximately 0.75 miles downstream from the mouth of Lower St. Mary Lake (see Figure 4.0). The easterly portion of the dam consists of two fixed weir segments – each approximately 95 feet long with a 5-foot wide bridge pier in between for a total weir length of about 195 feet. The fixed portion of the dam is equipped with a heavy wooden timber about 12 inches wide bolted to the top of the concrete crest (see Figure 4.1.1). This was not shown on the original plans and may have been an addition to create more diversion head and to enhance canal flow. The weir crest has a reported elevation of 4457.5 feet.

Figure 4.1.1 Looking east across St. Mary River at the two fixed weir segments below the remaining bridge spans. Note condition of concrete, magnitude of sediment deposition upstream of dam and timber plank added to fixed weirs (10/06/04).

The westerly portion of the dam consists of three sluiceways separated by piers – one approximately 19 feet wide and the other two approximately 18.5 feet wide for a total sluiceway width of 56 feet (see Figure 4.1.2). Each of the three sluiceways has an invert elevation of 4452 feet and is divided into two segments separated by a short pier to support the stop log gate on either side. The stop logs for the easterly two sluiceways are individual timbers each about 8 inches wide. These timbers fit into concrete slots in the pier on each side. The individual timbers must be placed by hand. In 1995, the westerly sluiceway was equipped with two wooded panels which are dropped into place manually using overhead hand-operated hoists mounted on a short access platform above the gates. The gates slide into steel guide rails on each side of the channel. The original sloping concrete guides have been abandoned.

Figure 4.1.2 Looking downstream (north) at three sluiceways on the west side of diversion dam. Canal headgates are left of photo. Note two manually operated lift gates used to regulate flow and permit passage of off-season flow (10/06/04).

A concrete retaining wall separates the concrete sluiceway channel in front of the canal headgates from the fixed weir portion of the dam. The area behind the retaining wall and upstream of the fixed weir segment of the dam has completely filled with sediment to a point nearly even with the concrete crest of the dam (Figures 4.1.3 and 4.2.6).

The diversion dam is an uncontrolled overflow structure with a reported discharge capacity of 20,000 cfs at a backwater elevation of 4468.0 feet. The dam abutment crests have an elevation of 4471.0 feet.

Figure 4.1.3 Looking upstream from sluiceway portion of diversion dam. Note condition of sluiceway training wall (10/13/04).

The dam was originally constructed with a bridge for vehicle travel. The bridge was supported on the piers dividing the sluiceways. The bridge span has been removed from above the three sluiceways on the westerly side. Remnants of the bridge are still in place above the fixed weir section of the dam. Currently, the bridge is not usable. The deck timbers and support beams are rotted and unsafe. An access platform has been constructed between the westerly piers to operate the timber stop log panels.

A floating trash boom was installed upstream of the dam to divert debris away from an electric fish barrier located on the upstream side of the canal headgates. The effectiveness of this boom is uncertain. Trees generally collect near the end by the dam (Figure 4.1.2).

During late March and early April, diversion begins when river flows exceed 100 cfs. Diversion decreases considerably in late August to September and is halted typically in mid October or earlier if significant maintenance activities are scheduled.

4.1.2 Existing Conditions and Deficiencies.

End Wall Abutments.

The east abutment of the dam is in very poor condition. Approximately one third of the downstream wingwall concrete is missing and the steel reinforcement (rebar) is exposed. The upstream wingwall also has a large piece of concrete missing with exposed rebar, but the hole was partially filled with sediment and its extent is unknown (Figure 4.1.4). The concrete in the center of the abutment that supports the bridge is in better, but marginal, condition. The wingwalls pose a risk of failure if the channel erodes around the abutment.

Figure 4.1.4 Looking at east abutment. Note condition of concrete and exposed reinforcement (11/11/04).

The west abutment and wingwalls are in better condition, but a hole is observable in the downstream wingwall just above the waterline.

Fixed Weir Section.

The fixed weir section has a sloped structural buttress wall supported by pier walls at about 10 feet on center. The top of the sloped wall forms the concrete crest for the dam. The wall slopes up in the downstream direction and is covered by sediment on the upstream face. A one-foot high wood timber has been bolted to the top of the concrete crest apparently to increase the height of the upstream reservoir.

The sloped concrete wall is in very poor condition with large pieces of concrete missing and exposed rebar. In some areas, the rebar forms a net that directly supports cobbles and sediment deposited on the upstream side of the wall (Figure 4.1.5). If the sediment were to be eroded or removed, water would discharge through the holes and the effectiveness of the dam would be compromised.

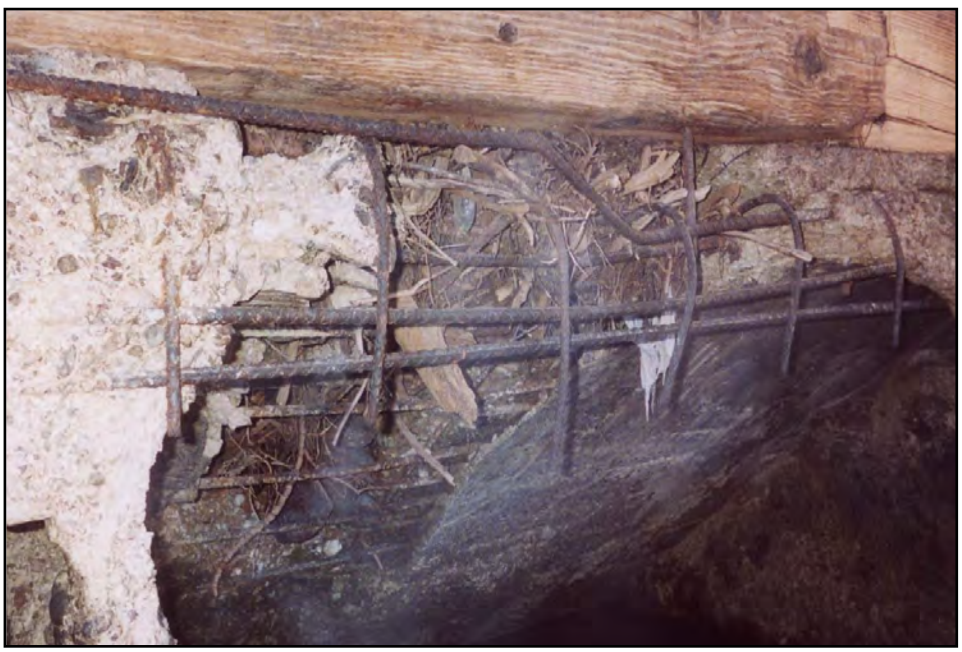


Figure 4.1.5 View of concrete condition of the underside of fixed weir portion of diversion dam (11/11/04).

The supporting piers are also in poor condition (Figure 4.1.6). The foundation and apron were under water or ice at the time of our site visit. A thorough inspection was not possible, but the concrete in general seemed in better condition where it was visible. Previous BOR inspections indicated this concrete is in fairly good condition.

Figure 4.1.6 Looking at downstream side of weir. Typical condition of fixed weir support piers (11/11/04).

The sediment mound that is building upstream of the dam is having some adverse affects on the river channel. As the mound builds upstream above the dam and headgates, the current is being directed toward the westerly bank where erosion is actively occurring (Figure 4.1.3). This represents a threat to the headgates and upper end of the canal if it isn't controlled or corrected.

Sluiceway Section.

The concrete piers forming the walls of the three sluiceways are badly deteriorated near the waterline. The upstream face of these piers is missing more than a foot of concrete at some locations (Figure 4.1.7). Previous concrete repairs appear to be failing. The downstream portion of some of these piers is also in poor condition (Figure 4.1.8). Large holes extend deeply into or through the piers. The guide slots for the stop logs are deteriorating. Metal guide frames have been installed in the westerly sluiceway for use with the wooden gate panels.

Figure 4.1.7 Looking west at upstream edge of sluiceway piers. Note concrete condition and exposed reinforcement (11/11/04).

Figure 4.1.8 Downstream edge of sluiceway piers (11/11/04).

Fish Passage

Fish passage is a major deficiency with this structure. Bull trout that inhabit the stream are listed as a threatened species. Studies indicate that fish do move up and down the river indicating they are able to pass through dam when the gates are open. Fish passage, however, is precluded during diversion when the sluiceway gates are closed. A fish passage is needed on or around the dam to permit fish movements during the diversion season.

Operation and Safety

Operating and safety deficiencies are a major concern. The timber stop logs in two of the sluiceways are not readily accessible to heavy equipment and must be manually placed by personnel in the stream. Although hoists are available to lift the two wooden panel gates, operators have to rely solely on the weight of the gate panel for proper closure and seating. There is no apparent way to mechanically assist closure or remove debris preventing the gate from proper seating.

No provisions or access have been made to help operating personnel safely remove logs and debris hung up on the dam. Debris has to remain until the stream flow is relatively low and the gates can be opened and personnel can enter the channel. This could endanger the structure during a flood event if a major blockage were to occur.

Chain link fencing and a hand rail have been erected on the headgate structure and west abutment for protection of personnel operating the gates. Gates can be locked to prevent visitors from walking across the headgate facility. The old bridge is still accessible from the east side. This structure is very hazardous and should be removed or fencing placed to preclude access.

Automation/Remote-Control Operation

The diversion dam does not have any automation features, instrumentation or remote-control capabilities. The dam is operated manually and is monitored manually. This is labor-intensive and can pose operational difficulties when quick changes must be made. The BOR maintenance headquarters (Camp Nine) is 9 miles away.

4.1.3 Rehabilitation Alternatives (Includes Headgates)

Replacement Priority

The diversion dam and canal headworks are in very poor condition. The existing structures do not appear to be in immediate danger of failure, but their remaining life span is limited. Some immediate repairs are needed on the canal headgates if flow is to be stopped during the irrigation off-season. The facility, in general, will continue to be a safety hazard to the public and for employees attempting to operate gates or remove debris until it is replaced or modified.

Field studies indicate bull trout and other fish enter and are trapped in the canal system. Preventing fish loss to the canal would help the local populations to recover. BOR has installed an electric fish barrier upstream of the headgates in order to prevent fish from entering the canal. The effectiveness of this system has not been reported at this time. We understand that this system will continue to be evaluated during the 2005 season.

The diversion dam creates a barrier to fish movement in the St. Mary River during diversion when the gates are closed and water overflows the weir. Fish tagging studies indicate that fish do move up and down the river past the dam. This movement evidently occurs in the off-season when the canal is shut down from October to early March. Fish passage during the spawning season in September may be of assistance in helping populations to recover. Closing the canal down during the spawning season or construction of a temporary fish passage may be methods of helping the population if replacement of the existing structure must be delayed. Potential benefits of these temporary measures may be minimal depending on how many of the fish spawning in feeder streams to St. Mary Lake are river-based fish or lake-based fish. Additional input from fish biologists and the U.S. Fish and Wildlife Service (USFWS) is recommended in order to determine the importance of temporary fish passage measures until a permanent solution is implemented.

Discussions with BOR staff indicate that the diversion dam and canal headgates may likely represent the initial improvements to overall Project rehabilitation. Listing the bull trout as a threatened species is the primary factor in rating the importance of improvements at the dam in relation to other needed improvements of the remaining system. Since the dam and canal have been in operation for approximately 90 years without eliminating bull trout or other fish species, survival of the bull trout may not necessarily hinge entirely on the diversion dam. If the experimental electric fish barrier proves reasonably effective, delaying the replacement of the diversion dam may be a reasonable option if failure of other structures is more imminent. Discussions with the Blackfeet Tribe and Fish and Wildlife Service are warranted to discuss the weight of the threatened species versus other potential environmental and economic catastrophes.

BOR Alternatives

The BOR has considered several alternatives including: (1) construction of a higher crest dam at the same site that would raise the level of St. Mary Lake and make more stored water available; (2) construction of a new dam at the outlet to St. Mary Lake to effectively raise the lake level and make more stored water available; (3) construction of a large dam on the St. Mary River closer to the border that would create a large lake that backs up to St. Mary Lake and into the Spider Lake Coulee area where a new canal outlet could be constructed; (4) construction of an infiltration gallery under the St. Mary River above the existing dam in order to intake water and prevent entry of fish; (5) reconstruction of the fixed weir portion of the existing dam at its existing site with a new canal headworks facility and river sluice gates just downstream of the fixed weir section of the dam; and (6) construction of a new dam and canal headworks facility just downstream of the existing dam.

Alternatives 1, 2, & 3 raise significant environmental, cultural resource, land use, land ownership, cost and Tribal issues. These alternatives would be difficult to implement and appear to have been properly eliminated by the BOR without detailed evaluation. Alternative 4 also appears to be impractical and properly eliminated by BOR. We have briefly mentioned these alternatives in this engineering report, but believe further evaluation is not warranted.

In our opinion, alternatives 5 and 6 are potentially the most cost-effective and viable alternatives. Both alternatives included fish passage on the diversion dam and fish screens for the canal structure. Both have been further evaluated by BOR in the "St. Mary Diversion Dam and Canal Headworks Concept Design Study" dated May 2003. Although alternative 5 (Repair) was estimated to be slightly less costly than Alternative 6 (Replacement), BOR recommended implementing the Replacement Alternative. This is consistent with our design philosophy as mentioned earlier in Section 4.0.

The BOR's design study only considered steel radial gates for the new dam and headgate structure. Radial gates are an "under-flow" structure and considerable reservoir impoundment is lost when "flushing" floating debris downstream. In the spring, sedimentation and channel bed load (cobbles) must be removed in order for the gate to seat and seal properly. Also, radial gates are problematic in ice-affected streams due to adfreeze and backside freezing. In our opinion, an "over-top" style discharge gate such as an inflatable crest gate system or other similar type of gate should be evaluated during the Feasibility Study. Also, the BOR did not include discussions of instrumentation, automation or remote-control capabilities. We believe these features should be incorporated into the replacement structure.

The concept design study by BOR recommended a vertical, mechanically-cleaned screen with 0.07 to 0.09-inch openings. Based on our experience, this screen opening is typical of the size recommended for fish hatcheries. The various bull trout studies for the area indicate that the small fish remain in their spawning streams until they are large enough to prey on other fish. At that time, they migrate to the lake or the river depending on their species. Larger openings may therefore be appropriate for this run-of-river diversion dam. The larger openings would help reduce overall screen size, cleaning requirements, and costs. Also, if the screens could be eliminated in March and early April when ice is a problem, substantial problems could be eliminated and potential construction savings made. Alternative screens such as drum screens may be more feasible if icing is not an issue. Additional input from fish biologists and environmental scientists is warranted on this issue. Alternative screens should be evaluated as appropriate for the required conditions.

Alternative Recommendations

Based on our review of the data available, we would recommend the following:

- Rehabilitation of the dam and headgates should consist of new replacement structures.
- The replacement structures should be located downstream to permit summer construction during the normal diversion season.

- Alternative crest and reservoir control gates (other than radial arm gates) should be considered to improve operation, maintenance, passage of debris, and performance in ice-affected waters. These alternatives may include an inflatable crest gate or a hinged crest gate.
- Additional evaluation of fish screening types and size openings is warranted to reduce costs and operation issues and still meet objectives.
- The new structures should include automation, instrumentation and remote-control capabilities to improve safety and efficiency.

4.1.4 Estimated Rehabilitation Costs

The BOR-developed project costs for both the rehabilitation option (Concept 1) and replacement option (Concept 2) at four different canal flow regimes. The costs were calculated September 2002 and checked February 2003 by BOR staff.

Our comments about the BOR-determined cost estimates are as follows:

- The costs need to be projected into the future to reflect an anticipated construction date. We have assumed a spring 2007 start and a 3% annual inflation rate.
- The BOR included 15% for "unlisted items" (design contingencies) and 25% for "contingencies" (construction-related differences) but nothing for "non-contract costs". The BOR considers "non-contract costs" to include planning, investigations, designs and specifications, construction/contract administration, water rights, environmental permits, and rights-of-way issues. In all other cost estimates (siphons, canal prisms, drops, etc.) the BOR incorporated 37% for these project-related, non-contract costs.
- The BOR's cost estimates do not include 5% for TERO (Tribal Employment Rights Ordinance) fees and the Tribal Contractor Excise Tax.

The table below summarizes the original BOR cost estimates for the two proposed concepts at different canal capacities. We have updated the costs to reflect a 2007 start (x 1.1593), included non-contract costs (37%), included Tribal fees (5%), and included costs for automation and SCADA ($100,000).

Table 4.1.1 Cost Estimates to Rehabilitate the Diversion Dam and Canal Headgates

Canal Capacity	BOR Cost Estimates - 2002		Projected Costs - 2007[1]	
	Repair Existing	Replacement	Repair Existing	Replacement
500 cfs	$6,900,000	$7,400,000	$11,611,600	$12,445,400
670 cfs	$8,500,000	$8,967,000	$14,279,800	$15,058,600
850 cfs	$9,000,000	$9,500,000	$15,111,600	$15,947,400
1000 cfs	$9,700,000	$10,000,000	$16,280,900	$16,781,200

(1) = [(BOR Cost * 1.37 * 1.1593) + $100,000] * 1.05

The BOR has yet to recommend a canal capacity for overall Project rehabilitation. We cannot discount that a canal capacity larger than 850 cfs may be selected as the Preferred Alternative (PA). Therefore, it would be prudent at this time to budget for $17,000,000 to replace the diversion dam and canal headgates.

4.1.5 Rehabilitation Schedule

The replacement structure option is preferred over attempts to repair and modify the existing structures because a new replacement structure allows summer construction downstream concurrent with normal diversion operations. Also, due to possible unknowns and the potential for construction change orders, a replacement structure is prudent when cost differences are relatively small. The BOR projects a 2-year construction duration for either option. It is our opinion, based on similar projects, that a replacement system could be completed in 1.5 years beginning in the fall with transition tie-in to the existing canal being made the second following spring. However, this will depend on timing restrictions imposed on the Contractor by environmental permitting and the type of replacement structure selected. We have prepared estimated durations to complete rehabilitation of the diversion dam and canal headgates.

Table 4.1.2 Estimated Time to Rehabilitate the Diversion Dam and Canal Headgates

Task	Duration
1) Update BOR Design Study to include SCADA, alternative crest control and fish screens.	4 months
2) Final Design	8 months
3) Construction Phase	18-24 months
TOTAL TIME	30-36 months

4.2 CANAL HEADGATE STRUCTURE

4.2.1 Structure Overview

The St. Mary Diversion headgate structure was completed at the same time as the diversion dam in 1915. The headgate structure is contiguous with the dam on the west abutment (Figure 4.2.1).

Figure 4.2.1 Looking at downstream end (canal side) of headgate structure. Diversion dam is located behind headgates (10/13/04).

The structure contains eight steel slide gates. Each gate is 5 ft. x 5.5 ft in size. Hoists located on top of the structure are used to open and close the gates. The main gate wall is about 59 feet long and 19 feet high. A wing wall extends upstream about 65 feet above the headgates (Figure 4.2.2). A concrete channel extends from the dam along the front of the gates and transitions to the original channel about 30 feet upstream of the last gate. Original plans indicate this channel was 20 feet wide, but the visible portions of the channel wall on the east side suggest the channel is closer to 57 feet wide. The gates were originally equipped with mechanical operators. These have been replaced with hydraulic operators on Gates 2 through 7. Gate 1 remains a mechanical operator. Gate numbering starts with 1 on the north end of the structure.

Figure 4.2.2 Upstream view of headgates showing trash boom, electric fish barrier, and dam sluiceways (11/11/04).

Debris is a problem for gate operation and for the electric fish barrier. A floating boom was installed upstream of the electric fish barrier and gates to divert debris; however, debris still impacts gate operations (Figure 4.2.3).

4.2.2 Existing Conditions and Deficiencies

Headgate Structure.

Some concrete repairs were made to the upstream side of the structure in 2003 when the experimental electric fish barrier was installed. Water flowing in the channel prevented a close inspection of the upstream side of the gates. The BOR 2003 review report indicated concrete on this side was in satisfactory condition at this time. That report indicated that several of the gate stems were bent and in need of replacement and one gate was missing a stem. The Gate 5 operator was in the process of being repaired during our inspection.

Figure 4.2.3 Upstream view of gate openings (11/11/04).

The bottom member of gates 1, 4, 6, & 7 were reported to be bent and cracked in the 2003 report. Debris is currently preventing total closure of gates 3 and 5 and these gates are leaking badly (Figures 4.2.3 and 4.2.4). The remaining gates had some leakage, but not as bad.

Figure 4.2.4 Downstream view of headgate structure. Note heavy leakage through Gates 3 and 5 (10/13/04).

Concrete on the top walkway has spalled and reinforcing steel is exposed in some locations. The concrete on the downstream side of the gates is in poor condition. Concrete is spalled around the gate frames and on the piers, and rebar is exposed in many places. The floor of the structure downstream of the gates is pitted and eroded to varying degrees up to depths of about 3 inches. Reinforcing steel is exposed in places along the floor.

Figure 4.2.5 Close-up (downstream) of heavy leakage and debris on Gate 3 (10/13/04).

The cemented rip rap downstream of the structure appears generally adequate. Some failure is starting to occur on the south side at the junction with the concrete wall and will get worse.

Sluice Channel.

The concrete channel wall on the east side of the sluiceway (in front of the headgates) is in extremely poor condition where it is exposed (Figure 4.2.6). Most of the wall is hidden beneath sediment. The channel bottom was not observable.

Figure 4.2.6 Sluiceway training wall upstream of canal headgates (11/11/04).

Floating Boom

A floating boom has been installed to divert debris away from the headgates and the electric fish barrier. The boom appears to have diverted some debris, but has not been entirely effective.

Fish Barrier

Loss of fish into the canal system is another related issue that must be controlled to protect the bull trout population. An electric fish barrier was attached to the concrete walls at the entrance to each gate in the Spring of 2003. A report on its effectiveness was not available at this time. It is our understanding that evaluation of this system will continue during the 2005 season. The barrier appears to be in good condition.

Operation and Safety

The gates at a minimum need repair so that they can completely shut off the flow of water during the off-season. Flow of water in the canal during the winter aggravates concrete deterioration problems caused by freezing at the headgates and at the Kennedy siphon and check structure. Debris will continue to be a major operational problem once the gates are repaired unless some type of debris barrier is installed. Currently there is no way to safely remove the debris. The floating boom deflects some debris but also becomes entangled with trees and larger debris. There is no way to clear the boom without entering the stream.

There are safety issues related to the electric fish barrier. There are warning signs, but there are no physical barriers that prevent someone from contacting the barriers if they were in the stream.

As with the diversion dam, the headgates do not have instrumentation, automation, or remote-control capabilities to enhance operation and improve safety.

4.2.3 Rehabilitation Alternatives

See Section 4.1.3 for a combined discussion of repair and replacement alternatives for both the diversion dam and the canal headgates.

4.2.4 Estimated Rehabilitation Costs

See Section 4.1.4 for a combined discussion of estimated rehabilitation costs for both the diversion dam and the canal headgates.

4.2.5 Rehabilitation Schedule

See Section 4.1.5 for a combined discussion of the anticipated rehabilitation schedule for both the diversion dam and the canal headgates.

4.3 KENNEDY CREEK SIPHON

4.3.1 Structure Overview

The Kennedy Creek siphon passes the canal flow beneath Kennedy Creek (Figure 4.0) through a concrete conduit approximately 200 feet long. The conduit has a 5-foot radius circular top and a rectangular bottom section. Interior height is 9.25 feet and the bottom width is 8.5 feet. There is a concrete transition structure and headwall at each end of the siphon with grouted rip rap that extends about 20 feet beyond the concrete transition (Figure 4.3.1). Training dikes have been constructed upstream on Kennedy Creek above the siphon to control and direct the stream flow to the passage point above the siphon. Kennedy Creek is a major stream drainage atop an active alluvial fan and has the propensity for channel migration during flood flows.

The upstream side of the siphon has a chain link fence around the top of the structure and along the sides of the transition. A floating boom has been placed in the channel upstream of the transition structure as a safety measure.

4.3.2 Existing Conditions and Deficiencies

Inlet Transition Structure and Headwall.

The inlet to the siphon appears to be in generally poor to marginal condition (Figure 4.3.1). There are areas of deteriorated concrete with pockets and holes near the winter low water line. Some reinforcing steel is exposed. The headwall is cracked in several places (Figure 4.3.2).

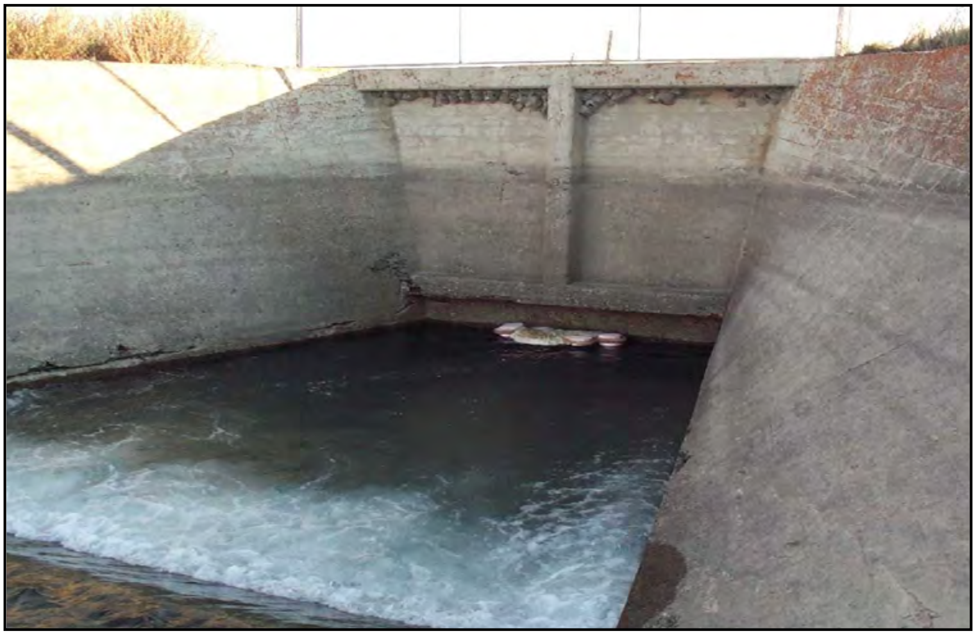


Figure 4.3.1 Inlet section (south side) of Kennedy Creek Siphon (10/13/04).

<u>Siphon.</u>

The siphon was full of water and could not be fully inspected. The siphon was dewatered in 1999 by BOR staff and found to be in relatively good condition. The top of the siphon structure was reported to be exposed in Kennedy Creek during a field inspection in 2002. The top was not visible in the 2003 BOR inspection nor was it visible during our inspection. The stream has apparently recovered the siphon with alluvial deposits since the 2002 inspection. Stream erosion, failure of the upstream dike system and subsequent channel migration pose the largest threats to the canal system at this location.

