RECLAMATION

Managing Water in the West

O'Donnell Creek Fish Barrier

Feasibility Investigations

Final Report for Central Arizona Project Fund Transfer Program Task 4-46

Submitted to:

U.S. Fish and Wildlife Service
U.S. Bureau of Land Management
The Nature Conservancy

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I. Introduction

Reclamation is pursuing construction of a series of fish barriers within the Gila River basin to prevent nonnative fishes and other aquatic organisms from invading high-priority streams occupied by native fishes. This program is mandated by two U.S. Fish and Wildlife Service biological opinions on impacts of Central Arizona Project water transfers to the Gila River basin. The fish barrier construction program was stipulated as one of several measures to prevent jeopardy to the continued existence of four federally-listed native fishes.

Although declines of native fishes in the American southwest prior to the mid-1900's were principally a result of habitat destruction and alteration, in the past several decades it has become apparent that presence of nonnative fishes precludes or negates benefits from habitat protection and restoration (Mueller 2005). Contamination by nonnative fishes now is considered the most consequential factor preventing sustenance and recovery of imperiled native fishes in the southwest (Meffe 1985, Minckley 1991, Marsh and Pacey 2005), and perhaps globally (Cambray 2003). Habitat restoration cannot successfully advance biological recovery of native fishes unless preceded or accompanied by elimination of nonnatives (Marsh and Pacey 2005, Mueller 2005).

Highest-priority streams under Reclamation's fish barrier construction program are those that can be secured to prevent extinction and stabilize rare stocks of native fishes, or that can be protected and renovated to replicate rare stocks of native fishes. O'Donnell Creek, Santa Cruz County, Arizona, jointly owned and managed by The Nature Conservancy (TNC), U.S. Forest Service (USFS), U.S. Bureau of Land Management (BLM), and others, was chemically renovated in 2001 to remove nonnative green sunfish that became established and threatened the continued persistence of the endangered Gila chub (*Gila intermedia*) and other native fishes. Since that successful renovation, endangered Gila topminnow (*Poeciliopsis occidentalis*) and longfin dace (*Agosia chrysogaster*) again have been found in the stream, and with Sonora sucker (*Catostomus insignis*) and Gila chub, now comprise the native fish assemblage of the stream. O'Donnell Creek, therefore, meets the criteria of preventing extinction and stabilizing a rare population of Gila chub, and has served to replicate a population of Gila topminnow.

O'Donnell Creek is currently protected against upstream invasions of nonnative fishes by two concrete barriers erected in the past for either stock watering or grade control purposes. Normally such structures would provide adequate protections against upstream fish movements. However, both were constructed only part way across the stream channel, and both are in imminent danger (perhaps during the next major flood) of being eroded around and failing. When the two existing barrier structures fail, there no longer will be certain impediments to upstream movements of nonnative fishes that reside in perennial reaches of Babocomari River (O'Donnell Creek's distributary) or other O'Donnell Creek tributaries such as Post Canyon.

Once established, the only proven technique to rid a stream of unwanted fishes is to perform a complete chemical renovation of the entire stream. Chemical renovations are controversial and expensive, and they kill all non-target (native) fishes that cannot be salvaged in advance of the application. Such action, therefore, is to be avoided where possible and should be used only as a last resort. As just mentioned, renovation previously was required on O'Donnell Creek to save the native fish assemblage, and action taken now in the form of a new fish barrier can avoid a repeat of that scenario.

This feasibility study evaluates fish barrier options on O'Donnell Creek, describes the construction features, and provides feasibility level cost estimates. These details will allow further evaluation by all affected parties before a decision is made to proceed or not with National Environmental Policy Act and other environmental compliance and barrier construction.

II. Study Area

The three potential fish barrier sites in this report are located southeast of Elgin, Arizona, within the southeast quarter of Section 28, Township 21 South and Range 18 East (Figure 1). All three sites are within a quarter-mile from one another and are located on the USGS O'Donnell Canyon quadrangle map. The sites are located at approximate UTM coordinates 3,492,940 N, 545,130 E (latitude 31° 34' N, longitude 110° 31' W). The two downstream sites are on Bureau of Land Management (BLM) land (managed by the Audubon Society), and involve working with two small existing concrete dams (Figures 2 and 3). The upstream site would be a new structure, located on The Nature Conservancy (TNC) property (Figure 4).

The O'Donnell Creek watershed drains approximately 15.0 square miles upstream of the study area. The maximum elevation of the drainage is 6,171 ft (Lookout Knoll). The study area is about elevation 4,850 ft. There are about 1.5 miles of perennial stream upstream of the study area, and about a quarter-mile downstream. The stream is ungaged, but flows during two separate site visits are estimated at 200 gallons per minute. Local unconfirmed accounts indicate that the current drought has dried flows up entirely for short periods near the study area.

The stream channel can be characterized as cienega-like, with stable silt banks supporting grasses, interrupted by bedrock intrusions. The stability of the riparian reach may be primarily due to the two existing dam structures and a grade control structure about 1,500 ft upstream of the dams. The two dams are arched concrete structures approximately 8 ft high, creating 50-ft long shallow ponds. At this time, the dams are preventing headcutting from advancing into the lower O'Donnell Creek cienega, although there is concern about the stream eroding laterally around the structures.

III. Methods

Three site investigations were conducted to support this report. The first took place on March 20, 2003, with Reclamation staff, at which time dimension measurements were taken, conceptual options developed, and biological impacts of construction were evaluated. The second visit was on March 14, 2005, and included representatives from BLM, TNC, the Audubon Society, U.S. Fish and Wildlife Service, and Arizona Game and Fish Department. Reclamation's conceptual designs were discussed with the land owners. A final site visit occurred on January 23, 2006, where Reclamation staff further evaluated options. Site evaluations consisted of measurements of proposed construction features, photos, global positioning system locating, visual evaluations with respect to foundation materials, construction, and access issues.

