Final Report

For the

HARTLAND DIVERSION DAM FISH PASSAGE FEASIBILITY STUDY

Submitted to the

Colorado Water Conservation Board

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Section 1 Project Executive Summary

The Hartland Diversion Dam Fish Passage Feasibility Study was a five task project with one primary objective. The primary objective was to develop a conceptual design for a dam modification that enabled the fish passage of three target fish species (roundtail chub, flannelmouth sucker, and bluehead sucker) while insuring that the Hartland Irrigation Company maintains complete access to their senior pre-Colorado River Compact water decree.

The first task completed during this project was the Kick-off meeting, in which the key stakeholders helped established the technical requirements that the conceptual design must meet to achieve the primary objective. Once these requirements were established, the project moved through Task 2, concept drawings, Task 3, Hydraulic Analysis, and Task 4, Cost estimates, to evaluation multiple potential concepts. From these results, the conceptual design was chosen and the project moved to Task 5, which was the generation of the details of the 40% conceptual design.

The Hartland Diversion Dam Fish Passage Feasibility Study successfully developed and has documented in this final report:

- A conceptual design for fish passage modification for three target fish species applicable to the Hartland Diversion Dam that insures the Hartland Irrigation Company maintains complete access to their senior pre-Colorado River Compact water decree,
- An up-to-date cost estimate of construction and permitting costs, and
- Defined environmental compliance requirements pursuant to potential Army Corps of Engineers jurisdiction over the project.

Taking this conceptual design to final design and implementation will:

- Eliminate the last major fish blockage in the lower Gunnison and significantly improve river system health
- Reconnect fragmented river habitat of three target fish species, which is expected to result in increased populations. The fish passage should also increase the general fish population in this section of the river.
- Provides fish with access to approximately 90 river miles of upstream habitat
- Improve navigational safety on the river
- Eliminate trespassing issues on private property that occur when boaters portage around the dam

Project Location Information

Nearest Town or City	Delta, Colorado
County	Delta
Township/Range/Section	15 South/97 West/5
Latitude/Longitude	108 degrees 2’ 29.63” W 38 degrees 46’ 9.14” N
State Senate District	5
State Representative District	58
Stream Name and Watershed	Gunnison River
Water Division	4
Water District	40

Section 2 Problem Background

Hartland Diversion Dam is located in Delta County, Colorado, on the Gunnison River (river mile [RM] 59.9) 3.6 RMs upstream of the Uncompahgre River confluence near Delta, Colorado. See map in Appendix A. This dam is a five-foot high structure that was originally constructed in 1881 for agricultural irrigation and stock-watering purposes. The system diverts approximately 43 cubic feet per second (cfs) through a head gate on the north side of the river generally from March through November. The system includes the dam which spans the entire river width (~ 120 yards), an irrigation head gate control and canal on the north bank of the Gunnison River. It is constructed of railroad iron driven vertically into the riverbed and horizontally placed cribbing. The cribbing is filled with river cobbles and boulders. The structure was repaired and upgraded in 1942. The Hartland Irrigation Company owns the diversion dam and operates and maintains the head gate and irrigation canal.

Fragmentation of river reaches and blockage of movement by dams and water diversion structures have been recognized as important causes for the decline of native fishes in the Upper Colorado River Basin (Tyus 1984; Burdick and Kaeding 1990). Diversion dams eliminate population connectivity by blocking fish migration routes. Providing fish passage past instream barriers has come to be considered an important means to aid the restoration and recovery of native fish populations. Research indicates Hartland Diversion Dam impacts the upstream range and movement of the roundtail chub (*Gila robusta*), as the numbers of adult roundtail chub captured in both 1992 and 1993 immediately upstream of the diversion dam were about five times lower than those downstream of the structure (Burdick 1995).