Figure 4.3.2 Kennedy Creek side of inlet structure (11/11/04).

Outlet Transition Structure and Headwall.

The outlet of the siphon is in similarly poor condition as the inlet. The beam at the top of the retaining wall at the siphon exit is in poor condition with a large amount of spalling and reinforcing steel exposed (Figure 4.3.3). The retaining walls appear to have been extended since the original construction based on the appearance of joints and types of exposed rebar.

Figure 4.3.3 Kennedy Creek side of outlet structure (11/11/04).

Operation and Safety

The inlet transition structure has had fencing placed part way around it, but does not extend down to the water line nor does it extend upstream to the safety boom. The fence should be extended for improved safety.

4.3.3 Rehabilitation Alternatives

The headwalls on either end of the siphon have some severe cracks with exposed reinforcing steel. The concrete inlet and outlet sections have deteriorated concrete at the winter water line. In general, this structure appears to be repairable. However, the cost difference of a replacement structure and the ability to perform summer construction make structure replacement the prudent alternative. Also, the hydraulic capacity of this siphon needs to be analyzed to determine if it is compatible with the various proposed design flows for the canal (>850 cfs). If inadequate, a parallel and larger replacement siphon is definitely warranted.

The siphon also needs to be reviewed with respect to Kennedy Creek. The top of the siphon was exposed in the creek bed a couple years ago. The stream deposition has since apparently recovered it. A general review of the creek channel width at the siphon, siphon depth, and upstream training dikes is recommended. If a new siphon were required, it may be advisable to adjust the length and depth of the siphon for added protection. A means of draining the siphon is also desirable to facilitate periodic inspection and maintenance of the facility.

Presently, Kennedy Creek is a barrier with respect to maintenance vehicles. In our opinion, it may be possible to construct a low water crossing using low-profile gabions which would permit maintenance vehicle access across Kennedy Creek. This system could be designed and incorporated to also provide protection against erosion and scour of the buried replacement siphon.

4.3.4 Estimated Rehabilitation Costs

In March 2003, the BOR estimated rehabilitation costs would vary from $700,000 to $1,250,000. For budgeting purposes, these costs should be updated and projected to a future anticipated construction season. We have assumed a construction season of 2007 and an inflation of 3%

(1.1255 factor). The BOR cost estimates include "non-contract costs" of 37% but do not include 5% for Tribal fees.

The following table lists the original BOR cost estimates and the projected 2007 costs.

Table 4.3.1 Cost Estimates to Rehabilitate Kennedy Creek Siphon

Canal Capacity	BOR Cost Estimates - 2003		Projected Costs - 2007[1]	
	Repair Existing	Replacement	Repair Existing	Replacement
500 cfs	$820,000	$700,000	$969,100	$827,300
670 cfs	$880,000	$800,000	$1,040,000	$945,500
850 cfs	$930,000	$950,000	$1,099,100	$1,122,700
1000 cfs	$1,000,000	$1,250,000	$1,181,800	$1,477,200

(1) = [(BOR Costs) * 1.1255] * 1.05

4.3.5 Rehabilitation Schedule

The existing siphon is in marginal condition and some repair work is warranted. This work can be delayed for a few years if necessary, although some immediate repair work may help preserve the structure if it is to be rehabilitated and utilized as part of the future system. Some safety improvements should be implemented soon. These include extension of fencing around the inlet and outlet. Replacement may be required in order to increase capacity consistent with the Preferred Alternative. This will ultimately control whether the structure is repaired or replaced.

Once an overall Preferred Alternative is selected, designs for the siphon can be completed within four months. Construction may take 12 to 14 months, depending on environmental restrictions associated with wildlife and Kennedy Creek (Table 4.3.2).

Table 4.3.2 Estimated Time to Rehabilitate the Kennedy Creek Siphon

Task	Duration
1) Feasibility Study	1.5 months
2) Final Design	2.5 months
3) Construction Phase	12-14 months
TOTAL TIME	16-18 months

4.4 KENNEDY CREEK CHECK AND WASTEWAY

4.4.1 Structure Overview

The Kennedy Creek check and wasteway structure (Figure 4.4.1) is one of two wasteways located along the 29-mile canal. It is located about 1,000 feet downstream along the canal from the Kennedy Creek siphon (Figure 4.0) and serves primarily as an emergency discharge point should Kennedy Creek breach or overtop the canal prism. The wasteway also serves as a drain for off-season inflows. The structure is located such that the wasteway appears to discharge into a previous channel of Kennedy Creek.

Figure 4.4.1 Upstream view of Kennedy Creek check structure. Wasteway is located at right side of photo (10/13/04).

The check portion of the structure is approximately 29 feet wide and 11.5 feet high with three radial gates. Each of the gates is 9 feet wide and 10 feet high. The gates are wood-faced and do not appear to have been operated in a long time. The gates are secured in the open position with chains to lock them open. This may be a safety measure to prevent unauthorized operation or accidental closure if the operating cables failed. The check structure slab is about 20 feet long and has hand laid rip rap extending upstream and downstream from the structure.

The wasteway portion of the structure is depressed 2 feet below the bottom of the check structure. The wasteway has an overall height of 13.5 feet and an overall width of about 13 feet. The structure contains two 6 ft. x 6 ft. radial gates of similar construction as the check structure. Only one gate appears to be operable. The second gate appears to have wooden wedges driven between the gate and concrete sidewall to minimize leakage around the perimeter. The face of each gate has been covered with a plastic membrane over the wood face to further reduce leakage. The plastic is deteriorating. The concrete base of the structure is about 11 feet long. Concrete wing walls and a slab extend about 20 feet downstream. Hand-laid rip rap is placed both upstream and downstream of the structure.

4.4.2 Existing Conditions and Deficiencies

Check Structure

The concrete structure overall is in fair to poor condition. The channel divider walls between the gates and the abutment wall have many areas of deteriorated concrete. Past concrete repairs are apparent and generally appear to be holding.

The wooden gate faces are badly deteriorated. Each gate is equipped with a mechanical hoist and cable system to raise and lower the gate. The cables have worn grooves in the wood face of the gates. The gates are chained so that they cannot close without removing the chain. BOR studies indicate that the gates are inoperable. Their deteriorated condition makes it probable they would perform poorly if they were operable. Hand-laid rip rap upstream and downstream of the structure appears in good condition.

Wasteway

The concrete on the wasteway portion of the structure is in a much more deteriorated condition. There is significant spalling and reinforcing steel exposed in each of the raceways above the low water line. The downstream walls and center wall are also in poor condition. The top slab is extremely deteriorated and can no longer support the reaction thrust produced by the gate operators. Steel beams have been placed beneath the operator for the only operable gate to support the gate reaction load (Figure 4.4.2).

Figure 4.4.2 Upstream view of Kennedy Creek check structure (left) and wasteway (right). Note modifications to wasteway operator slab to maintain operation (11/11/04).

Figure 4.4.3 Upstream view of wasteway. Note condition of concrete. Wasteway is open during off-season to drain inflows and seepage (11/11/04).

The other gate has wood wedges driven around the perimeter in an attempt to seal it and doesn't appear operable. The faces of both gates have been covered with plastic since the wood is deteriorating.

Figure 4.4.4 Downstream view of wasteway (11/11/04).

Operation and Safety

Both the check structure and the wasteway structure pose substantial safety hazards to operating personnel. There are no handrails or other fall protection measures around the structures. Operating mechanisms have only small access areas with no fall protection.

Only one of the wasteway gates appears operable. The main check gates are in poor condition and are inoperable.

The check and wasteway are primarily used for emergencies to control excess canal flows. However, the structures lack instrumentation, automation or remote-control capabilities. The single gate of the wasteway is the only operable component of the combined structure. Access to the structures may be limited during an emergency.

4.4.3 Rehabilitation Alternatives

The Kennedy Creek check structure concrete has been repaired in the past and could be serviceable for a while. The gates, however, are not usable. Since the check structure protects the downstream portion of the canal from flooding, the existing structure poses risk to this reach. A new structure with power actuated gates and a radio telemetry and supervisory control and data acquisition (SCADA) system is recommended. An operating wasteway is an integral part of the check and control system.

Alternatives to be evaluated for the check structure involve (1) gate type and size; (2) structure location, and (3) construction integral or separate from the wasteway structure. The structure is currently located on an old channel of Kennedy Creek and downstream of the Kennedy Creek siphon. This siphon will have less flexibility in passing unexpected high flows than the rehabilitated canal channel. As such, placement of the check or wasteway above the siphon may be more desirable than its current location. The existing location, however, may provide additional downstream canal protection if Kennedy Creek were to breach the canal dikes. This would favor separating the wasteway and the check structure or adding a second relief wasteway.

The Kennedy Creek wasteway structure is contiguous with the check structure. Only one of the two radial gates is operable and the concrete on this structure is badly deteriorated. Repair of this structure is impractical. The structure also lacks basic safety features to protect the operator from falls while operating the gate.

Alternatives for replacement involve (1) gate type and size; (2) structure location; and (3) construction integral or separate from the check structure. The structure currently discharges into an old channel of Kennedy Creek, but relocation upstream of Kennedy Creek may be beneficial to the overall protection of the Kennedy Creek siphon and canal. An analysis of costs and benefits would be beneficial. A SCADA type control system to automatically control this emergency component is essential to protecting the canal system.

The BOR recommends replacing these structures with a new system slightly upstream of its present location. The recommendation is for a new check with three radial gates 10 ft. x 10 ft.

each and a wasteway with two sluice gates 6 ft. x 6 ft. each. In our opinion, use of overshot gates in the check and wasteway structures warrants further consideration. This type of gate system has been used successfully in Canada on similar canals. An example of an overshot gate check structure is shown in Figure 4.4.5. The main disadvantage of a radial gate, especially in a check structure, is that they fail in a closed position. The BOR does not include automation in their alternatives or cost estimates but do indicate that the new structures should be designed to allow for automation in the future.

Figure 4.4.5 Typical check structure equipped with overshot style gates.

4.4.4 Estimated Rehabilitation Costs

BOR estimated project costs for the radial arm check vary from $900,000 to $1,160,000 and from $530,000 to $560,000 for the sluice-gated wasteway, depending on the design flow. The cost estimates are dated March 2003 and do not include automation. It is not clear whether the contingencies include Tribal fees (5%). A discrepancy was noted in the 850 cfs design summary report. The summary table on page 16 of the BOR report lists the costs for the 850 cfs sluice-gate wasteway as $560,000, but the supporting worksheet in the Appendix indicates a cost of $420,000. For budgetary purposes, the larger amount was used.

We have updated the BOR cost estimates in the table below to reflect automation ($25,000 for each component), a 2007 construction season (1.1255 factor) and Tribal fees (5%).

Table 4.4.1 Cost Estimates to Rehabilitate Kennedy Creek Check and Wasteway Structures

Canal Capacity	BOR Cost Estimates - 2003		Projected Costs - 2007[1]	
	New Check	New Wasteway	New Check	New Wasteway
500 cfs	$900,000	$530,000	$1,089,900	$652,600
670 cfs	$970,000	$560,000	$1,172,600	$688,000
850 cfs	$1,040,000	$560,000	$1,255,300	$688,000
1000 cfs	$1,160,000	$560,000	$1,397,100	$688,000

(1) = [(BOR Costs * 1.1255) + $25,000] * 1.05

4.4.5 Rehabilitation Schedule

The existing inoperative structure poses some additional flooding risk to the downstream canal. Since one of the existing wasteway gates is still operable, there is still some ability to control flooding downstream even without the check structure. Canal operating personnel utilize a conservative operating procedure and reduce flows from the river into the canal when major storms are predicted. In general, check structures that must be visited and manually controlled, provide limited flood protection during an emergency. Automated gates provide a much greater level of protection. This structure poses a medium risk to the system and would have a lower priority than several other components of the system.

This replacement project would have a medium priority similar to that of Kennedy Creek siphon structure. Although it is important to the safety of the system, it can be utilized for a few more years. Some repairs of the gate and safety fencing for fall protection should be provided in the near future.

These components are within the canal and must be completed in the off-season unless the canal is proposed to be rerouted or can be rerouted to the new check/wasteway structures. Construction during the summer season is preferred.

Table 4.4.2 Estimated Time to Rehabilitate the Kennedy Creek Check and Wasteway Structures

Task	Duration
1) Feasibility Study	2 months
2) Final Design	4 months
3) Construction Phase	12-14 months
TOTAL TIME	18-20 months

4.5 ST. MARY AND HALLS COULEE SIPHONS

4.5.1 Structure Overview

St. Mary River Siphon

The St. Mary River Siphon is one of the most significant features of the 29 miles of the St. Mary River Diversion Facilities. The inverted siphon consists of two riveted steel pipes ranging in diameter from 84 to 90 inches. The 90-inch pipe transitions to an 84-inch diameter as it crosses the St. Mary River Bridge and then back to 90 inches (See Figures 4.5.1 and 4.5.2). The overall siphon length varies from reported lengths of 3,205 to 3,230 feet long. The original wall thickness of the pipes varies from 1/4-inch to 3/8-inch, depending on its location. The discharge capacity of each pipe is 425 cfs for a combined capacity of 850 cfs. Water velocities range from 9.63 to 11.05 fps for the two different diameters. The maximum static head is 165 feet (71.5 psi) which is the elevation difference between the inlet water level and the center of the pipes crossing the bridge. The siphon inlet and outlet are concrete transition structures (Figures 4.5.3 and 4.5.4).

Figure 4.5.1 St. Mary River Siphon, looking upstream (northwest) across St. Mary River (10/13/04).

Figure 4.5.2 View of the St. Mary River Bridge carrying the siphon (06/04/04).

Figure 4.5.3 St. Mary River Siphon Inlet Structure (10/13/04).

Figure 4.5.4 St. Mary River Siphon Outlet Structure (10/13/04).

For orientation purposes, the steel pipe is referred to as the “left pipe” (north pipe) and the “right pipe” (south pipe) when viewing downstream.

The left pipe was constructed from 1912 to 1915, and the right pipe was constructed from 1925 to 1926. Most of the left pipe was placed underground with 3 to 5 feet of soil cover. The water diversion started in June of 1916 with just the left pipe. After nine years of operation, the left pipe underwent a major repair due to damage from corrosion, compression buckling, and development of major leaks. Because of this, it was decided that the right pipe should be constructed above ground on concrete saddles on 20-foot centers to support the pipe. This also facilitated maintenance of the outside protective coating. It was also decided to use more expansion/contraction joints and increase the internal joint movement distance from 10 inches to 24 inches. A typical expansion/contraction joint with a cathodic continuity cable is shown in Figure 4.5.5.

During the 1926 operation season, the newly constructed right pipe failed at the outlet transition. The pipe moved downslope such that approximately 100 lineal feet collapsed or was damaged. The repair was made by constructing an anchor just upstream of the outlet transition to stabilize the pipe and prevent it from moving downslope.

Figure 4.5.5 St. Mary River Siphon - Typical Expansion/Contraction Joint, Including Cathodic Protection Continuity Cable (10/26/04).

In the Spring of 1937, the left pipe underwent a major renovation which took place over two years. The earth material was removed from the left pipe and concrete supports were constructed under the portions of the pipe that laid on the ground in the trench. Both pipes were recoated at that time.

In 1954, a section of the left pipe was replaced and steel plates were installed where corrosion had damaged the steel. Figures 4.5.6 and 4.5.7 show typical siphon repairs due to deflection and corrosion. Also, there appeared to be seepage from the canal which moved along the siphon support foundation at both pipes. The left pipe was further unearthed and a perforated drain pipe installed, surrounded with well-graded gravel. One drain was installed on the north side of the left pipe, and one on the south side of the right pipe. A cathodic protection system was also installed on both pipes. This system remained in effect until 1997 when the pole support for the rectifier tipped over damaging the rectifier beyond repair.

Figure 4.5.6 Typical siphon repair due to deflection and/or corrosion (10/13/04).

Figure 4.5.7 Typical siphon repair due to deflection and/or corrosion (10/13/04).

In 1986, the insides of both pipes were sandblasted and repainted with coal tar epoxy. Several sections of the left pipe were replaced because of extensive corrosion.

The left siphon between Station 512+30 (location of the most downstream pipe anchor) and Station 518+21 (downstream end of steel pipe) has been a major problem area. Part of this section has moved up to 4.5 feet downslope since the pipe was constructed. The movement caused major compression buckling near Station 513+00.

An inspection in the Fall of 1996 revealed complete closure of all the expansion joints in the left siphon, which resulted in compression buckling. This also caused the pipe supports to rotate downslope which created a point-load bearing condition. This resulted in up to 6-inch indentations in the pipe at the points of the concentrated load (Figure 4.5.8).

Figure 4.5.8 Photo shows ground movements right to left causing rotation of concrete support and point-loading of siphon which can lead to buckling (10/13/04).

The right siphon exhibits similar movement, but because this pipe was constructed with a different type of expansion joint, this allowed the pipe to accommodate more movement. In any event, several of the right siphon expansion joints also became entirely closed.

In June 1996, there was a significant amount of surface water which appeared to be coming from leaks in both siphons along the north slope. This resulted in erosion and loss of support for the left pipe at a vertical change in slope.

Repairs were carried out in February 1997. The work done is listed as follows:

- Buckled section in left pipe was replaced.
- The expansion joint near the buckled section was re-done.
- A seven-inch long extension was welded to the downstream end of the left pipe.
- The male ends in two expansion joints in the right siphon were cut and repaired to make them again operable.

Halls Coulee Siphon

Similar to that of the St. Mary River Siphon, Halls Coulee Siphon (Figure 4.5.9) was constructed in two phases: 1912 to 1915 and 1925 to 1926. These siphons, approximately 1405 feet each, are also rivet steel conduits, have a 78-inch diameter and a combined design capacity of 850 cfs. The original wall thickness of the pipes was 1/4-inch. The first pipe was buried except along the bottom of the coulee. Due to problems associated with the St. Mary River Siphon, the second pipe at Halls Coulee was constructed above ground and supported on similar concrete saddles (Figure 4.5.10). The siphons at Halls Coulee are relatively stable compared to the St. Mary River Siphon but have experienced some minor problems with sliding, leakage and closure of expansion/contraction joints.

Figure 4.5.9 Looking downstream (southeast) along Halls Coulee Siphon (10/13/04).

Figure 4.5.10 Photo shows concrete failure of a Halls Coulee Siphon support saddle (10/13/04).

4.5.2 Existing Conditions & Deficiencies

St. Mary River Siphon

The existing works have problems described as follows:

- Inlet and outlet structures have large areas of delaminated concrete and spalls.
- There are substantial voids under the concrete apron of the outlet structure.
- The exposed concrete pipe supports are deteriorating.
- Concrete on the bridge abutments and center pier also needs to be replaced.
- The left conduit continues to slide down the slope.
- Concrete supports under the conduit are rotating because of ground movements relative to the pipe. As the supports tip they buckle the bottom of the pipe.
- Portions of the conduit continually need to be removed at the expansion/contraction joints to keep them functional. Additional lengths of conduit need to be added to replace displaced sections.
- Most of the expansion/contraction joints are leaking and have saturated the hillsides (see Figure 4.5.11).

Figure 4.5.11 Leaking expansion/contraction joint on St. Mary River Siphon. Note erosion of supporting soil (10/13/04).

This siphon was inspected on two occasions: on October 13, 2004 and on October 26, 2004. On October 26, 2004, detailed inspections were done of the insides of both siphon pipes.

The people who worked on the October 26, 2004 inspection are listed as follows:

- Dave Firewick, Civil Engineering Technologist, BOR
- Jerry C. Moore, Civil Engineer, Volunteer (Retired from BOR)
- Dave Scanson, Civil Engineer, BOR
- Bill McStraw, Engineer, BOR
- James Keith, Engineer, BOR
- Irv Martens, Civil Engineer, UMA Engineering Ltd.

The work consisted of the following:

- Marking each siphon conduit at 50 feet intervals, and more often wherever problems were identified.
- Taking horizontal and vertical measurements of the siphon, at least every 50 feet, and noting deficiencies. Photos were taken of deficiencies.
- Taking wall thicknesses of the conduits, at or near invert locations, at least every 50 lineal feet.

The results of this inspection confirmed information found in previous reports, namely:

- Concrete supports under the conduit are rotating. As the supports rotate, they crimp the bottom of the pipes.
- Portions of the conduits have slid downslope causing expansion/contraction joints to close, and compression buckling of the siphon barrels.
- Expansion/contraction joints are leaking.
- Some sections of the siphon barrel have been replaced with welded steel pipe.
- Generally the left siphon was found to be in worse condition than the right siphon.

Several items were noted which were not found in previous reports. These are:

- Large portions of the siphons are egg-shaped. The most extreme egg-shaped siphons and the corresponding horizontal and vertical measurements were noted as follows:

Table 4.5.1 Internal Siphon Dimensions of St. Mary River Crossing Measured Fall 2004

Left Pipe - St. Mary River Crossing		
Station (ft)	**Horizontal Width (ft)**	**Vertical Height (ft)**
486+50	8'-0"	7'-3"
487+00	8'-4"	6'-10"
487+50	8'-0"	7'-1"
491+00	8'-2"	7'-1"
491+50	8'-2"	6'-11"
493+00	8'-0"	7'-3"
515+38	8'-0"	7'-1"
515+50	8'-1"	7'-1"
516+50	8'-0"	7'-1"
Right Pipe - St. Mary River Crossing		
Station (ft)	**Horizontal Width (ft)**	**Vertical Height (ft)**
492+69	7'-1"	7'-4"
492+89	8'-0"	7'-2"
493+00	7'-10"	7'-5"
517+70	8'-6"	6'-11"
518+00	8'-5"	6'-11"
518+23	8'-1"	7'-0"

Note: Original diameter was 7'-6".

- Bolt heads are sticking up approximately 4 inches above siphon invert near the downstream end of the left siphon.
- The thinnest wall thickness was measured to be 0.23 inches.
- Circumferential cracks were noted in the steel of the right siphon, at Station 518+00. From the discussion at the site, it was understood that these cracks will be repaired prior to the next operating season.

Another observation that was made during the October 13, 2004 inspection is listed as follows:

- Rebar is exposed at the floor of the concrete inlet transition of the right siphon.
- Photos were taken of typical deteriorated areas of the siphons and are shown on Figures 4.5.12 through 4.5.15.

Figure 4.5.12 Typical Buckling at the Top of St. Mary River Siphon (10/26/04).

Figure 4.5.13 Typical Buckling at the Bottom of St. Mary River Siphon (10/26/04).

Figure 4.5.14 Cracks in the Steel Near the Downstream End of the Right St. Mary River Siphon (10/26/04).

Figure 4.5.15 Exposed part of left siphon where expansion/contraction joint has closed. This joint was being replaced in the Fall 2004 (10/26/04).

Halls Coulee Siphon

The existing works have problems described as follows:

- The inlet and outlet structures have areas of delaminated concrete and spalls.
- The exposed concrete pipe supports are deteriorating.
- The expansion/contraction joints are leaking.
- The steel pipe walls are becoming thin and are difficult to repair.

This siphon was inspected on two occasions; on October 13, 2004, and on October 27, 2004. The inspection of October 27, 2004 was done by the same people who inspected the St. Mary River Siphon on October 26, 2004. A similar procedure was followed for this siphon.

The results of this inspection confirmed information found in previous reports, namely:

- There are indications of conduits sliding downslope causing expansion/contraction joints to close to some extent, and resulting in compression buckling of the pipes. However, this phenomenon is considerably less pronounced at Halls Coulee compared to the St. Mary River siphon.
- The steel pipe walls are becoming thin. Wall thicknesses as low as 0.19-inch were recorded, which is significantly less than the minimum wall thickness of 0.23-inch recorded at St. Mary River Siphon.
- Expansion/contraction joints are leaking.

Several items were noted which were not found in previous reports. These are:

- Large portions of the siphon barrels are egg-shaped. The most extreme egg-shaped barrels and the corresponding horizontal and vertical measurements were noted as follows:

Table 4.5.2 Internal Siphon Dimensions of Halls Coulee Crossing Measured Fall 2004

Left Pipe - Halls Coulee Crossing		
Station (ft)	**Horizontal Width (ft)**	**Vertical Height (ft)**
715+80	7'-3"	6'-3"
716+00	7'-0"	6'-2"
716+50	7'-2"	6'-3"
717+00	7'-3"	6'-2"
717+50	6'-10"	6'-6"
718+00	7'-0"	6'-2"
725+50	7'-0"	6'-1"
726+00	7'-0"	6'-2"
726+50	7'-0"	6'-3"
727+00	7'-0"	6'-2"
727+50	7'-0"	6'-4"
728+00	7'-0"	6'-3"
728+50	7'-0"	6'-3"
Right Pipe - Halls Coulee Crossing		
Station (ft)	**Horizontal Width (ft)**	**Vertical Height (ft)**
722+00	6'-9"	6'-5"
722+50	6'-10"	6'-4"

Note: Original diameter was 6'-6".

- The concrete inlet structure has major cracks at the joints. A significant amount of concrete has been plucked out of the concrete floor and side slopes, in the area of the flow passage.
- Rebar is exposed at the concrete inlet transition to the right pipe.

4.5.3 Rehabilitation Alternates

St. Mary River Siphon

The St. Mary River Siphon is in very poor condition and represents the most fragile component of the overall Diversion Facilities. Sudden failure could cause both economic and environmental catastrophes. Two concepts were considered by the BOR for replacing the St. Mary River Siphon. These include:

Table 4.5.3 BOR Alternatives for Replacement of St. Mary River And Halls Coulee Siphons

• **Alternative 1**	• Replace siphon with two new steel conduits out of the ground. Included are: • New inlet structure • New outlet structure • New upstream highway bridge • Replace existing bridge carrying siphon
• **Alternative 2**	Replace siphon with two buried precast concrete pressure pipes, cross under the river, and construct a new highway bridge. Construct new inlet and outlet structures.

In both cases, a two-barrel replacement siphon system is to be relocated downstream (from river crossing) of the existing siphon. Both alternatives include buried pipe drains for slope stabilization hillsides, and stoplog slots to allow for isolation of one conduit, for maintenance.

The elevated steel pipe would require expansion/contraction joints and installation of deep-seated pipe supports resistant to surficial slope movements. Cathodic protection and pipe coatings would be required for the new steel pipe.

The concrete pressure pipe would not require cathodic protection, expansion/contraction joints, or a new bridge to cross the river. Hydraulic pressures would most likely dictate a prestressed section along the lower portions of the siphons.