TOPO! map printed on 08/31/06 from "Untitled.tpo"

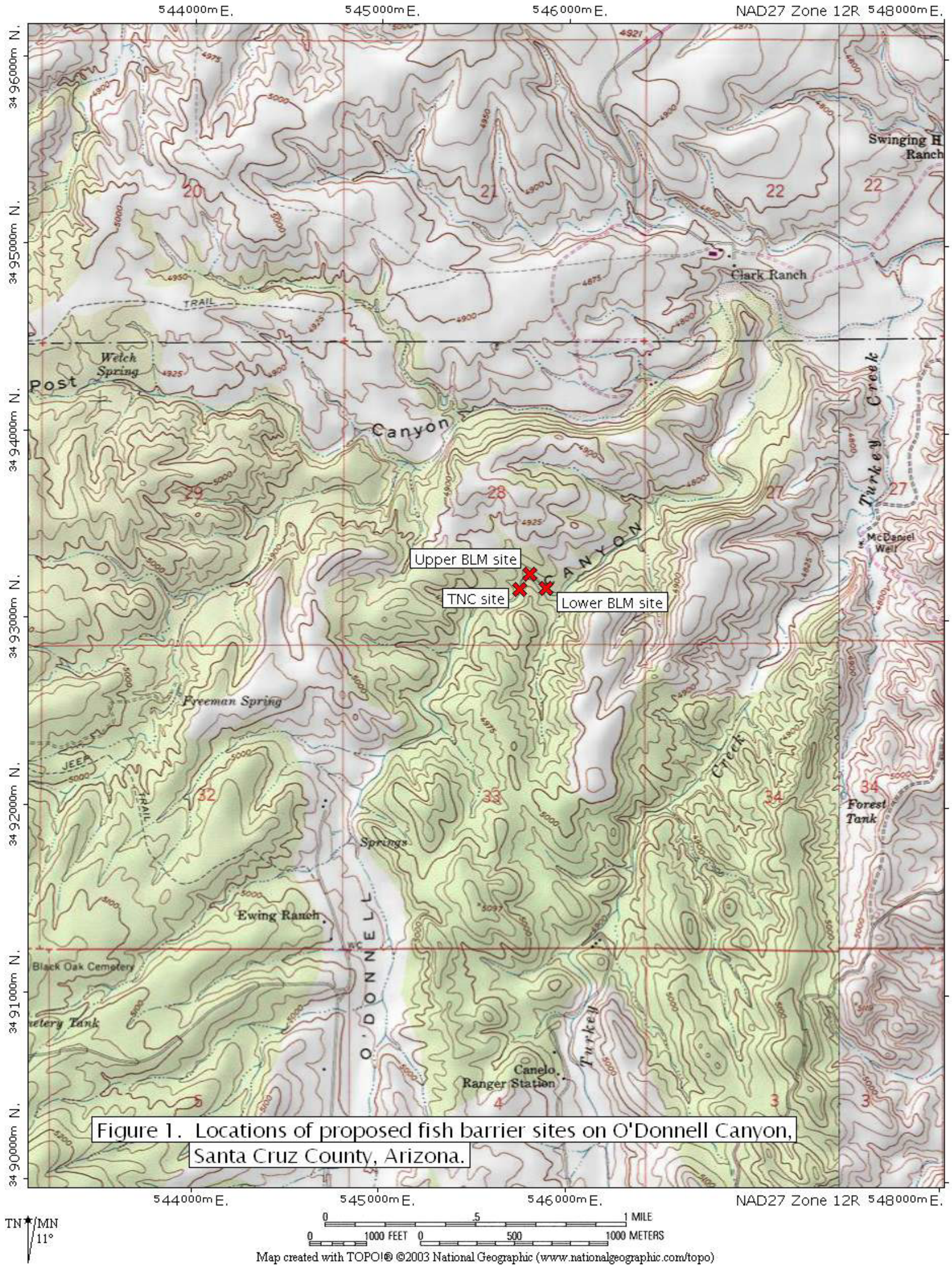


Figure 1. Locations of proposed fish barrier sites on O'Donnell Canyon, Santa Cruz County, Arizona.

Map created with TOPO!® ©2003 National Geographic (www.nationalgeographic.com/topo)

Figure 2. Upper dam on BLM lands.

Figure 3. Lower dam on BLM lands.

Figure 4. Potential fish barrier site on TNC lands.

IV. Results

A. General Design Considerations – The two existing dams currently protect the stream and cienega from headcutting erosion. However, exposed earth abutments at each dam are undergoing erosion that may eventually allow the stream to erode laterally around the structures. The revetment of these areas may involve concrete, gabions, earth and riprap, or a combination of these. Any method used must be able to withstand large runoff flows.

A new fish barrier upstream of the dams would be constructed of concrete. The site provides bedrock to tie into across the stream channel and up the banks, thereby eliminating scour concerns. Anchorage into the rock is relatively simple with steel anchor bars drilled and grouted into the rock contact. The main engineering concern is whether there is any potential for high runoff flows to cut behind the rock outcrop and create a new channel alignment. An apron or splash pad located immediately below the barrier crest is an important design element for a fish barrier, although primarily for biological reasons. The purpose of an apron is to eliminate the potential for a scour pool to develop that could facilitate fish leaping attempts over the barrier. In addition, an apron designed with a steep slope will ensure high current velocities and shallow depths below the barrier crest that will further limit fish access to the barrier.

There are several sources of concrete in the Nogales area. Some research should be done to determine the reliability of these plants, from a production and quality standpoint. Those plants meeting the necessary criteria should be listed in the construction specifications as approved sources.

Flooding effects resulting from the revetment work at the two existing dams would be minor if not indiscernible. The existing structures will not be raised, so an increase in sedimentation upstream of the dams is not expected.