Although the USFWS considers the three fish species targeted by this project as species of concern, a consortium of State Departments of Wildlife, including the Colorado Division of Wildlife (CDOW), identifies two of the target native fish species as species of special concern. These two species are the roundtail chub (*Catostomus discobolus*), and flannelmouth sucker (*C. latipinnis*). A range-wide conservation strategy has been developed for roundtail chub, flannelmouth sucker, and bluehead sucker (Utah Division of Wildlife Resources 2006) the goal of which is to ensure the persistence of these three species throughout their ranges. One of the objectives of this plan is to establish and/or maintain sufficient connectivity between populations so that viable metapopulations are established and/or maintained. Diversion dams and dewatering within stream reaches have been identified as decreasing the amount of connectivity between populations of aquatic species.

The upper limit of critical habitat for two federally listed native species, the razorback sucker (*Zyrauchen texanus*) and Colorado pikeminnow (*Ptychocheilus lucius*) in the Gunnison River is the confluence of the Uncompahgre and Gunnison rivers (RM 56.3). However, occupied habitat for these two listed species in the Gunnison River extends upstream to Hartland Dam. While numbers of the two listed fishes appear to be low in the immediate downstream river reach from the Hartland Dam, it is possible that the proposed fish passage structure at the Hartland Dam also would allow the upstream passage of the two listed species.

The existing structure has dramatically changed the river morphology. Upstream of the structure, the river gradient has generally been decreased and the sedimentation dynamics adversely changed. Downstream of the structure, river stability has also been adversely impacted. Bank erosion has been so severe that the landowner, with support from the local utility company, has recently invested nearly $30,000 to address the continued soil loss, which impacts his property's health and value. This project has been somewhat successful, but has not eliminated the problem. The implantation of this project will address these morphology issues to increase river stability to the benefit of the adjacent landowners, agricultural interests, aquatic wildlife and riparian habitat.

The Hartland Dam is an extreme safety hazard to boaters that can result in life-threatening accidents when boats attempt to go over the dam. Boats and their passengers can get trapped in the hydraulic re-circulating wave at the toe. At least three people have drowned in boating-related accidents around the dam and there was a near loss of life in June of 2009. This accident, involving three boats and four people, required the Delta county and city rescue teams to safely remove people from the river.

To avoid this river hazard, boaters must trespass on the adjacent private property, which generates an undesirable situation with potential liability for the landowner.

Section 3 Task Results

Painted Sky was the lead organization for this project and will be leading the final design/implementation project. Painted Sky has established partnerships and an Integrated Project Team (IPT) with the key project stakeholders to participate and support the project. The following list includes the project stakeholders who have been involved in the project and planning to date:

- US Fish and Wildlife Service,
- USDA-Natural Resources Conservation Service,
- Hartland Irrigation Company,
- Will Hutchins, private landowner
- Colorado River Water Conservation District,
- Colorado Division of Wildlife,
- Gunnison Basin Round Table,
- Colorado Water Conservation Board,
- Delta and Montrose Counties,
- Delta and Montrose Cities,
- Delta Conservation District and
- Colorado Watershed Assembly

3.1 Task 1 Site Visit and Kick-off Meeting

These key stakeholders have been involved in the planning and development of the project and are supportive of this project because of the multiple benefits the project affords.
Painted Sky's CWCB-funded conceptual design study officially started with the kick-off meeting held on July 29, 2009. The key stakeholders and project team members in attendance are presented in Table 1. During the meeting, past Hartland fish passage studies were reviewed, potential design concepts were introduced and discussed and fish physical characteristics that impact fish passage were defined. The kick-off meeting attendees also completed a project site tour to identify site specific issues including the concerns of adjacent landowners. This Kick-off meeting team defined the functional dam modifications required to accomplish the critical objectives.

The initial recommendations for fish specific modification design criteria were the following:

- Target species are the roundtail chub, flannelmouth sucker, and the bluehead sucker.
- No studies have been completed on the target species. Since the razorback sucker is closely related to the target specifics and data is available for the razorback, velocity and depth guidelines established for the razorback will be used as the initial criteria.
- Burst speeds (peak flow velocities need to be held below 4 Ft/sec and sustained speeds below 2 ft/sec).
- Minimum depth of two feet across the weirs and drops with more depth in the pools
- Pool length should be established using an industry standard criterion
- Emphasis on stability must be placed on fish passage/channel bank ties and at the toe of the passage

The basic design concept for the fish and boat passage is a chute and pool approach, as illustrated by the 4-step chute and pool design in Appendix B. As a result of the Kick-off meeting, a one-day field investigation was conducted in the river bed. The results of the field investigation indicate that depth to bedrock is sufficient to allow for the successful implementation of the chutes/pools concept.