Another alternative, which should be considered during the Feasibility Study, is to utilize a buried cast-in-place (CIP) concrete conduit. Cast-in-place concrete allows a single pipe option. At a velocity of 13 fps, a single pipe 9.0 to 10.0 feet in diameter would be required for 850 to 1000 cfs respectively. This type of siphon construction used was for replacement of the East Arrowwood Siphon in southern Alberta in 1999. For that project, the single siphon pipe diameter is 13.1 feet with a discharge capacity of 1800 cfs. A steel slip form was used to construct the CIP concrete siphon (Figures 4.5.16 through 4.5.18). The advantages of a single pipe siphon include a potential construction cost savings and essentially half the future maintenance.

Figure 4.5.16 Preparation of reinforced concrete footings and foundation concrete. Note conduit construction in background (July 1999).

Figure 4.5.17 Close up of steel slip form partly in place in preparation of placing a 30 foot length of siphon (July 1999).

Figure 4.5.18 Filling form with concrete (July 1999).

Halls Coulee Siphon

The condition of Halls Coulee is less severe than that of the St. Mary River Siphon. The BOR recommended two siphon replacement alternatives for Halls Coulee that are essentially the same as for the St. Mary River Siphon: buried precast concrete and elevated steel pipes. Both alternatives would utilize a two-pipe replacement scheme.

We believe the cast-in-place alternative described above for the St. Mary River crossing should also be considered and evaluated for Halls Coulee as a considerable cost savings to the BOR's alternatives.

A fourth alternative is to construct an earthen fill embankment across Halls Coulee. The canal would cross atop the fill in a lined, two-bank section. The embankment would incorporate internal drainage and geogrid reinforcement. Cross drainage, wildlife crossings and access to the buried crude oil pipeline could be maintained using pre-cast concrete arch sections. The existing siphon pipes could be filled and abandoned in-place.

4.5.4 Estimated Rehabilitation Costs

The BOR cost estimates (March 2003) for the St. Mary River and Halls Coulee siphons are summarized below. We have adjusted the costs for a 2007 construction season (x 1.1255) and included 5% for Tribal fees. The prices below are for the precast concrete pressure pipe alternative, which is the BOR recommendation. In our opinion, a single barrel, cast-in-place alternative would be a potentially significant cost savings at both siphon locations. The cost per lineal foot for the Arrowwood Siphon in Alberta was approximately $3330/LF (1998 prices). This siphon had a 13.1-foot diameter and an 1800 cfs capacity. Based on the 1000 cfs projected costs (list below), the St. Mary River and Halls Coulee siphons costs for the BOR's alternative are $4215/LF and $3535/LF for the 3225-ft. and 1405-ft. crossings, respectively. The earthen embankment option for Halls Coulee also could be less expensive.

Table 4.5.4 Cost Estimates to Rehabilitate the St. Mary River And Halls Coulee Siphons

Canal Capacity	BOR Cost Estimates - 2003		Projected Costs - 2007[1]	
	St. Mary River	Halls Coulee	St. Mary River	Halls Coulee
500 cfs	$6,200,000	$3,300,000	$7,327,100	$3,899,900
670 cfs	$7,500,000	$3,400,000	$8,863,400	$4,018,100
850 cfs	$8,500,000	$4,100,000	$10,045,200	$4,845,300
1000 cfs	$11,500,000	$4,200,000	$13,590,500	$4,963,500

(1) = [(BOR Cost) * 1.1255] * 1.05

4.5.5 Rehabilitation Schedule

The St. Mary River Siphon should be the first structure of the overall Diversion Facilities to be rehabilitated due to its serious condition and potential for catastrophic failure. Each of the replacement alternatives could be constructed during the normal water diversion season with the transitions to the existing canal being completed during October to March. We anticipate a two-year construction duration per siphon facility depending on environmental restrictions. Designs for each siphon location should not be finalized until the geotechnical and slope stability studies (Section 7.2) have been completed. Construction of the siphons should not begin until the existing St. Mary Bridge is replaced with a new structure capable of supporting construction-related loads.

Table 4.5.5 Estimated Time to Rehabilitate St. Mary River And Halls Coulee Siphons

Task	Duration
1) Replacement Bridge at St. Mary River	Prerequisite
2) Slope Stability Analyses	12-18 months
3) Feasibility Studies, Both Sites	6 months
4) Final Designs, Per Site	6 months
5) Construction Phases, Per Site	18-24 months
TOTAL TIME	42-54 months

4.6 HYDRAULIC DROPS

4.6.1 Structure Overview

The St. Mary canal empties into the North Fork of the Milk River after passing through five reinforced concrete drop structures. The total drop created by these structures is approximately 218 feet. The drop structures were originally designed by the BOR and construction was completed in 1915. The structures are similar in longitudinal and transverse section but vary in length and overall drop. The structures are numbered 1 to 5, from upstream to downstream.

Throughout the years, various concrete repairs have been made to the drop structures. These repairs have ranged from grouting of cracks in the slabs and side walls to replacement of entire sections of a structure due to concrete deterioration and failure. Maintenance of these structures has been a regular practice over the years and to date is an ongoing process. A recent failure within Drop No. 2 resulted in replacement of an entire chute and side wall section within that structure.

4.6.2 Existing Conditions and Deficiencies

An initial cursory inspection of the canal and drop structures was performed by the project team on October 13, 2004. Each of the five drop structures were inspected in further detail during a site visit on November 10, 2004. The system was not in operation at the time of the inspections. However, the plunge pools were inundated, which prevented a complete inspection of the plunge pool slab and lower walls.

Personnel from the BOR performed a detailed inspection of the drops in October of 1999. Water was pumped out of Drops 2, 3, and 4 so that the structures could be inspected in a dewatered condition. The results of that inspection are documented in the Saint Mary Canal O&M Condition Assessment Trip Reports (January, 2000).

The following paragraphs present a brief discussion of each drop structure and observations from our recent inspections.

Drop Structure No. 1

Drop No. 1 has a total length of approximately 215 feet and a vertical drop of approximately 36.5 feet. An overall view of the structure is shown in Figure 4.6.1. This structure appears to be in the best condition of all five drops. The spillway chute downstream of the V-notch has experienced moderate concrete spalling. However, the approach slab has experienced moderate to severe spalling as shown in Figure 4.6.2.

Figure 4.6.1 Looking west towards Drop No. 1 (11/10/04).

Figure 4.6.2 Looking at approach section of Drop No. 1. Note condition of concrete (11/10/04).

Water in the plunge pool prevented a complete inspection of the condition of the lower walls or slab. Rebar is exposed on the visible portion of the vertical face just downstream of the chute as shown in Figure 4.6.3. There is also a large crack, with exposed rebar, at the left wall to chute slab interface just upstream of the vertical drop as shown in Figure 4.6.4.

Figure 4.6.3 Looking at vertical face downstream of chute section of Drop No. 1 (11/10/04).

Figure 4.6.4 Looking at left (north) retaining wall at terminus of chute section (Drop No. 1). Note structural cracking (11/10/04).

The condition of the foundation under the entire structure is unknown as is the case with all of the structures except as discussed for Drop No. 3.

Drop Structure No. 2

Drop No. 2 has a total length of approximately 205 feet and a vertical drop of approximately 29.5 feet. An overall view of the structure is shown in Figure 4.6.5. A section of this structure (slab and sloping side walls) was replaced after a partial failure that occurred in 2002 as shown in Figure 4.6.6.

Figure 4.6.5 Downstream view of Drop No. 2. Note stilling basin landslide in background (11/10/04).

Figure 4.6.6 Downstream view of chute of Drop No. 2. Note new section replaced in 2002 and extent of landslide in background (11/10/04).

The ogee crest appears to be in good condition as shown in Figure 4.6.7. The slab upstream and downstream of the replaced section shows widespread spalling. The chute slab is shown in Figure 4.6.8, upstream and downstream of the replaced section, respectively. The condition of the foundation under the entire structure is unknown.

Figure 4.6.7 View of ogee crest of Drop No. 2 (11/10/04).

Figure 4.6.8 Downstream view of chute section of Drop No. 2 (11/10/04).

A section of the left wingwall (perpendicular to end of the plunge pool) appears to be failing as shown in Figure 4.6.9. Rebar is exposed on the downstream face of this wall and a seep hole has developed along the opposite side of this wall as shown in Figures 4.6.10 and 4.6.11, respectively. Sink holes are an indication of the loss of backfill soil due to seepage. Also, severe deterioration of the concrete has occurred on the vertical face of the plunge pool with rebar exposed as shown in Figure 4.6.12. Water in the plunge pool prevented a complete inspection of the condition of the lower walls or slab. It appears that the downstream section of the chute floor, just before the vertical drop, is possibly settling as evidenced by the type of cracking and opening of joints within the chute section also shown in Figure 4.6.12.

Figure 4.6.9 Left (north) wingwall of Drop No. 2 is failing (11/10/04). Also, see Figures 4.6.10 and 4.6.11.

Figure 4.6.10 North wingwall of Drop No. 2. Note wall displacement, concrete loss and exposed reinforcement (11/10/04).

Figure 4.6.11 Sink hole developing behind north wingwall of Drop No. 2 (11/10/04).

Figure 4.6.12 Looking at terminus of chute section for Drop No. 2. Note condition of plunge pool headwall and end of chute (11/10/04).

Drop Structure No. 3

Drop No. 3 has a total length of approximately 139.5 feet and a vertical drop of approximately 27.8 feet. An overall view of the structure is shown in Figure 4.6.13. At the time of the inspection, a BOR maintenance crew was in the process of replacing the entire chute slab from the first joint downstream of the ogee crest to the end of the chute. This work is shown in Figures 4.6.13 and 4.6.14. In talking with the crew, upon removal of the slab, there was no evidence of piping or voids observed in the foundation materials below the chute slab. The foundation was noted to consist of large cobblestones with drains along the full length of the chute at the slab to chute wall interface.

Figure 4.6.13 Looking upstream toward Drop No. 3 (11/10/04).

Figure 4.6.14 Photo shows maintenance work being performed on Drop No. 3 (11/10/04).

The crew pointed out that they had recently filled a large sinkhole on the backside of the north (left) training wall just downstream of the end of the chute. This sinkhole extended the full height of the training wall. At the base of the wall at the location of the sinkhole, the concrete deterioration has resulted in a hole all the way through the wall. Figure 4.6.15 shows this deteriorated area and the fill placed by BOR crews. The sinkhole formed due to moisture seepage which caused the soil to pipe or "wash" through the hole in the concrete.

Figure 4.6.15 Looking at north (left) training wall in plunge pool of Drop No. 2. BOR crews filled large sink hole behind wall (11/10/04).

The approach and ogee crest section appear to be in good condition as shown in Figure 4.6.16. The concrete is deteriorated with exposed rebar on the vertical face of the plunge pool as shown in Figure 4.6.17. Water in the plunge pool prevented a complete inspection of the condition of the lower walls or slab. Extensive concrete deterioration has also taken place near the base of the retaining wall on the right side of the plunge pool as shown in Figure 4.6.18. As has already happened at the base of the left wall and as discussed in the previous paragraph, it may only be a matter of time before the concrete deterioration extends through the thickness of the right training wall resulting in similar piping and subsequent sinkholes on the backside of these walls.

Figure 4.6.16 Ogee section of Drop No. 3 (11/10/04).

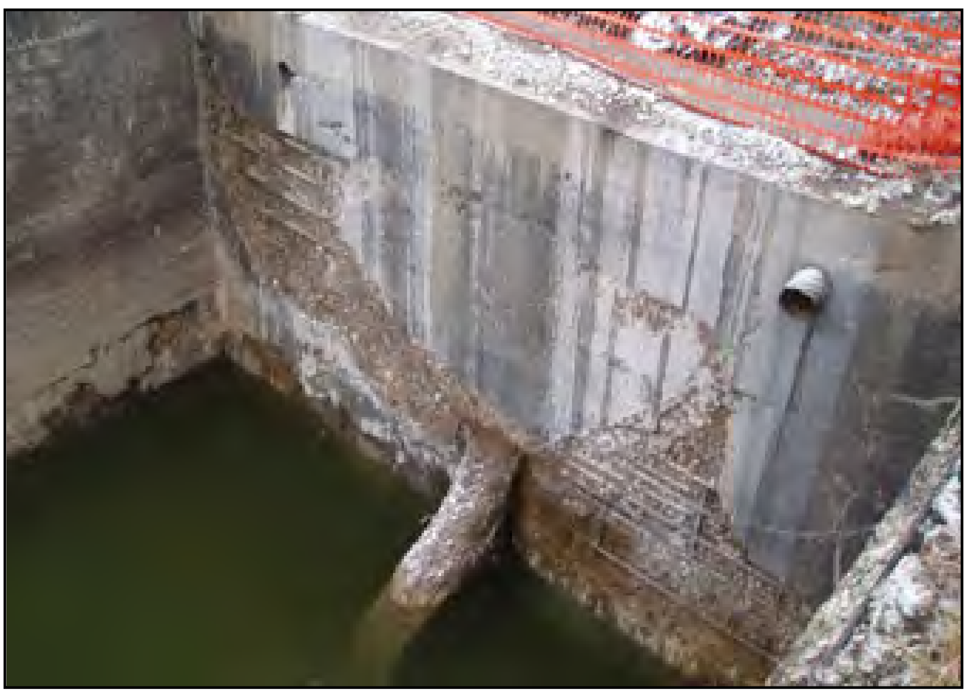


Figure 4.6.17 Condition of plunge pool headwall at drop No. 3 (11/10/04).

Figure 4.6.18 Typical condition of south (right) training wall at Drop No. 3 (11/10/04).

Drop Structure No. 4

Drop No. 4 has a total length of approximately 340 feet and a vertical drop of approximately 67 feet. An overall view of the structure is shown in Figure 4.6.19. The chute is in poor to marginal condition as shown in Figure 4.6.20. There are several areas within the chute that have severe deterioration. For example, the deterioration in the chute slab (approximately 4 inches wide by 6 inches long) shown in Figure 4.6.21. and in the chute side wall slab (approximately 28 inches wide by 32 inches long) shown on the left side of Figure 4.6.22 is of concern. These deteriorated areas vary from partial depth to full depth of the concrete and could result in piping under the slab or complete blowout of the slab concrete if not corrected soon. Widespread spalling of the concrete is evident near the downstream end of the chute as shown in Figure 4.6.23.

Figure 4.6.19 Looking downstream at Drop No. 4 (11/10/04).

Figure 4.6.20 Looking at chute section of Drop No. 4 (11/10/04).

4.6.21 Close-up of concrete deterioration of Drop No. 4 chute floor (11/10/04).

As is the case with the other drop structures, concrete deterioration and exposed rebar is visible on the vertical headwall of the plunge pool. Water in the plunge pool prevented a complete inspection of the condition of the lower walls or slab.

Figure 4.6.22 Looking upstream at Drop No. 4. Note concrete deterioration (11/10/04).

Figure 4.6.23 Looking at terminus of chute section (Drop No. 4). Note the degree of concrete spalling (11/10/04).

Drop Structure No. 5

Drop No. 5 has a total length of approximately 259 feet and a vertical drop of approximately 57.3 feet. Past minor repairs to the chute and side walls are evident throughout the structure. Moderate to severe concrete spalling and cracking exists throughout the structure and the spalling is heaviest near the bottom of the slab as shown in Figure 4.6.24. The depth of the concrete deterioration in this section is between one to three inches.

Figure 4.6.24 Heavy spalling of chute floor in Drop No. 5 (11/10/04).

A couple of areas of severely deteriorated concrete in the chute slab are a concern. One of the areas is shown in Figure 4.6.25. This particular hole appears to be through the thickness of the slab and would likely lead to piping or complete blowout of the slab concrete if not corrected soon.

Figure 4.6.25 Hole in chute floor of Drop No. 5 (10/13/04).

The training walls on both sides of the plunge pool are heavily eroded and damaged as shown in Figure 4.6.26. Exposed rebar beyond the top of both walls can be seen in the photo. The plunge pool water level was high during the inspection, so it was not possible to inspect the condition of the lower walls or slab. Exposed rebar and concrete deterioration is evident towards the top of the vertical face of the plunge pool as shown in Figure 4.6.27 around both drains.

Figure 4.6.26 Heavily damaged/eroded wing and training walls on Drop No. 5 11/10/04).

Figure 4.6.27 Terminus of chute section of Drop No. 5. Note condition of plunge pool headwall (11/10/04).

General

Past performance of the drop structures has shown that during high flows, water "jumps" out of the chutes and onto the side banks towards the bottom of the structures. If allowed to continue, this will result in side bank erosion and undermining of the structures and eventual failure.

During a recent meeting with BOR personnel on December 9, 2004, the problem of snow buildup upstream of the drop structures during initial spring startup was discussed. It was noted by BOR personnel that during initial filling of the system, the flowing water picks up the snow and ice and transfers it downstream. The suspended ice collects within the transition to the drop. Clearing of this accumulation of ice and snow is routinely required.

Hydropower Studies

According to the Regional Feasibility Study of North Central Montana [Reclamation 2004], hydropower development has previously been investigated at the St. Mary Canal terminal drop structures. A private enterprise evaluated a small hydropower facility at the St. Mary Canal drops in the 1980s. Apparently, economic factors precluded hydropower development at that time. Documentation of this study was not available for review.

A low-head hydroelectric evaluation and inventory completed under Public Law 95-482 [Reclamation 1980] included an individual assessment of each of the five drops on the St. Mary Canal. The study assumed replacement of each drop with a penstock and small hydroelectric facility. During the first round of the evaluation, field costs for site-specific features such as penstocks, tailrace, switchyard equipment, transmission lines, and other costs were estimated on a uniform basis. A summary of the first round of the evaluation is shown in the table below.

Table 4.6.1 Summary of Low-Head Hydroelectric Evaluation Performed by BOR in 1980

Assessment of Small Hydroelectric Development at Existing Facilities Round One Evaluation Summary [Reclamation 1980]					
Drop	Ave. Head (feet)	Installed Capacity (kilowatt)	Ave. Annual Energy (GWH)	Investment Cost ($1000)	Benefit-Cost Ratio
1	36	906	2.93	2328	0.63
2	29	664	2.18	2185	0.51
3	27	556	1.87	2104	0.45
4	61	1939	5.85	2643	1.08
5	51	1616	4.88	2617	0.92

Four of the sites were eliminated at the end of the first round of the evaluation due to a benefit-cost ratio less than one. During the second round of the evaluation, layout sketches of the possible power plant location and equipment were prepared and the costs were upgraded to an appraisal level to reflect site specific conditions. As a result, the investment cost for installation of a small hydroelectric facility at Drop 4 almost doubled, which reduced the benefit-cost ratio to less than one and thus eliminated the site from further consideration.

More recently, at least one company indicated interest in hydropower development at the St. Mary Canal drops. The Federal Energy Regulatory Commission (FERC) issued a preliminary permit on October 22, 2001 to BAE Energy in Cut Bank, Montana to study development of a small hydroelectric facility at the St. Mary Canal drops. The preliminary permit was surrendered on July 26, 2002. The request for termination of the preliminary permit indicated that economic conditions were unfavorable.

The BAE Energy preliminary permit application for hydropower development at the St. Mary Canal drops proposed to replace the existing drop structures with a new canal approximately 1.5 miles long and a 9.5 foot diameter penstock approximately 1,300 feet long. The proposed penstock would supply two 1.4 MW Francis turbines. The proposed average flow was 500 cubic feet per second with an average head of 98 feet. Average annual generation was proposed to be approximately 21,000 MW-hours. Approximately three miles of new 12.5 KV three-phase transmission line would be required to connect to the existing grid. The study was terminated before any of these values were confirmed.

4.6.3 Rehabilitation Alternatives

Feasibility level costs were developed in the Engineering Appendix Report (April, 2003) for replacement of the five drop structures. Costs were developed for four flow capacities; 500 cfs, 670 cfs (estimated current flow in canal), 850 cfs (original design flow), and 1000 cfs. For each of the four flow capacities, costs were developed for three structure concepts; baffled apron drop, pipe drop, and chute with a stilling basin (similar to existing).

The BOR's recommended alternative was a pipe drop for all five structures. The cost for this alternative either fell in between the baffled apron drop and the chute and stilling basin or was below the cost of both of the other alternatives for all five drops for all flow capacities. The chute and stilling basin was the most expensive alternative for all five drops and all flow capacities. Several advantages were listed for the pipe drop over the other two alternatives, including: access across the canal, elimination of safety hazards associated with open structures, and elimination of O&M costs associated with snow and ice removal required for early spring use.

In our opinion, the open chute has more advantages than a pipe drop which deserves additional consideration during the Feasibility Study. Pipe drops are a closed conduit, and as such, have a limited capacity and are prone to more O&M issues related to icing, floating debris and blockage. In our opinion, the current issue with snow and ice in the canal impacting the chutes is related to the controlling ogee entrance section and insufficient canal freeboard to account for the development of backwater. The chutes can be equipped with access platforms for personnel or vehicles to cross the canal. Also, it is the experience of several members of our team that open chutes are more cost effective than a pipe drop. Also, in our opinion, there may be opportunity to combine 2 or more drops into a single drop. This may or may not reduce costs but should be evaluated.

Since the decision of whether or not to develop the hydroelectric power will impact the types and locations of replacement drop, the feasibility of hydropower should be updated before the drops are designed. Considerations should include the Blackfeet Nation's plans to develop wind farms east of Duck Lake.

4.6.4 Estimated Rehabilitation Costs

The cost estimates presented by the BOR are dated on March 21, 2003. These cost estimates were reviewed. Discrepancies observed were noted between the summary table on page 3 and the individual cost estimate tables for separate drops (BOR, 2003). The BOR has indicated that the summary table values are correct. The cost estimating worksheets did not specifically add 5% for Tribal fees. Assuming construction would occur in the summer of 2007, it is appropriate to update these estimates by escalating the costs by 3% per year for four years (x 1.1255). The following tables present the cost estimates originally prepared by the BOR for the pipe drop alternative and those projected to 2007 with 5% Tribal fees.

Table 4.6.2
Estimated Costs to Rehabilitate Drop Structure No. 1

Canal Capacity (cfs)	BOR Cost Estimates - 2003			Projected Costs – 2007[1]
	Baffled Apron Drop	Pipe Drop	Chute & Stilling Basin	Pipe Drop
500	$620,000	$590,000	$840,000	$698,000
670	$660,000	$620,000	$950,000	$733,000
850	$740,000	$810,000	$960,000	$957,100
1000	$860,000	$840,000	$1,100,000	$992,700

[1] = [BOR cost) * 1.1255] * 1.05

Table 4.6.3
Estimated Costs to Rehabilitate Drop Structure No. 2

Canal Capacity (cfs)	BOR Cost Estimates - 2003			Projected Costs - 2007[1]
	Baffled Apron Drop	Pipe Drop	Chute & Stilling Basin	Pipe Drop
500	$660,000	$730,000	$930,000	$863,000
670	$730,000	$730,000	$1,000,000	$863,000
850	$770,000	$890,000	$1,050,000	$1,051,800
1000	$890,000	$900,000	$1,200,000	$1,063,600

[1] = [BOR cost) * 1.1255] * 1.05

Table 4.6.4
Estimated Costs to Rehabilitate Drop Structure No. 3

Canal Capacity (cfs)	BOR Cost Estimates - 2003			Projected Costs - 2007[1]
	Baffled Apron Drop	Pipe Drop	Chute & Stilling Basin	Pipe Drop
500	$530,000	$630,000	$860,000	$745,000
670	$600,000	$660,000	$890,000	$780,000
850	$590,000	$790,000	$1,000,000	$933,600
1000	$750,000	$810,000	$1,100,000	$957,200

[1] = [BOR cost) * 1.1255] * 1.05

Table 4.6.5
Estimated Costs to Rehabilitate Drop Structure No. 4

Canal Capacity (cfs)	BOR Cost Estimates - 2003			Projected Costs - 2007[1]
	Baffled Apron Drop	Pipe Drop	Chute & Stilling Basin	Pipe Drop
500	$820,000	$810,000	$1,050,000	$958,000
670	$970,000	$840,000	$1,100,000	$993,000
850	$1,100,000	$1,050,000	$1,125,000	$1,240,900
1000	$1,250,000	$1,100,000	$1,350,000	$1,300,000

[1] = [BOR cost) * 1.1255] * 1.05

Table 4.6.6
Estimated Costs to Rehabilitate Drop Structure No. 5

Canal Capacity (cfs)	BOR Cost Estimates - 2003			Projected Costs - 2007[1]
	Baffled Apron Drop	Pipe Drop	Chute & Stilling Basin	Pipe Drop
500	$840,000	$690,000	$1,100,000	$816,000
670	$950,000	$700,000	$1,200,000	$828,000
850	$1,000,000	$890,000	$1,300,000	$1,051,800
1000	$1,100,000	$930,000	$1,450,000	$1,099,100

(1) = [BOR cost) * 1.1255] * 1.05

4.6.5 Rehabilitation Schedule

Previous reports have presented various alternatives for rehabilitation. The majority of the recommendations call for complete replacement of the five drop structures due to their overall deteriorated condition and age. Sections of the chute slab and side walls within areas of severe concrete deterioration could fail at any time. In addition, an increase in piping and subsequent sink holes is a strong possibility along the downstream training walls on either side of the plunge pool. The potential for piping directly under the chute slab just upstream of the plunge pool is also a strong possibility due to the severe deterioration in the vertical headwall at the end of the chute.

Drops 4 and 5 represent the worst condition relative to Drops 1 and 2. Portions of Drop 3 are being restructured during the off-season of 2004-2005. Due to the potential failure of the drop structures at any time, a top priority during the next phase of work should be to evaluate the alternatives and select an approach for rehabilitation or replacement. The feasibility of hydropower needs to be determined initially, as this would impact the rehabilitation on the drops.

Replacement of all five drop structures could be completed within 24 months. The construction can be accomplished during the normal diversion season.

Table 4.6.7 Estimated Time to Rehabilitate Hydraulic Drops No. 1 Through No. 5

Task	Duration
1) Hydropower Feasibility Study	4 months
2) Replacement Feasibility Study	4 months
3) Final Design *	8 months
4) Construction Phase	24 months
TOTAL TIME	40 months

* Does not include costs for design of hydropower machinery.

4.7 CANAL PRISMS

4.7.1 Structure Overview

The St. Mary Canal was construction between 1907 and 1915, and its original design capacity is 850 cfs. The canal is approximately 29 miles long and is an earthen, unlined, one-bank, contour canal. The original prism had the following parameters.

- 26-foot flat bottom trapezoidal section
- 2:1 (H:V) side slope fill sections
- 1½:1 side slope in cut sections
- invert slope of 0.00010 feet per foot (0.53 feet per mile)
- constructed of natural materials

The canal has been realigned and relocated in several locations since original construction. A significant relocation involved abandoning an elevated flume and placing the flow in a replacement canal between the outlet of St. Mary River Siphon and Spider Lake. Other relocations have been minor but warranted due to slope instabilities.

Cross drainage consisting of culvert structures under the prism exist at seven locations. All other drainages flow directly into the canal and are term stormwater inflow. Grassed overflow sections were constructed at several locations to accommodate excess inflows. The cross drains are listed below.