If a new fish barrier structure were to be constructed on the TNC property, there would be localized flooding effects caused by the structure, and from sediment trapped upstream of the barrier. Sediment deposited by the stream is expected to eventually fill the space upstream of the barrier, so the stream channel invert will be raised for some distance upstream, depending on stream slope. There are no improvements that would be affected by increased upstream flooding, although these areas will need to be quantified if easements are necessary.

Frequency floods have been estimated below using the regression equations from Arizona Department of Transportation "Methods for Estimating the Magnitude and Frequency of Floods in Arizona" September 1978. The engineer should use these figures with an understanding that this does not constitute an in-depth hydrologic study.

Instantaneous Peak Flow Frequency Floods

Interval	Flow (cfs)
2-year	434
5-year	1,027
10-year	1,577
25-year	2,453
50-year	3,239
100-year	4,127

The design flood will likely correspond with the 100-year flood, or about 4,200 cfs.

Reclamation's barrier designs typically have the crest of a structure built about 5 ft above the general contours of the existing channel cross-section (a 4-ft drop plus an additional 1 ft for a sloping apron).

<u>B. Construction Access Issues</u> - The landowners have indicated they would prefer that Reclamation make a concerted effort to perform the work without constructing new roads. Workers would have a short hike of about 500 feet if the access road from the north can be used. If this road is unavailable, the hike would be closer to ½ mile from the south. These roads are fine for pickup trucks, but may be difficult for fully loaded transit mixers. Although a road could be graded to the fish barrier sites, this report and associated estimates assume the barrier would be constructed without vehicular access, unless noted.

Without vehicular access, the work must to be accomplished without heavy equipment, which raises the cost and reduces options. In this study, only the lower dam has an option that involves significant earthwork with heavy equipment.

Without vehicular access, the primary method of moving construction materials and equipment would be by helicopter. Concrete transit mixers can easily get within 2 miles of the site, from which point the concrete would be helicoptered to the work site. Lumber, rebar, gabions, generators, and other supplies and equipment can be transported by air. Use of long lines would make it unnecessary to land the helicopter at the work site.

For small jobs such as this, the contractor would likely use a Bell Long Ranger or a Sikorsky helicopter. Bell helicopters have load capacities from 800 to 1,000 pounds. They cost approximately $1,200/hr and are common. Sikorsky helicopters are less common, but can be found in the Phoenix area. Sikorskys have a load capacity of 2,500 to 3,000 pounds and cost about $2,000/hr. In these estimates, Bell helicopters are assumed for hauling the materials and placing concrete.

The following is a list of construction equipment that would be expected on-site at times during construction. The equipment actually used may vary somewhat depending on the contractor's approach to the work and equipment availability.

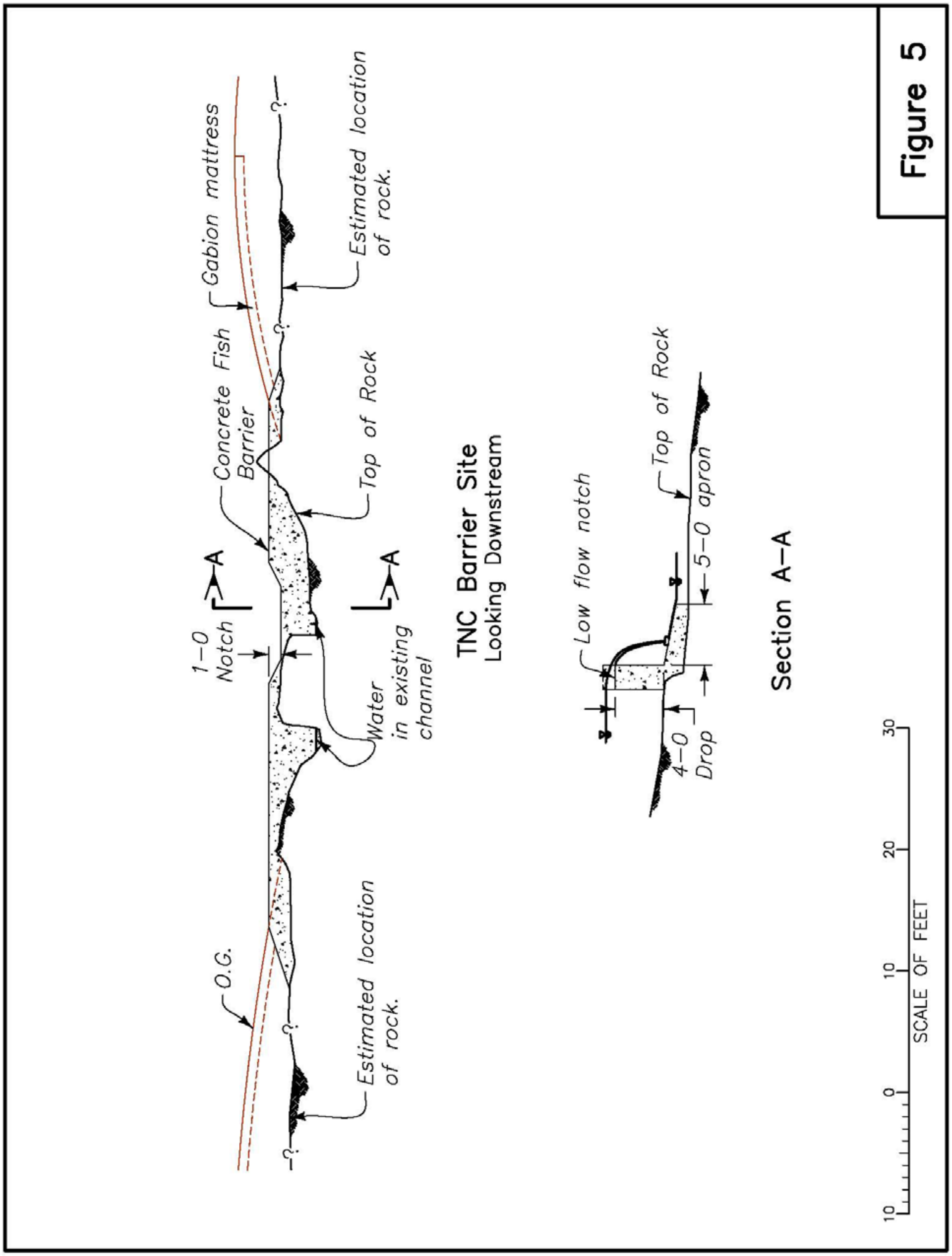
Helicopter
Generator(s)
Pumps (electric or gasoline)
Rock drills
Power saws
Concrete vibrators
Walk-behind compactors