Table 1 – Kick-off meeting attendance list

Name	Organization/Position	Area of Expertise
Peggy Bailey	Tetra Tech – Project Manager and Staff engineer	Management, water resources engineer, hydrology, hydraulics
Jeff Crane	Crane Associates – subcontractor to Tetra Tech	Engineering, hydrologist, river structure design and implementation
Mike Drake	NRCS Earth Team volunteer (Painted Sky Executive Director as of October 16, 2009)	Project management, engineering, federal contracting
Anna Hutchins	owner of land on east	

Eric Jessen	Painted Sky and Delta Conservation District – Board Member	
Dave Kanzer	Colorado River District – Staff Engineer	Water improvement project engineering
Olen Lund	Painted Sky – Board Member	
Ernie Schaaf	Hartland Irrigation Company – Vice President	Construction and dam maintenance
Alaina Smith	Tetra Tech – Staff engineer	water resources engineer, hydrology, hydraulics
Wayne Stancill	US Fish and Wildlife Service – Staff engineer	hydraulic engineer, habitat improvement, fish ladder design and implementation
Paul Van Ryzin	NRCS – Coordinator for Painted Sky	Habitat improvement and project management

3.2 Task 2 Concept Drawings & Task 3 Hydraulic Analysis

The project team developed a preliminary set of conceptual plans sufficiently complete to enable the initial analysis required to evaluate the concepts. Appendix B illustrates the drawing detail for the four chute/pool concept. A hydraulic analysis was completed using HEC-RAS for the four concepts chosen. The results are given in Table 2.

Table 2 – HARLTAND FISHPASSAGE COMPARISON OF AVERAGE VELOCITIES TOP OF CHUTES

River Flow (cfs)	350 (exceeded 90% in Aug & July)	650 (average low flow over period of record)	1200 (exceeded 50% in August)	2000 (Mid-target flow)
Three (3) chutes and pools, 2 ft drop each				
Chute Velocity (fps)	3.8	4.2	4.5	Not computed
Four (4) chutes and pools, 1 ½ ft drop each				
Chute Velocity (fps)	3.1	3.1	3.6	4.0
Six (6) chutes and pools, 1 ft drop each				
Chute Velocity (fps)	3.0	2.9	3.2	3.6
Twelve (12) chutes and pools, ½ ft drop each				
Chute Velocity (fps)	2.9	2.8	3.0	3.3

The velocities and other considerations led to the decision that the 12 chute/pool concept (1/2 foot drop) was needed to meet the fish passage requirements. The discussions leading to this decision also refined the recommendations for fish specific modification design criteria to the following:

- Maximum vertical height drop at the chutes of 0.5 feet
- Maximum velocities at the toe of drops of 4 feet per second
- Maximum burst time in high velocity areas of 3 to 5 seconds
- Minimum 2 feet water depth at the top of the drop structures
- Maximum velocities in the pools of 2 feet per second
- Pools water depth typically greater than 2 feet
- 20 feet minimum pool length

For the final design, the fish passage requirements were used with an adjustment of the pool length to 25 feet to allow for a typical raft to enter the pool without physically spanning the top of drops.

3.3 Task 4 Quantities and Costs

The preliminary cost estimate and quantities for each of the concepts listed in Table 2 are given in Table 3. It must be noted that these cost estimates do not include overall project management costs for the final design and construction efforts.