Table 4.7.1 Major Canal Cross-Drainage Structures

Cross Drain	Type	Constructed/Rehab.
Powell Creek	2 - 66-inch RCP	1995
Cow Creek	4.5’ x 5’ conc. Box	Original
Sta. 978+61	30-inch RCP w/CMP extension, 143 LF	Original
Sta. 1051+71	30-inch RCP, 140 LF	Original
Sta. 1093+94	30-inch RCP, 168 LF	Original
Sta. 1132+35	30-inch RCP, 143 LF	Original
Sta. 1195+65	30-inch RCP, 157 LF	Original

Note: RCP – reinforced concrete pipe
CMP – corrugated metal pipe

Eight bridges cross the canal section and range from county roads to private ranch accesses. The bridges are listed below, and two examples are shown in Figures 4.7.1 and 4.7.2.

Table 4.7.2 Existing Bridges Related to Project

Bridge	Location	Use
Babb	Sta. 66+65	Public
Kennedy Creek	Sta. 260+00	Public
Memorial	Sta. 395+20	Maintenance
St. Mary River	Sta. 501+00	Public
DeWolfe	Sta. 670+00	Private
Halls Coulee Wasteway	Sta. 884+93	Maintenance
Martin	Sta. 990+00	Public
Emigrant Gap	Sta. 1375+00	Public

Figure 4.7.1 Looking downstream at Martin Road Bridge (11/11/04).

Figure 4.7.2 Looking downstream at Emigrant Gap Road Bridge (11/11/04).

Other features include 8 drain turnouts which have been installed by BOR crews to facilitate maintenance and inspection activities. Two check structures, Kennedy Creek (Section 4.4) and Spider Lake, are used to control flows. Like the Kennedy Creek check, the Spider Lake check structure is inoperable. Two wasteways, Kennedy Creek (Section 4.4) and Halls Coulee, are used for emergency discharge of excess canal flows. However, the Halls Coulee wasteway is inoperable.

4.7.2 Existing Conditions & Deficiencies

General

Numerous deficiencies have been discussed by BOR staff and observed during our cursory inspections. They include, in part, the following:

- Reduced Capacity - The BOR reports that the canal has an available capacity of 850 cfs between the diversion dam and the inlet to the St. Mary River Siphon but only 670 cfs downstream of the river crossing. Based on current canals flows of 670 cfs, we did not observe sufficient and continuous freeboard upstream to support a claim of 850 cfs capacity upstream of the St. Mary Siphon. Canal capacity decreases have occurred because of prism degradation, sedimentation, erosion, encroaching upslope landslides, and settlement of fill sections. Figure 4.7.3 shows the effect of slope instability on the canal prism and reduced flow area, i.e. capacity.

Figure 4.7.3 Typical earth slide encroaching into canal prism and reducing capacity (11/11/04).

- Limited Access - Due to its inherent nature, i.e. one-bank construction, maintenance crews experience access limitations to the upslope portion of the canal. The existing maintenance road is narrow (10-feet wide) with many sharp curves and steep grades, making access with modern maintenance vehicles difficult and hazardous. The maintenance road has insufficient gravel surfacing, and maintenance crews express concerns of impassable roads during inclement weather. This poses a hardship for a manually inspected and operated system such as the St. Mary Diversion Facility.

- Inadequate Regulation - Both check structures and one of the two wasteways are inoperable. Again, for a manually operated system, this significantly curtails operational efficiency and response time in the event of an emergency. Presently, the canal operators attempt to anticipate, as much as 3 days in advance, any significant storm events so that diversion flows can be reduced to account for potential inflows which may or may not actually occur. In addition, the existing siphon inlets and outlets are not gated, which would allow maintenance to be performed on one of the siphons while water diversion continues, albeit reduced.

- Lack of Automation - The canal and its major structures lack automation, instrumentation and remote-control capabilities, which would improve efficiency, monitoring and safeguards in the event of emergencies. Automation should be incorporated at the dam and headgates and all checks and wasteways. Of course, operating checks and wasteways are a prerequisite to the future implementation of automation.

- Slope Instabilities - Slope movements and failures are occurring in both natural soils upslope from the canal prism and within the fill section (downslope bank). The 1½:1 original cut slopes and 2:1 fill slopes with an imposed canal pheratic surface are excessive for the nature of the fine-grained soils predominant downstream of the St. Mary crossing. Original construction techniques or limitations and inadequate surface preparation are most likely the main causes of fill embankment settlements and failures. Figures 4.7.3 and 4.7.4 show typical cut slope instabilities downstream of the St. Mary River Siphon. Figures 4.7.5 and 4.7.6 show typical cut and fill sections of the canal prism, respectively.

Figure 4.7.4 Looking downstream at typical canal prism. Note irregular cross-section, erosion of right bank, relatively recent armoring on left bank and slope failure in background (11/10/04).

Figure 4.7.5 One-bank canal section downstream of St. Mary River Siphon. This reach is excavated into bedrock and is stable (11/11/04).

Figure 4.7.6 Typical fill-section of canal at edge of coulee downstream of Spider Lake check structure (11/11/04).

- Seepage Losses - Seepage losses are observed along the entire length of the canal. However, the first 6 miles of canal most likely accounts for the majority of the seepage losses. Native soils consist of coarse alluvial fan deposits of Swiftcurrent and Kennedy Creek. Past the St. Mary River Siphon, soils are typically fine-grain glacial till and glacial drift soils. The BOR reports between 70 and 80 cfs is lost due to seepage between the diversion dam and the inlet of St. Mary River Siphon. Seepage losses reflect conveyance efficiency and contribute to fill section instabilities. Figure 4.7.8 shows typical material associated with alluvial fan deposits, which are prone to high seepage losses.

Figure 4.7.7 Rocky channel bottom decreases hydraulic capacity. This highly permeable material is typical of alluvial fan deposits associated with Swiftcurrent and Kennedy Creeks (11/11/04).

The following design-specific deficiencies were observed during our site inspections:

1. *Canal Shape.* Irregular cross-section over much of its length decreases flow capacity. At many locations only one embankment was installed during canal construction. The west side of the canal includes a left overbank at many locations that expand the canal to many times its normal width. Figure 4.7.8 shows an example of an irregular cross-section.

Each time that the canal shape expands or contracts it reduces flow capacity. All other things being equal, the canal capacity will increase if the shape is constant. In order to achieve a constant shape, a defined embankment would need to be installed on both sides along the entire canal (i.e., two-bank construction). Installation of a left embankment will require that local drainage (inflow) into the canal be addressed.

Figure 4.7.8 Example of irregular canal prism cross-section (11/11/04).

2. *Livestock Damage.* The canal right-of-way is not fenced. In general, livestock appears to have unrestricted access along the length of the canal. Over time the livestock can, and have, damaged the canal prism. Livestock increase the irregularity in canal shape as well as increase the roughness factor of the channel. Heavily used areas become more susceptible to erosion which further exacerbates the problem of inconsistent canal shape. Livestock tend to reduce canal efficiency and increase maintenance.

3. *Leakage.* Water leakage out of the canal has a negative impact in a number of ways. The canal size must be increased to account for water lost due to leakage. At some locations leakage can be detrimental to embankment stability. Significant leakage (70 to 80 cfs) has

been reported in the first 9 miles of the canal. Figure 4.7.7 shows typical material prone to high seepage losses.

4. *Local Runoff.* Some fairly large drainage areas contribute runoff directly into the canal. In general, little or no erosion protection has been provided at drainage culverts that divert water into the canal. As a result, severe erosion has occurred at numerous locations.

Figure 4.7.9 Severe inflow erosion at drainage culvert (11/11/04).

While addition of water to the canal may be beneficial under certain circumstances, it can be a major problem at other times. The canal should either be oversized with sufficient free board to carry the additional inflows with overflow or wasteway structures used for emergencies, or under-flow, cross-drainage beneath the canal should be provided. The former is preferred.

5. *Groundwater Piping.* Groundwater piping was evident at a few locations. At a couple of areas inside the canal, piping was obvious. This is indicative of upgradient groundwater entering into the canal. In general this type of piping should not be of serious concern. However, it would need to be addressed if a liner were to be installed inside the canal. At one

location groundwater piping was noted on the exterior embankment. This is of greater concern; since it is likely evidence that groundwater is leaking out of the embankment at a high enough rate that it is carrying sediment out of the embankment. Over time this could lead to embankment failure. An example of piping, most likely associated with construction of a drain turnout, is shown in Figure 4.7.10.

Figure 4.7.10 Piping on fill bank near existing drain turnout. Note areas of ongoing piping. (11/11/04).

6. *Sinuosity.* Numerous curves exist in the canal alignment. Each curve causes a loss of hydraulic momentum, which reduces the overall capacity. Minimizing the curves is recommended for any future canal improvements. Also, increased sinuosity increases both erosion and deposition within the canal prism. Erosion can increase instability issues of the canal side slopes. Examples of inefficient canal alignment (sinuosity) are shown in Figures 4.7.3 and 4.7.11.

Figure 4.7.11 Typical canal section showing sinuosity inherent to contour canals in rolling terrain (11/11/04).

7. *Roughness.* The roughness of the channel varies along its length and its cross section. Some areas are very rough and rocky while others are relatively smooth. The overbanks contain combinations of grass, bare soil, rocks, and brush. The BOR assumes a Manning's roughness of 0.0225 for new canals. An example of high surface roughness is shown in Figure 4.7.7.

8. *Slope.* The bottom slope of the canal is irregular. The invert has ups and downs that cause obvious ponding at low flows. This irregular slope decreases the efficiency of the canal in two ways. First it causes irregular cross sectional areas that are constantly creating contracting or expanding flow conditions. These conditions reduce canal capacity compared with a consistently shaped invert. Examples of an irregular slope are shown in Figures 4.7.1, 4.7.2 and 4.7.7.

9. *Access/Maintenance Road.* The existing access road exists only on one side of the canal. At three locations the road is discontinuous; at Kennedy Creek and at the two wasteways. The road follows along the canal and has relatively short radius bends that may make access with modern equipment difficult. The access road is rutted in some locations and very narrow at

some locations. The road, in many places, is reported by BOR staff to be impassable during inclement weather.

10. *Overflow Protection.* The existence of grassed overflow sections is reported (Engineering Appendix, April 11, 2003) but the locations of the overflows were not obvious. One may be present in just upstream of Memorial bridge. The location, size and design flow needs to be verified with any future improvements.

4.7.3 Rehabilitation Alternatives

The rehabilitation alternatives to be considered during the feasibility study and design phases for the canal prism and related structures include the following.

- ultimate canal capacity (preferred alternative)
- One-bank versus two-bank construction (two-bank preferred)
- reconstruction versus rehabilitation
- degree of realignment to improve efficiency, avoid slope instability, etc.
- degree of armoring
- seepage control and lining issues
- optimum types and ultimate locations of inline canal structures
- styles of gates on checks and wasteways
- level of automation, instrumentation and remote-control capabilities
- canal access crossings
- livestock fencing
- environmental and cultural restrictions

4.7.4 Estimated Rehabilitation Costs

Feasibility level costs were developed in the Engineering Appendix Report (April, 2003) for canal prism rehabilitation including reshaping and lining. Also developed in this report were costs for the following canal prism-related structures.

- Replacement of the seven culverts (required for canal and road widening)
- Landslide stabilization
- Replacement of Spider Lake check structure

- Replacement of existing drain turnouts and construction of new drain turnouts
- Replacement of Halls Coulee wasteway
- Widening of existing O&M roads, construction of new O&M roads in the Halls Coulee Siphon area, in the Drop Structure No. 1 area, and between Drop Structures No. 4 and 5.
- Replacement of 3 bridges
- Possible land acquisition specifically for reshaping of canal, raising canal banks, reducing slide slopes in slide areas, and offsetting new structures to allow for summer construction.
- Tree Removal
- Installation of fencing to protect any future canal lining and side slopes from livestock.

The cost estimates prepared by the BOR for the above items are dated on March 21, 2003. These cost estimates were reviewed and appear reasonable with several exceptions, the canal should be armored for protection against side channel erosion and bottom erosion during low flows. Also, canal reconstruction may be implemented in lieu of reshaping to improve efficiency and reduce impact of active landslides. Discussions with BOR staff on December 9, 2004 indicated that a final, two-bank canal prism is preferred for maintenance and efficiency. In our opinion, neither the BOR studies nor the BOR's canal prism cost estimates reflect the desire for two-bank construction.

Assuming construction would begin in the summer of 2007, it is appropriate to update these estimates by escalating the costs by 3% per year for four years. An additional cost for canal reshaping to include an allowance for additional armoring should be added. The following tables present the cost estimates originally prepared by the BOR projected to 2007 (with an assumed 20% additional allowance for additional gravel armoring, limited canal reconstruction and/or relocation and two-bank construction). Tribal fees (5%) were also added to the initial costs developed by the BOR.

Table 4.7.3 Cost Estimates to Rehabilitate Canal Prism Excluding Major Structures

Facility Component	BOR Cost Estimates - 2003		Projected Costs – 2007[1]	
	Q=850 CFS	Q=1000 CFS	Q=850 CFS	Q=1000 CFS
Canal Prism Reshaping and Lining	$33,000,000	$34,495,000	$47,000,000	$49,000,000
Landslide Stabilizations	$21,000,000	$21,000,000	$24,900,000	$24,900,000
Drain Turnouts	$750,000	$790,000	$886,500	$934,000
Powell Creek Culvert	$470,000	$480,000	$555,500	$567,500
Spider Lake Check	$1,140,000	$1,220,000	$1,407,000	$1,501,000
Cow Creek Culvert	$560,000	$560,000	$662,000	$662,000
Halls Coulee Wasteway	$1,400,000	$1,400,000	$1,714,000	$1,714,000
Culvert -Sta. 978+61	$210,000	$210,000	$248,500	$248,500
Culvert -Sta. 1051+71	$180,000	$190,000	$213,000	$225,000
Culvert -Sta. 1093+94	$210,000	$210,000	$248,500	$248,500
Culvert -Sta. 1132+35	$210,000	$210,000	$248,500	$248,500
Culvert -Sta. 1195+65	$190,000	$200,000	$225,000	$237,000
O&M Roads	$45,000	$45,000	$53,500	$53,500
Tree Removal	$320,000	$320,000	$378,500	$378,500
Land Acquisition	$54,000	$108,000	$64,000	$128,000
Fencing	$1,420,000	$1,420,000	$1,679,000	$1,679,000
TOTAL	$61,159,000	$62,858,000	$80,483,500	$82,725,000

(1) [(Adj. BOR Cost) * 1.1255] * 1.05

Recent canal rehabilitation projects (2000-2004) of similar nature and scope north of the Border have averaged approximately $1,600,000 per mile for two-bank construction. This price includes armoring, cross-drains, fencing and land acquisition, as well as studies, designs and construction administration. For this project, approximately 28 miles of canal would equate to $44,800,000. Subtracting this amount and the projected costs for landslide stabilizations ($24,900,000) from the total projected costs at 850 and 1000 cfs capacities leaves $10,783,500 and $13,025,000, respectively. In other words, the adjusted and projected BOR cost estimates for canal prism rehabilitation (minus landslide stabilizations) equates to approximately $1,985,100 and $2,065,200 per mile for 850 and 1000 cfs capacities.

The two largest influences on the costs of canal prism rehabilitation are the quantity and costs of additional ROW and the canal capacity, i.e. Preferred Alternative.

4.7.5 Rehabilitation Schedule

The majority of rehabilitation for the canal prism and related in-line structures, unfortunately, must be performed during the off-season. This will involve cold-weather construction and innovative techniques. Of course, mobilization, staging and stockpiling of materials can occur prior to winter shutdown of the canal. Only limited segments or reaches can be accomplished per construction season (irrigation off-season) to ensure uninterrupted water diversion and conveyance the following season. However, multiple reaches, whether the same or different contracts, can be performed concurrently.

It would be prudent to rehabilitate those reaches with the greatest capacity restrictions so that canal capacity could be increased incrementally each successive season. However, conventional canal rehabilitation is typically performed in an upstream to downstream fashion so that construction access is extended with each completed reach. We anticipate that complete canal prism rehabilitation may require 4 to 6 seasons.

4.8 SUMMARY

4.8.1 Overview

The majority of the structures comprising the St. Mary Diversion Facilities are in poor to very poor condition and are approximately 90 years, well beyond their design life. The continued degradation has resulted in a current diversion of 670 cfs, well below its original capacity of 850 cfs. In addition, maintenance costs, just to maintain minimal service, are escalating beyond the ability of the prime beneficiaries to pay them. Water shortages in the Milk River Basin have been largely attributed to the gradual deterioration of the St. Mary River Diversion Facilities. This has been echoed in many BOR and DNRC reports, and a representation of quotes is presented below.

- “The current system of canals and storage reservoirs supply irrigators with only one-third to one-half of the water needed for full crop production in a normal year.”

- “The deteriorating St. Mary Canal system and decreasing storage in Milk River reservoirs due to sedimentation are major causes of water shortage in the Milk River Basin.”
- “The key component of the project is the St. Mary Canal. The 29-mile long canal has outlived its design life, having been completed in 1915. The St. Mary River Siphon in the canal and five large drop structures are in imminent danger of failure. Capacity has diminished from the design capacity of 850 cfs to about 650 cfs today.”
- “Based on current trends, catastrophic failure of the St. Mary Canal is likely to occur between now and 2050.”
- “The 85-year old St. Mary Canal (now 90 years) is badly in need of rehabilitation; most of the structures have exceeded their design life and thus are in need of major repairs or replacement. Canal capacity has dropped from the original 850 cfs in 1925 to about 650 cfs today. Landslides along the canal route and the dilapidated structures make the canal unreliable as a water source.”

In our opinion, the St. Mary River Siphon and hydraulic drops represent the greatest potential for catastrophic failure due to their present condition and estimated damage resulting from failure. Catastrophic failure of either of these two components would result in severe and irreversible environmental damage to the St. Mary River and the North Fork of the Milk River, respectively. Repairs would most likely take two years for significant failure of one of the two siphon locations and at least one year for a failed drop. This would create an economic disaster for north central Montana directly and indirectly for the remainder of the State.

Catastrophic failure of the canal prism most likely could be repaired in the same season depending on its location. Likewise, the resulting environmental damage would be contained and less severe.

Most of the remaining components of the diversion facilities do not pose a high risk of catastrophic failure, but their overall rehabilitation is warranted to increase diversion capacity, decrease water shortages, improve operational flexibility and efficiency, improve safety, reduce maintenance costs and protect threatened/endangered species.

4.8.2 Rehabilitation Alternatives

The single largest design-related decision impacting overall rehabilitation of the St. Mary Facilities is the required and/or desired canal capacity (Preferred Alternative). The BOR has prepared cost estimates based on four flow regimes: 500, 670, 850 and 1000 cfs. Since the demand for water and the opportunity to utilize more diverted water has increased, it is impractical to consider a rehabilitated system with less than the original capacity (850 cfs).

From an engineering perspective, any reasonable capacity could be designed and constructed. From our review of previous water supply studies, justification for diversion capacity in excess of 850 cfs has been established. In our opinion, the primary factors limiting system capacity are: 1) the St. Mary River hydrology, 2) appointment requirements mandated by the 1909 Boundary Waters Treaty and the 1921 IJC Order, and 3) the potential requirements of the unsettled Blackfeet Nation Water Rights Compact.

With respect to individual structures comprising the Diversion Facilities, it is our professional opinion that there are additional alternatives beyond those mentioned by the BOR which should be considered. These alternatives may represent an initial construction savings and/or a cost savings associated with O&M activities. These alternatives, mentioned in previous discussions, include the following:

Table 4.8.1 Alternatives Proposed for Future Consideration

Hydraulic Structure	Proposed Alternatives
Diversion Dam	− Overshot style gate – greater ability to pass floating debris and ice floes − Pneumatic Crest Gate – better performance in ice-affected flow regimes − SCADA
Canal Headgates	− Fish screen alternatives with openings larger than 0.07 to 0.09 inches − SCADA
Checks and Wasteway Gates	− Overshot style gates − SCADA
St. Mary River and Halls Coulee Siphons	− Single pipe siphon − Buried cast-in-place concrete

Hydraulic Structure	Proposed Alternatives
Hydraulic Drops	− Hydropower considerations − Combining multiple drops − Open chute vs. pipe
Canal Prism	− Additional freeboard for inflows − Two-bank canal − Armoring − Realignment and reconstruction

4.8.3 Estimated Rehabilitation Costs

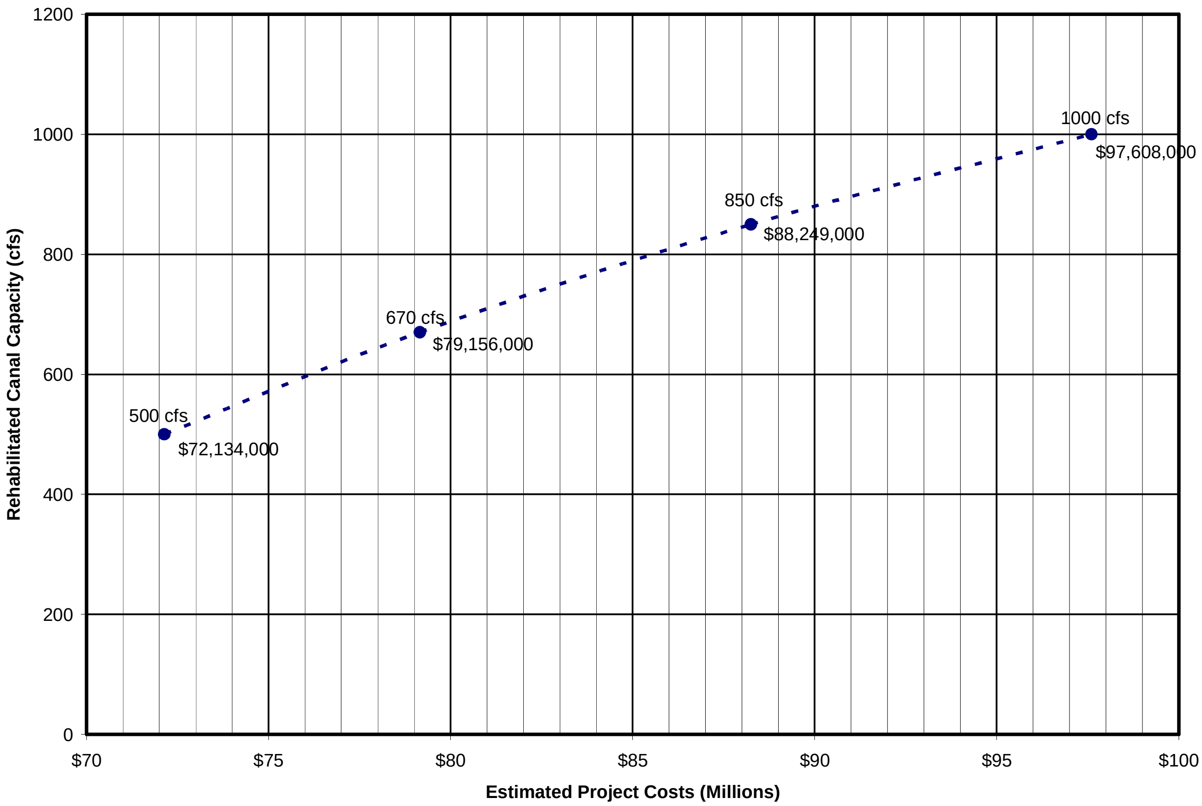
In 2003, the BOR estimated rehabilitation costs of $88,249,000 and $97,608,000 for diversion and conveyance capacities of 850 and 1000 cfs. Values for 500 cfs and 670 cfs were also prepared in order to develop a cost-capacity curve (Figure 4.8). The following represents our comments regarding our review of their studies and project cost estimates.

- Prices were developed in March 2003 (2002 for the diversion dam and headgates) and basically were out-dated when the reports were published. We have projected their estimates into the future assuming a 2007 start date. Further assuming a modest inflation index of 3%, this represents an increase of 1.1255 for 4 years. For the diversion dam and headgates, we used a factor of 1.1593 since the cost estimates were prepared in September 2002.
- Discrepancies were noted in the Engineering Appendix (BOR, 2003) between the estimating worksheets, overall summary table and summary tables prepared for discussion of individual components. In all cases, we used the higher value for budgetary purposes.
- The cost estimates for the diversion dam and headgates used 5% for mobilization, 15% for unlisted items and 25% for contingencies. No consideration was given for “non-contract costs”. The cost estimating worksheets reviewed for the remainder of components and structures used 8% for mobilization, 10% for unlisted items, 25% for contingencies and 37% for non-contract items. To be consistent, we have adjusted the estimates for the diversion dam and headgates to include non-contract costs (37%).
- The BOR has indicated that the Tribal fees (5%) were not included and are not considered part of the non-contract costs. The BOR defines non-contract costs as planning, investigations, designs and specifications, contract administration, water rights,

environmental permits and rights of way. For budgetary purposes, we have increased the BOR's cost estimates by 5% to include Tribal fees.

- The BOR recommends that individual components be designed to incorporate future automation, instrumentation and remote-control capabilities. The cost estimates, however, do not include such SCADA devices. We believe it would be prudent to include such costs and incorporate this equipment into the overall project rehabilitation. We have added additional costs to the diversion dam, headgates, checks and wasteways to reflect this recommendation.
- The BOR's discussions and cost estimates for prism rehabilitation consists of "reshaping and partial lining" in accordance with Design Standard No. 3. In our December 2004 meeting, BOR personnel indicated a preference for a two-bank prism. In addition, canal reconstruction will likely be required to avoid active landslides, reduce seepage, improve efficiency, and reduce canal sinuosity. It is our preliminary opinion that the BOR cost estimate for Canal Prism Reshaping and Lining does not account for a two-bank canal prism or, partial reconstructions and realignments. We have increased their estimate by 20%. Typical construction costs for recent projects involving canal prism rehabilitation of similar nature and scope in Canada have averaged approximately $1,600,000 per mile. This difference reflects the difference between "appraisal level" cost estimating and actual construction bids.
- We are in general agreement with the BOR's original cost estimates. They represent a substantial initial effort given the preliminary nature of the overall project. At this stage, appraisal level estimates, the BOR's approach is to incorporate unknowns as design and construction contingencies. More accurate construction cost estimates would be developed as the study and design phases progress.
- It is our opinion that there are other alternatives which should be considered further in subsequent studies and that may represent cost-saving opportunities.

Figure 4.8 Rehabilitated Canal Capacity vs. Estimated Costs



Note: Estimated costs are BOR's original 2003 values.

The following table summarizes the BOR's cost estimates for only the 850 and 1000 cfs capacities along with the modified values adjusted per the discussions above.