<u>C. New Structure (TNC Site)</u> – This option involves the construction of a new concrete fish barrier. This is the furthest upstream of the three options and is on TNC property at GPS coordinates 545726 E, 3493153 N (NAD27). A conceptual cross-section of the fish barrier structure is depicted in Figure 5. Dimensions shown on the drawings are only for magnitude reference, and will undergo adjustments during the engineering phase.

The proposed barrier would be constructed of steel-reinforced concrete (see Figure 5). The structure would be low profile, essentially filling in the gaps between bedrock spines. A center notch would be constructed to ensure base flow discharges over a section of the barrier that provides the full 4-foot drop, impinging on a downstream apron. Base flow and up to about 13 cfs would be contained within the center notch.

The visible portion of the fish barrier would be about 45 feet across the stream channel. Gabion mattresses or riprap would need to be placed on the surface of the abutments to ensure the stream does not erode laterally around the barrier.

The cost of construction for this site is estimated at $71,000.



Gabion mattress
Estimated location of rock.
Concrete Fish Barrier
Top of Rock
1–0 Notch
A
A
Water in existing channel
O.G.
Estimated location of rock.
TNC Barrier Site
Looking Downstream
Low flow notch
4–0 Drop
5–0 apron
Top of Rock
Section A–A
10
0
10
20
30
SCALE OF FEET

Figure 5

Cost estimate, New Structure on TNC Property:

Assumptions for constructing a barrier at this site include: 1) materials will be brought in by helicopter or by hand; 2) concrete will be batched at an off-site location, slung to the site, and placed using helicopter; 3) bedrock foundation except at the upper banks which will be protected from erosive flows by gabion mattresses; and 4) weights of construction materials are approximately:

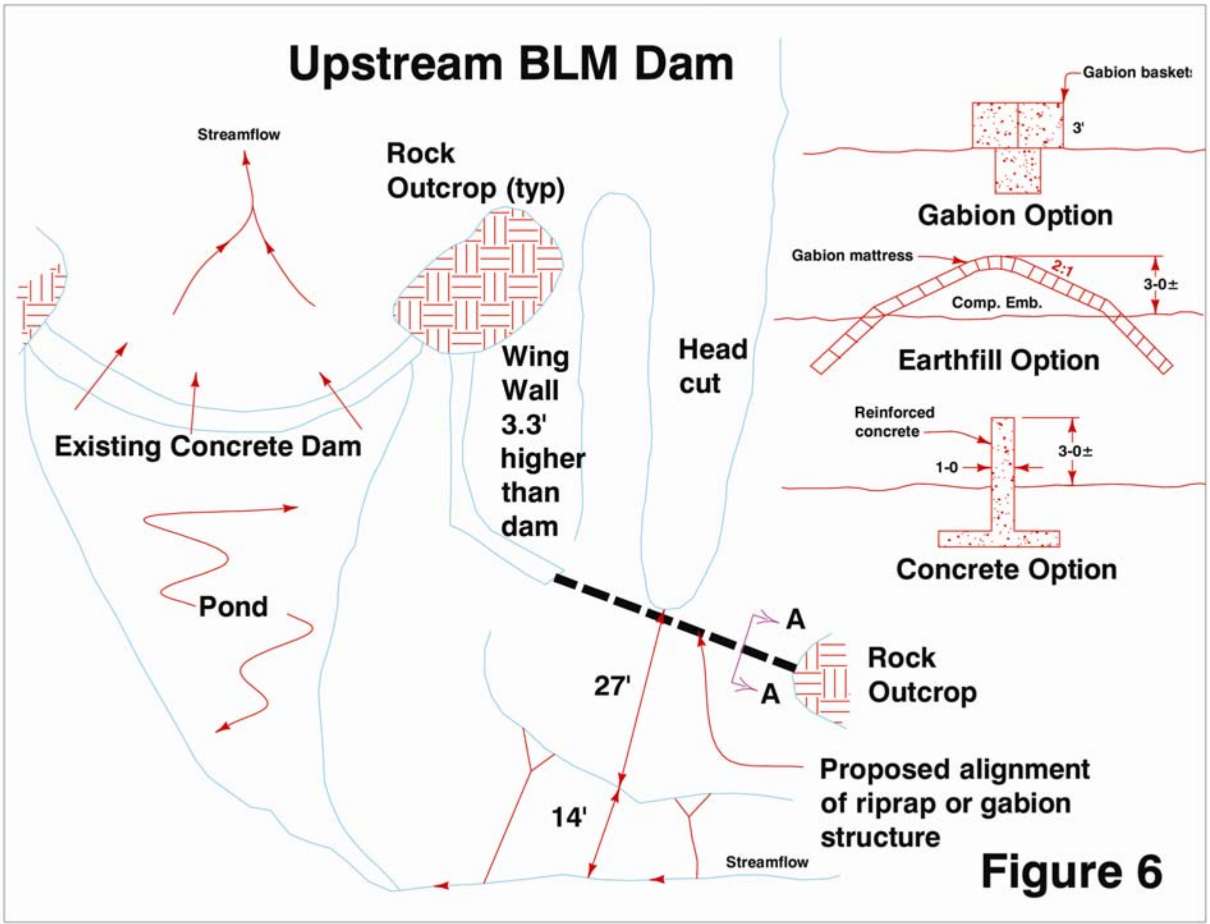
> (18 yds^3 of concrete)(4,000 lb/cy) = 72,000 lb
> 2,000 lb rebar and anchors
> 1,000 lb forming materials
> 46,000 lb gabions and rock
> 4,000 lb miscellaneous tools, tool boxes, generators, pumps, etc.
> Total weight = 125,000 lb