Table 3 Preliminary Cost Estimates for the Four Initial Concepts Evaluated

	ITEM DESCRIPTION	UNIT	UNIT PRICE	THREE CELLS (2FT DROPS)		FOUR CELLS (1.5 FT DROPS)		SIX CELLS (1 FT DROPS)		TWELVE CELLS (1/2 FT DROPS)	
				QUANTITY	SUBTOTAL	QUANTITY	SUBTOTAL	QUANTITY	SUBTOTAL	QUANTITY	SUBTOTAL
	Length of passageway	FT		125' /series	390' total length	100' /series	420' total length	90' /series	570' total length	60' /series	780' total length
1	Mobilization/demobilization	LS	$26,000	1	$26,000	1	$26,000	1	$26,000	1	$26,000
2	Site preparation	LS	$14,000	1	$14,000	1	$14,000	1	$14,000	1	$14,000
3	Water Control/Dewatering	LS	$32,000	1	$32,000	1	$32,000	1.1	$35,200	1.2	$38,400
4	Headgate										
	Remove existing dam	LS	$16,000	1	$16,000	1	$16,000	1	$16,000	1	$16,000
	Concrete headwall	CY	$1,000	250	$250,000	250	$250,000	250	$250,000	250	$250,000
	Riprap wall protection, d_{50}=24 in	CY	$45	2500	$112,500	2500	$112,500	2500	$112,500	2500	$112,500
5	Earthwork										
	Excavation	CY	$10	10000	$100,000	7500	$75,000	7500	$75,000	7500	$75,000
	Use excess-grade on site	CY	$5	1000	$5,000	1000	$5,000	1000	$5,000	1000	$5,000
6	Boat/Fish Passageway										
	Subgrade grading and bed comp	EA	$4,000	3	$12,000	4	$16,000	6	$24,000	12	$48,000
	Boulders - guide rocks, 6 ft diam	CY	$60	24	$1,440	24	$1,440	24	$1,440	24	$1,440
	Boulder Chutes, d_{50}=36 in	CY	$50	1200	$60,000	1700	$85,000	2800	$140,000	6100	$305,000
	Engineered stream bed	CY	$40	340	$13,600	360	$14,400	390	$15,600	430	$17,200
7	Riprap bank protection, d_{50}=24 in	CY	$45	2300	$103,500	2300	$103,500	2300	$103,500	2300	$103,500
8	Native Seeding	AC	$5,000	4	$20,000	4	$20,000	5	$25,000	6	$30,000
9	Ditch crossing-temporay access roa	LS	$5,000	1	$5,000	1	$5,000	1	$5,000	1	$5,000
	SUBTOTAL				**$771,040**		**$775,840**		**$848,240**		**$1,047,040**
	DESIGN/ SURVEYING/ INSPECTION (8%)				**$61,683**		**$62,067**		**$67,859**		**$83,763**
	CONTINGENCY (20%)				**$154,208**		**$155,168**		**$169,648**		**$209,408**
	TOTAL ESTIMATED COST				**$986,931**		**$993,075**		**$1,085,747**		**$1,340,211**

3.4 Task 5 Final Conceptual Design

The 12 chute/pool final conceptual design is shown in Appendix C. The details of the final conceptual design are contained in Appendix D. This conceptual design meets all the project objectives.

The cost estimates given in Appendix D only cover the design and construction costs. Adding program management and permitting costs, the total cost estimate to complete this project is $1,750,000.

There are four permit/approval issues to be dealt with as this project moves forward.