Table 4.8.2 Estimated Overall Project Costs to Rehabilitate St. Mary Diversion Facilities (850 cfs and 1000 cfs)

Facility Component	BOR Cost Estimates - 2003		Projected Costs – 2007[1]	
	Q=850 CFS	Q=1000 CFS	Q=850 CFS	Q=1000 CFS
Diversion Dam, Fish Ladder, Headworks and Fish Screen	$9,500,000	$10,000,000	$15,947,400	$16,781,200
Canal Prism Reshaping and Lining	$33,000,000	$34,495,000	$47,000,000	$49,000,000
Landslide Stabilization	$21,000,000	$21,000,000	$24,900,000	$24,900,000
Drain Turnouts	$750,000	$790,000	$886,500	$934,000
Kennedy Creek Siphon	$950,000	$1,250,000	$1,122,700	$1,477,200
Kennedy Creek Wasteway	$560,000	$560,000	$688,000	$688,000
Kennedy Creek Check	$1,040,000	$1,160,000	$1,255,300	$1,397,100
Powell Creek Culvert	$470,000	$480,000	$555,500	$567,500
St. Mary River Siphon - Concrete	$8,500,000	$11,500,000	$10,045,200	$13,590,500
St. Mary River Bridge	$1,500,000	$1,500,000	N/A	N/A
Spider Lake Check	$1,140,000	$1,220,000	$1,407,000	$1,501,000
Cow Creek Culvert	$560,000	$560,000	$662,000	$662,000
Halls Coulee Wasteway	$1,400,000	$1,400,000	$1,714,000	$1,714,000
Halls Coulee Siphon - Concrete	$4,100,000	$4,200,000	$4,845,300	$4,963,500
Culvert -Sta. 978+61	$210,000	$210,000	$248,500	$248,500
Culvert -Sta. 1051+71	$180,000	$190,000	$213,000	$225,000
Culvert -Sta. 1093+94	$210,000	$210,000	$248,500	$248,500
Culvert -Sta. 1132+35	$210,000	$210,000	$248,500	$248,500
Culvert -Sta. 1195+65	$190,000	$200,000	$225,000	$237,000
Drop 1 - Pipe Drop Alt.	$810,000	$840,000	$957,100	$992,700
Drop 2 - Pipe Drop Alt.	$890,000	$900,000	$1,051,800	$1,063,600
Drop 3 - Pipe Drop Alt.	$790,000	$810,000	$933,600	$957,200
Drop 4 - Pipe Drop Alt.	$1,050,000	$1,100,000	$1,240,900	$1,300,000
Drop 5 - Pipe Drop Alt.	$890,000	$930,000	$1,051,800	$1,099,100
O&M Roads	$45,000	$45,000	$53,500	$53,500
Tree Removal	$320,000	$320,000	$378,500	$378,500
Land Acquisition	$54,000	$108,000	$64,000	$128,000
Fencing	$1,420,000	$1,420,000	$1,679,000	$1,679,000
TOTAL	**$91,739,000**	**$97,608,000**	**$119,622,600**	**$127,035,100**

[1] Cost estimates adjusted and projected per previous discussions.

5.0 BLACKFEET NATION ISSUES & CONCERNS

The Blackfeet Nation is an important stakeholder because the entire diversion and conveyance system to the North Fork of the Milk River lies within the boundaries of the Blackfeet Nation. As such, they have had issues with the Diversion Facilities over the last 90 years and concerns regarding the proposed project rehabilitation. A meeting was held on November 30, 2004 in Browning with Tribal environmental and natural resource staff to discuss the project and their concerns. Their issues are threefold: 1) the Blackfeet Nation, its people, its cultures and Tribal ordinances; 2) land and water quality; and 3) impacts to wildlife.

Blackfeet Nation

The Blackfeet Nation should provide input on design alternatives and should be involved with the review process. This can be accomplished with public meetings, public announcements and coordination with Tribal staff. This involvement must also include that from local landowners adjacent to the project.

It is likely that additional ROW and/or easements will be required for relocation and construction of replacement structures such as the diversion dam and canal headgates, Kennedy Creek, St. Mary River and Halls Coulee siphons, the St. Mary River Bridge, and the hydraulic drops. Also, improvements to the canal prism involving realignment and widening will require additional land acquisition. The BOR is currently developing a GIS-based map compiling their understanding of documented land ownerships, easements and ROW. It is important that this map also show the present locations of the canal, maintenance roads, and related structures. At this stage of the process, only general statements can be made as to a likely location of a given replacement structure or canal realignment. Actual land acquisition requirements, both permanent and temporary for construction purposes, can only be fully determined during the design phases. Land acquisitions and negotiations will involve both tribal and non-tribal land owners, the Blackfeet Tribe and the Bureau of Indian Affairs (BIA).

Sensitivity to cultural resources, living history, archaeology, ethnographic/traditional cultural properties must be understood and properly mitigated prior to project rehabilitation. This will involve a close working relationship with the Blackfeet Tribal Historic Preservation Office (THPO).

All Tribal ordinances including, but not limited to, environmental permitting, environmental compliance, TERO, and other Tribal fees must be adopted and incorporated into project rehabilitation.

<u>Impacts to Land and Water Quality</u>

These issues include, in part, the following:

- Changes to riparian corridor and wetlands that results from canal leakage.
- Provision for future livestock watering.
- Creation of additional wetlands.
- Aesthetics of the finished project.
- Temporary construction impacts to land and water quality.
- Water quality in North Fork of Milk River.
- Impacts of canal system on Babb water system and nearby wells.
- Environmental impacts, erosion and sedimentation from, and including, Lake Sherbourne to the diversion dam.

These concerns can be systematically addressed and incorporated into the project as the studies and designs progress by working closely with Tribal staff and local landowners.

<u>Impacts on Wildlife</u>

Concerns expressed regarding potential impacts to wildlife include, in part, the following:

- Destruction of existing and the creation of new habitat for waterfowl and other game birds.
- Lack of wildlife crossings (elk migration) with respect to the rehabilitated canal prism and livestock fencing.
- Elevated siphon affects elk migration.
- Bull trout issues with respect to the diversion dam and canal headgates.
- Implications of increasing hunter and other human access to wildlife.

- Construction impacts on grizzly bears, bald eagles, wolves, lynx, bull trout, elk calving areas.

These issues should be addressed and incorporated into the design and construction phases.

6.0 ENVIRONMENTAL COMPLIANCE

6.1 OVERVIEW

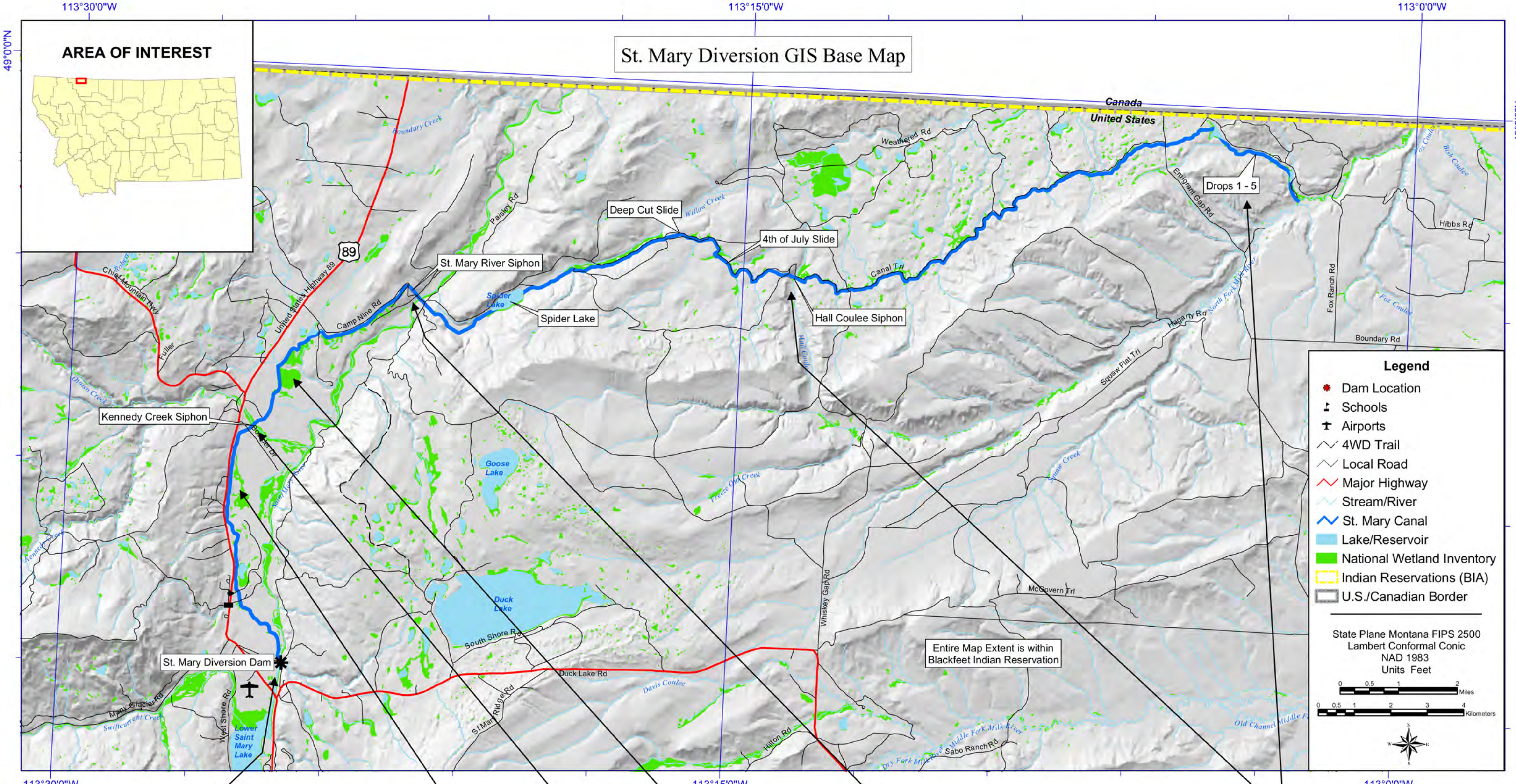
Existing environmental information is limited for the project area. The Bureau of Reclamation (BOR) recently published a Regional Feasibility Report that included the St. Mary Rehabilitation and provided a general summary of environmental effects. A limited-scope Environmental Assessment was produced in 1990 on canal maintenance involving vegetation removal. The State of Montana has some GIS coverages for the project area, including wetland mapping from the National Wetland Survey. Project GIS mapping has been initiated based on this available information (see Figure 6.1).

Environmental issues related to irrigation facility rehabilitation are primarily centered on the cultural resources, fish and wildlife resources, and water resources of the project area. The BOR has been conducting research on bull trout related to the St. Mary Diversion; reports are available.

A preliminary environmental process is defined, outlining potential roles of the Blackfeet Tribe and other Stakeholders, including Federal Agencies. The permitting will follow Blackfeet Tribe permitting procedures. The Blackfeet Tribe will be involved in the entire environmental process. The Bureau of Reclamation (BOR) will be the lead agency for the National Environmental Policy Act (NEPA) process. At this time, a NEPA Environmental Assessment is scoped as the appropriate documentation; however, if environmental impacts are significant, an Environmental Impact Statement (EIS) may be warranted.

The United States Fish and Wildlife Service (USFWS) will be a key agency in the implementation of the Fish and Wildlife Coordination Act (F&WCA) and the Endangered Species Act. An expected outcome of following the F&WCA will be the avoidance, minimization, and mitigation of impacts to biological resources.

The Tribal Historic Preservation Office and/or the State Historic Preservation Office will be involved with cultural resource clearances.



Bull Trout issues at St. Mary Diversion and other areas

Riparian and upland habitat adjacent to canal

Riparian habitat along stream return flow

Wetland habitat flooding area adjacent to canal

Historic bridge at St. Mary River crossing

Wetland crossing at Hall Coulee Siphon

Water quality issues at Milk River

Figure 6.1

The purpose of this work is to outline the environmental process necessary to obtain permits for replacement and/or rehabilitation of the St. Mary Diversion Facilities.

6.2 EXISTING ENVIRONMENTAL DATA

Our understanding of existing environmental data was based on face-to-face interviews conducted with the Blackfeet Tribe and the Bureau of Reclamation. We also conducted phone interviews with the, Montana Department of Natural Resources and Conservation, Environmental Protection Agency, Bureau of Indian Affairs, National Park Service, Fish and Wildlife Service, as well as project staff for the engineering design of the project.

These interviews sought to identify existing environmental data, identify environmental issues pertinent to the project, and define the environmental permitting process.

6.2.1 Existing Information and Reports

Several reports were reviewed in developing the environmental roadmap for this project. Several are listed below with brief summaries on content and relevancy to the project.

- ***Regional Feasibility Report, North Central Montana*** (2004, October). U.S. Bureau of Reclamation, Montana Area Office, Billings, Montana. The Chippewa Cree Tribe of the Rocky Boy's Reservation Indian Reserved Water Rights Settlement and Water Supply Enhancement Act of 1999 (Public Law No. 106-103) directed BOR to conduct a regional feasibility study of north central Montana. The purpose of the study was to identify present and potential water supplies, water uses and management, major water-related issues, and opportunities to resolve these issues.

  The study found that the St. Mary Canal System enhancements alternative is the only alternative that would significantly address the water supply and related issues of north central Montana and that would produce positive economic benefits. The other five alternatives considered in the report would contribute to the water supply on a much smaller scale and would not produce net economic benefits when only agriculture is considered.

Environmental effects identified by the BOR (2004) for St. Mary System Enhancements included:

- Positive effect on the Milk River Irrigation Water Supply
- Positive effect on the municipal, rural, and industrial (MR&I) Water Supply
- Slightly positive effect on Threatened and Endangered Species assuming bull trout mitigation occurs with fish passage, entrainment protection at the diversion site and winter releases of flows from Sherburne Dam. Grizzlies could benefit from habitat enhancement due to water in wetlands and the riparian corridor or could be negatively impacted if canal rehabilitation results in a loss of existing wetlands. Piping plover had potential negative and positive effects, depending on water management practices. Pallid sturgeon and other species might benefit from higher spring flows in the lower Milk River.
- Slightly positive effect on water quality with higher flows and lowering of contaminant concentrations.
- Positive effects on water rights issues with Fort Belknap Reserved Water Rights, Blackfeet Reserved Water Rights, and Water for Bowdoin National Wildlife Refuge.
- Positive effects on fish and wildlife species with more water in the Milk River Basin, including downstream reservoirs.
- Positive effects on recreation in downstream river reaches and reservoirs.
- Positive effects on hydropower opportunities at canal drop structures and at Fresno dam, downstream.

♦ ***Environmental Assessment*** (1990, September 28). St. Mary Canal Milk River Project, Montana. Bureau of Reclamation, Great Plains Region, Billings, Montana. This report discussed the impacts to listed species from the continued operation and maintenance clearing of vegetation along the canal by the BOR. The EA cited the 1987 BIA and Blackfeet Tribe research on Grizzly bears and the researchers' intuitive conclusion that bears use the riparian corridor along the canal for travel routes. The EA concluded that selection of a alternative that was a compromise between no maintenance action and following strict BOR clearing policy would result in no significant impacts on grizzly bear and gray wolf.

♦ ***Draft Environmental Assessment Rocky Boy's/ North Central Montana Regional Water System*** (2004, March 25). A Joint NEPA/MEPA Compliance Document. Lead Agency: U.S.

Bureau of Reclamation, Cooperating Agency: U.S. Bureau of Indian Affairs Montana Department of Natural Resources and Conservation Montana Department of Environmental Quality. This report provides an example of the type of NEPA document that has been recently produced by the BOR on water resource projects. The BOR staff recommended this as a good example to follow for the St. Mary project, assuming an Environmental Assessment is the chosen NEPA document. The data does not apply to the St. Mary's project area.

- ***Finding of No Significant Impact*** (2002, August). Final Programmatic Environmental Assessment Fort Peck Reservation Rural Water System, Fort Peck Reservation and Dry Prairie Service Areas. Department of Interior, Bureau of Reclamation Montana Department of Natural Resources and Conservation, Montana Department of Environmental Quality. This report provides an example of the type of NEPA document that has been recently produced by the BOR on water resource projects. It also contains an example of using the Fish and Wildlife Coordination Act procedures in reducing project impacts. The BOR staff recommended this as a good example to follow for the St. Mary project, assuming an Environmental Assessment is the chosen NEPA document. The data does not apply to the St. Mary's project area.
- ***Fish and Wildlife Coordination Act*** [Chapter 55, approved March 10, 1937, 48 stat. 491] [As Amended Through P.L. 108-204, March 2, 2004]. (2004, March 2). The BOR staff recommended this process as the preferred approach to avoiding, minimizing, and providing effective mitigation for environmental impacts associated with the St. Mary project.
- ***Bull Trout (Savelinus confluentus) Use of Tributaries of the St. Mary River, Montana.*** Mogen, J. T., & Kaeding, L. R. (2004, May). U.S. Bureau of Reclamation, Billings, Montana This report concludes that operation of the St. Mary's facilities is negatively affecting the bull trout in the St. Mary's drainage. This report also details out the recommendations to improve conditions for bull trout directed at the facilities and operation.
- **Bull Trout (Salvelinus confluentus) in the St. Mary River Drainage, Montana and Alberta,** A Progress Report Based on Field Investigation Conducted During 1997-2002. Mogen, J. T., & Kaeding, L. R. (2003, October). U.S. Bureau of Reclamation, Billings, Montana. This very comprehensive report concludes that operation of the St. Mary's facilities is negatively affecting the bull trout in the St. Mary's drainage. This report takes a

very close look at fish populations, distributions, and species in the St. Mary's drainages and impacts from the operation of the current facilities.

- **Fish entertainment Investigations at the St. Mary Diversion Dam, St. Mary River Montana.** A Progress Report Based on Field Investigation Conducted in 2002. Mogen, J. T., & Kaeding, L. R. (2002, December). U.S. Bureau of Reclamation, Billings, Montana. This report focuses on the entrainment of fish into the canal from the existing sub-standard facilities. The report documents that many species and sizes of fish including bull trout are entering the canal. This report recommends temporary screening options for installation at the diversion and identified issues associated with use and sampling.

6.2.2 Resource Agency Interviews

Our understanding of existing environmental data was based on face-to-face interviews conducted with the Blackfeet Tribe and the Bureau of Reclamation. We also conducted phone interviews with the, Montana Department of Natural Resources and Conservation, Environmental Protection Agency, Bureau of Indian Affairs, National Park Service, Fish and Wildlife Service, as well as project staff for the engineering design of the project.

Blackfeet Tribe

A meeting was held at Tribal offices in Browning on November 30, 2004 with Blackfeet Environmental Staff to discuss environmental issues. This summary attempts to concisely document relevant Blackfeet Tribe information to guide the environmental process for the rehabilitation project. It is not intended to be a meeting transcript.

Who will be the project contacts?

Tribal Contact for Environmental Topics: Barry Adams – Blackfeet Environmental Office-406-338-7421. Entranco can work directly with Barry as long as Erling Juel is kept in the communication coordination.

John Murray is the point of contact for cultural resources.

For overall project permitting, and Tribal Council topics – Barry will refer to Mike Tatsy and Pat Thomas of the Tribe for direction.

Who will be the lead agency for NEPA Environmental Documentation?
The consensus was that a partnership between the Tribe and the Bureau of Reclamation.

The Tribe is interested in a multiple agency signature page on the environmental documentation. This could imply co-lead NEPA status or Cooperating Agency NEPA status.

The Tribe is uncertain about the role of the Bureau of Indian Affairs (BIA).

The Tribe clearly stated that the State of Montana has no permitting authority on the reservation.

The Tribe expressed interest in being involved with the environmental process, including data collection (wetland delineations) and cultural resources. They do not have an environmental consultant; they would like to use tribal staff/members.

The Tribe will recognize procedures of the Endangered Species Act.

The Tribe has its own Cultural Resources Ordinance and Tribal Historic Preservation Office (THPO).

What environmental procedures will the Blackfeet Nation recognize and do they have their own procedures?
The Blackfeet Nation has an environmental policy and permitting process through their Environmental Department. Ordinance 90-A contains policy, permitting procedures, permitting costs, contractor requirements, etc. The Nation recognizes NEPA processes and has cooperated with the Bureau of Reclamation and other agencies. They also work with other agencies, such as the Army Corps of Engineers and the US Fish and Wildlife Service.

In regard to cultural resources, the Tribe has a working relationship with the Montana State Historic Preservation Office.

What environmental baseline information is available from the Tribe?

There are preliminary wetland maps from the National Wetland Inventory from our project termini – St. Mary's Diversion downstream to the canal's confluence with the Milk River. These maps have not been field verified.

There are separate studies being conducted upstream for fish and other aquatic organisms. This includes the work on Boulder Creek, Swift Creek, and Sherburne Reservoir. Geomorphologic work, including sediment loads, stream cross-sections, etc. has been conducted.

The Tribe has been working on a preliminary Environmental Comprehensive Plan. It has not been adopted or reviewed, nor do we understand if it has information that can be used in our report.

Tribe has a water quality non-point assessment.

Bureau of Reclamation

A meeting was held at BOR offices in Billings on December 9, 2004 to discuss the project. This summary attempts to concisely document relevant Bureau of Reclamation (BOR) information to guide the environmental process for the rehabilitation project. It is not intended to be a meeting transcript.

Who will be the project contacts?

BOR Contact for Environmental Topics: Tom Sawatzke - 406-247-7314. Entranco can work directly with Tom as long as Erling Juel is kept in the communication coordination.

Other BOR environmental staff includes:

Jeff Baumberger – NEPA documentation.

Sue Camp – Fisheries - ESA

Bill Vincent - contact for cultural resources.

Other Blackfeet Tribal staff noted by BOR include Gail Skunkcap – ESA; and Dan Carney – bear biologist

Who will be the lead agency for NEPA Environmental Documentation?

Bureau of Reclamation will be the lead agency for NEPA.

The potential exists for the Bureau of Indian Affairs (BIA), US Fish & Wildlife Service (USFWS), and the Environmental Protection Agency (EPA) to be cooperating agencies for NEPA.

BIA contacts are Doug Davis and Mike Black (406) 247-7998

USFWS contact is Mark Wilson, Field Supervisor, Helena.

EPA contact is John Wardell in Helena

The Blackfeet Tribe and the Montana DNRC would be key stakeholders for the NEPA documentation. Their role can be established to be part of important milestones.

The BOR was not sure on which type of NEPA document to produce. Two examples were provided of recent NEPA EAs (Rocky Boy's and Ft. Peck Regional Water Systems). The BOR (Tom Sawatzke) recommended that the project follow the provisions of the Fish and Wildlife Coordination Act (see references below) in order to develop project alternatives that would avoid and minimize environmental impacts. This is an early coordination process that allows the BOR to fund the USFWS to collaborate early in the project. The process was used on the Ft. Peck Reservoir project. The outcome of this process would help determine the type of NEPA document needed. He recommended we contact USFWS – Mark Wilson – 406-449-5225 – Ext. 205; Brent Esmiol – Ext 215; or Lou Hanaberry for further information on this approach.

Jerry Moore (recently retired BOR engineer for St. Mary Project) said project rehabilitation permitting was coordinated with the Tribe, EPA, ACOE, and BOR during 2 meetings per year.

Endangered Species Act (ESA)

The BOR has place priority in Endangered Species Act compliance for the St. Mary Rehabilitation.

The BOR and US Fish and Wildlife Service are collaborating through informal consultation on bull trout research for the St Mary Rehabilitation. Key issues include:

- No winter flows in Swiftcurrent Creek immediately downstream of Sherburne Reservoir. Modifications to the dam to allow winter releases are being studied.
- Fish passage through the St. Mary Diversion Dam
- Fish entrainment in the St. Mary Canal.

BOR recognizes Federal, State of Montana and Tribal environmental regulations and procedures.

What environmental baseline information is available from the BOR?

BOR's understanding was that all available environmental references were provided to Montana DNRC. Montana DNRC had prepared a list of BOR references they have identified. Most of these documents were forwarded to the DNRC consultant team. One item on the list referred to a compilation of environmental reports. We confirmed that the TD&H team did not receive this information.

Dale Anderson, with consultant team, also asked about a reference listed in the Alternatives Report, referring to an EA produced for vegetation removal along the St. Mary Canal and its impact to the grizzly bear. BOR will try to locate the document and others listed during the meeting.

BOR has air photos and infrared photos of the project corridor (1-inch to 200-feet) taken on 10-23-93. They also have another flight taken in 1997. The earliest flight was taken in 1947 by the SCS.

The BOR is planning to prepare GIS mapping of the land ownership along the St. Mary project. Paul Azevedo recommended looking into the State's NRIS system for natural resource coverage's in GIS.

BOR also provided two examples of their EAs on their projects: 1) Final Programmatic Environmental Assessment – Fort Peck Reservation Rural Water System Fort Peck Reservation and Dry Prairie Service Areas. 2) Draft Environmental Assessment Rocky Boy's / North Central Montana Regional Water System.

BOR also provided the September 2004 listing of ESA species for Montana counties.

BOR also provided an outline of "Service Fish and Wildlife Coordination Act Involvement" and a document by USFWS entitled "Issues in Fish and Wildlife Planning – Water Resource Planning Under the Fish and Wildlife Coordination Act".

A list of additional documents was recorded at the meeting; the BOR will try to locate and forward these documents to DNRC for the consultant team.

Cultural Resources

Bill Vincent, cultural resource staff for the BOR, said the following information would be needed for environmental documentation for cultural resources:

- Engineering facility history - The BOR has a 3-volume binder of the history of the St. Mary Project. It does not completely fulfill 106 National Historic Preservation Act requirements for the historical component for the cultural resource clearance for the St. Mary Rehabilitation.
- Class 3 survey for impacted areas
- Traditional cultural issues

Bill recommended doing a programmatic agreement (memorandum of understanding – MOU) on how cultural resources investigations are done as the St. Mary Rehabilitation progresses. The agreement should include the Tribal Council, THPO, BIA, and BOR.

Environmental Protection Agency

John Wardell of the USEPA suggested that if the NEPA product was going to end up being a Categorical Exclusion or an EA, they would probably not play a large role or formally participate as a cooperating agency. He noted that the Bureau of Reclamation has a NEPA process and that the Blackfeet Nation would be involved, so the EPA didn't really see that there was much of a necessity to get involved.

If, however, any part of the project came to the point of becoming a full EIS, they would want a reviewing role. Mr. Wardell asked that we contact him in the future, particularly if our scoping identifies anything that might result in the production of an EIS. He also suggested that they might want to be updated about the NEPA process informally, just so they would be able to manage their work load should they need to become more involved with the project.