Cost estimate - new structure:

- Helicopter mat'ls to site [(125,000 lb)/(900 lb/load)/(10 loads/hr)]($1,300 hr)	$ 18,056
- Diversion of stream	$ 5,000
- Form and place ready-mix concrete ($1,500/cy)(18 cy)	$ 27,000
- Rebar ($0.60/lb)(2,000 lb)	$ 1,200
- Drill & grout anchor bars (20 bars)($240/bar)	$ 4,800
SUBTOTAL 1	$ 56,056
Mobilization (5% of Subtotal 1)	$ 2,803
SUBTOTAL 2	$ 58,859
Contingencies (20% of Subtotal 2)	$ 11,772
TOTAL COST, New Structure (Subtotal 2 + contingencies)	$ 70,631

<u>D. Upstream Existing Dam</u> – This existing dam is currently functioning as an effective fish barrier and backs up water for about 100 feet upstream (see Figure 6). It is located at GPS coordinates 545744 E, 3491359 N (NAD27). The concern is that high flows during runoff events eroded a channel on the right bank and terrace that has begun to headcut around the dam structure. Continued headcutting could shift the stream channel laterally around the structure, thereby compromising the fish barrier qualities of the dam.

The dam itself is a concrete arch tied to a non-erodable rock bank at the left abutment. The right end of the arch ties into a thrust block and wing wall that appears to be built on bedrock. The wing wall is 3.3 feet higher than the dam, and appears to be an effort to direct flows away from the right terrace and over the dam. Base flows discharge over the crest of the dam. The headcut has eroded from the channel downstream, past the thrust block, to about the upstream end of the wing wall, an estimated distance of 30 feet. There is about 27 feet of what appears to be erodible material preventing the stream from bypassing the dam entirely.



The proposed fix would involve connecting the wing wall, either with gabions or concrete, to rock further up the right bank, a distance of about 60 feet. This connection wall would need to be large enough to prevent flow over the top, or the headcutting would continue and undermine the connection wall. If, after looking at the hydraulics, it is unreasonable to construct the wall that high, a cutoff wall would need to be constructed to prevent further upstream movement of the headcut. A cutoff wall could not be expected to be constructed without a backhoe.

If the connection wall is constructed with concrete, excavation down to rock would be necessary, or excavation to allow construction of a footing deep enough to resist scour. A gabion wall could be constructed with less excavation than the concrete wall using standard 3' x 3' x 6' baskets, but would require 150,000 lbs of rock. A combination of embankment and gabion mattresses could be used to reduce rock quantities, but would require an on-site borrow area to significantly reduce costs.

For all three approaches, a backhoe would be extremely beneficial. As the landowners have indicated a strong preference for no vehicular access, so the estimates below are done with and without backhoe access. The Recommendations section (below) discusses the possibility of transporting a backhoe to the site using a helicopter. The depth to rock is not known at this time and could significantly affect costs. Based on what can be seen at the headcut, rock may be 3 to

4 feet below the surface, but this is conjecture and further investigations should be performed prior to design work.

Cost Estimates, Upstream Existing Dam:

1. Concrete wall, with backhoe: Assume 4-foot wide footing used. Assume cutoff trench required to prevent headcut from undermining wall.

- Excavation and backfill - backhoe, Means 2006, 01 54 33 20 0450	
($232/day, rent)(4 days)+($10.50/hr, gas, etc)(30 hrs)	$1,243
- operator ($55.40/hr)(30 hrs)	$1,662
- Concrete - Volume wall = [(4' foot)(0.5') + (3'wall)(0.5')](60') = 8 cy	
Volume cutoff trench	
(8 yds^3 of concrete)(4,000 lb/cy) = 32,000 lb	
1,000 lb rebar and anchors	
1,000 lb forming materials	
2,000 lb miscellaneous tools, tool boxes, generators, etc.	
Total weight = 36,000 lb	
- Form and place ready-mix concrete ($1,500/cy)(8 cy)	$ 12,000
- Helicopter matls to site [(36,000 lb)/(900 lb/load)/(10 loads/hr)]($1,300 hr)	$ 5,200
- Diversion of stream	$ 0
- Rebar ($0.60/lb)(1,000 lb)	$ 600
- Drill & grout anchor bars (10 bars)($240/bar)	$ 2,400
SUBTOTAL 1	$ 20,200
Mobilization (5% of Subtotal 1)	$ 1,010
SUBTOTAL 2	$ 21,210
Contingencies (20% of Subtotal 2)	$ 4,242
TOTAL COST (Subtotal 2 + contingencies)	$ 25,452

2. Concrete wall, without backhoe:

- Excavation (60')(2.5'deep)((4'+2')+(4'+2'+5')/2) = 1,275 cu ft = 47 cy	
Assume 3 laborers. Assume production of 2 cy/day/laborer	
47 cy/(2 cy/day)/3 laborers = 8 days to excavate, 4 days to backfill	
(12 days)(3 laborers)(10 hrs/day)($42.65/hr)	$ 15,354
- Concrete - Volume = [(4' foot)(0.5') + (3'wall)(0.5')](60') = 8 cy	
(8 yds^3 of concrete)(4,000 lb/cy) = 32,000 lb	
1,000 lb rebar and anchors	
1,000 lb forming materials	
2,000 lb miscellaneous tools, tool boxes, generators, etc.	
Total weight = 36,000 lb	
- Form and place ready-mix concrete ($1,500/cy)(8 cy)	$ 12,000
- Helicopter matls to site [(36,000 lb)/(900 lb/load)/(10 loads/hr)]($1,300 hr)	$ 5,200
- Diversion of stream	$ 0
- Rebar ($0.60/lb)(1,000 lb)	$ 600