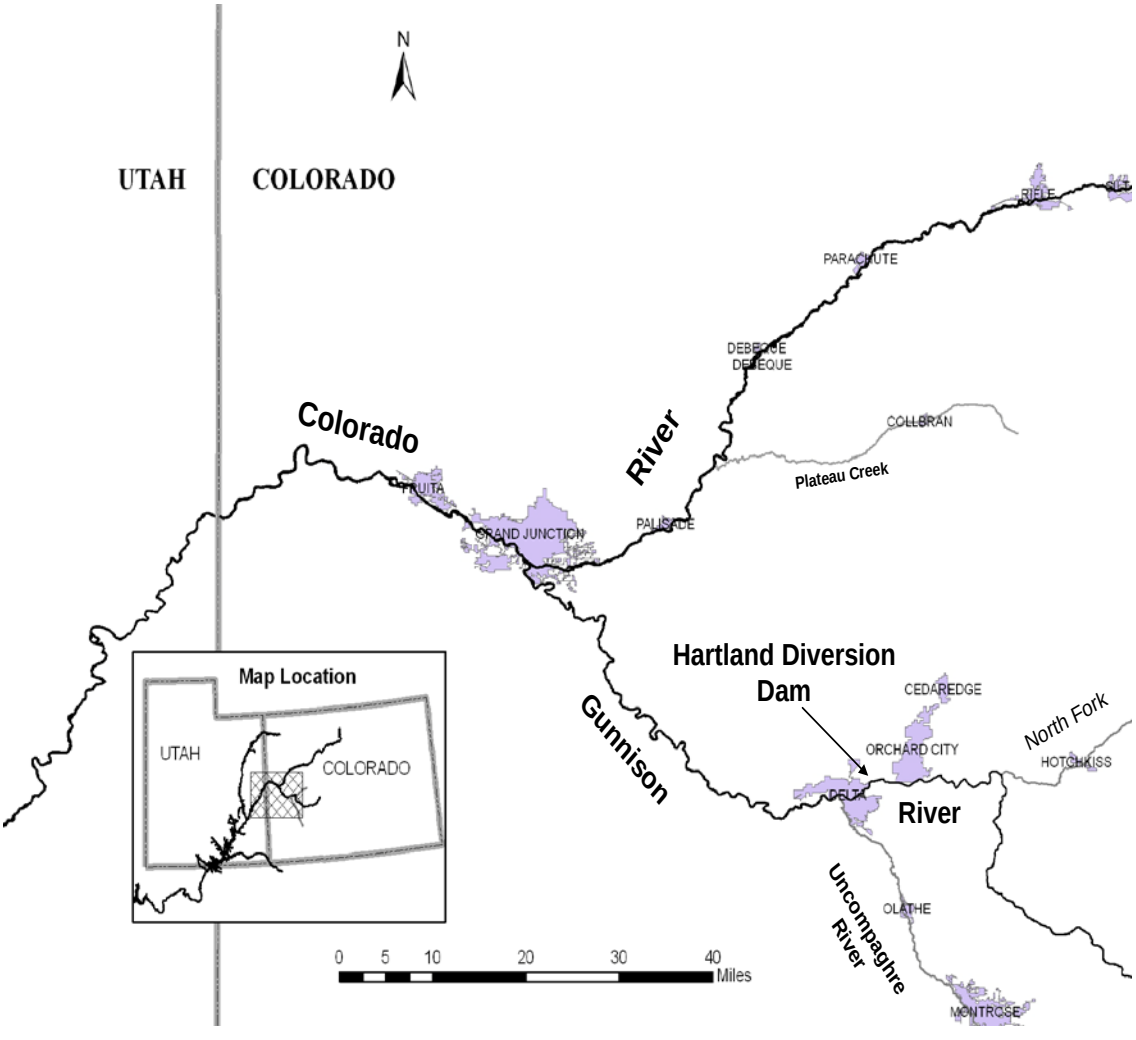
Painted Sky has received assistance from NRCS's Cultural Resources Specialist to confirm a finding of "no adverse effect", as required by Section 106 of the National Historic Preservation Act. This opinion was shared with, and confirmed by, US Fish and Wildlife Service staff in 2009.

The two primary regulatory requirements for the project are NEPA compliance and permitting from the US Army Corps of Engineers for a Section 404 permit. Both of these issues required a finalized Conceptual Design and can now be addressed. Section 404 of the Clean Water Act requires a permit for discharge of fill material in the Gunnison River. However, initial conversations with the Army Corps leads to the expectation that they will issue an exemption pursuant to Section 404(f) (1) (A), known as the "agricultural exemption," since the work involves modification of an agricultural irrigation structure. The expected Corps decision also will eliminate the NEPA permit requirement.