Bureau of Indian Affairs

Doug Davis and Rick Stefanic of the Bureau of Indian Affairs (BIA) office in Billings, Montana commented regarding the role of the BIA in the environmental process. The BIA would like to be a formal cooperator in the NEPA process, and accept that the Bureau of Reclamation would be the lead agency. Their concern lies with representation of the Blackfeet Nation and with their own NEPA reviews that might promulgate from the project. One of their primary concerns is the duplication of effort that would come about if they were not to sign off on the NEPA document, and a subsequent change in status of some Indian Trust lands was to be required. A separate study and NEPA process would have to be undertaken for an exchange or lease of Trust ground, and they feel that it would be most expedient for them to be involved from the beginning of the process.

National Park Service

Mary Riddle, the environmental officer for the National Park Service (NPS) in Glacier National Park, suggested that there were no pressing issues that would directly affect conditions in the Park. Therefore, she did not see the NPS becoming a formal cooperator in the NEPA process. However, since the Park shares a boundary with the Blackfeet Nation, she felt that it would be in everyone's best interest that the Park is kept informed as to the progress of the environmental side of the project. Naturally, if any issues were to be uncovered during the course of the NEPA process that might directly affect conditions within the Park, they would want to be informed.

Fish and Wildlife Service

Mark Wilson and Lynn Kaeding of the US Fish and Wildlife Service (USFWS) communicated the process their agency would like to follow for Endangered Species Act Section 7 consultation as well as more general fish and wildlife impact assessment procedure for a project of this type. The USFWS would like the project participants to conduct standard section 7 consultation for Threatened and Endangered Species as well as prepare a report for compliance of the Fish and Wildlife Coordination Act (FWCA), which pertains to all wildlife species potentially affected by the project. The FWCA compliance report would determine the mitigation goals and commitments for the all species found to require mitigation measures. The Report would be initiated in response to a planning document sent to the USFWS from the lead agency. The goal of the report would be concurrence signatures from all cooperating agencies approving the report and the mitigation outlined within it. The FWCA and Section 7 compliance can be prepared concurrently and, depending on the outcome the T&E investigations, portions of the Section 7 consultation can be attached to the FWCA document as technical backup. This process may identify the needs for additional environmental studies for fish and wildlife not completed or to supplement studies already completed.

Montana Department of Natural Resources

The Montana Department of Natural Resources (DNRC) will serve as a reviewing agency for the environmental process and documentation. All elements of the Montana Environmental Policy Act (MEPA) that might apply to the project will be met through the NEPA process. Permitting will be directed through the Blackfeet Nation Ordinance 90-A and through the appropriate federal agencies, so no state procedures are anticipated. The DNRC, as the budgeting and project management agency, will necessarily review all documentation, investigations and permitting, and will have a presence at all meetings pertaining to those aspects of the project. Their comments and revisions will be incorporated with the cooperation of the lead and cooperating agencies.

6.3 PROJECT COMPLIANCE ISSUES

6.3.1 Environmental Issues

Currently the BOR and US Fish and Wildlife Service are collaborating through informal consultation on bull trout research for the St Mary Rehabilitation. Key issues include:

- No winter flows in Swiftcurrent Creek immediately downstream of Sherburne Reservoir; Modifications to the dam to allow winter releases are being studied;
- Fish passage through the St. Mary Diversion Dam;
- Fish entrainment in the St. Mary Canal;

Interviews with the Blackfeet Tribe and the BOR has identified the following list of plants and animals, topics and issues that may required a combination of new data collection, data analysis, and or additional environmental studies to achieve the goals of the NEPA compliance of the project. This list of environmental issues will likely be changed during Scoping (see process below).

The following environmental issues have been identified the following as potentially requiring analysis in the environmental document:

- wildlife crossings of the canal, including elk migration.
- canal lining and how different linings (e.g. concrete, PVC, HDPE) affect wildlife crossings.
- effects of widening or deepening the canal.
- effects of canal fencing.
- effects on grizzly bears, wolves, lynx, bull trout, bald eagle and slender moonwort (plant).
- timing of construction and potential effects on wildlife.
- implications of increasing hunter and other human access to wildlife.
- effects on elk populations with nearby calving areas.
- changes to riparian corridor and wetlands resulting from canal leakage control.
- potential to disrupt sub-irrigation of farmland with canal improvements. Potential to disrupt cattle watering. Potential to eliminate creek flows fed by canal leakage. About 70

to 80 cfs of flow is lost from the canal between the St. Mary diversion dam and the St. Mary siphon.

- concern exists about native plants along the canal and project impacts.
- pondweeds are a maintenance problem downstream of the St. Mary siphon – especially at Spider Lake.
- local runoff at drain inlets area a sediment problem.
- spring water enters the canal between the St. Mary siphon and drop structure #1.
- cultural Resources - Impacts to Tribal spiritual places. For example, a spiritual place is located near the St. Mary Diversion structure. The Tribe knows other important areas.
- concern about water source impacts (quantity and quality) to the Babb School, assuming canal leakage is recharge for local groundwater.
- water quality concerns (primarily sedimentation) in the North Fork of the Milk River resulting from drop structure hydraulics.
- interest in habitat mitigation related to wetlands and wildlife, including waterfowl and other game birds.
- upstream concerns:
- bio-transfer (inter-basin transfer) of unwanted fish species (e.g. troutperch).
- concern about Swiftcurrent Creek and changes in water level, flows, and being de-watered. Also a sediment problem.
- concern about sediment problems in Sherburne Reservoir and Lower St. Mary Lake.
- instream flows in St. Mary River below diversion dam.

6.4 ROADMAP OF ENVIRONMENTAL PROCESS

A roadmap to environmental compliance and permitting for the project is shown in Figure 6.2. The roadmap includes three major environmental coordination areas: 1) Blackfeet Tribe and Federal Agency Coordination, 2) NEPA and NHPA 106 Compliance, and 3) Fish and Wildlife Coordination Act (F&WCA) and Endangered Species Act Compliance.

6.4.1 Blackfeet Tribe/Federal Coordination

Rehabilitation of the St. Mary Diversion and Conveyance facilities is a major project that involves many stakeholders. The Blackfeet Tribe is an important stakeholder because the proposed improvements are located entirely within their reservation boundaries. The Bureau of Reclamation, as owner and operator of the facilities, will be the lead Federal Agency under the National Environmental Policy Act. The Bureau of Indian Affairs will likely be a Cooperating agency due to their role with Indian Trust lands.

The State of Montana, Department of Natural Resources & Conservation has been a facilitator of moving this project forward and working with the St. Mary Rehabilitation Working Group.

The USFWS would like to have a major role in the project alternative development to consider impacts to fish and wildlife through the Fish and Wildlife Coordination Act and the Endangered Species Act (see discussion below).

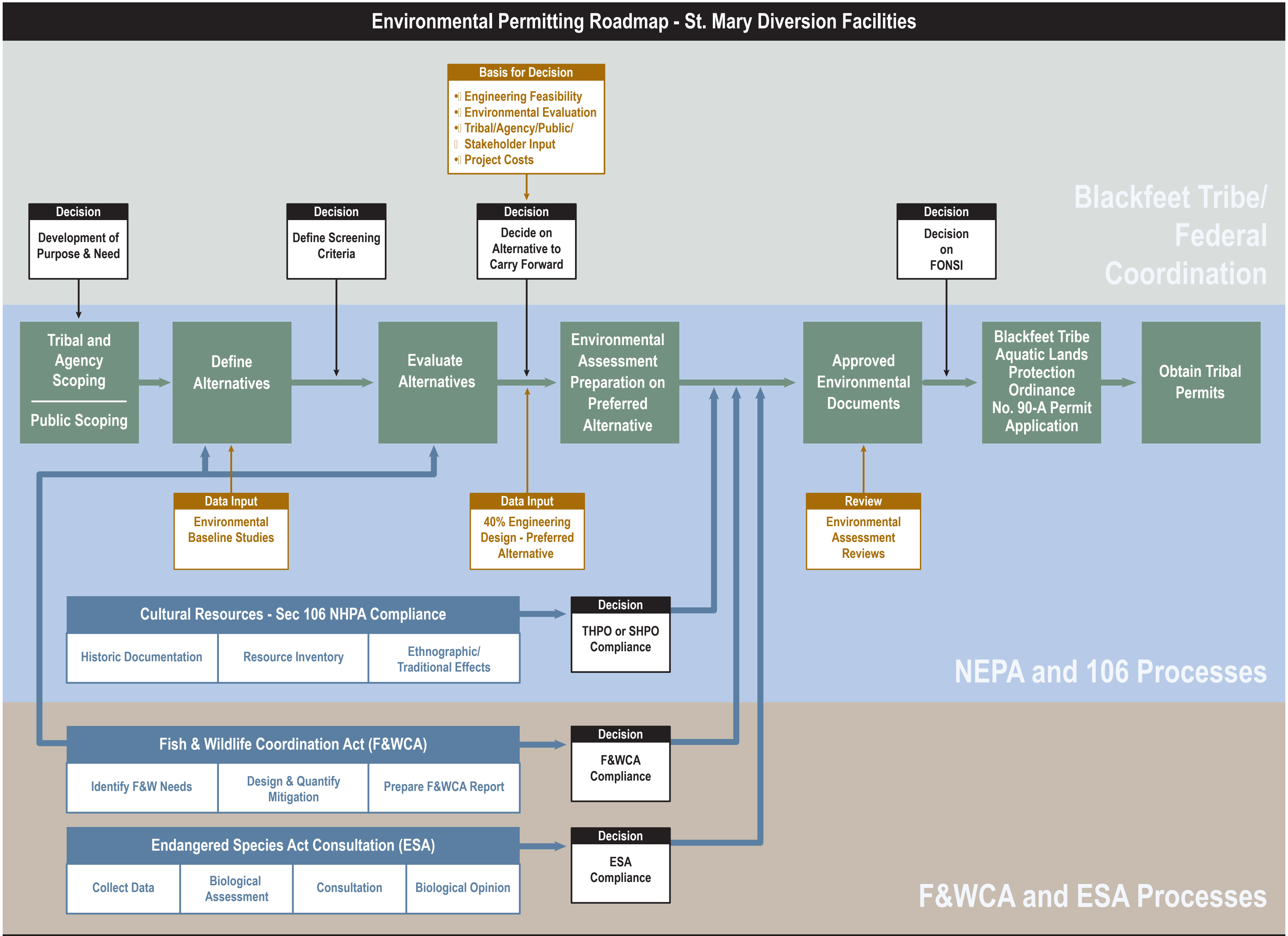
As shown in Figure 6.2, several decisions are needed to facilitate the rehabilitation and environmental approvals. Stakeholders will be involved in the development of the project's purpose and need and alternative development.

6.4.2 NEPA and NHPA 106 Processes

NEPA Process

For this report, it was assumed that a NEPA Environmental Assessment (EA) would be produced. A critical assumption in EA production is that project impacts can be mitigated to result in a “Finding of No Significant Impact (FONSI)". It is also assumed that the NEPA EA will be adopted for MEPA compliance.

A key step in the process recommended by the BOR is the use of the Fish and Wildlife Coordination Act (F&WCA) to help define the project alternatives that consider fish and wildlife needs (see discussion below). Depending on the outcome of alternative definition, the type of NEPA environmental document may change.



Environmental Permitting Roadmap - St. Mary Diversion Facilities
Basis for Decision
• Engineering Feasibility
• Environmental Evaluation
• Tribal/Agency/Public/ Stakeholder Input
• Project Costs
Decision
Development of Purpose & Need
Decision
Define Screening Criteria
Decision
Decide on Alternative to Carry Forward
Decision
Decision on FONSI
Blackfeet Tribe/ Federal Coordination
Tribal and Agency Scoping
Public Scoping
Define Alternatives
Evaluate Alternatives
Environmental Assessment Preparation on Preferred Alternative
Approved Environmental Documents
Blackfeet Tribe Aquatic Lands Protection Ordinance No. 90-A Permit Application
Obtain Tribal Permits
Data Input
Environmental Baseline Studies
Data Input
40% Engineering Design - Preferred Alternative
Review
Environmental Assessment Reviews
Cultural Resources - Sec 106 NHPA Compliance
Historic Documentation
Resource Inventory
Ethnographic/ Traditional Effects
Decision
THPO or SHPO Compliance
NEPA and 106 Processes
Fish & Wildlife Coordination Act (F&WCA)
Identify F&W Needs
Design & Quantify Mitigation
Prepare F&WCA Report
Decision
F&WCA Compliance
Endangered Species Act Consultation (ESA)
Collect Data
Biological Assessment
Consultation
Biological Opinion
Decision
ESA Compliance
F&WCA and ESA Processes
W:2-85-04160 St. Mary diversion\graphics & images\environmental permitting roadmap.ai (12/22/04) dgb

Figure 6.2

Figure 6.2 shows the environmental documentation steps for NEPA compliance. NEPA steps include: Internal scoping, public scoping, development of the purpose and need, development of project alternatives, development of environmental documents, mitigation plans, public review, and NEPA decision.

Environmental coordination with the BOR, BIA, USFWS, Blackfeet Tribe, DNRC, and the St. Mary Rehabilitation Working Group, and the public will occur to comply with NEPA public involvement guidance. Key points of interaction include: 1) Scoping, 2) Development of Alternatives, and 3) Development of the Environmental Assessment.

The project's purpose and need and reasonable and feasible alternatives will be determined. Agency and public scoping will be conducted for alternative identification and determination of environmental elements to be analyzed. It is assumed that NEPA discipline reports (DRs) will be prepared for the following environmental elements: wetlands, waterways, floodplains, fish and wildlife, vegetation, visual quality, cultural resources (historic, archaeological, and pre-historic resources), land use, economics, and environmental justice. Field studies are anticipated for wetlands, fish and wildlife, vegetation, visual quality, and cultural resources. Other environmental elements may be added during scoping. The DRs will include studies and coordination, methods, affected environment, and environmental impacts of the one action alternative compared to no action.

Environmental mitigation design will likely be required in the event that impacts cannot be avoided or minimized. Mitigation design usually involves a multidiscipline team to plan and design mitigation such as wetlands or riparian habitat. The mitigation work begins with development of conceptual mitigation plans as provided in the EA. Conceptual mitigation plans are usually expanded into detailed mitigation plans that include proposed monitoring plans. It also includes taking the project through final design to bid documents which include construction specifications and design drawings. Environmental on-site construction and mitigation monitoring assistance, involving a multidiscipline team, would likely be required.

National Historic Preservation Act - 106 Process

The proposed rehabilitation of the St. Mary's Diversion system has several jurisdictional and administrative aspects due to the involvement of multiple Federal, Tribal and State entities. The jurisdiction issue may have a significant impact to the cultural resource procedures and review process for this project. Establishing a Memorandum of Understanding (MOU) between the various Federal, Tribal and State entities is recommended to clearly define the cultural resource procedures for this project.

The project clearly meets the definition of a federal undertaking for purposes of Section 106 and 110 of the National Historic Preservation Act (NHPA). It is therefore subject to federal legislation requiring cultural resource inventory in compliance with the NHPA (Public Law 89-665, as amended), Executive Order 11593 (Protective and Enhancement of the Cultural Environment), and the National Environmental Policy Act. The lead agency will be the Bureau of Reclamation. The Bureau of Indian Affairs and the Army Corps of Engineers may also be involved with cultural aspects of the project.

As the project lies entirely on the Blackfeet Indian Reservation, the Blackfeet Tribal Historic Preservation Office (THPO) will be the primary Section 106 compliance reviewer. The role of the THPO is defined the same as the Montana State Historic Preservation Office (SHPO), that is, to conduct Section 106 compliance reviews. The THPO is recognized by and bound to National Park Service (NPS) standards and its staff must include specialists in history, archaeology, architectural history and other fields who meet NPS professional standards. If the THPO staff does not meet these standards, duties may be deferred to the SHPO or the Advisory Council on Historic Preservation (ACHP). It is unlikely that the Blackfeet THPO will be able to meet the NPS standards, so outside assistance may be required in one or more area. The lead agency may also defer review to the ACHP.

The project will be subject to the American Indian Religious Freedom Act (AIRFA) and Native Americans Graves Protection and Repatriation Act (NAGPRA). And because any archaeological materials, if discovered, will occur on Blackfeet tribal lands, the standard of the Archaeological Resources Protection Act (ARPA) must be met (that is, data recovery must be professionally supervised, follow an approved mitigation plan and be conducted to professional standards (per 36 CFR 79). Tribal Employment Rights Office (TERO) requirements will be included in all cultural resource investigations associated with this project.

Three general aspects of cultural resource concerns have been identified. First, the existing diversion system to be replaced is a historic structure that qualifies for the National Register of Historic Places (NRHP) under multiple criteria. Documentation of its historic context and the facilities history, as well as implementation of an appropriate mitigation strategy, will be required. Second, as a federal undertaking, a cultural resource inventory of the Area of Potential Effect (APE) will be required, per Section 110 of the NHPA. The project will require a Class III (intensive) pedestrian inventory and assessment of all as yet unknown resources, including archaeological, paleontological and historical properties, within the Area of Potential Effect. Third, the "living history" or ethnographic/traditional cultural effects of the project will need to be identified and addressed.

The historic St. Mary's diversion system will be eligible for the NRHP under Criteria A, for its association with events that have made a significant contribution to the broad patterns of our history. The system will also be eligible for the NRHP under Criteria C, for embodiment of distinctive characteristics of a type, period or method of construction. Criteria B, that is, association with the lives of persons significant in our past, may also be applicable pending the development of a historic context. The preparation of a comprehensive historic context for the diversion system as well as historic documentation of the facilities construction and maintenance history will be required to support the NRHP significance of the system. Also included are two ancillary historic bridges and the BOR administrative field office and work camp associated with the construction of the system. As the diversion system is slated for complete replacement and reconstruction, determination of an adverse effect to its NRHP eligibility is expected. Approval and implementation of an appropriate mitigation plan will be required. Typically historic and photographic documentation to the standards of the Historic American Engineering Record (HAER) fulfill mitigation needs or this type of project.

Preliminary research materials will include BOR records of the St. Mary's diversion system and other historic documentation of the system and the local area. A review of the Montana State Historic Preservation Office, the cultural records office at the University of Montana and the Blackfeet Tribal Historic Preservation Office will also be required prior to fieldwork. Historic records of the St. Mary's - Milk River Project may also be found at the National Archives and Records Administration Denver Office.

The Class III (intensive, pedestrian) inventory and assessment of the Area of Potential Effect will establish the baseline cultural resource data. This inventory would ideally take place early in the process to allow time for fieldwork, dissemination of results and agency review of resource assessments. Furthermore, the identification of significant cultural resources may necessitate additional work.

Anticipated cultural resources, in addition to the diversion system and related structures and facilities, may include two historic allotment or homestead complexes, depending upon the determination of the width of the APE. There is moderate to low potential for prehistoric archaeological resources in the area. Anticipated archaeological resources in the region include aboriginal campsites, surface stone features such as rock cairns, alignments and tipi rings, lithic tool manufacture sites and bison kill sites. The St. Mary's River valley floor is heavily scoured by seasonal runoff and is unlikely to contain archaeological materials adjacent to the canal. The final determination of the APE will obviously affect the potential for archaeological resources. Paleontological resources within the Cretaceous Formations of the project area are also possible.

The effects of the proposed undertaking to Blackfeet "living history," including ethnographic/traditional cultural properties will need to be identified and addressed. The Blackfeet THPO office or their designee will identify the extent of study necessary to properly evaluate these effects and will coordinate the selection of the appropriate person(s) to conduct this work.

Places of significance to Blackfeet cultural tradition may be found near the canal corridor. Indirect effects, such as construction noise intruding on ceremonial use of an adjacent traditional cultural site, or visual impacts, should be considered.

The Class III inventory of the APE should ideally take place as early as possible in the project schedule to allow time for fieldwork, dissemination of results and agency review of resource assessments. Also, in the event of unanticipated discoveries, additional documentation and mitigation time may be required. Establishing an MOU prior to the start of the project would allow expeditious scheduling, for example, by prior agreement, canal construction could commence concurrently with the preparation of a HAER document or other mitigation report.

Fieldwork will have to be limited to snow-free conditions, essentially May through October. Although the boundaries of the APE have not been determined, the anticipated boundaries would be approximately 30 miles long and up to 400 ft wide.

The Class III inventory, if conducted by the consultant team, would be conducted by two archaeologists, assisted by one or two tribal representatives, over a period of about six to seven field days. Some of the data for ethnographic/traditional cultural concerns as well as some documentation of the diversion system itself could be collected concurrently with the pedestrian inventory. The Class III inventory report preparation may require up to 45 days, including historic research. The ethnographic/traditional cultural report will take an undetermined amount of time. Agency review may take up to 30 days.

HAER documentation is the preferred mitigation for adverse effect to the diversion system. Three to five field days may be required to complete HAER documentation various significant components of the diversion system. The HAER document itself may require as much as 30 days to prepare. The mitigation plan(s) should be negotiated between the agencies to allow concurrent commencement of construction work if possible.

6.4.3 Fish & Wildlife Coordination Act and Endangered Species Act Processes

The BOR recommended that the project follow the provisions of the Fish and Wildlife Coordination Act in order to develop project alternatives that would avoid and minimize environmental impacts. This is an early coordination process that allows funding of the USFWS collaboration early in the project. The outcome of this process would help determine the type of NEPA document needed.

Environmental coordination with the consultant team will occur to avoid, minimize and mitigate environmental impacts. Key points of interaction include: 1) provide environmental information and GIS mapping to engineers so alternative development can avoid and minimize impacts; 2) coordinate with engineers to determine reasonable and feasible alternatives to meet the project's purpose and need and to evaluate/screen alternatives; 3) if impacts are unavoidable, work with engineers to identify mitigation measures. For example, maintenance of wetlands and riparian habitat adjacent to canals through innovative design features.

The BOR has place priority in Endangered Species Act compliance for the St. Mary Rehabilitation. It is anticipated that compliance with the Endangered Species Act will involve preparation of Biological Assessments (BA) for several species. The following species would likely be addressed: bull trout, bald eagle, grizzly bear, Canadian lynx, gray wolf, slender moonwort (plant). This species list may change through consultation with USFWS, MFWP, or the Blackfeet F&W Department.

6.5 PRELIMINARY SCOPE, COSTS & SCHEDULE

6.5.1 Proposed Scope of Work

Environmental documentation and permitting efforts have been identified in 14 tasks for the Preliminary Environmental Scope of Work. These tasks are provided to convey the necessary scope of work as currently understood, however tasks may be modified as the project Purpose and Need is developed and as Tribal, Agency and Public scoping proceeds.

Task 1 - Project Kickoff/Information Review/Work Plan/Define Purpose & Need & Initiate Fish &Wildlife Coordination Act - The purpose of this task is to provide a coordinated start-up for the project by presenting and having stakeholder agreement on the project work plan, purpose and need for the St. Mary Rehabilitation and to initiate early coordination on fish and wildlife needs related to the project.

Task 2 - Tribal and Agency and Public Scoping Meetings/Issue Identification - The purpose of this task is to discuss with all stakeholders the project's purpose and need, alternatives, and potential environmental impacts to provide guidance for completion of the NEPA documentation.

Task 3 - Field Reconnaissance and Environmental Constraints Mapping/Cultural Resources Inventory - The purpose of this task is to conduct necessary environmental field work to determine baseline conditions for alternative development and preparation of environmental documentation to meet NEPA, NHPA 106 and F&WCA requirements.

Task 4 - Define Alternatives - Efforts to Avoid, Minimize, and Mitigate through F&W CA - The purpose of this task is to integrate environmental needs into the preliminary design of project alternatives and to develop a range of reasonable and feasible alternatives.

Task 5- Alternatives Screening - The purpose of this task is to screen and select a preferred alternative to be addressed in the environmental documentation. This would involve stakeholders in the screening process.

Task 6 - Prepare Draft Discipline Reports - The purpose of this task is to prepare technical reports and selected environmental elements to define the affected environment, environmental impacts, and mitigation. These documents serve as the technical basis for the EA preparation. This would also include the draft report for compliance with the Fish and Wildlife Coordination Act.

Task 7 - Prepare Final Discipline Reports - These reports would be finalized after receipt of review comments by the Tribe, BOR, and other cooperating agencies, and interested permitting agencies.

Task 8 - Prepare Draft EA - The purpose of this task is to prepare the draft Environmental Assessment for review by the Tribe, BOR, and other cooperating agencies. The EA would be finalized and published for public review.

Task 9 - Prepare BA - The purpose of this task would be to prepare the required biological assessments and conduct consultation on ESA species with the USFWS and the BOR.

Task 10 - Prepare Draft EA Comment Analysis - The purpose of this task is to review EA public comments and prepare draft responses for review by the Tribe, BOR, and other cooperating agencies.

Task 11 - Prepare Final EA and FONSI - The purpose of this task is to prepare final Environmental Assessment with responses to comments and publish for use by the BOR for FONSI development and public review.

Task 12 - Prepare NHPA 106 Compliance Documentation - The purpose of this task is to provide necessary cultural resource documentation and coordination.

Task 13 - Apply for Tribal Permits - The purpose of this task is to use the NEPA and 106 environmental documentation as a technical basis to obtain Tribal permits for the rehabilitation work. Other permits under Federal and State authority would be prepared, if necessary.

Task 14—Compile and Maintain Administrative Project Record and Project Management - The purpose of this task is to effectively manage the project through completion.