- Drill & grout anchor bars (10 bars)($240/bar)	$ 2,400
SUBTOTAL 1	$ 35,554
Mobilization (5% of Subtotal 1)	$ 1,778
SUBTOTAL 2	$ 37,332
Contingencies (20% of Subtotal 2)	$ 7,466
TOTAL COST (Subtotal 2 + contingencies)	$ 44,798

3. Gabion baskets with backhoe

Assume ground excavated such that top of gabions match to top of wing wall (about 3 feet). Assume 3' x 3' x 6' long baskets, 22 req'd. Excavation and gabion rock done with backhoe.

- Excavation and backfill - backhoe, Means 2006, 01 54 33 20 0450	
($232/day, rent)(10 days)+($10.50/hr, gas, etc)(80 hrs)	$3,160
- operator ($55.40/hr)(80 hrs)	$4,432
- Install gabions - Means 2006, 02370 450 0800 - ($121/sq yd)(44 sy)	$5,324
- Helicopter matls to site - 150,000 lb rock + 4,000 lb gabions + 2,000 misc = 156,000 lb	
[(156,000 lb)/(900 lb/load)/(10 loads/hr)]($1,300 hr)	$22,533
- Mobilization (5%)	$1,772
- Contingencies 20%	$7,444
	$44,667

4. Gabion baskets without backhoe

Assume all costs the same as estimate 3 (above), except earthwork and filling gabions, which will be done by hand.

- Earthwork (60')(2.5'deep)((4'+2')+(4'+2'+5')/2) = 1,275 cu ft = 47 cy	
Assume 3 laborers. Assume production of 2 cy/day/laborer	
47y/(2 cy/day)/3 laborers = 8 days to excavate, 4 days to backfill	
(12 days)(3 laborers)(10 hrs/day)($42.65/hr)	$ 15,354
- Filling gabions - 44 cy, assume 3 gabions (6 cy) filled/day = 8 days	
(8 days)(3 laborers)(10 hrs/day)($42.65/day)	$10,236
- Other activities	$27,857
- Mobilization (5%)	$ 2,672
- Contingencies	$11,224
TOTAL COST	$67,343

5. Embankment and gabion mattresses, with backhoe

Assume embankment and gabion mattresses are placed to elevation of wing wall. Use 9-inch thick mattresses keyed down on the upstream and downstream sides of the embankment.

Earthwork - Assume earth is lifted in by helicopter, moistened using creek water, placed and wheel rolled with backhoe. Then gabion mattress toe-down is excavated, gabions and rock placed, and backfilled. Gabion mattresses cover entire earth embankment.

- Materials quantities:
  - Earth - 65 cy @ 120 lb/cf = 210,600 lb
  - Gabions - (30')(60') = 67 cy, so 227,800 lb of rock required

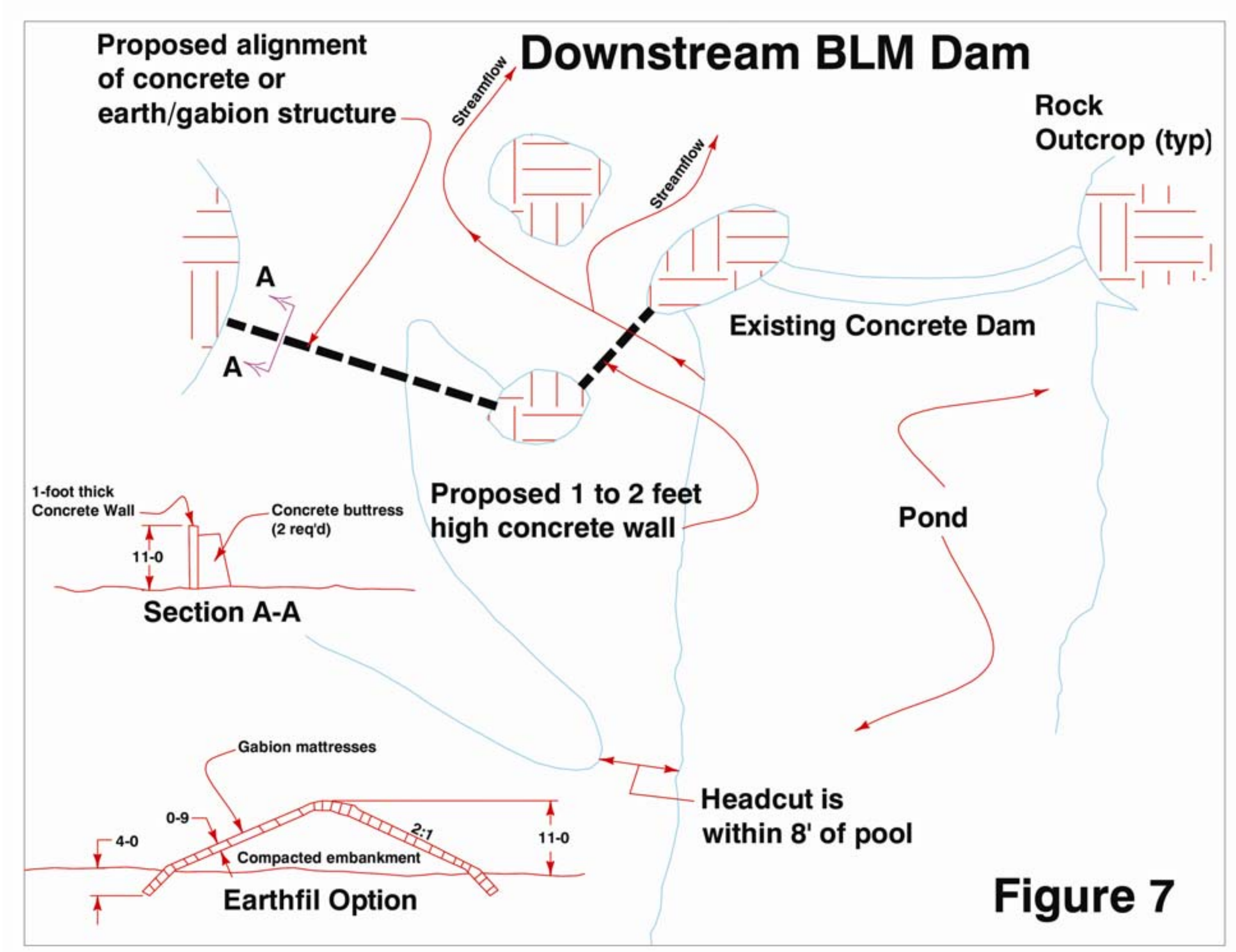
- Helicopter mat'ls - [(440,000 lbs)/(900 lb/load)/(10 loads/hr)]($1,300 hr)	$64,000
- Earthwork - 70 cy req'd excavation, assume backhoe 10 days to excavate, fill gabions, backfill.	
($232/day, rent)(10 days)+($10.50/hr, gas, etc)(80 hrs)	$3,160
operator ($55.40/hr)(80 hrs)	$4,432
- Install gabions - Means 02370 450 0500 (200 sq yd)($49/sy)	$9,800
- Mobilization (5%)	$4,070
- Contingencies 20%	<u>$17,092</u>
	$102,554