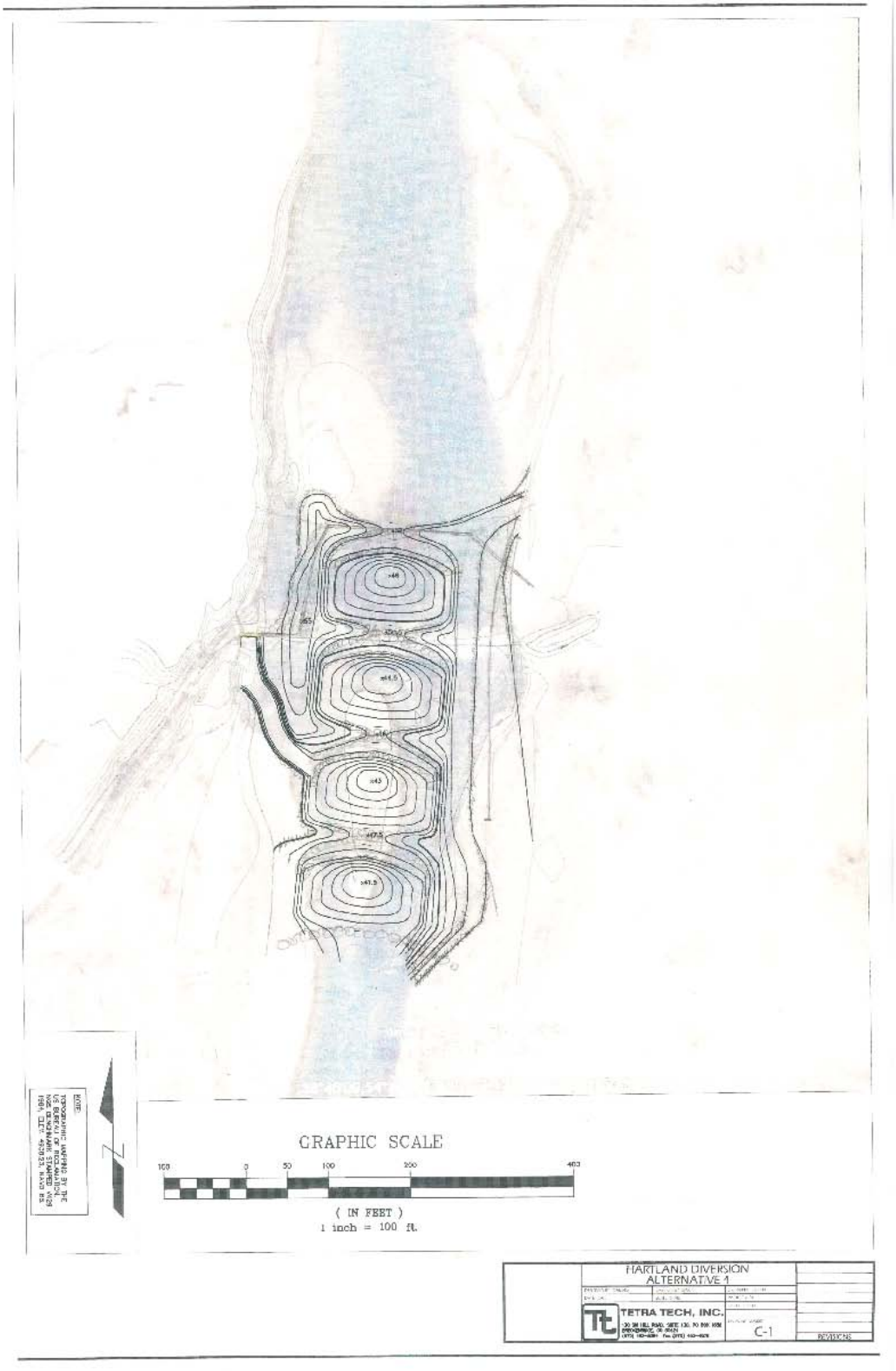
In addition, approval will be required from the Federal Emergency Management Agency, National Flood Insurance Program to alter floodplain elevations. The precise impact of the change in floodplain elevations can not be defined until the on-site survey and the final design analysis are completed.

Required Colorado Department of Public Health and Environment permits include a Stormwater Management Discharge Permit and a Construction Dewatering Permit. Local permits may also be required for excavation, dewatering, grading and erosion control.