6.5.2 Environmental Study Costs

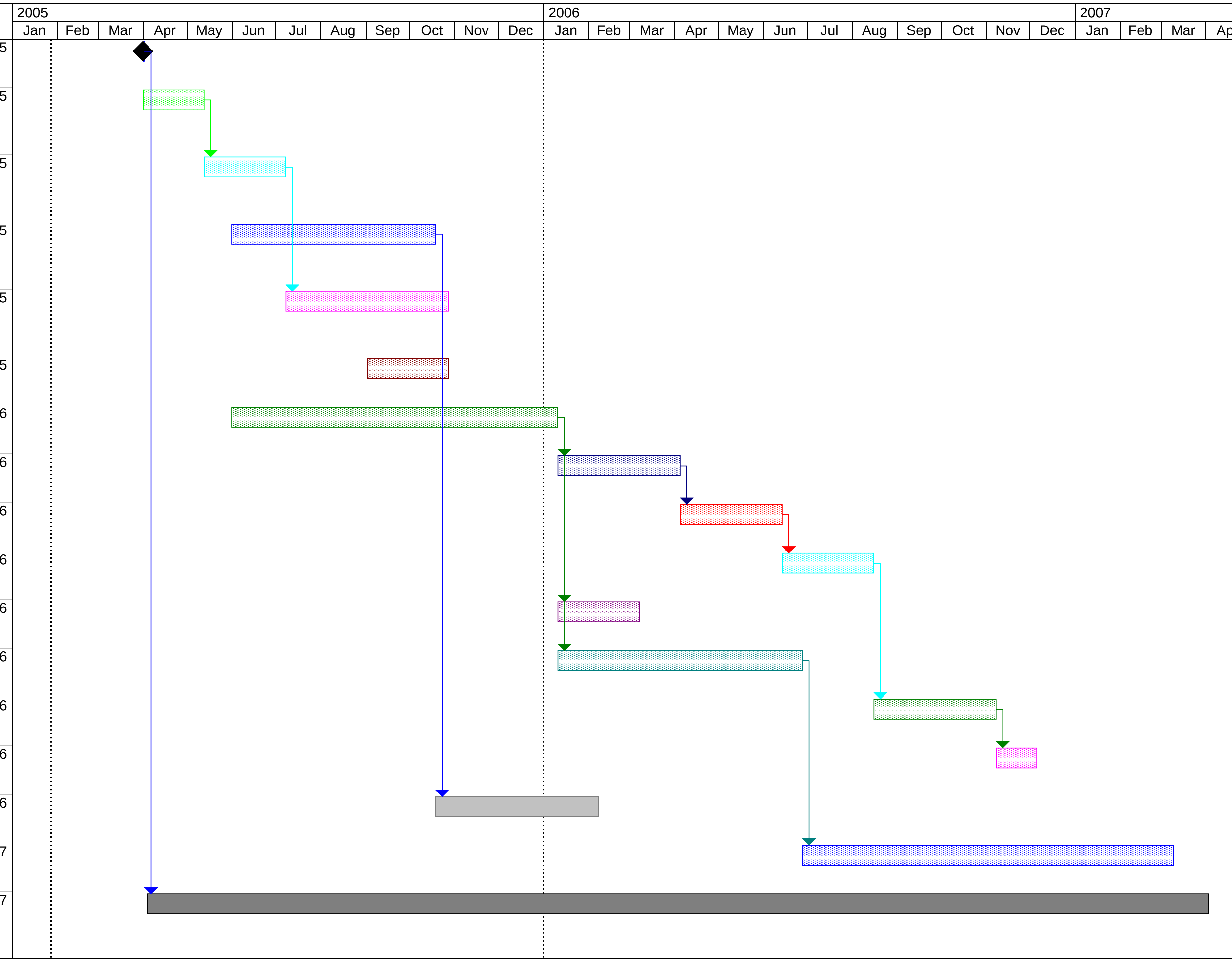
We have estimated a preliminary environmental compliance and permitting cost of between $262,500 and $1,000,000 including 5% Tribal fees. These funds will allow us to conduct tasks stated above and will be significantly influenced by our work plan development and scoping. The higher cost approach allows key tasks to collect field data which will aid alternatives screening, provide early coordination with resource agencies on mitigation, and provide Discipline Reports as technical back-up to the Environmental Assessment. However, if field-based environmental inventories (for example, wetland delineations) and related technical analyses are deferred until the time of final facility design, similar to recent BOR Water System Projects, the NEPA EA cost could be reduced to around $262,500. In this lower cost approach, the NEPA EA will be considered more of a Programmatic EA. Permit costs would be deferred to a later phase of the project.

6.5.3 Estimated Schedule

A preliminary project schedule for the environmental compliance phase is shown on Figure 6.3; the project duration is estimated at 24 months and will be a function of the actual scope of work.

Environmental Phase Schedule - St Mary Diversion Facilities

ID	Task Name	Duration	Start	Finish
1	Obtain notice to Proceed	1 day	Fri 4/1/05	Fri 4/1/05
2	Task 1 - Project Kickoff/Information Review/Work Plan/Define Purpose & Need & Initiate Fish &Wildlife Coordination Act	30 days	Fri 4/1/05	Thu 5/12/05
3	Task 2 - Tribal and Agency and Public Scoping Meetings/Issue Identification	40 days	Fri 5/13/05	Thu 7/7/05
4	Task 3- Field Reconnaissance and Environmental Constraints Mapping/Cultural Resources Inventory	100 days	Wed 6/1/05	Tue 10/18/05
5	Task 4 - Define Alternatives - Efforts to Avoid, Minimize, and Mitigate through F&W CA	80 days	Fri 7/8/05	Thu 10/27/05
6	Task 5- Alternatives Screening	40 days	Fri 9/2/05	Thu 10/27/05
7	Task 6 - Prepare Draft Discipline Reports	160 days	Wed 6/1/05	Tue 1/10/06
8	Task 7 - Prepare Final Discipline Reports	60 days	Wed 1/11/06	Tue 4/4/06
9	Task 8 - Prepare Draft EA	50 days	Wed 4/5/06	Tue 6/13/06
10	Public Release of EA	45 days	Wed 6/14/06	Tue 8/15/06
11	Task 10 - Prepare Draft EA Comment Analysis	40 days	Wed 1/11/06	Tue 3/7/06
12	ESA Consultation	120 days	Wed 1/11/06	Tue 6/27/06
13	Task 10 - Prepare Draft EA Comment Analysis	60 days	Wed 8/16/06	Tue 11/7/06
14	Task 11 - Prepare Final EA and FONS	20 days	Wed 11/8/06	Tue 12/5/06
15	Task 12 - Prepare NHPA 106 Compliance Documentation	80 days	Wed 10/19/05	Tue 2/7/06
16	Task 13 - Apply for Tribal Permits	183 days	Wed 6/28/06	Fri 3/9/07
17	Task 14—Compile and Maintain Administrative Project Record and Project	521 days	Mon 4/4/05	Mon 4/2/07



Project: enviro sch
Date: Thu 1/27/05

Task		Milestone		Rolled Up Split		External Tasks		Deadline	
Split		Summary		Rolled Up Milestone		Project Summary			
Progress		Rolled Up Task		Rolled Up Progress		External Milestone			

Figure 6.3

7.0 ADDITIONAL STUDIES AND ENGINEERING

This section identifies additional studies which must be conducted prior to the design phase. We have prepared preliminary work scopes and cost estimates for each additional study identified. In addition, we have provided preliminary design scopes and estimated fees for the canal prism and each of the major structures discussed in Section 4.0. At this stage, the scopes and cost estimates are preliminary and are subject to revisions and negotiation.

7.1 TOPOGRAPHICAL SURVEYS

Accurate topographical surveys are a prerequisite early in the study and preliminary design phases of the overall rehabilitation project. Specifically, these surveys would provide valuable information for the following:

- Existing canal alignment and prism geometry. Known right-of-ways and property ownership could be superimposed on the survey. As stated earlier, the BOR is currently working on the creation of a GIS-based map showing land ownerships, easements, and rights-of-way (ROW).
- Detailed surface information is needed at major structures including all existing and proposed locations for the siphons, checks, wasteways, the diversion dam, and headgates and each hydraulic drop.
- Upslope terrain and geometry needs to be established at all active landslides to reliably model behavior and design corrective measures. Locations of soil borings, piezometers, and slope inclinometers (Section 7.2) should be established. Slope movement reference markers should be installed and monitored by periodic surveying. These markers would be used to monitor slope movement velocity and direction.

Our initial thoughts were to recommend that an aerial topographical survey be completed over the full length of the diversion facilities. The BOR indicated that they have an existing aerial survey completed in 1993. The degree of accuracy, i.e. contour interal, is not known. Discussions with a surveying contractor who performs this service indicated that considerable flight paths would be required to generate a 1-foot contour map due to the steep-sided canals and canal curvature. In addition, the canal should be free of water, ice and snow to avoid errors. Small-scale surface features would require follow-up, on-the-ground surveying. This type of survey is generally considered a valuable reconnaissance-level planning tool during realignment and relocation considerations of the major structures and canal rehabilitation as well as assisting with future environmental studies.

An aerial topographical survey is a useful reconnaissance tool but cannot replace more accurate, site-specific design surveys required for final design and construction. These more accurate and detailed surveys would be performed using conventional, on-the-ground techniques such as total stations or GPS techniques to facilitate preparation of construction drawings for the major structures and large earthwork phases of the project.

There are only two times of year to conduct the aerial survey: 1) in the spring once the snow cover has melted and prior to canal filling and leafing of adjacent deciduous trees; and 2) in the fall after the canal is drained and prior to snow cover. The canal is typically wetted in the spring with remnant snow drifts still in the canal. Pools of water, and later ice, remain in the canal throughout the off-season. These are problems for an aerial survey but are easily overcome with on-the-ground, conventional surveying methods. Conventional surveying of the interior canal prism would have to be performed during one of the two times described above. Outside the canal prism, surveying could be conducted during the water diversion season.

We have provided cost estimates to conduct a topographical survey from the diversion dam to the Milk River. Expanded coverage would be performed at locations of the major structures and active landslides.

Table 7.1 Estimated Surveying Costs

Item	Aerial Survey	GPS and Total Stations
Aerial Survey	$95,550	---
Establish Ground Control	$23,100	---
Conventional Survey	---	$94,524
Tribal Fees (5%)	$5,950	$4,726
TOTAL	**$124,600**	**$99,250**

We recommend that a copy of the 1993 BOR aerial survey be obtained for reconnaissance studies and that a topographical survey be performed by on-the-ground conventional methods starting in the Fall of 2005.

7.2 ST. MARY RIVER SIPHON LANDSLIDE STUDIES

Background

The BOR has conducted preliminary geotechnical investigations at several locations along the St. Mary Canal as part of the North Central Montana Feasibility Study (2003). Forty-four drill holes were completed between the diversion dam and Drop No. 5. Their locations are summarized below.

Table 7.2.1 Summary of Geotechnical Borings Conducted by BOR

Purpose/Location	# of Drill Holes
Diversion Dam & Headgates	6
Kennedy Creek Check & Wasteway	1
St. Mary Siphon - West Slope	3
St. Mary River Replacement Bridge Foundation	2
Spider Lake Check	1
Potential Spider Lake Dam Site	3
Cow Creek Culvert	1
Halls Coulee Wasteway	1
Halls Coulee Siphon	2 west, 3 east
979+70 Culvert	1
1052+72 Culvert	1
1096 + 93 Culvert	1
1134+68 Culvert	1
1994+29 Culvert	1
Proposed Wasteway (1293+00)	1
Drop No. 1	3
Drop No. 2	3
Drop No. 3	2
Drop No. 4	4
Drop No. 5	3

Conversations with BOR staff (Lloyd Crutchfield) indicate that the purpose of the geotechnical investigations was to provide designers with preliminary subsurface information with respect to reconnaissance level scoping studies. Laboratory testing of samples collected was not performed and design specific geotechnical recommendations were not developed. Mr. Crutchfield indicted that additional drilling and sampling should be conducted once design phases are initiated.

In 1999, three drill holes were bored along the south slope of the St. Mary River Siphon to investigate ongoing slope movements. Preliminary recommendations were provided to stabilize siphon supports.

In general, the geologic setting of the St. Mary Diversion Facilities is described as follows:

- Coarse-grained (gravels, cobbles, & boulders) fluvial and alluvial fan deposits dominant near surface conditions from the diversion dam to nearly Powell Creek (330+69). Relatively shallow Cretaceous-age sedimentary rock is anticipated on the east side of the St. Mary River.

- As the canal “climbs” (relative to the St. Mary River) past Powell Creek, surficial soils are classified as relatively fine-grained glacial and glaciofluvial deposits comprised of lean clay and silty to clayey sand. Depth to the underlying sedimentary bedrock is variable.

- Downstream of the St. Mary River Siphon, fined-grained glacial till blankets underlying Cretaceous and Tertiary-aged sedimentary bedrock. Depth to bedrock is variable and ranges from ±10 feet on the side hills to over 40 feet in the topographically low areas.

From the diversion dam to the last hydraulic drop, BOR staff has identified at least 15 landslides or earth slumps impacting or having the potential to impact the Diversion Facilities. They are listed below.

Table 7.2.2 Summary of Slope Instabilities Associated With Diversion Facilities

Slide Id.	Approximate Station
Camp Nine Slide	N/A
St. Mary River Siphon	N/A
DeWolfe Ranch Slide	650+00
DeWolfe Bridge Slide	675+00
Mid Section 22 Slide	690+00
East Section 22 Slide	710+00
Grizzly Slide	735+00
Big (Deep) Cut Slide	765+00 to 780+00
4th of July Slide	870+00
Halls Coulee Slide Complex	910+00 to 935+00
Gravel Road Bridge Slide	980+00
Martin Slide	1025+00 to 1035+00
Pipeline Slide	1125+00
Drop No. 2 Slide	1500+00
Drop No. 5 Slide	1529+00

The BOR maintains a Landslide Register for all landslide and embankment instabilities impacting BOR projects. For the St. Mary Diversion Facilities, only one slide was listed in the Register prior to 1995. This slide, known as the St. Mary Canal Slide, was a long area extending from approximately Sta. 650+00 to 800+00. No specific slides were delineated. In 1995, this area was replaced with discrete individual slides identified by a local landmark and approximate canal stationing.

In 1995, heavy precipitation triggered many of the former slides. In 1996, two new slides were added to the Register along with the St. Mary River Siphon instabilities. An additional slide was included in the Register in 1997. In 2002, three more slides were added. BOR geologists conduct annual inspections to observe the known slides. In the last three to four years, little significant landslide activity has been observed. To our knowledge, subsurface soils information does not exist for the identified landslides downstream of the St. Mary River Siphon.

Future Geotechnical Investigation and Recommendations

Site specific geotechnical investigations should be performed at all the major replacement structures including the diversion dam and canal headgates, all checks and wasteways, foundations for replacement bridges, the siphon locations and hydraulic drops. In addition, subsurface information is warranted in areas where significant earthwork is anticipated such as canal prism reconstruction, relocation or landslide/embankment stabilization. With the availability of the BOR's geotechnical reconnaissance information, these follow-up investigations could be conducted during the design phase in Fall 2005 or Spring 2006 once locations of replacement structures have been finalized.

However, in our opinion, the subsurface conditions comprising the sideslopes of the St. Mary River Siphon should be investigated and characterized as soon as possible. Siphon movements were observed as early as five years after original construction and have continued to date. We propose to install slope inclinometer casing on both sideslopes of the St. Mary River Valley in the vicinity of the siphon. These devices would allow slope movements to be measured periodically. This data can be reduced and analyzed to establish the depth to the slide plane, slope movement velocities and the seasonal impacts of movements. The primary goal would be to accurately model slide mass behavior so that geotechnical recommendations can be developed to help ensure long-term performance of the replacement siphons. In order to obtain sufficient, useful data, slope inclinometer measurements should be collected monthly for at least 18 months or longer. For our fieldwork, we propose to use an ATV-mounted CME-550X drill rig capable of hollow-stem augering, continuous sampling and rock drilling/coring.

Our proposed scope of work includes the following:

- Install 3 slope inclinometers (SI) on each slope of the St. Mary River Siphon.
- Inclinometers will be extended at least 10 feet into the underlying sandstone and will have an assumed 50-foot depth each.
- Use a continuous sampler, collect Shelby tubes and ring samples.
- Perform index testing, corrosivity testing, consolidation, direct shear testing and unconfined compressions on samples collected.
- Perform monthly SI measurements and data reduction for 18 months.

- Final report will provide summary of results, slope stability analyses using UTEXAS3, and geotechnical recommendations pertaining to siphon replacement alternatives.

The estimated costs are listed below:

Table 7.2.3 Estimated Costs to Conduct Slope Stability Analyses of St. Mary River Siphon Structures

Phase	Task Description	Estimated Engineering Fee
1.	Fieldwork, 6 Slope Inclinometers to 50 Feet Each	$21,520
2.	Laboratory Testing	$6,350
3.	Summary Report w/Recommendations	$2,529
4.	Monthly Measurements w/Data Reduction - 19 Trips @ $2,380/Trip	$45,220
	Subtotal	***$75,619***
	5% Tribal Fees	$3,781
	Total	**$79,400**

7.3 ECONOMIC STUDIES

We believe an economic study (or studies) has merit for the following reasons:

- Provides credence and a factual basis for the significance of the St. Mary Diversion Facilities and the Milk River Basin Irrigation Project on North Central Montana, as well as Montana as a whole,
- Provides credible and non-partisan backup for lobbying support during the request of State and Federal appropriations, and
- Provides justification for a change in the percentage of reimbursable O&M costs that the BOR is currently required to recover from the irrigators. We understand that the BOR is currently working on a similar study.
- Independent economic justification for a Preferred Alternative (project capacity) greater than 850 cfs.

The level and type of economic study to be conducted should be discussed with DNRC and the Working Group. The required scope of work, estimated costs and completion time will all be directly related to the desired level of study and intended purpose of the final product. The economic studies would support the analysis and selection of a Preferred Alternative (system capacity). Depending on the scope, economic studies can range in cost from $10,000 to over $200,000. For an initial level of study, we recommend $52,500 (includes 5% Tribal fees). We have provided a preliminary scope of work for an initial economic study. This study could be expanded to a higher level of study in the future, if warranted. The preliminary scope includes the following:

- Gather baseline information on the regional economy of the Milk River Basin and economic demand for major water uses including irrigation, municipal and recreational uses.
- Attend several meetings of the St. Mary Rehabilitation Working Group and provide an economic perspective on the Group's tasks, as directed.
- Identify and review existing economic studies, both on the U.S. and Canadian side of the border, relating to the St. Mary/Milk River Project regional economic impact.
- Identify and review existing studies that provide a cost-benefit perspective for all major end uses of the project including irrigation, municipal and recreational.
- Identify and review existing studies relating to the economic dependence on the St. Mary/Milk River Project, by sector for this basin.
- Supplement existing economic studies with updated information on the region and project.
- Develop a detailed scope of work and budget for the next phases of economic studies for the project, including NEPA compliance.

7.4 BASIN HYDROLOGY STUDIES

As mentioned earlier, one of the governing factors affecting the selection of a Preferred Alternative is the availability of water at the diversion dam as a function of time throughout the diversion season. Overall peak conveyance is reported to be 670 cfs due to canal limitations. Peak diversion is approximately 720 to 750 cfs to account for seepage losses in the first 9 miles of the canal. Hydrologic basin studies are proposed for the St. Mary River and North Fork of the

Milk River as they relate to the diversion and conveyance of water. Areas of study would include developing an unencumbered hydrograph of the natural flows of the St. Mary River downstream of the diversion dam at the U.S-Canadian border. This information would be compared to seasonal releases from Sherbourne Dam. The data would be reviewed to determine the optimum-sized canal to take advantage of flows which exceed current diversion capabilities.

Also, the potential canal inflows would be quantified to determine the advantage of an oversized canal to intercept and convey this unregulated water. Currently, BOR staff monitor potential precipitation events as much as three days in advance in order to reduce diversion and create canal freeboard for the potential stormwater inflows. Opportunity to maximize water diversion is lost, especially if the anticipated storm event does not fully materialize. A properly sized canal would allow reasonable inflows without altering the diversion potential.

In addition, diversion and conveyance capacity has historically diminished over the years. It would be prudent to investigate the impact of increased diversion flows, especially in excess of 850 cfs, on the current condition of the North Fork and main Milk River channel from Drop No. 5 to Fresno Reservoir.

Our proposed scope of work would develop an understanding of the basin hydrology for both the St. Mary River and the North Fork of the Milk River with respect to their impact on optimizing diversion and conveyance flows and the ultimate decision of selecting a Preferred Alternative. Our scope includes the following:

- Review all USGS stream flow data as well as data from the Water Survey Division of Environment Canada pertaining to the St. Mary River in the U.S. and Milk River conveyance channel downstream to Fresno Dam.
- Interview BOR staff with respect to historical operations of Sherbourne Dam and the St. Mary Diversion Facilities.
- Establish flow models of stream flow and potential canal inflows in order to evaluate optimum canal size.

- Assess the Milk River conveyance channel from Drop No. 5 to Fresno Dam in order to develop a professional opinion regarding the conveyance of diverted flows in excess of 850 cfs.

The estimated cost for this study is provided in the table below. We anticipate this study would take approximately 3 months and would be used to support selection of the Preferred Alternative.

Table 7.4 Estimated Cost for Basin Hydrology Studies

Phase	Task Description	Estimated Engineering Fee
1.	Review Existing Stream Flow Data & BOR Records	$6,560
2.	Develop Flow Models and Hydrographs	$5,628
3.	Assess Milk River Conveyance	$3,444
4.	Summary Report	$3,225
	Subtotal	***$18,857***
	5% Tribal Fees	$943
	TOTAL	**$19,800**

7.5 HYDROPOWER FEASIBILITY STUDY

This study involves evaluation of the feasibility of a hydropower facility to replace one or more of the existing drop structures and canal sections between the five drops. The following subtasks will be completed to compare the alternatives for the hydropower facility:

- Collect and review existing data and establish minimum, maximum and average monthly flows and a flow duration curve.
- Estimate the location, length and size of penstock(s) required based on assumed maximum velocity. Estimate head losses and net head available for energy generation based on the penstock arrangement and flow duration curve.
- Analyze projected flow and pressure data, develop a flow versus head curve and select the type of unit most applicable to the site based on available literature.
- Develop a conceptual project arrangement for the selected turbine and generator type and prepare the following conceptual drawings:
  - Powerhouse and switchyard plan (topography will not be included)

- Powerhouse conceptual arrangement and cross section(s)
- Single line diagram of power facilities from generator to transmission line

- Perform power studies to estimate the amount of power and energy that can be generated.
- Consider potential, mutually beneficial impacts of Blackfeet Wind Farm proposed northeast of Duck Lake.
- Approximate the distance to the nearest power transmission line (U.S. or Canada) and estimate construction costs for the transmission line and interconnection facilities, if required.
- Estimate costs for mobilization, demolition, site work, structures, equipment, penstocks, switchyard, contingencies, engineering and administration and interest during construction and calculate the total investment cost.
- Estimate annual operation and maintenance costs based on our experience and data from other existing small hydroelectric facilities.
- Establish the rates for energy and annual cost for debt service and perform an economic analysis to determine the return on the investment.
- Prepare a feasibility report to document the tasks completed and present the results, conclusions and recommendations.

The budgetary cost estimate to complete the Hydropower Feasibility Study is $40,450 (includes 5% Tribal fees) and is estimated to take three months.

7.6 PREFERRED ALTERNATIVE SELECTION STUDY

This first major design decision, which must be made towards the goal of overall project rehabilitation, is the desired or optimum capacity (Preferred Alternative) of diversion and conveyance to the North Fork of the Milk River. Current BOR studies (BOR, 2004) have discussed alternatives for alleviating documented water shortages in the Milk River Basin from Havre to Glasgow. Their studies indicate that rehabilitating the St. Mary Facilities afforded the greatest opportunity towards reestablishing a constant and reliable source of water to the Basin and to reduce water shortages. Four capacities were discussed and include

500 cfs, 670 cfs, 850 cfs and 1000 cfs. However, a final recommendation and supporting documentation has not been made.

We propose a study to assist DNRC and the Working Group select a Preferred Alternative so that funding can be obtained and the environmental and engineering studies can commence. The Preferred Alternative Study scope of work would include the following:

- Utilize the results of the Basin Hydrology Study (Section 7.4) to assess water availability versus time relationships, as well as other findings discussed above.
- Utilize results of economic studies (Section 7.3) to assess cost-benefit relationships for various system capacities.
- Review IJC 1921 order and water balance accounting procedures. The IJC's Administrative Measures Task Force Interim Report is expected March 28, 2005 with the Final Report due June 30, 2005.
- Review BOR maintenance and operation records regarding historical releases from Sherbourne Dam and canal diversions.
- Review BOR-prepared land ownership, easement records and ROWs to determine land availability for larger canals and related structures. The BOR is currently preparing this information in a GIS-format, and it is our understanding that it will be available in March or April of 2005.
- Prepare a final report summarizing the background information and findings, and provide a recommended Preferred Alternative to the Working Group for consideration.

The budgetary cost estimate to complete the Preferred Alternative Study is $44,650, which includes 5% for Tribal fees and would take approximately 5.5 months.

7.7 ENGINEERING OF INDIVIDUAL STRUCTURES

Engineering services are required for the individual components comprising the St. Mary Facilities. These services would be completed in three phases: 1) Feasibility/Design Studies, 2) Final Design, and 3) Construction Administration. Design studies are required to determine the most practical replacement or rehabilitation option. The final design phase would detail the selected replacement option, and final construction drawings and specifications would be prepared. Construction administration involves assistance during the bidding phase, construction management and construction inspection services. At this current stage, the scopes of work and estimated fees are preliminary in nature and are intended for budgetary purposes. Once recommended replacement options are selected from the Feasibility/Design Studies, we can provide more accurate estimates for design and construction management fees.

7.7.1 Diversion Dam and Canal Headgates

Engineering services for the diversion dam and canal headgates would include the following:

- Follow-up geotechnical and survey data, as needed.
- Assess river flow regime and diversion backwater relationships,
- Evaluate fish passage options,
- Determine diversion dam, crest control, headgate and sluiceway options (look at other alternatives),
- Evaluate fish screening alternatives,
- Design automation, instrumentation, and remote-control package,
- Prepare feasibility report with options, estimated costs and recommendations,
- Prepare final design drawings, specifications and revised construction costs,
- Assist with Contractor solicitation,
- Review shop drawings and submittals,
- Perform construction administration and inspection,
- Provide project close-out report and record drawings.

The estimated engineering fees for the diversion dam and headgates are shown below.

Table 7.7.1 Estimated Design Fees for the Diversion Dam and Canal Headgates

Phase	Task Description	Estimated Engineering Fee
1.	Preparation of Design Criteria, Preliminary Design, Cost Estimate, and Preliminary Engineering Report.	$120,000
2.	Detailed Designs, Including Final Drawings and Specifications	$630,000
3.	Construction Management Services	$1,400,000
	Subtotal	***$2,150,000***
	5% Tribal Fees	$107,500
	ESTIMATED TOTAL	**$2,257,500**

7.7.2 Kennedy Creek Siphon

Engineering services for the Kennedy Creek Siphon replacement would include the following:

- Follow-up geotechnical and survey data, as needed.
- Determine optimum layout and siphon geometry for Preferred Alternative flows,
- Structural engineering for reinforced concrete sections,
- Review geomorphology of Kennedy Creek with respect to siphon performance and bull trout issues,
- Prepare feasibility report with options, estimated costs and recommendations,
- Prepare final design drawings, specifications and revised construction costs,
- Assist with Contractor solicitation,
- Review shop drawings and submittals,
- Perform construction administration and inspection,
- Provide project close-out report and record drawings.