6. Embankment and gabion mattresses, without backhoe

Assume embankment and gabion mattresses are placed to elevation of wing wall. Use 9-inch thick mattresses keyed down on the upstream and downstream sides of the embankment.

Helicopter mat'ls - [(440,000 lbs)/(900 lb/load)/(10 loads/hr)]($1,300 hr)	$64,000
- Earthwork	
Assume 5 laborers for 25 days to place and compact embankment and fill gabions.	
(5 laborers)(25 days)(10 hrs/day)($42.65/hr)	$53,312
- Install gabions - Means 02370 450 0500 (200 sq yd)($49/sy)	$9,800
- Mobilization (5%)	$6,356
- Contingencies (20%)	<u>$26,694</u>
	$160,161

<u>E. Downstream Existing Dam</u> – This existing dam is currently functioning as an effective fish barrier and backs up an approximate 150-foot long reservoir (see Figure 7). It is located at GPS coordinates 545828 E, 3493329 N (NAD27). The dam is a concrete arch that ties to the right abutment, which is made up of good, stable rock. The left end of the arch ties into a bedrock feature. Beyond the left abutment tie-in is a 7-ft deep, 60-ft wide channel with a stable rock outcrop on the left bank. Base flows discharge harmlessly over the bedrock around the left end of the dam and plunge about 7 vertical feet down natural rock steps to the stream channel. However, relatively minor flooding causes water to flow over the left bank of the reservoir. As a result, a headcut starting at the 7-ft deep channel has eroded upstream, around the dam through the silt bank to within 8 ft of the pond. This situation is very close to bypassing the dam altogether. When the 8 ft of silt finally gives way, fish will be able to move freely upstream around the dam.



The proposed fix would involve preventing streamflows from continuing to discharge through the channel between the bedrock feature at the left end of the dam and the left bank. The means to block this channel either would be a concrete wall or an earth embankment with gabion mattress armoring. Gabions would need to be used instead of riprap because it would not be feasible to place riprap by helicopter. Both alternatives represent a large enough project that performing the work without backhoe access is not considered a cost effective option.

Cost estimates, Downstream Existing Dam:

1. Earth and gabion embankment connecting left abutment of channel to the left end of the dam.

Assumptions: Walk backhoe to site without building a road; backhoe needed for 6 weeks; all materials helicoptered in; constructing embankment and gabion mattresses 4 feet higher than dam is enough to direct most flow over the dam with only minor flows over the embankment; 9-inch thick gabion mattresses are adequate; earth embankment dimensions are 60' long, max 11' high (avg. 9' high), 2:1 slopes, 8' wide top, max 52' wide bottom (avg 44' wide), total volume = 520 cubic yards; gabion toe-down 4 vertical feet on 1:1 slope; gabion dimensions are 60' long x 63' wide avg. x 9 inches thick = 140 gabions (9' x 3') = 105 cy rock.

Weight of materials:

Rock - (105 cy)(2,800 lb/cy) = 294,000 lbs
Gabions - (140 gabions)(50 lb/ea) = 7,000 lb
Soil - (520 cy)(3,240 lb/cy) = 1,684,800 lb
Total = 1,985,800 lbs

Helicopter mat'ls - [(1,985,800 lbs)/(900 lb/load)/(10 loads/hr)]($1,300 hr)	$286,838
- Earthwork:	
Backhoe for 6 weeks at $695/wk + $10.90/hr(300 hrs), Means 2006	$7,440
Backhoe operator - ($35/hr)(300 hr)	$10,500
Assume 5 laborers for 15 days to place and compact embankment.	
(5 laborers)(20 days)(10 hrs/day)($42.65/hr)	$42,650
- Furnish and install gabions - Means 02370 450 0500 (420 sq yd)($49/sy)	$20,580
- Mobilization (5%)	$18,550
- Contingencies (20%)	$77,912
	$467,470

2. Concrete wall connecting left abutment of channel to the left end of the dam.

Assumptions: Walk backhoe to site without building a road; backhoe needed for 6 weeks; all materials helicoptered in; need to excavate to rock; one week to clean foundation; concrete wall 60 feet long, avg. height 9 ft, 7 inches thick with supporting buttresses every 20 feet (2); dowel anchors into rock contact every 2 feet; place concrete with helicopter.