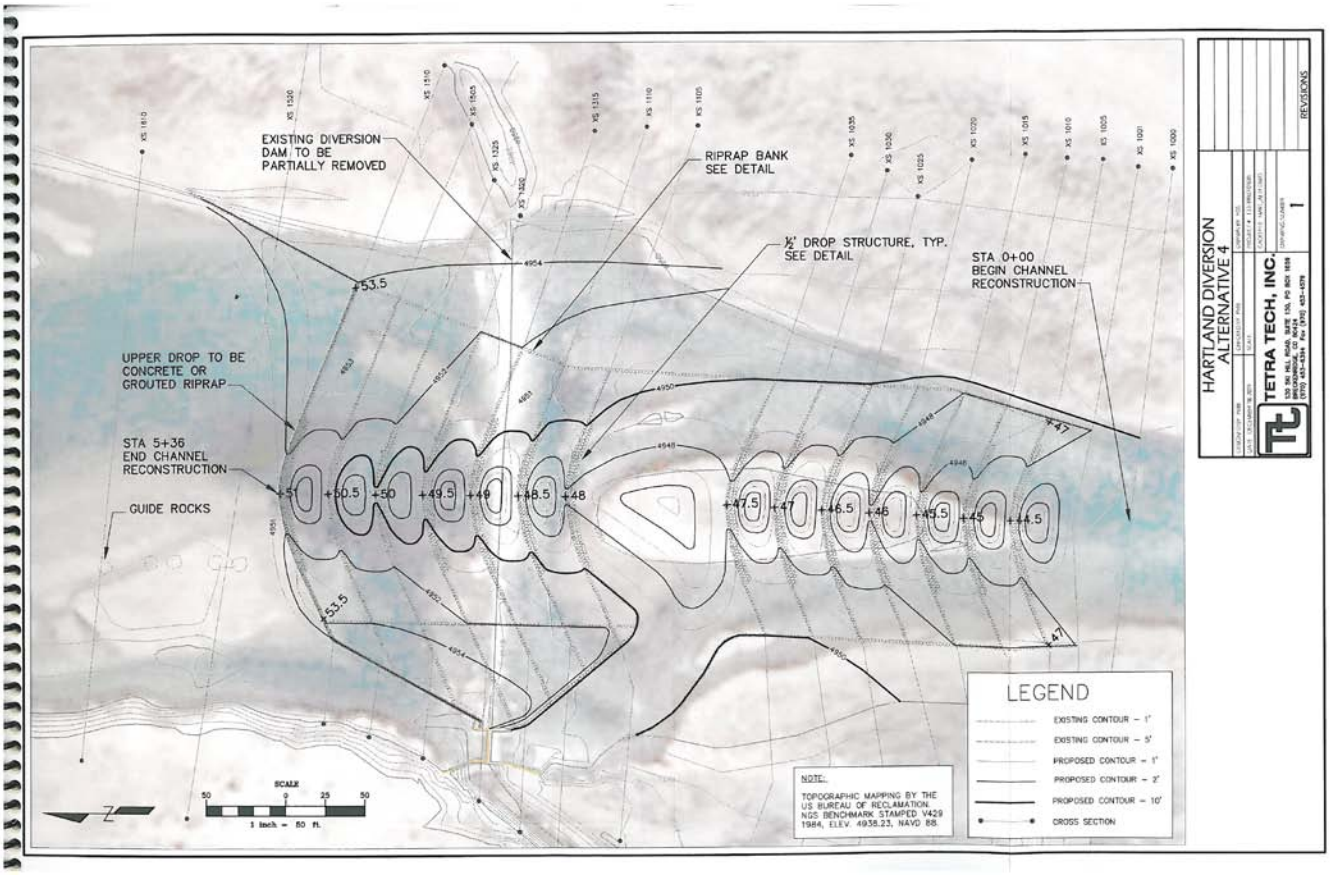
Appendix A – Area Map with Location of the Hartland Dam



Appendix B – Chute and Pool Design Concept Illustration



Appendix C – Final 12 Chute and Pool Conceptual Design



Appendix D – Final 12 Chute and Pool Conceptual Design Report