Table 7.7.2 Estimated Design Fees for Kennedy Creek Siphon

Phase	Task Description	Estimated Engineering Fee
1.	Preparation of Design Criteria, Preliminary Design, Cost Estimate, and Preliminary Engineering Report.	$30,000
2.	Detailed Designs, Including Final Drawings and Specifications	$110,000
3.	Construction Management Services	$160,000
	Subtotal	***$300,000***
	5% Tribal Fees	$15,000
	ESTIMATED TOTAL	**$315,000**

7.7.3 St. Mary River and Halls Coulee Siphons

The recommended Scope of Work associated with both major siphon installations is listed as follows:

- Perform additional geotechnical investigations and surveying in the areas of the St. Mary River Siphon and the Halls Coulee Siphon,
- Upgrade cost estimates for alternatives which were previously investigated,
- Prepare cost estimates for newly identified alternatives in this report,
- Prepare preliminary design sketches for the preferred alternatives,
- Prepare preliminary cost estimates of the preferred alternatives,
- Prepare preliminary engineering report, recommending the alternatives to accept for Detailed Design,
- Prepare final design drawings and specifications,
- Assist with Contractor solicitation,
- Perform construction management services.

Table 7.7.3 Estimated Design Fees for St. Mary River and Halls Coulee Siphons

Phase	Task Description	Estimated Engineering Fee
1.	Preparation of Design Criteria, Preliminary Design, Cost Estimate, and Preliminary Engineering Report	$230,000
2.	Detailed Designs, Including Final Drawings and Specifications	$800,000
3.	Construction Management Services	$1,550,000
	Subtotal	***$2,580,000***
	5% Tribal Fee	$129,000
	ESTIMATE TOTAL	**$2,709,000**

7.7.4 Canal Check & Wasteway Structures

The recommended Scope of Work associated with the siphons is listed as follows:

- Perform geotechnical investigations and topo surveys as required,
- Determine optimum layout and geometry for Preferred Alternative flows,
- Design automation, instrumentation and remote-control package,
- Structural engineering for reinforced concrete sections,
- Prepare feasibility report with options, estimated costs and recommendations,

- Prepare final design drawings, specifications and revised construction costs,
- Assist with Contractor solicitation,
- Review shop drawings and submittals,
- Provide project close-out report and record drawings,
- Prepare final design drawings and specifications,
- Assist with Contractor solicitation,
- Perform construction management services.

Table 7.7.4 Estimated Design Fees for
Kennedy Creek and Halls Coulee Check and Wasteway Structures

Phase	Task Description	Estimated Engineering Fee
1.	Preparation of Design Criteria, Preliminary Design, Cost Estimate, and Preliminary Engineering Report	$70,000
2.	Detailed Designs, Including Final Drawings and Specifications	$277,000
3.	Construction Management Services	$423,000
	Subtotal	***$770,000***
	5% Tribal Fee	$38,500
	ESTIMATE TOTAL	**$808,500**

7.7.5 Hydraulic Drop Structures

Several alternatives exist to address the current condition of the drop structures. Regardless of the approach, it is essential to provide a structure that will contain the maximum flow that occurs in the canal, as compared to the present situation. Prerequisites to designing the replacement drop structures, are to determine the desired flow capacity of the canal (Preferred Alternative, Section 7.6) and the feasibility of hydropower (Section 7.5).

The following scope of work should be performed:

- Evaluate the various structure configurations, including in-kind replacement, or replacement with baffled apron drop, pipe drop, or chute with stilling basin.
- Determine required cross-sections, overall structure dimensions, and structure layout for the alternate structures.
- Evaluate methods to reduce snow/ice buildup within the transition to the drop during initial system filling.

- Evaluate and address safety (including guardrail, chute entrance, etc.) and access (including bridge crossing) considerations.
- Evaluate whether replacement structure should be located in same location as existing or adjacent to existing structure.
- Evaluate location of replacement structure relative to property boundary and available space, if located adjacent to existing structure.
- Evaluate types of energy dissipation to be used.
- Evaluate foundation properties and surface geology mapping.
- Evaluate potential required modifications to the canal sections between the drop structures.
- Develop conceptual level drawings, including plan, elevation and typical cross sections.
- Perform detailed review of existing BOR construction cost estimates for the three above mentioned structure configurations and update as necessary. Develop additional conceptual level construction cost estimates for additional alternative designs.
- Prepare final drawings and specifications.
- Assist with Contractor solicitation.
- Provide construction management and inspection services.

Table 7.7.5 Estimated Design Fees for Hydraulic Drop Nos. 1 Through No. 5

Phase	Task Description	Estimated Engineering Fee
1.	Preparation of Design Criteria, Preliminary Design, Cost Estimate, and Preliminary Engineering Report.	$130,000
2.	Detailed Designs, Including Final Drawings and Specifications*	$303,000
3.	Construction Management Services	$650,000
	Subtotal	***$1,083,000***
	5% Tribal Fee	$54,150
	ESTIMATE TOTAL	**$1,137,150***

*Does not include cost for design of hydropower machinery.

7.7.6 Canal Prism Rehabilitation

The recommended Scope of Work is provided for the reach of canal from the diversion dam to Drop No. 5. It is likely the canal rehabilitation will require at least 6 separate construction projects due to the limited construction season and the need to not interrupt the normal water diversion season.

It was assumed that the following information will be available:

- Plans showing the existing land ownership and right-of-way for the canal and related structures.
- Costs per acre of acquiring additional right-of-way and construction easements.

The Scope of Work is the following:

- Conduct additional geotechnical investigations.
- Plan and arrange for preparation of plan-profile drawings for the individual reaches of the canal.
- Prepare Design Criteria for rehabilitation of the canal. Included in this task is consideration of the following:
  - Design flow rate
  - Manning's "n" for the canal
  - Existing canal design elements
  - New canal design elements
  - Freeboard requirements. To determine freeboard, consideration needs to be given to drainage inflows, and wasteway requirements, as well as conveying the design flow rate.
  - Considerations for a two-bank canal or one-bank canal.
- Considerations for gravel armoring.
- Whether road gravel is to be provided on both the driving banks and maintenance bank or just driving bank.
- Criteria for straightening various reaches of the canal. This could be a combination of general straightening of the existing canal as well as longer relocations of the canal which would in turn generate the required borrow material.

- Criteria for designing the parts of the canal where landslides have occurred or are in danger of occurring.
- Criteria related to canal maintenance requirements.
- Type of drainage structures. This could be cross drains or drain inlet structures.
- Criteria for determining design flow rates for drainage structures.
- Incorporating Blackfeet environmental and cultural concerns.
- Type of turnout structures.
- Type of check or check/drop structures and control gates.
- Type of wasteway structure, including design discharge rate.
- Number and type of canal crossings.
- Fencing and livestock watering issues.
- Type of seepage control, if required.
- Prepare preliminary plan-profile drawings of the new canal.
- Prepare typical cross-sections of the new canal design.
- Prepare preliminary sketches of canal structures.
- Prepare preliminary cost estimate of the canal rehabilitation work.
- Prepare cost estimate of additional right-of-way required, including construction easements.
- Prepare preliminary engineering report.
- Prepare final construction drawings and specifications.
- Assist with Contractor solicitation.
- Perform construction administration and inspection services.

Table 7.7.6 Estimated Design Fees for Overall Canal Prism Rehabilitation

Phase	Task Description	Estimated Engineering Fee
1.	Preparation of Design Criteria, Preliminary Design, Cost Estimate, and Preliminary Engineering Report.	$850,000
2.	Detailed Designs, Including Final Drawings and Specifications	$2,650,000
3.	Construction Management Services	$4,000,000
	Subtotal	***$7,500,000***
	5% Tribal Fee	$375,000
	ESTIMATE TOTAL	**$7,875,000**

Note: Assumes Multiple Reaches and Separate Construction Contracts

8.0 REHABILITATION PLAN

8.1 PROPOSED SCHEDULE

The overall rehabilitation of the St. Mary Diversion Facility may take up to 10 years. There is a critical path to project completion which consists of selecting a Preferred Alternative (system capacity) and the environmental compliance documents. Portions of the environmental compliance studies should be started as soon as funding permits, due to the anticipated time required to finish this phase. The Preferred Alternative requires some level of economic study and an understanding of basin hydrology for the St. Mary River and the North Fork of the Milk River and their influence on the Facilities. Once a Preferred Alternative is selected, the preliminary engineering can commence. The environmental compliance documents can be completed concurrent with the feasibility studies and final designs.

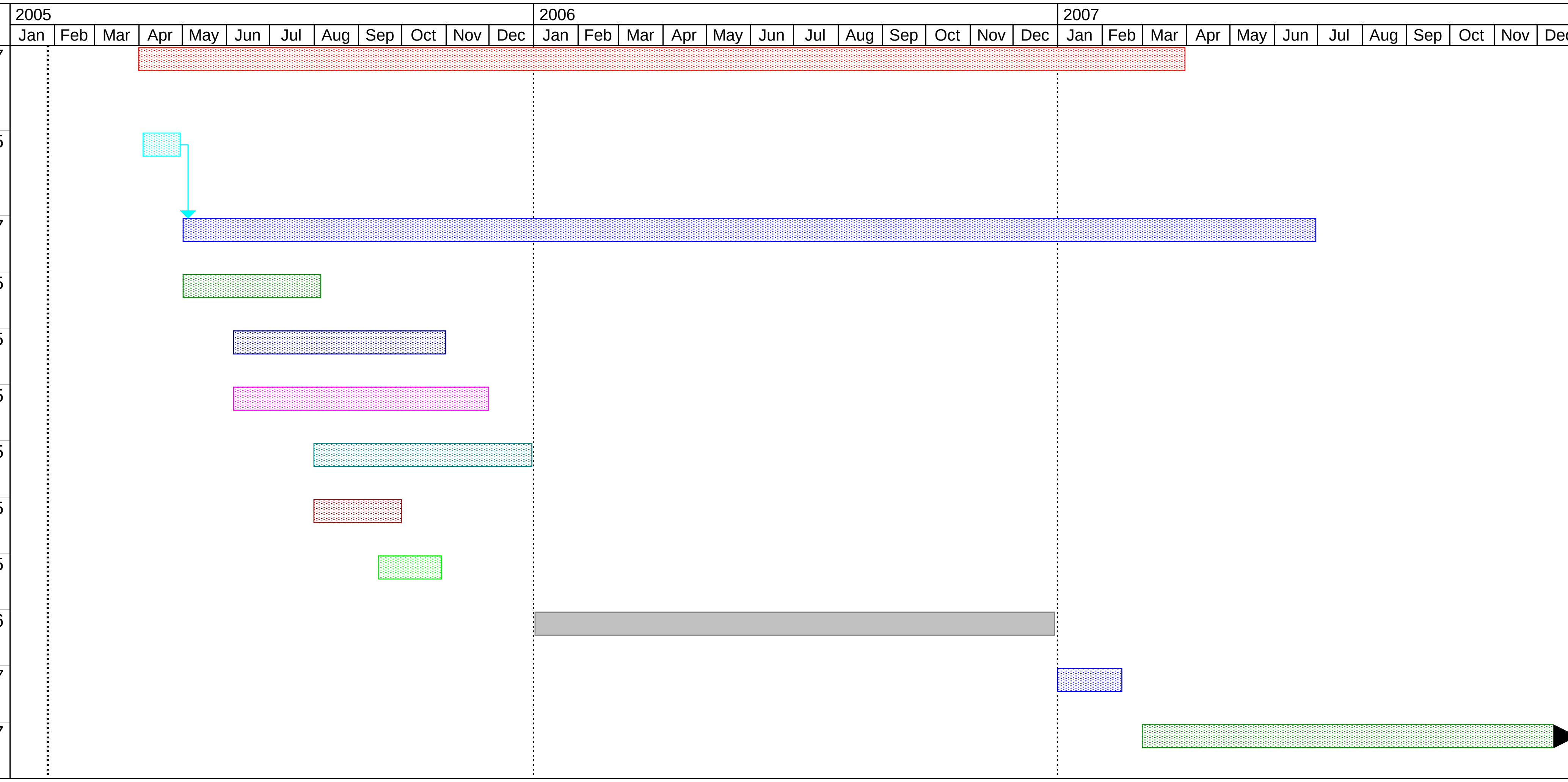
A parallel critical path involves the design of the St. Mary River Siphon replacement. We have recommended that this structure be replaced first (See Table 8.1). It is critical that the ongoing slope movements be studied, monitored and modeled so that their impact on the siphon replacement can be established. This slope stability analysis would be used to properly design the appropriate siphon replacement and/or develop slope remediation corrective measures.

With respect to the hydraulic drops, the feasibility of hydropower generation must be established to minimize engineering costs related to evaluating and designing replacement structures. A proposed timeline is shown on Figure 8.1, which assumes a projected construction start time of Spring 2007. This timeline presents our recommendations for the order of studies to be completed to achieve the target construction start date.

The construction phase of Project rehabilitation will take several years due to the size of the project and the importance of maintaining normal service during the irrigation season. Some components can be designed as replacement structures and constructed adjacent to existing structures to take advantage of the summer construction season. This would be true for the siphons, the hydraulic drops and the diversion dam/headgate facility.

PROPOSED REHABILITATION SCHEDULE - ST MARY DIVERSION FACILITIES

ID	Task Name	Duration	Start	Finish
1	Environmental Compliance Documents	521 days	Fri 4/1/05	Fri 3/30/07
2	Geotechnical Studies / Landslide Drilling Phase	20 days	Mon 4/4/05	Fri 4/29/05
3	Landslide Monitoring Phase	565 days	Mon 5/2/05	Fri 6/29/07
4	Basin Hydrology Studies	70 days	Mon 5/2/05	Fri 8/5/05
5	Economic Studies	106 days	Mon 6/6/05	Mon 10/31/05
6	Preferred Alternative Study	128 days	Mon 6/6/05	Wed 11/30/05
7	PER/Feasibility Studies	110 days	Mon 8/1/05	Fri 12/30/05
8	Hydropower Feasibility Study	45 days	Mon 8/1/05	Fri 9/30/05
9	Topographical Surveys	32 days	Thu 9/15/05	Fri 10/28/05
10	Concurrent Design Phases	260 days	Mon 1/2/06	Fri 12/29/06
11	Contractor Solicitation	33 days	Mon 1/1/07	Wed 2/14/07
12	Construction - First Phase	217 days	Thu 3/1/07	Fri 12/28/07



Project: REHAB PLAN
Date: Thu 1/27/05

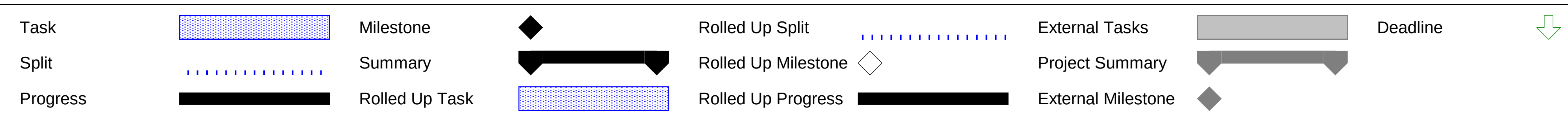


FIGURE 8.1

For other structures such as checks, wasteways and Kennedy Creek Siphon, it may also be possible to design and construct adjacent replacement structures during the irrigation season, depending on canal realignment issues. The canals themselves will have to be designed and constructed in separate reaches consistent with what can be reasonably constructed during the off-season to avoid disruption of water service. Significant relocations away from the existing alignment may be constructed during the summer, if possible.

We have provided a recommended priority list of rehabilitation for the major structures and critical canal reaches below. One (1) is the highest priority and four (4) is the lowest.

Table 8.1 Recommended Priority of Rehabilitation

Component of Canal Systems	Recommended Priority of Rehabilitation	Reasons for Recommendations
St. Mary River Bridge	1	Existing bridge precludes access with large construction equipment and restricts replacement of the siphon and other components downstream. In addition, deterioration of the bridge has resulted in limited load capacity when the St. Mary River Siphons are full. Therefore, this is a prerequisite to replacing the St. Mary River Siphons.
St. Mary River Siphon	1	The existing siphon is in poor condition and in danger of failing at any time during an operating season. Catastrophic failure of one pipe could result in complete failure of the second pipe. Significant failure could result in loss of diverted water for two years, especially if a design for a replacement has not been prepared. Potential environmental and economic disasters.
Drop Structures Nos. 4 and 5	1	These components appear to be in danger of collapsing at any time. Loss of a drop could result in losing more than one year of diverted water.
Diversion Dam/Canal Headgates	2	Ecological impact on bull trout.
Drop Structures Nos. 1, 2 and 3	2	These components represent moderate risk of failure but less than Drops No. 4 and No. 5. Drop No. 3 chute was replaced during the winter of 2004-2005.

Component of Canal Systems	Recommended Priority for Replacement or Rehabilitation	Reasons for Recommendations
Halls Coulee Siphon	2	From the investigations which were done during the site tours, Halls Coulee Siphon appears to be in better condition than the St. Mary River Siphon. However, steel wall thicknesses were actually found to be less at Halls Coulee Siphon that at St. Mary River Siphon. This indicates that excessive corrosion has taken place at the Halls Coulee Siphon. Because of this, we are recommending that this siphon be replaced as soon as possible after St. Mary River Siphon is replaced. Catastrophic failure would be the same economically and less environmentally as the St. Mary River Siphon.
Kennedy Creek Check & Wasteway	3	It is considered advantageous to replace these structures relatively early during the rehabilitation program in the interest of being able to better control the release of excess water in the canal upstream of St. Mary Siphon.
Halls Coulee Wasteway	3	This component should be replaced because of the importance of being able to operate a wasteway structure in conjunction with Halls Coulee Siphon.
Canal from Spider Lake Check to Halls Coulee Siphon	3	Rehabilitation of this reach of canal is considered to be a higher priority than most other reaches because of the problem with landslides in this reach of the canal. If landslides occur and fill the canal with earthen material, this may result in significant disruptions to water delivery of the system until such time as the canal is cleaned out and the canal bank is repaired and stabilized.
St. Mary Canal from the Diversion Works to the St. Mary Siphon Kennedy Creek Siphon Canal From St. Mary River Siphon to Spider Lake Check Spider Lake Check Canal from Halls Coulee Siphon to Drop No. 5	4 4 4 4 4	These components are considered to be of the same priority in terms of urgency for rehabilitation. These components will likely need to be broken down into a number of packages with each package being of a reasonable size for construction to be done in a one-year period.

8.2 PROJECT COSTS

The estimated overall project costs were summarized in Section 4.8. A detailed summary of the project costs for each major structure is provided in Tables 8.2.1 and 8.2.2 for 850 and 1000 cfs, respectively. The BOR's original costs (2002 and 2003) were adjusted to include additional items such as SCADA, Tribal fees (5%) and inflation costs (3%) for an anticipated start date of Spring 2007.

Table 8.2.3 shows the total costs due to inflation, unlisted items, contingencies, non-contract items, additional recommended items, and Tribal fees. The BOR's Cost Estimating Handbook (BOR, 1989) defines unlisted items, contingencies, and non-contract items as follows:

- Unlisted Items – Percentage allowance for additional items of work which will appear in the final design required for a fully finished feature.
- Contingencies – Percentage allowance to cover minor differences between actual and estimated quantities, unforeseeable difficulties at the site, possible minor changes in the plans, and other uncertainties.
- Non-contract Costs – Non-contract activities are usually based on a percentage of the construction cost. Non-contract costs include: planning, investigations, designs and specifications, contract administration, water rights, environmental permits, and rights-of-ways.

TABLE 8.2.1 OVERALL ESTIAMTED PROJECT COSTS – 850 cfs

Line Items	Diversion Dam and Headgates	Kennedy Creek Siphon	Kennedy Creek and Wasteway	St. Mary River Siphon	Hall Coulee Siphon	Hydraulic Drops No. 1 – No. 5	Canal Prism Rehab.	TOTALS
Approx. Construction Costs	$6,608,700	$504,300	$849,300	$4,512,300	$2,176,500	$2,351,600	$32,466,900	$49,469,600
Inflation Costs [(1)]	$1,052,600[(2)]	$63,300	$106,600	$566,300	$273,200	$295,200	$4,074,900	$6,432,100
Subtotal	$7,661,300	$567,600	$955,900	$5,078,600	$2,449,700	$2,646,800	$36,541,800	$55,901,700
Unlisted Items (10%)	$1,149,200[(3)]	$56,800	$95,600	$507,900	$244,900	$264,700	$3,654,200	$5,973,300
Subtotal	$8,810,500	$624,400	$1,051,500	$5,586,500	$2,694,600	$2,911,500	$40,196,000	$61,875,000
Contingencies (25%)	$2,202,600	$156,100	$262,900	$1,396,600	$673,700	$727,800	$10,048,500	$15,468,200
Subtotal	$11,013,100	$780,500	$1,314,400	$6,983,100	$3,368,300	$3,639,300	$50,244,500	$77,343,200
Non-Contract Costs (37%)	$4,074,900	$288,700	$486,400	$2,583,700	$1,246,300	$1,346,600	$18,590,500	$28,617,100
Subtotal	$15,088,000	$1,069,200	$1,800,800	$9,566,800	$4,614,600	$4,985,900	$68,835,000	$105,960,300
TD&H Recommended Items	$100,000 [(4)]	$0	$50,000 [(4)]	$0	$0	$0	$7,816,000 [(5)]	$7,966,000
Subtotal	$15,188,000	$1,069,200	$1,850,800	$9,566,800	$4,614,600	$4,985,900	$76,651,000	$113,926,300
Tribal Fees (5%)	$759,400	$53,500	$92,500	$478,400	$230,700	$249,300	$3,832,500	$5,696,300
Total Costs per Structure	$15,947,400	$1,222,700	$1,943,300	$10,045,200	$4,845,300	$5,235,200	$80,483,500	$119,622,600

Notes: 1. Inflation costs are based on 3% growth rate over 4 years (12.55%), except where noted.
2. Inflation costs are based on 3% growth rate over 5 years (15.93%).
3. 15% used to calculate unlisted items.
4. SCADA
5. SCADA and considerations for canal realignment, relocation, armoring and two-bank construction.

TABLE 8.2.2 OVERALL ESTIAMTED PROJECT COSTS – 1000 cfs

Line Items	Diversion Dam and Headgates	Kennedy Creek Siphon	Kennedy Creek and Wasteway	St. Mary River Siphon	Hall Coulee Siphon	Hydraulic Drops No. 1 – No. 5	Canal Prism Rehab.	TOTALS
Approx. Construction Costs	$6,956,500	$663,600	$913,000	$6,104,800	$2,229,600	$2,431,300	$33,368,500	$52,667,300
Inflation Costs [(1)]	$1,108,000[(2)]	$83,200	$114,600	$766,200	$279,800	$305,200	$4,188,000	$6,845,000
Subtotal	$8,064,500	$746,800	$1,027,600	$6,871,000	$2,509,400	$2,736,500	$37,556,500	$59,512,300
Unlisted Items (10%)	$1,209,700[(3)]	$74,700	$102,800	$687,200	$251,000	$273,600	$3,755,700	$6,354,700
Subtotal	$9,274,200	$821,500	$1,130,400	$7,558,200	$2,760,400	$3,010,100	$41,312,200	$65,867,000
Contingencies (25%)	$2,318,600	$205,400	$282,600	$1,889,500	$690,100	$752,600	$10,328,100	$16,466,900
Subtotal	$11,592,800	$1,026,900	$1,413,000	$9,447,700	$3,450,500	$3,762,700	$51,640,300	$82,333,900
Non-Contract Costs (37%)	$4,289,300	$380,000	$522,800	$3,495,600	$1,276,600	$1,392,200	$19,106,800	$30,463,300
Subtotal	$15,882,100	$1,406,900	$1,935,800	$12,943,300	$4,727,100	$5,154,900	$70,747,100	$112,797,200
TD&H Recommended Items	$100,000 [(4)]	$0	$50,000 [(4)]	$0	$0	$0	$8,038,600 [(5)]	$8,188,600
Subtotal	$15,982,100	$1,406,900	$1,985,800	$12,943,300	$4,727,100	$5,154,900	$78,785,700	$120,985,800
Tribal Fees (5%)	$779,100	$70,300	$99,300	$647,200	$236,400	$257,700	$3,939,300	$6,049,300
Total Costs per Structure	$16,781,200	$1,477,200	$2,085,100	$13,590,500	$4,963,500	$5,412,600	$82,725,000	$127,035,100

Notes: 1. Inflation costs are based on 3% growth rate over 4 years (12.55%), except where noted.
2. Inflation costs are based on 3% growth rate over 5 years (15.93%).
3. 15% used to calculate unlisted items.
4. SCADA
5. SCADA and considerations for canal realignment, relocation, armoring and two-bank construction.

Table 8.2.3 Overall Estimated Project Costs

Item	850 cfs	1000 cfs
Construction Costs	$49,469,600	$52,667,300
Unlisted Items (10/15%)	$5,973,300	$6,354,700
Contingencies	$15,468,200	$16,466,900
Non-Contract Cost (37%)	$28,617,100	$30,463,300
TD&H Recommended Items	$7,966,000	$8,188,600
Inflation Costs	$6,432,100	$6,845,000
Subtotal	***$113,926,300***	***$120,985,800***
5% Tribal Fees	$5,696,300	$6,049,300
TOTAL PROJECTED COSTS	**$119,622,600**	**$127,035,100**

Estimated engineering fees for studies to be initiated in 2005 and subsequent design phases were presented in Section 7.0 and are summarized below.

Table 8.2.4 Summary of Design and Study Costs

Study/Design Phase	Estimated Fee
Environmental Compliance Documents	$262,500 to $1,000,000
Economic Study	$52,500
Basin Hydrology Study	$19,800
Preferred Alternative	$44,650
St. Mary Siphon Landslide Study	$79,400
Hydropower Feasibility	$40,450
Topographical Surveys	$99,250
Engineering Studies Subtotal	***$598,550 to $1,336,050****
Preliminary Engineering Reports (Total)	$1,430,000
Final Design (Total)	$4,770,000
Construction Management (Total)	$8,183,000
Engineering Design Subtotal	***$14,383,000***
5% Tribal Fees	$719,150
Total Design Costs	***$15,102,150***
TOTAL ESTIMATED ENGINEERING FEES	**$15,700,700 to $16,438,200**

* Includes 5% Tribal Fees

It is anticipated that the BOR will realize administration costs associated with this project such as reviews for feasibility/design studies and final design documents and limited construction oversight.

Although our estimated engineering fees are less than half (approximately $15,000,000 less) of that of the BOR's, we recommend using the Total Projected Costs listed above for funding request limits, since it is not known whether or not the BOR will perform engineering for this project.

We understand that the DNRC is seeking a one-time request for State funding in the amount of $500,000. If successful, we recommend initiating the Environmental Compliance process. Also, the Preferred Alternative (PA) study should be completed in 2005 to stay on track for an early 2007 construction start. The PA study requires the Basin Hydrology and Economic Studies be completed. In addition, the St. Mary Siphon Landslide Study should be started as soon as possible to obtain useful design information and observe the effects of two consecutive springs (2005 and 2006).

It is important to maintain progress, since some studies require up to two years and construction could take 8 to 10 years. Inflation increases project costs ±$3 million each year, and it is too important to the State of Montana to stop or delay progress made by DNRC and St. Mary Rehabilitation Working Group.

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