Weight of materials:

Concrete - [(60')(9')(0.58')+(9')(8')(0.5)(2 buttresses)](1/27) = 25 cy
Concrete - (25 cy)(4,000 lb/cy) = 100,000 lbs
Rebar - 1,000 lbs
Anchors - 1,000 lbs
Forming mat'ls - 2,000 lbs
Misc. tools = 2,000 lbs
Total = 106,000 lbs

Helicopter mat'ls - [(106,000 lbs)/(900 lb/load)/(10 loads/hr)]($1,300 hr)		$15,311
Form and place concrete - ($4,500/cy)(25 cy)		$112,500
Backhoe for 6 weeks at $695/wk + $10.90/hr(300 hrs), Means 2006		$7,440
Backhoe operator - ($35/hr)(300 hr)		$10,500
	Subtotal	$145,751
- Mobilization (5%)		$7,288
- Contingencies (20%)		$30,608
Total =		$183,646

VI. Environmental Compliance

Consideration of an O'Donnell Creek fish barrier beyond the feasibility stage must include provisions for compliance with National Environmental Policy Act (NEPA), Endangered Species Act (ESA), and Clean Water Act (CWA). The NEPA process entails writing draft and final Environmental Assessments of the preferred project and its considered alternatives, and potentially presenting the preferred and alternative projects at public meetings. The NEPA process can take 6-12 months to complete. If Reclamation were to undertake the NEPA compliance, our costs to perform this work is estimated at approximately $50,000, depending on the proposed action selected. We assume that BLM would be a co-lead with Reclamation on NEPA compliance if the proposed action were to occur on BLM lands.

ESA compliance likely will involve writing a Biological Assessment that determines effects of the project to federally-listed species and designated critical habitat for species. The Fish and Wildlife Service (FWS) has previously determined in their 2001 biological opinion on CAP effects to native fishes in the Gila River basin that a fish barrier project on O'Donnell Creek will not adversely affect designated critical habitat, but project impacts to listed species likely must undergo formal consultation. As the project is for the benefit of native fishes, consultation with FWS should proceed smoothly, as it did with Reclamation's Aravaipa Creek and Fossil Creek fish barrier projects. Reclamation estimates that ESA compliance activities should not take more than 3-6 months, depending on the priority it receives from FWS. Estimated costs for ESA compliance is approximately $20,000.

The acquisition process for a 404 permit under requirements of CWA includes determining the impact footprint of the barriers (flooding, sedimentation, and construction zones), receiving a jurisdictional delineation from U.S. Army Corps of Engineers, and further processing of a 404 permit application. Identification of mitigation for impacts to "waters of the US" for this barrier has already been completed through Reclamation acquisition of stream/riparian habitat along the San Pedro River. Processing time for CWA compliance will be 3-6 months. Reclamation estimates that compliance costs associated with CWA regulations would be approximately $10,000.

V. Recommendations

The three potential options; a new structure on TNC property, and remediation work on one of the two existing dam structures, are all feasible with respect to construction. The work is straightforward and not particularly difficult. The end products of the three options have similar opportunities for erosion failure, so there is not an option that is clearly more risk-free than the others. Failure to address existing headward erosion potential at the BLM sites will eventually result in significant loss of sediment behind one or both structures. All three options provide a similar benefit to native fish.

Estimated costs vary widely and are highly dependant on the weight of materials required to be air-lifted to the sites, as helicopter work is associated with all options. Work associated with the two existing dams requires earth fill and gabions to be brought in by helicopter, adding significant weight and cost. Construction costs at these structures would be substantially less if vehicles were allowed to access the areas, and would eliminate the need for helicopters. Vehicular access would allow materials to be driven to the site, allow earth embankments to be wheel rolled compacted, and speed gabion installation. The downside is the impact of vehicles to the landscape.

Although the Audubon Society has indicated it strongly prefers no vehicles be allowed at the sites, in our opinion the lower dam fix cannot be constructed without a backhoe or skip loader to excavate, and place and compact the earth embankment. A backhoe could be walked down to the lower dam with minimal disturbance to the surrounding area and any disturbance could be mitigated by scarification and reseeding. The proposed work at the upper dam also would be easier, faster, and less expensive to construct with a backhoe or skip loader.

If a backhoe cannot access the sites by road, whether due to owner restrictions or geographic difficulties, consideration could be given to air-lifting in the piece of equipment. This would require an Aircrane type helicopter. The cost to use large helicopters such as these is estimated to be about $20,000 per day. All other equipment and materials would probably be dropped in that same day to take advantage of the helicopter's payload capacity.

Regarding access roads; as described earlier in this report, the road from the north through BLM property provides vehicular access to within 500 feet from the potential work sites. The TNC road from the south allows vehicles to drive to about ½ mile from the work. All construction options would benefit cost-wise if vehicles could utilize the BLM road. Hiking time would be reduced, certain equipment and materials could be carried in by hand, injury evacuations would be simpler and faster, and in general, construction planning and logistics would be easier. Any road restrictions imposed by the landowners need to be defined and well understood as this would have significant impacts to construction and costs.

Considering the access restrictions described in this report and the estimated costs of the various options, we recommend pursuing the new structure option or the upstream dam option. The downstream dam option requires much larger amounts of materials, and without vehicular access, the costs become much higher than the other two options. In the final analysis, however, Reclamation is willing to consider any of the various construction options for any of the sites discussed above, and perhaps even remedying the erosion problems at both of the BLM sites. We are committed to preserving the high conservation value of O'Donnell Canyon to native fishes and other aquatic organisms. We look forward to realizing a solution to the non-native fish threat that is agreeable to all parties.